Dolphins, Porpoises and Whales of the World

The IUCN Red Data Book

IUCN – The World Conservation Union

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IUCN - THE WORLD CONSERVATION UNION

Founded in 1948, IUCN - the World Conservation Union - is a membership organisation comprising governments, non-governmental organisations (NGOs), research institutes and conservation agencies in over 120 countries. The Union's objective is to promote and encourage the protection and sustainable utilisation of living resources.

Several thousand scientists and experts from all continents form part of a network supporting the work of its six Commissions: threatened species, protected areas, ecology, sustainable development, environmental law, and environmental education and training. Its thematic programmes include tropical forests, wetlands, marine ecosystems, plants, the Sahel, Antarctica, population and sustainable development, and women in conservation. These activities enable IUCN and its members to develop sound policies and programmes for the conservation of biological diversity and sustainable development of natural resources.

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The World Conservation Monitoring Centre (WCMC) is a joint venture between the three partners in the World Conservation Strategy: IUCN - the World Conservation Union, the World Wide Fund for Nature (WWF), and the United Nations Environment Programme (UNEP). Its mission is to support conservation and sustainable development by collecting and analysing global conservation data so that decisions affecting biological resources are based on the best available information.

WCMC has developed a global overview database of the world's biological diversity that includes threatened plant and animal species, habitats of conservation concern, critical sites, protected areas of the world, and the utilisation and trade in wildlife species and products. Drawing on this database, WCMC provides an information service to the conservation and development comunities, governments and United Nations agencies, scientific institutions, the business and commercial sector, and the media. WCMC produces a wide variety of specialist outputs and reports based on analyses of its data.

UNEP - THE UNITED NATIONS ENVIRONMENT PROGRAMME

UNEP - the United Nations Environment Programme - is a Secretariat within the United Nations which has been charged with the responsibility of working with governments to catalyse the most sound forms of development, and to coordinate global action for development without destruction.

GEMS - the Global Environment Monitoring System - coordinated by UNEP, is a collective effort of the world community to acquire, through global monitoring, the data which are needed for rational management of the environment. Monitoring activities fall into five major programmes: climate-related monitoring, long range transport of air pollutants, health-related monitoring, oceans and terrestrial renewable resources.

IUCN - THE WORLD CONSERVATION UNION

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The IUCN Red Data Book

compiled by
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on behalf of the World Conservation Monitoring Centre
in collaboration with the United Nations Environment Programme
with the help and advice of the IUCN/SSC Cetacean Specialist Group,
the IWC Scientific Committee members and other experts throughout the world.

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A contribution to GEMS, the Global Environment Monitoring System and the UNEP Marine Mammal Action Plan.

UNEP WWF WORLD CONSERVATION MONITORING CENTRE NATURE CONSERVANCY COUNCIL

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Preface

History In 1978 the Nature Conservancy Council (NCC) published 'Proposals Concerning the Cetacea' (Klinowska, 1978). This was in support of the UK Government's proposal that all species of Cetacea (dolphins, porpoises and whales) should be included under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which was adopted by the Parties in 1979.

The original Proposals had to be written to a very tight timetable, and detailed accounts could only be produced for those species proposed for Appendix I listing. These were chosen by the Committee then dealing with UK CITES matters, after much discussion and consideration of all the threats each species might be facing, such as population size and any known decreases, level of direct and indirect taking, and the state of the habitat. This review revealed that the riverine and tropical coastal dolphin and porpoise species were seriously threatened by all these problems. The Proposals and the supporting evidence were also extensively discussed with individual members of the International Whaling Commission (IWC) Scientific Committee, with the CITES Secretariat, and with other experts throughout the world.

The detailed reviews of species were later extended through a request from the Environment and Consumer Protection Service of the Commission of the European Communities to the NCC for a preliminary status report on the marine mammals of major relevance to Europe (Rudge, Klinowska and Anderson, 1981).

Finally, the task of reviewing all the species was completed for the 1981 meeting of the CITES Parties, again through the support of the NCC (Klinowska, 1980). The draft text was submitted to the IWC Scientific Committee in 1980, where valuable amendments and contributions were made by members and the CITES Secretariat representative.

The credit for initiating and sustaining the work to produce the first comprehensive review of the status of all the cetacean species must go to Mr A.J.B. Rudge, who has recently retired from the NCC.

The IWC Scientific Committee subsequently agreed to take over from NCC the task of regularly updating the species reviews (IWC, 1982a). Unfortunately financial difficulties made it impossible to carry out the work.

Soon after, Dr M. Tillman, at that time Chairman of the IWC Scientific Committee, became head of the IUCN Conservation Monitoring Centre (now the World Conservation Monitoring Centre - WCMC) in Cambridge. He arranged that the update would be supported by the United Nations Environment Stamp Conservation Fund through the United Nations Environment Programme and would appear in the IUCN Red Data Book series. Production of the revised text began in late 1984 and should have lasted for a year, but was suspended with the agreement of WCMC while an urgent review of dolphin keeping was undertaken for the UK Department of the Environment (DoE). Some of the consequences of the report, which was published in mid-1986, were only resolved in late

1988 (Klinowska and Brown, 1986; DoE, 1988). This volume was largely completed in March 1989. The problem of finding funds for printing was solved by Dr Tillman and the US National Oceanic and Atmospheric Administration.

Publication follows that of the IUCN Species Survival Commission (SSC) Cetacean Specialist Group *Action Plan for Conservation of Dolphins, Porpoises and Whales: 1988-1992* (Perrin, 1989), which proposes a number of projects to precipitate activity to prevent extinction of the species and populations currently in danger. The Action Plan and this review of the current status of the species have evolved together and are complimentary. This volume provides the detailed background, and the Action Plan proposes the ways in which the most pressing problems can be addressed. (Recent revisions of species listings have resulted in minor differences between these two publications).

Acknowledgements I thank colleagues in the IUCN/SSC Cetacean Specialist Group, IWC Scientific Committee, IWC Secretariat and many other experts worldwide who have commented on the proposed listing of species and on earlier drafts of the species reviews for all their help and advice over the years.

I am grateful to the NCC and John Rudge for initiating the cetacean reviews, to Mike Tillman and the IUCN for their contract to revise them, and to Professor Peter Jewell, Head of the Research Group in Mammalian Ecology and Reproduction, Physiological Laboratory, University of Cambridge, for accommodation and encouragement. Special thanks are due to Jane Thornback of the WCMC for her efficient administrative and moral support.

Since completion of the manuscript at the end of March 1989, Justin Cooke has very kindly reviewed the text and re-written the Introductory Chapters (including the species listings) and the population sections for the sperm, minke, fin, blue, sei, humpback, bowhead, right (northern and southern) and gray whales. Other important new information was also added, including that available at the 1990 meeting of the IWC Scientific Committee and that suggested by other referees. Sarah Fowler, of the Nature Conservation Bureau, undertook the final editing and production of camera-ready copy. This task included shortening the manuscript, particularly by amending the text to accommodate the exclusion of two major Appendices on international and national legislation respectively. I am most grateful to Sarah for her careful and patient work. However, the bulk of the text represents the situation as known by March 1989.

The cover picture, of a group of *Inia geoffrensis*, the Vulnerable boto or Amazon river dolphin, is based on a photograph by U. Schiller taken at Duisburg Zoo, by kind permission of Dr. W. Gewalt. The drawing is by Mrs Dee Hughes, the Physiological Laboratory artist, who also kindly prepared all the maps, except the IWC stock management maps, which are used by courtesy of the International Whaling Commission. Dr M.V. Ivashin generously provided a copy of Sokolov (1984).

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Introduction and Overview
Justin Cooke

The Red Data Books The Red Data Books are designed to provide an inventory of threatened species and to focus attention on the earth's vanishing wildlife. The concept originated with the late Sir Peter Scott in the mid 1960s and has expanded both as new information has become available and, unfortunately, as the number of species adversely affected by human activities grows. The purpose is to highlight those species or groups of plants and animals that currently appear to be at risk of declining or disappearing as a result of contact with humans and to encourage appropriate conservation action.

The overview of cetaceans and detailed species accounts presented in this volume should be read in conjunction with the IUCN Species Survival Commission *Action Plan for Conservation of Dolphins, Porpoises and Whales: 1988-1992* (Perrin, 1989). This Plan summarises the actions required to prevent the extinction of species and populations currently in danger and aims to promote sustainable relationships between cetaceans and people, in order to secure the long-term future for all cetacean species and populations. (There are minor differences between the species listings in these two publications due to recent revisions).

Introduction to the Cetacea The mammalian Order Cetacea includes three Suborders: the Archaeoceti or 'ancient' whales, extinct forms known only from fossils; the Mysticeti or 'moustached' whales, including at least ten living species of baleen or whalebone whales; and the Odontoceti or 'toothed' whales, including about 70 living species of dolphins, porpoises and whales with teeth but no baleen. So far, humans have not driven any cetacean species to extinction, although some are now severely threatened.

General biology The cetaceans are mammals which spend all their lives in water, and have evolved many adaptations to this way of life. The body is streamlined, with no hind limbs, reduced forelimbs and a powerful horizontal tail for propulsion. The 'nostrils' have become blow holes at the top of the head (except in the sperm whale, which has one at the left of the front of the head) to facilitate respiration while travelling through the water; baleen whales have two, toothed whales one.

The baleen whales have a series of plates made of a material similar to human fingernails, known as baleen or whalebone, in the roof of the mouth. These plates are used to sieve food, which may be small shrimp-like crustaceans (known as krill) or schooling fish, from the water. The baleen plates differ from species to species, their size, shape and number relating to the preferred food.

The toothed whales all have teeth, although they may erupt only in adult males, take strange shapes or become badly worn or shed in older individuals. The dentition is roughly related to feeding habits, with the squid eaters having few or no visible teeth, and those with more varied diets, particularly where schooling fish are included, having a generally longer snout and many teeth.

The majority of the large cetacean species are baleen whales, including the 30m blue whale, although there are also some smaller baleen whales, including the 10m minke whale and the 7m pygmy right whale. The latter is the only baleen whale species which has not suffered any depletion through commercial whaling. Many baleen whales travel long distances every year, between summer feeding grounds in polar waters and wintering grounds in the tropics. In general, baleen whales seem to live in small social groups, although these can join to form very large herds, for example on rich feeding grounds.

The range in size among toothed whales is wide, from the 18m (male) sperm whale to the smallest dolphins and porpoises at less than 2m. They have extremely varied habits; some travel long distances between summer feeding grounds and wintering areas every year, but others are relatively sedentary, perhaps only ranging over tens of kilometres in their lifetimes. Their social life is also highly varied, some species living in small groups or usually alone and others in schools of several hundred, although these may be composed of a number of smaller social units. Some species have very fluid social groups, with individuals moving from one to another in no apparent pattern; others seem to spend all their lives in the group into which they are born.

The fossil history of the cetaceans is somewhat incomplete and controversial, but in general it seems that they evolved from land mammals which may have returned to the water some 70-90 million years ago. The Archaeocetes flourished 45-55 million years ago, and essentially modern forms have been present for the past 10 to 12 million years.

Over their long history, cetaceans have exploited all types of productive marine, estuarine and major riverine habitats. They can propel themselves through the water at speeds and to depths sufficient to overtake prey and avoid predators, exchange air without interrupting the smooth forward motion, maintain a fairly constant core body temperature in an environment which dissipates heat much more rapidly than air, and bear their young in the water. Cetacean calves are generally larger relative to the size of the mother than the young of land mammals, the large body size probably reducing the amount of relative heat loss.

Tactile contact seems to be important to all cetaceans. Vision in air and water varies with species, from some river dolphins which can distinguish light and dark only, to some dolphins with apparently excellent vision in both media. In the large whales the position of the eyes restricts the field of view, and they do not appear to have stereoscopic vision. Most species are vocal, producing calls and whistles which probably have a social function: for example the 'song' of the male humpback whale, the individual 'signature' whistles of bottlenose dolphins and the 'pod identity' calls of killer whales. Many toothed whale species are known to echo-locate, using pulses of high frequency sound to explore their environment and seek prey.

More general information on cetacean biology can be found in: Evans (1987), Leatherwood and Reeves (1983), Gaskin (1982), Herman (1980), and Harrison and Bryden (1989).

Nomenclature Unfortunately, the popular terms 'dolphin, porpoise and whale' are not very precise taxonomically. For example, if 'dolphin' is used to refer to members of the Superfamily Delphinoidea, this includes the Family Phocoenidae or 'porpoises', and the Subfamily Globicephalinae which all have common names ending in 'whale'. Members of the Superfamily Platanistoidea are also known as dolphins. To make matters even more confusing, in the USA and many coastal areas elsewhere in the world, any small cetacean is known as a 'porpoise' or the equivalent in other languages.

The International Whaling Commission (IWC) is in difficulties because the Convention refers only to 'whales' and, while some people interpret this to mean all cetaceans, others disagree but have difficulty in providing an agreed list of 'whale' species. However, most people continue to use the terms 'dolphin, porpoise and whale', although the unambiguous terms 'Cetacea' and 'cetacean' are preferable for official purposes. The IWC term 'small cetaceans' means any species within the responsibility of the subcommittee on small cetaceans for the time being, although a few of these species are named in the Schedule and some other management decisions may have been made.

As for most major groups, there is a certain amount of flux in the taxonomy of cetaceans. The treatment here is not intended to be definitive or revisionary, and has been developed in parallel with that used in the IUCN/SSC Action Plan (Perrin, 1989). The taxa above the species level follow Barnes *et al.* 1985), as later developed by Barnes (1985a; 1985b). The species largely follow Honacki *et al.* (1982) and Jones *et al.* (1986), and incorporate revisions of the spotted dolphins by Perrin *et al.* (1987) and of the porpoises and platanistoid dolphins by Barnes (1985a; 1985b). Treatment of the right whales follows Brownell *et al.* (1987). The two unidentified ziphiids are noted by IWC (1989). The common names of the species follow IWC (1977; 1981-3; 1986a-8), with minor changes (Perrin *et al*, 1987; Perrin *et al.*, 1989).

Changes of opinion in taxonomy, however, have practical consequences beyond the scientific field. Some international and national conservation legislation depends on the accurate naming of species and other taxa, and such naming may be difficult to change once enshrined in primary legislation. It is therefore safer, when aiming to protect species or other taxa, to list names in a form which can be easily changed if necessary, and to refer to the lists in such a way that protection is not lost because of a change in opinion on nomenclature, in assignment of species to higher taxa or the recognition of new or sibling species or subspecies.

Formal description and naming of subspecific taxa have not been a common practice in cetacean systematics in recent years. The morphologically distinct populations that have been defined but not formally named for several cetaceans correspond in degree of distinctness to the entities in terrestrial mammals that have received subspecific scientific names. Thus an endangered cetacean population that might find a place in lists of endangered 'species' were it described as a subspecies does not receive such recognition. The implication is that in these cases potentially significant genetic variability and unique components of regional ecosystems are at risk (Perrin, 1989). The classification of species according to categories of threat does not necessarily of itself pinpoint the most serious conservation problems, and the reviews aim to draw attention to any such sub-populations and to local stocks where there are particular problems.

Systematic lists are sometimes used to assess the seriousness of threats to taxa. For example, because all the few members of the Superfamily Platanistoidea are Endangered or Vulnerable or suspected of being so, they are considered to be collectively in a worse situation than the Delphinoidea, with many members some of which are quite abundant. The same kind of relative analysis can be made at the Family and Subfamily level. These points are developed further in Fitter and Fitter (1987).

List of cetacean species There follows a list, in taxonomic order, of the living cetacean species generally recognised to date, including two species which have not yet been fully described but whose existence is considered very likely, but excluding a new one where a formal description is still in press. Besides the scientific and English name, a code indicating the Red Data Book status category is shown. These categories are explained in the following chapter. The codes are: E - Endangered; V - Vulnerable; I - Indeterminate; K - Insufficiently Known; U - unlisted.

Suborder Odontoceti (toothed whales)		
Superfamily Platanistoidea		
Family Platanistidae		
Platanista gangetica	Ganges river dolphin	V
Platanista minor	Indus river dolphin	E
Family Pontoporiidae		
Subfamily Lipotinae		
Lipotes vexillifer	baiji, Yangtze river dolphin	E
Subfamily Pontoporiinae		
Pontoporia blainvillei	franciscana, La Plata dolphin	K
Family Iniidae		
Inia geoffrensis	boto, Amazon river dolphin	V
Superfamily Delphinoidea		
Family Monodontidae		
Subfamily Delphinapterinae		
Delphinapterus leucas	white whale, beluga	K
Subfamily Monodontinae		
Monodon monoceros	narwhal	K
Family Phocoenidae		
Subfamily Phocoeninae		
Phocoena phocoena	harbour porpoise	K
Phocoena spinipinnis	Burmeister's porpoise	K
Phocoena sinus	vaquita	E
Neophocaena phocaenoides	finless porpoise	K
Subfamily Phocoenoidinae		
Australophocaena dioptrica	spectacled porpoise	K
Phocoenoides dalli	Dall's porpoise	K
Family Delphinidae		
Subfamily Steninae		
Steno bredanensis	rough-toothed dolphin	K
Sousa chinensis	Indo-Pacific hump-backed dolphin	K
Sousa teuszii	Atlantic hump-backed dolphin	K
Sotalia fluviatilis	tucuxi	K
Subfamily Delphininae		
Lagenorhynchus albirostris	white-beaked dolphin	K
Lagenorhynchus acutus	Atlantic white-sided dolphin	K
Lagenorhynchus obscurus	dusky dolphin	K
Lagenorhynchus obliquidens	Pacific white-sided dolphin	K
Lagenorhynchus cruciger	hourglass dolphin	K
Lagenorhynchus australis	Peale's dolphin	K
Grampus griseus	Risso's dolphin	K
Tursiops truncatus	bottlenose dolphin	K

Stenella frontalis	Atlantic spotted dolphin	K
Stenella attenuata	pantropical spotted dolphin	K
Stenella longirostris	spinner dolphin	K
Stenella clymene	clymene dolphin	K
Stenella coeruleoalba	striped dolphin	K
Delphinus delphis	common dolphin	K
Lagenodelphis hosei	Fraser's dolphin	K
Subfamily Lissodelphinae		
Lissodelphis borealis	northern right whale dolphin	K
Lissodelphis peronii	southern right whale dolphin	K
Subfamily Cephalorhynchinae		
Cephalorhynchus commersonii	Commerson's dolphin	K
Cephalorhynchus eutropia	black dolphin	K
Cephalorhynchus heavisidii	Heaviside's dolphin	K
Cephalorhynchus hectori	Hector's dolphin	I
Subfamily Globicephalinae		
Peponocephala electra	melon-headed whale	K
Feresa attenuata	pygmy killer whale	K
Pseudorca crassidens	false killer whale	K
Orcinus orca	killer whale	K
Globicephala melas	long-finned pilot whale	K
Globicephala macrorhynchus	short-finned pilot whale	K
Subfamily Orcaellinae		
Orcaella brevirostris	Irrawaddy dolphin	K
Superfamily Ziphioidea		
Family Ziphiidae		
Tasmacetus shepherdi	Shepherd's beaked whale	K
Berardius bairdii	Baird's beaked whale	K
Berardius arnuxii	Arnoux's beaked whale	K
Mesoplodon pacificus	Longman's beaked whale	K
Mesoplodon bidens	Sowerby's beaked whale	K
Mesoplodon densirostris	Blainville's beaked whale	K
Mesoplodon europaeus	Gervais' beaked whale	K
Mesoplodon layardii	strap-toothed whale	K
Mesoplodon hectori	Hector's beaked whale	K
Mesoplodon grayi	Gray's beaked whale	K
Mesoplodon stejnegeri	Stejneger's beaked whale	K
Mesoplodon bowdoini	Andrews' beaked whale	K
Mesoplodon mirus	True's beaked whale	K
Mesoplodon ginkgodens	ginkgo-toothed beaked whale	K
Mesoplodon carlhubbsi	Hubbs' beaked whale	K
Mesoplodon sp.	unidentified species	K
Ziphius cavirostris	Cuvier's beaked whale	K
Hyperoodon ampullatus	northern bottlenose whale	K
Hyperoodon planifrons	southern bottlenose whale	K
Hyperoodon sp.	unidentified species	K
Superfamily Physeteroidea		
Family Physeteridae		
Subfamily Physeterinae		
Physeter macrocephalus	sperm whale	K

Family Kogiidae		
Kogia breviceps	pygmy sperm whale	K
Kogia simus	dwarf sperm whale	K
Suborder Mysticeti (baleen whales)		
Family Balaenidae		
Balaena mysticetus	bowhead	V
Eubalaena glacialis	northern right whale	E
Eubalaena australis	southern right whale	V
Family Neobalaenidae		
Caperea marginata	pygmy right whale	K
Family Eschrichtiidae		
Eschrichtius robustus	gray whale	U
Family Balaenopteridae		
Subfamily Balaenopterinae		
Balaenoptera acutorostrata	minke whale	K
Balaenoptera borealis	sei whale	V
Balaenoptera edeni	Bryde's whale	K
Balaenoptera musculus	blue whale	E
Balaenoptera physalus	fin whale	V
Subfamily Megapterinae		
Megaptera novaeangliae	humpback whale	V

Threats Threats to cetacean species include directed take (e.g. whaling), incidental take (such as by-catches in gillnet fisheries), pollution, habitat destruction and fragmentation (such as damming of rivers), other habitat degradation (such as reduction of food supply) and disturbance.

The river dolphins are particularly susceptible to all the above types of threat, and include some of the most endangered cetacean species. The species in most immediate danger of extinction is probably the baiji or Yangtze river dolphin *Lipotes vexillifer* whose surviving population is perhaps as low as 300 individuals and is still subject to accidental taking in addition to the other threats. Because the Yangtze river is so heavily utilised, it may be that semi-natural reserves are the only way to save this species (see baiji review). The status of the other exclusively riverine species is reviewed in more detail in another IUCN publication (Perrin *et al*, 1989).

Commercial whaling Commercial whaling has been the main threat to the larger cetaceans until recently. The northern right whale has been reduced to a population of the order of a few hundred animals in the North Atlantic and probably to an even lower level in the North Pacific, and to date has shown no signs of recovery despite many years of protection. Based on surveys conducted during the last decade, it now appears that the blue whale in the southern hemisphere has also been reduced to only a few hundred animals (excluding the pygmy blue whale), from an initial population of around a quarter million at the beginning of this century.

Catches of the baleen whales, the sperm whale, and the northern bottlenose whale have been regulated by the International Whaling Commission (IWC), a body established under the International Convention for the Regulation of Whaling (1946). In its first 20 years of operation, the IWC was not effective in conserving whale populations. It allowed the depletion of the blue, fin, sei and humpback whale populations to continue almost unabated.

Once criticised as a 'whaler's club' concerned more with stabilisation of the world market for whale products than with the conservation of whales, the IWC has since grown into a wider body comprising 36 governments representing 85% of the world's population, including many countries not themselves engaged in whaling.

The IWC imposed progressively stricter limits on commercial whaling in the 1970s and 1980s, culminating in a decision to suspend all commercial whaling from 1986, which by 1989 was observed by all countries with the exception of whaling conducted under exemptions for scientific research.

A major landmark year was 1974, when the IWC adopted a procedure to regulate whaling according to the principles of sustainable utilisation (IWC, 1976). The New Management Procedure (NMP) set out to manage each whale population separately. Populations depleted to below their level of maximum sustainable yield (MSY) were to be protected, while catches from populations above were limited so as not to deplete them below this level. The NMP was introduced in response to outside pressure, including moves in the United Nations to call for a complete suspension of commercial whaling. Although some of the major whaling nations voted against the introduction of the NMP, they abided by most of the catch limits set under the NMP in its first few years of operation.

The NMP was initially successful in achieving the protection of the more depleted species, including the fin and sei whales in the North Pacific and Southern Hemisphere, and in containing the catches of sperm whales. It was less successful at providing a basis for regulating catches of other species, because the knowledge of whale populations required to determine maximum sustainable catches was not available. There was also no incentive to obtain such information because, under the Procedure, catches were allowed to continue at their previous level in the absence of evidence to the contrary. The IWC Scientific Committee, which had the task of calculating the status of populations and recommending the appropriate catch limits, found itself in the position of having to provide advice for which it did not have adequate data, and therefore found it increasingly difficult to come to agreement. Whaling countries made increasing use of the formal objection procedure to exempt themselves from the catch limits set by the IWC. In the face of these and other problems, the IWC decided in 1982 to suspend all commercial whaling from 1986 onwards, the decision to be reviewed in 1990 following a comprehensive assessment of the situation.

The World Conservation Strategy (IUCN/UNEP/WWF, 1980) states the view that commercial whaling should remain suspended until the following conditions are met:

1. the consequences for the ecosystems concerned of removing large portions of the whales' populations, and such populations' capacity for recovery, can be predicted;

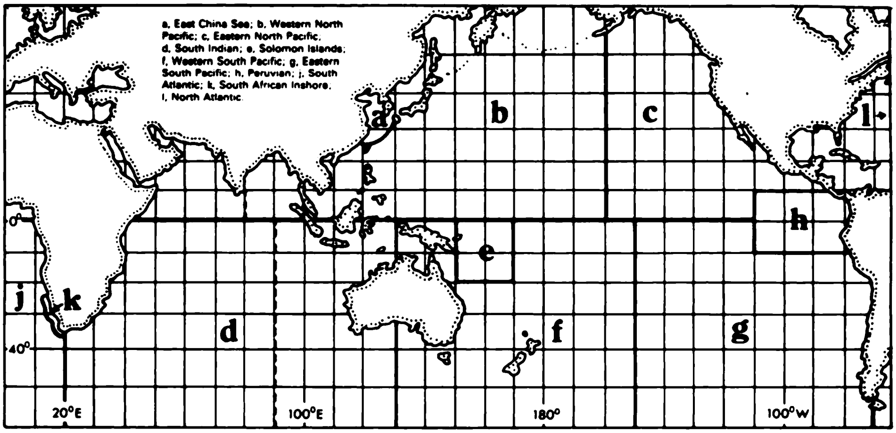
2. permitted levels of exploitation are safe, and an effective mechanism exists for detecting and correcting mistakes in the management of any stock;

3. member nations of the IWC are no longer purchasing whale products from, or transferring whaling technology and equipment to, or otherwise supporting, non-member nations, or pirate whaling ships.

It appears that condition 3 has now been met, due not least to the controls on international trade imposed by CITES.

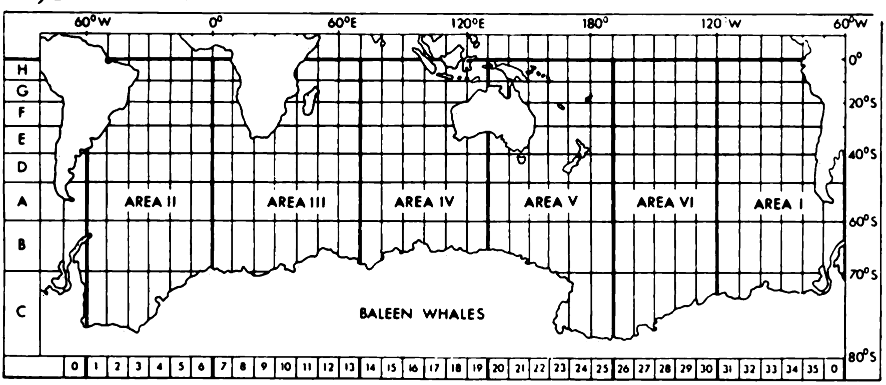
The IWC Scientific Committee has been working on alternative approaches to the management of whale populations, which are based on direct use of data that can actually be obtained (such as surveys of whale abundance), instead of features of whale

International Whaling Commission Bryde's whale Stock Divisions

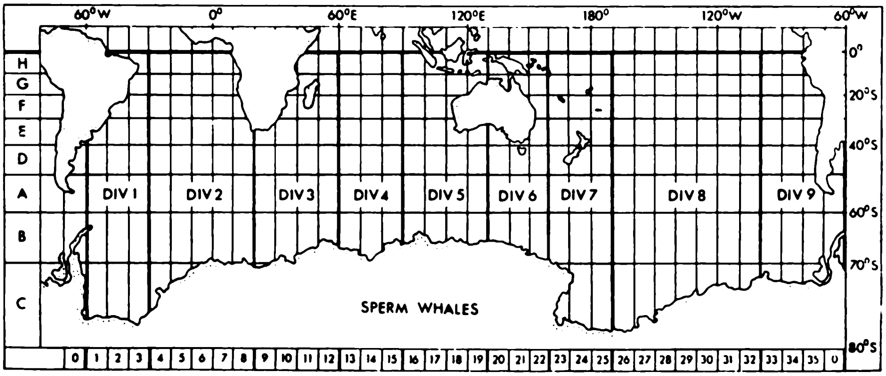


International Whaling Commission Southern Hemisphere Stock Divisions (excluding Bryde's whales)

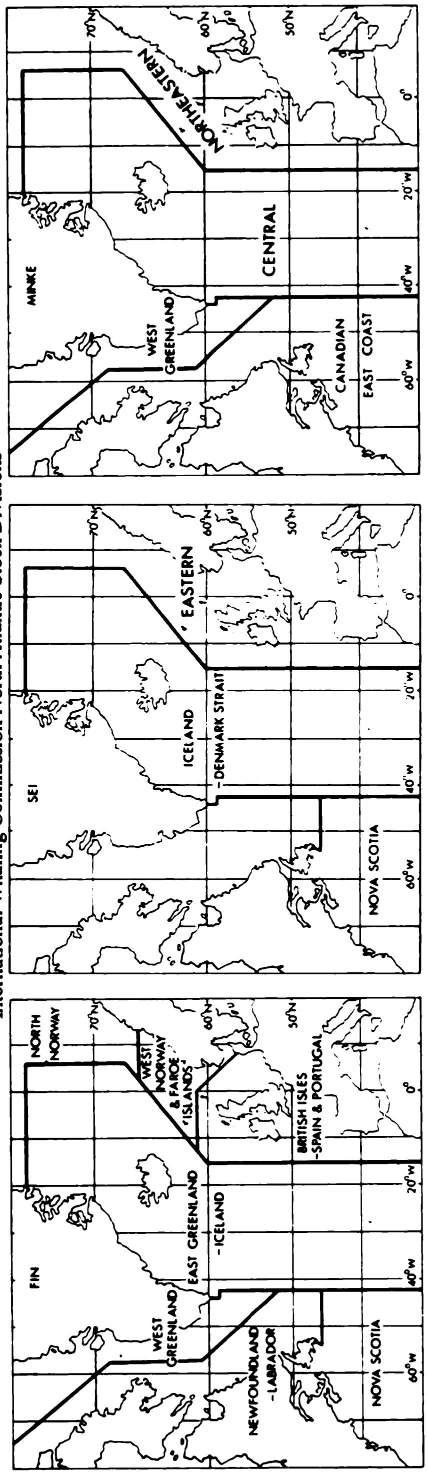
a) Baleen whales



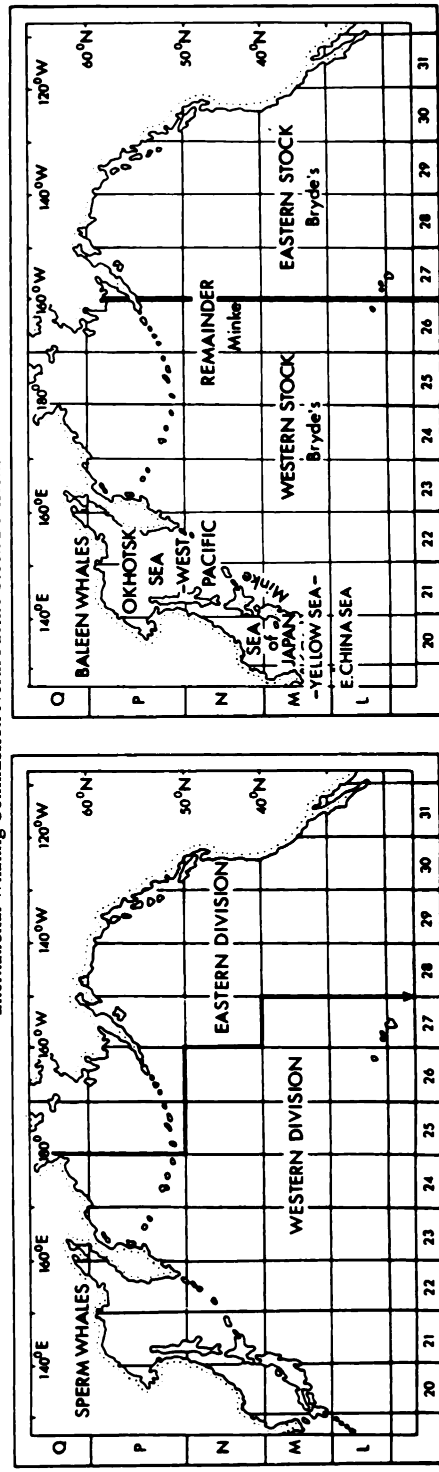
b) Sperm whales



International Whaling Commission North Atlantic Stock Divisions



International Whaling Commission North Pacific Stock Divisions



population dynamics which are unknown and in some cases even unknowable. Some of the procedures being considered are designed with built-in safeguards to minimise the risk of depleting or eliminating whale populations. Since it would be too risky and take too long to test the procedures on real whale populations, the Scientific Committee has made extensive use of computer simulations of the procedures in their first stage of testing. An interesting result of this work is that simulation testing of the NMP revealed that populations managed under the NMP were quite likely to be exterminated, even when more reliable data are available than has been the case for most of the stocks that were managed under the NMP (IWC, 1990a).

At the time of writing it is not clear whether any of the new procedures under investigation will perform sufficiently well in simulation tests for it to be considered safe to apply them in practice. The IWC is now under strong pressure to reopen commercial whaling. It is to be hoped that it will only do so on the basis of a management procedure that has been fully developed and tested, and which is free of the drawbacks of the NMP.

Although there is not much prospect for meeting condition 1 completely in the near future, the results of the work by the IWC Scientific Committee to date suggest that successful management of cetacean populations may be achievable even in the absence of a full understanding of the relevant ecological interactions.

Aboriginal subsistence whaling The current suspension of commercial whaling does not apply to 'aboriginal subsistence whaling to satisfy aboriginal subsistence need', for which the IWC continues to set catch limits. This type of whaling includes catches of bowhead whales off Alaska, catches of gray whales off the Arctic Siberian coast, and catches of fin and minke whales off Greenland. The IWC does not attempt to define what is meant by aboriginal subsistence whaling, but it also includes whaling on behalf of aboriginal people to cover cases where the vessels are not necessarily operated by aboriginal people. The eastern North Pacific gray whale population has been increasing over the last 20 years despite the aboriginal take. The Alaskan bowhead fishery now no longer appears to be a major threat to the survival of that species following the successful reduction in the annual numbers of whales struck-and-lost. The involvement of local people in the management of the Alaskan bowhead hunt, coupled with the relative prosperity of that region, have helped to ensure a high level of research and monitoring. The situation in Greenland is less clear, because the whale populations there are less well researched, and it is possible that they are not isolated populations but are part of wider populations which have until recently also been exploited commercially by Norway and Iceland. The individual species reviews give more details of each of these situations.

Small cetacean fisheries Although the International Convention for the Regulation of Whaling, the treaty under which the IWC operates, does not explicitly exclude them, there is no consensus amongst IWC members with regard to its competence to manage the exploitation of the 'small' cetaceans. There is consensus only on the competence of the IWC to regulate catches of the baleen whales, the sperm whale and the northern bottlenose whale, although the IWC Scientific Committee does review the status of the other species from time to time. The IWC Secretariat also compiles statistics on the directed catch of small cetaceans which are sent to it on a voluntary basis as the successor to the former Bureau of International Whaling Statistics (BIWS). The term 'small cetacean' is not strictly accurate because some species included with the small cetaceans are larger than some species managed by the IWC.

The IWC Commission agreed in 1972 (IWC, 1973) to recommend that Parties collect and provide information on all direct and indirect takes of all species, but few have responded. At its 1990 meeting the IWC affirmed through a Resolution its duty to collect information on small cetacean fisheries and to assess the status of small cetacean stocks. There are hopes that this may be the start of a process which will break the deadlock on the question of competence to manage small cetaceans.

There are extensive directed takes of cetaceans in Japanese waters, mainly for meat for human consumption, which are partly directed at particular species, and partly generic. Of particular concern is the recent increase in the take of Dall's porpoise (to over 40,000 in 1988) which is unlikely to be sustainable. The white whale and narwhal, hunted in the Arctic, may also be seriously depleted. Several species are hunted for bait around the coasts of South America, including species which may also be subject to considerable incidental take here (see below), as well as in other parts of the world. The generic small cetacean fisheries off Sri Lanka may be a threat to some populations in the region (Leatherwood and Reeves, 1989). There appears to have been a general increase in recent years in the direct taking of small cetaceans in some of the less developed parts of the world. These situations require careful but tactful monitoring (Perrin, 1989). Because of the generic nature of many of these fisheries, it would probably be difficult to manage them on an individual species basis.

Incidental takes Incidental takes may now be a bigger problem for cetaceans worldwide than directed takes. A source of particular concern in recent years is large scale monofilament pelagic driftnetting. In addition to the concerns about overfishing, there is concern over the high rate of entrapment of marine mammals and seabirds. A resolution was adopted at the UN General Assembly on 22 December 1989 calling for all pelagic large-scale driftnet fishing on the high seas to end by 30 June 1992, unless or until measures are taken which can be shown to limit effectively the harmful effects of this type of fishing. Several countries have already banned this kind of fishing within their 200-mile zones. Signatories to the Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific, of November 1989, jointly agreed not to conduct this form of fishing on the high seas of the South Pacific and not to allow this form of fishing to be conducted within their respective 200-mile zones, although these measures, when ratified, will not of themselves necessarily end pelagic driftnetting in the region because most of it is conducted by third countries on the high seas. Discarded drift nets ('ghost nets') are also capable of entangling cetaceans and can remain 'active' for several years.

The IWC co-hosted a meeting on the 'Mortality of Cetaceans in Passive Fishing Nets and Traps' in 1990. The meeting undertook a global review of such fisheries, of their impacts on species and populations of cetaceans and of causes of and solutions to the problem. (IWC, 1990b). It has unfortunately not been possible to include the material into the species data sheets, but it was concluded that the following stocks of cetaceans are unable to sustain current levels of removal by such fisheries:

- vaquita in the Gulf of California
- baiji in the Yangtze River
- hump-backed dolphins along the eastern coast of South Africa
- striped dolphins in the Mediterranean Sea
- harbour porpoises in the eastern and western North Atlantic
- bottlenose dolphins along the eastern coast of South Africa.

Concern was also expressed about the status of the following stocks:

- dusky dolphins in the eastern South Pacific
- northern right whale dolphins in the central North Pacific
- sperm whales in the Mediterranean Sea

Much fishing takes place in coastal waters, and cetaceans become entangled and drown. Some types of gear, particularly set nets of various types, are more dangerous than others, and research is needed to find some way to deter cetaceans from such gear, without affecting fishing efficiency (Northridge, 1984). The species reviews highlight several primarily coastal species which are thought to be at particular risk.

There is still a large kill of dolphins by tuna purse seiners which set nets on dolphins. In 1986 the international fleet of tuna seiners in the eastern tropical Pacific killed an estimated 129,000 dolphins (of several species), while ten years ago the take was much greater (IWC, 1988).

Habitat degradation Coastal developments can destroy fish nurseries, reducing the food supply. Coastal mangrove swamps in tropical regions are particularly rich habitats, providing fish nursery areas and shelter for adult fish. They are also a favourite habitat for coastal small cetaceans in these areas, presumably because of the rich food supply. Unfortunately mangroves are being widely destroyed, and their dependent species with them (e.g. Scott and Carbonell, 1986).

Riverine species are particularly affected by damming of rivers (see *Inia* review). As well as their general effect on the ecology of the river, dams can split cetacean populations into isolated groups, some of which may be too small to be viable, and prevent seasonal migrations.

Pollution Pollutants can enter the food chain, eventually building up in the bodies of top predators, such as the cetaceans. The effects of such pollutants on cetaceans are unknown, but in other mammals it is known that, for example, polychlorinated biphenyls (PCBs) can affect reproduction (IWC, 1986b). Cetacean deaths due to pollution are not likely to be recognised as such, except in particular incidents when many deaths occur together. Several fin whales appear to have been poisoned by heavy metals from industrial waste dumping in the Mediterranean (see fin whale review).

The dangers of entanglement in discarded fishing gear have already been mentioned, but cetaceans are also liable to ingest this and other waste material with possible detrimental effects.

There has been concern about the possible effects on cetaceans of mineral exploration and exploitation. Such work as has been done on the subject appears to indicate that, provided the animals are not directly caught in survey explosions or oil spills, they can adapt to some disturbance and avoid oiled areas (St. Aubin *et al.*, 1984; Fraker, 1984).

Disturbance and accidents Ship traffic results in some cetacean mortality due to collisions and propeller injuries. Propeller scars seem to be common on right whales in the North Atlantic, and any deaths that may occur will reduce the chances of survival of this extremely depleted species. Another possible cause for concern has arisen in recent years, with the growing popularity of 'whale watching'. It has been feared that increasing numbers of visitors and boats will disturb the animals. From the few studies so far, it appears that the animals can habituate to careful visitors (e.g. Watkins, 1986). Although established operators of whale watching ventures are often conscious of the importance of not harassing their quarry, pressure from private visitors can also become excessive.

Population, status and research The methods traditionally used to assess the status of exploited whale populations were based mainly on data from catches: these included the use of Catch Per Unit Effort (CPUE) as an index of abundance; data on pregnancy rates and age at maturity as measures of productivity; age data to estimate recruitment and mortality; and capture of marked animals to estimate population size and to define separate stocks. Analyses by the IWC Scientific Committee over the past few years have shown many of these methods to be unreliable both in principle and in practice.

Paradoxically, for the more heavily depleted populations the quantity known with greatest precision has often been the initial (pre-whaling) population size: where catches have greatly exceeded likely sustainable yields, a good estimate of the initial population size is obtained by simply summing up the catches taken, if the small remaining population is negligible in comparison.

Following the adoption of the moratorium on commercial whaling, there has been an increase in efforts to survey whale populations directly, enabling current populations of several species to be estimated for the first time. The science of estimating whale abundance through surveys has developed greatly in the last few years. Most of the revised procedures for managing whaling that are currently under consideration by the IWC rely primarily on population estimates from surveys, although there is some disagreement over the role of supplementary, catch-based data. It is hoped that recent developments signal a trend towards placing the burden of proof on potential exploiters to demonstrate that whale stocks are large enough to withstand catches, so that there will be a continuing incentive to conduct regular surveys.

Recent developments in molecular genetic techniques offer the promise to analyze the genetic structure of whale populations without the necessity for lethal sampling, using biopsies and sloughed skin. However, there is some way to go before genetic information can be used directly for the determination of the stock divisions required for management.

Despite the increased research on some of the directly exploited species, quantitative population estimates are still only available for a minority of marine cetacean species. The species for which good population estimates are available are by and large restricted to those which are either: (i) especially easy to survey, owing to particular habits such as narrow coastal migration corridors as in the case of gray and bowhead whales; or (ii) the subject of substantial investment in surveys by virtue of their great commercial value, such as minke whales. In the latter case, sightings of non-target species are also usually recorded and can provide useful information, which has been utilised in several of the species reviews in this volume.

Even though there has been a great increase in cetacean research generally in recent years, most species are still little known. There are severe logistic constraints on the estimation of abundance of the rarer oceanic species, and no currently feasible level of monitoring would be sufficient to detect changes in population size in these species within a reasonable time. Conservation measures for most species will therefore need to be of a preventative nature: identifying, reacting to and even preempting threats, without necessarily waiting for confirmation of adverse population trends in particular species.

The greatest research needs are for more information on levels of direct and incidental takes in all areas, for research into methods to reduce incidental takes and mortality in different types of fishing gear, and to identify effective means of management and regulation of direct and incidental takes. More work is also needed to identify the habitat requirements of riverine species and marine species spending part or all of their life cycle in coastal environments. The 1988-92 IUCN Action Plan for the conservation of cetaceans (Perrin, 1989) includes urgent projects in all these fields, as does the Global Plan of Action for Marine Mammals (FAO/IWC/IUCN/UNEP, 1985).

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Classification and Reviews of Species
Justin Cooke

Red Data Book (RDB) status categories At the time of writing, the IUCN Red Data Book categories of threat are defined as follows:

Extinct (Ex)

Not definitely located in the wild during the past 50 years.

Endangered (E)

Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction. Also included are taxa that are possibly already extinct but have definitely been seen in the wild in the past 50 years.

Vulnerable (V)

Taxa believed likely to move into the Endangered category in the near future if the causal factors continue operating. Included are taxa of which most or all of the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance; taxa with populations that have been seriously depleted and whose ultimate security has not yet been assured and taxa with populations that are still abundant but are under threat from severe adverse factors throughout their range.

NB: In practice, Endangered and Vulnerable categories may include, temporarily, taxa whose populations are beginning to recover as a result of remedial action, but whose recovery is insufficient to justify their transfer to another category at present.

Rare (R)

Taxa with small world populations that are not at present Endangered or Vulnerable but are at risk. These taxa are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

Indeterminate (I)

Taxa *known* to be Endangered, Vulnerable or Rare, but where there is not enough information to say which of the three categories is appropriate.

Insufficiently Known (K)

Taxa that are *suspected* but not definitely known to belong to any of the above categories, because of lack of information.

Out of Danger (O)

Taxa formerly included in one of the above categories, but which are now considered relatively secure because effective conservation measures have been taken or the previous threat to their survival has been removed.

Experience with the use of these definitions has revealed a number of problems: firstly, they are formulated in very imprecise terms, which do not necessarily permit an unambiguous interpretation; secondly, some of them depend on information which may not be available in practice. A detailed (but unfortunately inconclusive) discussion of the history and problems of categorizing the status of taxa can be found in *The Road to Extinction*, edited by Fitter and Fitter (1987). The system of threat categories is currently under review by the IUCN Species Survival Commission, and a revised system is likely to emerge in the near future.

A common misconception arising from the listing of species by categories of threat is that only endangered species are in need of protection. An important conservation objective is to prevent species from becoming endangered, not merely to rescue the ones that already are. Furthermore, a drawback of the current definitions is that a high level of knowledge of a species is needed to classify it as Endangered: the lesser-known species are in danger of becoming extinct before enough is known about them to list them as Endangered (Brownell, Ralls and Perrin, 1989). One observer has even remarked that one of the easiest ways to endanger a species is to list it as 'not endangered'.

It is also important to distinguish between the objectives of conservation of populations as living resources, and the conservation of genetic diversity. IUCN's policy, outlined in the World Conservation Strategy (IUCN/UNEP/WWF, 1980) is that exploitation of populations and ecosystems should not exceed sustainable levels, that populations be maintained above levels of maximum net productivity, and that conservative management objectives be set that take account of error, ignorance and uncertainty, as well as effects on non-target species. In most circumstances this means that exploited populations should be maintained well above levels at which extinction becomes a serious danger.

There follows a discussion of some of the problems that arise in attempting to apply these definitions to cetacean species, and how these have been resolved for the purpose of listing the species here.

Endangered classification There is ambiguity over what is meant by the 'continuation' of the 'causal factors'. If the threat is directed exploitation, then whether survival of the species is likely depends not merely on whether the exploitation continues or not, but at what level.

A definition of the 'current level' of exploitation might be the current management procedure under which the exploitation is regulated. As explained in the Introduction, the question of the likelihood of survival of a whale population under a given management procedure has not yet been definitively answered. The recent finding that the New Management Procedure under which the IWC regulated whaling from 1974 to 1986 would be quite likely to drive whale populations to extinction in the longer term, serves as a warning that even a well-intentioned procedure can have unexpected properties.

Another problem with the definition of Endangered is the determination of the 'critical level' for each species. This question has not been addressed in detail for marine cetaceans, but one approach would be to adopt an arbitrary population size below which species are to be listed as Endangered. Mace (1989) suggests a figure of 2,000-5,000 for animals in general. Even if the figure itself cannot be rigorously justified, the existence of a dividing line could at least provide a way of drawing attention to the rarest or most depleted species.

However, it would be very difficult in the case of marine cetaceans to specify which species had a total population below the value chosen, because of the difficulty of measuring the population size of dispersed species accurately enough. Suppose, for example, that an attempt is made to estimate the abundance of a tropical species, suspected to occur in all oceans, through a large scale ship-borne survey, involving a total of 200,000 nautical miles of search track, enough to circumnavigate the globe ten times. Even if the species in question were not observed at all on the survey, the data would still be consistent with a global population of well over 10,000 if it were a species tending to form medium or large schools, and with a population of at least 2,000 otherwise. There are cetacean species which have never been seen alive but may have total populations in the tens of thousands. Unless it is known for sure that a species is restricted to a particular, limited, area, it is hard to put a meaningful upper bound on its probable abundance.

If some of the rarer oceanic marine cetaceans have already been or become in the future severely depleted, through incidental takes, depletion of food species, or for any other reasons, it is unlikely that there would be sufficient information to classify them as Endangered under the current system of threat categories. Fifty years after the last confirmed record, they would be listed as extinct.

Despite these difficulties, the Endangered classification has been applied in this volume to species for which the best estimate of population size is less than 2,000 or which for other reasons are 'believed' to have been reduced to below the 'critical' level of about 2,000, even if the population estimates are not very accurate, and even if the existence of additional, unsurveyed populations cannot be ruled out. On this basis, the baiji (Yangtze river dolphin), Indus river dolphin, vaquita and northern right whale are listed as Endangered. No judgements are ventured about the likelihood of survival of any species.

Many Red Data Books for terrestrial animals classify taxa on the sub-specific level, but few cetacean sub-species have been recognised. Therefore in this volume only full species are assigned to a category of threat. However, in cases where the division of a species into sub-species is fairly widely recognised, then a species is listed as Endangered if the 'major' sub-species, were it to be treated as a separate taxon, would meet the above criteria for Endangered. The blue whale is the only case where this provision has been invoked in this volume.

It is quite possible that as cetacean taxonomy advances, other Endangered sub-species will be recognised.

Vulnerable classification Determination of whether 'most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance' predicates being able to identify and delineate the separate populations of a species. For most cetacean species the information is not available with which to determine the number of different populations and their respective ranges. At best it is sometimes possible to place a minimum on the number of separate populations, but not a maximum.

In order to be able to apply the Vulnerable category, the definition of 'most' populations is interpreted in this volume on a weighted basis: reduction of a species as a whole to a small fraction of its original abundance qualifies it for the Vulnerable classification, even when the separate populations have not been delineated.

'Over-exploitation' is a difficult concept to define precisely, but for the purpose of this volume it is defined as reduction of a species or population to below the population level conventionally regarded as the maximum sustainable yield level. This accords with the policy set out in the World Conservation Strategy. On this basis the following species have been listed as Vulnerable: fin whale, sei whale, humpback whale, bowhead whale, southern right whale.

There are several other species which are likely to have been depleted to this extent, but for which the available evidence is not considered conclusive, mainly due to the lack of reliable population estimates and catch statistics, and which have therefore not been listed as Vulnerable in this volume. These include the northern bottlenose whale, the white whale, and the narwhal.

The Ganges river dolphin is listed as Vulnerable on the grounds that its populations have decreased through a combination of over-exploitation, extensive destruction of habitat and other environmental disturbance. The Amazon river dolphin is listed as Vulnerable as a taxon 'with populations that are still abundant but are under threat from severe adverse factors throughout their range'.

The annotation to the definition of the Endangered and Vulnerable category implies that species which formerly met the criteria for Vulnerable or Endangered remain in these categories, even after remedial action has been taken, until their recovery is sufficient to justify their transfer. The definition offers no guidance as to appropriate criteria for a recovery to be 'sufficient': for the purpose of this volume a recovery is considered sufficient when a species is believed to have reached the level at which it would not originally have qualified for the Endangered or Vulnerable category had remedial action been taken to arrest its decline at that level.

Of the depleted species, so far only the humpback, southern right and gray whales show definite evidence of recovery, and only in the case of the gray whale is the recovery deemed sufficient for removing the species from the Vulnerable category. The southern right whale, which could legitimately have been listed as Endangered 10-20 years ago, is now considered to have recovered sufficiently to be listed as merely Vulnerable.

Rare and Indeterminate classifications Apart from the species mentioned above, there are many cetacean species which appear to be rare, and may be subject to some risk, but in the absence of reliable population estimates they cannot be so listed. A further problem is that the definition offers no guidance as to how rare a species should be to be considered Rare.

Hector's dolphin, a species apparently endemic to the coastal waters of New Zealand, appears to number only in the low thousands, and on the basis of evidence of incidental takes in fishing gear is likely to be substantially depleted. It is regarded, therefore, as at best Rare, and, if it is depleted, Vulnerable, or even Endangered if its numbers are near the lower end of the range of population estimates. It is therefore listed here as Indeterminate, which means that it is definitely Rare, Vulnerable or Endangered, but that there is insufficient evidence to judge which category is the most appropriate.

No other species are listed as Rare or Indeterminate in this volume.

Insufficiently Known The definition of Insufficiently Known does not specify how well-founded the suspicion that a species is Endangered, Rare or Vulnerable needs to be. Given the difficulty in deciding on what criteria to draw the line, the Insufficiently Known category is interpreted in this volume rather more widely than usual. Any species not definitely known *not* to satisfy the criteria for one of the Threatened categories is listed as Insufficiently Known.

The only circumstances in which a species can be said to be definitely known not to satisfy the criteria for Vulnerable would be when most or all of the populations are known not to be decreasing. The only case where this occurs is the gray whale, where the total population of the species is known to be increasing. Hence all cetacean species, apart from the gray whale and those listed as Endangered, Vulnerable or Indeterminate, are listed as Insufficiently Known.

This definition of Insufficiently Known could be criticised for being too all-encompassing, in that it includes under the same umbrella a very wide range of different situations. At one end of the scale there are some beaked whale species known only from a very few specimens. At the other end we have species such as the minke whale, whose absolute abundance in most oceans is known relatively accurately, but which is still listed as Insufficiently Known because it will not be known whether the populations are increasing or decreasing until the populations have been regularly monitored for several more years.

Although the category itself is not very informative, the individual species reviews indicate how much is known about each of the Insufficiently Known species, and about the level of threat they face. For some of the species, there are no known or suspected threats, whereas for others there are known threats that may be serious.

Out of Danger This classification has not been used in this volume. The only species to which it could have been applied is the gray whale, which has been listed as **Unclassified**. Two of the three original stocks of this species are endangered or extinct, but the main population is currently making a satisfactory recovery under protection. It is stressed that while the conservation measures in place for the remaining viable stock are sufficient to counteract the known threats to the taxon, provided they are maintained and enforced, the gray whale is still subject to entanglement and habitat encroachment of unknown significance.

It should be emphasized again that the unit for classification is the species as a whole. The status of populations within a species can be highly variable, and the overall listing for a species says nothing about the status of individual populations of that species. However, such information is given in the body of the species review.

Layout of species reviews Reviews of species are written in the general format of previous IUCN Red Data Books, and the following sections and headings are used:

Name, taxonomic position and status The name comprises the name of the genus (by convention written with a capital letter) and the name of the species (by convention written in lower case), authority for the description of the taxon, and the date the description was published. Where the authority appears in brackets it indicates that the original description assigned the species to a different genus. A single English common name is given. The Order Cetacea is divided into two Suborders, and these in turn are divided into Superfamilies, Families and Subfamilies. The Suborders and Families are indicated at the head of each review, and the other divisions appear in the list in the previous chapter. The Red Data Book status is given as described above.

Distribution The most recently available distribution information is given, together with any information on reduction in range. Some reviews are accompanied by maps, where these can usefully illustrate the range. In many cases too little information is available for range maps to be useful; in other cases the range is all oceans, rendering a map unnecessary. The maps used by the IWC to describe their management stocks are reproduced in the Introductory section. In many cases good information on distribution is lacking. This is an important problem for conservation, particularly where species occur in national waters and rivers. Governments cannot be expected to take steps to protect species if they are not aware that such species are present within their jurisdiction. In this context, a brief survey of the books on national mammalian fauna in the Cambridge University Library revealed that the vast majority do not refer to Cetacea at all, although other sources may show the presence of a number of species. A basic source of information on detailed cetacean distribution is Hershkovitz (1966), although it contains some errors and is somewhat out of date. More recent references are usually cited in the species reviews.

Population The most recently available information on past and present population levels is given, as is that for geographical or management stocks, where these are defined. However, in very many cases this information is controversial, vague or simply does not exist. Since one of the most frequent questions asked about cetacean species is 'How many are there?', readers may be disappointed to see that more or less only the kind of detailed information on numbers available is that acceptable (at the quoted date) to IWC scientific bodies, and even some of this is outdated or questionable in terms of current methodology. While it would have been possible to give rough estimates of the order of magnitude of world populations for many species (e.g. low hundreds, tens of thousands, several million), such exercises are counterproductive in conservation terms. This is because the lack of information on past and present population levels, and on stock identity, are major conservation problems. Without this basic knowledge the status of the species and stocks cannot be properly assessed nor can effective management take place. It is not helpful to produce estimates which may obscure this basic need for good information on abundance.

It is perhaps worth emphasizing here that records of animals washed up on shore, or stranded, are not reliable guides to the numbers of animals alive at sea, although they are extremely useful for other purposes and indeed provide the major source of information on the biology of some species (IWC, 1986). The same is true of informal sightings records, which can say as much about the habits of the observers as about those of the animals, although again they are useful sources of other information on biology and behaviour. These points are discussed further in the harbour porpoise review. The carefully conducted survey remains the best (and unfortunately most expensive) technique for assessing present numbers, although the new photo-identification and acoustic methods are proving valuable for many species.

For species first subject to major exploitation in the 20th century, historical catch records can provide a good indication of original abundances. For species exploited in earlier times records tend to be incomplete, although careful historical research can sometimes unearth considerable additional material (IWC, 1983; Mitchell, 1975).

An encouraging development in recent years has been the degree of international cooperation in making extensive surveys of large sea areas, for example in the Antarctic under the IWC International Decade of Cetacean Research (IDCR) programmes, and in the eastern North Atlantic (IWC, 1988). Unfortunately, pressure to provide information on exploited or potentially exploitable stocks has resulted in a lack of priority for the analysis of the survey data relating to other species.

Habitat and Ecology The emphasis here is on information potentially relevant to conservation and management: these sections are not intended to be an exhaustive account of all knowledge on the species in question. The external appearance is not generally described, except where there is particularly interesting new information. Reliable guides to appearance and field recognition are given by Leatherwood and Reeves (1983). Some species employ particular areas for important behaviours, such as feeding and calving, and it is necessary to identify these, and any threats to them. The riverine species are particularly vulnerable here, as they spend all their lives in comparatively restricted habitats.

Threats This section includes any known or probable threats to the species. The mention of a threat does not always imply that it is considered to be seriously detrimental to the survival prospects of the species. In some cases the section has been divided into Historical and Present, particularly where the problem was over-exploitation in the past.

The CMC kindly provided a tabulation of all the international trade in cetaceans reported by CITES Parties for 1976-1985 (CMC, 1987). For most species very few international movements are reported; these are simply noted in the following section, with the reference to the CITES listing. In a few cases, where international trade may be of some conservation interest, the comments appear in this section. One of the reasons for proposing the listing of all cetacean species in the CITES Appendices was to monitor the international trade, and with the large and expanding number of CITES Parties, trade outside this monitoring system must be steadily declining. So far, a generally reassuring picture has emerged. The volume of recorded international trade is very small for the majority of species; most transactions are non-commercial, and usually involve scientific specimens. Even if this should change in the future, the level of any new trade can be easily monitored. In this respect the Proposals for CITES listings will continue to serve a useful conservation purpose. However, the largest commercial consignments have simply been reported as 'Cetacea spp.' and their nature sometimes unspecified. From the countries of origin and destination they are likely to have been commercial whaling products, probably mainly meat for human consumption. No such consignments are recorded after 1983, but it would greatly assist trade monitoring if the use of such general categories was avoided and the species listed, even where products of several species are shipped together.

Conservation Measures The section begins with a list of countries of origin, or general areas of origin in those cases where very long lists of countries are involved. Overseas territories are listed in brackets under the governing State. Relevant international and national conservation measures are briefly summarized. The wide range of relevant, or potentially relevant, international and national legislation reflects the complexity of the problems facing cetaceans today. By noting so many pieces of international and national legislation which could be relevant, as well as pointing out the particular countries with responsibility for each species, it is hoped that much wider attention will be given to cetaceans and to their special problems. In general, there seem to be plenty of potentially protective legal measures available, the problem is to use them effectively. Proposals for further conservation action are made in this section. Many of them refer to those of the IWC subcommittee on small cetaceans, which over the years has served to bring forward and assess a wealth of information on the status of species. Proposals made by other groups, and particularly those in the IUCN/SSC Action Plan, are also included.

The IUCN conservation policy, adopted in the IUCN/SSC Action Plan, is as set out in the World Conservation Strategy (IUCN/UNEP/WWF, 1980). This is to maintain essential ecological processes and life-support systems, to preserve genetic diversity, and to promote rational utilization and management on a sustainable basis, recognizing that decisions about the relative importance to be given to wildlife conservation and short-term human welfare must rest with national peoples and governments. The IUCN *Guidelines for assessing priorities for action in conserving biological diversity*, developed at the IUCN 1988 General Assembly (Huntley and Edwards, 1988) have been taken into account. These goals are also embodied in the UNEP *Global Plan of Action for Marine Mammals* (FAO/IUCN/IWC/UNEP, 1985).

Captive Breeding The IUCN Policy Statement on captive breeding (IUCN, 1988), which was prepared by the SSC Captive Breeding Specialist Group, and approved by IUCN Council in September 1987, recommends that demographically self-sustaining captive populations of endangered species be developed where necessary. It suggests that management to reduce best the risk of extinction requires the establishment of supporting captive populations at an early stage, preferably when the wild population is still in the thousands. Such action should not, as in the past, be left to the last moment, when extinction is probable. It is suggested that vertebrate taxa with a current population below one thousand individuals in the wild require close and swift cooperation between field conservationists and captive breeding specialists, to make their efforts complementary and minimise the likelihood of the extinction of these taxa.

Sadly, the plight of the baiji, or Yangtze river dolphin, has brought the question of cetacean conservation through captive breeding to the fore. Maintenance of semi-captive populations in reserves may be the only way now left open to save this species, of which perhaps only 300 individuals remain, and there is woefully little information with which to start. By the above criteria, captive breeding programmes should also be seriously considered at least for the Indus river dolphin, and possibly for some other species with small world populations. Some cetacean species are simply too large for captive breeding ever to be a practical conservation option, if they are to survive it must be through conservation and management in their natural habitat.

It should be emphasised that the maintenance of complete self-sustaining captive populations has only been explored for a very few species. It is not sufficient merely that births in captivity occur, but that both birth and survival rates be high enough for persistence of the captive population. This does appear to be the case now for at least the bottlenose dolphin (see species account). Keeping of captive cetaceans is sometimes defended on the grounds that research on captive animals provides information on the species that can be useful for the conservation and management of wild populations.

References In the interests of brevity, recent reviews have been cited in preference to original papers, and the conclusions of the IWC Committees and subcommittees rather than the papers on which they are based. Unfortunately, it has been impossible to avoid citing unpublished work and various kinds of internal reports. The unpublished IWC papers can be readily obtained from the Secretariat at The Red House, Station Road, Histon, Cambridge CB4 4NP, UK (the cost of copying etc. is charged). In case of other material, the originating body should be approached. Personal communications described as *In litt.* refer to letters; other personal communications refer to personal conversations.

N.B. As stated above, the assignment of species to categories of threat and the information on which they are based are likely to change as new information is received. Users are therefore strongly advised to check with the IUCN/SSC Cetacean Specialist Group (Present Chairman: Dr W.F. Perrin, PO Box 271, La Jolla, California 92038, USA), before embarking on any major undertakings based on this material.

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GANGES RIVER DOLPHIN **VULNERABLE**

***Platanista gangetica* (Roxburgh, 1801)**

Suborder ODONTOCETI Family PLATANISTIDAE

Summary Formerly apparently quite abundant, there is evidence that populations have severely declined more or less throughout the range. The species is therefore listed as Vulnerable. The major problems are: extensive habitat damage, particularly through dam construction; direct and incidental catching; pollution; and boat traffic. Cooperative conservation and research efforts are needed by the four countries of origin (Bangladesh, Bhutan, India and Nepal) with assistance from the international conservation community. These should include surveys and habitat assessment, action to ameliorate the effects of existing and proposed dams, increased legal protection and more energetic enforcement of existing protective legislation, reserve areas, education of local people to prevent direct catching, and exploration of the question of captive or semi-captive breeding.

Distribution This dolphin is found in the Ganges, Brahmaputra, Karnaphuli and Meghna river systems, from the foot of the Himalayas to the limits of the tidal zone, in India, Bangladesh, Nepal and Bhutan. It has been suggested that they might also occur in the headwaters of the Brahmaputra in PR China, but they have never been recorded there.

Anderson (1878) provided a detailed account of the distribution, as reported to him. He described the range in the Ganges as falling between 77°E and 89°E, and in the Brahmaputra to 95°E 27°30'N. The upstream limits were determined by lack of water and rocky barriers, and the downstream limits by sea water. However, according to Mohan (1989) the dolphins are present in the Brahmaputra system as far north-east as the Dihang, Buri Dihing and Lohit rivers in eastern Assam, and as far north as the Tista river and its tributaries, which extend into Sikkim and Bhutan.

In recent years the Ganges river dolphin has been reported as far upstream as Dioghat on the Narayani river in Nepal (Kasuya and Haque, 1972), which is 250m above sea level and 100km further upstream than recorded by Anderson (1878). These authors found no evidence of the dolphins in the Rapti river, at least during the dry season, but others have reported them from this area. They have also been occasionally reported from the Gerwa river near Manao in Nepal (Reeves and Brownell, 1989). Shrestha (1986) reports observations in the four main river systems, Karnali, Narayani, Kosi and Mahakali, in Nepal.

The dolphins ascend the Meghna river system in Bangladesh at least to Sunamganj (Jones, 1982). The Farakka barrage in the Ganges is thought to have isolated the animals on the upstream side from the rest of the aggregate population (Reeves and Brownell, 1989).

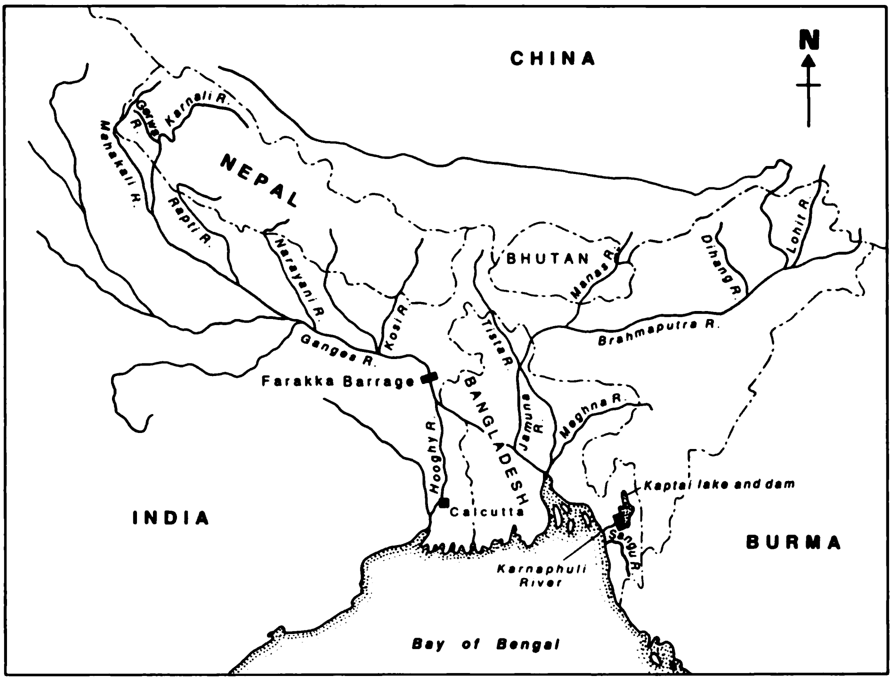
Outside the Ganges-Brahmaputra-Meghna systems, these dolphins are present in the Karnaphuli river and possibly the Sangu river in eastern Bangladesh. They have been seen within 3km of the mouth of the Karnaphuli river and in the Hoogly river downstream of Calcutta (Reeves and Brownell, 1989). Jones (1982) suggested that the broad plume of fresh water created by the outflow of the Ganges in the northern Bay of Bengal may assist the dispersal of dolphins outside the main Ganges-Brahmaputra-Meghna systems.

While recent research has extended knowledge of known distribution, it has also revealed reductions in range. For example, the dolphin is no longer found above the

Kaptai dam on the Karnaphuli river, and there are few left above the dam which isolated the headwaters of the Ganges river system in Nepal. There is a general impression in the literature that other reductions have occurred, but much of the range has never been surveyed in detail (Jones, 1982; Kasuya and Haque, 1972; Haque, 1976; Shrestha, 1986; Reeves and Brownell, 1989).

Both the Ganges and Indus river dolphins have recently been reviewed by Reeves and Brownell (1989). They express considerable doubts about the evidence put forward so far in support of the existence of two species of *Platanista*, and advocate a complete taxonomic review of the genus. In the meantime the custom of using a separate name for the populations in the Indus river system is continued. The Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989) also conducted an extensive review.

Map 1. Distribution of the Ganges river dolphin



Population There have been no complete surveys of the Ganges river dolphin populations, although the animals appear to have been relatively common in the past. Current population estimates are extremely rough and quite possibly incomplete.

In a 52 square km area of the Karnali river system it was estimated that the density of dolphins was 0.23 per square km in September 1982 and 0.38 per square km in January 1983. There are probably fewer than 100 dolphins in total in Nepal, with the group of about 20 in the Karnali river above Chisapani being the single largest concentration (Shrestha, 1986).

Kasuya (1972) estimated that hundreds existed in the Ganges (above the delta) and thousands in the rest of the river system. He suggested that the Brahmaputra system might have been acting as a reservoir from which individuals could, at that time, migrate to the Ganges. Kasuya and Haque (1972) surveyed the Ganges and Brahmaputra systems in Bangladesh. Of the 772 schools sighted, 64% were seen in the upper Meghna river, 24% in the lower Meghna river, and 9% from Tistamukhghat to Goalindoghat, on the Jamuna river. Jones (1982) divided the area of distribution into four zones: 1. Ganges Delta Zone - covering the Ganges below the Farakka barrage, the Brahmaputra below Tistamukhghat, and the Meghna below Bairab Bazar; 2. Ganges River Zone - above Farakka, including all tributaries; 3. Brahmaputra and Tributaries - above Tistamukhghat; 4. Meghna River Zone - above Bairab. He estimated that there were about 3,000 to 3,500 animals in the Ganges Delta Zone, 500 to 750 in the Ganges River Zone, 500 in the Brahmaputra Zone and 750 in the Meghna Zone. These figures do not appear to be based on a survey or other kind of quantitative data, and should be regarded as informed guesses (Reeves and Brownell, 1989). In addition, Haque (1976) reports about 100 animals in the Karnaphuli river below the Kaptai dam.

Accidental capture in fishing gear and habitat modification have caused a chronic decline in the populations in the Ganges and its tributaries in India above the Farakka barrage. Although still common in the Padma, Jamuna and Meghna river systems of Bangladesh, they have disappeared from the hilly rivers in the Chittagong and Hill Tracts districts since the completion of the Kaptai dam and hydroelectric project in the mid 1970s. The population of the Padma river system is said to be declining due to the construction of the Farakka barrage. Illegal capture, construction of dams and deterioration in water quality are said to have contributed to population declines in Nepal (Reeves and Brownell, 1989).

Habitat and Ecology The longest measured female was 2.52m and the longest male 2.12m. Estimated average lengths at physical maturity are 2.00 to 2.10m for males and 2.50m for females. The longest foetus was 0.89m, and the smallest calf 0.67m (Reeves and Brownell, 1989). Anderson's (1878) estimate of an eight to nine month gestation appears low in comparison with the 11-12 months common in other small odontocetes, and does not in any case appear to be based on observational data (Reeves and Brownell, 1989). Kasuya (1972) suggested that the young begin eating solid food one to two months after birth, and are weaned before one year of age. He also suggested that males become sexually mature at 1.70m or less, at an age of about 10 Growth Layer Groups (GLGs) in the teeth, which is assumed to represent 10 years of age. The smallest sexually mature female so far reported was 2.00m. No sexually mature females have been aged so far. The oldest male animal so far aged had 28 GLGs in the teeth.

Ganges river dolphins seem to eat a variety of fish and invertebrates. Stomach contents have included prawns, clams, catfish, freshwater shark, mahseers, gobies and carp. The quantities taken in the wild are not known, but captive animals have eaten between 0.5kg and 1.5kg of fish per day (Reeves and Brownell, 1989).

These dolphins usually live in small groups or alone. Kasuya and Haque (1972) found that 90% of the groups and 80.4% of the total dolphins seen during the dry season in the Meghna and Jamuna rivers of Bangladesh were solitary individuals. However, reports from the 19th century speak of 'large schools' to be seen near most large towns on the Ganges (Reeves and Brownell, 1989).

Seasonal habits and movements are not well known, but there is some evidence of seasonal change in distribution, with animals travelling upstream as the water level rises, and entering smaller streams. The young possibly remain in the smaller streams during the first year, at least in the Bangladesh area (Kasuya, 1972; Shrestha, 1986). The species prefers deep water, but other characteristics of its habitat in most of India and Bangladesh, where the rivers flow slowly through the plains, are quite different from those in Nepal, where it can be found in relatively clear water and rapids. In summer they are confined to deep pools, particularly in the lower river. They have been found in water between 8°C and 33°C (Jones, 1982; Kasuya and Haque, 1972; Haque, 1976; Shrestha, 1986; Reeves and Brownell, 1989).

Threats The species faces a series of threats, including pollution, dams, mining and directed and incidental catch. The lack of information on past and present distribution, population, ecology and biology, are serious problems in assessing the status of this species, and in formulating protective actions.

In India, about 2,500 tons of pesticides and 1.2 million tons of fertilizers are used in the vicinity of the Ganges each year, making the rivers heavily polluted. The effects of the chemicals on the food chain are unknown, but it can be speculated that they are ecologically deleterious to the dolphin population (Geisler and Pilleri, 1971; Jones, 1982; Mohan, 1989).

Construction of dams for irrigation and hydroelectric power has divided the dolphin population of the Ganges system into small, isolated, subpopulations. There some 22 dams and barrages already on the Ganges and associated river systems, with a further 7 under construction. Most of these are in India, but one is under construction in Bhutan. There are no significant dams on the Brahmaputra (Perrin and Brownell, 1989).

After the construction of the Kaptai dam, on the Karnaphuli river, in Bangladesh, *Platanista gangetica* appeared to survive well in the upper river for the first ten years after the dam was closed (to 1964-65), but disappeared over the next six or seven years (Haque, 1976). The population below the dam also seems to be severely reduced. Decreased water flow into the delta region has allowed seawater intrusion that, in addition to the adverse effects on estuarine fauna, has isolated the lower Karnaphuli dolphins. With the closing of the Farakka barrage, at the entrance to the Ganges proper, yet another permanent division of the populations will occur. It will also reduce the water flow to the lower Sundarbans (delta region) where *Platanista gangetica* is abundant at present, and the postulated exchange of individuals between the Ganges and Brahmaputra will then be impossible (Kasuya, 1972; Jones, 1982; Haque, 1976). A further problem in India is that water drawn from the Ganges for irrigation causes drastic decreases in water level, shrinking the available dolphin habitat. In Nepal, the construction of dams in the Indian frontier areas appears to have resulted in major decreases in the dolphin populations above these dams. The planned construction of a large dam at Chisapani, on the Karnali river, is likely to have a severe effect on the remaining small population of dolphins, as well as on commercial and subsistence fisheries (Shrestha, 1986; Jones, 1982; Mohan, 1989; Shrestha, 1989). Further discussion of the effects of dams on river dolphin populations is given in the *Inia* review.

In Nepal, quarrying of building stone has caused severe erosion of the river banks in some areas, which may change the riverine habitat enough to adversely affect the few dolphins that remain. Mining of the river bed for stones and gravel is also degrading the habitat (Shrestha, 1989).

The Ganges river dolphin is hunted illegally in India, Bangladesh and Nepal. Trained otters have been used to assist the capture of dolphins in Bangladesh and Nepal. Tame herons and egrets have been similarly employed (Reeves and Brownell, 1989; Shrestha, 1988). Along the Brahmaputra river it is hunted for meat and oil, both of which are used medicinally. The oil is also used to attract catfish in a net fishery. The catch for these purposes is at least 40 a year. In Nepal dolphin eyes are used in folk medicine. Some incidental catch of dolphins may occur in India and Bangladesh, and some dolphins are caught incidentally in gill nets in Nepal (Haque, 1982; Mohan, 1989; Shrestha, 1986; Reeves and Brownell, 1989).

The siltation of river beds is an additional problem in Bangladesh (Perrin and Brownell, 1989).

Conservation Measures Countries of origin are: Bangladesh, Bhutan, India and Nepal.

Platanista gangetica is listed on Appendix I of CITES. The following international trade is recorded: one bone from Japan to USA in 1985, for scientific purposes (CMC, 1987). No other specific international protection has been found. Bangladesh, India and Nepal are CITES members. India is a member of CMS. Habitat protection conventions such as the World Heritage Convention and Ramsar Convention (India is a member) may also offer opportunities to protect river dolphins.

The Ganges river dolphin is protected in Bangladesh, Nepal and India. No information on the situation in Bhutan was found, although a large wild life sanctuary set up in 1969 adjoining the border with India may protect relevant areas. The dolphin is mentioned among the fauna of four protected areas in Nepal, and there are others near dolphin habitat which may be relevant. The National Chambal Sanctuary in India includes the Ganges river dolphin among the fauna. At least five other protected areas may be relevant, particularly the sanctuary on the Manas river.

The Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989) recommended that census surveys be carried out by all the nations having populations of *Platanista gangetica*:- India, Bangladesh, Nepal and Bhutan. The Brahmaputra river, especially, should be surveyed in detail. These surveys should be coordinated, but be carried out by national scientists of the countries involved. Efforts should be made to standardize survey techniques, to allow valid comparisons and combination of results.

Focal centres of research on the Ganges river dolphin and its ecosystem should be established at major universities on the Ganges/Brahmaputra river systems. These could include Gauhati University on the Brahmaputra and Benares University on the Ganges in India; Chittagong University on the Karnaphuli river and Mymensingh University on the Ganges system in Bangladesh; Tribuhwan University in Nepal and Thimpu University in Bhutan. Funds could be solicited and research coordinated through an overall River Dolphin Project, similar to the highly successful 'Project Tiger'. Attempts should be made to initiate projects on reproductive biology and behaviour, ecology, population dynamics and movements. A regional scientific committee should be formed to plan research and evaluate results. A substitute should be sought for the dolphin oil used in fisheries in India.

In Nepal, a regional planning approach is needed to preserve and protect some natural dolphin habitat, while meeting the need for hydroelectric power. To compensate for the loss of important habitat which will be a consequence of the proposed large dam in the Karnali river, alternative habitat should be constructed and enhanced. Dolphin sanctuaries should be established in stretches of the river comprising prime dolphin habitat. Efforts should be made to curtail or ameliorate the effects of human activities in these areas, including the use of ferryboats and motorboats, logging and other activities leading to deforestation, stone and gravel quarrying and water removal. The possible use of fish ladders for both fish and dolphins to bypass the proposed dam should be investigated. The effects of gill netting on the dolphins and on the populations of fishes on which they feed and which support important recreational activities should be investigated and ameliorated. A campaign should be mounted to discredit the folk belief that dolphin oil has medicinal value.

In India and Bangladesh the main causes for depletion of the Ganges river dolphin are probably industrial pollution, reduction of water levels in the upper reaches of the river system, fishing activities and increased vessel traffic. Efforts to save the dolphins should be directed at all these problems. The laws prohibiting catching and possession of carcasses and parts need to be more effectively enforced. Top priority should be given to educating the fishermen and tribal peoples that live along the rivers, especially the Brahmaputra. This should be done with the help of local governing bodies and village communities. Areas where dolphins are found in large numbers should be declared sanctuaries. These include the lower reaches of the Meghna river and the section of the Brahmaputra between Tezpur and Jorhat.

Interest needs to be aroused and investigations initiated in Bhutan.

All the needs mentioned above have been incorporated into the IUCN/SSC Action Plan, and given the highest priority for urgent action (Perrin, 1989).

Captive Breeding An animal about 1m long was captured near Dacca and transported to Calcutta in a bath filled with water. It lived for 10 days in captivity (Anderson, 1878). Another young animal was kept alive in a swimming pool for five weeks in 1977 or 1978, then released in the same place where it had been captured (Reeves and Brownell, 1989). The major attempt so far to keep the Ganges river dolphin in captivity appears to have been made by a Japanese research expedition in the early 1970s. Seven animals were kept in Bangladesh for a short period, of which three females and one male were taken alive to Japan, where they survived at Kamogawa Sea World for between 64 and 176 days (Kasuya, 1972). No details of husbandry appear to have been published, except some notes on capture and initial reactions to captivity (Haque *et al.*, 1977). Another female was sent to Japan in October 1970, which lived for 299 days. An additional eight or so animals were taken in various parts of the Brahmaputra, Jamuna and Meghna river systems in Bangladesh between January 1970 and May 1973, and maintained in local pools and ponds (Reeves and Brownell, 1989).

In view of the loss of important habitat which will result from the proposed dam on the Karnali river in Nepal, Shrestha (1989) presented a proposal for a large 'river park' on the Karnali river, where a breeding group of dolphins could be established. It would consist of an artificial channel connecting to the river at both ends. The channel would be 3km long, 1km wide and 20m deep. A fish farm would be built in conjunction with the park to supply food for the dolphins. In the long term, dolphins could be released into the natural habitat of the river as the population of the park increased.

The Workshop (Perrin and Brownell, 1989) recommended that the possibility of captive breeding should be investigated. They were informed (Mohan, 1989) that Gauhathi University has facilities which could be used for this.

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INDUS RIVER DOLPHIN **ENDANGERED**
Platanista minor Owen, 1853

Suborder ODONTOCETI Family PLATANISTIDAE

Summary This dolphin was formerly apparently reasonably common throughout the Indus river system, but only about 500 animals now remain, and these are all in Pakistan. Over 400 are confined to one 170km stretch between two irrigation barrages, which forms the Indus Dolphin Reserve in Sind. The population in the Reserve may have increased, assisted by an energetic enforcement and education programme. Nevertheless the species remains listed as Endangered since the total population size is still critically low.

Elsewhere, populations between other dams have either been exterminated (some within the past 10-15 years) by illegal catching and habitat destruction, or, in the Punjab, are in serious decline. The Government of the Punjab (in cooperation with the Government of North West Frontier Province where appropriate) should be urged to enforce their legal protection of this dolphin, set up a dolphin refuge, and educate fishermen and the public about the need for protection.

Distribution The Indus river dolphin was formerly said to be distributed throughout the Indus river system, from the Himalayan foothills to the sea, and in the main tributaries - Jhelum, Chenab, Ravi and Sutlej - from the hills to their junction with the Indus (Anderson, 1878).

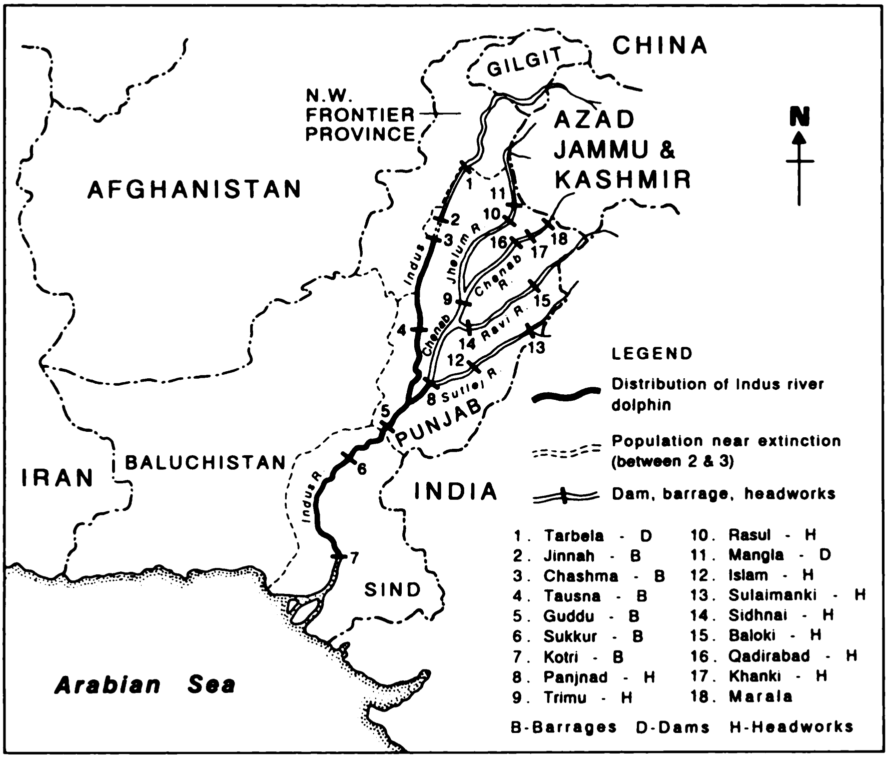
The construction of dams or barrages on the rivers, beginning in the 1930s, has had a major effect on the dolphin populations. The smaller volume of water, particularly in the dry season, has greatly reduced available habitat. Subpopulations on either side of these barriers are now isolated and hence more vulnerable to extinction through hunting, accident or environmental change. Today, the Indus river dolphin is found only in Pakistan; it is known to be present in the Indus river between Jinnah barrage in the Punjab and Kotri barrage in Sind. It also still inhabits a short stretch of the Chenab river below Panjnad headworks. The species is now extinct in the parts of its former range in the Indus above Jinnah barrage and in the rivers above Panjnad headworks; the remaining populations there were exterminated in the late 1970s by illegal hunting and lowering of water levels (Pilleri and Zbinden, 1974; IUCN, 1978; Khan and Niazi, 1989).

Both the Ganges and Indus river dolphins have recently been reviewed by Reeves and Brownell (1989). They express considerable doubts about the evidence put forward so far in support of the existence of two species of *Platanista*, and advocate a complete taxonomic review of the genus. In the meantime the custom of using a separate name for the populations in the Indus river system is continued. The Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989) also conducted an extensive review.

Population The Indus river dolphin appears to have been reasonably common throughout the original range in former times. Khan and Niazi (1989) report that only about 500 dolphins remain today. Most of them (429 counted in 1986) are in the 170km stretch of the river between Guddu and Sukkur barrages in Sind which forms the Indus Dolphin Reserve. Only 21 animals have been counted in the long stretch of the river below Sukkur barrage to Kotri barrage, and 72 above Guddu barrage in the Punjab. This area is divided into three sections by barrages: Guddu to Taunsa on the main Indus river and to Panjnad at the Chenab-Sutlej confluence; Taunsa to Chashma; and Chashma to

Jinnah - both the latter on the main Indus river, which partly serves as the border between the Punjab and the North West Frontier Province in this area. The Chenab population (upstream of Panjnad headworks) and Sutlej population (upstream of Sulaimanki headworks) were exterminated by the late 1970s. The Chashma-Jinnah population appears to be also on the verge of extinction. There are, therefore, no longer any Indus river dolphins in Jammu and Kashmir, most of North West Frontier Province, Gilgit, or in the Indus tributaries in India.

Map 2. Present distribution of the Indus river dolphin in Pakistan



The population in the Indus Dolphin Reserve appears to have increased under protection. Results of surveys from 1974 to 1986 suggest a constant and regular increase. However, it is not clear whether the difference between the early estimates (138 - Pilleri and Zbinden, 1974; 233 - Kasuya and Nishiwaki, 1975), and the most recent estimate of 429 (Khan and Niazi, 1989) reflects only population increase. It is likely that improved survey techniques and differences between observers have contributed to the increased numbers counted (Perrin and Brownell, 1989; Reeves and Brownell, 1989). Bhatti and Pilleri (1982) implied an annual rate of increase greater than 15%, which is highly unlikely in view of the rates of increase (less than 10%) estimated for other dolphin populations with similar calving intervals and population structures (Reeves and Brownell, 1989). The rate of increase between the last count of Bhatti and Pilleri (1982) in 1980, of 346 and the most recent count of Khan and Niazi (1989) is less than 5% per year, a more feasible estimate (Perrin and Brownell, 1989).

Habitat and Ecology The Indus and Ganges river dolphins are said to be indistinguishable in external appearance, and the life history parameters are usually assumed to be similar and interchangeable (Reeves and Brownell, 1989). Females reach about 2.5m in length and males just over 2.0m. Young are somewhere between 0.70 and 0.90m in length at birth, and may be weaned by one year of age. Apparent breeding behaviour was observed in May, and calving in April and May. Khan and Niazi (1989) also report that their observations indicate a male:female sex ratio of 2:1, gestation of 10-11 months and a calving interval of two years. Kasuya (1972) suggested a calving interval of at least two years. (For further details see Ganges river dolphin review.)

The dolphin is almost blind, the rudimentary eye lacking a lens. It swims on its side, orienting and hunting by echo-location (Herald *et al.*, 1969; Pilleri, Gihr and Kraus, 1971). The stomachs of two very young animals studied by Butt (1977) contained prawns (*Palaemon malcolsonii* and *P. carcinus*) and gobies (*Glossogobius giuris*). It is also reported that food species include catfishes (*Wallago attu* and *Macrones aor*) and the carp *Catla buchanani* (Pilleri and Zbinden, 1974).

Recent observations in the Reserve show that the dolphins do not stay permanently in one place, but move according to the availability of their food fish. They are often seen at the mouth of irrigation canals and side channels. In winter they may move up to 5km (Khan and Niazi, 1989). The dolphins may be attracted by human activities (Pilleri and Zbinden, 1974; Khan and Niazi, 1989).

The Indus and its tributaries are fed by melting snow and ice and also by seasonal rainfall. Fifty percent of the annual discharge occurs in summer (July-September) and 15% in winter (October-March) (Pilleri and Zbinden, 1974). There are two dams, six barrages (low earth dams to divert water for irrigation) and ten headworks (smaller dams) on the river and its tributaries in Pakistan. They were built over the past forty years to control flow, supply energy and permit irrigation. The dams split the dolphin population into subpopulations (of which only six remain), completely isolated from each other. The distance between the barrages varies from 48 to 306km, and they contained sub-populations of dolphins range from only a few to over 400 individuals. The numbers are not related to the size of the enclosed areas, indicating that other factors may be important in affecting dolphin density. The barrages do not impound large amounts of water, and thus the problems created for dolphins are less obvious than in the case of high dams. It is thought that there is little scope for the construction of further dams or barrages (Khan and Niazi, 1989; Perrin and Brownell, 1989). However, the dams have changed the water levels, particularly in the lower reaches where levels are now very low in winter - especially below the Kotri barrage. During the high water season the barrages are kept open (Geisler and Pilleri, 1971).

Threats Incidental takes in fishing nets appear to have occurred from the earliest times. Trained otters have been used to assist direct captures near Sukkur (Anderson, 1879). Live fish have also been used to attract the dolphins near enough to be netted (Herald *et al.*, 1969; Pilleri, 1970).

Direct hunting of these dolphins for their meat and oil has been substantial. At least five boats fully equipped for dolphin catching were active between the Sukkur and Guddu barrages in 1974 (Pilleri and Zbinden, 1974). The heavy hunting pressure was from non-Muslim dolphin catchers called 'Dagori' in the Punjab and 'Jabar' in Sind. The flesh is consumed by the fishermen, although most other communities are forbidden to eat it. The blubber is rendered to extract the oil, which is used by local people both as a rub for muscular pains and orally for medicinal purposes. It is also used as a medicine for domestic animals and for boat maintenance (IUCN, 1978; Pilleri, 1972; Jones, 1982; Reeves and Brownell, 1989).

The species is now extinct in the parts of its former range in the Indus above Jinnah barrage, and in the other rivers above Panjnad headworks. These populations were exterminated by the late 1970s through illegal hunting and lowering of water levels. The two small populations above Guddu barrage, and the dolphins above Chashma barrage are thought to be on the verge of extinction. The decline may be at least partly due to the very small population size (Ralls, 1989), as well as to continued hunting and habitat degradation (Perrin and Brownell, 1989). Further discussion of the effects of dams on river dolphin populations is given in the *Inia* review.

Conservation Measures The Indus river dolphin is listed on Appendix I of CITES. No international trade is reported (CMC, 1987). As the species is found only in Pakistan, there is probably little scope for further international legal protection, although it may be possible to protect more habitat under, for example, the World Heritage Convention or Ramsar Convention.

In Pakistan, conservation is a provincial responsibility. On the recommendation of the 1970 Wildlife Enquiry Committee, the Government of Sind gave the dolphin full legal protection in 1972. Effective protection, however, began in 1974, when the Government established the 170km section between Guddu and Sukkur barrages as the Indus Dolphin Reserve, in response to recommendations from the World Wild Fund for Nature. Four guards were appointed to patrol the Reserve. The protection was codified in 1975, with penalties for killing or trapping dolphins. The legal protection was widely publicised in an intensive campaign at all levels of government and society, and appears to be generally observed. In collaboration with the Government, and supported by the World Wild Fund for Nature and the Volkart Foundation, an IUCN project carried out studies of the dolphin and the local situation for some years from 1977. The personnel made a television film, prepared educational material for schools, and helped with enforcement (IUCN, 1978). The protection efforts have had success, as the dolphin population in the Reserve appears to be increasing.

The Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989), considered this reversal of the previously poor situation in Sind to be an excellent example of what can be accomplished with a serious commitment to protection, enforcement and education. They praised the efforts of the Sind Government, and hoped that their example would be emulated.

The situation in the Punjab, however, is critical. Despite legal protection since 1972, the populations there continue to decline. The establishment of reserves, and enforcement of the legal ban on hunting, are urgently needed if the species is not to become extinct in the Punjab (Perrin and Brownell, 1989). There is already a Nature Reserve at Taunsa barrage, which should protect some habitat.

The dolphin has been legally protected in North West Frontier Province since 1975, but this has not been enforced and the species has now become extinct there above Tarbela dam. Parts of the Indus forming the border between Punjab and North West Frontier Province still contain a few dolphins, and joint protection efforts would appear to be appropriate. The legal protection of the Indus river dolphin from 1975 in Azad Jammu and Kashmir did not prevent extermination in this province.

The Workshop (Perrin and Brownell, 1989) recommended that the census surveys should continue in both Sind and the Punjab, with particular attention paid to methodology, so that the results are comparable from area to area, and from year to year. Research in Sind should also be directed to obtaining quantitative estimates of calf production and mortality, and on investigating habitat parameters. Research should begin immediately in the Punjab to identify and quantify the causes of the continuing decline in dolphin numbers.

The Government of the Punjab (in cooperation with the Government of North West Frontier Province where appropriate) should be urged to enforce the legal protection of this dolphin, in particular the prohibition on the possession, sale or purchase of dolphin meat, bones or oil. Adequate resources should be provided to enforce legal protection, and to educate the fishermen and the public about the need for protection, and the penalties for violations.

The Government of the Punjab should be urged to establish a dolphin refuge between Guddu and Taunsa barrages, and to give attention there not only to protection of the dolphins themselves, but also their habitat.

The needs mentioned above have been incorporated into the IUCN/SSC Action Plan and given the highest priority (Perrin, 1989).

Captive Breeding About 11 live specimens have been taken. Three young females went to an aquarium in the USA in 1968, where they survived for a few weeks. Another female was taken to the same institution in 1970. Several expeditions were mounted by the Brain Anatomy Institute of Berne, Switzerland. It appears that seven animals were successfully live-captured and taken, together with one incidentally caught animal, to Switzerland for research. Some tens of animals either died or were released during catching attempts. Most of the animals died soon after transport, although one survived for a year, one for three years and one for five years. No details of husbandry appear to have been published for the USA animals, and few for the Swiss animals (Collet, 1984; Pilleri, 1970; Pilleri, 1976; Herald *et al.*, 1969; Reeves and Brownell, 1989).

Although the wild population is in a critical state, recovery in the wild under protection does appear to be possible. Therefore additional effective protection for the wild population would seem more appropriate than any captive breeding efforts at present. However, if any new threats arise or additional effective protection in the wild proves to be unfeasible, the establishment of captive or semi-captive breeding groups should be considered. There is certainly no case for the removal of animals for any other purpose until the wild populations have been re-established at a much higher level throughout the present range.

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BAIJI **ENDANGERED**

Lipotes vexillifer Miller, 1918

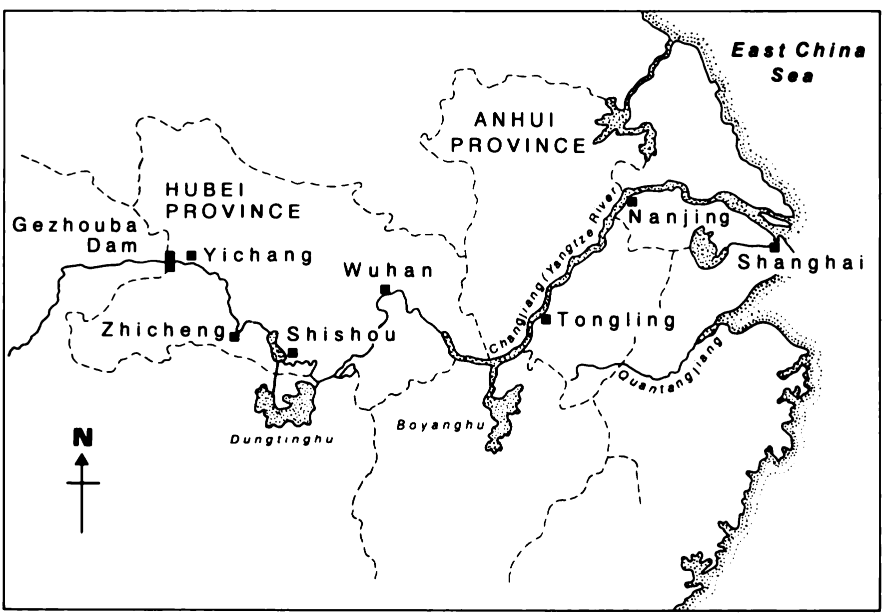
Suborder ODONTOCETI Family PONTOPORIIDAE

Summary The baiji is among the rarest and most Endangered of cetaceans. This dolphin is only found in China where, despite extensive legal protection, the population (of about 300 individuals) appears to be declining and the species is liable to become extinct in the wild unless extensive new conservation measures are implemented. The major problems are incidental catching, collisions with boats, use of explosives, extensive habitat damage and possible food shortage.

Tentative protection plans include increased educational efforts and reserve areas in some parts of the river, with harmful fishing activities banned, speed limits set for vessels and enforcement staff. Two semi-natural reserves are being set up, where it is hoped to establish semi-captive breeding groups. Additional assistance from the international conservation community is required for all these projects.

Distribution The baiji is found only in the Changjiang (Yangtze river) in China. Although the presence of this dolphin in the Changjiang is noted in documents going back at least 1,600 years, the detailed historical distribution is not known. However, it appears that the species was found from the mouth of the river to just above Yichang, where the Three Gorges form a geographical barrier. Dungtinghu lake was incorrectly reported to be the only habitat (Miller, 1918).

Map 3. Distribution of the baiji in the Peoples' Republic of China



Modern investigations show that the baiji is distributed chiefly along the middle and lower reaches of the main river. The dolphins do enter both the large lakes (Dungtinghu and Boyanghu), but only in the flood season when water levels are high. In particularly wet seasons some individuals have been known to cross the Boyanghu to the tributary river Fu. The animals do not spend the winter in the lakes, but return to the main river as the water levels subside. One specimen was collected from the Quantangjiang (Quantang river) during the major floods of 1954 (Chen, 1989).

The lack of a permanent modern population in the major lakes is attributed by Chen *et al.* (1980) to the increasingly restricted surface area of the lakes. They note that as early as 1921 Pope (1940) had to wait a month to catch a specimen, although at that time the lakes were still relatively deep and wide. The damming of lakes and dredging of navigation channels, including clearing reefs and sandbanks, have restricted habitat and removed preferred areas (Zhou, Quian and Li, 1977). The distribution appears to be becoming progressively more restricted everywhere. Baiji are now rare below Nanjing, where they were once common, and they are very rare above Zhicheng (Chen and Hua, 1989; Zhou and Li, 1989; Zhou, 1986).

Chen (1989) provides a recent review, as does the Workshop on Biology and Conservation of the Platanistoid Dolphins (Perrin and Brownell, 1989).

Population No estimates of past numbers are available, but fishermen believe that the animals were more common in the 1950s than at present (Chen, 1989). The current estimate for the entire population is 300 individuals, of which 100 are in the lower region of the river. The results of several censuses suggest that the population is declining, but as yet no extrapolation has been made to predict when extinction would occur if the present decline continues (Perrin and Brownell, 1989).

Habitat and Ecology The maximum size of males is about 2.30m and of females 2.50m (Zhou, 1986). Length at birth is about 0.9m, and sexual maturity is attained at about 2m for both sexes. Births are known to occur in the main river at least from January to March. Mating has not been observed, and the length of gestation is not known.

The baiji appear to take any available species of freshwater fish, the only selection criterion being size. No specimens larger than 6.5cm in width or over 250g in weight are taken. The quantity taken in the wild is not known, but captive specimens average a daily intake of 10-11% of body weight. In winter consumption rises to 16%, but falls to 7-8% in summer. The dolphins particularly frequent regions where tributaries enter the main river and where the river is connected to lakes, as well as the vicinity of sandbanks and the ends of islets. These are all places where most fish gather. Hunting mainly takes place in the early morning and at nightfall (Zhou, Quian and Li, 1977; Chen, 1981; Chen, 1989).

The baiji usually occurs in small groups of 1-4, and rarely in groups of up to ten. The large groups appear to be made up of several sub-groups. They may rest in the quiet area in the centre of eddies near sandbanks. A group may stay in one eddy for 5-6 hours. When the dolphins leave an area, they appear to leave as a group (Zhou and Li, 1989; Hua, Zhao and Zhang, 1989).

Threats The skin, meat and fat of the animal are edible and may also be used in industry and medicine. It is said that the fat is a very effective treatment for burns (Chen and Chen, 1975). There seems never to have been an organized fishing operation, but the baiji may be accidentally caught in other fishing operations, particularly for the sturgeon *Acipenser sinensis*.

The baiji is subject to several forms of human-induced mortality. The greatest problem seems to be entanglement in bottom longlines set to snag bottom feeding fish.

The gear for this type of fishing is called 'rolling hooks'. When a dolphin investigates a hooked fish it too may become snagged by the very sharp barbless hooks tied to the longline every few cm. This gear is now illegal, but still widely used. Some dolphins are also captured incidentally in gillnets and fishtraps. Fishing gear may account for about half of the known deaths (Lin, Chen and Hua, 1986; Zhou and Li, 1989) or possibly more (60%: Chen, 1989).

Some animals are thought to be killed by boat propellers. This problem seems greatest in the lower river, where 32% of known deaths were thought to be caused by collision with boats, whereas only 6% are thought to have died in this manner in the middle reaches of the river. The difference may be due to the different amount of boat traffic in the two areas. Traffic is expected to double on the lower river in the next 10 years (Zhou and Li, 1989; Chen, 1989). There are no available estimates for future traffic on other parts of the river. It is not known whether any particular type of boat is involved (Perrin and Brownell, 1989).

Explosions account for about 15-20% of the known deaths. Dynamite is used primarily for construction purposes, but occasionally it has been used illegally for fishing. In one instance, six dolphins were killed by one construction blast. Some dolphins are known to have been beaten to death by local people, when the animals stranded on sand bars, but this is now rare (Zhou and Li, 1989; Chen and Hua, 1989).

In 1984, 20 animals were reported dead in the section from Honghu to Wuhu. Of these, 7 were killed by explosions, 10 in fishery operations, 1 by electric shock, 1 stranded alive and died before rescue, and 1 died of unknown causes. Between May 1984 and July 1985 an education campaign took place, aimed at increasing awareness of the need to protect the dolphins. Fishing by electricity, dynamite and poison was banned. Only one death has been reported from this area since 1985 (Chen and Hua, 1989).

There has been considerable damage to the habitat of the baiji. Construction of dams and other barriers along the river and its tributaries has led to changes in fish abundance and distribution (Zhou and Li, 1989; Chen and Hua, 1989). A single hydroelectric dam, Gezhouba, was completed in 1983 below the Three Gorges, and a high dam is planned in the Three Go:ges region. Both these sites are above the known historical distribution of *Lipotes* (Zhou, 1986). Environmental impact research has not yet detected downstream effects on fish populations, with the exception of the sturgeon, which is presently being cultured and released into the river. The effects of lowered siltation on the habitat are unknown. (A study of the likely effects of the proposed Three Gorges dam has been carried out by the Institute of Hydrobiology, Academica Sinica at Wuhan, but is not yet available in translation.) Further discussion of the detrimental effects of dams on dolphin habitat is given in the *Inia* review.

The banks of the Yangtze have been extensively modified to prevent destructive flooding of agricultural areas, thus reducing the floodplain area. The most important modification is probably the isolation of most of the lakes along the river by sluice gates that retain the water in the lakes during the dry season for irrigation and fish culture. This may have affected species composition and biomass of fish in the river, because such lakes are important nursery areas (Perrin and Brownell, 1989). The dredging of navigation channels, including clearing reefs and sandbanks, may remove preferred areas (Zhou, Quian and Li, 1977).

Some fish stocks appear to have been greatly reduced through overfishing, pollution and a reduction in the size of lakes, which have been drained to create farmland. This reduction in the fish populations could be a major factor in the decline of the baiji (Zhou and Li, 1989; Chen and Hua, 1989; Lin, Chen and Hua, 1986).

Conservation Measures The species is listed on Appendix I of CITES. No international trade is reported (CMC, 1987). As this species is found only in the Peoples Republic of China, and inhabits a waterway of major economic importance, there is probably little scope for further international legal protection.

In China, the baiji has been protected since 1949. It is listed as a 'Protected Animal of the First Order' and its protection has high priority. Violators of the protection laws are prosecuted when caught. Most of the deaths are accidental however, and it is difficult to change many of the responsible factors: the heavy boat traffic and fishing pressure are inevitable, for example. The species has been the focus of extensive research in China in the past few years. Much of this research was presented at the Workshop on Biology and Conservation of the Platanistoid Dolphins, in 1986 (Perrin and Brownell, 1989).

In one area where the baiji is most common (Anhui Province) a council has been set up called the '*Lipotes vexillifer* Conservation Association'. The Association is to spread information about the baiji, especially among fishermen along the Changjiang. An increased awareness of the baiji may have accounted for the rescue of several animals which had been hit by propellers (Wang, 1989).

In addition to the passage of laws and regulations, and an education campaign, a national conference on the protection of the baiji was held in Wuhan in 1985. This resulted in several new cooperative efforts, including a joint census survey in early 1986 by the research groups at Wuhan and Nanjing. The incidental death rate may have declined as a result of the education campaign. However, the difficulty in dealing with the dolphin/fishery problem was emphasised; fishing with traditional methods is an important part of the local economy in many places. It is also difficult to know what do about the increasing boat traffic, because that too is important to the expanding economy (Wang, 1989).

Tentative plans for further protection include setting up reserve areas in the river, where harmful fishing activities would be prohibited and speed limits set for vessels, establishment of stations with enforcement staff and patrol vessels (for the protection of other endangered species such as the sturgeon as well as for the dolphin), and increased educational efforts. The need for additional assistance from the international conservation community has been stressed (Wang, 1989).

Additional recommendations made by the Workshop for baiji conservation include making every effort to eliminate or reduce the illegal 'rolling hook' fishery in regions of high dolphin density; development of procedures to ensure that dolphins are absent or removed from the area before explosives are used (see *Inia* review for one possible method) and research work aimed eventually at compiling a catalogue of every individual dolphin in the river, obtaining more information about breeding and social behaviour particularly in relation to captive breeding, and investigation of propeller wounds to determine the type of vessels involved (Perrin and Brownell, 1989).

These needs have been incorporated into the IUCN/SSC Action Plan, and given the highest priority (Perrin, 1989).

Captive Breeding Survival time for four specimens kept in captivity at Wuhan between 1980 and 1986 was from two and a half months to at least nine years. The adult male QiQi, who arrived in 1980 and is still alive, showed peaks of sexual activity in April-May and in August-September, although some sexual activity took place throughout the year. Resting behaviour took up a larger proportion of time in winter and summer than in spring and autumn. This animal exhibited marked food preferences, selecting species with high fat content. This is in contrast to the more varied composition of stomach contents from animals in the wild. The captive dolphins are less active at night than during the day (Chen and Liu, 1989).

It is thought that the decreased levels of activity in winter may be a form of thermoregulation, as the pool is somewhat colder than the river in winter. This may also account for the preference for fish with high caloric content. The decreased activity in summer may also be related to pool temperature, which is rather higher than in the river (Perrin and Brownell, 1989). Further details of housing, husbandry and medical treatment are given by Chen (1989).

In view of the serious situation in the wild, a captive breeding programme is planned. Two semi-natural reserves have been proposed. At Shishou in Hubei Province (Chen and Hua, 1989) a by-passed oxbow of the river is the proposed site. There is some fishing there, with an annual yield of about 650 tonnes, but the proposers feel that there would be enough fish for the dolphins as well. It is planned to reduce, but not eliminate, the fishery. The oxbow was by-passed by a channel to improve transport; it is still connected to the river at high water (about five months of the year). It is planned to plant a cordon of willow trees across the entrance from the main river, to prevent the dolphins escaping, but it is not known whether this will be effective. Fifty percent of the fish species in the oxbow breed in still water, so complete isolation from the main river would not destroy the fish fauna, although the species composition may change.

The semi-natural reserve at Tongling in Anhui Province (Zhou and Li, 1989) has been approved by the National Environment Protection Agency, and some funds have been obtained for it. A small holding pool has been constructed. The site is a channel 1,550m long and up to 220m wide, between two islands, closed off from the main river by earth dams with sluice gates. There is no fishery in the channel and no nearby discharge of effluents. Water flows throughout the year. There are not enough fish here to support a group of dolphins, and food fish would have to be reared in nearby fish culture ponds, or provided in other ways.

The Workshop considered the question of the minimum size of the captive breeding population. Small populations lose genetic variability at a rate inversely proportional to population size. Based on a goal of preserving 90% of genetic diversity for 200 years, and using estimates of life-history parameters for the baiji, a recommended effective (i.e. contributing to the gene pool) founder population of 25 dolphins was estimated. Not all the captive dolphins need to be kept in the same place, nor do they all need to be brought into captivity immediately; the captive population can be built up through captures over a period of years. The final effective captive population (including dolphins born in captivity) should be 200-300; at that point re-introductions can be made into the wild. It is especially important that the entire captive population not be held at one site, because of the possibility of complete loss of the animals in one place through natural disaster, disease or accident (Ralls, 1989; Perrin and Brownell, 1989).

The Workshop pointed out the strong need at both sites for systematic monitoring of the quantity and nutritive quality of the fish for the dolphins, through at least one full cycle of flood and low-water seasons. The possibility that contaminants may concentrate in the water at both sites needs to be explored. The Workshop was very concerned about what may happen when additional high dams are built on the main river. Such dams can be expected to change the river dynamics drastically, possibly affecting the sites adversely. They advised thorough surveys and investigation of the effects of foreseeable changes before any dolphins are placed in the reserves. The probable effects on the fish populations should also be evaluated.

The Workshop recorded that the dedication and enthusiasm of the scientists, local authorities and citizens at both sites was impressive. There was very good potential for saving the baiji from extinction with this approach, and it was hoped that work at both sites would proceed as soon as possible (Perrin and Brownell, 1989).

Remarks The name 'white flag dolphin', by which this animal is widely known in non-chinese literature, is a mistranslation and should be 'white fin dolphin'. Baiji, beiji, pei ch'i and pai ji-tun are various transliterations of the present chinese name. The ancient name was 'ji' and the word 'bai' (meaning white) is a later addition.

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FRANCISCANA **INSUFFICIENTLY KNOWN**
Pontoporia blainvillei (Gervais and d'Orbigny, 1844)

Suborder ODONTOCETI Family PONTOPORIIDAE

Summary Although there are no estimates of abundance of the franciscana, it is suspected that the large and incompletely monitored incidental take in gillnets throughout the range has depleted the species and it is therefore listed as Insufficiently Known. This take has existed for at least the last 30 years, and may have had a significant effect on the population(s) of this endemic coastal species. Research is urgently required to obtain information on population size, movement patterns, stock identity, and on the extent and effect of the incidental take.

Distribution This is the smallest of the platanistoid dolphins, and the only one that occurs in marine waters. Franciscanas are found in coastal central Atlantic waters off South America. The known range is from the Doce river (19°37'S), Regencia, Espirito Santo, Brazil, southward to Peninsula Valdez (42°30'S), Argentina. In recent years these dolphins have not been observed south of Bahia Blanca, Argentina. There are no records from the Uruguay and Parana rivers which empty into the La Plata estuary, although the species is recorded as far into the estuary as Buenos Aires. There seems to be some seasonal movement, with the largest catches on the northern coast of Uruguay in summer (January-February) but there is no information to show whether they spend the rest of the year in the south or north. The 20 fathom line is thought to be the limit of distribution out to sea (Brownell, 1975; Pindeo, Praderi and Brownell, 1989; Brownell, 1989).

The species has recently been reviewed by Brownell (1989) and by the Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989).

Population There is no information on past or present abundance, but the species is said to be relatively common on the Uruguayan side of the Rio de la Plata (Brownell, 1989).

Habitat and Ecology Most existing biological information is derived from individuals taken incidentally in fisheries. The franciscana is one of the smallest cetaceans, with adult males ranging between 1.25 and 1.58m in total length, and adult females ranging between 1.34 and 1.74m. Length at sexual maturity is between 1.21 and 1.37m in males, and between 1.37 and 1.47m in females, with weights of 24.5-29kg and 30-34kg, respectively. Physical maturity is attained soon after the onset of sexual maturity. The oldest female examined was 13 years old, and the maximum age in females may be only about 15 years. The oldest male was 16 years old, and the maximum life span may be only about 18 or 20 years (Brownell, 1989).

Deposition of tooth growth layers is annual, with the formation of an unstainable layer between August and November (austral winter). Sexual maturity is attained in females between two and four years of age, and in males between two and three years of age, according to the number of growth layers in the teeth. In Uruguayan waters, calves are born at about 0.75-0.80m in length. Neonates between 0.59 and 0.77m in length have been reported from Brazilian waters, although the smaller specimens may have been aborted after the mothers were caught in gillnets. Gestation lasts around 10.5 to 11.1 months. Lactation may last for at least nine months, but calves begin to eat solid food from about three months of age. Calving in Uruguayan waters mainly occurs in

November and December. In southern Brazilian waters most calving takes place in November. Pregnant and simultaneously lactating females are sometimes encountered, and a two-year breeding cycle is reported (Brownell, 1989).

At least 24 species of fish (mainly bottom feeding), three species of shrimp and one species of squid are eaten, with considerable regional and seasonal variation in the proportion of each species taken. At least in summer, feeding may occur twice a day. The diet also varies with sex and age. The franciscana is extremely difficult to see in the wild, but it does not appear to form large groups. Nothing is known of movements or the mating system (Brownell, 1976; Pinedo, Praderi and Brownell, 1989; Brownell, 1989).

Threats The status of this species is uncertain, as there are no estimates of abundance, and it is not known whether more than one stock exists. The coastal-estuarine habitat is subject to destruction from pollution, boat traffic, industry, tourism and other fishing operations.

At least 2,444 *Pontoporia* were taken in the shark fishery in Uruguay between 1974 and 1985. This fishery started in 1942, and has always included an incidental take of these dolphins. Fishermen at Punta del Diablo estimated annual takes of about 2,000 in the late 1960s, and 1,500 in the early 1970s. The take has been decreasing since 1979, because of the decline of the shark fishery. At least 723 dolphins were taken in southern Brazil between 1976 and 1985. The number taken annually from 1983 to 1985 was lower than during the period 1976-1981, although fishing effort increased during this time (Brownell, 1989). Monitoring of incidental take in Argentina began in 1985. The catch is at least 340-350, not including animals captured in the Mar del Plata, one of the most important fishing areas, and may be greater in total than that in Uruguay (Perez-Macri and Crespo, 1989). The most dangerous type of gear appears to be set gillnets with a 30cm mesh size (Perrin and Brownell, 1989; Praderi, Pinedo and Crespo, 1989).

In the past, dolphins entangled in nets were discarded, but in more recent years they were part of the Uruguayan fishing operation and were assigned a value, which was always less than for sharks or other commercial species. In Punta del Diabolo, the main fishing area, the blubber oil was sold to the tanning industry. The oil was also used to waterproof boats and as a lubricant for pulleys and capstans. The meat was thrown into the sea or used as pig feed. In the Coronilla area, the entire carcass, together with the shark waste, was used for fish flour (Brownell, 1976). The products mentioned are not reported to enter international trade. The Uruguayan shark fishery fluctuates, depending on economic conditions. At present there appears to be a lull, with consequent decreases in dolphin mortality, but the fishery could revive at any time if markets improve (Praderi *et al.*, 1989).

Conservation Measures Countries of origin: Argentina, Brazil and Uruguay. *Pontoporia blainvillei* is listed on Appendix II of CITES: Argentina, Brazil and Uruguay are Parties. The movement of one skeleton from South Africa to USA in 1985, for scientific purposes, is recorded (CMC, 1987). However, Brownell (1988) reports that the specimen travelled from USA to South Africa. There are no protection agreements between the three countries of origin. As a coastal species, there may be scope for further international protection of habitat, for example under WHC, the Ramsar Convention or CMS. There is no legislation concerning the protection of cetaceans in Uruguayan waters, although hunting and trade in most indigenous wildlife is forbidden under Decreto No. 261 of 1978. Two of the three coastal National Parks might protect some habitat. The harassment, hunting, fishing or capture of franciscanas is forbidden in Brazilian waters (011-SUDEPE, 1986). Directed take of marine mammals is forbidden in Argentina, but incidental catch is not included. There are no reserves in any of the countries of origin which specifically protect the species.

The Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989) was concerned about the large and incompletely monitored incidental take. The take was considered to be potentially dangerous to an endemic coastal species, but the effect is impossible to evaluate because of the lack of information on total population size, movement patterns and stock identity. Research to obtain information on these problems should be given high priority.

Efforts to monitor incidental take should continue, and be expanded to cover all the relevant fisheries. The possibility of modifying the gillnets to reduce the number of dolphins captured should be explored (Perrin and Brownell, 1989).

The only existing research programmes serving conservation and management are those based on animals taken incidentally in the three countries of origin. Funding has been sporadic, and at very low levels (Perrin and Brownell, 1989).

A regional approach to research, conservation and management is very important, because it is possible that a single population is being exploited by Brazil, Uruguay and Argentina (Perrin and Brownell, 1989).

The Governments of Brazil, Uruguay and Argentina should collaborate to develop a regional plan for coordinated research and conservation. This should include a training programme for national biologists. National plans of action should be developed to assess and monitor the population(s), including comprehensive programmes for the collection of incidental catch statistics. National protective legislation should be improved where necessary, and enforcement of existing laws improved (Perrin and Brownell, 1989).

These needs have been incorporated into the IUCN/SSC Action Plan and given high priority (Perrin, 1989).

Captive Breeding This dolphin has not, as far as is known, been kept in captivity. The Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989) recommended that a few specimens could usefully be brought into captivity, to allow investigation of echolocation characteristics and capabilities. This information could be useful in designing less damaging fishing gear.

If any animals are brought into captivity for this purpose, the opportunity should also be taken to study basic biology and behaviour, and to calibrate ageing techniques. This information would not only be useful for conservation and management of the wild population, but may provide details useful for the conservation of the more threatened platanistoid dolphin species, as well as base-line information in case conservation through captive breeding ever became necessary for the franciscana.

Remarks The Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989) recommended that this species be listed as Vulnerable. However, since it is only suspected, and not definitely known, to have been seriously depleted, it is listed here as Insufficiently Known. It should be noted that an Insufficiently Known classification does not in any sense imply a more favourable status than Vulnerable.

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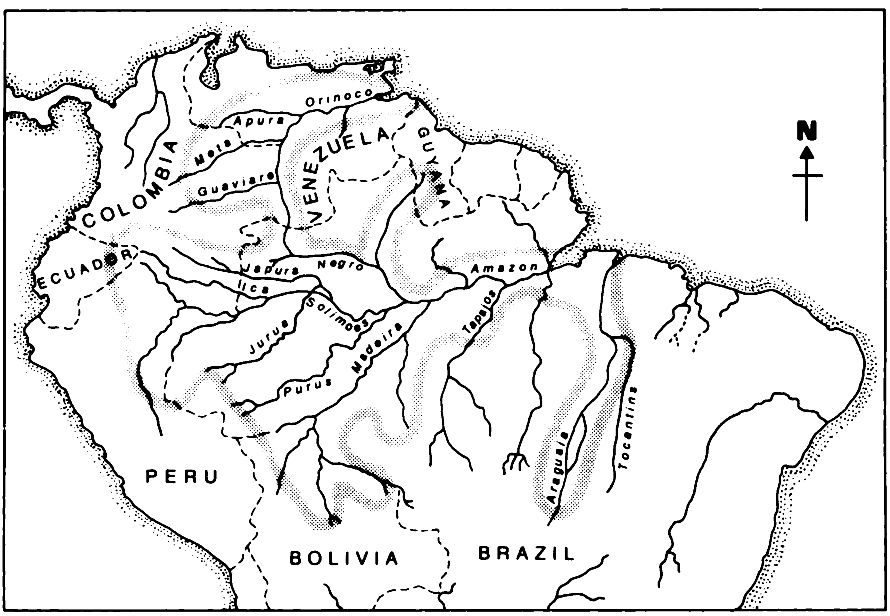
BOTO VULNERABLE
Inia geoffrensis (de Blainville, 1897)

Suborder ODONTOCETI Family INIIDAE

Summary Although the populations are suspected to be in fairly good condition today, the species is listed as Vulnerable because of serious threats throughout its range. These include incidental catching, hydroelectric development, deforestation and pollution. There is a major need for all levels of society and government in South America to become aware of the threats to the aquatic ecosystem. This is absolutely necessary if existing protective laws are to be properly enforced, and additional protection and reserves established.

Distribution The boto (pronounced 'boatoo') is found in all the main rivers in the Orinoco and Amazon basins: populations existing in Venezuela, Colombia, Ecuador, Guyana, Peru, Bolivia and Brazil. *Inia* is more common at the junctions of rivers and tributaries, it will enter the 'igapo' or inundated forest as well as lakes. During the dry season *Inia* is almost completely sympatric with *Sotalia fluviatilis*, as both dolphins are restricted to the larger water bodies. When the rivers are in flood, *Inia* is then able to use both the flooded forest and grasslands, even swimming among the trees. Shallow water is frequently used for feeding. The principal limits to the distribution of *Inia* seem to be impassable rapids and possibly cold waters from the smaller tributaries near the Andes at the headwaters of the Amazon basin. *Inia* is capable of passing extensive rapids, which even boat traffic cannot use. Animals are found in water from 23-30°C under natural conditions. They are not found in the estuaries (Best and da Silva, 1989a).

Map 4. Distribution of the boto in South America (shown by the wide dotted strip)



In general, the past and present distribution are considered to be similar, principally because there is no evidence of major exploitation, and habitat degradation is localized within the river basins. This situation may change rapidly over the next few years (Perrin and Brownell, 1989).

Only one species of *Inia* is recognised at present, but further work is needed to clarify the status of the three populations (sometimes described as subspecies) at least partially isolated in the Orinoco basin (*'I. g. humboltiana'*), the upper Madeira River region above the Teotonio rapids (*'I. g. boliviensis'*), and the Amazon basin excluding the upper Madeira (*'I. g. geoffrensis'*) (Perrin and Brownell, 1989). The species has recently been reviewed by Best and da Silva (1989a) and by the Workshop on Conservation and Biology of the Platanistoid Dolphins (Perrin and Brownell, 1989).

Population There are no estimates of total past or present populations. *Inia* is less common than *Sotalia fluviatilis* in the river channels and lakes, but because of its wider distribution may have a larger total population. In nine line-transect surveys of the Amazon between Manaus and San Antonio de Ica (approximately 1,200 km), an average of 322 (± 55) *Inia* were seen, and extrapolated estimates of abundance are being developed. There are a number of other abundance estimates in the literature, but because of differences in survey techniques, it is not possible to combine or compare them. In general, the populations are thought to be in fairly good condition at present (Best and da Silva, 1989a; 1989b).

Habitat and Ecology Adult males reach a length of 2.55m and weigh up to 160kg; females reach 1.96m and 96.5kg. The longest male reported (Peruvian) was 2.74m and the longest female (Orinoco) 2.28m (Best and da Silva, 1989b). Growth data are only available for a few captive *Inia* and these range from 20.7cm/year in young animals to 3.4 - 5.9cm/year in larger individuals (Caldwell and Caldwell, 1966; Klocek, 1981). Weight gain may range from 4.8kg/year over long periods of captivity to as high as 21.9kg/year for growth spurts (Herald, 1967; Klocek, 1981; Penner and Murchison, 1970).

Reproduction is reviewed by Best and da Silva (1984). Age at sexual maturity is not yet known, although males appear to reach sexual maturity, as indicated by combined testicular weights exceeding 0.4% of body weight, at body lengths over 1.98m. Testis size increases curvilinearly with body length. There is no evidence for seasonal changes in testis size. Females become sexually mature between 1.60 and 1.75m, based on the presence of *corporea lutea* in the ovaries. Gestation is estimated at 10-12 months, and the young are born at a length of about 0.79m. Lactation appears to be prolonged (well over a year), and animals concurrently pregnant and lactating are recorded.

Reproductive seasonality in the Amazon is synchronised with the annual river cycle. River levels start to fall from July, and are lowest (up to 10m change) in November. Reproductive seasonality is evident, and births coincide with the beginning of the drop in water level, which would be when fish in the flooded part of the forest and grasslands begin to be forced back, and concentrated, in the remaining waterways. By synchronising the birth period with this time of year, *Inia* females may offset the high energy demands associated with the latter part of pregnancy and subsequent lactation through the greater availability of fish, as these are forced out of the flooded forest and grasslands by the receding waters (Best and da Silva, 1984).

The boto is a generalist feeder; the diet is known to include over 50 species of fish, but there is very little overlap with fish species important in commercial and subsistence fisheries. The diet varies markedly on a seasonal basis in synchrony with the flood cycle (Best and da Silva, 1989a; 1989b).

Typically for riverine dolphins, *Inia* are predominantly solitary, with only 12-26% of sightings involving pairs, and larger groups rarely seen. There do not seem to be seasonal differences in group size (Best and da Silva, 1984).

Behaviour in the wild is described by Layne (1958); activity is more intense during the early morning and late afternoon, when a marked movement into lakes from the river was noted. Weather conditions affected activity, with more dolphins in evidence on cloudy or rainy days. Behaviour in captivity is described by Layne and Caldwell (1964).

The species appears to be non-migratory, in that regular long journeys do not appear to be undertaken. There are, however, seasonal changes in range, relating to the flood cycle of the rivers. Several authors (Trebbau and van Bree, 1974; Pilleri, 1969; Pilleri and Gihr, 1977; Layne, 1958) imply the use of territories or home-ranges by *Inia*. Other observations (Magnusson *et al.*, 1980) indicate an apparently random distribution, signifying that if they have home-ranges, these are large and overlapping. Tagging studies in the central Amazon have shown that the same individuals may remain in the same area for periods of over a year, although it was not possible to determine the exact area used by each animal (Best and da Silva, 1989b).

There are some reports that *Inia* may assist fishermen by helping to localize fish schools or by driving fish. Wild *Inia* are extremely curious, and there are numerous accounts of them grasping paddles in their mouth and rubbing themselves on the undersides of boats. At least one animal would play with swimmers (Best and da Silva, 1989b).

Inia is associated with a number of local stories: it turns into a handsome young man and seduces unmarried girls (Lamb, 1954; Santiago, 1967); it becomes a lovely young girl who leads young men to the water, seizes them by the waist and takes them away for ever (Bates, 1962; Allen and Neill, 1957); it attacks menstruating women (Carvalho, 1963); and the souls of drowned people become dolphins. *Inia*, in contrast to *Sotalia* in the same area, is regarded as a 'bad' spirited animal. There is a strong belief throughout the region that sight of this dolphin is a sign of misfortune and danger, which has served to protect the animal in past times (Meschkat, 1961). It is believed that if *Inia* oil is burned in a lamp, anyone looking at the lamp will go blind (Cabrera and Yepes, 1940).

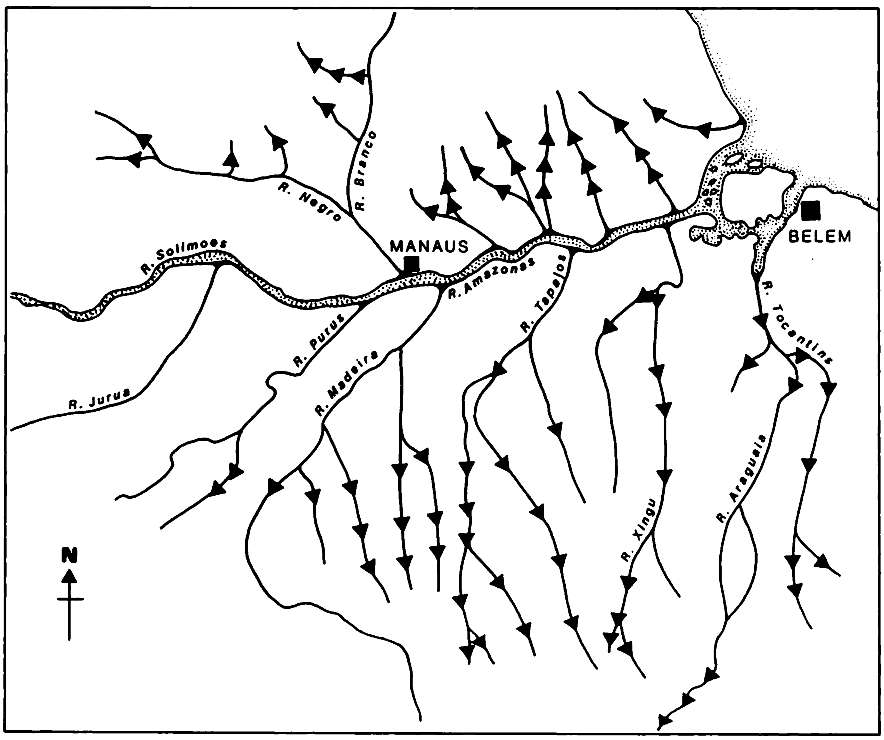
Threats The populations are at considerable risk, because of several threats to the Amazon-Orinoco aquatic ecosystems. These threats include interactions with fisheries, hydroelectric development, deforestation, and pollution from agriculture, industry and mining. The situation was extensively reviewed by the Workshop on Biology and Conservation of the Platanistoid Dolphins (Perrin and Brownell, 1989).

Hydroelectric development poses the biggest threat to *Inia*. The first three dams on the Brazilian Amazon became operational between 1917 and 1984. Tucurui, the fourth largest dam in the world, dammed the lower reaches of the Tocantins river, potentially affecting *Inia* populations above and below the site. A short study was made of dolphin density and food habits before closure of the dam. A follow-up study of dolphin density after closure is needed. Twenty-seven additional potential dam sites have been identified on the Tocantins-Araguaia rivers, and a dam at the mouth of the Araguaia river is about to be constructed. A total of 80 potential dam sites have been identified for the Brazilian Amazon region, and it is proposed that about 40% of Brazil's future energy production could be produced by hydroelectric plants (Best and da Silva, 1989b).

In the Orinoco river basin, the Guri dam, recently constructed on the Caroni river, a tributary of the Orinoco, has caused apparent depletion of *Inia* in its lower reaches. It seems that few, if any, additional dams are planned for this river in Venezuela. In Colombia, the dams have been constructed in the headwaters, where there is greater topographic relief (Best and da Silva, 1989b).

Dams can cause several problems: the food supply for dolphins above a dam may be greatly reduced, as migratory fish are no longer able to spawn; habitat for many fish species is reduced as levels of oxygen in the water are reduced; and levels of hydrogen sulphide may become high enough to cause die-offs of fish. In one impoundment, the number of species of fish was reduced by 77%. For *Inia* to adapt from a general feeding pattern involving 50 species of fish to reliance on only a few is likely to be difficult. Also, as the flow of fresh water is reduced, the mouth of the river becomes more saline; this may adversely affect nursery areas for many fish species of importance to the river (Perrin and Brownell, 1989). In addition to the problems of habitat degradation, dams may break dolphin populations into small, isolated groups. Such small populations have much higher extinction rates than larger ones, because of accidents and reduced genetic variability (Ralls, 1989).

Map 5. Existing and proposed dams (shown by arrowheads) in the Amazon river basin



Another major threat to *Inia* and all the other components of the riverine ecosystem, is deforestation. Many species of fish depend heavily on fruit and seeds that fall from trees when the flood plain is inundated annually. Much of the flood plain forest is being cut down by settlers to create pasture and croplands. The threat is critical to the most important commercial species of fish in the Amazon, and to many of the fishes in the diet of *Inia* (Perrin and Brownell, 1989).

Heavy pollution from several sources is potentially harmful to the aquatic ecosystem and the dolphins. These include agricultural pesticides (some of which are banned in developed countries, but exported by them to Brazil and other developing nations), mercury from extensive gold mining, and massive effluent (containing N, P, Cl, Al, Ba, Ca, Fe, K, Mg, Na and Si) from wood pulp mills. Very little work has been done to determine environmental levels of the contaminants or their concentrations and effects in the flora and fauna (Perrin and Brownell, 1989).

Because of the present rapid growth of commercial fisheries in the Amazon basin (a fourfold increase over the last 25 years), incidental mortality in fishing operations may become a threat to the dolphin populations in the future. There are no estimates of present incidental take. Of 34 such animals examined, 70% died in lampara seine nets and 30% in gill nets. Two animals were harpooned, possibly to prevent interference with the fishing. *Inia* have learned to steal fish from nets and are constantly associated with the lampara seine operations, where they will enter the net to catch fish trapped inside. Where fish are entangled in nets, the dolphins tear them out, often tearing the net in the process and releasing the rest of the catch. There are places in the Amazon where lampara and gill nets cannot be used because of such dolphin predation (Best and da Silva, 1989b).

Unknown numbers of dolphins were killed during oil prospecting along the main channels of the Amazon river. Large charges of several hundred pounds of dynamite were exploded along the length of the main tributaries, and the Amazon itself (Best and da Silva, 1989b).

In Venezuela an interesting way was found to avoid dolphin mortality when it became necessary to dynamite some rocks which were endangering shipping at the Canal del Infierno and the Vuelta del Torno on the Orinoco river. For about ten days before the operation a boat with people blowing whistles and waving flags passed through the area to a point well away from the blasting site, where about 200kg of 'sardines' were thrown into the water for the dolphins to feed upon. By the last day it was estimated that there were about 200 *Inia* around the boat, and that there were no dolphins killed by the blasting (Best and da Silva, 1989b).

Fishing with dynamite is illegal, but is still commonly used and may kill dolphins. However, a more serious problem is the fact that some *Inia* learn that an explosion means a supply of easily gathered fish, and converge on the explosion area. The dolphins then compete directly with the fishermen in collecting the fish, angering the fishermen, who attempt to drive away, or sometimes, to kill the dolphins (Best and da Silva, 1989b).

Best and da Silva (1989b) report that recent accounts that *Inia* and other dolphins are captured on a wide scale to obtain eyes and genitalia are incorrect. Although these items are sold as charms, they are obtained from animals captured incidentally in fishing operations, and sold to help offset any damage done to the nets. The price obtainable by fishermen for the parts is low, and further costs are incurred for ceremonies before the parts are considered to be effective as charms. Therefore, the economic incentive to capture the dolphins specifically to obtain these organs would be low, particularly considering the high cost of the nets which would have to be used, and the time and effort involved in repairing the nets. They also report that press accounts of dolphins being stranded due to the draw-down of water for irrigation are greatly exaggerated. This occurs only in the Formoso River, and is not common. Only about 40 animals are at risk (see below under Captive Breeding).

There was formerly a small catch in Brazil for oil. Today, at least in Brazil, there is no direct fishery on any level. The oil was used as a treatment for rheumatism (Best and da

Silva, 1989b). Other uses of body parts of accidentally caught animals are: the fat as a cure for asthma, and an amulet made of a tooth to ward off aches, especially toothache (Cabera and Yepes, 1940; Carvalho, 1963).

Conservation Measures Countries of origin: Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru and Venezuela. *Inia* is listed on Appendix II of CITES. No international trade has been recorded so far (CMC, 1987). Several other international agreements may provide opportunities to protect river dolphins in South America. These include WHC, NPWH, the Ramsar Convention and CMS. There are also several relevant agreements between the Amazonic states, for example TAC, CP and PB (Perrin and Brownell, 1989; Best and da Silva, 1989b).

The three defined sub-populations are sufficient for management purposes, as they encompass different geographical areas and countries, and as such should permit separate treatment of conservation problems as they pertain to each region. Research on the question of whether populations of dolphins are genetically separable between the different major tributaries is of the utmost importance for the conservation of the species and its natural genetic variability. If hydroelectric dams isolate, and possibly even exterminate, upstream populations, then the contribution of these populations to the overall genetic variability of the population will be reduced each time a major tributary is dammed. *Inia* appears to be relatively sedentary, and the potential for natural isolation within a tributary of the Amazon is high, especially towards the headwaters. It may be that populations which are genetically unique to each tributary are at risk when a dam is constructed, instead of simply diminishing the general population through degradation of the habitat (Best and da Silva, 1989b).

Inia has been protected in Brazil since February 1986, but enforcement of the law has been very poor. Hydroelectric developments in Brazil have recently been obliged to assess and ameliorate likely environmental problems. If a net loss is predicted, the company must not only minimise such loss, but also replace as much of it as possible through other activities, such as providing funds for conservation research and for the establishment and enhancement of reserves in other areas (Perrin and Brownell, 1989).

The only active research project serving conservation and management at present is based at the National Research Institute for the Amazon (INPA) at Manaus, Brazil. A Centre for Research and Conservation of Aquatic Mammals is near completion at the hydroelectric dam at Balbina, and will be the base for research sponsored by the electrical company ELETRONORTE (Perrin and Brownell, 1989).

Peru has legislation specifically protecting *Inia*, Colombia forbids hunting, except for subsistence, Ecuador has general conservation legislation and forbids export of indigenous species, Bolivia bans hunting and trade in endangered species (including *Inia*), as does Venezuela. No information has yet been found about legislation in Guyana.

There is a major need for more education at all levels in society and government in South America concerning the complexity, fragility and great value of the aquatic ecosystem resource in all the countries in the region. This is absolutely necessary if existing protective laws are to be meaningfully enforced, and additional protection and reserves established (Perrin and Brownell, 1989).

Large conservation areas need to be established in wetlands containing significant populations of *Inia*. Further protective legislation may be required, particularly in Colombia, Venezuela, Ecuador and possibly in Guyana, as well as efforts to ensure the effective enforcement of existing laws (Perrin and Brownell, 1989).

The effects of dams should be minimised by concentrating them on a few rivers, rather than scattering them over many rivers. They should also be placed near the headwaters whenever possible, to leave as much of the dolphin population as possible in a continuous habitat. Dams should not, if possible, be placed on undisturbed tributaries. Where the energy need can be met by 'staircase' dams, this is preferable. From the ecological point of view, a series of dams on one river is preferable to single dams in several rivers. The original fish migration patterns should be maintained as far as possible through the use of fish ladders, or transporting migrating fish from one side of the dam to the other. Extreme and non-seasonal changes in water levels should be avoided, so as not to destroy habitats for prey species or perturb fish breeding cycles. This will also help to avoid stranding dolphins in shallow water. If no other means to avoid habitat damage can be found, developers should finance natural reserves elsewhere, or, if this is not possible, finance semi-captive or captive breeding facilities within the overall cost of the project. Fish breeding stations are also needed to propagate prey species of fish which will be affected by the dam (Perrin and Brownell, 1989).

The seven nations with wild populations of *Inia* (Brazil, Peru, Venezuela, Colombia, Ecuador, Guyana and Bolivia) should be encouraged to exchange information on the populations, and to cooperate in research and in regional planning for development. This can be accomplished through the existing bilateral and multilateral Agreements (Perrin and Brownell, 1989).

Standardised surveys are required to monitor trends in the population throughout the range. The level of genetic differences between populations in the Amazon and Orinoco basins needs investigation. Baseline studies of contaminant levels in dolphins and their principal prey in representative areas throughout the range are needed. Levels should be related to sex, age, reproductive condition and health. Incidental kill in fisheries should be monitored, and carcasses salvaged for scientific study (Perrin and Brownell, 1989).

These needs have been incorporated into the IUCN/SSC Action Plan, and given high priority (Perrin, 1989).

Captive Breeding From about 1950 to the mid-1970s, a number of *Inia* were captured live in the Manaus area of Brazil (Herald, 1967; Waterman, 1967), Leticia, Colombia (Allen and Neill, 1957; Layne and Caldwell, 1964; Layne 1958) and in the Orinoco river (Gewalt, 1978; Trebbau, 1975) for export to aquaria in North America, Europe and Japan. Over 100 were taken in all (Collet, 1984; Brownell, 1984), with more than 70 *Inia* exported to the USA. Mortality rates were high during capture, transport and in captivity. Imports ceased because of the high cost, high mortality, and the restrictions imposed by USA legislation in 1972. Because careful records were not kept, rather little is known about the problems encountered. It appears that aggression contributed to the high death rate. Many animals died from wounds inflicted by other animals. Relatively isolated animals survived for the longest periods (10-19+ years). As this dolphin rarely occurs in groups of more than two in the wild, the high rates of aggression may have resulted from keeping animals in pools too small to allow normal spacing between individuals to be maintained. One specimen survives in the USA today, which has been in captivity since 1970.

Inia were also exported to other countries, but again, little is known of their history in captivity. Similar problems with aggression were found. Some were displayed in Japan (one survived for 16 years). Today two are exhibited in Sao Paulo, Brazil and two in Duisburg, FRG. *Inia* has twice bred in captivity (Caldwell and Caldwell, 1972; Huffman, 1970). One calf only survived for a few minutes, the other for two weeks. Further births cannot be expected, without moving existing animals or new captures, because the only places with other than single animals are Duisberg (two males) and Sao Paulo (two females).

The only recent live capture for display was a female and female calf caught in late 1985 on the Formoso river, Brazil and held in Sao Paulo, Brazil. Up to eight other *Inia* were captured in the same region and moved to Sete Lagoas in Minas Gerais state, ostensibly as biological control for piranhas in these lakes isolated from the Amazon river system. After pressure from local ecological groups, the reason for the captures was changed to imply that these dolphins were being rescued from the river that was regularly being drained for irrigation of large soja and rice plantations. A major capture and relocation operation for dolphins in this area was planned for August 1986, but apparently did not take place because it was found to be unnecessary. There has been no scientific documentation of the situation, and this should be undertaken before any more dolphins are removed from their natural habitat (Best and da Silva, 1989b).

The Workshop on Biology and Conservation of the Platanistoid Dolphins (Perrin and Brownell, 1989) recommended that because of this aggressive behaviour in captivity, pools should be designed to minimise aggression. Designs might allow for isolation, quick separation of individuals or sufficient space to allow animals to separate themselves. It was also recommended that collected dolphins should be at least 1.5m and not over 2.1m, to ensure that they are weaned but not too old to be useful in starting a long-term breeding group.

There is a need for more information on the husbandry, captive social behaviour and breeding biology of this species (for application to the more threatened river dolphins). Such studies could usefully take place, in cooperation with national research workers, outside the countries of origin. Export of limited numbers of *Inia* for *bona fide* research of this nature should be permitted (Perrin and Brownell, 1989).

Remarks The Vulnerable classification follows the recommendation of the Workshop on Biology and Conservation of the Platanistoid Dolphins, and readers are referred to the report of the workshop (Perrin and Brownell, 1989) for the rationale for the classification.

Acknowledgements The late Robin Best assisted greatly with this review and provided drafts of the maps.

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WHITE WHALE **INSUFFICIENTLY KNOWN**

Delphinapterus leucas (Pallas, 1776)

Suborder ODONTOCETI Family MONODONTIDAE

Summary Knowledge of the status of the white whale or beluga is considerably lacking, although it appears that some stocks are overexploited; some of these may be only 10 or 20% of their estimated initial size. The major depletion, however, was probably caused by past commercial exploitation. Catches today are made by Arctic peoples for their own use (except perhaps for some USSR takes) and have tended not to be accurately recorded.

The lack of any reasonable catch statistics (particularly including hunting loss rates) or good information on abundance and stock identity, however, make it impossible to investigate this situation properly, despite greatly increased research efforts in recent years. Unfortunately, much of this work is unpublished or exists only as internal reports. Although some biological parameters are reasonably well known for some catching areas, others (notably natural mortality rates), are not.

Population surveys and abundance estimates are urgently needed in a number of areas where catches continue, as well as improved catch reporting (particularly loss rates) and use of modern techniques to determine stock identity, so that any over-exploited stocks can be properly managed. Management through the active cooperation of local people is likely to be more effective than attempts to enforce regulations made by outsiders.

Distribution The white whale is widely distributed throughout the Arctic and sub-Arctic seas. The range covers the northern North Atlantic, Hudson Bay, Baffin Bay and Davis Strait, the Barents, White, Kara, Laptev, East Siberian, Chuckchi, Beaufort and Bering Seas, the Sea of Okhotsk and the northern-most part of the Sea of Japan. Stragglers have been found in the Baltic and along the UK, Dutch and French coasts as far as the mouth of the Loire and the Bay of Biscay, as well as outside the usual range in North America and USSR. The ranges of the white whale and narwhal, however, appear to be mutually exclusive. White whales are generally found in shallow coastal water, and they may regularly enter rivers, travelling some tens of kilometres and spending several hours in brackish or fresh water before returning to the sea as the tide ebbs. Solitary animals have been reported hundreds to thousands of kilometres up rivers, although these are most likely to be vagrants (Tomilin, 1957; Kleinberg *et al.*, 1964; Sergeant, 1979; Fraker, 1980; Yablokov, 1979; Gurevich, 1980; Braham, 1979; Ivashin and Mineev, 1981). The species has recently been reviewed by Brodie (1989).

The definition and status of stocks of the white whale were reviewed in detail by the small cetaceans subcommittee of the IWC in 1979 (IWC, 1980). The original model of distribution and migration adopted is now somewhat out of date and requires thorough revision by the subcommittee. In the meantime, that model is the only one available, and is shown (with some modifications to take account of new information) in Map 6.

The model takes account of:

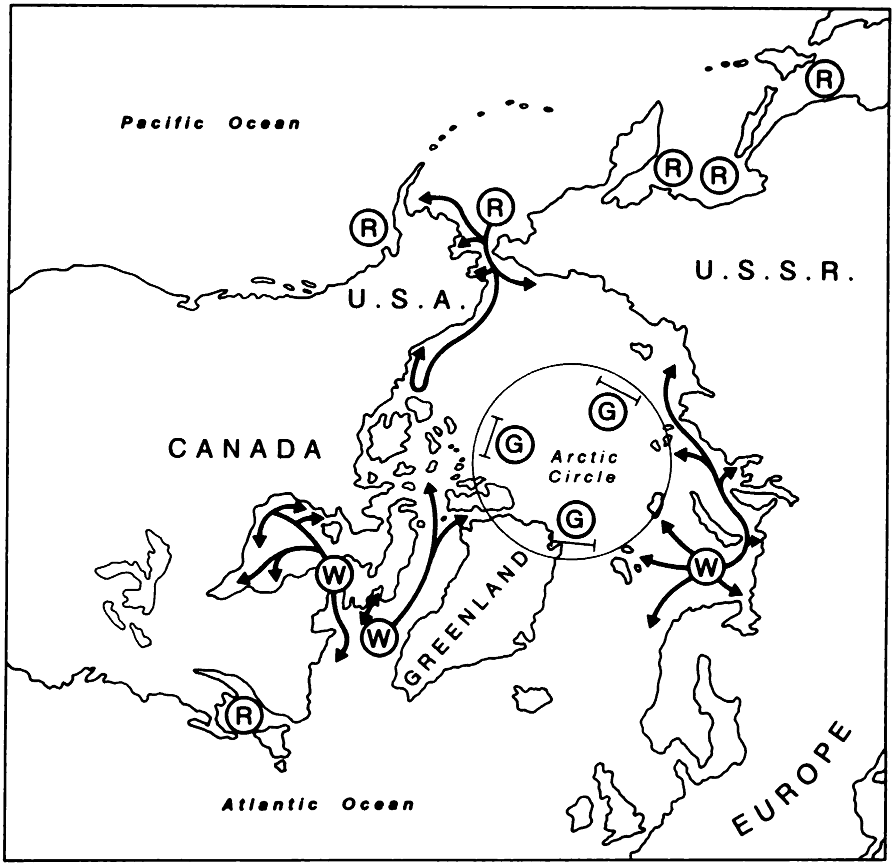
(i) Isolated year-round resident populations at low latitudes, for example, St. Lawrence Estuary population and Okhotsk Sea population(s);

(ii) Several major wintering grounds near the edge of the pack ice, for example, West Greenland, Hudson Strait, the SE Barents Sea and the SW Bering Sea;

(iii) Seasonal migrations of varying length to and from the smaller number of major wintering grounds to a much larger number of major summering grounds, typically in the region of large, relatively warm-water river deltas, for example, White Sea, mouths of Siberian Arctic rivers, Anadyr Gulf, Mackenzie River Delta, Creswell Bay in the Canadian High Arctic and Cumberland Sound, Baffin Island;

(iv) Longitudinal gaps between the ranges of the groups of high-latitude summering populations, derived from the major wintering grounds, at approximately the longitudes of Iceland, the New Siberian Islands (approx. 130-150°E longitude) and Victoria Island in the Canadian Arctic (approx. 110-120°W longitude).

Map 6. Model of distribution and movements of white whales



Arrows indicate spring migrations to main summering grounds.
W - major wintering ground.
R - year-round population.
G - longitudinal gap in distribution.
Re-drawn from IWC (1980) and incorporating new information.

The subcommittee recognized that the model is likely to be an over-simplification and that minor wintering grounds exist, that year-to-year climatic variation affects the tenability of potential winter and summer grounds, and that considerable diversity of tenability of potential winter and summer grounds, and that considerable diversity of scientific opinion exists concerning the migrations and affinities of particular populations (IWC, 1980).

Since that time, Brodie, Parson and Sergeant (1981) have suggested that the Cumberland Sound population may be isolated, not wintering in Hudson Strait, but travelling offshore at this season. Finley *et al.* (1981) have provided evidence for the discreteness of the three stocks wintering in Hudson Strait. This is based on independent changes in the population levels, indicating little or no exchange between them, and on the fact that the summer migration has already separated the populations by the time of calving (late May). Ognetov (1981) provided morphological evidence that the animals inhabiting the White and Kara Seas are related, suggesting that they are one stock. Further evidence supporting the idea that the populations of the White, Barents and Kara Seas are all one stock was presented the following year (Ognetov and Potelov, 1982). They reported that some animals are present throughout the year in the White Sea, adding another minor wintering area to those known at Cheshskaya Guba in the southern Barents Sea, in the 'North Water' between Canada and Greenland, in Bristol and Kuskokwim Bays in Alaska, and in west Hudson Bay (Davis and Finley, 1979; Braham, 1979; IWC, 1980; Ivashin and Mineev, 1981). It is not known whether these resident groups, which have been observed to contain adults and young in winter, are separate stocks or related to the summer immigrant population.

The hypothesis of wintering grounds shared by several geographical summer populations permits two major alternative conclusions on stock discreteness:

(i) The wintering group consists of a single interbreeding stock which disperses in spring;

(ii) Animals in summering grounds constitute separate stocks which winter in a common area.

In 1979 there was no direct evidence for either view, but the evidence of Finley *et al.*, (1981) points to the second conclusion, at least for the Hudson Strait wintering population. If it is generally true that stocks are defined by summering grounds, this is the correct basis for management. As much hunting takes place in summer, this strategy provides a better basis for ensuring that local stocks are not depleted.

Population The following population information is based on Table I of the subcommittee report (IWC, 1980), and on Braham (1984). Some estimates are very approximate: for example, the Thule population was deduced from a guess that there were fewer white whales than narwhals in the area in summer - an estimate of 2,500 narwhals was quoted, and the 2,000 white whales appeared (Davis and Finley, 1979; IWC, 1980); other estimates are based on extensive aerial surveys, for example, Canadian Arctic (Davis and Finley, 1979); or are direct counts, for example, White Sea (Ognetov and Potelov, 1982). The figures given should, therefore, be treated with care. The stocks are listed by major wintering ground, with summering grounds given below.

Braham (1984) estimated that there were at least 40-60,000 white whales worldwide and Brodie (1989) arrived at a similar figure. From the information given below a total of 50-70,000 can be obtained; the differences simply reflect some improvement in population estimates. However, the important point is that some populations are clearly very depleted and require adequate management for recovery.

Cook Inlet, Alaska A resident population, estimated at 600-1,000, was extrapolated from an aerial survey (Murray and Fay, 1979).

SW Bering Sea	
Bristol/Kuskokwim Bays	1,000-1,500 (Braham 1979, from various earlier surveys)
Yukon/Norton Sound	no estimate
Kotzebue Sound	no estimate
Alaskan NW coast	no estimate
Beaufort/Mackenzie Delta	6-7,000 (Finley *et al.* 1981, from aerial surveys) 7-11,000 (Braham 1984, from more recent surveys?)
Bering Sea (including Anadyr)	2,000-3,000 (Yablokov 1979, rough estimate, no survey) (too low ? - see below, and Ivashin and Shevlyagin, 1987)
East Siberian/Chukchi	1,000-2,000 (Yablokov 1979, rough estimate, no survey)

Okhotsk Sea From aerial surveys in 1980-82, the total summer population was estimated to be 8,000 to 9,000. These were distributed between Sakhalin Bay and the Amur river (6,000 to 7,000) and in Shelikov Bay (2,000). Aerial surveys in winter support the suggestion that these stocks are resident, responding to ice edge shifts by local movements (Melnikov, 1982). Braham (1984) gives <10,000 for this population.

Barents Sea	
White Sea, including some residents	200-1,000+ (Ognetov and Potelov 1982, direct counts in different years)
Barents Sea	1,500-3,000 (Braham 1984, source not given)
Barents/Kara/Laptev Seas	7,000-10,000 (Yablokov 1979,* rough estimate - no survey)
(small part Kara Sea)	1,700-1,900 (Ognetov and Potelov 1984, direct count in one season)

* NB: This population estimate was mistakenly quoted as 1-2,000 by IWC (1980), by Klinowska (1980), by Rudge, Klinowska and Anderson (1981) and by Braham (1984), leading to the calculation of gross over-exploitation rates.

Counts of animals in the White Sea ranged from a low of 232 in 1979 to a high of 1,570 in 1971 and were negatively correlated to the severity of ice conditions in the Kara and Barents Seas. Numbers in the White Sea fluctuate, although there are some animals present at any time of year. White whales move into the Kara Sea as the ice retreats, and remain until the ice returns. Numbers fluctuate considerably through the season, but are usually greatest in late July-early August. In 1975, 1,700-1,900 animals were counted passing the Dikson area during August, of which about 1,400 passed in the first ten days. In Severok Bay, the same number of animals were seen in a nine-day observation period in 1980, as were seen in a 16-day period in 1977; ice was present until August in 1980 but had cleared by mid-July in 1977 (Ognetov, 1981; Ognetov and Potelov, 1982; 1984).

The above list of summering stocks does not specifically include northern Norway or Spitzbergen, although there is no recent information from these areas (Gurevich, 1980).

St. Lawrence Estuary A resident population was estimated at 325 from a ship survey (Sergeant, 1979). A more recent estimate of 300 has been made, and the stock is believed to be declining, for reasons poorly understood (IWC, 1983). Braham (1984) gives 350-400 as the current stock, <10% of initial.

Hudson Strait Although there is a small winter population in western Hudson Bay (IWC, 1980), new evidence shows that the majority of white whales summering in this area spend the winter, together with animals from eastern Hudson Bay and Ungava Bay, in the pack ice of Hudson Strait (Finley *et al.*, 1981). The Cumberland Sound population may be isolated, and not part of this wintering group (Brodie, Parson and Sergeant, 1981).

	Historical	Current	% of original
W. Hudson Bay	10,000 (Sergeant, 1973)	8-9,000 (Finley *et al.* 1981, estimated proportion from Hudson Str. aerial survey)	80-90%
		5,000-9,000 (Braham, 1984)	50-90%
E. Hudson Bay	5,000 (Finley *et al.*, 1981)	<500 (aerial survey)	<10%
		>1,000 (Braham, 1984)	>20%
Ungava Bay	>1,000 (Finley *et al.*, 1981)	<200 (aerial survey)	<20%
		200-1,000 (Braham, 1984)	>20%
Cumberland Sound	5,000 (Mitchell and Reeves, 1981)	600-700 (Brodie, Parson and Sergeant, 1981) (aerial surveys)	12%
		600 (Braham, 1984)	<12%
Southampton Island	?	?	?
Frobisher Bay	-	250-300 (Kemper 1980, aerial survey)	
High Arctic			
Canadian Arctic	-	10,250-12,000 (Davis and Finley 1979, aerial surveys in several years)	
Thule/Melville Bay	-	2,000 (Davis and Finley 1979, guess, see above)	
Total Unit	-	12,250-14,000 (Canada plus Thule)	

East Greenland Although a resident stock was proposed here (IWC, 1980), it was omitted from the original stock tabulation, and by Braham (1984). Gurevich (1980) only found one reference to their presence here (Jensen, 1928); only the odd one or two animals are occasionally reported as caught in recent years (see Threats - Present section), although catches of narwhals, for example, are regularly reported. White whales have not been reported in recent surveys (e.g. Born and Kapel, 1986). It seems improbable that a resident population would show so little evidence of its presence, given the inshore habits of the species, and it seems more likely that the area is occasionally visited by individuals or groups from west Greenland, or by vagrants from the Barents Sea.

Habitat and Ecology Age determination has been based on counts of dentinal layers, and it has been shown that two growth layer groups are laid down each year (Brodie, 1982). On this basis, the age at sexual maturity in males is between 7.5 and 10.5 years and in females between 5.5 and 6.5 years (Brodie, 1982). Maximum observed age of females appears to be about 20 years, and of males about 30 years, indicating that average longevity will be rather less.

Braham (1984) has summarised information on reproduction. The length at birth is 1.5-1.6m and weight 78kg. Maximum adult length is 4.27m for males and 3.62m for females, although there may be differences between different stocks. Length at sexual maturity is about 85% of that at physical maturity. Fifty percent of adult body length is reached at three years in females and at five years in males. Yearling white whales average 2.16m and weigh 188kg but have no erupted teeth. Body length increases 16% and weight 42% during the first year. Whitening of the skin begins at about six years and is complete by about age 13, overlapping the age of sexual maturity.

The proportion of pregnant to all mature female white whales taken in one Canadian fishery was 0.41 and in an Alaskan fishery 0.44. On average, mature females produce one calf every 32-37 months, although Sergeant (1973) observed that about 75% of the adult females produced a calf every three years and 25% every two to three years. The proportion of mature females in the population may be between 0.56-0.62, although proportions in particular harvests vary considerably, through selective catching and sexual segregation in the population. The maximum length of the female breeding period is about 15 years. Mortality rates appear to increase after about 15 years of age. From this data Braham (1984) calculated the gross annual reproductive rate to be between 0.083 and 0.118.

Ognetov (1985a; 1985b) has provided new information on the reproductive biology, and on age and sex composition of the USSR catch. It appeared that there was a gestation period of 11 months and an observed pregnancy rate of 0.308, indicating a three-year reproductive cycle, from examination of ovaries and foetal growth. Considerable variation was found in the sex and age composition of catches between years, although studies in the 1930s and early 1960s also showed such variations. In some years males predominate in catches, in other years females. The majority of harvested whales were between six and 20 years old, counting two growth layer groups in tooth dentine per year.

The white whale is thought to feed mainly on benthopelagic fish e.g. arctic cod, herring, smelt, and on flounders and various crustaceans. Plant debris, sand, stones and even paper, have been reported from stomachs, although it is thought that this material is taken accidentally during bottom feeding. Gurevich (1980) gives an extensive tabulation of reported food species, which depend on geographical location and season. Kleinenberg *et al.* (1964) also give considerable details of geographical variation in feeding habits and suggest that some migrations may follow schools of arctic cod, although Ognetov and Potelov (1984) quote evidence against this hypothesis.

Threats - Historical White whales have been hunted throughout their range by local people from the earliest times. Commercial whalers began to take white whales in significant numbers from about 1840. Both the hide and the blubber were valuable. Local people sometimes cooperated with the whalers, helping them to drive large herds ashore, and presumably obtaining supplies of the meat in return. Nets were occasionally used, but this technique was not always so successful as driving. Scottish whalers alone took more than 20,000 from the eastern Canadian Arctic/Davis Strait area between 1868 and 1911. Catches by other whalers (mainly American), traders and local people are unknown for this period (Reeves and Mitchell, 1981).

However, by about 1900 the international commercial whalers had left to pursue large whales in other waters. In Canada commercial catching was taken over by land-based trading companies. They often employed local people to assist the catching, particularly where drives or nets were in use, but there was also considerable hunting with rifles by trading post staff, and by local people attached to the post. The peak years of this catching appear to be between 1923 and 1932. At one post alone, Pangnirtung, Cumberland Sound on Baffin Island, 3,609 white whales were taken during this period, leading to estimates that this population must have initially contained more than 5,000 whales. From 1966 the killing of white whales in Canada was restricted to subsistence hunters and to licensed commercial hunters operating in specified zones (Reeves and Mitchell, 1981).

Canada was not the only area with commercial white whaling. In general, it appears that similar early catch histories exist wherever the species could be found in significant numbers, including at Spitzbergen, where it is said that at one time dynamite was used to help drive the whales into nets (Reeves and Mitchell, 1981). Yablokov (1979) also mentions Russian and Norwegian drive fisheries at Spitzbergen in the 18th century. It appears that these other commercial fisheries died out by about 1900, except for those in Russia/USSR, which are briefly described by Tomilin (1957). He says that a white whale fishery existed as early as the 9th century, when Russian settlements on the White Sea paid tribute to the Princes of Novgorod in white whale hides. There were also hunts along the northern coast of Asia in the 18th and 19th centuries, where the main catching method appears to have been driving. Catching continued into the 20th century, using nets and seines (in an offshore White Sea fishery). Stake nets were also used, mainly in the autumn, and most such catches made at night. These catches seem to have peaked in most areas in the 1930s and 1940s, but the major catches in the Kara Sea were made between 1959 and 1966 (Yablokov, 1979). From the 1950s metal nets were used in the Barents Sea. Rifles were also used for catching near shore and in rivers, as well as to help drive the animals into nets. More recently capron nets have been introduced in the Barents Sea. Somewhat fragmented catch statistics are given by Yablokov (1979), some going back to the 1890s. Another list is given by Ivashin and Mineev (1981).

Threats - Present Today almost all catches are by local people for their own use, although it is not clear whether or not some commercial taking may still occur in the USSR (e.g. Ivashin and Mineev, 1981). The major objectives of such white whale hunting are muktuk (blubber) for human consumption, meat for human and dog food, and oil for fuel and light (although the latter is in less demand today, see narwhal review).

Hunting loss rates depend on the hunting method and the water conditions. Boat, rifle and harpoon methods probably result in two lost for every one taken, of which one may die (Brodie, 1973); the ice edge, rifle, boat hunt in NW Alaska may lose four or five for each one taken, and the hunts in the Mackenzie Delta and Canadian Eastern Arctic may lose one for every two taken. Kapel estimated loss rates in the Greenland hunt from one lost per two landed in savssat hunts, to one lost per ten landed in the summer hunts (IWC, 1980).In the USSR nets are used in some hunts and rifles in others (Yablokov, 1979). No loss rates for these hunts were available, but nets tend to have fewer losses (Brodie, Parson and Sergeant, 1981).

Braham (1984) took 33% as an overall killed but lost rate and added this to the average reported landed kill for the last decade. He also calculated the percentage kill of his estimates of current stock size. For the present purpose, the estimated total removals of white whales and the percentage kill of estimated current stock have been similarly estimated, using updates and corrections taken from national progress reports submitted to IWC covering the past ten years, and from new information given in the Population section above. Revisions are shown in brackets; hunting loss rates have been estimated at 33% of reported landed catch, following Braham (1984). It was only possible to calculate average catch over ten years for west Greenland; in other areas whatever data were available were used to produce an annual average.

Summering Stocks	Estimated current take	Percentage kill
Canada		
Mackenzie Delta	192	4%
	(137	2%)
W Hudson Bay	182+	<5%
	(278-282	3-6%)
E Hudson Bay	507	<50%?
	(57 - 1986 only)	
Ungava Bay	162	15-80%
	(42 - 1986 only)	
Frobisher Bay	7	2-3%
	(36	12-14%)
Cumberland Sound	57	9-10%
	(Quota of 40 imposed from 1980)	
	(52	9% after 1980)
St Lawrence Estuary	38	10-12%
	(catches banned from 1980)	
High Arctic		
Canada	280	2-3%
	(116-121	<1%)
W. Greenland	100+	<10%
	(787-1,023	39-51% all takes)
(Total Unit	903-1,144	5-9%)
(E. Greenland	2-3	1975-77, none reported since)
USA (Braham 1984 made no correction for hunting loss here)		
Cook Inlet	3-6	<1%
	(4-9	1-2%)
Bristol/Kuskokwim Bays	10-20	<3%
	(13-27	<3%)
Yukon/Norton Sound	88-103	?
	(117-137)	
Kotzebue Sound	58	?
	(112-114)	
NW Alaska/US Beaufort	38-50	?
	(85-90)	

Summering Stocks	Estimated current take	Percentage kill
USSR		
Okhotsk Sea	0	0
	(39	<1%)
Barents Sea	824	>28-55%
White Sea	256	26-51%
	(92	<9-46%)
Barents/Kara/Laptev Seas	186	9-18%
	(203	2-3%)
	(using corrected population estimate)	
(Kara Sea	238	3-14%
		all takes)
Bering Sea/Anadyr Gulf	34	1-2%
	(186	6-9%)
	(excluding 1984/5 savssat)	
E Siberia/Chukchi	?	?
	(1	<1%)

It should be stressed that the 'catch statistics' on which the harvest level calculations are based are very fragmentary; USA has by far the worst reporting record (although there have been some recent improvements - IWC, 1989) and Greenland the best. Some of the differences from Braham's (1984) figures are undoubtedly due to later revisions of catch reports and to the availability of new information. Another problem is that catch reporting in USA, Greenland, USSR and Canada is not easy to relate to the stocks defined by IWC (1980). USA, for example usually combines Kuskokwim and Yukon catches; the Beaufort/Mackenzie Delta stock is divided between USA and Canada, with consequent separate reports; Canada reports by community and, without very detailed maps, it is impossible to know which community is where; USSR does not always use the stock areas for reporting; and the catches south of Thule in Greenland do not seem to fit in with the 'population estimate', which refers only to the Thule summer population. Since Greenland and Canada appear to be exploiting the same stock it is important that further information on the summer populations in Greenland are obtained. Cooperative studies of the whole wintering population are also required.

For all areas some places do not report catches every year, and it is not always clear whether catches took place but were not reported, or whether white whales were not available in that place in that year. Such uneven reporting leads to apparent fluctuations in catches. There are also the problems mentioned above with the population estimates, which can lead to unrealistic estimates of harvest rates, as well as the lack of precise information on hunting loss rates. In general, therefore, it seems that without great improvements in all these matters, it is not possible to evaluate the true status of any stock.

Braham (1984) took Sergeant's (1973; 1979; 1981) estimated net recruitment of greater than 5% for west Hudson Bay as a guide for evaluating harvest levels. On this basis there are a number of stocks where harvest levels appear to be very much greater than net recruitment. However, these fisheries have a long history and such gross over-exploitation could never have been maintained. Since the reported catches must represent minimum removals, the problem is likely to lie with the abundance estimates and/or the adoption of inappropriate stock units. This may not apply to some Canadian stocks, because they are comparatively well-studied. In particular, if the Cumberland Sound stock is indeed isolated, greater efforts are needed to persuade the local people to reduce catches in view of the facts that it is only about 12% of initial and that the exploitation rate seems well above estimated net recruitment.

Yablokov (1979) said that catches in USSR waters had declined since 1960, because takes from permanent land stations had been unstable and because there had been a decline in demand for products. He was, however, optimistic about the future prospects for the industry (as far as the ability of the stocks to withstand increased catches was concerned). He noted that the economic viability of the fishery depended on full utilization of the carcasses. Since that time, it appears from the catch reports that the fishery has generally continued to decline. It is not known what proportion of the reported catch is currently industrial and what proportion is taken by local people for their own use (Ivashin and Mineev, 1981). Developments in the North American Arctic caused concern to the IWC subcommittee in 1979 (IWC, 1980). These included hydro-electric projects at James Bay and Nelson River.The latter involved diversion of the Churchill River.The estuaries of the Nelson and Churchill comprise two of the three main estuaries used by calving white whales in summer. Flows in all the rivers would be drastically reduced. Surveys in 1973 failed to find white whales on Manicouagan Bank in the St. Lawrence, where they had been common thirty years before. It was believed that the damming of the Manicouagan and Outardes rivers for hydroelectric power had altered the heat budget in the area sufficiently to have eliminated calving there (Sergeant and Brodie, 1975). These authors note a number of other potential habitat problems.

Yablokov (1978) says that industrial development does not affect the USSR populations and that none of the rivers used are being dammed or changed in such a way as to deny access at present. There is no information on whether there have been any changes in this situation.

In Greenland, the Black Angel lead-zinc mine deposits its tailings directly into the sea, the fjord is now heavily polluted, a rapid rise in heavy metals detected in marine organisms has been noted and most organisms in the immediate area have died. There is some evidence that pollution is spreading to the adjacent fjord. The Nanisivik mine on Baffin Island, Canada, also a lead-zinc mine, is depositing tailings into a lake which flows into the sea.There is evidence of cadmium bio-magnification in the food chain and very high levels have been found in narwhal brain. This raises questions as to the suitability of narwhals for human food as well as possible dangers to the narwhals themselves. White whales are also likely to be affected (IWC, 1980). A number of monitoring studies have been made since that time, but it appears that no firm conclusions on the possible effects of such pollution on wildlife, and on the human populations using wildlife for food, can yet be drawn.

Increasing oil and gas exploration, shipping and marine pipelines all pose potential problems, not only through pollution and disturbance but also because it is feared that white whales and narwhals may follow the tracks of ice-breaking liquid natural gas tankers and become entrapped in the track as it freezes (IWC, 1980). This particular project has not yet been implemented, mainly for economic reasons. These projects, however, have given rise to a very great deal of survey and other research work on the marine mammals of the Arctic. Almost all the recent Canadian white whale population estimates, for example, come from surveys connected with industrial development projects. Unfortunately, a lot of the work remains unpublished or in report form, and is not easily accessible.

There appears to be no demand for the leather and oils today, except perhaps in the USSR, as synthetic substitutes are preferred. It has been feared that increasing Inuit populations in Canada may be expected to increase hunting (Kemper, 1980). However, from the available records it is difficult to see whether or not catches are increasing. The demographic trends in Greenland show a fairly stable population in the areas where hunting is the only way of life, because of a movement to the towns, particularly by young people (Kapel and Petersen, 1982). Apparent increases in catches here are almost certainly the result of improved reporting in recent years. White whales were once proposed as an alternative to bowheads in the Alaskan hunt (IWC, 1980), but an IWC Panel Meeting of Experts concluded that, for cultural reasons, no substitution was possible (IWC, 1982).

Conservation Measures The main countries of origin are USSR, USA (Alaska), Denmark (Greenland), Norway (Spitzbergen) and Canada (excluding countries where vagrants may sometimes be found). The white whale is listed in Appendix II of CITES. The only international trade recorded is the movement of eight live animals (for zoological purposes) from Canada to USA in 1984, and of four live animals (for commercial purposes) from Canada to USA in 1985 (CMC, 1987). As all the countries of origin are Parties, this is likely to be a reasonable picture of recent international trade, which is therefore clearly of no current significance for the conservation of the wild populations. However, the monitoring provided by the CITES Appendix II listing is useful, as it will indicate any future changes in this situation.

Delphinapterus leucas is listed on Appendix II of CMS, but so far no conservation Agreements have been made. At present only Norway and Denmark are Parties, although any State may join Agreements relating to cetaceans whether they are CMS Parties, Range States or neither. It is therefore possible that an effective international management programme could be arranged under CMS in future.

The IWC Scientific Committee recommended that the white whale should be specifically listed in the Schedule and appropriate management procedures implemented.They further recommended that the Cumberland Sound stock should be classified as a Protection Stock with zero catch, and called for urgent research on a number of other populations (IWC, 1980). The Schedule change was not agreed by the Commission. The IWC Scientific Committee again recommended in 1980 that active management of white whale stocks be initiated, and again no action was taken by the Commission (IWC, 1981). (For a fuller discussion see narwhal review). No further action has been taken by the IWC Commission on this matter. Canada, which had been a considerable source of information and expertise, left IWC from 1982. Since that time the status of the white whale has not received detailed consideration by the small cetaceans subcommittee, although new information (including that which Canada continues to supply as an informal annual report) has been monitored. It is unfortunate that the effort to persuade the IWC Commission to undertake active management of this species failed, because all countries of origin (except Canada, although usually represented at meetings by Observers) are IWC Parties. However, the IWC Scientific Committee still has a mandate from the Commission to monitor the species and to provide management advice. The Committee therefore continues to be the best international forum for consideration of white whale management and conservation at present.

As this species uses shallow coastal water and river mouths for calving and early rearing of calves, as well as specific areas for summer feeding, there could be scope for protecting such critical habitat under the Ramsar Convention or WHC. All the countries of origin, except USA, are Ramsar Convention Parties and all except USSR are WHC Parties.

Kemper (1980) describes the Canadian regulations, which in general only allow local residents to take animals for their own use, although other taking (e.g. live capture) may be allowed under permit. Catches were prohibited in the St Lawrence, and a catch limit of 40 was set for the Cumberland Sound stock from 1980. However, in view of the apparent level of total removals in relation to the estimated stock size, and the fact that the current population is only about 12% of initial, the quota appears to be too high and there have been calls for catching to be banned here until the stock has recovered (e.g. IWC, 1980; IWC, 1981; Braham, 1984). A total hunting ban is unlikely to be feasible, and other conservation actions such as helping local people to reduce hunting losses, a voluntary agreement to limit catches further, and education of local people in conservation and management, may be more practical (Brodie, Parson and Sergeant, 1981).

The hunting methods in the USSR are regulated, and animals younger than one year may not be taken. Ivashin and Mineev (1981) say that quotas are set but for various reasons are never completely taken. The white whale is the only small cetacean species where hunting is currently permitted. In Alaska the take, being aboriginal, is not regulated. The white whale is one of the species which may be taken in Norwegian waters without permit. All catches in Greenland have to be reported, but there are no catch limits set (Kapel, 1977). There are also local hunting regulations, designed to retain the traditional character of the hunt and to discourage waste. Further information on national legislation is given in Appendix II to this volume.

This species suffers from heavy local taking and some environmental damage. A primary requirement is for information on stock identity. Use might also be made of identification techniques to follow the travels of naturally marked animals, enlisting the interest of local people both as observers and as protectors of particular animals. Secondly, despite the very real practical difficulties involved, better catch and loss statistics must be obtained and regularly published in detail. Thirdly, without interfering too greatly with traditional hunting methods, some improvements might be introduced to reduce loss rates. More use should be made of the opportunity to collect biological material during the hunts, if this can be done without unduly intruding on the social life of the small communities. If possible the taking should be kept at the present level or reduced where exploitation appears to be heavy, and no new commercial enterprises begun until the status of the stock in question has been made clear. There is much scope for international cooperation in all these matters, and it is necessary where stocks are exploited by more than one country, although final regulation will be at national and local levels.

Brodie's (1972) approach, explaining the need for conservation to local people in their own language and seeking their active cooperation, appears to be the most practical way to manage the harvest, since regulations made by remote national and international agencies can be resented, misunderstood and ignored, and are extremely difficult to enforce in remote areas. In this context, the operation to rescue the white whales entrapped by ice in Senjavin Strait may be relevant. Because the case was widely reported nationally and internationally, the authors hope that local people will be encouraged to call in assistance to deal with similar accidents in the future (Ivashin and Shevlyagin, 1987).

Since the IWC subcommittee on small cetaceans reviewed the species in 1979 (IWC, 1980), a great deal of work has been done to elucidate stock status, biological parameters and population abundance. Unfortunately much of this is unpublished, including some of the informal Canadian reports to IWC containing the detailed catch statistics. It would also be helpful if all the catch reports contained maps showing the location of the reporting communities. A new review by the IWC small cetaceans subcommittee could be valuable in bringing this work forward, and in providing a new overall view on the current state of the stocks.

The IUCN/SSC Action Plan mentions the status of white whales exploited by native peoples in Canada and Greenland, and the status of white whales exploited in USSR as subjects to be monitored (Perrin, 1989). The exploited USA stocks could also be added to this list, although they are covered by general projects for monitoring local fisheries.

Captive Breeding White whales were probably the first cetacean species to be successfully maintained in captivity: although there are scattered references to small cetaceans (almost certainly harbour porpoises) in European aristocratic menageries from about the 15th century (Collet and Duguy, 1987), there is no information on their survival times. White whales were exhibited in New York in the early 1860s; one survived for nearly two years. Additional white whales were also captured in the St Lawrence for delivery to cities in eastern North America and Europe. They were transported in boxes of sea weed and protected from drying and dehydration by frequently pouring buckets of water over them. These transport methods must have been reasonably successful, since most animals seem to have arrived alive, even after two weeks or so in transit. For example, the animal sent to the UK in 1877 survived for four days after arrival, and of the four sent in 1878, one died during a storm at sea and the other three were delivered alive. There is no information on their subsequent history. The popularity of white whale exhibits seems to have declined by the early 20th century and was not revived until the late 1950s (Reeves and Leatherwood, 1984).

Since that time about 100 animals have been taken for exhibition (and a few for research), mainly in the USA and Canada. Five went to the UK in the early 1960s, three to FRG (2F - 1969; 1M - 1975), two to France in 1970 and three to Japan in 1976. Two of the FRG animals are still alive at the time of writing. The animals sent to France only lived for about a month, and of the UK animals, the first was said to be a suckling and to have died soon after arrival. The other four travelled by sea; two of them were washed overboard in a storm, one was killed and the fourth so badly injured that it only survived a few days after arrival. There is no information on the animals sent to Japan or on the survival times of the vast majority of the North American animals.

A male was born at Vancouver Aquarium in 1977, and survived for four months (Macneill *et al.*, 1978). One animal is said to have died in stillbirth. It is not stated in either case whether conception had taken place in the wild or in captivity. There appear to be no other reports of breeding in captivity (Reeves and Leatherwood, 1984). Since 1984 further captures have taken place in Canada (see above), and the first live captures made in the USSR (Ognetov and Minibayeva, 1986).

The majority of white whales were taken into captivity before modern husbandry methods were developed. They are also large animals requiring much space, and few establishments have been able to keep more than two or three animals at any one time. It is also almost certain that the vast majority taken would have been juveniles, for ease of transport. The failure, so far, to breed in captivity could therefore be due to the animals being too young, single sex groups, unsuitable group size or composition, or primitive husbandry. As individuals seem to be able to survive for long periods in captivity, the prospects for captive breeding ought to be good.

A captive animal has already served to calibrate the aging techniques (Brodie, 1982), and two others were used in studies of diving and blood oxygen (Ridgway *et al.*, 1984). However, the captive animals are a much under-used research resource, and every opportunity should be taken to collect more information, particularly on biology, behaviour and breeding, which would be useful for conservation and management of the wild populations, as well as for captive breeding, should this ever become necessary for conservation.

As some stocks seem to be subject to heavy catching, live captures should only take place from "properly" monitored stocks known to be reasonably abundant, as has happened in recent years in Canada (Reeves and Leatherwood, 1984).

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NARWHAL **INSUFFICIENTLY KNOWN**

Monodon monoceros Linnaeus, 1758

Suborder ODONTOCETI Family MONODONTIDAE

Summary The true status of the narwhal is unknown, because of insufficient information on population size, stock division, biology, natural mortality rates and detailed hunting mortality rates, despite greatly increased research efforts in recent years. Unfortunately, much of this work is unpublished or exists only as internal reports. The effect of the continued takes by local people for their own use is therefore not known. The tusk of the male narwhal may be sold, and some enter international trade. Such trade, at least among CITES Parties, does not appear to be very great in relation to known catches and thus not of primary significance for the conservation of the wild populations. Until sufficient information for management is generally available, there must be some concern about the status of the species, and particularly about exploited local populations, in the longer term.

Distribution Narwhals are found only in the high Arctic waters of the Northern Hemisphere. They occupy one of the most northerly habitats of any cetacean species, remaining north of the drifting ice boundary, and are seldom found further south than latitude 70°N (Tomilin, 1957). Spatially, narwhal and white whales are mutually exclusive (Braham, 1984). Rare records from the Baltic, off the coast of Norway and the Netherlands are given by Aguayo (1978), and off the UK coast by Fraser (1949). Reeves and Tracey (1980) review information on other records outside the main distribution areas.

Present distribution is circumpolar, north of the drift ice boundary in the Canadian archipelago, Greenland, Davis Strait, Baffin Bay, Hudson Bay, upper latitudes of the North Atlantic, Spitzbergen, Franz Josef Land, Novaya Zemlya, New Siberian Islands, Wrangel Island and northern Alaska. In winter they are sometimes found in the Bering Sea. Tomilin (1957) gives sources for these records and considers the narwhal most rare between the Kolyma river and Point Barrow. He notes that fewer records and smaller numbers had been reported recently from the Franz Josef Land and Novaya Zemlya regions. Suggestions in Mitchell (1975) that this was the result of hunting are not accepted by all experts. Yablokov (1978; 1979) says that the species is very rare in the seas of the USSR, and that no hunting has taken place this century. His personal opinion is that the earlier reports indicating that the species was widely distributed simply reflect the wide distribution of early Russian marine explorers.

Narwhals are most common in the eastern Canadian arctic and west Greenland area. The species is also known from east Greenland, particularly in summer, but apparently only in small numbers (Kapel, 1977).

The most important factor governing the distribution of the narwhal may be fluctuations in the distribution of sea ice. Vibe (1967) gives considerable details of these fluctuations over the past hundred years and relates them to catches and sightings of narwhal and other marine mammals. In colder periods narwhal may be seen off southern Greenland, but in warmer periods it is assumed that they stay in the northern regions or go westwards at a higher latitude and cross the Davis Straight north of Holsteinborg or at Disko. The southerly migrating narwhals are thought to follow the Canadian current. During periods when the West Greenland current advances further north than usual, the narwhals seem to stay at a higher latitude for a longer period during autumn and winter.

The species has recently been reviewed by Hay and Mansfield (1989).

Population In 1979 the IWC subcommittee on small cetaceans reviewed information on distribution, migration and stock identity (IWC, 1980a). After considerable discussion three main stocks were recognised. These are the Davis Strait-Baffin Bay stock, the east Greenland-Spitzbergen stock and a tentatively identified stock in Foxe Basin, Canada (IWC, 1980a). The status of animals found in northern Siberian and Alaskan waters is not clear - they may be stragglers or separate stocks (Yablokov, 1979; IWC, 1980a). Braham (1984) recognises a northwest Europe to east Siberian Sea stock.

Davis Strait - Baffin Bay This stock winters in the pack ice between Disco Bay and eastern Hudson Strait (Kemper, 1980). Migration northward in spring is believed to be along the Greenland coast to the Thule and Melville Bay areas, and through the central pack ice into Lancaster Sound and various summering areas in the Canadian archipelago. Kapel (IWC, 1980a) suggests that there may be a discrete stock that summers in the Thule and Melville Bay region. The subcommittee took the total population as 22,500 to 32,500, of which about 2,500 were estimated to belong to the Thule and Melville Bay group.

There was some debate at the 1980 meeting of the IWC small cetaceans subcommittee as to whether one or two stocks of narwhal exist along western Greenland and near eastern Canada, but although two new reviews were available as well as some new sightings information, no firm conclusions could be drawn (IWC, 1981; Meldgaard and Kapel, 1981; Mitchell and Reeves, 1981). There has been no further progress in resolving this problem.

Surveys made in Canada and Greenland in 1984 provided a population estimate of about 29,000 narwhal summering in the Canadian Eastern Arctic and Inglefield Bay, west Greenland (IWC, 1986). The total population of the whole stock must therefore be somewhat larger than that estimate, and may be larger than the upper limit of the IWC 1979 estimate.

Foxe Basin No population estimates have yet been accepted by IWC for this stock, which may winter in Hudson Strait.

East Greenland - Spitzbergen This stock is not well defined, but it appears that, at least historically, narwhals were widely distributed in this area. Larsen (1984) provided a conservative estimate of 176 narwhals in the Scoresby Sund area in September 1983. Counts in similar areas in 1984 indicated that more animals may be present earlier in the season (Born and Kapel, 1986). There is no quantitative information on past or present narwhal populations in the rest of this large area.

NW Europe to E. Siberian Sea Braham (1984) quotes Yablokov's (1974) estimate of a current population of several thousand, which was repeated by Yablokov (1979).

Habitat and Ecology In the western Canadian Arctic the food of the narwhal is arctic cod *Boreogadus saida* Lep., Greenland halibut *Reinhardtius hippoglossoides* Walb. and some crustaceans (Decapoda) (Breummer, 1971). Tomilin (1957) considers cephalopods as the main diet, citing a number of early workers. He also lists skate, flounder, halibut, codfish, salmon and herring. Mansfield, Smith and Beck (1975) report squid and polar cod from animals killed in the Koluktoo Bay. Reeves and Tracey (1980) give further details of reported food species.

The most conspicuous feature of the narwhal is the long tapering tusk. In embryos two pairs of teeth develop on each side of the jaw. The posterior ones remain rudimentary and eventually disappear. In the adult male the left anterior tooth develops into the tusk, which rarely exceeds 2m in length. The right anterior tooth normally remains embedded in the skull, but sometimes develops into a tusk. In females the two anterior teeth develop in the same way as the right anterior tooth of the male; usually they remain embedded in the skull, but sometimes the left one develops into a tusk and occasionally both. Six of 72 females taken from a group of at least 115 animals in a savssat (natural ice trap), in October 1979 in Canada were tusked (Mitchell, 1981). Two-tusked narwhals are very rare in nature, but their skulls may be more common in museum collections than the normal form. The tusk appears to be a secondary sexual characteristic, which may play a part in male display (Silverman and Dunbar, 1980).

Narwhals are social animals and are frequently observed in herds, especially when migrating. Greendale and Brousseau-Greendale (1976) noted that during the westward migration past Cape Hay, animals with tusks tended to group together, forming the larger groups and passing earlier in the migration. Groups with young were observed sporadically throughout the survey. Newborn calves were first observed on June 26, and became most numerous in late July. Groups of females and calves were predominant on 23 and 24 July. This sexual segregation of migrating narwhals may be a significant factor as far as hunting is concerned. Further evidence of possible sex segregation comes from a catch of narwhals in a savssat, where 108 of 115 animals were landed (4 were lost). There were more females (72) in this group than males (11), and the calf-to-adult ratio was 23% (Mitchell, 1981). However, sexual segregation is not apparent during the spring mating season (Best and Fisher, 1974).

The narwhal is a seasonal breeder, with a gestation period of about 15.3 months, with mating in March-May and calving in July-August of the following year. Lactation exceeds 12 months and may continue for as long as 20-24 months (Braham, 1984). The interval between successive conceptions is normally three years, although about 20% of the females conceive at the first mating season following the birth of a calf. Females may ovulate up to four times before conceiving (Hay, 1980). Other authors estimate a two- or three-year calving interval (Best and Fisher, 1974). Vibe (1950) and Tomilin (1957) have observed that narwhals copulate vertically in the water, belly to belly. Ovulation occurs primarily in the left ovary and a single calf is born, but occasionally twins are produced. Birth takes place tail first. Vibe (1950) suggests that calving takes place every second year, although Degerbol and Freunchen (1935) consider that narwhals breed every third year, since the calves remain with the mother for an extended period.

Best and Fisher (1974) consider that the body length at birth is likely to be between 1.5 and 1.7m, based on the size of the smallest narwhal recorded and the largest foetus described in published data. The calves weigh about 80kg at birth (Mansfield, Smith and Beck, 1975) and are already well protected by a 2.5cm layer of blubber. When fully grown the adult female reaches about 4.0m and weighs about 900kg, while the adult male grows to about 4.7m and 1,600kg. Males attain sexual maturity at about 3.9m and females at 3.4m (Braham, 1984).

Hay (1980) used growth layers on the polished dentinal surface of the longitudinally sectioned unerupted tooth and thin transverse sections of the periosteal zone of the anterolabial portion of the mandible to estimate age. However, some problems with these methods were revealed when they were reviewed (IWC, 1980b), and other methods, such as tagging young animals, are required to elucidate age determination in this species (Hay, 1980). Estimates of lifetime reproductive potential based on ages obtained through counts of growth layers in hard tissue (one growth layer group per year) give a lifetime reproductive potential more than twice that of white whales, which is unlikely, and provides further evidence that current ageing techniques are not satisfactory (Braham, 1984).

The only natural enemies of the narwhal are the Greenland shark, the walrus, possibly the killer whale and perhaps polar bears. Killer whales may aid their hunting by driving narwhals (Mansfield, Smith and Beck, 1975; Reeves and Tracey, 1980).

Although they are well adapted to life among the ice, narwhals sometimes find themselves trapped by accumulations of ice floes, particularly in shallows and near shores. This species is normally found in deep waters, in contrast to the white whale which frequents shallow waters. When freezing of the sea is intensive, the narwhal remains in polynyas, breaking the newly formed ice, provided the thickness does not exceed 5-6cm. The small holes which the ice-bound animals keep open have an Inuit name *savssat* and the local people frequently take advantage of this situation to kill the entire group from the ice (Tomilin, 1957). Groups could also perish if the ice became too thick.

Threats - Historical From the earliest times the narwhal has been an important quarry for the local kayak hunters. The meat (usually used as dog food), blubber and fat (used for heating and lighting), and skin (known as muktuk, an important source of vitamin C (Rodhal, 1949) eaten raw or cooked, by humans), sinews (for sewing), and tusk (earlier used as spear or harpoon shafts, later as a good trading commodity), are all valuable (Reeves and Mitchell, 1981; Davis, Finley and Richardson, 1980). The use of oil for fuel is now discontinued in Canada, and as very few working dogs are now kept there, the demand for dog food was thought to be lower (Reeves and Mitchell, 1981). However, it appears that most communities still have as many dogs (as pets) as people, and there has been some return to the use of working dogs because of the increasingly prohibitive costs of owning and operating snowmobiles (Canada, 1985). In Greenland, a more traditional way of life is retained: there are still many working dogs in the hunting areas, supplies of alternative fuels may be less readily available, the meat is still highly esteemed for human consumption, and muktuk is most often eaten raw (Kapel, 1980).

In the past the tusk was highly prized, and specimens were presented to monarchs, used as bishops' croziers and made into luxury items. narwhal tusks were said to be endowed with magical or medicinal properties. Ground into powder they were used as an antidote against arsenical and mercurial poisons and as a haemostatic. A large part of the prestige of these items was based on the belief that the narwhal tusk was the horn of the unicorn. Once it became generally known that 'twas nothing but the tooth of a fish' the market value dropped considerably. The Danish naturalist, Ole Wurm, appears to have been responsible for establishing the link between the unicorn and the narwhal in 1638 (Reeves and Tracey, 1980; Reeves and Mitchell, 1981).

Narwhals were probably hunted by Europeans for commercial purposes as early as the 10th century, soon after the Vikings began to establish permanent settlements in southwest Greenland, when ivory and skins were important export goods. Many of the colonists' seasonal hunting expeditions were sponsored by the Norse Greenland Church, which took a special interest in the acquisition of walrus and narwhal ivory. Settlers sometimes paid their church tithes in ivory. The volume of this trade, which was possibly modest in relation to the narwhal population, probably ended during the late 1300s, when commerce between Europe and the Viking colonies gradually came to an end (Reeves and Mitchell, 1981). No quantitative assessment of this early trade or of local utilization is available, but it has been estimated that no more than 50 tusks were present in Europe (outside the hunting areas) by the mid 16th century (Shepard, 1978).

The next phase of hunting probably began early in the 17th century, with the renewed penetration of European explorers into the Davis Strait. It appears that UK and Dutch seafarers took advantage of every opportunity to barter for tusks with the local people, but seldom hunted narwhals themselves. However, it was the Danish/Norwegian kingdom which claimed the entire area of the northern North Atlantic and provided the main source of narwhal ivory, through their permanent trading posts in Greenland. Again, the volume of trade is not well documented, but 'ship loads' are mentioned at this time. Demand appears to have somewhat abated in Europe, but was still strong in the Orient, Russia and the Middle East. It appears that even as late as the 1950s, powdered narwhal ivory was still sold as a drug in Japan (Reeves and Mitchell, 1981). From the 17th century, European and American commercial whalers occasionally hunted narwhals, although the main source of tusks remained the local people. A market for the skins also arose: the 'porpoise leather' was tough, pliable and waterproof; it was popular for making boots and shoes. During the 1920s there was a special market in Peterhead, Scotland, for narwhal skins, which were shipped to France for manufacture into fashionable gloves (Reeves and Mitchell, 1981).

Besides Greenland, permanent trading posts were also established in the North American Arctic, particularly in Canada where trade in narwhal products was, at times, on a large scale. Some such posts, for example at Pond Inlet in northern Baffin Bay, accounted for several hundred narwhals a year (not counting those lost because these hunters used firearms, rather than the traditional harpooning methods of the local people, which resulted in few such losses). The decade from 1915-1924 was probably the peak period for this type of hunting in both Canada and Greenland, and it is estimated that a total of about 11,000 animals were removed (including about 4,000 animals killed in Greenland during three savssat hunts). After that time, possibly partly through lack of international demand, it appears that annual catches were lower, although detailed statistics are not available (Reeves and Mitchell, 1981).

Threats - Present In recent years, combined catches for Canada and Greenland were of the order of 1,000 a year (with some fluctuations, mainly resulting from years when savssat kills were available), including allowances for animals killed-but-lost (Reeves and Mitchell, 1981). Today, there is no commercial narwhal hunt. Local people catch them for much the same reasons as in earlier years, particularly in Greenland. In Canada, the muktuk is now the major objective. This change in the objective of the Canadian hunt has led to the view that the cash value of the tusk could also be a major incentive - no longer merely a useful by-product (Reeves and Mitchell, 1981).

Narwhal catches reported in the last five years (not including any correction for hunting losses).

	Canada	Greenland	USA	Total	Source
1986	263	?		263+	IWC, 1988
1985	314	130-335		444-649+	IWC, 1987
1984	285	563-665		848-950	IWC, 1986
1983	344	355-465	?	669+	IWC, 1985
1982	403	342-400		744+	IWC, 1984

Traditional hunting methods, using kayak and harpoon with floats and drogue, are associated with efficient hunts. The introduction of rifles, first used to kill harpooned animals and more recently employed to shoot at unharpooned animals, has greatly increased the Canadian hunting loss rate. Loss rates vary depending on the type of hunt, but must be considered when assessing the effects of hunting. In some cases they may be very high, making them the most important element of exploitation. Rates may vary from season to season even within a community, particularly where savssat conditions may occur. For example, in the Thule district the killed-but-lost percentage for the summer hunt is estimated at one lost per 20 landed, but for savssat (winter) hunts it is one lost per two landed (IWC, 1980a). Savssat hunts are usually responsible for the great fluctuations in catch from year to year, as they do not occur every season. There are also variations from year to year in the completeness of reporting, and there may be some under-reporting in all years (IWC, 1980a).

For the Davis Strait - Baffin Bay stock, the loss rate for the Canadian archipelago was estimated at about 52% (IWC, 1980a). The Thule/Melville Bay loss rate was thought to average 5% (Kapel, 1977). In Foxe Basin, the loss rate was estimated to be 52%, and in the East Greenland-Spitzbergen stock, hunting loss rate was estimated at 25% (IWC, 1980a).

The fluctuations in catch from year to year, and the absence of detailed information on local stock identity, make it difficult to assess the effect of hunting.

Narwhal tusk is one of the few cetacean products still in commercial international trade. The CITES reports indicate that of the order of 100 tusks a year are involved, some of which will be secondary trade (re-exports). The export figures for producing countries do not necessarily mean that all the tusks noted were taken in that year. However, the tabulations do give an impression of the volume and pattern of trade (CMC, 1987). There was an enormous increase (almost double) in international movements in 1979/80. This was presumably in connection with the proposal that the narwhal be listed on CITES Appendix II, which was adopted by the Parties at their 1979 meeting. At that time, the main pattern of international trade was export from Canada to the UK, and re-export from the UK to a variety of countries. From about 1982, the proportion of tusks originating in Greenland/Denmark has increased, until, in 1985 (the last year for which figures are currently available) this has outstripped the Canadian trade (15 tusks Canada, 55 tusks Greenland/Denmark). However, it is not clear whether this represents a real increase in international trade or simply an increase in recording, through the recent changes in Greenland's status in relation to Denmark and to the European Community. The UK is no longer a major trade centre (only two tusks recorded in 1985), presumably in response to the European Community actions to treat all cetaceans as if they were listed in Appendix I of CITES, although specimens and products (of Appendix II species) originating from local people in Greenland are exempted. Japan may be emerging as the major world consumer of narwhal tusks (about 20 imported in each of the last three years), while signs that Switzerland or Italy might become the new world trading centres seem to have disappeared over the last two years. In addition to the tusks, some ivory carvings are mentioned. The volume of these is low, and in any case the number of tusks required is low, as several carvings may be made from one (usually broken) tusk. Two skin/leather items have also moved from UK to USA (1982 and 1983) and 13 kg of meat from Greenland to Canada in 1984 (CMC, 1987).

With total world narwhal catches at about 1,000 animals a year (probably about half of these tusked animals), and only about 100 tusks in international trade each year, it is clear that the international market cannot be a major incentive for catches. Also, following the European Community action, prices on the international markets were considerably reduced, and the hunters received only $150 to $300 per tusk, as opposed to an average of $900 in 1982 (Canada, 1985).

There is no information available on national trade in Greenland, but it appears that (tagged) tusks are sold by Canadian Inuit Cooperatives to tourists and itinerant workers. It is said to be difficult for untagged tusks to be removed from the North West Territories, because the private and commercial air carriers, which provide virtually the only means of access to the hunting communities, are sensitive to the issue, and refuse to carry 'suspicious parcels' or untagged tusks. The Hudson's Bay Company stopped buying tusks in 1982; before that time it consistently held a surplus of tusks. The only other dealer has also consistently held a surplus of tusks, as he is not able to trade internationally or domestically all tusks bought in one year. Arctic Enterprises continues to purchase tusks in order to encourage patronage by the Inuit for other staple items (Canada, 1985).

It therefore appears that, at least currently in Canada, there is much less cause for concern that demand for narwhal tusk outside the hunting areas may be causing over-exploitation. There appears to be no hard evidence of illegal trade, but there is a body of opinion, mainly within conservation organisations, that some does occur at all levels from hunters to international trade.

Mansfield, Smith and Beck (1975) and IWC (1980a) express concern that the increasing search for mineral and hydrocarbon resources in the Arctic and their possible large-scale exploitation may have adverse effects on the local marine mammals. The Nanisivik lead-zinc mine on Baffin Island, Canada, is depositing tailings into a lake which flows into the sea. There is evidence of cadmium bio-magnification in the food chain, and very high levels have been reported in narwhal brain. This raises questions about the suitability of the narwhal for human food as well as possible dangers to the narwhals themselves. In Greenland, the Black Angel lead-zinc mine deposits its tailings directly into the sea, the fjord is now heavily polluted, a rapid rise in heavy metals in marine organisms has been noted and most organisms in the immediate area have died. There is some evidence that the pollution is spreading to the adjacent fjord (IWC, 1980a). Changing techniques in traditional hunts may result in increased disturbance. In this context, Breummer (1971) and Kapel and Petersen (1982) report that the Greenlanders have themselves forbidden the use of motor boats in the narwhal hunting areas in summer.

There is no information on habitat threats to the USSR and Alaskan populations, but mineral prospecting and exploitation could present similar potential problems.

Braham (1984) says that, on the basis of presently available information, the stocks of narwhal are probably collectively producing young at a greater rate than they are being removed by hunters. This does not mean, however, that all exploited local stocks are in the same position.

Conservation Measures Countries of origin are Canada, Denmark (Greenland), Norway (Spitzbergen), USSR, USA (Alaska), and Iceland; excluding countries outside the main range where vagrants have occasionally been recorded.

The narwhal is listed in CITES Appendix II. Records of international trade are discussed in the Threats - Present section above. All the countries of origin, except Iceland, are Parties. No other specific international protection legislation was found, although a conservation Agreement under CMS, to which Denmark and Norway are Parties, might be possible.

As a result of the thorough review of the status of the species, the IWC Scientific Committee recommended that it be named in the Schedule, so that appropriate management steps could be taken (IWC, 1980a). This was not agreed by the Commission, in that year, or in the next, when the recommendation was again made (IWC, 1981). Canada, which had been a considerable source of information and expertise, left IWC from 1982. Since that time the status of the narwhal has not received detailed consideration by the small cetaceans subcommittee, although new information (including that which Canada continues to supply in the form of an informal annual report) has been monitored. Since all the countries of origin, except Canada, are IWC Parties, the small cetaceans subcommittee is still the best international expert forum for discussion of conservation and management.

Kemper (1980) gives a detailed account of the Canadian regulations, which include a settlement quota system. He reports that the quotas are regularly exceeded and that enforcement has not been attempted. However, an informal document circulated by Canada at the 1985 CITES meeting (where a proposal to add the narwhal to Appendix I was rejected) states that 'in no year has the overall quota been surpassed, although occasionally individual communities have surpassed their annual quotas. This has not been a general practice and in those instances where this has happened, action has been taken by Department of Fisheries and Oceans (DFO) enforcement personnel to rectify the situation' (Canada, 1985). A Table of DFO harvest statistics (landed animals only) is appended in support of this statement. The quota system is operated by the DFO, which issues tags. These have to be attached to each tusk or carcass of tuskless females and immature males. Export of any part or derivative (including tusks) from the North West Territories requires a permit, and only tagged tusks may be exported. Export from the country also requires a CITES permit.

Kapel and Petersen (1982) described the Greenland situation in some detail, with further information in Kapel (1977). There are no specific regulations for narwhal hunting alone; the general regulations relate to both narwhals and white whales, and are designed to retain the traditional character of the hunt, and discourage waste. All catches must be reported.

The narwhal is protected in the USA and import of products prohibited, although exemption is given to local USA people of the Aleutian islands, Bering Sea and Arctic Ocean. The species is also fully protected in the USSR. The narwhal is said to have full protection under Norwegian law (Canada, 1985), although such protective legislation has not been found; according to available information, narwhals may be taken without permit in Norway. No information was found on the legal status of small cetaceans in Iceland.

The regulation and reporting of catches by isolated communities in the Arctic regions is by its nature a very difficult practical task. In this case, however, the product traded outside the catching area, the tusk, is distinctive, and valued intact. The Canadian system of requiring tusks in trade to be accompanied by the catch tag seems a very practical method of control, and could be a means of checking international trade at all levels. Kapel (1980) indicated that there are considerable practical difficulties in implementing such a system in Greenland, the other major catching area. There is, however, provision in CITES, Article VI, 7, for Management Authorities to mark appropriate specimens to assist identification. This could be implemented in this case both at point of export, for newly caught specimens, and at point of re-export, for specimens already in trade. This is important, as tusks do not deteriorate over hundreds of years in normal use, are almost impossible to date by normal methods, and many pass regularly through the market. In time it should be possible to detect tusks in trade from any unauthorised sources. However, at the moment it appears that the tusk trade is not an important incentive for catching, and the volume of international trade is low in relation to the possible numbers of tusked animals caught each year. The trade situation could change, however, and requires continued monitoring, particularly in Greenland, where very little information is available.

A much more important conservation concern is the evaluation of the effects of the catches for local use. Much work has been undertaken in recent years but unfortunately has not been published or exists only as internal reports. It is particularly unfortunate that the regular informal Canadian reports to IWC are not always published, as these contain detailed catch statistics. It would also be helpful if these reports contained maps showing the location of all the reporting communities, since these small settlements rarely appear on internationally available maps. A new review by the IWC small cetaceans subcommittee could be valuable in bringing this work forward, and in providing a new, overall view, of the current state of the stocks.

In the meantime, further research on vital parameters and stock identity is needed, especially on the Davis Strait-Baffin Bay stock, where removals are greatest, and on the East Greenland stock, where there is very little available information. The new biochemical techniques requiring only small samples of tissue could be useful for elucidating stock identity (IWC, 1988).

The IUCN/SSC Cetacean Specialist Group Action Plan mentions the status of narwhals exploited by native peoples in Canada and Greenland as a subject to be monitored (Perrin, 1989).

Captive Breeding Specimens of Canadian origin have twice been kept in captivity but not successfully maintained. The first one to be exhibited, in the early 1960s, was a neonate flown from Grise Fjord to the New York Aquarium; it died after a month. In 1970 six were captured, one from Grise Fjord and the others from Eclipse Sound, and exhibited at Vancouver Public Aquarium. All died within four months (Reeves and Tracey, 1980). At least in one case, preliminary capturing activities caused narwhals to leave the area (Newman, 1970).

Considering that the adult male could be up to 7m long (including the tusk), the species may be only marginally practical to keep in captivity, except at the largest establishments. Semi-captivity in reserves is probably also not practical, because of the severe climate. Captive breeding may, therefore, not be a readily feasible conservation option.

The failure to maintain animals some years ago, however, should not be taken to imply that the species could not be kept under modern husbandry. If any animals are brought into captivity in future, the opportunity should be taken to obtain biological, behavioural and breeding information useful for conservation and management of the wild populations, in particular ageing studies for calibrating the current techniques, as well as for captive breeding, should this ever become necessary.

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HARBOUR PORPOISE **INSUFFICIENTLY KNOWN**

Phocoena phocoena (Linnaeus, 1758)

Suborder ODONTOCETI Family PHOCOENIDAE

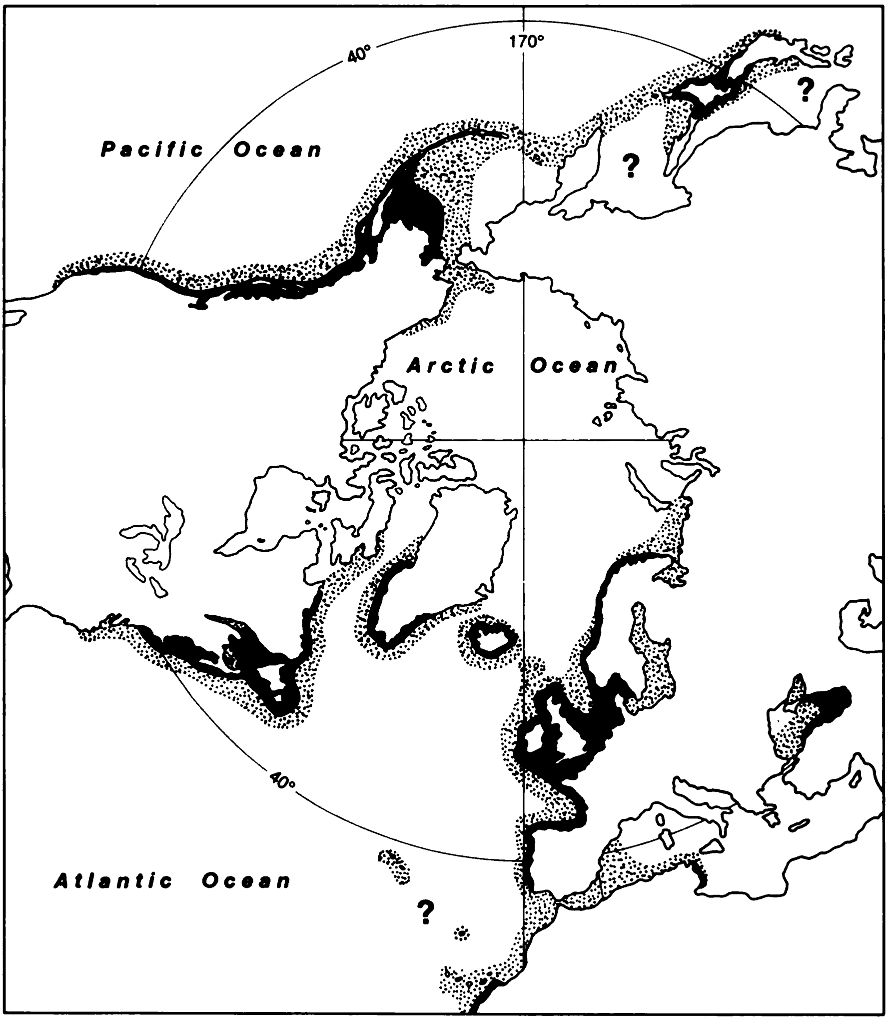
Summary The harbour porpoise is subject to incidental capture in fisheries throughout the range. Such takes appear to be adversely affecting at least the Bay of Fundy population, but in most cases the level of take is not known, nor the size of the local populations. The single most important action that must be accomplished to protect the harbour porpoise throughout the range is to reduce incidental take in gillnets and other fishing gear. There is also some direct catching, apparently at low levels except off west Greenland. There are fears that the populations in the North, Baltic and Black Seas have declined. The major needs are for much better information on catch levels, and for research into the causes and prevention of net entanglement.

Distribution *Phocoena phocoena* is a generally coastal species, limited to cold temperate and subarctic waters of the Northern Hemisphere. It appears to be limited to relatively shallow waters, and is rarely seen in waters deeper than about 200m (Barlow, 1987; Watts and Gaskin, 1985). Gaskin (1984) has recently reviewed distribution, and the map accompanying this review is based on this, with a some alterations to take new information into account. The harbour porpoise is found in bays, estuaries, tidal rivers, tidal channels, and adjacent offshore shallows. In the eastern North Atlantic the range is from the Kara Sea to Senegal in West Africa, including the Faeroe, Cape Verde and Azores Islands, and the Baltic Sea. It appears to be absent from the eastern Mediterranean, and it is not clear whether the very few records in the western Mediterranean represent strays from the Atlantic or a viable local population. Ktari-Chakroun (1980) however, has recently reported its presence along the Tunisian coast. In the western North Atlantic it is found from southern Greenland and southern Baffin Island south to North Carolina. It is not yet clear whether the Icelandic population, which moves offshore in winter, is in contact with the Faeroes population, nor whether the Faeroe population is in contact with Irish/UK populations. In the eastern Pacific Ocean, harbour porpoises may occasionally be found as far north as Point Barrow and the Mackenzie estuary, and the southern limit is about Los Angeles, California. They are present near islands in the Bering Sea and are found along the western Pacific coasts as far south as the northern Japanese islands. Wang (1984) however, quotes a report from Taiwan. There is an isolated population in the Black Sea.

Some authorities have distinguished three divisions: *Phocoena phocoena relicta* in the Azov/Black Sea; *Phocoena phocoena phocoena* in the North Atlantic; and *Phocoena phocoena vomerina* in the North Pacific. Tomilin (1957) reviews the anatomical evidence, but most recent authorities regard the divisions as below species level, probably representing geographic races. The IWC subcommittee on small cetaceans (IWC, 1984) did not accept the detailed working definitions of subpopulations proposed by Gaskin (1984), although they agreed that the three major population divisions were likely to be composed of semi-isolated subpopulations. They believed that present knowledge was not yet adequate to allow delineation of such boundaries, but they agreed that the suggested subpopulation units did provide a good provisional basis for review and planning.

Yurick and Gaskin (1987) have now provided morphometric and meristic evidence for the separation of the eastern Pacific, western Atlantic and eastern Atlantic populations. They do not yet have sufficient samples for conclusive definition of tions, but there were trends which suggested that some segregation of Dutch, Baltic and eastern UK (North Sea) animals might be demonstrated with larger samples. On some tests Dutch, English Channel and Irish Sea samples tended to differ from North Sea UK samples. Unfortunately, although Kinze's (1985a) study of Baltic and North Sea material was very similar, he did not make any correction for age and therefore cannot rule out the possibility that sampling bias, and not intraspecific variation, was responsible for the observed variation between the samples.

Map 7. Current distribution of the harbour porpoise *Phocoena phocoena*



Black areas: known consistent occurrence; stippled: occasional, peripheral or probable range. Based on Gaskin (1984), with some changes to take new information into account.

The harbour porpoise no longer appears to enter the Azov Sea, where it was once abundant in the southern part, possibly because of over-hunting or pollution. Some parts of the range in the eastern Baltic now contain very few animals. No reports indicate reductions in distribution in the North Pacific, although rather little information is available in general about this area, nor on the western side of the Atlantic (Gaskin, 1984).

Movements are related to movements of food species and also show a seasonal change. In general this movement is inshore in summer and offshore in winter, and in some areas movements to the north in summer and south in winter are noted (Gaskin, 1984; Tomilin, 1957). There has been much speculation as to whether the Baltic population moves into the North Sea or even to the Scottish coast in winter (Gaskin, 1984). The evidence for the latter idea is unfortunately based on an anomaly in the UK strandings recording system, and is unlikely to represent a real influx of animals in winter (Klinowska, 1985). Kinze (1985b) provides evidence for a small resident winter population in inner Danish waters, and Ropelewski (1957) and Skora *et al.* (1988) note information which suggests a wintering population in ice-free areas of the eastern Baltic. The balance of opinion points to the northern North Sea as the wintering area for the majority of animals from inner Danish waters, although it is possible that Norwegian waters may also be used (Gaskin, 1984; IWC, 1984). This more restricted pattern of movement is in accordance with the known habits of the species elsewhere. Some recent surveys, and other evidence, however, indicates that it also occurs in deep offshore waters. The species has recently been reviewed by the IWC Scientific Committee sub-committee on small cetaceans (IWC, 1990).

Population Most of the little formerly available information on population is summarised by Gaskin (1984). Vessels surveys directed mainly at minke whales in 1988 and 1989 provided abundance estimates for harbour porpoises in the Lofoten-Barents Sea area of 10,994 (c.v. 0.239) and in the northern North Sea at 82,619 (c.v. 0.217). Populations in the Bay of Fundy and Gulf of Main are estimated at 7,956 ± 1,327 (95% confidence limits) and 15,300 ± 2,552 maximum, although these may be underestimates as the entire range in the region was not surveyed (IWC, 1990). Barlow (1987) gives an estimate of 49,862 (s.e. 8,891) animals for the coasts of California, Oregon and Washington (USA), based on survey data. There are no estimates for the rest of North Pacific, except a tentative 1,000+ for the Gulf of Alaska. There is a relatively large concentration in Glacier Bay, Alaska (Taylor and Dawson, 1984). In the North Atlantic the West Greenland population was estimated to be 10-15,000 animals and the Bay of Fundy population at between 2,600 and 4,000. It is thought that there may be in the region of 15,000 animals in total inhabiting the area between southern Nova Scotia and North Carolina. There are no estimates of current population for any other part of the North Atlantic, although Mitchell (1975a) estimated, from catch statistics, an initial population for the Danish fishery of 10,000-15,000 animals.

There has recently been considerable interest in the harbour porpoise in European waters because of fears that the population is declining (e.g. IWC, 1984). Klinowska (1987) has recently reviewed the available information for the North and Baltic Seas and concluded that although there is good evidence for major population declines in parts of the Baltic (e.g. in Polish and some Danish waters), the situation elsewhere is far from clear. Unfortunately, no systematic surveys have been carried out, and the only information on trends in harbour porpoise populations comes from informal sightings reports and strandings records. Both these sources have severe limitations, which have not been realised by a great many authors who have sought evidence for population changes in such records. Except in very special circumstances, such sightings and strandings records, by their very nature, cannot provide information on population changes, although they do provide a great deal of other information about the animals (Klinowska, 1985).

The relative position of the harbour porpoise, as by far the most frequently reported species in both sightings and strandings records, has not changed. There are significantly fewer strandings reports in the past 35 years for the UK southern North Sea coasts in comparison with the first 35 years of the recording scheme, but there is increasing circumstantial evidence that this change is related to decreases in fishing effort (e.g. Northridge, 1988). Nevertheless, the subjective reports of population decline in the southern North Sea should not be dismissed, and research is urgently needed to elucidate the situation.

Estimates for the Black and Azov Seas are complicated by the facts that the fishery covered three species, *Phocoena phocoena*, *Delphinis delphis* and *Tursiops truncatus*, and that catches were recorded by weight. Numbers and species composition have to be estimated. From 1967 aerial surveys have been undertaken by the USSR. Zemsky and Yablokov (1974) calculated population sizes from these surveys ranging from, for *P. phocoena*, 12,600 in 1969 to 33,300 in 1973. These estimates, however, show no consistent trends and the methodology has been severely criticised by Smith (1982) and by the IWC subcommittee on small cetaceans (IWC, 1983). Very high estimates of abundance obtained by Çelikkale *et al.* (1989) have also been flawed on methodological grounds (IWC, 1990), being derived from an extrapolation of the density in a narrow coastal strip to the entire Black Sea. The general picture is that the Black and Azov Sea populations were greatly reduced by over-exploitation leading to closure of the USSR, Romanian and Bulgarian operations in 1966.

Habitat and Ecology Information on food species is considerable, one study alone being based on examination of 4,000 stomachs (Gaskin, Arnold and Blair, 1974; Tomilin, 1957). Mainly benthic fish are taken, but also pelagic species and in three cases the alga *Ulva lactuca* was observed in stomachs. A small proportion of benthic invertebrates are also taken. There are seasonal and regional variations in reported feeding habits.

In the Canadian study, seasonal movements seemed to correlate quite closely with those of the main food species, herring and mackerel (Gaskin, 1977). On the European coasts herring and whiting are among the species taken, and seasonal movements are attributed to the pursuit of herring (Tomilin, 1957). However recent investigations of the diet of harbour porpoises in UK waters found a low prevalence of herring in their stomachs (IWC, 1990). In the Black Sea in spring and autumn the species follows schools of anchovy. Tomilin (1957) assumes that similar movements in pursuit of prey are characteristic of the North Pacific populations.

Gaskin *et al.* (1984) have reviewed reproduction and life history parameters. Although a maximum life span of 15 years has been suggested in European waters and 13 years in some North American samples, few harbour porpoise appear to live beyond 7-8 years of age. Mating mainly takes place between June and August, although sexual behaviour can be observed between May and September. The gestation period is somewhere between 10 and 11 months, and young are born from May to early August. Parturition takes place offshore, but mothers and calves move quickly into sheltered coves. Ovulation takes place almost entirely in the left ovary, the right being small and non-functional. This has been recorded in other odontocetes but no explanation found (Ohsumi, 1964; Harrison, Boice and Brownell, 1969). Lactation may last no more than eight months, although the young can stay with the mother until the birth of the next calf, or even slightly longer. Average length at birth is 75cm, but sexual dimorphism is present even at this stage, with females larger than males. Both males and females appear to reach sexual maturity earlier in the western North Atlantic than in the North

Sea. Both sexes are mature in the Bay of Fundy population by three to four years of age; in the North Sea males mature at five and females at six years. Maximum body length is about 1.89m in females and 1.78m in males, although there is some variation between populations (Gaskin *et al.*, 1984). The 2.13m animal reported by Fraser (1953) was neither expertly measured nor was there any independent confirmation of species. Examination of testes shows that males have an annual reproductive cycle. Females, particularly young animals, may ovulate several times before fertilization occurs. Information reviewed by Tomilin (1957) indicates very similar parameters for Black Sea and North Pacific populations. Taylor and Dawson (1984) report that the Glacier Bay population contains about 6% calves.

In the Bay of Fundy it was observed that 14% of all mature females experienced post-partum pregnancy. One calf is produced at a time. Marked females here have been observed to breed every year for at least four years. Gross annual reproductive rates have been calculated as 0.16 for the Baltic and 0.10 for the Bay of Fundy. Gaskin *et al.* (1984) believe that their latest estimate of 0.06 is too low, and may have been biased by a failure to find very small foetuses.

Gaskin *et al.* (1984) conclude that the species is short-lived and may already be maximising its productivity. The reproductive flexibility is therefore likely to be limited, especially if more than half the breeding females are producing calves in successive years. These remarks by Gaskin *et al.* (1984) are based mainly on their experience with the Bay of Fundy population, which suffers from fairly heavy losses through net entanglements (Gaskin, 1987) and may not apply to populations with low removal rates.

Phocoena phocoena is a social animal, usually found in groups of 2-10, although there are seasonal variations. For example, Taylor and Dawson (1984) report singles as the most common group size in summer and that groups of three or more are most common in winter. Large schools of 50 or more are sometimes seen, but they may be loose aggregations of these small groups, formed seasonally for migration or for taking advantage of particularly rich feeding areas. Old bulls tend to form separate schools, and immatures of both sexes may also form separate groups (Tomilin, 1957; Gaskin, 1977). Epimeletic behaviour has been observed, both standing by captured young and standing by captured or injured adults (Tomilin, 1957). The harbour porpoise is a slow swimmer and usually does not jump clear of the surface. It is particularly difficult to observe at sea in all but almost calm conditions (Amundin and Amundin, 1974; Gaskin, 1977; Taylor and Dawson, 1984). It is a timid species and does not approach boats.

Ice cover seems to be a particular hazard for the harbour porpoise, in early hard winters they may be trapped by rapid ice formation and suffocate, particularly in areas which are ice-free in normal years. This has been reported on several occasions in the Baltic and in the Sea of Azov (Tomilin, 1957; Lindroth, 1962).

Threats - Historical In the past, the harbour porpoise has been directly or indirectly caught throughout the range: frequently for use as food by local people, but also at times for oil, meat, meal and other commercial products. In the Baltic such catches have taken place since at least the 14th century. The most famous fishery was in the Danish Lille Belt, taking passing porpoises between November and January. The main product was oil for lamps. Andersen (1982) gives catches in the 1830s and 40s as between 330 and 1,684 annually, with a mean of 981 and a ten-year total of 10,791. In the 1880s and 90s, 301-1,831 per year were caught, with a mean of 1,278 and a total over ten years of 15,330. During World War I about 1,600 were caught, and 773 during World War II. These were all used for human consumption. For comparison, Andersen observed only about 20 animals in the same area in the entire year 1969-70.

There are some scattered references to small cetacean catches (assumed to be harbour porpoise where not expressly stated) going back to 1378 off what is now the Polish coast, although this does not appear to have been a major direct fishery. In the 19th century it appears that animals accidentally caught in other fisheries were used to provide lubricants for harness and other leather. The oil was also used as a medicine by the local fishing communities. It is perhaps interesting to note Benecke's (1881) remark that although by-catches were frequent 30 years ago, at the time of writing the catch of even a single animal along the entire coast was rare. However, the Polish population must have recovered by the 1920s, because the authorities introduced a bounty as the animals were said to be harmful to fisheries, damaging nets as well as fish stocks. The bounty was substantial in relation to the probable income of the fishermen, and the surviving payment records provide the catch statistics quoted by Ropelewski (1957) for 1922-1932. These refer only to the Bay of Gdansk and neighbouring waters. In some of these years several hundred bounty payments were made, in others only tens. Ropelewski (1957) attributed the high catches to severe winters, which forced the animals into the restricted ice-free zones. Most animals, however, were taken as by-catches in a spring salmon net fishery. No further records are available until the early 1950s, probably partly because there was no fishing during the war and no data collecting institution for some years afterwards. There is no obligation to report catches and only sporadic captures and strandings have since been recorded. A survey in 1986 revealed only two cases of incidental catch, which indicates that the level of capture has probably indeed been low and is not simply the result of under-reporting (Skora *et al.*, 1988). There are clearly far fewer harbour porpoises in the area today than in the 1920s.

In contrast, Schulze (1985), after an examination of historical and present records, does not believe that the harbour porpoise is a permanent resident of the GDR Baltic coast. Over the past 150 years there has been no direct taking, and observations and by-catches were small and sporadic. They were made mainly in summer, and there appears to be a decrease in abundance from west to east.

The distribution and abundance of the harbour porpoise in the Baltic therefore appears to be more complicated than is usually appreciated, although there seems to be little doubt that, at least in some areas, there are far fewer animals than earlier this century.

In the Black and Azov Seas, a drive fishery using purse seines existed until 1967. USSR, Bulgaria and Romania participated. Some difficulties with the catch records are mentioned above. Total catches of all three species involved were of the order of 100,000-300,000 a year before the Second World War, declining to 5,000-7,000 by the mid-1960s. The composition of the catch changed from perhaps equal numbers of adults of both sexes to 70-75% young and pregnant or nursing females in the 1963 and 1964 seasons. There was also a change from predominantly *D. delphis* (80-90%) to predominantly *P. phocoena* (Smith, 1982), further complicating the interpretation and conversion of the catch statistics. This is particularly so as a conversion figure of 50-54kg per animal seems to be used. Tomilin (1957) quotes the average weight for harbour porpoise, calculated for the annual catch as 28kg and, taking spring caught animals only, as 30.2kg. If correct, this would double the estimates of catch for harbour porpoise, although references to other areas give around 75kg as an average weight (Scheffer and Slipp, 1948; Mohl-Hansen, 1954). The conversion figure of around 50kg does not correspond to any simple relationship between the mean weights of the three species as given by Tomilin (1957). These are, for *Tursiops truncatus* 175kg, for *Delphinus delphis* 51kg, and for the harbour porpoise as given above. The products of the USSR fishery are listed as 'delphinol', a cod-liver oil substitute used as a vitamin D source in medicine, oil for varnishes, paints and engine oil, jaw fat for lubricating oil for the precision instrument and aircraft industries, residues after fat removal for soap manufacture and remains for fuel. The meat was used for sausages, the skin being porpoise intestine. All scraps were used for meal and for glue. The skin could be used for footwear, handbags etc. (Tomilin, 1957). The products of the Bulgarian and Romanian fisheries are not known, but probably similar.

The Turkish fishery, which was suspended in 1983, is described by Berkes (1977). Purse seining and shooting were the two major capture methods, and the main products were oil and meal. Catching tended to be in relatively few areas; in 1969 90% came from two centres in the eastern Black Sea: Ordu, by far the highest, and Rize. The shooting method of capture takes mainly young and inexperienced animals and has a 50% loss rate. Berkes (1977) quotes an unpublished report of the Hydrobiological Research Institute of Istanbul University concluding that dolphins are overfished, but the recommendation that shooting be ended was not followed, as some groups of dolphin fishermen objected. He notes that attitudes of fishermen to dolphins differ. In the Mediterranean and Aegean they complain about damage to nets but believe hunting them sinful. Some groups complaining of dolphin damage now complain that there are not enough to drive fish into their nets or keep sharks and dogfish away. It is difficult, in the absence of accurate catch statistics, to estimate the size and composition by sex and age of the Turkish catch, although harbour porpoises were known to make up about 80% of the total. Between 1976 and 1981 the average annual kill was about 34,000 to 44,000 (IWC, 1983).

Recent reports suggest that the Turkish fishery will be re-opened when a stock assessment has been made. There is no timetable for this, but there is great pressure from the fishing industry to end the hunting ban. Contrary to earlier reports there is no large backlog of cetacean meal and oil that has to be disposed of. Sale of meal and oil to the European Community is no longer possible, but a ready market for these products exists in Japan, where much of the production from other Turkish fisheries in the Black Sea is presently exported (Perrin 1988). There would appear to be no legal impediment to such trade, as the harbour porpoise is listed in CITES Appendix II and catches are not regulated by IWC (see Conservation Measures section below). No information is yet available on a research project initiated in 1986, although some of the reported studies would require capture of animals and/or sampling of a fishery catch (Perrin, 1987).

Threats - Present Greenland is the only country presently reporting large direct catches of harbour porpoises, which are mainly used for human consumption. Catches are listed by Kapel (1983) and more recent information has been tabulated by the IWC subcommittee on small cetaceans (IWC, 1985; 1986; 1987; 1988). The catch takes place from all types of boats, except perhaps the largest trawlers. The relative share of the catch taken by different methods is not well known, but some are taken by shooting (with consequential, but unknown, losses), others are taken as a by-catch in nets (Kapel, 1983). Catches are highly variable, and the quality of reporting varies, but from 1982 between about 700 and 1,000 animals were taken each year. This is very similar to known average annual takes going back to the beginning of the century, although there was rise in catches to about 1,100 to 1,600 a year between 1965 and 1975. A non-Greenlandic salmon drift net fishery took an estimated 1,500 a year from the late 1960s, but was phased out between 1972 and 1976. The total catch for this area in that period therefore could easily have been 2,500 to 3,000. There was disagreement among the members of the IWC subcommittee on small cetaceans as to whether or not the long series of stable catches (except for the temporary increase) indicates that the population has not declined. All agreed, however, that the information necessary for an assessment of status did not exist (IWC, 1984).

On the French Atlantic and Channel coasts small cetaceans, including harbour porpoises, were caught and sold for human consumption until this practice was made illegal from 1970. However some direct take using harpoons continues by fishing boat crews to obtain meat for consumption at sea, although the main species involved are not harbour porpoise (Duguy and Hussenot, 1982). In the Basque area of Spain the animals are said to be taken for human consumption (Mitchell, 1975a).

There was a long tradition of harbour porpoise hunting by local people on the USA and Canadian coasts. Gaskin (1984) could find no evidence that the eastern Canadian Indians continued the hunt, although he says that if animals are trapped in herring weirs they will sometimes be eaten. Some USA Indian hunters may still be active in the Bay of Fundy area, taking probably fewer than 50 animals a year. In the period 1969-77 about 125 harbour porpoises were taken from this area for research purposes (Gaskin, 1984). Some few tens each year may still be taken for meat by hunters along both shores of the St. Lawrence (Laurin, 1976). There does not appear to be any direct hunting in Newfoundland, but a few are taken on one part of the coast of Labrador (Mitchell, 1975b).

An unspecified, but 'large number' of harbour porpoises were traditionally taken in coastal Icelandic waters, for their meat and to use the intestines as bait for fish. The catch may continue in some areas, but certainly at a far lower level (Gaskin, 1984).

In the eastern North Pacific the coastal Indians of Washington State were reported to be hunting harbour porpoises with shotguns until fairly recently, but there is no estimate of any numbers presently taken. There appears to be no evidence of a direct hunt in the Bering Sea (Gaskin, 1984). Some tens to low hundreds are taken every year in Japanese coastal fisheries, mainly for human consumption (Gaskin, 1984).

Therefore, except for the uncertain status of the Turkish fishery, it appears that there is no longer any major commercial fishery for harbour porpoises, and that the only direct fishery of any size is that in Greenland. If the long series of apparently stable catches here is taken to mean that the fishery is not detrimental to the local population(s) there is no cause for concern. However, this is not certain, and it would be prudent if some studies were made, as very little is known about the species in this area.

Incidental captures during other fishing operations almost certainly occur throughout the range, although they are not always reported fully and accurately. In the western North Pacific some tens per year are known to be taken in Japanese waters. No records are available for Korean, Chinese or USSR waters. A very few have been reported in the Bering Sea. In the Copper river and Prince William Sound area of Alaska about 100 a year may be entangled, of which about half die. At least some tens of animals die every year in fishing nets off British Columbia, Washington and Oregon. It appears that many of these carcasses were left to wash ashore and have been recorded as 'strandings' (which are often, mistakenly, assumed to represent only natural mortality in cetacean populations). The situation further south on the USA coast seems to be similar: some tens of animals die in nets each year, and their bodies may provide 50% or more of the recorded 'strandings' in the area. In the Monterey Bay region, a recent large increase in gill net fishing appears to be associated with an increase in 'stranded' harbour porpoises, from about two a year between 1963 and 1981 to as many as 13 in a single month in 1982. As the population here has been estimated at about 600 animals, the incidental take could be having a detrimental effect on the population (Gaskin, 1984).

In the North Atlantic, the Greenland incidental and direct catch has been mentioned above. A survey of incidental take in Newfoundland and Labrador in 1980 revealed that respectively about 1,800 and 300 harbour porpoises had been killed in various fisheries.

In Newfoundland most kills came from a few areas in certain seasons, indicating that locally dense herds were suffering high kill rates (Gaskin, 1984). Laurin (1976) estimated that about 50 a year might be taken in the St Lawrence. About this number are also caught in herring weirs in the Bay of Fundy plus about 350-400 a year for the last three years in gill nets (Gaskin, 1987). It is estimated that 4-500 a year may be killed in gill nets off the rest of the North American coast each year. Again, many of the bodies appear on the beaches as 'strandings' (Gaskin, 1984).

Incidental catches of harbour porpoises are known in both Icelandic and Norwegian waters. The size of the catch is not known, although Iceland reported 63+ in 1982. There is no recent information on incidental take in USSR waters (Gaskin, 1984). By-catches in and around UK waters have been thought to be small, and only one or two a year at most are reported to the official monitoring scheme. Northridge's (1988) study of marine mammal interactions with fisheries in the UK shows a much higher level of incidental take, although the information gained was not sufficient for a numerical estimate. Harbour porpoises seem to be the main species involved, and set gear responsible for most such takes. There is some evidence that many 'strandings' of this species are in fact incidental takes washed ashore. The situation appears to be similar in other European countries, with considerably more incidental taking than the sparse official records (where these exist) would indicate, and some incidental takes arriving on beaches to be recorded as 'strandings'.

Clausen and Andersen (1988) estimated that as many as 3,000 harbour porpoises were being taken each year by Danish fishing operations using set-nets in the North Sea and Skagerak, with perhaps several thousand more taken in other set-nets and trawls. These estimates were extrapolated from the collection of 149 carcasses through a special scheme in 1980 and rough estimation of effort in one set net fishery. While there are undoubtedly incidental catches of some hundreds a year in these Danish fisheries, some of the assumptions made to obtain the extrapolated figures may not be correct. Further investigation of the situation is urgently required.

Some are incidentally taken in the Turkish Black Sea purse-seine fishery for anchovy (Perrin, 1988), and it is likely that fishing operations by other countries in the Black Sea will also have an incidental take.

As a coastal species *Phocoena phocoena* is exposed to pollution and disturbance. There has been much speculation about the possible effects of pollutants, particularly PCBs, on reproduction in cetaceans, but so far no clear evidence that any particular levels are damaging. Kayes (1985) has extensively reviewed potential habitat problems for small cetaceans in the North Sea. Recent information on directed and incidental takes, and on habitat damage is given in IWC (1990).

Conservation Measures Countries of origin: USA, Canada, Denmark (Greenland, Faroes), Iceland, Norway, USSR, Sweden, Finland, Poland, GDR, FRG, Netherlands, UK, Ireland, Belgium, France, Spain, Portugal (Azores), Morocco, Mauritania, Senegal, Cape Verde, Romania, Bulgaria, Turkey, Tunisia (and possibly other western Mediterranean countries), Japan, China, DPR Korea, R Korea, USA, Canada.

The harbour porpoise is listed on Appendix II of CITES. Very few international movements are recorded, and most of these are small numbers of scientific specimens (CMC, 1987). Two live animals were sent from Denmark to FRG in 1980 and six live animals from Canada to USA in 1981. Both consignments were for zoological purposes. Seven bodies were illegally introduced into the Netherlands from the sea in 1984 (presumably an incidental catch was confiscated).

The IWC Scientific Committee has several times urged immediate action, particularly on research. The Commission has agreed, but little has been done. At the 31st meeting in 1979 the Scientific Committee expressed particular concern about the harbour porpoise in European waters and once more urged the Parties to take steps to investigate the possible decline in numbers and the effects of industrial activity (IWC, 1980). The harbour porpoise was reviewed by the IWC subcommittee on small cetaceans in 1983 (IWC, 1984) and in 1990 (IWC, 1991).

The ICES Marine Mammals Committee has repeatedly discussed the problems of this species, in particular with reference to the effects of pollutants, and called for further research (IWC, 1984).

The first meeting of the CMS Parties in 1985 resolved to instruct the Secretariat to develop Agreements for the conservation of North and Baltic Sea populations of harbour porpoise. The meeting also resolved to set up a Working Group on Small Cetaceans to develop proposals for the inclusion of other small cetacean species in Appendix II (only the white whale was listed). At the 1988 meeting the draft Agreement for protection of North and Baltic Sea harbour porpoises was not taken further, although these populations were included in Appendix II. During the Third International Conference on Protection of the North Sea, a Memorandum of Understanding was signed on 8 March 1990 by Ministers from all North Sea coastal states agreeing to promote the conservation of small cetaceans in this area. The provisions include actions to monitor and prevent incidental taking. The harbour porpoise has also been recently added to Appendix II of the Berne Convention.

The BS Commission meetings have been used to exchange information on Black Sea dolphin stocks. The ten-year moratorium on dolphin fishing announced by USSR, Romania and Bulgaria in 1966 was extended for a further ten years in 1976. Turkey has so far not taken up the invitation to join this agreement.

If areas of critical habitat can be defined, it is possible that they could be protected under the Ramsar Convention or one of the other appropriate international agreements. The major problem of incidental taking could be brought to the attention of the various international fisheries authorities, with the aim of encouraging the collection of catch statistics and research to minimise such catches.

The harbour porpoise has complete protection in many countries, but unfortunately it appears that, not only has this done little or nothing to prevent incidental catches, but it has also served to discourage the reporting of such catches (e.g. Gaskin, 1984; Northridge, 1988; Clausen and Andersen, 1988). Care is therefore needed in the drafting of protective legislation so that while incidental taking is not encouraged, the reporting of such catches and the preservation of carcasses for research is facilitated.

Gaskin (1987) reports that attempts are being made to persuade fishermen in the Bay of Fundy to change from gillnetting to longlining, in order to reduce the incidental kill of harbour porpoises. This is an approach which might be tried in other areas with large incidental takes.

Information on catches, particularly by-catches, on population abundance and trends, and on biology are needed before the true status of the harbour porpoise can be assessed.

At present there is cause for concern over the North Atlantic populations in the North Sea and Baltic because of the apparent population declines and possibly heavy incidental take, in the Greenland area because of high catches from a population of unknown size, and in the Bay of Fundy because of the high incidental take in relation to estimated population.

In the Black and Azov Seas the extent of stock damage to this species through exploitation is not clear, but could have been substantial. None of the fisheries should be reopened until sufficient reliable information for stock assessment is available. The few reports from the North Pacific should not be taken as indicating that there are few problems for the species in the area, and further studies should be encouraged.

The IUCN/SSC Cetacean Specialist Group Action Plan for Conservation of Dolphins, Porpoises and Whales mentions the status of the harbour porpoise in the North and Baltic Seas and the Black Sea, the incidental kills in the eastern North Atlantic, Bay of Fundy, off California, Japan, Taiwan and the Korean peninsula, and the exploitation in Greenland as topics to be monitored (Perrin, 1989).

Captive Breeding Probably at least 150 harbour porpoises have been kept in captivity worldwide, although the vast majority were incidental catches and kept for research purposes. There are scattered references to small cetaceans (almost certainly all harbour porpoises) in European aristocratic menageries from about the 15th century (Collet and Duguy, 1987), but no information on survival times. With the growth in interest in public aquaria in the late 19th century there were a number of attempts to keep incidentally caught animals alive for exhibition, particularly in Europe (Collet, 1984). Generally such animals were in poor condition and did not survive for long. This has also been the general pattern since that time, with incidently caught or stranded animals taken into captivity for rehabilitation and sometimes subsequently exhibited or, rarely, released. Perhaps less than 20 animals in total (not counting those mentioned in the section on trade above, whose catch history is unknown) were actively live captured, and most of these used for research.

By far the largest number of harbour porpoises (about 100 in total) have been kept in Denmark. All except two were incidental catches, and almost all were used for research. About half the animals died within a month, from diseases already contracted in the wild and from damage sustained at capture and in transit. The maximum survival time was 14 months (Collet, 1984). In 1986 attempts to rehabilitate seven incidentally taken harbour porpoises in Denmark resulted in the release of three animals six months later (Klinowska, 1987 -unpublished observations).

There appears to be only one report of a birth in captivity, and that was the result of conception in the wild (James, 1914). However, except in Denmark, specimens of this species have almost always been kept singly. The apparent failure to survive and breed in captivity might be due to the fact that no attempt seems to have been made to select and maintain a healthy group of animals of appropriate age and sex. On the other hand, it may be that the harbour porpoise has some needs which have not yet been met in the captive environment or is unsuited in some way to life in captivity. As a small species with inshore habits, the harbour porpoise should be feasible to keep and breed under appropriate conditions.

If any more animals are brought into captivity, the opportunity should be taken to collect more information on biology, behaviour and breeding, which would be useful for conservation and management of the wild populations, as well as for captive breeding, should this ever become necessary for conservation. Research relevant to the prevention of net entanglement is particularly important.

As some stocks seem to be subject to heavy catches or to be depleted, live captures should only take place from properly monitored stocks known to be relatively abundant.

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BURMEISTER'S PORPOISE **INSUFFICIENTLY KNOWN**
Phocoena spinipinnis Burmeister, 1865

Suborder ODONTOCETI Family PHOCOENIDAE

Summary Burmeister's porpoise suffers from high levels of take in demersal gillnets off Peru. Incidental takes are also known in Chile, Argentina, Uruguay and Brazil. The species is also involved in the expanding bait fisheries in the southern part of the range. Estimates of abundance, and of levels of incidental taking, are urgently needed throughout the range. Basic information on range, stock identity, biology and behaviour are also required for the effective conservation and management of this species.

Distribution Burmeister's porpoise is only found in the temperate waters of the Atlantic and Pacific coasts of South America (e.g. Leatherwood and Reeves, 1983). Guiler, Burton and Gales (1987) did report a specimen from Heard Island (53°S, 73°30'E), but this has now been re-identified as *Australophocoena dioptrica* (Brownell *et al.*, 1988).

On the Atlantic coast of South America it is known to occur from southern Brazil southwards to Patagonia in Argentina (Brownell *et al.*, 1988). On the Pacific coast Burmeister's porpoise occurs from Bahia de Paita, Peru 05°0'S, southwards to Valdivia, Chile, 39°50'S (Aguayo, 1975; Allen, 1925). The distribution of this porpoise along the coasts of southern Argentina and Chile is not well known. Goodall and Polkinghorn (1979) report four sightings. Single sightings were made in the Golfo de Ancud, Chile; south of Punta Arenas in the Strait of Magellan; the Beagle Channel and Bahia Slogett, east of the Beagle Channel. Other sightings in the Beagle Channel have been reported to these authors by fishermen.

Although the known distribution of Burmeister's porpoise extends from Peru to Uruguay, it is not continuous. Some of the discontinuity may be due to lack of observations. Differences in maximum length between the porpoises from Peru and Uruguay suggest that at least these two groups represent separate stocks. Where stock boundaries occur is unknown.

Population Nothing is known of the size or status of any stock. Brownell and Praderi (1982) consider it the most abundant small coastal cetacean off southern South America, although the species is believed to be much more common along the Pacific coast than the Atlantic coast (Leatherwood and Reeves, 1983). In Tierra del Fuego it represents 1.3% of the cetacean specimens found (IWC, 1991).

Habitat and Ecology Recent data are reviewed by IWC (1990). Maximum lengths recorded are 1.83m off Peru, 1.83m off southern Chile, and up to 2m off Uruguay. Evidence from specimens collected in Peruvian waters suggests that calving occurs in February and March and may be annual. Data from Chile and Tierra del Fuego suggest a similar calving season, but with some calvings earlier in the summer in the southern part of the range. A sample of stomachs collected off Peru contained primarily anchoveta. Samples from Chile also contained anchoveta as well as other fish. Stomachs from three specimens taken off Tierra del Fuego contained fish, mysid shrimp and euphausiids. The group size appears to be small, although one sighting reported a school of eight (Aguayo, 1975). Wursig, Wursig and Mermoz (1977) found that the more usual group number was around three animals.

Threats Recent information on direct and incidental takes of Burmeister's porpoise are summarised by IWC (1991). Burmeister's porpoises are taken in gillnets in Peru. The meat is used for human consumption. The largest take of porpoises (47%) is in gillnet sets for demersal elasmobranchs, such as rays and small sharks, with 31% of the porpoises taken in drift gillnet sets for blue sharks *Prionace glauca* and dusky dolphins *Lagenorhyncus obscurus*. The majority of porpoises are taken during October-November and April-May. It is estimated that 1,500-2,500 Burmeister's porpoise were taken in Peru in 1988, but this may be an underestimate because of lack of coverage of ports in northern Peru.

Burmeister's porpoises are captured both directly and incidentally in Chile. In northern Chile they are taken incidentally in nets. In southern Chile they are shot and harpooned for use as crab bait. Some were caught in nets set for southern king crab off Terra del Fuego in Argentina. This fishery is now illegal but low-level takes may continue. Burmeister's porpoise are taken incidentally in shore-based set gillnets in northern Argentina as well as in shark nets off Uruguay. An unknown number of Burmeister's porpoise have been reported taken incidental to fishing operations in Brazil.

Conservation Measures Countries of origin: Brazil, Peru, Chile, Argentina and Uruguay.

Burmeister's porpoise is listed on CITES Appendix II. The movement of 11 specimens from Peru to USA (status undeclared) and of one scientific specimen in 1985 is recorded. A skeleton was also sent from South Africa to USA, for scientific purposes, in the same year (CMC, 1987). No other specific international protective provisions were found, but as a coastal species there should be some potential for protection of habitat through the Ramsar Convention and WHC. A conservation Agreement between the Range States through CMS may also be useful, and there are some local international agreements which could be relevant.

There are problems with lack of enforcement of existing protective legislation in some South American countries of origin and a lack of protective legislation in others. There are already a number of conservation areas within the range which could protect important habitat.

The IUCN/SSC Action Plan pays considerable attention to the major problems of Burmeister's porpoise (Perrin, 1989): projects are proposed to reduce the illegal use of small cetaceans for bait in South America, to continue work on fishery interactions and direct exploitation in Peru, and to improve statistics on fishery interactions in Argentina.

Basic information on range, population, stock identity, and behaviour are also required for conservation and management purposes.

Captive Breeding It appears that no attempts have so far been made to capture live specimens, although a stranded animal was kept alive for nine days (Goodall, Galeazzi and Lichter, 1986). As this is a small species, captive breeding should be a feasible conservation option. If any animals are taken into captivity, the opportunity should be taken to collect information on biology and behaviour relevant to conservation and management, as well as to collect information for captive breeding, in case this ever became necessary for conservation.

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VAQUITA **ENDANGERED**

Phocoena sinus Norris and McFarland, 1958

Suborder ODONTOCETI Family PHOCOENIDAE

Summary The vaquita is found only in the northern Gulf of California, Mexico. It has the most limited range of any marine cetacean species and one of the smallest populations. It is taken incidentally in gillnets for totoaba and in other fisheries. In view of the extremely limited range and consequent low total population, this species is especially vulnerable to extinction through the incidental catching and habitat degradation. It is listed as Endangered on the recommendation of the IWC Scientific Committee subcommittee on small cetaceans, because of the low population size and continuing incidental takes.

Distribution Although all researchers do not agree, most believe that the distribution of the vaquita is limited to the extreme north of the Gulf of California in Mexico. Some sightings have been claimed south of this area, but no specimens have been found outside the northern Gulf. The sightings records in the central regions of the Gulf and southward have been questioned (Brownell, 1986; Barlow, 1986).

Population This species was first described in 1958 so that comparisons of original and present distributions are hardly possible. Before 1986 only 20 sightings of the vaquita had been published, and many of these lacked sufficient details to be substantiated (Brownell, 1986).

Several independent expeditions have surveyed the area: Villa (1976) reported three probable sightings in 15 days; Wells, Wursig and Norris (1981) covered 1,959km with two probable sightings; Vidal *et al.* (1985) made one (or possibly two) sightings in 1,665km; Turk *et al.* (1986) surveyed at least 300km and made one probable sighting; Silber sighted 110 individuals in a total of 4,216km of boat and aerial surveys conducted over 1986-89, including 43 individuals seen during 1,715km of boat transects (Silber, 1990). At the time of writing, none of these data have been worked up into quantitative population estimates, but the IWC Scientific Committee subcommittee on small cetaceans concluded that the total population was very small, perhaps in the low hundreds (IWC, 1991).

Habitat and Ecology Very little is known about the vaquita, even the external appearance and morphology have only recently been described (Brownell *et al.*, 1987). The most obvious external characters are a proportionately higher dorsal fin than in other Phocoenidae and large black eye and lip patches. Females appear to reach a maximum size of about 1.50m and males of about 1.40m.

Nothing is known about life history. The animals are usually seen in small groups of one to four (Norris and Prescott, 1961), although aggregations of up to eight or ten animals have been reported (Barlow, 1986). The vaquita has been described as 'elusive' and avoids vessels. Individuals have been sighted in water 13-28m deep, but they have also been caught in nets set in water less than 10m deep (Barlow, 1986). Information on food species comes from analysis of the stomach contents of one animal. Remains of grunts *Orthopristis reddingi*, gulf croakers *Bairdiella icistius* and squid were found. Both fish species are abundant throughout the upper Gulf (Fitch and Brownell, 1968).

Threats Recent information is summarised by IWC (1991). 85 vaquitas are known to have been taken since 1985. Available information suggests at least 30-40 are taken incidentally each year. The majority of recorded incidental takes were in experimental and illegal nets set for the endangered sciaenid totoaba, *Totoaba macdonaldi*, which is marketed in the USA. Following depletion of the totoaba the fishery was closed in 1975 but illegal fishing continues. New information has shown that vaquitas are also taken in nets for sharks, as well as those for sierra, *Scomberomorus* sp., and in shrimp trawls.

The totoaba fishery developed about 1929, and the methods changed from spearing, handlines and dynamite to modern nylon gillnets. The peak commercial catch was recorded in 1942, with other peaks in 1934, 1962 and 1967. The fishery was mainly limited to the totoaba spawning grounds in the far north of the Gulf. Brownell (1982) estimated that tens to the low hundreds of vaquitas per year were being taken in the early 1970s, on the basis of various catch reports (e.g. one day's catch in one area was ten animals). The totoaba may be in danger of extinction from illegal fishing and possible habitat degradation, although some fishing cooperatives claim that stock levels have recovered and the fishery should be re-opened (Barlow, 1986; Brownell, 1983; Flanagan and Hendrickson, 1976; Arvizu and Chavez, 1972).

Experimental gill-net fishing operations were carried out in March 1985, to assess the population status of the totoaba, in which seven vaquitas were accidentally captured and killed. The local fishermen of El Golfo de Santa Clara, where the experimental fishery had taken place, were asked to keep any other animals accidently captured in their gill net fisheries (e.g. for sharks). Six more specimens were collected in this manner in May 1985 (Brownell, *et al.*, 1987).

Given the limited range of the vaquita, habitat quality may play a major part in determining the status of the population. Water flow into the Gulf of California from the Colorado river has been greatly reduced by dams and water projects in the southwestern USA. The river may have been a major source of nutrient input into the Gulf, and it is possible that the general levels of biological productivity have been reduced, reducing the levels of food resources available to the vaquita. The possible consequences include increased natural mortality or reduction in reproductive capacity through scarcity of food. It is also possible that, if the carrying capacity of the ecosystem has been reduced, fewer vaquitas could now be supported (Barlow, 1986). There are fears that organochlorine pollutants may have entered the food chain, particularly through contamination of the waters of the Colorado river, although appropriate investigations have not been carried out (Barlow, 1986).

Other fisheries have continued to develop in the northern Gulf of California. It is not possible to predict the effect of these fisheries on the vaquita's food supply, because it is not known to what extent these animals depend on fish species taken in these operations (Barlow, 1986).

Exploratory drilling for oil has begun in the upper Gulf. Three drilling platforms operated in the early 1980s, and oil reserves are reported to have been found. Exploration has currently stopped and two platforms removed. It is not known what effect the operations, or future exploitation, may have on the vaquita (Barlow, 1986). However, it appears unlikely that minor oil spills are a serious problem for small cetaceans (Smith, Geraci and St Aubin, 1983; Barlow, 1986).

Conservation Measures The vaquita is found only in Mexico. The species is listed in Appendix I of CITES. The only recorded international trade is the movement of one bone from Japan to USA in 1985, for scientific purposes (CMC, 1987). As the species occurs only in Mexican waters there is probably little scope for further international specific protection, but habitat could be protected under WHC or NPWH.

The species is included in the Mexican list of wildlife species that are rare or in danger of extinction (Barlow, 1986). The Federal Act of 10 May 1972, which came into effect on 9 June, 1972, on Fisheries Development (Diario Oficial 25 May 1972) regulates all taking of aquatic species in territorial waters. Only domestic fishing for consumption by the person concerned is exempt from permit. Dolphins and porpoises are further protected by the regulations of Circular No. 20 of 12 September 1977. Capture is banned and various instructions given for the release of animals accidently captured during tuna fishing.

Barlow (1986) lists the steps which should be taken to gain further information about the status of the vaquita. These include: estimates of population size and distribution; studies of food habits; information on behaviour as it might relate to survey design; knowledge of the fisheries currently taking the species; accurate estimates of the annual rate of incidental fishing mortality; information on age at sexual maturity, calving interval and longevity; analysis of tissue samples for pollutant levels; information on the productivity of the northern Gulf of California and any trends; and information on any future industrial developments.

The IUCN/SSC Action Plan for Conservation of Dolphins, Porpoises and Whales (Perrin, 1989) calls for surveys and monitoring to determine the rates of incidental kill in gillnet fisheries.

However, the most direct way to improve the status of the vaquita would be to reduce the level of incidental catching. There is sufficient legal provision for such action, but there appear to be problems with enforcement, otherwise the catches would already be reduced. An educational campaign among fishermen has been effective elsewhere in reducing takes (e.g. see Indus river dolphin and baiji reviews) and should be instituted.

If areas of important habitat can be identified, steps should be taken to protect these as reserves and to exclude fishing operations and any other harmful developments.

Captive Breeding The species is not known to have been kept in captivity. However, as this is a very small animal, it should be feasible to keep, and captive breeding could be an ultimate option for species conservation. If any animals are removed for this purpose, the opportunity should also be taken for research on biology, reproduction and behaviour, which would provide information necessary for the conservation and management of the wild population.

Remarks The vaquita has previously been known as the cochito. Brownell *et al.*, (1987) proposed that, as the local fishermen use the term 'cochito' to refer to several delphinoid species, 'vaquita' should become the common name, because the fishermen use this consistently to refer to *Phocoena sinus*. The species is listed here as Endangered on the advice of the IWC Scientific Committee subcommittee on small cetaceans (1991).

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FINLESS PORPOISE **INSUFFICIENTLY KNOWN**
Neophocaena phocaenoides (Cuvier, 1829)

Suborder ODONTOCETI Family PHOCOENIDAE

Summary The finless porpoise is widely distributed, and although described as common in some places, in other areas the species has disappeared or numbers have been greatly reduced, mainly through habitat destruction. Much of the range, however, has not been studied, and it is feared that as a tropical inshore/riverine species more problems are likely to be revealed. A further difficulty is that parts of the range overlap (or did so in the past) with those of the Endangered baiji and Indus river dolphin and with the Vulnerable Ganges river dolphin, diverting attention from the finless porpoise in these areas. The major need is for more information on the populations, their biology and possible problems throughout the range so that the true status of this species may be determined and any remedial actions required initiated.

Distribution The finless porpoise is found in warm rivers and coastal waters from the Persian Gulf, through the Indian subcontinent to southeast Asia, Indonesia, and north to China, the Korean peninsula and Japan. The northern limit may be near Ojika Peninsula in northern Japan. They are found in the middle and lower reaches of the Yangtze (Changjiang) river in China, as far as Yichang, and in the adjacent lakes, such as Dongtinghu and Boyanghu (see map in baiji review). Elsewhere they are reported from mangrove areas, estuaries, deltas and freshwater lakes connected to rivers. They are found in all major rivers in this area (Mitchell, 1975a and b; Pilleri and Gihr, 1972; Pilleri and Gihr, 1974; Leatherwood and Reeves, 1983; Tadjalli-Pour, 1976; Zhuge, 1982; Wang, 1984).

Although some differences have been noted between populations in different parts of the range, insufficient study material is available to determine whether the various populations differ at the species, subspecies or lower level. Pilleri and Gihr (1972) have suggested that the Sino-Japanese population should be regarded as a separate species, *Neophocoena asiaeorientalis*, but this has not been widely accepted (e.g. Honacki *et al.*, 1982).

There is some dispute about the presence of the species in South Africa. The type specimen was apparently collected there, but there have been no other reports since that time. Hershkovitz (1966) and Tomilin (1957) include South Africa in the distribution, while Allen (1923), Rice and Scheffer (1968), Leatherwood and Reeves (1983), and most other modern writers seem to regard the anomalous location of the type specimen as resulting either from a vagrant or from a mistake of some kind.

Population No information is available to enable many comparisons of past and present distribution to be made. In former times when there was more water in the lower Indus, the animals were found in the same areas as *Platanista minor*. Today both species have disappeared from this area (Pilleri and Gihr, 1972). (For further information see Indus river dolphin review.)

Kasuya and Kureha (1979), on the basis of sightings, estimated a maximum population in April of 4,900 and a low of 1,600 in early winter in the Inland Sea of Japan, from a total of 1,194 individuals seen. Wang (1984) says that it is the most commonly seen cetacean in nearshore waters of China, and far more common than the baiji in the Yangtze river. It is abundant off the coast of Bombay (Tomilin, 1957), but seen less frequently in recent years in the mouth of the Indus (Pilleri and Gihr, 1972). A survey of the middle reach of the Yangtze river counted seventy-one specimens (Chen *et al.*, 1980).

Habitat and Ecology The maximum known length of the finless porpoise is about 1.9m, although physical maturity is attained at lengths of 1.6m or less. Males are slightly larger than females. Several calves born in the Yangtze river were about 0.55m long (Leatherwood and Reeves, 1983).

In Japan, the finless porpoise migrates annually to and from the Pacific coast, mainly through the two passes at the eastern Inland Sea. Most animals are found in April, at the beginning of the parturition season, and the fewest in early winter. Parturition occurs between April and August with a possible peak in April and May. It appears that most cows with new calves may leave the Inland Sea during the summer months. Weaning takes place from December to June after a nursing period ranging from 6 to 15 months. Pregnancies in two consecutive years are not frequent. A two-year breeding cycle seems to be the most common. Annual production of about 870 calves and gross annual reproductive rate of 17.9% are provisional estimates for the Inland Sea (Kasuya and Kureha, 1979).

Kasuya *et al.* (1986) found that the average length at birth was 80cm, and the longest male in their sample was 1.87m and the longest female 1.64m. They calculated a gestation time of 10.6 to 11.2 months and a late foetal growth rate of 0.279cm/day. Comparison of the body lengths of wild and aquarium reared animals with growth layer groups in the teeth suggest that one growth layer group is deposited annually. Among six males caught in the wild, four were producing sperm (1.44, 1.48, 1.57 and 1.87m in length) but two (1.55m and 1.65m) were not. (A situation recalling that in *Sotalia* - see review.) Eight wild females of between 1.41 and 1.64m in body length were sexually mature, the longest immature female so far found was 1.18m.

Food species in Pakistan include squid, sepias, shrimps and small fishes. Pilleri and Gihr (1972) report that in the area of the Indus mouth the animals migrate to the sea at the end of April and return to the creeks and delta in October. The migrations are related to the habits of the prawns, the main local food species. The animals appear regularly at certain places.

In China the finless porpoise can be seen throughout the year, usually in areas where river and ocean water mix, and often in the mouths and lower reaches of small and large rivers (Wang, 1984).

Tadjalli-Pour (1976) notes the coastal, estuarine, riverine and freshwater lake habitat, and says that they are usually seen singly or in pairs in Iran.

In Japan, groups of about 50 animals are seen, subdivided into pods of 5-10 animals. Groups of animals may cooperate in catching prey, surrounding schools of sandlance so that the fish cannot escape (Mitchell 1975a). Kasuya and Kureha (1979), however, noted the largest school of 13 individuals; 50% of the sightings were of single animals and overall mean school size was 1.97 individuals.

Threats Rivers, estuaries and mangrove areas are favoured by this porpoise, rendering it particularly vulnerable to habitat damage. The animals left Ise Bay in Japan during a time of great pollution, but returned when this was reduced (Nishiwaki, quoted by Mitchell, 1975b). In some parts of Japan, pollution may have reduced food species (Kasuya, quoted by Mitchell, 1975b). Kasuya and Kureha (1979) express concern about pollution in the Inland Sea which has increased in recent years. In spite of legal measures taken in 1973 and subsequently to reduce pollutant discharge, there is no indication of improvement.

Boat traffic may have driven the Indus mouth population away (Pilleri and Gihr, 1972). Although only a few instances of habitat destruction appear in the literature, it is probably safe to assume that further study would reveal similar problems throughout the range.

Neophocoena phocaenoides was involved in the Japanese small cetacean fishery, particularly in the East China Sea (Ohsumi, 1972). This exploitation, however appears to have more or less ceased from 1982, with Japan reporting no direct takes (except for some live captures in 1982) and less than ten animals indirectly taken each year (Japan, 1982; 1983; 1984; 1985; 1986; 1987). However, since indirect catches may not be reported if carcasses are discarded rather than landed for market, indirect takes are probably higher than indicated by these figures (IWC, 1984).

Chen *et al.* (1980) refer to catches in China. Leatherwood and Reeves (1983) refer to hunting of this species with guns, harpoons and 'fish forks' in China. The meat is probably used for human consumption, and the oil is also a desired commodity (Shou Chen-Huang, 1962, quoted by Mitchell, 1975b). No details of such catches are available.

Accidental taking in other fisheries is reported from Japan and the Indo- Pakistan coast, but is certain to occur to some extent throughout the range. If not discarded, carcases would be used for human consumption or oil (Mitchell, 1975a; 1975b). The finless porpoise is apparently not greatly affected by the habitat destruction in the Yangtze river which has brought the baiji to the brink of extinction, nor does it become entangled in the 'rolling hook' fishing lines which trap the baiji (see baiji review for further details).

Kasuya and Kureha (1979) note that although the incidental catch was once numerous in the Tachibana Bay in western Kyushu, this ended because of a change in the fishing method.

Conservation Measures Countries of origin include: Oman, Qatar, United Arab Emirates, Saudi Arabia, Bahrain, Kuwait, Iraq, Iran, Pakistan, India, Sri Lanka, Bangladesh, Burma, Thailand, Indonesia, Malaysia, Philippines, Kampuchea, Viet Nam, China, Taiwan, Japan, R Korea, and DPR Korea (and possibly South Africa and the nations of the western Indian Ocean between Oman and South Africa, where the cetacean fauna is practically unknown).

The finless porpoise is listed on Appendix I of CITES. The movement of one specimen (status undeclared) from China to USA in 1985 is recorded (CMC, 1987). No other specific international protection was found, although some habitat is already protected under the Ramsar Convention and WHC, and further action could be taken. An Agreement between Range States under CMS may be helpful, and some of the regional international conservation legislation could be invoked.

The only specific national legislation protecting the species found in countries of origin is in Bangladesh and Japan (only within 1.5km radius of the southern tip of Awashima Island near Takehama city), although a number of conservation areas in these and other countries may protect some habitat.

The main need is for more information about stock identity, range, population, biology, behaviour and breeding throughout the range. There is also a need for information on levels of incidental and direct take, and on habitat conditions. The IUCN/SSC Action Plan mentions the Yangtze river and Chinese coastal populations as in need of special monitoring, and proposes a survey of cetaceans in Chinese waters. Other relevant projects include a review of the effects of disturbance on coastal and riverine cetaceans, a review of the status of cetaceans in the Sea of Japan, and a workshop on population census methods for coastal and riverine dolphins (Perrin, 1989).

Captive Breeding Specimens have been maintained in captivity in Japan, with a total of 71 animals (3 to 22 removed per year) taken between 1973 and 1982. Some were taken before this time also, but the records are incomplete. Until 1972 animals were obtained from incidental catches, but more recently specific collections have been made. In total about 94 animals have been kept in Japan, at least 11 in China and two in Java (IWC, 1984). Breeding has taken place at three Japanese establishments, and in 1984 an animal born in 1979 and one born in 1982 were still alive. Three other calves died soon after birth, and another was stillborn (Kasuya *et al.*, 1986). These authors used information from captive animals to obtain the reproductive information mentioned above and to calibrate their ageing method.

The Japanese work indicates that this species can thrive and breed in captivity. Captive breeding could thus be a conservation option. The captive breeding has also yielded some useful information for the conservation and management of the wild populations.

Unfortunately, the live captures have not been made from monitored and managed populations, nor have there been systematic efforts elsewhere to obtain useful information from captive animals. In future more attention should be paid to these matters.

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SPECTACLED PORPOISE **INSUFFICIENTLY KNOWN**
Australophocaena dioptrica (Lahille, 1912)

Suborder ODONTOCETI Family PHOCOENIDAE

Summary Although the spectacled porpoise appears to be common off Tierra del Fuego, it could be involved to an unknown extent in the illegal bait fisheries of this region. They are also taken incidentally in inshore gillnets: the level of take is unknown but has probably increased since 1988. None of the information on population, stocks or biology required for conservation and management is available for any part of the range. Research is urgently needed to establish the status of this species, particularly in the Tierra del Fuego area.

Distribution The spectacled porpoise has been discovered in comparatively recent times to occur in the Auckland Islands, Macquarie Island, Kerguelen Island, south of Tasmania, in the Falkland Islands and South Georgia as well as off the South American mainland, which was previously thought to be the only area of distribution. A specimen has also recently been reported from Heard Island and there are sightings records from New Zealand and Kerguelen waters (Brownell *et al.*, 1988). It is not yet clear, however, whether the island populations are isolated (for example see Commerson's dolphin review) or whether there is some contact between them. In South America it is known from the southern coast of Uruguay (about 34°S) to Tierra del Fuego (Leatherwood and Reeves, 1983; Fordyce, Mattlin and Dixon, 1984; Goodall, 1978; Praderi and Palerm, 1971; Brownell, 1975). The species has recently been reviewed by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1991).

Population Until the mid-1970s only ten specimens were known, but the work of Goodall and colleagues added 112 and mentioned another 29 from Tierra del Fuego (Goodall, 1978). However there have been only four sightings in this area - in the Strait of Magellan south of Punta Arenas, in the Golfo de Ancud, Chile, in the Beagle Channel and in Bahia Sloggett, east of the Beagle Channel (Goodall and Polkinghorn, 1979).

The beach collections suggest that the spectacled porpoise is the most common cetacean in inshore waters of Tierra del Fuego. There is no information on abundance in other areas.

The spectacled porpoise was previously considered to be one of the rarest porpoises and illustrates how perceptions of the relative abundance of a cetacean species can be altered in a short time, once recorders are present in the right places.

Habitat and Ecology Parturition is thought to occur from October to February in southern South America. Body lengths of seven females ranged from 125 to 204 cm. Nine males ranged in length to 224 cm. The largest male was physically mature. Two females of 186 cm were pregnant. (IWC, 1991). As the sightings and many of the strandings for which such information is available relate to single animals it would appear that this species does not school (Brownell, 1975; Goodall and Cameron, 1980). The few reports of sightings may indicate that the species has unobtrusive habits. Little is known about diet.

Threats Records have not been kept until fairly recently, but dolphins of several species, including the spectacled porpoise, have become entangled and drowned in tangle nets set for centolla *Lithodes antarctica* (southern king crab), robalo *Eleginops* *maclovinus* (Patagonian blenny) and congrio in Tierra del Fuego (Goodall and Cameron, 1980). Tangle nets are not in use in this area today (Goodall, Galeazzi and Lichter, 1987).

There is no known direct take at the present time, although if they occur in inshore waters in Chile they may be taken for crab bait (IWC, 1991). These porpoises are taken incidentally in gillnets set for fish by artisanal fishermen in areas with a tidal range of 8-10.5m. The extent of this take is unknown. This fishery has been expanding since 1988.

No particular habitat threats are noted at present, although oil and other mineral extraction is under consideration and could be a threat. There are a number of expanding fisheries around the Falkland, Kerguelen and other islands within the range, which may increase the danger of accidental captures.

Conservation Measures Countries of origin include: Chile, Argentina, Uruguay, UK (Falklands and South Georgia), France (Kerguelen), New Zealand (Auckland Islands) and Australia (Macquarie Island). Other countries in the area may report specimens in future.

The spectacled porpoise is on Appendix II of CITES. No international movements are reported (CMC, 1987). No other international legislation specifically protects the spectacled porpoise, but the Ramsar Convention and WHC might be employed to protect some habitat. An Agreement among Range States under CMS may also be useful, and there are some agreements between the South American countries which could be invoked.

The spectacled porpoise will be protected by general legislation in Australia, New Zealand and Kerguelen. The situation in the Falklands is unknown. There is some protective legislation in Argentina and Chile, but apparently there are enforcement problems (Goodall and Cameron, 1980). There is no protective legislation in Uruguay.

While this species is not as rare as was once thought, it is certainly among the least known. None of the information on abundance or biology required for conservation and management is available for any part of the range. The IUCN/SSC Action plan has no specific projects relating to the spectacled porpoise, although general projects such as reducing the illegal use of cetaceans for crab bait in South America and improving statistics on incidental catches are relevant (Perrin, 1989).

Captive Breeding No specimens appear to have been kept in captivity, but as this is a small species captive breeding could be a feasible conservation option. If any specimens are taken into captivity, the opportunity should be taken to collect information on biology, breeding and behaviour relevant to conservation and management, as well as to collect information required for captive breeding in case this ever became necessary.

Remarks The spectacled porpoise was previously known as *Phocoena dioptrica.*

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DALL'S PORPOISE — **INSUFFICIENTLY KNOWN**

Phocoenoides dalli (True, 1885)

Suborder ODONTOCETI — Family PHOCOENIDAE

Summary The populations of Dall's porpoise in Japanese waters suffer from extremely heavy direct taking (in excess of 110,000 animals from 1986-89) in relation to estimated abundance. There is particular concern for the truei-type population, which is only abundant in the area where catching takes place. The planned reduction of catches in 1990 by 15% is inadequate to prevent population decline if the population estimates for this area are even roughly correct. Incidental takes in gillnets occur throughout the range, but the information is insufficient to enable reliable estimation of the total size of the incidental take.

Distribution Dall's porpoise is found in the northern North Pacific, in the west from north of Choshi and central-eastern Honshu, Japan, and in the east from about 28°N. It inhabits the Sea of Okhotsk and the southern Bering Sea, and in summer ranges as far north as the Pribilof Islands. In general, there do not appear to be any obvious gaps in distribution which might indicate the existence of subpopulations within the overall offshore North Pacific and Bering Sea range (IWC, 1984).

Variation in oceanographic features may affect distribution. In 1977, when the Alaska stream in the Gulf of Alaska was weak and the western subarctic gyre (south of Kamchatka) was strong, few animals were taken south of Kamchatka. In 1976, when many animals were taken in this area, the converse oceanographic conditions occurred (IWC, 1978).

There are two forms, known as dalli-type and truei-type, distinguished by somewhat different distribution of the black and white colouring, as well as some intermediate forms, in the waters around Japan. The precise relationship between the colour morphs has not yet been resolved. Houck (1976) could find no significant differences between samples on external measurements or skull measurements and considers the porpoise polymorphic with regard to colour pattern, with the dalli- and truei-types constituting the two major colour morphs. The truei-type are abundant only off the Pacific coast of northern Japan and off the Kuril Islands, where they overlap with the dalli-type (IWC, 1988). Recent evidence suggests that at least six stocks of dalli-type and one stock of truei-type occur in the North Pacific associated with the calving grounds (IWC, 1991).

Population Although estimates have been made of the abundance of Dall's porpoise population in the offshore North Pacific ranging from a few hundred thousand to over two million, none of these have yet been widely accepted. Data collection and analysis continue, and in the meantime these estimates are probably best regarded as simply indicating the general order of magnitude of the population. Recent surveys in the waters around Japan give a minimum estimate of abundance of the dalli-type in the Sea of Japan/Okhotsk Sea area excluding USSR waters of about 47,000 (c.v. = 0.23). The total truei-type population was estimated at 58,000 animals (Miyashita and Kasuya, 1988).

Habitat and Ecology There have been extensive studies of Dall's porpoise in recent years, much work resulting from a USA/Japan agreement in 1978 on cooperative research in connection with the incidental take of these porpoises in the Japanese land-based and mother-ship salmon gillnet fisheries in the North Pacific (see below). Other work has been undertaken in connection with the Japanese inshore harpoon fishery.

Dall's porpoises reach maximum body length at about 2.2m and a weight of 220kg. The length at birth is between 0.85m and 1.0m (Leatherwood and Reeves, 1983).

Available data for the pelagic driftnet catches showed a very high annual pregnancy rate (90-95%) and a much lower age (3.3 years) at sexual maturity than in the inshore harpoon fishery (6.8 years in 1978) (IWC, 1984). However, it appears that some segregation by age and sexual condition occurs, biasing the samples from the gillnet fishery. Females in late pregnancy, lactation or pregnancy and simultaneous lactation are mainly distributed in the northern areas, and the southern areas are mainly occupied by males and females not accompanied by calves. This indicates that not all females become pregnant every year. Males in the population involved in the salmon fishery attain sexual maturity at 5-6 years, in comparison with an average 8.1 years in the Japanese coastal population (IWC, 1984). Calves are born mainly in summer, but the calving season may be protracted and a few births may occur at any time of year (Leatherwood and Reeves, 1983).

Food species, as determined from stomach contents, include the squid *Loligo opalescens*, other cephalopods, capelin, Pacific hake *Merluccius productus*, jack mackerel *Trachurus symmetricus*, blennies and herring. These porpoises are thought to be capable of deep diving, because mesopelagic, bathypelagic and deep-water benthic species are represented in the diet. In the northwestern Pacific, stomach contents of animals entangled in trawls revealed Pacific mackerel *Scomber japonicus* as the most commonly taken prey, with some sardines *Sardinops sagax mel.*, saury *Cololabis saira* and squid *Onychoteuthis banksii* (Leatherwood and Reeves, 1983; Kuzin and Belyaev, 1984).

There appear to be at least three main breeding grounds for the dalli-type in the North Pacific. Two are in the Pacific area north of 45°N, and there is another in the central Bering Sea. Information is not available on any possible breeding grounds in the Okhotsk Sea or off North America. The truei-type may breed off the northern coast of Japan (Kasuya and Ogi, 1987).

Off Japan, Dall's porpoises inhabit waters below 24°C, but the upper limit of the surface temperature changes with season. Dalli-type individuals have a major wintering area in the Sea of Japan and summer in the Okhotsk Sea and Pacific coast of Japan. The truei-type inhabits waters off the Pacific coast of northern Japan and southern Kuril Islands, wintering off the Pacific coast of Japan and summering in waters between 40° and 45°N and west of 155°E (Miyashita and Kasuya, 1988).

Migration north in summer and south in winter is reported for all areas (Kasuya, 1982; Ohsumi, 1974; Noguchi, 1946; IWC, 1978). Although aggregations of at least 200 have been reported, the more usual group size is 10 to 20 animals (Leatherwood and Reeves, 1983).

Threats Catches of Dall's porpoise from the Japanese hand-harpoon fishery have increased greatly in recent years. Revised estimates of landed catches from the hand harpoon fishery are:

1986	16,515
1987	25,600
1988	40,367
1989	29,048

(Source: IWC, 1991)

Because the system for estimating catches changed in 1986 (and in 1976), catch estimates are not directly comparable over the recorded catch histories. The two recent schemes overlap in 1986 and 1987, and the figures suggest that takes may have been underestimated in recent years. The catch figures cannot be subdivided into the two colour morphs. An additional, unknown, number are struck-and-lost in this fishery. If the populations identified by Kasuya (1982) are indeed separate from each other, then these catches almost certainly greatly exceed the sustainable yields of the populations from which they are taken. Unknown numbers of the truei type are also taken in squid gillnet fisheries by Taiwanese and Korean vessels in the western North Pacific.

Offshore, a Japanese gillnet fishery for salmon, described by Fredin *et al.* (1978) has operated since 1952. Two types of operation are used, mother-ships with associated catcher-boats and land-based offshore driftnet vessels. Both fisheries are subject to regulation by the North Pacific Fisheries Commission (INPFC) and may, by this, not operate east of 175°W longtitude (Abstention Line). Japanese national regulations generally restrict the mother-ship fishery to north of 46°N latitude and the driftnet fishery south of that latitude. From 1978, restrictive fisheries agreements between Japan, USA, USSR and Canada have reduced the numbers of vessels operating. From 1962, the driftnet fishery has shifted operations eastwards, moving towards the Abstention Line (IWC, 1978).

In recent years incidental takes by the salmon fishery within the USA 200-mile Fishery Conservation Zone are estimated to have declined from 4,187 in 1982 to 741 in 1987 (IWC, 1991). Outside this zone no reliable estimates of take are yet available.

Conservation Measures Countries of origin include: USSR, Japan, R. Korea, DPR Korea, Canada, USA and Mexico.

Dall's porpoise is listed on CITES Appendix II. The following international trade, all involving scientific specimens, is reported: 1980 - one live specimen of undeclared origin entered USA; 1981 - five specimens from Japan to USA; 1982 - 150kg specimens from Japan to Canada and 30 specimens from Japan to USA; 1983 - seven sets of bones from Japan to USA and 348 specimens of undeclared origin from Japan to USA; 1984 - 2,657 specimens of undeclared origin from Japan to USA and 1,111 teeth of undeclared origin from Japan to USA (CMC, 1987). Except for the 1980 live capture, all these specimens are presumably being moved as part of the USA/Japan research programme.

A Protocol to the International Convention for the High Seas Fisheries in the North Pacific Ocean (INPFC), which entered into force in 1979, provides for joint research and cooperation between Japan and USA to determine the effects of the Japanese salmon fishery on marine mammal populations (in particular *Phocoenoides dalli*), and for work to reduce or eliminate the incidental catch. This Convention also set up an *ad hoc* Committee on Marine Mammals in 1978 to ensure the planning, coordination and conduct of studies of incidental takes of marine mammals, as well as a Scientific Subcommittee to review relevant studies. The volume and quality of information resulting from this initiative is impressive and illustrates the enormous contribution the international fisheries agreements could make to cetacean conservation.

No other international protection regulations were found. There may be scope for a conservation Agreement under CMS between the Range States.

The incidental take in the USA 200-mile Fishery Conservation Zone is subject to a USA permit under their Marine Mammal Protection Act. Under the original permit, up to 500 Dall's porpoises per year could be taken, on condition that the Japanese introduced new fishing gear and techniques to reduce the incidental take, and assisted in research. This permit expired in 1987, and a new permit has been denied because of an associated by-catch of northern fur seals (Perrin, 1989b). The IUCN/SSC Action Plan proposes that the situation of this species should be kept under review. There are also some general proposals, such as convening a workshop on interactions with gillnets, which are relevant (Perrin, 1989a).

At its 42nd Annual Meeting in 1990, the IWC passed a resolution calling for the directed take in the Japanese hand harpoon fishery to be reduced to pre-1986 levels - about 10,000 per year - and for further reductions to be considered when planned new stock assessment are considered.

Captive Breeding About nine specimens have been live captured in the USA altogether, and about the same number were taken in Japan in 1981 (IWC, 1984; CMC, 1987). Norris and Prescott (1961), and Ridgway (1966) report considerable difficulties in capturing Dall's porpoises and little success in maintenance. Immediate reactions of the animals to pool life included throwing themselves against the walls and bottom, refusal to swim and feed, and infection. A surviving male showed much nervousness and irritability when being made to respond to something new. The body skin was sloughed at an early stage, perhaps due to speed inhibition by space restrictions, indicating a very rapid rate of skin turnover (Ridgway, 1966). There is no information on the subsequent history of the Japanese animals. In view of the reported difficulties in capture and maintenance, this species may be unsuitable for captive breeding, precluding this as a conservation option. However, it does not appear that much interest has been taken in recent years, and modern techniques might be able to overcome the problems. There would be considerable conservation interest in the maintenance of a few captive animals, particularly for research on the problem of net entanglement. There is also a need for calibration of ageing techniques and for detailed information on biology, breeding and behaviour, which cannot be obtained from examination of catches or from observations at sea.

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ROUGH-TOOTHED DOLPHIN | **INSUFFICIENTLY KNOWN**

Steno bredanensis (Lesson, 1828)

Suborder ODONTOCETI | Family DELPHINIDAE

Summary Although the rough-toothed dolphin has a wide pelagic range, it does not appear to be particularly numerous in any specific area. Very few are reported in direct or incidental fisheries. The level of by-catch in pelagic driftnet fisheries within the range is unknown.

Distribution The rough-toothed dolphin occurs in tropical and warm temperate seas around the world, especially far offshore in deep water. It is usually seen in offshore areas where the sea surface temperature is above 25°C, and animals reported inshore or in colder waters are often considered to be vagrants. The precise extent of the range is not known, but these dolphins have been reported from the Indian (including the Gulf of Aden, Mozambique, South Africa, Nicobar Islands, and much of the Indo-Australian archipelago), Atlantic (Netherlands to the Ivory Coast in the east and southern USA to the West Indies in the west), and Pacific (northern California to Peru in the east and northern Japan to New Zealand in the west, including the Hawaii and Galapagos Islands) Oceans. It was thought that they were infrequent visitors to the Mediterranean Sea, but recent observations near Sicily seem to indicate a more permanent population (Hershkovitz, 1966; Leatherwood and Reeves, 1983; Watkins *et al.*, 1987). Miyazaki and Perrin (in press) have recently reviewed this species.

Population At present, rough-toothed dolphins are not thought to be particularly numerous in any specific area, although observations of herds of several hundred animals have been made. Throughout most of the range, however, they could be confused with bottlenose dolphins, raising the possibility that their abundance has been underestimated. It is also possible that, as with some other species of small cetacean, observers have not yet located areas of high relative abundance (see, for example, spectacled porpoise review) (Leatherwood and Reeves, 1983; Watkins *et al.*, 1987; Miyazaki and Perrin, in press).

Habitat and Ecology The longest mature male was 2.65m and the longest female 2.55m. The average length of sexually mature animals in the western North Atlantic was 2.32m for males and 2.31m for females. In the Eastern Tropical Pacific the average lengths were 2.27m and 2.34m respectively, and in Japanese waters 2.25m and 2.10-2.20m. The longest reported foetus was 0.87m (Perrin and Reilly, 1984; Miyazaki and Perrin, in press). Miyazaki (1980) found that animals killed in Japan in June were forming an unstainable growth layer in their teeth, while animals killed in October were forming a stainable layer. On this basis the average ages of sexually mature animals in the Western North Pacific was 14 years for males and 10 years for females, with maximum ages of 32 and 30 years, respectively. Examination of ovaries in relation to the growth layer groups in teeth showed that the rough-toothed dolphin may exhibit several almost simultaneous ovulations, and that many ovulations do not appear to result in pregnancy (Miyazaki and Perrin, in press). The species is thought to be mainly pelagic, particularly because pelagic octopus, squid and the remains of several species of pelagic fish have been found in stomachs, although nearshore species have also been reported. Herds of up to several hundred have been reported, but the more usual group size is said to be around 50, or 10-20. However, some recent information from USA sightings gives an average group size of six (Layne, 1965; Leatherwood and Reeves, 1983; USA, 1987; Miyazaki and Perrin, in press).

Threats There is a direct general fishery for small cetaceans in the West Indies, where this species is occasionally taken. Very small numbers are involved, as the primary objective is the short-finned pilot whale *Globicephala macrorhynchus* and other species are taken only if encountered. There are also small direct fisheries in the Solomon Islands, Papua New Guinea and Japan. The meat is used for human consumption (UK, 1980; Caldwell and Caldwell, 1975; Reeves, 1988; Miyazaki, 1980; Japan, 1987; Miyazaki and Perrin, in press). Accidental captures and stranded specimens have also been used for human consumption in West Africa. Small numbers are taken in the Pacific tuna fishery (USA, 1987 reports one specimen) and almost certainly in other purse seining operations in tropical waters (Mitchell, 1975). Small numbers are taken in gillnet fisheries in Sri Lanka and probably elsewhere in the Indian Ocean (Miyazaki and Perrin, in press). The incidental take in pelagic driftnet fisheries within the range is unknown.

Conservation Measures Countries of origin would include all those bordering the tropical and warm temperate seas. Specific reports are known from at least: the Netherlands, Belgium, France, Spain, Portugal (Madeira), Italy, Israel, Greece, Senegal, Ivory Coast, USA (including Hawaii), Cuba, St. Vincent and the Grenadines, Brazil, Peru, Argentina, UK (Tristan da Cunha), Japan, Ecuador (Galapagos Islands), Ethiopia, Somalia, D. Yemen, Yemen AR, Mozambique, South Africa, India (Nicobar Islands), Bangladesh, Burma, Indonesia, and New Zealand, although this list is not exhaustive (Hershkovitz, 1966; Leatherwood and Reeves, 1983; Collet, 1984; Watkins *et al.*, 1987). The rough-toothed dolphin is listed on CITES Appendix II. Only some movements of scientific specimens are recorded: one from USA to UK in 1981, six of undeclared origin imported into USA in 1983 and another of USA origin re-imported in that year, and one specimen of undeclared origin imported into the USA in 1985 (CMC, 1987). It has recently been listed on Appendix II of the Berne Convention, but no other international agreements referring to this species were found. If this is a mainly pelagic species, the most appropriate means for further international conservation and management efforts may be through the various fisheries agreements, although the IWC Scientific Committee's small cetaceans subcommittee is at present the major international forum for discussion of these topics. The rough-toothed dolphin will be protected by general legislation in a number of countries of origin, but no specific provisions were found. The IUCN/SSC Action Plan does not specifically mention this species, although general projects, for example monitoring incidental takes in gill nets and local subsistence fisheries, will be relevant (Perrin, 1989). The major requirement is for more information on all aspects of the biology of the species, particularly population and reproductive parameters. Secondly, more information on the extent of incidental catching and direct catching in all fisheries is required. In the absence of such information the true status of this dolphin cannot be determined.

Captive Breeding At least 43 specimens are known to have been taken into captivity worldwide. It is said to be easily trained for performances, and several specimens have been successfully trained for research in the open ocean. In Hawaii a female *Steno* mated with a male *Tursiops*, producing an apparently healthy calf which survived for five years. There are no other reports of breeding in captivity (Leatherwood and Reeves, 1983; IWC, 1984; Norris, 1974; Collet, 1984). Miyazaki (1980) used data from ten captive specimens in Japan to calculate the relationship between body length and weight. In view of its size, and the lack of reports of adverse reactions to captivity, it would appear to be a feasible candidate for conservation through captive breeding, should this become necessary. It is unfortunate that so little information relevant to conservation, management or captive breeding seems to have been obtained from the animals held so far. Efforts should be made to obtain such information from any animals still held, and from any which may be taken into captivity in future.

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INDO-PACIFIC HUMP-BACKED DOLPHIN **INSUFFICIENTLY KNOWN**

Sousa chinensis (Osbeck, 1765)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Although the Indo-Pacific hump-backed dolphin is widely distributed, the species (or possibly several species) is very little known. The tropical inshore and estuarine habitat is vulnerable, and there are known to be some incidental and possibly direct catches more or less throughout the range. Information on abundance, population identity, range, biology, behaviour and the levels of direct and indirect take are urgently required in order to assess the status and initiate conservation and management programmes.

Distribution The Indo-Pacific hump-backed dolphin is widely distributed in coastal and inshore waters of the Indian and western Pacific Oceans. It can also be found in estuaries and sometimes in the lower reaches of rivers, although the latter may be vagrants. Its presence has been confirmed from the southern tip of Africa northward along the east coast of the continent to the Suez Canal, in the Arabian Sea and Persian Gulf, along the Indian sub-continent, throughout much of Indonesia, in Australian coastal waters from the middle of the west coast northward, eastward and southward to Sydney on the east coast, in New Guinea, and from Borneo northward along the Indo-Chinese coast to the northern East Sea. No records exist from the Philippines, but it may also be present there (Leatherwood and Reeves, 1983).

Distribution probably is not continuous throughout this range, and the taxonomic status of various subpopulations is not clear. For the present purpose the subpopulations are treated together under the species name *Sousa chinensis*. Leatherwood and Reeves (1983) say that there appear to be two main groups of undescribed relationship, one west of Indonesia and one east and south of Indonesia. The latter seem to be lighter in colour and to lack the characteristic 'hump' at the base of the dorsal fin in adults. Pilleri and Gihr (1972; 1974) reviewed the nominal species, but were unable to resolve the situation definitively because of lack of specimens. Their scheme would give the following distributions: *Sousa chinensis* along the coast of China to the northern East Sea, at the mouth of the Mein Jiang, in Mei Zhou Wuan, Quan Zhou Wuan, Xia Men Inner Port and Tong Shan Wuan and other ports of Fujian Province (Wang, 1984); *Sousa lentiginosa* from South India and Sri Lanka across the Indian Ocean to Southern Africa; *Sousa plumbea* in the Indian Ocean from the Strait of Malacca to Southern India and Sri Lanka to the Arabian Sea, Persian Gulf, Red Sea and Suez Canal; and *Sousa borneesis* from Indonesia to Papua New Guinea and Australia. It is also possible that the Indo-Pacific hump-backed dolphin and the Atlantic hump-backed dolphin are conspecific (Perrin, 1989).

Suwelo (1988) gives the following distribution in Indonesia: Risu Island, Malakka Straits, Natuna-Siam Sea, east coast of Kalimantan, Dali river (Belawan).

There is no evidence on which comparisons of past and present distribution can be made.

Population The population on the Natal coast of South Africa is estimated to be 200 animals, from aerial surveys (Peddemors, Cockcroft and Wilson, in press). Only scattered comments relate to abundance in a few other parts of the range. They are described as 'frequent' in three areas along the south-eastern Cape coast in South Africa; Algoa Bay, Tsitsikama Coastal National Park and Plettenberg Bay (Saayman, Bower and Tayler, 1972), and as 'relatively common' in northeastern Australia (Mitchell, 1975). Wang (1984) says that they are seen 'often' in the Gulf of Tonkin.

Habitat and Ecology Perrin and Reilly (1984) report that the largest male was 3.2m and the largest female 2.44m. The smallest individual was 0.97m. The length at birth in South Africa was thought to be about 1m. The birth rate off South Africa was estimated to be 0.10 from visual observation of the percentage of calves in the population.

The group size is usually described as small, for example off South Africa (Saayman, Bower and Tayler, 1972). Off Fujian Province in China they usually appear in groups of 3-5 (Wang, 1984), although Leatherwood *et al.* (1984) tentatively identified a herd of about 30 widely scattered individuals off Sri Lanka as hump-backed dolphins.

Off South Africa the hump-backed dolphins occupied the most inshore areas, and appeared to feed around reefs (Saayman, Bower and Tayler, 1972). Some of this area was shared with bottlenose dolphins, although they also used deeper water areas. Sometimes hump-backed dolphins appeared to be integrated members of bottlenose dolphin schools, but sometimes the bottlenose dolphins were aggressive towards lone hump-backed dolphins. This population of hump-backed dolphins appeared to be resident throughout the year.

Studies in the Moreton Bay region in northeastern Australia has demonstrated that the hump-backed dolphins have a more inshore distribution than the bottlenose dolphins inhabiting this area. The hump- backed dolphins are observed more frequently in the region of the small Moreton Bay islands and in the Brisbane river. There is some overlap of range between the two species. Individuals have been observed to move up to 15km within the bay, but no identified animals have been seen outside the bay. Thirty Indo-Pacific hump-backed dolphins have been individually recognised here. Sexual behaviour was observed from October to April, and two newborn calves observed between October 1985 and March 1986 (Australia, 1987). Wang (1984) reports that these dolphins appear to be more frequently seen off Fujian Province between February and May, although they may be resident throughout the year in Qiamen Port.

These animals frequent mangrove zones, and indeed, the distribution of *Sousa* coincides fairly well with the limit of mangroves (see map in Pilleri and Gihr, 1974). Much concern has been expressed at the rate of destruction of mangrove areas (e.g. IUCN, 1987).

Threats In the Arabian Sea, Red Sea and Persian Gulf small numbers have been, and may still be taken and used for human consumption. In Kuwait the oil has been used to waterproof the decks and hulls of dhows (Mitchell, 1975). Occasional takes are reported in antishark nets in Australia, and in fishing nets off Pakistan, Iraq and Kuwait, although accidental takes are likely throughout the range (Leatherwood and Reeves, 1983; Al-Robaae, 1974). The mean annual catch in antishark nets off South Africa is about eight animals, possibly representing some 4% of the estimated population along this coast (Peddemors, Cockcroft and Wilson - in press).

Conservation Measures Countries of origin would include Indonesia, Brunei, Malaysia, Thailand, Burma, India, Bangladesh, Sri Lanka, Somalia, Djibouti, Ethiopia, Sudan, Egypt, Israel, Saudi Arabia, Yemen Arab Republic, Peoples'

Democratic Republic of Yemen, Oman, United Arab Emirates, Qatar, Bahrain, Kuwait, Iraq, Iran, Pakistan, South Africa, Mozambique, Madagascar, Republic of Tanzania, Kenya, Kampuchea, Viet Nam, Papua New Guinea, PR China, Taiwan, Australia and the Phillipines.

The humpbacked dolphins are listed on CITES Appendix I. Two scientific specimens, described as *Sousa* spp., are reported moving from South Africa to USA in 1984, and two commercial specimens, described as *Sousa chinensis*, of South African origin are reported moving from USA to USA (sic) in the same year (CMC, 1987). No other international provision was found, but there is scope for protection of habitat through the Ramsar Convention and WHC, for conservation Agreements between Range States under CMC, and possibly for some action under ACCN and other regional conservation legislation.

The Indo-Pacific hump-backed dolphin is protected by general legislation in some countries of origin, and there are a number of conservation areas within the range which may protect habitat.

There are a number of relevant projects in the IUCN/SSC Action Plan. Specific projects include: resolution of the taxonomy and distribution, assess population off Natal, South Africa and effect of accidental takes in anti-shark nets. General projects include: workshop on gillnets and cetaceans, survey of the status of cetaceans in Chinese waters, monitoring incidental gillnet catches in India and Sri Lanka, review of the effects of disturbance on coastal and riverine cetaceans, workshop on population census methods for coastal and riverine dolphins (Perrin, 1989).

An immediate contribution towards resolving the questions of range and potential problems could be made by a review of available information on the fauna of conservation areas within the range, for example the material on which IUCN (1987) and similar publications are based.

Captive Breeding A few specimens have been live-captured for display in Australia, three in South Africa and two in Hong Kong. Two of the Australian animals had been in captivity for 9 and 15 months respectively in 1983. The three South African animals were caught in January 1963 and survived for between 30 and 90 days (IWC, 1984). A female taken in 1968 was still alive in 1988 (after 20 years in captivity), and a female described only as a 'white river dolphin' (which may have been this species) survived for seven years between 1974 and 1981 in Australia (Australia, 1985; 1988). There are no reports of captive births, although so few animals have been kept (and the long-term survivors were kept singly) that this is hardly surprising. Nothing appears to have been published on the biology of captive *Sousa*.

As this is a small species, it should be feasible to breed in captivity for conservation purposes. If any more specimens are taken into captivity the opportunity should be taken to collect information on biology, behaviour and breeding relevant to conservation and management, as well as for captive breeding in case this ever became necessary for conservation.

Remarks The hump-backed dolphins were proposed for listing in CITES Appendix I because of their vulnerable habitat (particularly because at that time they were thought to be more riverine than now appears), the incidental and direct takes, and because this appeared to be the most satisfactory way to overcome the uncertainties caused by the taxonomic confusion (Klinowska, 1978). They were, however, a marginal case for Appendix I. Something of the same difficulty in assessment is still apparent.

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ATLANTIC HUMP-BACKED DOLPHIN **INSUFFICIENTLY KNOWN**
Sousa teuszii (Kukenthal, 1892)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The Atlantic hump-backed dolphin is a little known, apparently isolated population, and it is not yet clear at what level it differs from other *Sousa* species. There is probably some direct and indirect taking, and likely to be habitat destruction in many parts of the range. More information on stock identity, range, abundance, biology, ecology, and levels of any direct and incidental take is urgently needed.

Distribution The Atlantic hump-backed dolphin is known from the West Coast of Africa, from possibly as far south as Angola, but certainly from Cameroon to Senegal and Mauritania to 20°N. It is known to enter at least the rivers Niger and Bandiala, although it is not clear whether these are vagrants or represent riverine populations. The cetacean fauna of this area is generally so little known that an absence of published records cannot be taken to mean absence of a species. There is no evidence on which comparisons of past and present distribution can be made.

The taxonomic status of *Sousa* spp. is not clear. There appears to be rather little difference between the Atlantic hump-backed dolphin and the *Sousa* spp. from South Africa and the Indian Ocean, but the separate species name is retained for the present purpose because the Atlantic population appears to be isolated. Only the collection of more information can resolve this problem (Perrin, 1989; Leatherwood and Reeves, 1983; Maigret, 1981; Busnel, 1973; Cadenat, 1959; Maigret, Trotignon and Duguy, 1976).

Population There are no good numerical population estimates, although the Atlantic hump-backed dolphin is so far only known to be comparatively common in the waters of southern Senegal and off northwestern Mauritania (Leatherwood and Reeves, 1983). However, this could merely represent areas where some investigations have taken place, and not present a balanced picture. Maigret (1981) estimated populations in two places in Mauritania and Senegal to be small, perhaps consisting of only about 100 individuals in each of the Banc d'Arguin and Delta du Saloum study areas.

Habitat and Ecology The Atlantic hump-backed dolphin appears to use the coastal, estuarine and possibly somewhat riverine habitat. In the southern part of the range mangrove areas may provide important habitat. The fish genera *Ethmalosa* and *Mugil* have been reported in the diet (Cadenat, 1959; Busnel, 1973). In the original description, the species was described as herbivorous (Kukenthal, 1892). Various explanations have been given for this erroneous supposition, including the possibility that Captain Teusz, who found the first specimen, somehow managed to send it to Kukenthal accompanied by the stomach of a (certainly herbivorous) West African manatee. Other explanations are that the vegetable matter was ingested accidentally or was in the stomachs of fish which the dolphin had eaten (Leatherwood and Reeves, 1983).

The few known life history parameters are summarised by Perrin and Reilly (1984). The longest male reported was 2.48m and the longest female 2.35m. The average length of sexually mature males was 2.00m, based on a sample of three animals. The usual group size is two to four individuals, although groups of six to 25 animals can be seen during feeding. Births have been observed to occur in March and April in the Delta du Saloum (Maigret, 1981).

The villagers of Imraguens de N'memghar, Cap Timiris in Mauritania cooperate with dolphins, including this species, in fishing. During the mullet *Mugil cephalus* season (October to December and February to May) the villagers camp along the Bay d'Argun. They fish by entering the shallow water on foot, using their nets to take passing shoals. These fish are in the habit of leaping clear of the water, and re-entering with a splash. The fishermen imitate this splashing by hitting the water with the sticks which they use to carry the nets. The noise attracts the dolphins, and as they travel towards what appears to be a school of prey, they drive any mullet between them and the fishermen into the nets. Both fishermen and dolphins can thus catch fish more easily (Maigret, Trotignon and Duguy, 1976).

Threats The Imraguen villagers are said to be very protective of the dolphins in return for assistance in fishing, but will use stranded or accidently killed animals for food or oil. In the past Atlantic hump-backed dolphins are known to have been caught accidently, along with West African manatees, in beach seines and shark nets in Senegal (Leatherwood and Reeves, 1983).

In the Banc d'Argun National Park in Mauritania, where the species appears to be common, there is concern that overfishing by international fleets in waters just offshore may reduce food species, as well as increasing the risk of accidental taking. In the Delta du Saloum National Park, Senegal, where the species is also noted, there is a permanent threat to the mangroves by extension of rice culture and exploitation of forest in the Fathala area. Excessive fishing and conflicts with other industrial and agricultural development are also noted. These reported problems are typical of the conservation areas within the range of the Atlantic humpback-dolphin.

The species lives in an area of high population growth and protein food deficit, so where they are locally common there is potential for fishery for human consumption. The effects of increased fishery of food species are also important, not only because of reduced food, but also because of increased risk of accidental capture. The destruction of mangroves and other inshore habitat presents further risks to this species.

Conservation Measures Known countries of origin include: Cameroon, Nigeria, Dahomey, Togo, Ghana, Ivory Coast, Liberia, Sierra Leone, Guinea, Guinea Bissau, Gambia, Senegal and Mauritania. They might also be found in: Angola, Zaire, Congo, Gabon, Equatorial Guinea or even Sao Tome and Principe, although the latter islands are probably too far offshore.

The hump-backed dolphins are listed on CITES Appendix I. No international movements of the Atlantic hump-backed dolphin are reported (CMC, 1987). No other international legislation currently protecting this species was found, although some habitat is protected through the Ramsar Convention and WHC. An Agreement between Range States through CMC could be beneficial, as well as action through ACCN.

No national legislation protecting this species has been located in countries of origin, although there are a number of conservation areas, with varying degrees of legal protection, within the range.

The IUCN/SSC Action Plan proposes a number of relevant projects (Perrin, 1989). These include: resolution of the taxonomy and distribution, a review of incidental kills and direct exploitation, assessment of the status of any populations at risk, a review of the effects of disturbance on coastal and riverine species and a workshop on population census methods for coastal and riverine dolphins.

An immediate contribution to the collection of information on distribution and problems would be a review of all the material so far collected on conservation and protected areas within the range. A great many published and unpublished studies are reviewed by IUCN (1987), but unfortunately with little reference to whatever material may have been collected on cetaceans. According to this compendium there are conservation authorities and voluntary groups in many of these countries, and their aid should be enlisted.

Captive Breeding The Atlantic hump-backed dolphin does not appear to have been kept in captivity, but as it is a small species captive breeding should be feasible for conservation. If any specimens are taken into captivity, from well monitored and managed populations, the opportunity should be taken to collect information required for conservation and management, as well as for captive breeding in case this ever became necessary.

Remarks The *Sousa* and *Sotalia* species were proposed for CITES Appendix I listing as a group because of fears about their status, as they are coastal and riverine tropical species (Klinowska, 1978). The convention of referring to the South American species as *Sotalia* and the African and Asian species as *Sousa* had not then clearly emerged, nor was there any consensus on how many species were involved. In this situation it was thought to be a wiser conservation course to list everything together, at least for the time being. They were borderline candidates for Appendix I at that time, and although a little more is now known, their status is still unclear.

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TUCUXI INSUFFICIENTLY KNOWN

Sotalia fluviatilis (Gervais and Deville, 1853)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The Amazon river population(s) of the tucuxi, although reasonably abundant at present, could be seriously threatened if plans to construct an extensive series of dams in this river go forward (see *Inia* review). The estuarine and coastal populations are relatively little known and require monitoring, particularly outside Brazil. The extent of accidental catching throughout the range requires investigation, as does the taxonomy.

Distribution The tucuxi (pronounced 'tookooshee') may have two or more forms, which have sometimes been described as separate species or subspecies. At present there is insufficient study material available to resolve this question and the forms are treated together for the present purpose following current practice (e.g. review by da Silva and Best, 1986).

The estuarine form (sometimes known as *S.* or *S. f. guianensis*) is distributed along the tropical and sub-tropical Atlantic coasts of South and Central America. Northern records include Panama and Colombia, where they may be found at the mouth of the Magdalena river, Baranquilla. Although most animals remain between 100m and 2,000m from the river mouth, a small group (5-6 animals) may regularly enter as far as 600m into the river itself. They are also present in the Golfo de Cispata, near San Antero, Colombia. In Venezuela they are known from Lake Maracaibo and possibly up to 130km from the mouth of the Orinoco river. Specimens have been reported from Trinidad and from the French Guyana/Suriname border in the Marowijne river. In Suriname they are said to be common in the mouths of the larger rivers, ascending them as far as the limit of the tidal influence. In the Suriname river they are known from near Paramaribo and ascend it as far as Domburg and Paranam. In Guyana this dolphin has been reported from the Demerara, Cuyuni, Mazaruni and Essequibo rivers. Their upstream distribution is blocked by a 14km series of rapids. In Brazil, they are common in the mouth of the Amazon river and have been captured in the States of Paraiba and Espirito Santo, are common in the Baia de Guanabara (Rio de Janeiro) and are frequently observed in the State of Sao Paulo, particularly at Santos and Cananeia. The known range has recently been extended southward, with records from Paranagua Bay in the State of Parana (25°32'S), where this species is reported to be common in the estuarine complex of the region. A record from Argentina is considered to be unlikely, because the species is not known from further south in Brazil, nor from Uruguay. There is a reported specimen from Florida, which also seems unlikely as there are no intermediate records (da Silva and Best, 1986). These extreme records might represent vagrants, or carcasses which have drifted an unusual distance.

The riverine form (*S.* or *S. f. fluviatilis*) is here considered to be endemic to the Amazon river drainage. *Sotalia* is distributed from Belem through the main tributaries of the Amazon drainage system (e.g. rivers Tocantins, Xingu, Tapajos, Madeira, Negro, Purus, Jurua, Branco, Japura etc.) in Brazil, to Peru in the Ucayali and Putumayo rivers and their tributaries, such as the Maranon and Samira rivers to the south and the Napo and Tigre rivers to the north, as far as Ecuador. They do not apparently pass the rapids at Sao Gabriel da Cachoeria on the upper Rio Negro and thus do not enter into the upper Orinoco as does *Inia* (da Silva and Best, 1986). (Many of these place names can be found on the map accompanying the *Inia* review). The principal limiting factor to the distribution of the riverine *Sotalia* is the presence of rapids and small channels where their activity would be restricted. They are present in both the 'white-water' (coffee coloured) rivers as well as in the 'black-water' (tea coloured) rivers of the Amazon region, indicating that physical factors such as visibility and pH do not affect their distribution (da Silva and Best, 1986). There is no evidence on which comparisons of past and present distribution can be made.

Population The abundance or status of *Sotalia* populations anywhere is almost unknown.

It has been estimated that between 100 and 400 animals live at the mouth of the Magdalena river in Colombia, and they are apparently common in the Golfo de Crispo area near San Antero. In Suriname, they are regarded as 'rather common' in the mouths of the larger rivers. In Guyana they are reported as 'frequent' in the lower reaches and mouth of the Essequibo river. In the 1870s they were said to be very common in the Baia de Gunabara (Rio de Janeiro, Brazil), in 1886 their abundance was again noted in this locality, and they were still 'extremely common' here in 1933. A recent survey has estimated the population using this bay to be of the order of 100-400 individuals. In the Santos and Cananeia region of Sao Paulo State (Brazil) they are regarded as being common, and described as 'abundant' in their southernmost range, Paranagua Bay, State of Parana, Brazil. They are not common in the lower reaches of the Orinoco river (da Silva and Best, 1986).

In the Amazon drainage the riverine form is quite common, with a density of about 1.1 ±0.4 dolphins per kilometre, as determined by a boat survey of almost 500km of the Solimoes river, between Manaus and Tefe in 1979. Four longer surveys (about 1,525km - Manaus to Leticia) gave total counts of 768 ±104.7 animals per trip or 1.02 animals per kilometre. Such densities are almost double those of *Inia* for this region, and are the inverse of Layne's (1958) report for the Leticia area, although this may be a case of differential habitat use. In the Iquitos area 62 *Sotalia* and 66 *Inia* were recorded in 36 hours of observation. Further upstream in the Saimira river and its tributary, Santa Elena river, *Sotalia* were frequent (da Silva and Best, 1986).

Habitat and Ecology The estuarine form is found in shallow, protected estuarine waters or bays. In the Baia de Guanabara the dolphins prefer the deeper channels (about 25m depth), avoiding areas with less than about 6m of water. Where the rivers that feed such areas are large enough, these dolphins may penetrate up to 130km or more upriver. To what extent the coastal form enters the Amazon estuary or whether there is an intermingling of populations is a matter that requires investigation (da Silva and Best, 1986).

The riverine form may be found in the main channels of all the tributaries of the Amazon, as well as in the larger lakes where the access is not limited by a narrow and/ or shallow channel. These dolphins do not enter the flooded forest (or 'igapo'), and apparently avoid restricted areas, being comparatively 'pelagic'. Fast moving turbulent water as well as rapids are also avoided, thus limiting their distribution in many rivers as they leave the Amazon lowlands and enter into higher elevations. They do show a distinct preference for the junction of rivers and channels, due presumably in part to the abundance of fish and also to the fact that the turbulence disrupts fish schools making them more vulnerable to predation. The large (about 10m) seasonal fluctuations in river level may influence considerably the areas used by *Sotalia* as they may enter lake systems during high water but will leave these as the water levels recede, thus avoiding being landlocked in lakes that are too small or shallow (da Silva and Best 1986).

Interspecific relationships between *Sotalia* and *Inia* are apparently rare, but include associated feeding groups (not necessarily cooperative), the exclusion of *Inia* from a given area by a group of *Sotalia*, and one instance of play between an *Inia* calf and a *Sotalia* adult. In general these dolphins do not obviously interact even though they are frequently in close proximity.

The riverine form is frequently associated with terns *Phaetusa simplex* while feeding, this possibly being a mild form of symbiosis as the dolphins herd the fish schools towards the surface and the diving terns help fragment the school, making the fish more vulnerable to the dolphins' attacks. Studies of the estuarine form in the Baia de Guanabara did not note any relation between this dolphin and the abundant sea birds of this area (da Silva and Best, 1986).

No predators have been noted for *Sotalia*, although bull sharks *Carcharinus leucas* are present in the Amazon and sharks of many species abound along the coasts of Central and South America and could easily feed on these dolphins. There are also killer whales in the area (da Silva and Best, 1986).

The prey of the estuarine form is almost unknown. It has been suggested that it feeds on fish and shrimp in Suriname, although this opinion is not based on stomach content analysis. A specimen from Guyana contained 32 small herring-like fish, four small catfish, 39 crystalline lenses, and several otoliths. Although shrimp were common in the area, none were found in the stomach. In Brazil they are known to eat fish of the families Clupeidae and Scianidae, and specifically *Cynoscion jamaicensis, C. striatus, Poricthys poposissimus, Trichiurus lepturus*, and cephalopods (Loligidae). Fish and cephalopods have also been reported from a *Sotalia* captured in the State of Espirito Santo (da Silva and Best, 1986).

A detailed study of the food habits of the riverine form has been made in the Amazon region by da Silva. The maximum number of fish represented by remains in a single stomach was 135 fish. A total of 28 species of fish from 11 Families were found, of which the characoid Family, Curimatidae, was represented in 52.2% of the stomach contents, followed by the Family Scianidae (39.3%) and Siluriformes (53.6%). Of the fish taken by *Sotalia*, 82.1% are of pelagic habits, and 75% are active diurnally and form schools. Only 13 species of fish were eaten by both *Sotalia* and *Inia*, out of a total of 53 species identified as food items of these two dolphins, implying that little food competition exists between them. *Sotalia* eats fish whole and the maximum length of fish ingested was 37cm, whereas *Inia* may kill and tear up fish of up to 80cm in length. The greatest diversity in *Sotalia*'s diet occurs during the receding and lowest water levels, with 60.7% of the prey species identified being unique to this season, in contrast to the 10.7% which occur only during the flood season. This is probably because the fish are more concentrated in the main water bodies in the dry season, and thus more vulnerable to dolphin predation. During the flood period, many of these fish species enter the floodplains to feed, and *Sotalia* cannot pursue them in these restricted habitats (da Silva and Best, 1986).

The tucuxi is reported to live in groups of up to 30 animals, but the modal number for the estuarine form is two. Over 85% of observations for the riverine form are of one to three animals, with rare groups of more than four. Although the social composition of these groups is unknown, one captured group consisted of two females with male calves and another of a pregnant female and an immature female. This may indicate that the most stable social unit would be the female and calf, although more information is needed (da Silva and Best, 1986).

The riverine form is not apparently territorial in the sense that it defends a given area, but it is relatively sedentary, with tagged individuals resighted within 5km of the tagging area up to a year later. It seems possible that they have a home range, but the extent of this is not yet known. The same situation may exist for the estuarine form, although the probable area may be larger because of the distances between one protected bay and another. Alternatively, the populations in each bay may be relatively isolated. Unfortunately, there seems to be a lack of naturally marked animals, which makes the collection of information on individual movements difficult (da Silva and Best, 1986). Terry (1983) observed that as captive males became sexually mature they acquired more scars. However, this may be the result of some unsatisfactory aspect of that captive environment leading to increased aggression.

Little is known about the reproductive parameters. In the estuarine form, the smallest lactating female was 1.67m in length and two other females were recorded as lactating at 1.8m and 1.72m. A 1.82m female captured in Suriname had a 0.6m foetus, and it is said that young are born at between 0.6m and 0.65m. It is also suggested that sexual maturity is reached at between 1.6-1.7m (da Silva and Best, 1986). The reproductive parameters for the riverine form were reviewed by Best and da Silva (1984). Males longer than 1.39m may be reproductively active, from the size of the testes. However, males above this length may have small testes (200-400 grams) or very large ones (between 1 and 2kg or up to 5% of the body weight). This observation was not correlated with season or river levels, and both types were found in the same months. It is possible that some social factor may govern the reproductive status of males. In other mammalian species disproportionally large testes are associated with polyandry or sperm competition, where various males may mate with a single female. Males are not observed to be particularly scarred, and it is suspected that social dominance based on physical fighting is not important. Terry's (1983; 1984) observations of captive animals indicate rather more aggression but may be specific to that captive environment. Females of the riverine form attain sexual maturity at body lengths of between 1.32 and 1.37m, making them among the smallest cetaceans. Ovulation is invariably in the left ovary. Foetal growth rates have been estimated at 8.5cm a month, the gestation period at 10.2 months, and post-natal growth 2.5cm a month. Birth size is between 71cm (largest foetus) and 83cm (smallest calf). Seasonality of reproduction is synchronised with the flood cycle, such that young are born during the low water season when the fish are most concentrated in the main water bodies. The greater availability of fish at this time helps to offset the energy demands of lactation of the female. A 10.2 month gestation implies conception in January-February (Best and da Silva, 1984).

Threats There are no existing commercial fisheries for the tucuxi and do not seem to have been any in the past (Mitchell, 1975), except for some animals taken for display purposes (see below). They are protected by legends and myths believed by fishermen from Colombia to southern Brazil as well as in the Amazon. Because of this, fishermen will rarely harm dolphins accidently captured in their nets, although this does not prevent the use of dead animals to supply parts, which when properly prepared by a 'macumbeiro' or spiritual person, are thought to be useful for attracting lovers. Recent reports have suggested that these dolphins are being purposely killed to provide such parts, but da Silva and Best (1986) do not believe this to be the case, because it would be too expensive for a fisherman to risk a net worth a hundred times the value of the parts obtainable in order to attempt to catch these animals (see *Inia* review).

Modern fishing practices and the greatly increased intensity of fishing effort along the coasts and in the rivers is probably the greatest current threat to the species. Tucuxi are easily captured in monofilament gill nets, shrimp traps and seine nets. Of 34 tucuxi accidently caught in the Amazon, 74% died in gill nets and 15% in seine nets. No details of the total incidental kill anywhere within the range are available. Tucuxi do not apparently steal fish from nets as does *Inia*.

The relationships between the various populations need to be clarified, since the management of small, semi-isolated populations is more critical than that of reasonably continuous populations. A major potential threat, in both the riverine and estuarine environments, is that of damming of rivers for hydroelectric projects: future plans for the Amazon include series of dams along many of the main tributaries (see *Inia* review). The effect of such dams is to break up the populations into genetically isolated units. Most of the migratory fish on which they feed would become extinct in the reservoirs. The lower flux of freshwater may affect primary and secondary productivity of the estuarine fauna, thus reducing the feeding potential of these areas for estuarine tucuxi (da Silva and Best, 1986).

The suggestion by Meschkat (1961) that dolphin populations should be reduced in order to improve fish catches should never be taken up. The work of da Silva has shown that rather few of the fish species of interest to human populations are in fact also taken by dolphins, rendering the suggestion useless.

Conservation Measures Countries of origin include Brazil, Ecuador, Peru, Colombia, French Guyana, Suriname, Guyana, Venezuela, Panama, and Trinidad.

The tucuxi is listed on Appendix I of CITES. No international trade is recorded (CMC, 1987), and no other specific international protective legislation was found. However, there are several international agreements, such as the Ramsar Convention and WHC, which could be important for habitat protection, a number of conservation agreements between the countries of origin which could be invoked, and an Agreement under CMC could be useful for the coordination of protection between all the Range States.

There is some national protective legislation in countries of origin, as well as a number of conservation areas which could protect important habitat.

The IUCN/SSC Action Plan has a number of relevant projects (Perrin, 1989). These include a survey of coastal fishery interactions in Brazil, monitoring incidental take of dolphins in the Amazon, promoting the establishment of river dolphin conservation areas in Brazil, promoting legislation to protect river dolphins fully in Peru, Ecuador, Colombia and Venezuela, promoting the enforcement of existing laws protecting river dolphins in South America, and establishing communication on river dolphin conservation and management among Brazil, Peru, Venezuela, Colombia, Ecuador and Bolivia.

To these projects, which mainly address the more serious problems of the riverine population(s), could be added: a study of the relationships between the different populations to clarify the species and stock identities, investigation of the coastal populations in northern South America, and obtaining more information on biology, breeding and behaviour so that conservation and management can be improved.

Captive Breeding During the 1960s and 1970s about 45 tucuxi were captured alive in the Amazon and in Colombia for exhibition in USA and Europe respectively (da Silva and Best, 1986). Some of the 27 or so animals taken to Europe still survive (probably about eight), and one calf was born in 1986 in FRG (Terry, 1983; Klinowska, unpublished observations).

Tucuxi can be aggressive to other species in captivity, can be timid and are easily agitated (e.g. Terry, 1984). It appears that, with modern husbandry, the tucuxi is not impossible to keep in captivity, and captive breeding could be a feasible conservation option.

It is disappointing that so little information relevant to conservation and management has been obtained (or published) so far. If any more specimens are collected the opportunity should be taken to initiate such studies.

Remarks The *Sotalia* and *Sousa* spp. were proposed for CITES Appendix I listing because of their vulnerable tropical and riverine habitat and because the taxonomic confusion was such that it seemed preferable to list them together rather than possibly miss out a species in danger, although they were borderline candidates (Klinowska, 1978). Somewhat more information on *Sotalia* is now available, although the taxonomic questions remain.

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WHITE-BEAKED DOLPHIN **INSUFFICIENTLY KNOWN**
Lagenorhynchus albirostris (Gray, 1846)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Although survey data have not been analyzed in detail, the white-beaked dolphin appears to be fairly abundant within its range. There are no known serious threats, although some incidental catching in fishing nets is known to occur.

Distribution The white-beaked dolphin is found in the northern North Atlantic, in cold temperate and subarctic waters, including the Baltic Sea (Leatherwood and Reeves, 1983; Aguayo, 1978). It ranges as far south as Cape Cod in the west and Portugal in the east (McBrearty, Message and King, 1986). Reports of isolated records from Turkey (Hennipman *et al.*, 1961; Kumerloeve, 1975) require confirmation.

Population There are no population estimates for any part of the range, although the North Atlantic Sightings Survey programme will provide such information for much of the eastern part of the range (IWC, 1989). At present, white-beaked dolphins are said to be common off Cape Cod in spring, abundant at least seasonally off southern and western Greenland, Newfoundland and Labrador, and throughout the Davis Strait. In the east they are common around the Faeroe Islands, and seasonally present in the Norwegian Sea along the coast of Norway and the southern Barents Sea to Varanger Fjord and possibly Murmansk. They are abundant off southwestern Sweden and are said to be the most common dolphin in waters around Iceland (Leatherwood and Reeves, 1983). They are generally the third most commonly reported species in sighting and stranding records in the northern North Sea (Klinowska, 1987).

Habitat and Ecology The maximum recorded length of the white-beaked dolphin is about 3.15m for males and 3.05m for females. Males are sexually mature at 2.5 to 2.6m in length and females at about 2.5m. Newborn animals are about 1.2m long (Perrin and Reilly, 1984). Mating is believed to occur in the warmer months, and young are mainly reported between June and September. The diet includes squid, octopus, cod, herring, haddock, capelin and sometimes benthic crustaceans.

These dolphins are found near the northern limits of their range between spring and late autumn, apparently wintering in the south. Movement patterns may be more complex, however, since the species has been reported off the British Isles throughout the year, with perhaps a small increase in records from May to August in the northern North Sea.

White-beaked dolphins sometimes occur in herds of several hundred, particularly in the western part of the range. In the east the majority of reports have been of schools of two to five animals. Single animals are also reported here, as well as groups of up to several hundred in summer. The larger groups are often associated with feeding. Photo-identification studies are in progress in the Gulf of Maine, USA (McBrearty, Message and King, 1986; Leatherwood and Reeves, 1983; IWC, 1990).

Threats Small numbers have been taken in the past in most areas of the North Atlantic, mainly by local people for their own use. Today small numbers may occasionally be taken by local people in the Faeroe Islands and Greenland. A few specimens are also known to be taken accidently in fishing nets throughout the range (Kapel, 1975; Leatherwood and Reeves, 1983; IWC, 1989).

Conservation Measures Potential countries of origin include all those with coasts in cold and temperate North Atlantic waters. Specific locations so far reported include: Canada, Denmark (Faeroes, Greenland), Norway, Sweden, the Netherlands, UK, Ireland, Belgium, Portugal, Turkey, France, Iceland, USA and USSR.

The species is included in Appendix II of CITES. The following international trade is recorded: 1981 - 1 scientific specimen from France to USA; 1982 - 1 scientific specimen of French origin from USA to France; 1983 - 1 body of unstated status from Canada to USA, 5 live specimens for zoological purposes from Canada to USA; 1984 - 1 skeleton for scientific purposes from Denmark to Denmark; (1982 - 1 scientific specimen from UK to Switzerland, described only as *Lagenorhynchus* spp.) (CMC, 1987). The white-beaked dolphin is also listed in Appendix II of the Berne Convention. The North and Baltic Seas populations are listed in Appendix II of the Bonn Convention. No other international legislation refers to this species, but it will be protected by general legislation in several countries.

The IUCN/SSC Cetacean Specialist Group Action Plan does not have any specific projects relating to this species, although it will be included in general projects, such as monitoring incidental takes (Perrin, 1989).

Captive Breeding Five female white-beaked dolphins were netted off Newfoundland in March 1983 and taken to Mystic Marinelife Aquarium in Mystic, Connecticut (Reeves and Leatherwood, 1984). Attempts have been made in the UK to rehabilitate stranded animals on at least two occasions, but without success (Klinowska and Brown, 1986).

This species is of an appropriate size for conservation through captive breeding to be feasible, if necessary. In view of the complete lack of life history information, it should be a priority for such data to be collected from any captive animals, as well as that required for captive breeding.

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ATLANTIC WHITE-SIDED DOLPHIN **INSUFFICIENTLY KNOWN**
Lagenorhynchus acutus (Gray, 1828)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Although survey data have not been analyzed in detail, the Atlantic white-sided dolphin appears to be fairly abundant within its range. There are no known serious threats, although some incidental catching in fishing nets is known to occur.

Distribution The Atlantic white-sided dolphin is found only in the northern North Atlantic. The southernmost record on the western side is from the Chesapeake Bight. To the north it is reported from west Greenland and Iceland. In the east, it may penetrate as far north as the southern Barents Sea, and has been reported from the Baltic Sea. The most southerly records here seem to be from the Adriatic Sea and the Azores area, but may represent vagrants. The Atlantic white-sided dolphin is considered to be more pelagic than the white-beaked dolphin, but the ranges of both species are very similar (Aguayo, 1978; Leatherwood and Reeves, 1983; McBrearty, Message and King, 1986).

Population There are no population estimates, but the species is considered regionally abundant. Survey data have been obtained from the 1987 and 1989 NASS surveys, covering the northern and eastern part of the range, but not yet analyzed (IWC, 1989). Selzer and Payne (1988) report that Atlantic white-sided dolphins were common in the Gulf of Maine between latitudes 40° to 44°N. In spring, their distribution was centred in the southwestern Gulf of Maine, through the Great South Channel and east along the western edge of Georges Bank; the majority of sightings occurred between latitudes 40° to 42°N. Large aggregations were also observed along the continental slope of the mid-Atlantic region at approximately 39°N. In autumn, the distribution was again centred primarily in the Gulf of Maine, but sightings occurred throughout this basin, with most between 42° and 44°N, with a few south of 42°N.

In the eastern North Atlantic, McBrearty, Message and King (1986) note that reports of Atlantic white-sided dolphins were only 40% of those for white-beaked dolphins in this area. The same, or somewhat lower, comparative abundance of records is seen in the North and Baltic Seas (Aguayo, 1978; Klinowska, 1987).

Habitat and Ecology The maximum length of the Atlantic white-sided dolphin is about 2.75m in males and 2.43m in females. Length at birth is between 1.1m and 1.2m. Females seem to become sexually mature between 1.94 and 2.22m in length, at an average age of 12 tooth growth layer groups - possibly indicating 12 years of age. Males become sexually mature between about 2.1 and 2.4m in length. In the western Atlantic the season of birth has been calculated at between May and August, with a peak in June and July, following a gestation of somewhere between 10 and 12 months. Lactation may continue for about 18 months, giving a calving interval of between two and three years (Perrin and Reilly, 1984).

A wide range of fish and cephalopods are reported in the diet. These include short-finned squid *Illex illecebrosus*, herring *Clupea harengus*, smelt *Osmerus mordax* and silver hake *Merluccius bilnearis*. A few shrimp remains have also been noted.

These dolphins have been reported from waters with temperatures ranging from 1° to 15°C, with most reports from waters cooler than 12°C. There also seems to be some preference for less saline waters, and for areas with high sea floor relief. These observed distribution patterns are likely to reflect the distributions of important prey species.

The species is sometimes observed in small groups of six or eight in inshore areas in summer, but offshore herds may number many hundreds. There is some evidence of segregation within herds, with immature and newly matured animals largely absent from breeding groups. There are few mature males in breeding groups, perhaps indicating the presence of all-male groups or differential mortality rates between the sexes. That the latter may be the correct explanation is supported by reports that the oldest mature male showed 22 tooth growth layer groups, while the oldest female showed 27 growth layer groups (Leatherwood and Reeves, 1983; Selzer and Payne, 1988; Sergeant, St Aubin and Geraci, 1980).

Threats In the past, Atlantic white-sided dolphins have been taken in many parts of the range in drive fisheries, mainly by local people for their own use. Today they are sometimes directly taken in small numbers in Greenland (Kapel, 1975), and occasionally (76 in 1987) in the Faeroe Islands (IWC, 1989). There is some incidental take in fishing nets throughout the range (Leatherwood and Reeves, 1983).

Conservation Measures Potential countries of origin include all those with coasts in the northern North Atlantic. Specific locations so far recorded include: USA, Canada, Denmark (Faeroes and Greenland), Iceland, Norway (Spitzbergen), UK, USSR, France, Italy, Portugal (Azores), Belgium and the Netherlands.

The Atlantic white-sided dolphin is included in CITES Appendix II. The following international trade is recorded: 1985 - 1 skeleton from South Africa to USA for scientific purposes (CMC, 1987). The species is included in the Appendix II of the Berne Convention, and the North and Baltic Seas populations are included in Appendix II of the Bonn Convention. No other international legislation makes direct reference to this species, but general national legislation affords protection in some countries.

The IUCN/SSC Cetacean Specialist Group Action Plan will include this species within general projects to monitor by-catches, net entanglements etc. (Perrin, 1989).

Captive Breeding The Atlantic white-sided dolphin does not appear to have been kept in captivity so far (IWC, 1984). It is, however, of a size suitable for conservation through captive breeding should this be necessary. If any specimens are taken into captivity, the collection of life history and breeding information should be given priority, to provide information for the conservation and management of the wild populations, and for any captive breeding programme which might become necessary.

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DUSKY DOLPHIN INSUFFICIENTLY KNOWN

Lagenorhynchus obscurus (Gray, 1828)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The dusky dolphin population(s) off Peru suffer from a recently greatly increased and uncontrolled direct fishery, which may well constitute a major survival problem. Off Chile, these dolphins are taken (illegally) for use as crab bait. Other fisheries are known to take cetaceans within the range of the dusky dolphin but there is no information on the level of take of this species. More information on abundance and distribution and levels of direct and incidental take in order to assess the significance of such takes for local stocks and for the species as a whole.

Distribution The dusky dolphin is found in temperate and cold temperate circumpolar waters near all land masses of the Southern Hemisphere. Off New Zealand the distribution is thought to be associated with the Subtropical Convergence (Leatherwood and Reeves, 1983).

Population There are no population estimates for any part of the range, but the distribution is apparently discontinuous, and there may be several geographically isolated stocks. The species is generally considered to be abundant throughout most of the range (Leatherwood and Reeves, 1983).

Habitat and Ecology The maximum length for males is 2.11m and for females 1.93m. (Perrin and Reilly, 1984). Group size varies, at least in New Zealand and Argentinian waters. The basic group contains between six and 15 animals, although these small groups may come together for feeding. Group membership may be stable over periods of at least days, and there is some evidence that animals with young form separate groups. Off Argentina, these dolphins can be found throughout the year. They seem to follow closely the movements of their primary prey species, southern anchovy *Engraulis anchoita* (Leatherwood and Reeves, 1983; Wursig and Wursig, 1980). Off South Africa an albino specimen has been reported. Some dusky dolphins here occasionally interact with swimmers and other water users (Rice, 1981). Photo-identification studies are in progress in Argentina and New Zealand (IWC, 1990).

Threats Several threats to South American dusky dolphin populations have recently been discovered.

It has been known for some time that dolphins and porpoises incidentally caught in coastal gillnet fisheries for scaenids and sharks were sold for meat for human consumption in Peru. In the 1970s, unfavourable oceanographic conditions combined with overfishing to drive the Peruvian stocks of anchoveta to near extinction. The anchoveta fishery was at the time the largest fishery in the world, and its collapse put thousands of fishermen out of work. It now appears that many of these fishermen shifted to using gillnets to hunt dolphins, in particular the dusky dolphin, exploiting the market created previously by the sale of dolphins caught incidentally in other fisheries. The catch of dolphins in the directed fishery may now exceed 10,000 in some years, and may be sufficient to endanger the local population(s) (Perrin, 1989).

Intensive pelagic driftnet fisheries within the range (e.g. the Tasman Sea), which are known to take other cetacean species, may also involve the dusky dolphin. More information is urgently required.

Several thousand dolphins and porpoises are harpooned annually for use as bait in the Chilean crab fishery, along with seals, sealions, penguins, guanacos and other wildlife. The dusky dolphin is one of the species involved. Only four of 26 crab companies operating in the Magallanes area provide bait to the crab fishermen, and even in these cases the amount supplied is grossly inadequate. The crab fishery is expanding rapidly and now extends to the area south of the Beagle Channel, which is being fished extremely heavily at present. The multi-million dollar catch is exported to the USA, FRG, France, the Netherlands, Belgium (a re-exporter), Japan and Italy. Although the taking of wildlife in this way for bait is illegal, the fishery operates freely because of the isolation of the area and non-enforcement of national laws (Perrin, 1989).

In the past, dusky dolphins have been caught for human consumption in South Africa, and incidentally taken specimens may still occasionally be used for this purpose here. There is also some incidental taking in other parts of the range (Leatherwood and Reeves, 1983).

Conservation Measures Potential countries of origin include all those with coastlines in the temperate and cold waters of the Southern Hemisphere. Specific locations so far reported include: South Africa, Argentina, New Zealand (Campbell and Auckland Islands), Chile, Peru, France (Kerguelen Islands) and UK (Falkland Islands). As recipients of the products of the Chilean crab fisheries, USA, FRG, France, the Netherlands, Belgium, Japan and Italy, have special conservation responsibility for this species.

The dusky dolphin is included in CITES Appendix II. The following international trade is recorded: 1985 - 29 specimens of unstated status from Peru to USA (CMC, 1987). The Peru/USA consignment was for scientific purposes (Brownell, 1989). No other international agreements refer to this species, but it will be protected by general national legislation in some countries. However, as mentioned in the Threats section above, enforcement of protective legislation is not always effective.

The IUCN/SSC Cetacean Specialist Group Action Plan expresses considerable concern over the level of direct take in Peru, and calls urgently for further investigation of the problem. There is also a call for action to prevent excessive exploitation for crab bait off Chile, including investigation of alternative sources of bait. A number of general projects, such as investigating and preventing accidental takes in gill nets, are also relevant (Perrin, 1989).

Captive Breeding Dusky dolphins have been kept in captivity in South Africa (total 23, two or four of these were transferred to Switzerland) and New Zealand (total 22-24, two of these were transferred to Australia). The species is small enough for conservation through captive breeding to be practical, if necessary. Survival times of at least seven years are recorded in South Africa, but so far no births are reported (Best and Ross, 1984; Cawthorn and Gaskin, 1984). If any more dusky dolphins are taken into captivity, the collection of life history data, and of information relevant to conservation in the wild and to captive breeding should be given priority.

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PACIFIC WHITE-SIDED DOLPHIN **INSUFFICIENTLY KNOWN**

Lagenorhynchus obliquidens Gill 1865

Suborder ODONTOCETI Family DELPHINIDAE

Summary The Pacific white-sided dolphin is not known to be depleted at present, but in view of the intensity of gillnet fishing operations within its range, it cannot be considered safe until more is known about its population size and the levels of incidental take.

Distribution Pacific white-sided dolphins have a primarily temperate distribution, remaining north of the tropics and south of the colder waters influenced by arctic currents. They have been reported from Taiwan to the Kurile and Commander Islands on the west, from 20-21°N to 61°N on the east, and more or less continuously across the temperate waters of the North Pacific (Leatherwood and Reeves, 1983; Leatherwood *et al.*, 1984; Walker *et al.*, 1986).

Population Two stocks have been proposed: northwestern Pacific and northeastern Pacific, apparently separated by an area of low density along the south side of the central Aleutian Islands. Morphological differences appear to exist between animals in the northeastern Pacific north of southern California and those 'resident' off Baja California. The size of the population(s) is not known, although Nishiwaki (1972) stated that there were 30,000 to 50,000 in Japanese waters, and Fox (1977) estimated about 24,000 in 1.5 million square km off California and Baja California. However, they do appear to be the second or third most abundant delphinid in southern Californian waters in winter, and may perhaps be the most abundant delphinid in the temperate eastern Pacific (Leatherwood *et al.*, 1984).

Habitat and Ecology The Pacific white-sided dolphin reaches lengths of 2.50m in males and 2.36m in females. Maximum age so far recorded is 46 growth layer groups in teeth, which has been assumed to represent 46 years of age. Sexual maturity is reached at lengths of between 1.70m and 1.98m in males and between 1.70m and 2.16m in females. Maximum size and size at sexual maturity are believed to differ in different geographical regions. Length at birth is between 1.02m and 1.24m. Gestation may last for 10 months (Perrin and Reilly, 1984; Walker *et al.*, 1986).

They can form large groups of a thousand or more, although groups of several hundred or fewer are far more common. Herds usually contain individuals of all age groups and both sexes. The calving season is summer to early autumn.

Seasonal movements are not well understood in most areas, but off California and Baja California there appear to be resident pods which are augmented from autumn to spring by influxes of animals from other areas (which are thought to be farther north and offshore). Photo-identification studies are in progress in Monterey Bay, USA.

The species feeds on a wide variety of fish and squid, primarily at night. Northern anchovies, hake and the squid *Loligo opalescens* appear to be the most consistently important in the diet in the northeastern Pacific (Leatherwood and Reeves, 1983; Walker *et al.*, 1986; IWC, 1990).

Threats At Iki Island in Japan, fishermen became convinced in the 1960s that dolphins and small whales were eating, damaging or scaring away most of the yellowtail tuna (*Seriola* spp.) and squid on which the local fishery depended, and a programme of government-supported culls was undertaken. The peak years of the control programme were 1976-1980, when 934, 1,332, 1,646 and 1,819 small cetaceans were killed, respectively. The Pacific white-sided dolphin was one of the four species involved (Perrin, 1989). There is no evidence that culling ameliorated this situation.

The Pacific white-sided dolphin is taken in small numbers in Japan (e.g. 16 in 1987) for human consumption. Groups are said to be difficult to drive, and this appears to be a major reason why fisheries using this method, such as in those in Japan, take very few of this species.

Some are known to be accidentally killed in drift nets and gill nets set for salmon (e.g. at least 194 in 1987) (Leatherwood and Reeves, 1983; IWC, 1989). They are not involved to any great extent (e.g. 5 in 1987) in the eastern tropical Pacific tuna purse seine fishery incidental takes (Chivers, Hohn and Miller, 1988). Sixteen Pacific white-sided dolphins were taken in 1987 by the Canadian offshore flying squid experimental driftnet fishery (Baird, Langelier and Stacey, 1988). Eight were recorded in a six-week period of observation aboard a Japanese squid driftnet vessel in the central North Pacific in 1986 (Tsunoda, 1989). If these takes are typical of such fisheries then the total incidental takes could be substantial.

Conservation Measures Potential countries of origin include all those with coasts in the temperate waters of the North Pacific. Specific locations so far reported include: USA, Canada, USSR, PR China, Taiwan, Mexico and Japan.

The Pacific white-sided dolphin is included in CITES Appendix II. The following international trade has been reported: 1981 - 1 scientific specimen from USA to UK; 1983 - 4 live animals from Japan to Hong Kong for zoological purposes; 1984 - 4 live animals from Japan to Hong Kong for zoological purposes, 8 live animals from Japan to an unstated destination for commercial purposes; 1985 - 3 live animals from Japan to Republic of Korea for commercial purposes (CMC, 1987). No other international legislation refers to this species, but general national legislation will protect this dolphin in some countries.

The IUCN/SSC Cetacean Specialist Group Action Plan does not contain any specific projects relating to this species, but it will be covered by general projects such as investigating and preventing incidental takes in gill nets (Perrin, 1989). This is particularly important in view of the intensive fishing operations within the range.

Captive Breeding Pacific white-sided dolphins have been live-captured in the USA (a total of about 80 specimens) and Japan (a total of about 250 specimens). Some of these specimens were exported (see trade data above for examples) (IWC, 1984). The species is of a reasonable size for conservation through captive breeding to be feasible, if necessary. In view of the general lack of information on life history and behaviour, the collection of such data should be a priority for existing and any future captive specimens.

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HOURGLASS DOLPHIN **INSUFFICIENTLY KNOWN**

Lagenorhynchus cruciger (Quoy and Gaimard, 1824)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The hourglass is not subject to any known specific threats at present, but in view of the general lack of information on this species, more studies should be undertaken throughout the range. It is particularly important that the IWC/IDCR cruise data be analyzed as soon as possible, to provide population estimates for this part of the range.

Distribution The hourglass dolphin has a circumpolar distribution in the Antarctic and sub-Antarctic. It is found both north and south of the Antarctic Convergence, and in cool currents associated with the West Wind Drift. This is a truly pelagic species, rarely seen near land. It has been sighted off the Chilean coast as far north as 33°40'S, but the vast majority of records are from between 45°S and 65°S (Leatherwood and Reeves, 1983). The IWC/IDCR Cruises 1978/79 to 1983/84 (Kasamatsu *et al.*, 1988) observed hourglass dolphins in the study area (south of 58°S), ranging between 58°08'S and 67°38'S. With one exception, sightings occurred at greater than 90 nautical miles from the pack ice edge. One sighting was made within 25n.miles of the pack ice edge at 66°18'S 146°35'W). The northernmost sighting was at 44°42'S 59°32'W.

Population This species is widely distributed, but abundance estimates have not yet been calculated, although the data exist in principle to do so. The IWC/IDCR records (Kasamatsu *et al.*, 1988) show relative concentrations of sightings between 58°S and 65°S in Area VI (48 sightings, 59%) and Area I (18 sightings, 22%). Overall, 647 animals of this species were positively identified, in 81 schools. Of the 14 species recorded, the hourglass dolphin was the fifth most commonly encountered. The IWC/IDCR data should provide population estimates, when time is available for full analysis.

Habitat and Ecology The longest measured specimens were a 1.63m male and a 1.83m female, but so few have been examined that no conclusions can be drawn about size ranges (Brownell, 1974). There is no information on life history, breeding or feeding habits (Leatherwood and Reeves, 1983).

The range of school size reported by the IWC/ICDR (Kasamatsu *et al.*, 1988) is from 1-100 animals, with an average of 8.57 animals per school (standard deviation 14.30). Fifty six of the schools (80%) ranged from one to seven animals, and twelve schools (17%) ranged between one and two animals.

Two calves were sighted, one with a school of six animals in Area V (59°53'S 177°11'W) and a second with a school of seven in Area VI (59°30'S 161°25'W). The ratio of calves to adults sighted (0.3%) might indicate that cow/calf pairs are mainly distributed in waters north of 58°S.

Hourglass dolphins were observed in sea temperatures ranging from -0.3°C to +7.0°C. Within that range, 60 schools (71%) occurred between +1.0°C to +3.0°C. On transit to the main study area, hourglass dolphins were observed at sea temperatures between 5.0 and 5.9°C, where this sea temperature is thought to be just north of the Antarctic Convergence. The warmest sea temperature where a sighting occurred was 13.4°C.

There were 14 sightings of mixed schools of hourglass dolphins and other cetacean species, including fin, sei, killer, beaked and pilot whales, and southern right whale dolphins. These were predominantly mixed schools of two species, but in four cases hourglass dolphins were observed in schools with two other species.

Threats As far as is known, the hourglass dolphin has never been exploited, intentionally or accidentally (Leatherwood and Reeves, 1983). As a fully pelagic species in relatively unexploited and unfrequented waters, the status of the species can be presumed to be satisfactory.

Conservation Measures Potential countries of origin include all those with coasts in Antarctic and sub-Antarctic waters. Specific locations so far recorded include: Chile, UK (Falklands Islands), Argentina, Australia, South Africa and New Zealand. However, the vast majority of records are from waters outside the jurisdiction of any state, or from within Antarctic continental waters.

The hourglass dolphin is included in Appendix II of CITES. No international trade has been recorded (CMC, 1987). No other international legislation refers to this species, but some general national legislation will give protection.

The IUCN/SSC Cetacean Specialist Group Action Plan will include this species among general monitoring projects (Perrin, 1989). There is a major need for more information about this species, and in particular, the IWC/IDCR cruise data should be fully analyzed as soon as possible to provide population estimates for this region.

Captive Breeding As far as is known, the hourglass dolphin has never been kept in captivity (IWC, 1984). It is of an appropriate size for conservation through captive breeding to be feasible, if necessary. If any are brought into captivity, the collection of life history, breeding and behaviour data should have priority, particularly as nothing is known about these parameters in the wild populations.

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PEALE'S DOLPHIN **INSUFFICIENTLY KNOWN**
Lagenorhynchus australis (Peale, 1848)

Suborder ODONTOCETI Family DELPHINIDAE

Summary There is considerable concern about the level of (illegal) taking for crab bait in Chile and Argentina, particularly as Peale's dolphin has a comparatively restricted distribution. Information on these takes, and on populations, biology and behaviour is urgently needed. It is also important that alternative sources of bait are sought.

Distribution Peale's dolphin is only found in the coastal waters of southern South America and off the Falkland Islands. The most northerly record on the Pacific coast is Valparaiso, and on the Atlantic coast about Golfo San Matias. It is also found in the Magellan Strait, the Beagle Channel and off the southern coast of Tierra del Fuego to about 57°S (Leatherwood and Reeves, 1983).

Population There are no population estimates, but the species is said to be very common throughout the channels and Bays of Tierra del Fuego, but more numerous in the southern part, such as the Beagle Channel. It is also said to be common off the Falkland Islands (Leatherwood and Reeves, 1983; Goodall, 1978).

Habitat and Ecology The largest measured specimen of Peale's dolphin was 2.16m long (Perrin and Reilly, 1984). One individual collected near the Falkland Islands had the remains of octopus in the stomach. They seem to prefer fiords and deep bays off Tierra del Fuego (Leatherwood and Reeves, 1983; Goodall, 1978).

Threats Peale's dolphin is one of the species involved in the Chilean crab bait fishery (see dusky dolphin review for details). There is also similar uncontrolled (and illegal) exploitation in Argentina, where these dolphins are also taken in crab nets (Perrin, 1989). There appears to be no monitoring of by-catching off the Falklands Islands.

Conservation Measures This dolphin is known from Chile, Argentina and UK (Falkland Islands). The countries receiving the products of the crab fishery, USA, FRG, France, the Netherlands, Belgium, Japan and Italy, also have special conservation responsibility for this dolphin.

Peale's dolphin is included in CITES Appendix II, but no international trade has been recorded (CMC, 1987). No other international legislation refers to this species. Although protected by national legislation in Chile and Argentina, the direct fishery for crab bait continues because of the isolation of the area and non-enforcement of national laws. These dolphins do not appear to have any legal protection off the Falkland Islands.

The IUCN/SSC Cetacean Specialist Group Action Plan expresses considerable concern about the level of (illegal) taking for crab bait in Chile and Argentina. Several projects to monitor and possibly reduce the take are proposed (Perrin, 1989). There is also a clear need for further information on population size, biology and behaviour.

Captive Breeding Peale's dolphin does not appear to have been kept in captivity (IWC, 1984). The species is of an appropriate size for conservation through captive breeding to be feasible, if necessary. If any animals are taken into captivity, the collection of life history, breeding and behaviour data should be given priority.

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RISSO'S DOLPHIN **INSUFFICIENTLY KNOWN**
Grampus griseus (G. Cuvier, 1812)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Risso's dolphin has been rather neglected by researchers. There is no quantitative information on status or abundance, and the only known substantial threats are in the Indian Ocean. The high proportions of immature Risso's dolphins taken in the Sri Lankan gillnet fishery gives rise to concern, and the status of these populations requires urgent investigation. More information on range, abundance, biology and behaviour is needed in all areas.

Distribution Risso's dolphin is reported from tropical and warm temperate oceanic waters worldwide, generally in water deeper than 1,000m. It is also sometimes reported outside the main range. In the North Atlantic it has been found from Newfoundland and Sweden south to the Mediterranean and Lesser Antilles. In the South Atlantic it is reported south to Argentina and South Africa. It ranges from Alaska and the Kuriles south to central Chile, Australia and New Zealand in the Pacific Ocean. Off western North America there appear to be two gaps in distribution, at about 20°N and 42°N. The species is also found in the Indian Ocean, including the Red Sea (Leatherwood and Reeves, 1983; Leatherwood *et al.*, 1984; Kruse *et al.*, 1987).

Population No information on population is available, but the species is said to be abundant within the range (Leatherwood and Reeves, 1983). Studies in the Indian Ocean found it to be the third most frequently encountered species (Kruse *et al.*, 1987). McBrearty, Message and King (1986) describe sightings reported to them by amateur observers in the eastern North Atlantic and Mediterranean Sea as 'meagre'. With 35 encounters this was only the ninth most frequent of the 13 species listed for the North Atlantic, and with 33 encounters the sixth most frequent of the ten species listed for the Mediterranean Sea. However, this may simply reflect the distribution of observers, as the majority of reports in this study came from northern waters outside the main range of this species. Off the Azores they were the second most frequently encountered species (Gordon, Arnbom and Deimer, 1988). A photo-identification study is in progress in Monterey Bay, California. The catalogue contains 250 animals so far (IWC, 1988). Another such study has been initiated off the Azores, with 58 individuals catalogued so far (Gordon, Arnbom and Deimer, 1988).

Habitat and Ecology The longest male Risso's dolphin was reported to be 3.83m and the longest female 3.66m. The length at sexual maturity is between 2.62 and 2.97m in males and between 2.60 and 2.84m in females. The oldest animals reported so far were a male with at least 13 Growth Layer Groups (GLGs) in the teeth, and a female with more than 17 GLGs. Length at birth is between 1.35 and 1.66m (Perrin and Reilly, 1984). This information is based on very small samples from scattered locations.

Cephalopods are the main prey, but fish may also be taken. They are occasionally seen as solitary individuals or pairs, but they usually live in herds (Leatherwood and Reeves, 1983). Groups in the Indian Ocean contained between three and 150 animals, with a mean of 27. Herd size did not appear to vary with season. In Monterey Bay the typical group size was about 33 animals. Other studies off California report an average group size of 46 animals. In the eastern tropical Pacific average group size ranged between 15 and 26 (Kruse *et al.*, 1987). McBrearty, Message and King (1986) report an average group size of 6.3 in the northeastern Atlantic, with a maximum of 20 animals. There was an average of 6.7 in the Mediterranean, with a maximum of 30 animals.

Hybridization with bottlenose dolphins may have occurred in the wild (Fraser, 1940).

Threats Attempts at drive fishing were made in Newfoundland, but were not successful, as the animals became very excited and were difficult to contain (Mitchell, 1975).

Direct catches appear to be few and occasional, as part of more general small cetacean fisheries. The meat is used for human consumption. Areas with such fisheries include Japan, the Lesser Antilles, the Solomon Islands and Indonesia (Mitchell, 1975). They are said to be 'often' seen at fish markets in Taiwan (Wang, 1984). Some takes have been documented in European waters (Hentschel, 1937; Duguy, 1977).

Risso's dolphins comprised 25% of the cetaceans landed after being caught incidentally in gillnets off Sri Lanka between 1983 and 1986. As many as 92% of the animals appeared to be immature, although that figure may be biased upward by the tendency of fishermen to discard at sea most specimens larger than about 4.0m (Kruse *et al.*, 1987).

Conservation Measures Potential countries of origin include all those with coastlines in tropical and warm temperate waters. Locations so far reported include: Canada, USA, Sweden, Denmark, Netherlands, Belgium, Ireland, UK, France, Spain, Portugal (Azores), Italy, Greece, Argentina, South Africa, Chile, New Zealand, Australia, Japan, Indonesia, Solomon Islands, St Vincent and the Grenadines, Seychelles, Sri Lanka, the Maldives, India, PR China, USSR, Taiwan and Mexico.

Risso's dolphin is listed in Appendix II of CITES. The following international trade is recorded: 1984 - 1 commercial specimen from South Africa to USA, 1 scientific specimen from South Africa to USA; 1985 - 3 specimens for unspecified purpose from Peru to USA (CMC, 1987). It is also listed in Appendix II of the Berne Convention and the Baltic and North Seas populations are listed in CMS Appendix II. No other international legislation mentions this species, but it is protected under general legislation in several countries.

The IUCN/SSC Action Plan notes the incidental gillnet catches of Risso's dolphin in Sri Lanka as in particular need of monitoring and proposes that the status of other populations exposed to direct and indirect taking should be determined (Perrin, 1989). The main need is for more information on biology and population so that possible problems can be identified. The numbers taken as by-catches should be recorded and examined, and more use made of strandings.

Captive Breeding More than 50 Risso's dolphins are known to have been live-captured, the vast majority in Japan (IWC, 1984). Some stranded animals have been kept in the USA, a few surviving for several years. Only one specimen has been directly live-captured in the USA (in 1978), which lived for five days (Reeves and Leatherwood, 1984). The animals for Japanese institutions were obtained from incidental catches or drive fisheries (Kasuya, Tobayama and Matsui, 1984). Thirteen births of *Tursiops* x *Grampus* hybrids are recorded at Enoshima Marineland in Japan. Most were still-born or survived only a few months, but one lived for six years seven months (Sylvestre and Tasaka, 1985). No pure-bred Risso's dolphin births appear to have taken place in captivity.

The species is small enough for conservation through captive breeding to be feasible, and although no non-hybrid captive births are reported so far, there are also no reports that this species reacts badly to captivity. Existing and any future captive animals should be studied to provide information relevant to conservation and management. In particular, calibration of ageing techniques and details of reproduction are important. Data relevant to captive breeding should also be collected, in case this conservation method should become necessary.

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BOTTLENOSE DOLPHIN | **INSUFFICIENTLY KNOWN**

Tursiops truncatus (Montagu, 1821)

Suborder ODONTOCETI | Family DELPHINIDAE

Summary Although a few inshore bottlenose dolphin populations are relatively well studied, information is lacking for the majority of the inshore range and for the offshore populations. The species is known to be taken directly or indirectly (although mainly in small numbers) almost throughout the inshore range, and the inshore habitat is vulnerable to encroachment, disturbance and pollution. While there is at present little immediate concern about the survival of the species as a whole, it cannot be regarded as relatively secure in the longer term. In particular, there is concern that the level of removals by shark nets along the eastern coast of South Africa is not sustainable. More information on speciation, populations, distribution, biology, behaviour and direct and indirect taking throughout the range is required.

Distribution The bottlenose dolphin is found worldwide in temperate and tropical waters, both offshore and inshore. The species is absent only from polar waters. Outside tropical waters they are encountered principally in the coastal zone, less frequently to the edge of the continental shelf and beyond. In all areas where the systematics of bottlenose dolphins have been studied, there appear to be two main ecotypes, a coastal form and an offshore form (the latter including residents of coastal and oceanic island waters). The many nominal species may simply reflect differences within and between these two forms (Leatherwood and Reeves, 1983).

Walker (1981) distinguished three forms in the eastern North Pacific: a southern California and Mexico coastal form, corresponding to *Tursiops gilli*; a northern temperate offshore form and a closely related eastern tropical Pacific (ETP) offshore form, corresponding to *Tursiops nuuanu*. However, he considered it premature to attempt to assess the validity of these species. Specimens collected during the late 1800s indicate that the coastal form ranged further north than it did until recent years. The reasons for the southward shift in range are unknown, but might be related to natural environmental changes. During and since the 1982/83 El Nino warm water incursion, the species has been found in and near Monterey Bay, more than 600km north of their previous recent range, apparently re-establishing most of the historical range in this region (Wells *et al.*, 1990). A specimen of the coastal form, possibly a vagrant, was even found north of Seattle (48°36'N, 122°26'W) in 1988 (Ferrero and Tsunoda, 1989). The northern temperate offshore form may also have a more northerly range, but the supporting evidence is slender (Walker, 1981).

Ross (1977) was able to divide South African specimens into two groups, one similar to *Tursiops truncatus* specimens from British waters but with some differences, and one resembling *Tursiops aduncus* and confirming that (at least in this sample), *T. aduncus* is synonymous with the types *T. absulam*, *T. catalania* and *Delphinus gadamu*. Tomilin (1957) reviews information on a possible sub-species *T. t. ponticus* in the Black Sea. He concludes that *Tursiops* is represented by a single cosmopolitan species, with an as yet undetermined number of geographic races.

The name *Tursiops truncatus* is used for the present purpose as an inclusive term, covering all nominal species, pending further information. This is in accordance with current international practice. The terms 'Atlantic bottlenose dolphin' and 'Pacific bottlenose dolphin' often used to describe captive specimens, have no taxonomic basis.

In all areas where it has been studied, the nearshore ecotype appears to occur in discrete units with limited, overlapping home rages. This also appears to be true of the offshore form resident around oceanic islands. However, the offshore form in general seems to undertake seasonal migrations, presumably following their highly migratory fish and squid prey. Large influxes of such animals may seasonally supplement the resident populations (Leatherwood and Reeves, 1983).

Biochemical studies are now providing more information about the relationships within and between the ecotypes. Duffield (1980) found that variability at a number of gene loci revealed sharp differences between Atlantic and Pacific specimens, and suggested disjunct offshore-nearshore populations in the Atlantic. The coastal and offshore ecotypes can also be separated by haemoglobin levels, packed cell volumes and red blood cell counts, the offshore form having higher values for all three measures. Captive-bred crosses between coastal and offshore types produce animals with intermediate haematologic profiles, suggesting a significant genetic basis for these differences. The coastal-offshore differences were observed for both Pacific and Atlantic animals. One Pacific coastal area contained a mix of animals of both ecotypes, either as transients or as resident populations. Individuals of intermediate haematologic profile were also found here, indicating that reproductive exchange between coastal and offshore forms is occurring in this area. Coastal and offshore specimens trained to dive deeply showed an increase in red blood cells. The increase was far higher in the offshore specimens, possibly indicating different physiological responses made by the two types to deep diving (Duffield, Ridgway and Cornell, 1983).

There are a few reports of hybridization: Sylvestre and Tanaka (1985) review three cases in the wild and 19 cases in captivity. The other parent has been from genera including *Grampus*, *Steno*, *Pseudorca* and *Globicephala*.

Population Very few population estimates have been made, and then usually only for local areas. For example, Wells and Scott (1990) have studied an inshore population near Sarasota, Florida from 1970. This resident community of approximately 100 individuals inhabits a 40km section of coastal and associated inshore waters. The range and community size has remained relatively constant over this period. Wider studies include Mitchell's (1975a and b) estimated population of perhaps 17,000, based on cumulative catch records, for the stock fished off Cape Hatteras, North Carolina in the late 19th century. Recent estimates of the total population of bottlenose dolphins off the northeastern United States give a total of 10,000 to 13,000 individuals, of which less than 1,000 comprise the inshore stock. There are at least four possible explanations: 1) the inshore stock is significantly smaller now than during the 19th century, 2) the survey data used for the population calculations significantly underestimate abundance, 3) the surveys did not extend far enough south to census the majority of the inshore dolphins in the Hatteras area, and/or 4) the former fishery also exploited the offshore stock (Kenney, 1990). The population involved in the ETP tuna fishery has been estimated at 588,000 (IWC, 1978). Other population estimates include: about 40,000 in the Gulf of Mexico; at least 35,000 in the western North Pacific and Japanese coastal area; less than 10,000 in the Mediterranean; about 250 off the Indian Ocean coast of South Africa, south of Natal, and less than 1,000 off the Indian Ocean coast of South Africa north of Natal (IWC, 1990a). No population estimates for the Black Sea are considered reliable (IWC, 1983; 1990b).

From detailed studies of local populations involved in the southeastern USA live capture fisheries, estimates of the sizes of local populations range from 35 (Apalachicola/Sr Joseph Bays) to 1,342 ± 847 (Mississippi, Chandleur and Breton Sounds)

(IWC, 1984). Aerial surveys of the population in the Indian and Banana River complex suggested a local population of 200-600 animals, with 8-19% judged to be calves (IWC, 1986).

Claims have been made of dramatic changes in local bottlenose dolphin populations caused by human activities, but most are difficult to evaluate. In USA waters it appears that bottlenose dolphins were present in San Diego Bay through the early 1960s, then reportedly absent for nearly a decade. The apparent decline is attributed to severe pollution of the Bay. Water quality has improved markedly since the early 1970s and bottlenose dolphins can now be seen in or near the Bay at any time. However, no direct link between water quality and dolphin activity has been shown, and other factors, such as longer-term natural environmental changes cannot be ruled out (e.g. as in Wells *et al.*, 1990). The population in Biscayne Bay, Florida was at one time large enough to support a live-capture fishery. However, it declined to as few as 12 animals by the mid-1950s. Increased boat traffic, or a pollution-linked decline in food availability, have been put forward as possible causal factors (Leatherwood and Reeves, 1982).

Reports of population declines in the North and Baltic Seas (e.g. Fraser, 1974; Evans, 1980; van Bree, 1977; Verwey, 1975) cannot be quantitatively substantiated. The North Sea reports are partly based on variations in the number of dead animals washed up on beaches (passive strandings). However, such reports are unsuitable indicators of abundance because the relationship between mortality in the wild population and the number of dead bodies which happen to be washed up on beaches is unknown in this area. Also, there are variations between years in the efficiency with which strandings are reported (Klinowska, 1985). The reports of population changes based on collections of sightings records are similarly confounded by documented (Verwey, 1975) and undocumented (Evans, 1980) changes in observer effort (Klinowska, 1987). The basis for reports of population declines in the Baltic Sea is even less substantial. Aguayo (1978) extensively reviewed the literature, and concluded that although the bottlenose dolphin was possibly resident in a few southern areas, or at least a regular visitor, it was never a major component of the cetacean fauna and that there appeared to be no changes in its status.

A fishery, involving Turkey, USSR, Romania and Bulgaria, for three species of small cetacean (common dolphin *Delphinus delphis*, harbour porpoise *Phocoena phocoena* and bottlenose dolphin) existed in the Black and Azov Seas from 1870. All but Turkey halted the operation in 1966, following a collapse of the populations. The bottlenose dolphin formed a minor component of the catch (less than 10%). However, because the catch statistics only record the weight of the total catch, it is not possible to estimate how many animals of each species were taken, or how badly each species was affected by the take. Aerial, and other, surveys of dolphins have been conducted by the USSR since 1967, but because of methodological problems no satisfactory abundance estimates have emerged (IWC, 1983). The fishery has been banned by Turkey since 1983. Unfortunately, methodological problems cast doubt on population estimates obtained from sightings surveys carried out along the entire Turkish Black Sea coast (Celikkale *et al.*, 1989; IWC, 1990b).

Habitat and Ecology Bottlenose dolphins exploit an impressive range of habitats. The inshore form is occasionally reported in freshwater rivers, although these are most likely to be vagrants or temporary visitors. The usual inshore range includes river mouths, bays, lagoons, estuarine complexes and virtually any shallow water marine region (0.5-20m deep). Passes between open ocean and enclosed bays or lagoons are often centres of abundance, and the dolphins use intracoastal waterways and other deep channels to gain access to productive shallows. The offshore ecotype is well known on the margins of some coastal and oceanic islands and atolls. It is also encountered in the open ocean (Leatherwood and Reeves, 1982).

The most comprehensive information on food habits comes from the Black Sea population, where mostly inshore, bottom living fish are taken (Tomilin, 1957). Anchovy are also eaten, and the IWC subcommittee on small cetaceans noted with concern the reported increases in the Black Sea anchovy fisheries by both Turkey and the USSR, although there is insufficient information available to assess the possible effect of the anchovy catches on the cetacean populations (IWC, 1983).

Information from South African specimens suggest the *T. 'truncatus'* form feeds further offshore than the *T. 'aduncus'* form. Both forms take cephalopods as well as fish (Ross, 1977). Walker (1981) reports marked differences in feeding habits between the ETP offshore and coastal populations. The primary prey of the coastal form are fishes and invertebrates inhabiting the littoral and sub-littoral zones. Most of the species taken are year-round inhabitants of the near-shore environment and not known to undergo pronounced seasonal changes in distribution. The preferred prey species of the ETP offshore form are epipelagic fish and cephalopods. The small quantities of remains of mesopelagic fish were shown to have been introduced secondarily as prey of the larger species ingested. Captive specimens take from 6-7 kg (Mitchell, 1975a) to 20-30 kg (Tomilin, 1957) of fish a day, depending mainly on reproductive condition and water temperature (Klinowska and Brown, 1986).

In shallow water individuals commonly chase prey independently, sometimes along mud lines created by surf, tides or currents near steep dropoffs. They also hunt and feed cooperatively, especially in deep, open water. Such cooperation can involve a group holding a school of fish at bay while individuals alternately feed (Caldwell and Caldwell, 1972) or several dolphins driving fish into shallow water (Hoese, 1971). In general, their feeding strategies are related to the type of habitat occupied (Leatherwood and Reeves, 1982).

In some areas these dolphins have adapted their feeding habits to take advantage of human activities, eating netted or hooked fish, fish discarded by fishermen or stirred up by nets and propeller washes, and fish attracted to idle vessels and fixed platforms (Leatherwood and Reeves, 1983). These activities sometimes bring them into conflict with fishermen, as well as resulting in some mortality through entanglement in fishing gear. Further information on food habits and feeding is given in Leatherwood and Reeves (1990).

The longest recorded male was 3.81m and the longest female 3.67m. There is considerable regional variation in average size. The average length of sexually mature males is between 2.39m and 2.83m, and it is between 2.33m and 3.12m in females. Length at birth is between 0.84m and 1.22m (Perrin and Reilly, 1984).

Evidence from wild and captive animals supports the theory that one dentinal growth layer group is laid down each year (Sergeant, Caldwell and Caldwell, 1973; Ross, 1977; Perrin and Myrick, 1980; Hohn, 1990; Myrick and Cornell, 1990). On this basis, average age at sexual maturity is about 12 years in females and 11 years in males. The average age of sexually mature animals is 19 years for males and 26 years for females. The oldest dolphins so far known (and which are still alive as of 1990) are a 39 year old male and a 49 year old female in the Sarasota population (Wells, *in litt.* 1990). At least in the Sarasota community, females generally tend to live longer than males, with mortality rates for subadult males being higher than for other age/sex classes, except young of the year (Wells and Scott, 1990).

A three to six year calving inverval has been reported for the Sarasota population (Wells, Scott and Irvine, 1987). Gestation lasts for 12 months and lactation for 12 to 18 months or more. If the calf dies during lactation or is still-born, calving intervals may be shorter. Calving is reported in summer in European waters and in spring and autumn near Florida. Captive animals in Florida, however, showed a very marked mating and calving season from February to May (Tavolga and Essapian, 1957; Harrison, Brownell and Boice, 1972; Sergeant, Caldwell and Caldwell, 1973; Ross, 1977; Mitchell, 1975a; Perrin and Reilly, 1984).

Studies of the population in the Indian and Banana river complex of eastern Florida have resulted in estimates of 6.9% overall annual natural mortality and 9.3% annual perinatal mortality. This estimate was obtained by analysis of the numbers of stranded carcasses over eight years. The area, being almost completely land-locked and restricted, is one of the few where it can be assumed that stranded carcasses do directly represent the natural mortality in the local population, provided that, as here, there is a comprehensive system for reporting such incidents. Some animals were briefly captured, examined, marked and released. Monitoring of marked animals showed that this population appears to be discrete from those outside the river system, and from the unstudied population in the southern half of the area, although some genetic mixing seems to occur among the three (IWC, 1987). Wells and Scott (1990) used observations, recovered carcasses and disappearances from the Sarasota population for the period 1980-1987 to calculate a mean first year mortality rate of 0.189 (0.1246-0.2534) and an estimate of the true mortality rate for animals older than one year of between 01.010 and 0.038. From evaluation of testosterone levels, males were found to become sexually mature at eight to ten years of age (IWC, 1986).

Evidence exists of shark predation, and of a high frequency of shark-bite scarring among some populations (Wood, Caldwell and Caldwell, 1970; Wells, Scott and Irvine, 1987; Corkeron, Morris and Bryden, 1978)), but not in others (Lockyer and Morris, 1990). Predation presumably involves mainly sick, injured and unwary animals. However, there is also evidence that sharks and dolphins of many species travel together and peacefully coexist. There appear to be no documented accounts of predation on bottlenose dolphins by killer whales (Leatherwood and Reeves, 1982). There is evidence that inclement weather is related to increases in natural mortality (Leatherwood, Odell and Asper, 1985).

There is a degree of segregation within nearshore populations, based on age and sex. Adult males rarely associate with subadult males, the latter usually remaining in bachelor groups or with one or two adult females. Females with calves associate with each other, and occasionally with other age and sex classes. There is considerable movement between the groups, although longer-term bonds may be observed between males, and the adult female and young groups may be comparatively stable, containing mainly related adult females of more than one generation. The female groups tend to use specific portions (generally the most productive) of the community home range. Males begin to range further as they mature, apparently travelling from one female band to another. Adult males may also travel into the ranges of adjacent communities. There is a high degree of mixing: animals do not remain with one group over long periods (Wursig and Wursig, 1977; Leatherwood, Odell and Asper, 1985; Wells, Scott and Irvine, 1987; Wells and Scott, 1990). Leatherwood and Reeves (1982) give a table of observed group size in bottlenose dolphins, compiled from various sources. Mean group size is between two and 18, depending on area. Inshore herds of as many as 200 are exceptional, and probably represent convergence on an area of food abundance.

Offshore herds of 500 or more are seen occasionally. McBrearty, Message and King (1986) report the most common group size for bottlenose dolphins in European waters is two to five individuals, but the second most common sighting is of solitary animals. Large groups are seen, but infrequently.

Bottlenose dolphins use echo-location to explore objects and their environment and have individual signature whistles. Various other sounds are produced, which may have a social function. Body movements, chemical signals and tactile contact are other means of social communication (Herman, 1980). Behaviour in captivity has been studied in some detail, both free interactions and experimental investigations of learning, sound production and other factors (e.g. Tavolga and Essapian, 1957; Tayler and Saayman, 1972; Ross, 1977; Herman, 1980). Saayman, Tayler and Bower (1973) studied diurnal activity in captive and free animals, but unfortunately, in common with most cetacean behavioural studies, the crucial information on lighting cycles (essential for the evaluation of such studies) is not given; neither are the seasonal factors differentiated.

Several cases of bottlenose dolphin habituation to humans are known, involving both groups and single animals (Lockyer, 1990).

A rather unusual form of utilization - cooperative fishing - is reported from several areas, where bottlenose dolphins drive fish into the nets of the local fishermen (e.g. Mauritania - Leatherwood and Reeves, 1983; Brazil - Pryor *et al.*, 1990).

Threats In the fairly recent past there were many local directed fisheries, producing meat, leather, oil and meal (Mitchell, 1975b). Today, the main directed fishery is in Japanese waters, producing meat for human consumption. In 1988 812 animals were taken directly, including 51 live-captures for display (IWC, 1990c). In 1989 about 400 animals were taken, although this figure includes a few live captures for display (IWC, 1991). The Turkish fishery in the Black Sea has been closed since 1983, but recent reports suggest that there is considerable pressure from fishermen for it to be re-opened, although no satisfactory stock assessment has yet been made (IWC, 1990b) (see also common dolphin review). It was reported in 1982 (IWC, 1983) that catches were much reduced, because of restrictions on the export of products to the European Community, but it appears that a ready market for products exists in Japan, where much of the production from other Turkish fisheries is presently exported (Perrin, 1988). The Black Sea fishery by the USSR, Bulgaria and Romania was terminated in 1966, although a few specimens are still taken for display and research. Other areas where small directed takes are known to occur include: Sri Lanka, West Africa, Venezuela, the West Indies, Mexico, Guatemala, Costa Rica, St Helena, St Vincent and the Grenadines, St Lucia, Indonesia and Peru (Leatherwood and Reeves, 1982; Leatherwood and Reeves, 1983; Perrin, 1985; IWC, 1985; Gaskin and Read, 1987). However, there is good reason to believe that directed catches are under-reported, because when new areas are investigated (e.g. St Helena - Perrin 1985; Sri Lanka - IWC, 1985; Peru - Gaskin and Read, 1987) new fisheries are revealed. Although the bottlenose dolphin is usually not one of the main species involved, it does appear to be taken to some extent almost throughout the range. Most fisheries are for meat for human consumption, except the Turkish fishery, which is for oil and meal, and some of the South American fisheries where they are used for bait.

There is little information on fisheries in European waters. Duguy (1977) notes two taken in trawls and two shot between 1971 and 1976 on the French coasts. Collet (1983) gives a more general picture of small cetacean direct and indirect takes by French fishing vessels. Other sources (e.g. Fraser, 1974; Evans, 1987) suggest that there are almost certain to be other, unrecorded direct and indirect takes.

Indirect takes of small cetaceans are reported from most types of fishing operation, particularly from gill-netting, purse-seining and beach netting. Some reports (e.g. Australia, 1987) indicate that 4-500 animals are taken in this manner each year, but most mention only tens (e.g. IWC, 1987). However, there is good reason to believe that incidental takes are grossly under-reported. This view is supported by the fact that when areas are investigated for incidental takes of small cetaceans (e.g. Sri Lanka - IWC, 1985; Peru - Gaskin and Read, 1987) fairly substantial takes are revealed. A recent review has revealed that the level of incidental take in shark nets from the populations along the eastern coast of South Africa is not sustainable, and that incidental takes in fishing gear in the Mediterranean and in coastal waters of the western North Atlantic may not be sustainable (IWC, 1990). Although the bottlenose dolphin is not usually one of the main species involved, it does appear to be taken in both inshore and offshore fisheries throughout the range. The carcasses are often not used, and neither systematic information on numbers nor any biological information is collected.

Almost all international trade in this species involves live animals for display, although a few live animals may be moved for research, captive breeding or other purposes. This trade, however, cannot be described as extensive, with only some tens of animals in transit worldwide every year (and some of these movements are re-exports) (CMC, 1987). These data, however, are not entirely accurate or complete according to other sources (Klinowska and Brown, 1986). Some international movement of specimens (mainly skeletal material) and samples for scientific purposes also takes place (CMC, 1987). No strictly illegal trade is reported, but careful planning to avoid the more onerous national and international provisions relating to the movement of live animals certainly occurs. For example, the strict regulations in the USA since 1972 are associated with the development of live capture fisheries in other parts of the world (IWC, 1979a; Klinowska and Brown, 1986).

The bottlenose dolphin is blamed for damage to fisheries in many areas, including the Mediterranean (Mitchell, 1975b) and Turkey (IWC, 1990b). However, 'while the potential for significant competition between fishermen and marine mammals exists, and such competition has been demonstrated in some cases, in nearly all such situations the relationship is only asserted to exist, rather than demonstrated to exist' (IWC, 1979a). Some substantiated examples of bottlenose dolphin damage to fisheries are known, while others are not proven.

Commercial fishermen in the Indian and Banana rivers of Florida have complained that bottlenose dolphins are a major nuisance, sometimes injuring fishermen and causing an estimated $441,000 worth of damage per year to mackerel long lines and trammel nets (Cato and Prochanska, 1976). Help was requested in controlling the dolphin populations, but doubt remains as to whether large sharks or dolphins cause the damage (Leatherwood and Reeves, 1982).

Underwater photographs confirmed that in Hawaiian waters bottlenose dolphins remove hooked fish from a hand-line fishery (IWC, 1983). In the French tuna troll fishery in the eastern North Atlantic these dolphins are killed with hand harpoons to scare away other dolphins from the area (IWC, 1983).

Perhaps the best known case is at Iki Island, off the northern coast of Kyushu, western Japan. Although the conflict between dolphins and the hook-and-line fishery for yellowtail tuna has been apparent in the area since around 1910, the major problems only arose relatively recently. The yellowtail fishery operates in winter and the other major fishery in the area, which is for squid, operates from spring to autumn. There is evidence that the availability of yellowtail to the Iki Island fisheries was declining over the 14 years up to 1980. This may have made the fishermen less tolerant of the presence of dolphins on the fishing grounds. The dolphins affect the fisheries by damaging gear, taking caught fish, and are reported to disperse fish schools and/or to cause fish to stop feeding. Angling fisheries are affected to the greatest extent. Dolphins have been killed, sporadically, with hand harpoons from the early 1910s and later the fishery cooperative paid a bounty to fishermen who purchased harpoons to kill dolphins. A dolphin hunting team was established in 1956, and a bounty paid for each dolphin taken from 1957.

In the early 1960s there was an increase in reports of dolphins taking caught fish or otherwise interfering with fishing operations, and in 1964 the Governor of Nagasaki Prefecture was requested to assist. The request was repeated in 1965. Some fishermen were sent for training in dolphin hunting techniques and ten sound emitters purchased to drive away the dolphins. In 1967 the Governor called in a research team to investigate the problem, but their reports do not seem to have led to any practical solutions. Attempts to kill dolphin schools by the driving method were unsuccessful. A team equipped with shotguns was established in 1968, but their hunting seems to have had little or no effect on dolphin behaviour or on the dolphin populations. A small whaling boat was built in 1970, to kill and scare dolphins. It took only 20 animals over the following six years, after which this operation was stopped. An unsuccessful attempt to hunt dolphins using a large-mesh drift net was tried in 1976, but two drives succeeded in killing a total of 55 Risso's dolphins. Culls, using the driving methods, continued in later years. A second research team began work in 1978, but made no progress in developing practical methods for scaring the dolphins.

Residents of Iki Island are not accustomed to eating dolphin meat, and until culling began in 1976 catches were small. The annual number of dolphins killed increased until 1980, when a total of 1,819 were taken, and then declined to around 150 a year up to 1982. The total numbers killed by the operation were 4,147 bottlenose dolphins, 953 false killer whales, 525 Risso's dolphins and 466 Pacific white-sided dolphins. There are no reliable estimates of the dolphin populations in this area, but the percentage of days during the yellowtail fishing season when dolphins were present increased from about 25% in 1973 to about 79% in the 1979 season, after which it declined to about 26% by 1982. The increase is much greater than could be accounted for by natural increases in the dolphin populations, and implies a change in behaviour. Although the decrease in dolphin presence after the main culls might reflect a reduction in the populations, it might equally reflect another change in behaviour. Analysis of stomach contents indicated that yellowtail was a major food only for the false killer whale. Disposal of dolphin carcasses has been a problem, but from 1980 shredded carcasses were sent for rendering. Some live animals have been sent to aquaria and some carcasses used for human consumption. A bounty has been paid by Nagasaki Prefecture from 1978 if carcasses are not sold and special processing is necessary. So far no effective solution to the conflict has been found (Kasuya, 1985). Occasional culls by driving still take place, but, with fewer dolphins present on the fishing grounds, the perceived problem is somewhat ameliorated.

The habit of schooling with tuna has led to some kills in the eastern tropical Pacific, but only tens to hundreds have been involved annually, in comparison with the tens of thousands of other species (Perrin, Lo and Whalen, 1979).

Several hundred bottlenose dolphins from the population living off the eastern coast of the USA died in 1987/88. Although it was widely reported that 'pollution' was the cause, extensive research indicated that an algal toxin may have been responsible. It appeared that freak currents in 1986 carried a bloom of the alga *Ptychodiscus brevis* from its normal area in the Gulf of Mexico to Florida. Here the algae were eaten by menhaden, a local fish. Mackerel prey on menhaden, and dolphins eat both fish species.

The fish are thought to be immune to the algal toxin, but the dolphins became weakened and succumbed to a variety of secondary infections. The northward migration of the menhaden in spring provided contaminated food for dolphins all along the coast (Geraci, 1989). This conclusion was disputed, particularly on the grounds that the comparatively high levels of organochlorines and other pollutants found in the carcasses might equally indicate that this was the primary cause of the susceptibility of the animals to the secondary infections (e.g. Greenpeace, 1989).

Definitive research has not yet been done to test the effects of chemical pollution and harassment on bottlenose dolphins, although it may be reasonable to expect changes in behaviour, distribution and movement, and reproductive success as the quality of the coastal environment deteriorates.

Conservation Measures Countries of origin include all those with coasts in temperate and tropical waters.

The bottlenose dolphin is listed in CITES Appendix II. Within the European Community trade is more strictly controlled, through Regulation No. 3626/82. This treats all cetaceans as if they were listed on CITES Appendix I and, in addition, controls the accommodation, care, use, sale or disposal of specimens after import.

The Berne Convention requires Parties to give strict protection to the bottlenose dolphin. Unfortunately, the very explicit terms in which this protection is expressed are not particularly relevant to cetaceans. Apart from a ban on deliberate taking, only 'places of rest' and similar specific habitat is protected. This means that there is no real protection from any disturbance because cetaceans do not have 'places of rest' (see below). The North and Baltic Seas populations have been added to CMS Appendix II. Through a Resolution (IWC, 1977) and Recommendations in 1978 (IWC, 1979b), members of IWC are requested to report direct and indirect catches of small cetaceans as part of their National Progress Reports on Cetacean Research, but few such reports are routinely made.

The Ramsar Convention and WHC could provide further protection for bottlenose dolphin habitat, particularly inshore. The BS Convention has been used for exchange of information on Black Sea dolphin fishing, and other fisheries conventions could at least provide similar facilities or participate more actively in monitoring incidental takes and populations.

The bottlenose dolphin is protected by national legislation in a number of countries, usually through general cetacean protection provisions. Under the Endangered Exotic Animals Species Act, 1978, *Tursiops aduncus* is protected from trade in the Netherlands. In Europe members of the Berne convention protect the bottlenose dolphin through these provisions. Problems have arisen because they contain no general protection from harassment, only protection of specific habitat, such as a 'place of rest'. This has resulted in an inability to protect dolphins habituated to humans from excessive and inconsiderate visiting, which may have resulted in the animals abandoning the relevant parts of their range (e.g. Lockyer and Morris, 1986). Perhaps the simplest means to deal with this problem would be for a note to be added to the relevant Berne Convention Appendix to the effect that, for cetaceans, the entire aquatic environment is deemed to be a 'place of rest'. This would then automatically pass into national provisions.

However, information is accumulating on direct and indirect takes (although mainly in small numbers) almost throughout the range. The inshore habitat is also vulnerable to encroachment, disturbance and pollution. More information on geographical races is urgently required and in the meantime there must be some clear international agreement on the naming of populations to avoid any risk to live specimens in transit. In particular, a clear definition of those populations regarded by the Netherlands as *T. aduncus*, in simple terms related to live specimens, is needed. Knowledge of populations and distribution is poor in most places, particularly in areas outside the USA live capture sites. Reporting of direct and indirect catches should be improved and efforts made to collect biological information to help in the taxonomic and population work. Countries which already have international obligations to provide such statistics (i.e. IWC members) but do not do so, should take steps to fulfil these obligations. Countries without such obligations should also take similar steps, through national legislation if necessary. The IUCN/SSC Cetacean Specialist Group Action Plan contains a number of projects relevant to bottlenose dolphin conservation, including studies of accidental catching, of the inshore habitat and of local subsistence fisheries (Perrin, 1989).

Captive Breeding Live capture fisheries, providing animals for display and research, have occurred in many areas. A total of at least 2,700 animals were estimated to have been taken for this purpose from the 1860s to 1983 (IWC, 1984). Of these, an estimated minimum of 1,595-1,635 were taken from USA waters and 580 from Japanese waters. The Japanese animals were mainly (93%) taken from drive fisheries at Taji and Iki (where catches are otherwise used for human consumption) or from incidental catches in other fisheries. Other areas where live specimens have been taken include Australia, New Zealand, Indonesia, the Black Sea, the South China Sea, the Strait of Malacca, Western Malaysia, Hawaii, South Africa, Mexico, Argentina, the Philippines, Taiwan, the Bahamas, the Mediterranean, the Bay of Biscay, UK waters, Senegal, Mauritania and, more recently, Cuba (IWC, 1984; Collet, 1984; Klinowska and Brown, 1986). The earliest record for Europe is of an animal taken in UK waters in June 1883 and displayed at the Brighton Aquarium (The Field, 9 June 1883, p. 756). The IWC subcommittee on small cetaceans concluded that, although there is no basis at present for concern that live capture fisheries have had a detrimental effect on the species overall, there is concern that in the long term, sustained takes from localized populations may have had significant effects. They noted the USA government's interim management programme, in which population numbers were being estimated and takes of no more than 2% of the minimum estimated population per year were being permitted for each stock and felt that this 2% guideline was prudent and could be safely followed (IWC, 1984). However, since that time a more prudent and conservative approach has been adopted and, until specific information on the productivity of an individual stock is available, removals of anything more than 1% of the estimated local population are considered potentially not sustainable (IWC, 1990a).

The international trade in live specimens peaked in the early 1970s. The change was partly due to the restrictions imposed by the USA Marine Mammal Protection Act (1972), which effectively cut off the main source of supply to the international markets. The international movement of animals has also been reduced because the earlier practice of taking animals from one seasonal exhibition to another, often in other countries, has almost ended. This is partly due to increased national and international protective legislation, and partly due to a change in the practice of exhibitors, towards permanent displays of social groups of animals where captive breeding is facilitated (Klinowska and Brown, 1986). However, except in the USA, live animals are taken from unmonitored populations. Since at least the inshore ecotype, which is usually the subject of live capture, appears to live in local populations with limited home ranges along overlapping segments of coast, there is a danger that such local populations may be over-exploited. There has been concern that premature death or failure to breed in captive animals would increase demand for wild-caught specimens as replacements. DeMaster and Dervenak (1988) found a mean overall annual survival rate for captive bottlenose dolphins of 0.93 (95% confidence interval 0.92-0.94). The annual survival rate for bottlenose dolphin calves born in captivity was 0.61, and increased to 0.97 after the first year (which was not significantly different from the 0.95 survival rate of non-first year animals removed from the wild and maintained in captivity). These authors found significant differences in survival rates between institutions. For example: the two best results were 0.98 (0.75-1.0) and 0.95 (0.94-0.97), and the two worst 0.01 (0.000-1.00) and 0.54 (0.06-1.00). (The wide confidence intervals for the two worst results reflect the fact that the number of days on which dolphins were kept is very low in these cases). The institutional differences support the idea that management and husbandry are the critical factors for the welfare of captive dolphins, because all the institutions involved would have had pools of at least the USA minimum standard.

Wells and Scott (1990) used DeMaster and Dervenak's (1988) method to calculate a mean wild bottlenose dolphin annual survival rate for young of the year of 0.803 (0.7327=0.8733) and a survival rate for animals older than one year of 0.961 (0.9531-0.9689). Thus the annual survival rates for animals older than one year look to be very similar in captivity (0.95 for wild-caught and 0.97 for captive-born) and in the wild (0.9531-0.9689). (Note that Wells and Scott mistakenly quote the overall captive survival rate). Unfortunately DeMaster and Dervenak do not give confidence intervals for these estimates, but do mention that the two estimates are not significantly different. It is therefore not possible to make absolute statements about whether the wild and captive rates are statistically significantly different or not, but given that the 0.95 and 0.97 estimates were found not to be significantly different, it would be surprising if any significant differences between these wild and captive survival rates exist. The survival rates for young of the year (0.61 in captivity and 0.7327-0.8733 in the wild) do look very different, but without the confidence interval for the captive estimate it is not possible to make any absolute statements about whether they are statistically significantly different or not. Further, as Wells and Scott note, it is not feasible to be sure that all calves born in the wild are observed (and very easy to count all births in captivity). The wild first year survival rate is therefore likely to be an overestimate of the true rate. It therefore appears that, provided animals are taken from properly managed stocks and treated in accordance with the highest standards of husbandry, the trade in live specimens is not likely to damage wild stocks or result in excessive demand for replacment animals.

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ATLANTIC SPOTTED DOLPHIN **INSUFFICIENTLY KNOWN**
Stenella frontalis (G. Cuvier, 1829)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The taxonomy of the spotted dolphins has been confused. The recent revision has clarified the situation, but information on the status of the redescribed species has not yet had time to accumulate. The level of incidental take in the eastern tropical Atlantic tuna purse-seine fishery could be considerable and requires investigation. The level of incidental take in other fisheries within the range requires investigation.

Distribution The Atlantic spotted dolphin has recently been redescribed by Perrin *et al.* (1987), who give a map of the known distribution in the tropical, subtropical and warm temperate Atlantic. The species is not known from the Indian or Pacific Oceans, or at present from any specific location in the eastern Atlantic north of the Cape Verde Islands, although unidentified spotted dolphins reported from the Canary Islands may be of this species. Specimens recorded as from St Helena may be those of animals taken on voyages to or from the island, because only the pantropical spotted dolphin has been recorded at St Helena in this century. Alternative explanations for these records may be that Atlantic spotted dolphins formerly occurred here, or that they occasionally visit these waters.

Perrin, Caldwell and Caldwell (in press) have recently reviewed this species, and provide an updated map showing the locations of known specimens.

Population There are no abundance estimates, but the species is known to be common in the western North Atlantic and Gulf of Mexico. It may also be common along the coasts of South America and West Africa, where the cetacean faunas are still relatively poorly known. Recent efforts to estimate abundance in the Gulf of Mexico and off the southeastern United States have not attempted to differentiate between this species and the pantropical spotted dolphin (Perrin, Caldwell and Caldwell, in press).

Habitat and Ecology The spot pattern develops with maturation. Adult size and intensity of spotting both vary geographically; therefore body length at the onset of spotting also varies. Spots typically appear before the onset of puberty. There is also individual variation in spotting among adults from the same population.

The maximum recorded length is 2.26m for males (an immature specimen from North Carolina) and 2.29m for females (specimen of unknown maturity from Panama). Adult body length is greatest along the western North Atlantic coast and the Gulf of Mexico, averaging about 2-2.1m. Length at birth is between 0.88 and 1.2m. From the few known specimens, it appears that adults in the oceanic western North Atlantic are about 0.2-0.3m smaller than adults from the coast to the west and south. Except for the specimen mentioned above from Panama, Caribbean specimens are also smaller, centring around 1.8m. Too little information is available at the moment from Africa and the mid- tropical Atlantic for analysis.

There is marked geographic variation in the size and shape of the skull. The skulls from the oceanic western North Atlantic and the Azores closely resemble skulls from the coastal western North Atlantic in shape, but are very much smaller. It is hypothesized that this coastal/pelagic difference may reflect different feeding habits, with the coastal form taking larger (perhaps demersal) prey than is taken by the pelagic form. The African series of specimens appears to be intermediate, but the specimens came from sites scattered from Cape Verde to the eastern Gulf of Guinea and it is possible that more than one population is involved.

The variation in skull size also exhibits a latitudinal pattern, with the Caribbean offshore and mid-tropical Atlantic specimens forming a group of smaller skulls from between 10° and 20° (north and south), and the western North Atlantic oceanic and Azores series comprising a group of very small high-latitude skulls, all smaller than any other skulls from north of 20°N. This reflects the apparent circular distribution in the Atlantic, with coastal animals at mid-latitudes and small oceanic animals at low and high latitudes. However, the apparent circular pattern of distribution could be an artifact of sampling effort.

Along the southeastern coast of the United States and in the Gulf of Mexico the large heavily spotted form of *Stenella frontalis* inhabits the continental shelf, usually being found inside or near the 100 fathom (183m) line (within 250-350km of the coast) but sometimes seasonally coming into very shallow water near the shore, perhaps in pursuit of migratory fish prey. It is usually replaced in nearshore shallow waters by the bottlenose dolphin. The offshore distributions of the Atlantic spotted dolphin and the other, more oceanic forms in the Caribbean, mid-tropical Atlantic and oceanic western North Atlantic are very poorly known.

The stomach of a specimen of *Stenella frontalis* captured off northern Florida contained many small cephalopod beaks, and dolphins of this species have been observed to feed on small clupeoid and carangid fishes and large squid, and to follow trawlers to eat discarded fish. Of 19 specimens stranded on the USA east coast, the stomachs of nine contained only squid remains, six had both fish and squid, and four contained only fish. The otoliths from four of these stomachs were identified to species: a sciaenid *Cynoscion* spp. predominated in one, the sciaenid *Stentomuschrysops* in two, and a clupeoid *Anchoa* in the fourth; other Families represented were Congridae, Gadidae, Trichiuridae and Triglidae.

Pods usually consist of fewer than 50 individuals, and most typically of one to 15 in coastal waters. Schools may be segregated by age and by breeding status. Observations of wild and captive animals lead to the impression of a social organisation with individual recognition and bonding (Perrin *et al.*, 1987; Perrin, Caldwell and Caldwell, in press).

Threats The Atlantic spotted dolphin is taken in a subsistence harpoon fishery at St Vincent in the Lesser Antilles and possibly also at St Lucia and Dominica (Perrin *et al.*, 1987; Perrin, Caldwell and Caldwell, in press). This species is taken incidentally by purse-seine vessels of several nations fishing for tuna in the eastern tropical Atlantic off West Africa. The size of this by-catch is unknown but may be considerable (Perrin, Caldwell and Caldwell, in press).

Conservation Measures Potential countries of origin include all those with coasts in the tropical, subtropical and warm temperate Atlantic. Specific sites so far recorded include: Portugal (Azores), USA, Haiti, Puerto Rico, St Vincent and the Grenadines, Venezuela, Ivory Coast, Guinea, Colombia, Mexico, Cameroon, Mauritania, Cape Verde, Gabon, Bahamas and Brazil.

The Atlantic spotted dolphin is listed in CITES Appendix II. No international movements have so far been recorded under this species name, or under the name

Stenella plagiodon, which was often used in the past to refer to this species but is a junior synonym (Perrin *et al.*, 1987; CMC, 1987). No other international legislation refers to this species but it will be protected by general legislation in several countries.

More information is required about this species before any specific conservation measures can be usefully considered, although the level of by-catching in the eastern tropical Atlantic tuna purse-seine fishery requires investigation. Several of the general projects in the IUCN/SSC Cetacean Specialist Group Action Plan, for example on by-catching, will contribute towards further knowledge of this species (Perrin, 1989).

Captive Breeding One female Atlantic spotted dolphin lived for more than ten years in an oceanarium in Florida and performed in shows. Eighteen other individuals captured for display in Florida in the 1960s and 1970s lived from a few hours or days to about a year and a half. Several refused to eat. It is reported that pairs (either adults or adult and young, of any combination of sexes) or larger groups seem to survive better than single animals. This is observed whether the Atlantic spotted dolphins are segregated or in a community tank with dolphins of other species. Animals captured in summer do not survive well unless kept in heated tanks (Perrin, Caldwell and Caldwell, in press). Because of this history, the species is not considered to be well-suited to captivity, but modern husbandry might be more successful. The animals are small enough for captive breeding to be a feasible conservation option, if necessary. Some information on sound production has been obtained from captive animals (Perrin *et al.*, 1987). If any more specimens are brought into captivity, the collection of life history data should be a priority in order to fill one of the gaps in our knowledge of this species.

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PANTROPICAL SPOTTED DOLPHIN **INSUFFICIENTLY KNOWN**

Stenella attenuata (Gray, 1846)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Although the pantropical spotted dolphin is widely distributed and abundant within the range, there is serious concern about depletion of the eastern tropical Pacific populations through incidental kills in the tuna purse seine fishery. These populations can still be numbered in the millions, but reductions over the past 30 years are far in excess of any possible replacement rates. Efforts to reduce these kills have been less successful than previously thought, and further action is urgently needed by all nations (Costa Rica, Ecuador, El Salvador, Mexico, Panama, Spain, USA, Vanuatu and Venezuela) participating in this fishery. The level of incidental take in other fisheries throughout the range requires investigation.

Distribution The pantropical spotted dolphin has recently been redescribed (Perrin *et al.*, 1987), resolving the previous taxonomic confusion. The distribution is worldwide in tropical and some subtropical waters. Records of stranded animals in Alaska and New Zealand probably represent vagrants. In the eastern Pacific the northern limit of the range is at about 25°N (southern Baja California, Mexico) and the southern limit is at about 17°S, off southern Peru. It occurs around the islands in the Pacific. In the western Pacific it is found seasonally found at southern Honshu, Japan, and south to Australia. It inhabits the Indian Ocean south to about 33°S off the coast of South Africa, and has been recorded from the Red Sea. In the Atlantic it is known from comparatively few records: it is broadly sympatric here with *Stenella frontalis* except in the oceanic western North Atlantic and possibly off the northern coast of South America.

The pantropical spotted dolphin varies geographically in colouration, body size, cranial and postcranial measurements. The eastern tropical Pacific is particularly well studied in this respect; material from other areas is still limited and only tentative conclusions on geographical variation can be drawn. In the eastern tropical Pacific, dolphins close to the coast are more heavily spotted than those offshore. Specimens from the western Pacific, the southern Indian Ocean, Africa and the mid-tropical Atlantic are spotted to about the same extent as those in the offshore eastern tropical Pacific, although in some areas (e.g. Hawaii and St Helena) dorsal spotting in some adults is so weakly developed as to give the animal an unspotted appearance when seen from a distance (Perrin *et al.*, 1987; Perrin and Hohn, in press).

The species has recently been reviewed by Perrin and Hohn (in press). Gilpatrick *et al.* (1987) provide a list of known records and a map of their distribution.

Population Detailed studies have been made of the eastern tropical Pacific populations involved in the tuna purse seine fishery, but no studies have been made in other parts of the range.

The northern offshore pantropical spotted dolphin population in the eastern tropical Pacific has been estimated to have been reduced by 40 to 60% between the early 1960s and mid to late 1970s (Smith, 1983). Recent work indicates a further large decline, from about 4 million in 1975-80 to an average of 2.5 million in 1981-86, although fluctuations in oceanographic conditions may have confounded these results. Estimates of abundance of the southern offshore stock are difficult, because of low and variable observer effort, but it seems possible that stocks were smaller on average during 1981/86 than during 1976/80. The most recent calculations give stock sizes around 250,000 to

500,000 over this period (Buckland and Anganuzzi, 1988; Anganuzzi and Buckland, 1988).

Habitat and Ecology Body size varies geographically. Coastal pantropical spotted dolphins in the eastern tropical Pacific are the largest (males and females averaging 2.23 and 2.07m respectively) (Perrin *et al.*, 1985). The next in size appear to be those from the coastal western North Atlantic and Gulf of Mexico. The oceanic eastern tropical Pacific seems to be inhabited by the smallest animals with males averaging 2.00m and females 1.87m. Length also varies geographically within the oceanic eastern Pacific, samples from different latitudinal/longitudinal strata differ by as much as 3cm in average body length. It is not yet known whether this reflects only clinal variation or the existence of more than one breeding population (Perrin *et al.*, 1987; Perrin and Hohn, in press).

The species occurs both in coastal waters and in the open ocean. In the eastern tropical Pacific it commonly associates with schools of yellowfin tuna *Thunnus albacares* and may be found together with tuna, spinner dolphins *Stenella longirostris* and large numbers of sea birds. This multi-species aggregation is correlated in distribution with certain oceanographic variables, including depth and steepness of the thermocline and sea-surface temperature, and may constitute a symbiotic foraging association involving two or more of the species. Tuna fishermen take advantage of the dolphin-tuna association to facilitate the finding and taking of tuna (Perrin *et al.*, 1987; Perrin and Hohn, in press).

Recorded stomach contents include a large number of small epipelagic and mesopelagic fish and cephalopod species,as well as unidentified nemertean worms and crab larvae. Lactating females may feed more heavily on epipelagic fish than do pregnant females Perrin *et al.*, 1987; Perrin and Hohn, in press).

Pods range in size from a few individuals to several thousand. The species migrates into Japanese waters seasonally, following the northern edge of the warm Kuroshio Current. In the eastern tropical Pacific, schools range over several hundred nautical miles and may make seasonal east-west migrations, generally offshore in autumn and winter, and onshore in spring and summer. Average short-term net movement of schools is of the order of 30- 50 nautical miles per day (Perrin *et al.*, 1987; Perrin and Hohn, in press).

Average age at sexual maturity in males is 14.7 years and females mature on the average at 10-12 years, with a range of 10 to 17 years, as indicated by growth layer groups in teeth. Maximum longevity in both sexes may exceed 45 years. Aged females may become post-reproductive. Length at birth is about 0.85m in the offshore eastern tropical Pacific. Breeding is diffusely seasonal, with two to three calving seasons in the spring, in autumn and possibly also in summer. The average calving interval in the eastern Pacific is two to three years and in the western Pacific four to six years, the difference possibly related to the status of the populations (Perrin *et al.*, 1987; Perrin and Hohn, in press).

Threats The habit of schooling with tuna has caused major by-catching problems in the eastern tropical Pacific. Purse-seiners set nets around dolphin schools since these are reliable indicators of the presence of tuna, and serve to hold the tuna schools until they can be captured. Dolphins may be caught in the net itself and suffocate or simply 'give up' and sink to the bottom of the net. Various techniques have been developed to release trapped dolphins, but may not not always be strictly enforced throughout the international tuna fleet. It has been alleged that some of the apparent reduction in reported kill was because a number of USA registered ships changed flag to avoid the strict USA regulations. Dolphin mortality increases in proportion to increased fishing effort on dolphin/tuna aggregations, to large catches of tuna per set, to sets which end in darkness and to the proportion of (more vulnerable) pre-adult dolphins among those encircled. However, the pantropical spotted dolphin is known to experience several times lower mortality rates per set than common dolphins *Delphinus delphis* (see review). It is estimated that about 70,000 offshore pantropical spotted dolphins were killed during tuna purse seining in 1986 (Costa Rica, Ecuador, El Salvador, Mexico, Panama, Spain, USA, Vanuatu and Venezuela), 693 by direct catches in Japanese waters and that some were taken incidently in Australian waters (IWC, 1988). It is also known that some are taken by local fisheries in at least the Caribbean, Sri Lanka and the Solomon Islands (Leatherwood and Reeves, 1983). The pantropical spotted dolphin is one of the species blamed for interference in a hook-and-line fishery for yellowtail tuna off Iki Island in Japan (see bottlenose dolphin review for further details). Between 1976 and 1982, 538 of these dolphins were killed in efforts to reduce the interference (Perrin and Hohn, in press).

Conservation Measures Potential countries of origin include all those with coasts in tropical and subtropical waters. Reported locations so far include: USA (including Hawaii), Panama, St Vincent and the Grenadines, Brazil, Uruguay, UK (St Helena), Cape Verde, Peru, Gabon, Seychelles, Madagascar, South Africa, Oman, Tanzania, Thailand, Australia, New Zealand, Malaysia, Kenya, Vanuatu, Tuvalu, Fiji, Philippines, Papua New Guinea, Taiwan, India, Bangladesh, Maldives, Djibouti, Indonesia, PR China, Japan, Solomon Islands, Mexico, Sri Lanka.

The pantropical spotted dolphin is listed in CITES Appendix II. The following international trade, involving scientific specimens except where noted, is recorded: 1981 - 90 specimens of unstated origin from USA to FRG, 7 specimens of unstated origin from USA to UK; 1982 - 1 specimen from USA to Switzerland, 20 specimens from USA to Japan, 10 specimens from Taiwan to USA; 1983 - 20 specimens from USA to Japan; 5 specimens of unstated origin from USA to USA, 3 specimens of unstated origin to USA, 26 (personal) specimens of unstated origin to USA, 412 specimens of unstated origin to USA, 62 specimens of USA origin from an unstated place to USA; 1984 - 5 skeletons from USA to Canada, 32 specimens of unstated origin from USA to Canada; 4kg (commercial) specimens from USA to Japan, 49 specimens from Panama to USA, 2 specimens from USA to USA, 87 specimens of unstated origin from USA to USA, 10 bodies of unstated origin to USA, 9 specimens of unstated origin and status to USA, 159 specimens of unstated origin to USA; 1985 - 1 specimen from USA to Canada, 2 specimens from USA to France, 19 specimens of unstated status from Trust Territories of the Pacific Islands to USA, 481 specimens of unstated origin and status to USA, 21 (commercial) specimens of unstated origin to USA, 267 specimens of unstated origin to USA, 1 skeleton from South Africa to USA (CMC, 1987). Most of the specimens of unstated origin will have been collected by observers on board tuna fishing vessels (Perrin, 1989b).

At its 33rd meeting, IATTC took up the problem of small cetacean mortality incidental to the tuna purse seine fishing. At the 34th meeting in 1977 the Parties agreed that IATTC should undertake activities to evaluate the populations of small cetaceans in the eastern Pacific Ocean, and implement programmes aimed at reducing the incidental mortality. The implementation of this programme has been examined and confirmed at subsequent meetings, and a large body of information on the cetacean species involved assembled, analy and published. Unfortunately, recent analyses show not only that there have been serious reductions in the pantropical spotted dolphin populations involved, but also some increases in the take in recent years (IWC, 1988).

The pantropical spotted dolphin will be protected by general national legislation in some countries. Specific efforts have been made by the USA to monitor and reduce the incidental take by tuna purse seiners, including the setting of quotas for the various dolphin populations involved and the implementation of measures to reduce dolphin kills. Unfortunately a number of ships formerly registered in the USA have changed flag, because of various economic factors, and Mexico has greatly built up its fleet. Thus, although the USA fleet is now responsible for only a small proportion of the dolphin kill (estimated 20,500 in 1986, for all species - some hundreds over the national quota), this is achieved by a much reduced fleet (IWC, 1988).

The main problem for the pantropical spotted dolphin remains that of incidental take in the eastern Tropical Pacific, and although the IATTC and USA have made considerable efforts, a more determined international initiative is required to document catches and to deal with the problem.

The IUCN/SSC Cetacean Specialist Group Action Plan takes particular note of the situation faced by this species in the eastern tropical Pacific, as well as of the possible extent of catches in the coastal waters of the Indian Ocean. Several general projects relating to the monitoring of direct and indirect catch levels around the world are also relevant (Perrin, 1989a).

Captive Breeding Over 60 pantropical spotted dolphins have been kept in captivity in the USA (mainly in Hawaii), and over 70 in Japan (IWC, 1984). The majority of the animals taken in Japan came from the drive fishery at Taiji. It is not considered to be as easily trainable or as hardy as other species more commonly exhibited (Perrin and Hohn, in press). Conservation through captive breeding might be practical, if necessary, since show training need not be involved. Work with existing captive animals could usefully be directed towards obtaining relevant information on captive breeding conditions, as well as towards ways of reducing incidental mortality in fisheries.

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SPINNER DOLPHIN **INSUFFICIENTLY KNOWN**

Stenella longirostris (Gray, 1828)

Suborder ODONTOCETI Family DELPHINIDAE

Summary There is major concern about the eastern tropical Pacific spinner dolphin stocks, which have been greatly depleted through incidental kills in the tuna purse seine fishery. These populations, some of which originally contained millions of animals, can still be numbered in the hundreds of thousands, but despite some evidence of the beginning of a trend towards recovery in recent years, kill rates are high and efforts to reduce them have been less successful than previously thought. Further action to reduce kills is urgently needed by all the nations (Costa Rica, Ecuador, El Salvador, Mexico, Panama, Spain, USA, Vanuatu and Venezuela) participating in this fishery. The recently described dwarf form of the spinner dolphin in the Gulf of Thailand also requires attention because of known catches from an apparently local population of unknown size.

Distribution Spinner dolphins are found in the Atlantic, Indian and Pacific oceans, where they are mainly restricted to tropical and subtropical waters, although they can occur in some warm temperate areas. The primary distribution is pelagic, but they can be found in continental shelf waters off Central America and the southeastern United States. These dolphins also occur near islands, for example Hawaii, in the South Pacific, as well as off Australia, the Solomon Islands, New Guinea, Indonesia, Japan, Sri Lanka, Madagascar, eastern and western Africa, the Caribbean Sea and the Gulf of Mexico (Leatherwood and Reeves, 1983; Buckland and Anganuzzi, 1988; Howell and Pearson, 1977; Gilpatrick *et al.*, 1987). The species has recently been reviewed by Perrin and Gilpatrick (in press).

Population There is considerable variation between different spinner dolphin populations. Those involved in the eastern tropical Pacific tuna fisheries are particularly well-studied. The largest form is the Costa Rica spinner, the eastern spinner is a little shorter. The whitebelly spinner is more pelagic, larger and more robust. Intergrades between the eastern and whitebelly forms are occasionally seen. The Hawaiian form is similar to the whitebelly, but larger. A dwarf form of the spinner dolphin has also been recently described from the Gulf of Thailand. The characteristics of populations elsewhere have not been described in detail (Leatherwood and Reeves, 1983; Perrin *et al.*, 1987).

The Costa Rican spinner is found primarily less than 80km from shore along the western coast of Central America, between about 18°N and 7°N. Eastern spinners range from the southwestern coast of Baja California south to the equator and offshore to about 145°W. whitebellies occupy much of the equatorial Pacific, well offshore, extending south to 20°S off western South America, north to 20°N due west of Mexico, and west almost to the Hawaiian Islands. Eastern and whitebelly spinners overlap greatly in range. For the purposes of population estimates, Northern and Southern whitebelly stocks are deemed to be divided at 1°S (Perrin *et al.*, 1985; Leatherwood and Reeves, 1983; Buckland and Anganuzzi, 1988; Howell and Pearson, 1977).

The most recent eastern tropical Pacific population estimates, based on tuna vessel observer data collected by the IATTC, show a general trend of depletion in the late 1970s, and some evidence of a small increasing trend in the mid-1980s, with stability in between. According to this analysis, the eastern spinner stock declined from about one million in 1975 to around 300,000 in the early 1980s and had increased to about 600,000 by 1986. The Northern whitebelly spinner stock declined from about 1.25 million in 1976 to around 500,000 in the early 1980s, and possibly shows some increase since. There are, however, large unexplained fluctuations from year to year, and although the early decline and relatively stable later periods are probably a reasonable description of the recent history of this stock, the evidence for some recovery needs to interpreted with caution. The Southern whitebelly spinner stock declined from perhaps 500,000 in the late 1970s to about 100,000 in the early 1980s and may have recovered to somewhere in the region of 250,000, although again evidence for the trend towards recovery is not definitive (Buckland and Anganuzzi, 1988).

However, the tuna purse seine fishery is generally taken to have started in 1959, although it is known that there was limited use of this method as early as the 1940s. While there is comparatively little detailed data for the early period, Smith (1983) attempted to estimate pre- exploitation abundance (using 1959 as base year) and the subsequent population decline (through 1978). This study thus overlaps the period covered by Buckland and Anganuzzi (1988), but the results are not necessarily directly comparable because of differences in data base and methodology. Smith (1983) estimated that the eastern spinner dolphin population numbered between 4.8 and 5.6 million in 1959, while the whitebelly spinner numbered between 400,000 and 500,000 in 1969. The eastern spinner populations declined rapidly in the face of kills which were of the order of 7% to 12% of the 1965 population sizes annually. The whitebelly spinner population declined most rapidly in 1974, when the kill was between 11% and 16% of its population size. He concluded that the whitebelly spinner population had declined by 1979 to between 58% and 72% of its pre-exploitation size, and the eastern spinner population to around 20% of the pre-exploitation size.

No population estimates are available for stocks elsewhere, but the species is generally considered common within the range.

Habitat and Ecology The Costa Rican spinner is the largest form, with males about 2.2m and females about 2.1m. The eastern spinner is shorter, with males growing to about 1.9m and females to 1.8m. The more pelagic whitebelly spinner grows to about 2m (although the longest recorded animal, a male, was 2.38m) and is more robust. The Hawaiian form is similar, but larger (to over 2m). Newborn eastern and whitebelly spinners are 0.7 to 0.85m (average 0.77m).

Spinner dolphins may occur in herds of over 1,000 animals, although herds of 200 or fewer are common. They frequently associate with spotted dolphins in the eastern tropical Pacific, and with other oceanic dolphins and small whales in much of their range.

In the Pacific, the eastern spinner males reach sexual maturity at about 1.7m, and females at about 1.65m. In the larger (unexploited) Gulf of Mexico form, sexual maturity is reached at about 1.9m and 55-60kg in both sexes. Age at sexual maturity is similar in both populations for males (10 to 12 growth layer groups in teeth, probably representing 10-12 years of age), but female eastern spinners mature at a mean of 5.5 growth layers while those in the Gulf of Mexico mature at seven to ten layers. In unexploited populations, adult females give birth to a single calf every second or third year, after an average 10.6 month gestation period; births are more frequent in depleted populations. The calf is weaned after at least seven months, and there is no evidence for simultaneous pregnancy and lactation.

Spinner dolphins frequently associate with yellowfin tuna and less frequently with skipjack tuna in the Pacific, as part of an incompletely understood but strong bond. This is exploited by the high-seas tuna fishery (see Population and Threats sections). The food of eastern tropical spinner dolphins is small mainly mesopelagic fish, and epipelagic and mesopelagic squid (Perrin and Gilpatrick, in press; Leatherwood and Reeves, 1983).

Threats The major threat to the spinner dolphin is the large catches over many years in the eastern tropical Pacific tuna fishery. The population declines are documented above, and although there appears to be some recent evidence of stability and perhaps of some increases, these populations are still very much below their original sizes (Buckland and Aganuzzi, 1988; Smith, 1983).

Small cetacean fisheries elsewhere in the range are known to take at least some spinner dolphins, for example in the Solomon Islands, Japan and St Vincent in the Lesser Antilles. Carcasses of the dwarf spinner dolphin are sold in Bangkok for human consumption, but it is not known whether the these represent direct or incidental take, the level of this take nor the size of the local population. There is likely to be some direct and indirect taking elsewhere, but not on anywhere near such a scale as in the eastern tropical Pacific (Leatherwood and Reeves, 1983; Perrin *et al.*, 1987; Perrin and Gilpatrick, in press).

There is also concern about threats to habitat at Fernando de Noronha Island off Brazil where tourist development (including dolphin viewing trips) may adversely affect a resident spinner dolphin population which uses the shallow bays to rest during the day (Perrin, 1987; 1989a).

Conservation Measures Potential countries of origin include all those with coasts in tropical, subtropical and temperate waters. Reported specific locations so far include: South Africa, Japan, USA, Panama, Ecuador (Galapagos Islands), Australia (Solomon Islands), Argentina, Brazil, Thailand, Solomon Islands, Djibouti, Oman, Maldives, New Zealand, Malaysia, Vanuatu, Seychelles, Tonga, Philippines, Egypt, Kenya, Chile, Senegal, Bahamas, Sri Lanka, Uruguay, Mexico, India, Indonesia, Madagascar, St Vincent and the Grenadines, Papua New Guinea and Tanzania. The following countries, as participants in the eastern tropical Pacific tuna purse seine fishery, have a major conservation responsibility for this species: Costa Rica, Ecuador, El Salvador, Mexico, Panama, Spain, USA, Vanuatu and Venezuela.

The spinner dolphin is listed in CITES Appendix II. The following international trade, involving scientific specimens except where noted, is recorded: 1981 - 33 specimens of unrecorded origin from USA to FRG; 1982 - 3 specimens from USA to France, 23 specimens from USA to UK; 1983 - 24 specimens from USA to Japan, 2 specimens of unrecorded origin from USA to USA, 1 specimen of unrecorded origin to USA, 122 specimens of unrecorded origin to USA, 23 specimens of USA origin from an unrecorded country to USA; 1984 - 2 skeletons from USA to Canada, 11 specimens of unrecorded origin from USA to Canada, 3 commercial specimens of unrecorded origin from USA to France, 5kg commercial specimens from USA to Japan, 3 specimens of USA origin from France to USA, 72 specimens from Panama to USA, 1 specimen from USA to USA, 34 specimens of unrecorded origin from USA to USA, 50 specimens of unrecorded origin to USA; 1985 - 1 specimen USA to France, 8 specimens of unstated status from Pacific Islands Trust Territory to USA, 187 specimens of unstated status and unstated origin to USA, 14 commercial specimens of unstated origin to USA, 175 specimens of unstated origin to USA, 1 skeleton from South Africa to USA (CMC, 1987). The 33 specimens sent from USA to FRG in 1981 were foetuses obtained from the eastern tropical Pacific tuna fishery. Almost all the other USA specimens of unrecorded origin were specimens returned by observers on tuna boats (Perrin, 1989b).

At its 33rd meeting IATTC took up the problem of small cetacean mortality incidental to the tuna purse seine fishery. They have collected considerable quantities of data on the species involved, including the spinner dolphin (for further details see pantropical spotted dolphin review).

The spinner dolphin will be protected by general national legislation in some countries. Specific efforts have been made by the USA to monitor and reduce the incidental take by tuna purse seiners. Unfortunately, because of economic factors (e.g. the price of fuel) many USA registered ships have changed flag, and many new tuna boats have been built in Mexico. The USA fleet is now responsible for only a small proportion of the continuing dolphin kill. It was estimated that some 31,000 spinner dolphins were killed by the whole eastern tropical Pacific tuna fleet in 1986. At least 260 were also taken incidental to fishing operations in Australia (IWC, 1988). However, these are only catches reported to IWC, and there are known to be incidental takes in many parts of the range, although not on the scale of those in the eastern tropical Pacific.

The main problem for the spinner dolphin remains that of incidental take in the eastern tropical Pacific, and although the IATTC and USA have made considerable efforts, a more determined international initiative is needed to deal with this problem.

The IUCN/SSC Cetacean Specialist Group Action Plan refers several times to the eastern tropical Pacific spinner dolphin problem. There is also concern here about incidental kills and direct exploitation in West Africa, Sri Lanka and India, as well as about habitat threats at Fernando de Noronha Island off Brazil. Investigation of the status of a recently described dwarf form of the spinner dolphin (Perrin *et al.*, 1987) in the Gulf of Thailand is also given priority (Perrin, 1989a).

Captive Breeding A total of about 100 spinner dolphins are known to have been kept in captivity worldwide. These include at least 85 in Hawaii, 9 in Java and 1 in the Philippines (IWC, 1984). The species is of an appropriate size for captive breeding to be a conservation option, but has not thrived in capitivity in the past. Capture shock is a serious concern and much needs to be learnt about creating optimum conditions for survival in captivity (Wells, 1990). The wide differences between local populations imply that care is needed to preserve what may well be more or less isolated genetic types. If further specimens are brought into captivity, studies of life history, breeding and behaviour should be given priority so that information required for the conservation of the wild populations may be obtained, as well as that for captive breeding should that ever become necessary.

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CLYMENE DOLPHIN **INSUFFICIENTLY KNOWN**
Stenella clymene (Gray, 1846)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Almost nothing is known about the abundance or status of this species. There are no known threats, but incidental take in pelagic driftnet fisheries is possible and requires investigation.

Distribution The clymene dolphin was recognised as a valid species and re-described in 1981 by Perrin *et al.* The species was first described from a single skull from an unknown locality (Gray, 1846) and was subsequently placed in the synonymies of other species until examination of new material allowed the re-description.

The clymene dolphin is found in the tropical and subtropical Atlantic, and is not known to occur in the Indian or Pacific Oceans. Specimens have been reported from New Jersey, both coasts of Florida, Texas, the Caribbean, the mid-Atlantic and West Africa. The species has recently been reviewed by Perrin and Mead (in press), who give a map of the distribution of currently known observations.

Population No estimates of population are available, but the species is not thought to be uncommon within the range. Considering the difficulty in distinguishing it from similarly marked species at sea, the scarcity of records so far may well not be a realistic indication of abundance (Perrin and Mead, in press).

Habitat and Ecology The clymene dolphin has been observed at sea only in deep water (250-5,000 m or deeper). It may be a mid-water or night feeder on small fish and squid. The diet is similar to that of *Stenella longirostris*.

In the Caribbean this dolphin has been observed to 'spin' but the leaps were not as high or complex as those of *S. longirostris*. They have been seen riding bow waves in the Gulf of Guinea and on several occasions animals have approached boats sufficiently closely to make them vulnerable to harpooning or collecting from the bow. A school was seen in company with a large school of common dolphins off the west coast of Africa.

Known maximum length based on 75 specimens is 1.97m (a male). Twenty-seven adults ranged from 1.76m (a male) to 1.97m. Two adult females (one known to be lactating) which stranded together in Florida were accompanied by calves of 1.20m and 1.30m. Nothing further is yet known of the life history of this species (Perrin *et al.*, 1981; Perrin and Mead, in press).

Threats Some specimens are known to have been taken in the small cetacean fisheries of the Caribbean, probably for human consumption.

Conservation Measures Potential countries of origin include all those with coasts in the tropical and subtropical Atlantic. Specific reports are so far known from: USA, St Vincent and the Grenadines, Netherlands Antilles and Senegal. The species is included in CITES Appendix II. The movement of a pair of shoes, for commercial purposes, originating in the Sudan, from Italy to USA in 1985, is recorded under this species name (CMC, 1987). (This record may turn out to be a mistake of some kind since *Stenella* spp. skin is not normally used for leather products.) No other international or specific national legislation refers to the species.

Information is required on all aspects of the biology, habitat, ecology and possible problems of the clymene dolphin before any assessment of status or recommendations for conservation can be made. The species is not specifically mentioned in the IUCN Cetacean Specialist Group's Action Plan, but a number of general projects, particularly those relating to monitoring incidental catches, will be relevant (Perrin, 1989).

Captive Breeding Stranded clymene dolphins have been brought into captivity on several occasions, but none have survived for more than a few hours or days (Perrin and Mead, in press). This is not a large animal, and in theory at least, conservation through captive breeding could be feasible. The failure to rehabilitate stranded animals, which may well have been ill and/or damaged by their experiences, should not be taken to demonstrate that the species in general is unsuitable for life in captivity. If any more specimens are taken into captivity the collection of life history data and of information relevant to captive breeding should be a priority.

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STRIPED DOLPHIN **INSUFFICIENTLY KNOWN**
Stenella coeruleoalba (Meyen, 1833)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Although the striped dolphin is widely distributed and comparatively common within the range, there is some concern about the levels of direct and indirect catching. The population off Japan may have been overexploited and information on current catch levels in relation to population size is needed. Elsewhere, the main requirement is for the monitoring of all catches, so that any problem areas can be identified and appropriate action initiated.

Distribution The striped dolphin is found offshore in most tropical, subtropical and warm temperate marine waters. It is not an inhabitant of cold boreal waters, and the few records from such areas represent vagrants. There are many local variations, but so far, only a few discrete stocks have been proposed, including one off South Africa, one or two in the eastern tropical Pacific and another in the western North Pacific. It is also common in the Mediterranean and Red Seas (Leatherwood and Reeves, 1983; Wilson *et al.*, 1987; Perrin *et al.*, 1985). The species has recently been reviewed by Perrin and Kasuya (in press). Wilson *et al.* (1987) provide a detailed map of known records.

Population It has been estimated that there were between 176,000 and 252,000 striped dolphins off the Pacific coast of Japan (Kasuya, 1985). There are no population estimates for other areas, but this species seems to be relatively common within the range.

Habitat and Ecology The striped dolphin reaches 2.5 to 2.6m (average about 2.2-2.3m) in length, with males slightly larger than females. Sexual maturity is reached at about 1.8 to 1.9m and average length at birth is about 1m. These dolphins feed on a variety of fish, crustaceans and cephalopods. Feeding depth may extend below 200m, as judged from prey found in stomachs (Perrin and Reilly, 1984; Perrin and Kasuya, in press; Leatherwood and Reeves, 1983; Miyazaki and Nishiwaki, 1978).

The striped dolphin is commonly found in aggregations of a few hundred, and sometimes herds of several thousand are encountered. Three major types of schools are recognised: juvenile, adult and mixed. Adult and mixed schools are further divided into breeding and non-breeding schools. Juvenile schools may migrate closer to the coast than adult and mixed schools. Calves remain in adult schools until one or two years after weaning and then leave to join juvenile schools. Most subadult females rejoin non-breeding adult schools, but some join breeding schools directly. Males rejoin adult schools after reaching sexual maturity, about equal numbers joining breeding and non-breeding schools. Breeding schools contain sub-schools of fully adult females and apparently socially adult males. The socially mature males may leave the breeding school after most of the females have been impregnated. The breeding school thus evolves into a non-breeding adult school and, after the birth of the calves, into a mixed non-breeding school. The breeding system is most likely to be promiscuous, although some degree of polygyny or polyandry cannot be ruled out on present evidence (Perrin and Kasuya, in press).

Duguy and Aloncle (1976) report smaller school sizes in their short observations in the Atlantic - from single specimens to a school of over 100. McBrearty, Message and

King (1986) note that of 72 schools in the eastern North Atlantic, 34 (47%) contained 20 or more animals including seven with more than 100. In the Mediterranean, 48 (35%) out of 139 schools contained 20 or more animals with three schools of more than 100.

In the western North Pacific, where it has been most studied, the striped dolphin has a prolonged breeding season, with apparent peaks of mating activity in winter, spring and possibly late summer. Gestation lasts for about 12 months. Some young animals begin eating solid food three months after birth, but weaning is often not completed until well into the second year. Age at sexual maturity, based on growth layer groups in teeth, may be five to six years or it may be nine. Mature females probably bear a single calf every three years (Miyazaki and Nishiwaki, 1978; Perrin and Reilly, 1984; Leatherwood and Reeves, 1983).

A migratory pattern has been observed in Japanese waters. Striped dolphins approach the coast in September and October, and move southward along the coast, apparently dispersing into the East China Sea for the winter. In April they return along roughly the same path, but farther offshore. They eventually leave the coast to summer in the pelagic North Pacific. Southbound schools seem to be larger than northbound schools. In years when the Kuroshio current is close to the fishing area on the coast of Izu more schools of adults were caught, in other years juvenile schools were more frequent (Miyazaki and Nishiwaki, 1978; Leatherwood and Reeves, 1983).

Threats Striped dolphins have been hunted on the Pacific coast of Japan for several centuries. Schools may be driven ashore or animals taken with hand harpoons at sea. Annual catches ranged as high as 20,000 animals before the 1960s (Leatherwood and Reeves, 1983). The catch can fluctuate considerably from year to year, depending partly on local conditions (Miyazaki, 1982). However, the IWC Scientific Committee subcommittee on small cetaceans became alarmed by the size of the catches (about 16,000 in 1980) in relation to the estimated maximum sustainable yield (5-6,000). They were informed that in 1981 fishermen had voluntarily held the catch to 4,710 under advice from the Japanese Fisheries Agency. In discussing the situation in 1982, the subcommittee noted that some reproductive parameters seemed to have changed in a way consistent with density-dependent response. The average age of attainment of sexual maturity in females had been reduced from 9.7 years in 1956 to 7.2 years in 1970; the minimum age at attainment of sexual maturity had declined and the average length of the reproductive cycle had shortened from 4.0 years in 1955 to 2.8 years in 1977, mainly through shortening the lactation period, but also through change in the resting period between pregnancies and in the proportion of females simultaneously pregnant and lactating. Because of considerable uncertainties and problems with the catch and effort data, the subcommittee called for further information before firm conclusions on the status of this stock could be made (IWC, 1983; Kasuya, 1985). No further information has been forthcoming, although catches in recent years have been in the low thousands, e.g. 2,918 in 1986 (IWC, 1988).

In other areas, such as the Solomon Islands, they are included in small cetacean catches by local people. Some are also taken in the eastern tropical Pacific tuna purse seine fishery, but not in large numbers (Leatherwood and Reeves, 1983).

There is likely to be at least some by-catching in many parts of the range which requires monitoring. When such schemes are set up they can have unexpected results: for example in France it was found that although by-catches involved less than ten animals a year, possibly as many as 100 striped dolphins were being directly taken in the Mediterranean each year for onboard consumption or to scare the animals away from tuna nets (Collet, 1983). In Italy occasional by-catches are reported (e.g. Magnaghi and

Podesta, 1987) while in Sri Lanka the level of direct and by-catching may be comparatively high (Perrin, 1989).

Conservation Measures Potential countries of origin include all those with coasts in tropical, subtropical and temperate waters. Specific sites so far recorded include: Argentina, Uruguay, Japan, USSR, Canada, USA, New Zealand, South Africa, Jamaica, Oman, Ivory Coast, Spain, Senegal, Netherlands, St Vincent and the Grenadines, Solomon Islands, Mexico, Vanuatu, Maldives, Seychelles, Indonesia, Portugal, Sweden, Belgium, Cyprus, Greece, Monaco, Ireland, Cuba, Denmark (Greenland), UK (Gibraltar), France, Italy, Brazil, India, Sri Lanka.

The striped dolphin is included in CITES Appendix II. The following international movements, all of scientific material unless otherwise stated, are recorded: 1981 - three specimens from France to USA; 1982 - three specimens, of French origin, from USA to France; 1983 - six specimens, of unstated origin, to USA; 1984 - two skeletons from USA to Canada, four specimens, of unstated origin, from USA to Canada, 2kg of commercial specimens from USA to Japan, nine specimens of unstated origin to USA, two specimens from South Africa to USA, two commercial specimens from South Africa to USA; 1985 - one specimen from South Africa to USA, 200g specimens from South Africa to USA (CMC, 1987).

The striped dolphin is also listed in Appendix II of the Berne Convention. No other international legislation specifically refers to this species. Besides protection through national legislation implementing the Berne Convention, the striped dolphin will be protected by general legislation in several countries.

The Japanese striped dolphin fishery was recommended for management by IWC in 1976, but no action has been taken (IWC, 1980). This fishery has taken very many fewer animals in recent years, but a full population assessment is still required in order to clarify the status of this stock.

The IUCN/SSC Cetacean Specialist Group's Action Plan calls for monitoring of the striped dolphin catch in Sri Lanka. Several general projects are also relevant, including those for monitoring direct and incidental catches by Japan, Taiwan and R. Korea, as well as incidental catches in the eastern tropical Atlantic and Australian waters. The effects of pollution on the Mediterranean population are also mentioned (Perrin, 1989).

Captive Breeding Striped dolphins have been kept in captivity in Japan and in South Africa. The single animal in South Africa was stranded in 1985, and survived to at least 1987. It was reported to resist handling and training, primarily through a refusal to 'station' or be touched, and to be more active and 'nervous' than a bottlenose dolphin in the same tank (Perrin and Kasuya, in press). The striped dolphin is sufficiently small for captive breeding to be a potential for conservation, if necessary. Existing, and any future, captive animals should be studied to provide information on life history, as well as data required for captive breeding. This would contribute to management of the wild populations as well as preparing the way in case conservation through captive breeding was required in the future.

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COMMON DOLPHIN | **INSUFFICIENTLY KNOWN**

Delphinus delphis Linnaeus, 1758

Suborder ODONTOCETI | Family DELPHINIDAE

Summary Although the common dolphin is widely distributed and abundant, the species is surprisingly little known. There is clearly great regional variability in body form and habits, rendering extrapolations of data collected for one stock to the species in general problematical. Variability in movements from one season to another appears to have confounded a number of attempts to estimate abundance, as well as leading to fears of population declines in areas where systematic abundance data are not available.

Although the species as a whole is still abundant, it is subject to threats in several regions. The populations involved in the eastern tropical Pacific tuna purse-seine fishery require further attention urgently, because of the high level of removals and the uncertainties in the population estimates. The eastern Mediterranean, Black Sea and North Sea populations also need attention. In general, a thorough review of existing data is required, and analysis of all survey results should be expedited. This will reveal specific areas requiring further investigation, but more information on distribution, abundance, biology and behaviour is required, particularly from parts of the range not previously investigated. The contribution of the IATTC to knowledge of this species is valuable, and the various other fisheries commissions should also be encouraged to cooperate in data collection.

Distribution The common dolphin has been recorded in all temperate and tropical waters of the world, in coastal waters and offshore, approximately within the water temperature range of 10°-28°C. It is pelagic in most of the range, usually encountered along or seaward of the 100 fathom contour, although a neritic form occurs in the eastern temperate Pacific (Perrin *et al.*, 1985). There are several distinct forms which have been described as subspecies, racial groups or different species by various authors. There is a need for a thorough revision of the species, but for the present purpose the name *Delphinus delphis* is used to include all forms (Leatherwood and Reeves, 1983).

Distribution has been studied in most detail in the eastern tropical Pacific. Four main stocks are recognised: northern, central, southern and Baja neritic. They are divided by areas where sightings are comparatively rare although observer effort has been great. Sightings are also rarer further offshore, and only the central stock is considered to extend as far as about 140°W. In the Gulf of California and out to 100 nautical miles off the Pacific coast of Baja California, the Baja neritic form differs from the main northern stock in modal length, colour pattern and relative beak length. There also appears to be a stock off southern Mexico, in part of the central stock area, known as the Guerrero stock (Perrin *et al.*, 1985).

The marked differences in the local stocks in the eastern tropical Pacific, a comparatively small part of the common dolphin's world range, seem to occur in other areas. So far there are reports of distinct forms in the Mediterranean Sea, the Black Sea, along the European and African coasts, in the Indian Ocean and off Japan (Leatherwood and Reeves, 1983).

Population The only detailed population studies are for the stocks associated with the eastern tropical Pacific tuna purse seine fishery. Four common dolphin stocks are recognised here, northern, central, southern and Baja neritic (Perrin *et al.*, 1985). Various population estimates have been published over the years, the most recent of which are given below. Buckland and Anganuzzi (1988) used tuna vessel observer data collected between 1975 and 1986. They could find little evidence of changes in abundance of the northern stock, which they calculate to be in the region of 500,000 animals. There is evidence for a significant decline in the population of the central stock, from around 500,000 animals in the late 1970s to around 250,000 in the 1980s. The evidence for changes in the size of the southern stock is weak because there are insufficient data. Although inspection of the trend in abundance appears to show a dramatic decline from over 750,000 animals in 1976 to under 250,000 from 1982, tests of statistical significance of the differences in population before and after 1980 are only just on the 5% level.

Further calculations, with refinements to reduce bias, gave broadly similar conclusions (Anganuzzi and Buckland, 1988). Some weak evidence emerged for a decline in numbers in the early 1980s in the northern stock. The decline in the central stock from 1977 to 1981 was confirmed, but there were too few data to estimate trends in abundance for the southern stock. The new procedure, however, did give lower and more stable abundance estimates for the southern stock, lying between around 500,000 and around 100,000. Holt and Sexton (1988) presented relative abundance estimates based on sightings surveys in this area in 1986 and 1987. The estimates for common dolphins for 1986 were 1.8 million and 0.6 million for 1987. Such large differences between years are unlikely to be adequate representations of the populations, and it was suggested that these differences arose through the sampling of different habitats in different years. Since the track lines were almost the same in each year the habitats may have shifted. It is known that temporary global climatic shifts can alter the size and detailed position of the tropical aquatic habitat. It was also suggested that environmental variation could be responsible for at least some of the variation between years found in the analyses of the data collected on board the tuna seiners (IWC, 1989).

There have been suggestions, mainly based on strandings records, that common dolphin populations have declined in the North Sea (e.g. Fraser, 1974; van Bree, 1977). However, an IWC Scientific Committee Working Group (IWC, 1986) expressed considerable doubt about the likelihood of accurately assessing trends in species abundance from recorded strandings frequencies, because the relationships between the number of animals arriving on shore and the population at sea is unknown, as is the relationship between the numbers arriving on shore and those finally recorded.

Amateur observers in the eastern North Atlantic and Mediterranean Sea reported sightings of common dolphins far more frequently than any other species (796 records out of a total of 3,035, collected between 1978 and 1982, McBrearty, Message and King, 1986). There were reports from every area, except the northern Aegean Sea. The authors note that the greatest number of sightings in the most northerly part of the eastern North Atlantic were recorded in August. The most northerly record (73°34'N 11°04'E) was of a group of six animals observed in water with a surface temperature of 10.7°C during August. This was the only record north of 61°N. The highest sighting frequency of schools was in waters around the west of Scotland, the western approaches to the English Channel, the Straits of Gibraltar, and the western and central Mediterranean. Common dolphins were seen in all months in these areas. In each Atlantic area sightings were more frequent in the second half of the year, but in the Mediterranean the sightings were mainly in the first half of the year. The records for the North Sea east of 0° were comparatively sparse, with only nine sightings and none between June and October.

Surveys of the eastern North Atlantic (NASS 87 and 89) have collected data on common dolphins. Unfortunately analysis of the information for this species has yet to be done, and the sea areas from the Scottish northern and western islands, western

Ireland and northern Spain to the mainland of Europe are not covered (IWC, 1989).

Aguilar (1986) states that common dolphin abundance has apparently been declining in the northern part of the western Mediterranean range (Italy, France and northern Spain), and that 'it is clear that it has almost disappeared in areas in which it was once abundant'. In support he says that French strandings records have declined from 9% of all records in 1970-74, to 3.5% in 1975-79 and 1% in 1980-84; that in northern Spain there have been no strandings or sightings recorded since 1978, and that interviews and strandings records in Italy show a declining trend. However, data from Duguy *et al.* (1988), France (1988) and Duguy (1977) show that 14 of the 70 French strandings records (with positive species identification) for 1971-76 (20%) were common dolphins, 8 of 150 for 1976-82 (5.3%) and 5 of 179 for 1983-88 (2.8%) (1988 data incomplete) (Klinowska, 1989). Duguy *et al.* (1988) note five strandings of common dolphins on the Mediterranean coasts of Spain between 1977 and 1987. Two of these are from the northern provinces of Barcelona and Tarragona. They are not dated in this analysis, but since only one record is shown for 1978 and none for 1977, there must have been at least one stranding in northern Spain since 1978. In the first year of systematic cetacean strandings recording in Italy (1986) no common dolphins were reported (Centro Studi Cetacei, 1987). Duguy *et al.* (1988) say that the frequent confusion between *Delphinus delphis* and *Stenella coeruleoalba* which occurred until recently precludes any speculation about their past relative abundance.

These authors also note that the number of strandings does not necessarily bear any relationship to the number of animals alive at sea. McBrearty, Message and King (1986) note 25 sightings records for the western Mediterranean north of 40°N between 1978 and 1982, although this does cover a much wider area than the seas off northern Spain. There were 44 records for the area south of 40°N. The relatively greater abundance of records to the south is consistent with other reports (e.g. Duguy *et al.*, 1983). Aguilar (1989) confirms the lack of recent records in the northern part of the western Mediterranean from surveys, and believes that the amateur sightings records are likely to be the result of mistaken species identities.

Estimates of Black Sea populations are complicated by the fact that three species were involved in the fisheries. Authors do not always state whether figures refer to one species or to all three, and the proportions of the three species in the catch changed over the years. In the USSR fishery *Delphinus delphis* was the major species (80-90%) before 1964, but *Phocoena phocoena* came to dominate from 1964 to 1966 when the fishery was closed. *Tursiops truncatus* formed a variable proportion of the catch. It is unclear whether these figures refer to numbers or weight of animals. The species composition of the Turkish fishery was reported as 80% harbour porpoise, 15-16% common dolphins and 2-3% bottlenose dolphins in the early 1980s, although common dolphins were still the preferred catch. Aerial surveys of dolphins have been conducted by the USSR since 1967. The estimates for common dolphin varied between 28,000 and 285,000 from 1967 to 1973, with no obvious trend. More recent surveys from 1978 to 1980 showed schools of common dolphins distributed widely in all areas surveyed, but variably among years. A ship survey in 1981 reported common dolphins in both inshore and open waters. Twenty four schools of common dolphins were seen, with an average school size of 36.3 giving an encounter rate of 0.99 per km searched (IWC, 1983). No further information or analyses have been made available. Surveys were carried out along almost the entire Black Sea coast of Turkey in 1987, but no population estimates have so far been published (Perrin, 1988). The estimates from all the Black Sea aerial and ship surveys are suspect, because none have covered the waters of all four nations together and the dolphins are known to be highly mobile (Perrin, 1989b).

Wang (1984) notes tens to hundreds seen in all PR China waters, as well as off Taiwan.

Habitat and Ecology The longest reported male common dolphin from any region was 2.6m and the longest female 2.3m. Length varies between the different forms, the smallest of which appears to be that in the Black Sea with a maximum length for males of 2.19m and for females between 1.96 and 2.0m. The average length of sexually mature males varies between 1.70-1.80m (Black Sea) to 2.42m (Indian Ocean - small sample), and for females between 1.50-1.70m (Black Sea) and 2.12m (Indian Ocean - small sample). In the eastern North Atlantic and eastern tropical Pacific it is 2.0m in males and in the eastern North Atlantic 1.9m for females (Perrin and Reilly, 1984).

The average age of attainment of sexual maturity is 3 Growth Layer Groups (GLGs) in teeth, probably representing three years, in males and 2-4 GLGs in females in the Black Sea. In the eastern north Atlantic it is 5-7 GLGs in males and 6-7 in females, while in the eastern tropical Pacific it is 6-7 GLGs in males, and in the eastern North Pacific 7-12 GLGs in males. The maximum ages so far recorded are 22 GLGs (Black Sea) and more than 12 GLGs (eastern North Atlantic) for males and 20 GLGs (Black Sea) and more than 9 GLGs (eastern North Atlantic) for females (Perrin and Reilly, 1984).

Perrin and Reilly (1984) give Scott's (1949) calculation of 1.05m for length at birth in all areas, although from other data in the same Table this figure is clearly too high. The average length at birth for the eastern tropical Pacific is 0.813m, for the eastern North Pacific 0.79m and for the Black Sea 0.8-0.9m. In the Black Sea lactation is said to continue on average for between 14 and 19 months, and the young are on average five to six months old at weaning. There is an estimated resting period of four months before the next pregnancy. (These data come from different years and are not consistent with each other or with the reported calving intervals in this area.) Estimates of gestation vary between 10 and 11 months. The calving interval in the Black Sea between 1936 and 1946 was 1.3 years, and in 1949 it was 2.2-2.3 years. For all stocks in the eastern tropical Pacific it was 2.6 years. The Gross Annual Reproductive Rate (GARR) for Black Sea dolphins has been estimated as 0.106. For the exploited population in the eastern tropical Pacific the estimates are 0.096 (whole region), 0.087 (northern stock) and 0.066 (southern stock). The annual pregnancy rate (APR) is estimated as 75% in the Black Sea between 1936 and 1946, and 46.4% in 1949. For all stocks in the eastern tropical Pacific APR is estimated as 37.8% (Perrin and Reilly, 1984). All estimates of the various reproductive parameters in the Black Sea are unreliable, because inshore/offshore segregation by reproductive condition has been discovered (Perrin, 1989b). Tomilin (1957) mentions evidence that this species is an induced ovulator.

The main calving season is between June and August in the Black Sea, with a peak in July, although earlier work, also quoted by Tomilin (1957), indicates two breeding and calving peaks, one in spring and one in late summer-early autumn. Evans (1982) presents evidence for both spring and autumn calving seasons in the North Pacific. He found a significantly higher percentage of females neither pregnant nor lactating in the southern stock than in the northern stock. Schools described as accompanied by young were reported in almost all months in the southern English Channel, Bay of Biscay and off the southern Iberian peninsula. Such schools were reported only in July off Scotland and in April and August off southern British coasts (McBrearty, Message and King, 1986).

The diet of the common dolphin varies with stock and season. In the Black Sea, pelagic fish are the main food, and Tomilin (1957) summarises information gathered from tens of thousands of dolphins. In Californian waters Evans (1982) found that fish, particularly *Engraulis mordax* in autumn and winter and *Leuroglossus stilbius* in spring and summer, and cephalopods, particularly *Loligo opalescens* in autumn and winter and *Onychoteuthidae* in spring and summer, were taken. In autumn and winter 63% of the stomach contents were fish and 70% in spring and summer. Collet (1981) lists stomach contents of eastern North Atlantic animals. Fish, predominantly Gadidae, and cephalopods were taken. The variety of prey species indicates that common dolphins are opportunistic feeders, with stomach contents reflecting the local fish and cephalopod fauna. Like other cetaceans, common dolphins sometimes take advantage of human fishing activities by feeding on disabled fish which have escaped or been discarded from nets (Leatherwood and Reeves, 1983).

Off southern California common dolphins prey on organisms associated with the deep scattering layer (DSL). The daily activity cycle generally begins in the late afternoon, when small feeding groups scatter to await the ascension of the DSL. At dawn, or later on overcast days, as the light-sensitive DSL returns to the depths, these groups coalesce for periods of rest and social interaction (Leatherwood and Reeves, 1983).

In Californian waters, discontinuities in distribution may indicate competitive exclusions with *Stenella* spp. although they can equally be explained by water temperature preferences (Evans, 1982). Similar factors may be operating in the eastern Mediterranean (Duguy *et al.*, 1983). Seasonal movements following water temperature changes or food species migrations are reported in almost all areas (e.g. Tomilin, 1957; Evans, 1982). Selzer and Payne (1988) analyzed dolphin distribution and environmental features off the northeastern United States. They found that both common dolphins and white-sided dolphins were sighted more frequently over areas with high sea floor relief, but white-sided dolphins were found in colder areas with lower salinity and common dolphins in warmer, more saline waters. They relate these apparent preferences to environmental conditions contributing to preferred prey abundance.

Common dolphins are usually said to live in large groups, sometimes numbering over a thousand. However, the mean school size in the Black Sea surveys between 1978 and 1980 was 10.4 animals. In the 1981 survey it was 36.6 animals (IWC, 1983). In the eastern North Atlantic and Bay of Biscay area below 50°N, only 32% of recorded schools contained more than 20 animals. To the north, 24% contained more than 20 animals and to the south 35% contained more than 20 animals. In the Mediterranean school size decreased eastward, with 37% containing more than 20 animals in the Gibraltar area and none containing more than 20 animals reported in the furthest eastern sector (McBrearty, Message and King, 1986). Very much larger average school sizes are reported for the eastern tropical Pacific. Anganuzzi and Buckland (1988) give estimates of just over 1,000 for the northern stock, between 400 and 600 for the central stock and wide fluctuations from under 400 to over 1,400 for the southern stock. Small changes in the boundaries taken for the central stock area gave somewhat different estimates of school size, perhaps indicating that school size is a habitat or stock characteristic. The composition and status of these groups is debated. There may be some segregation by age and sex (Mitchell, 1975a) or they may represent a single limited gene pool (Evans, 1982; van Bree and Purves, 1972).

Schooling behaviour facilitates catching, particularly by seine nets as was formerly the case in the Black Sea. Here the school was chased into the net by felucca crews beating stones together and banging their oars (Tomilin, 1957). The habit, in common with that of other delphinids, of aggregating with tuna has involved very heavy mortality in the eastern tropical Pacific and eastern tropical Atlantic in recent years (Mitchell, 1975a). Common dolphins also follow boats and ride bow-waves, another habit facilitating capture. The bond between mother and young is particularly strong, if either is captured the other usually remains at least until the death of the captured animal. Males and females also sometimes exhibit similar behaviour, as do adults of the same sex (Tomilin, 1957). In some parts of the Mediterranean common dolphins are believed to assist fishing operations, but in other parts they are regarded as pests (Berkes, 1977; Tomilin, 1957).

Threats - Historical A fishery for three species (common dolphin, harbour porpoise and bottlenose dolphin) existed in the Black Sea from 1870 to 1983. (See also harbour porpoise and bottlenose dolphin reviews for further details.) Turkey, Romania, Bulgaria and USSR were involved. Tomilin (1957) describes the USSR fishery and its products. Berkes (1977) describes the Turkish fishery, the main products of which were oil and meal. All except Turkey halted the fishery in 1966, following a collapse of the stocks. This collapse was reportedly indicated by changes in the age, sex, species composition and size of the catch in 1964-65. The fishery in Turkey is not well documented, but a discussion of the failure of the USSR fishery to reach the catch rates achieved in the 1930s after the second World War mentions that the Turkish fishery continued throughout. This was blamed for destroying the breeding stock and young during the breeding season, although no supporting evidence was put forward. The Turkish fishery did catch the animals from small boats using rifles or shot guns - a method well known to have a very high loss rate, which may have exceeded 40 - 50% (IWC, 1983).

Catch statistics from various sources for the Turkish fishery are listed by IWC (1983), but there are large differences and it is not at all clear how the weights given should be divided to give the numbers of each species taken. However, it does seem clear that several thousand tonnes were landed each year from the 1960s. This of course takes no account of animals killed or wounded and lost which, if loss rates are correctly estimated, would give total removals 40-50% higher than landed catches. The IWC Scientific Committee's subcommittee on small cetaceans was unable to come to any conclusions about the status of the stocks because of the uncertainties in the catch and population data. They made a number of recommendations in an attempt to improve the situation, notwithstanding the fact that Turkey is not and never has been an IWC member. Concern was also expressed about reports that catches of anchovy, a major prey species, were increasing in the Back Sea, although there was insufficient information available to enable assessment of the likely effects of this on the cetacean populations (IWC, 1983).

The subcommittee returned to this question the following year. Some further information on catch levels was available from an FAO general fisheries mission. This gave an estimate of just under 250,000 individuals, of the three species together, taken between 1976 and 1981, giving an average of 41,221 a year. An independent estimate was obtained based on consumption of rifle ammunition in the hunt. About 103,000 to 133,000 rounds were used annually. Fishermen estimated that about one shot out of four killed a dolphin. This implied an annual kill of about 34,000 to 44,000, which was of the same order of magnitude as that estimated from the catch data (IWC, 1984). (It does not, however, take into account the supposedly high loss rate, unless by 'kill a dolphin' the fishermen meant 'kill and land a dolphin'.) The subcommittee has not subsequently returned to the question of the status of the Black Sea populations, as no new information is yet available.

Threats - Present The major incidental take of common dolphins is in the eastern tropical Pacific tuna purse seine fishery. It was estimated that in the region of 25,000 were killed in 1986 (Hall and Boyer, 1988). Common dolphins have on average four times greater mortality rates per set than spotted dolphins. The proportion of sets on common dolphins decreased from just over 7% in 1979 to about 1% between 1982 and 1984. It then rose again to almost 7% in 1986. The reasons for this are not known, but may be attributable to changing oceanographical factors. The kill was estimated at around 20,000 in 1987 when the proportion of sets on common dolphins was smaller at 5% (IWC, 1989).

The Turkish fishery has been closed from 1983 (IWC, 1984). However, recent reports suggest that it will be re-opened when a stock assessment has been made. There is no time schedule for this, but there is great pressure from the fishing industry to end the hunting ban. Contrary to earlier reports, there is no large back-log of dolphin meal and oil that has to be disposed of. Sale of meal and oil to the European Community is no longer possible because of their prohibition of imports of cetacean products for commercial purposes. However, a ready market exists for the products in Japan, where much of the production from other Turkish fisheries in the Black Sea is presently exported (Perrin, 1988). Although Turkey is a Party to the Berne Convention and the common dolphin is listed in Appendix II, re-opening the fishery might be possible under the exemption clause allowing Appendix II species to be taken to prevent serious damage to fisheries, provided that this would not be detrimental to the survival of the dolphin populations (see Conservation Measures section below).

Small numbers are directly taken, mainly for human consumption or animal feed, in many parts of the range. Mitchell (1975b) mentions the Azores, Venezuela and possibly Israel. Some dephinids were certainly taken in Israel during the second World War and used for human consumption (Bertram, 1979). A few common dolphins are taken in the Japanese small cetacean fishery (e.g. IWC, 1983; 1984; 1989). There are also unregulated direct catches in the Mediterranean by at least France and Spain, and elsewhere by France (e.g. Aguilar, 1986; Duguy, 1977; Duguy and Hussenot, 1982; France, 1988). Perrin (1989a) mentions incidental and directed takes in Peru, mainly for human consumption. The common dolphin is one species involved in this unregulated fishery. There is some reported taking by pelagic trawlers off west Africa. Common dolphins are also said to be shot at by 'sportsmen' for entertainment in the Mediterranean (Leatherwood and Reeves, 1983).

There are likely to be incidental takes in any part of the range where fishing activities occur. Specific reports include France (e.g. Duguy, 1977) and UK (Northridge, 1988). Selzer and Payne (1988) mention incidental takes of common dolphins off the continental slope of the northeastern United States by non-USA fisheries for mackerel and the squid *Loligo peali*. Some are also incidentally taken in the Turkish Black Sea purse-seine fishery for anchovy (Perrin, 1988). Wang (1984) mentions captures by purse seiners near Taiwan, which are most common in March and April. Common dolphins are also said to be 'often' captured by fishing boats in the Gulf of Tonkin and elsewhere.

Conservation Measures Potential countries of origin include all those with coastlines in tropical and warm temperate waters. In the comparatively few cases where countries in these areas have not yet reported specimens, lack of observers is more likely than absence of common dolphins.

The common dolphin is listed in Appendix II of CITES. The following international trade is recorded (all for scientific purposes unless otherwise noted): 1978 - 29 specimens from USA to FRG, 2 specimens from USA to UK, 12 specimens from France to USA; 1982 - 3 specimens from USA to France; 1983 - 14 specimens from USA to France, 14 specimens from USA to Japan, 10 specimens of unstated origin to USA, 7 specimens of USA origin from unstated country to USA; 1984 - 9 specimens from USA to Canada, 1,600 specimens from USA to France, 7kg commercial specimens from USA to Japan, 1 specimen from USA to USA, 1 specimen from South Africa to USA, 1 commercial specimen from South Africa to USA; 1984 - 3 skeletons from USA to Canada; 1985 - 611 specimens from USA to France, 15 specimens from Trust Territories of the Pacific to USA, 8 specimens from Peru to USA, 68 specimens of unstated origin to USA, 26 specimens of unstated origin to USA (CMC, 1987).

The BS meetings have been used to exchange information on Black Sea stocks and to coordinate the current moratorium on catching by USSR, Bulgaria and Romania. The North and Baltic Seas populations have been listed in Appendix II of CMS, and the species in Appendix II of the Berne Convention. However, the latter listing can be subject to exemption to prevent serious damage to fisheries, provided that this will not be detrimental to the survival of the dolphin populations. There thus appears to be no effective legal international impediment to the re-opening of the Turkish Black Sea dolphin fishery or to the export of products outside the European Community. Much information on the catches and populations in the eastern tropical Pacific has been obtained through the IATTC. The species will be protected by general legislation in several countries.

The IUCN/SSC Action Plan notes that the Black Sea, northeastern Mediterranean and coastal eastern tropical Pacific populations are or may be at risk. A specific project to assess the status of the western Mediterranean population is proposed. The species will also be included in general projects, such as the monitoring of direct and indirect takes worldwide (Perrin, 1989a). More information on biology, abundance, distribution and behaviour is needed in all areas. This is particularly important because of the variability between local populations. The populations involved in the eastern tropical Pacific tuna purse-seine fishery clearly require further urgent attention. It is particularly disappointing that the survey and other population monitoring work has so far not produced a clear picture of the situation. The same is also true for the Black Sea. It appears that survey methodology needs to be improved before reliable population estimates can be obtained. Despite its wide distribution and abundance, and the large numbers that have been taken in some areas, basic information on this species is particularly poor. Reporting of all incidental and direct catches should be improved, particularly by IWC members, in national waters, in those of any overseas territories, and in waters fished by far seas fleets. The IATTC has already made important contributions to knowledge of this species, and the various other fisheries commissions should be encouraged to take similar action.

Captive Breeding At least 90 common dolphins are known to have been kept in captivity worldwide: at least 37 were taken from the USA Pacific coast, 1 in Japan, 22 in the Mediterranean, 2 in other parts of western Europe and 28 in New Zealand (IWC, 1984). Although said to be easy to catch, they are also generally considered to be difficult to keep (e.g. Walker, 1975). However, the New Zealand dolphinaria have specialised in this species. Napier Marineland, the only one currently operating, was found to be of a good standard by an Officials Working Party (NZ, 1985), although no breeding has yet been achieved.

Perhaps because few specimens have been kept worldwide in recent years, very little research seems to have been done on captive animals. It would be particularly valuable if existing and future captive animals could provide information for the calibration of ageing techniques. It would also be useful if as much other information as possible relevant to conservation and management could be obtained from these animals. In view of the facts that most institutions have had little success in keeping this species, and breeding in captivity has not yet been achieved, it appears that conservation through captive breeding is not a feasible option at present. It would be prudent for relevant studies to be made of existing and any future captive animals, in case it ever became necessary to exercise this option.

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FRASER'S DOLPHIN **INSUFFICIENTLY KNOWN**

Lagenodelphis hosei Fraser, 1956

Suborder ODONTOCETI Family DELPHINIDAE

Summary Once considered rare, Fraser's dolphin is now known from tropical waters around the world, although no quantitative estimates of abundance are available. There is some direct and incidental coastal taking, but this does not appear to be on a scale to compromise the status of any populations. The level of incidental take in the extensive pelagic driftnet fisheries within the range is unknown, but requires urgent investigation. More information on distribution, abundance, biology and behaviour is also needed.

Distribution This species was described by F.C. Fraser in 1956 from a skeleton collected by C. Hose before 1895 in Sarawak, Malaysia (Fraser, 1956). Until the early 1970s this remained the only record, but then it was reported from several widely scattered localities in the tropical Pacific and Indian Ocean (Perrin *et al.*, 1973). Many observations have now been made both at sea, and of specimens obtained by various routes (e.g. Tobayama, Nishiwaki and Yang, 1973; Gambell, Best and Rice, 1975; Berzin, 1978; Hammond and Leatherwood, 1984; Uchida, 1985; van Bree *et al.*, 1986).

Fraser's dolphin is now known to be oceanic, avoiding shallow inshore waters, and is found in tropical waters around the world. Records of strandings from temperate waters in France and Australia may represent vagrants. The range in the central and western Pacific, the Indian Ocean and the Atlantic is not well known. In the eastern tropical Pacific the species has been found to have a broad and continuous distribution. The species has recently been reviewed by Perrin, Leatherwood and Collet (in press), who provide a map of known specimens and sightings, and by van Bree *et al.* (1986), who also give a distribution map as well as a list of records.

Population A maximum of 136,000 have been estimated to inhabit the eastern tropical Pacific, although this is likely to be an over-estimate, because the school density was extrapolated to the range of the spinner dolphin (*Stenella longirostris*). No population estimates exist for other parts of the range, but it is no longer considered to be rare (Perrin, Leatherwood and Collet, in press).

Habitat and Ecology The longest fresh specimens were 2.64m (a male and a female from the southern Indian Ocean). Eight sexually mature males measured between 2.31m and 2.64m, 13 sexually mature females were between 2.06m and 2.64m in length. The range in sizes suggests that there may be geographical variations in body size (Perrin, Leatherwood and Collet, in press).

Very little is known of the life history. The smallest reported calf was 0.95m and the largest foetus 1.10m, suggesting a birth length of about a metre. Available data do not suggest strong seasonality in breeding (Perrin, Leatherwood and Collet, in press). Assuming that one Growth Layer Group (GLG) is laid down each year, the oldest animal so far known was 16, although this female was still physically immature. The youngest sexually mature female in a small sample was eight years old, and the youngest sexually mature male seven years old (van Bree *et al.*, 1986).

Most schools sighted contain between 100 and 1,000 animals, but smaller groups of as few as four individuals have been seen. It is not known whether there is any segregation by age or sex within groups, but it is very difficult to split schools by pursuit (Perrin, Leatherwood and Collet, in press). Fraser's dolphins feed on mesopelagic fish, shrimps and squid in the eastern Pacific. In other regions they may also feed at the surface and on benthic organisms. Perrin, Leatherwood and Collet (in press) list known prey species.

Threats Small numbers of Fraser's dolphins are taken in local harpoon fisheries in the lesser Antilles, Indonesia and probably elsewhere in the Indo-Pacific region. A few are taken in gillnets in Sri Lanka and probably in other coastal gillnet fisheries also. Some are killed incidentally in the tuna purse-seine fishery in the eastern tropical Pacific (an estimated total of 26 between 1971 and 1975) (Perrin, Leatherwood and Collet, in press). Some are taken in a drive fishery in Taiwan (Hammond and Leatherwood, 1984; Tobayama, Nishiwaki and Yang, 1973). The level of incidental take in pelagic driftnet fisheries within the range is unknown.

Conservation Measures Potential countries of origin include all those with coastlines in tropical waters, and possibly in warmer temperate waters also. Locations reported so far include: Malaysia, Sri Lanka, Australia, Japan, Taiwan, France (Clipperton Island), USA, Indonesia, Ecuador (Galapagos Islands), Costa Rica (Cocos Island), St Vincent and the Grenadines, South Africa and Mexico, but this list is likely to be extended as knowledge of the species increases.

Fraser's dolphin is included in CITES Appendix II. The following international trade has been recorded: 1984 - 1 commercial specimen imported to USA from South Africa (where the export was recorded as scientific), 1 scientific specimen from South Africa to USA (CMC, 1987). No other international legislation refers to this species, but it will be covered by general legislation in several countries.

The IUCN/SSC Action Plan does not contain any projects specific to Fraser's dolphin, but it will be included in general projects such as monitoring direct and indirect taking (Perrin, 1989).

The population estimate, although probably too high, for the eastern tropical Pacific indicates that the level of incidental take (26 over five years) is not of any significance for the status of this population. However, the level of incidental take elsewhere is unknown and needs to be investigated. There is also a need for more information on abundance and distribution outside the eastern tropical Pacific, and for information on biology and behaviour in all areas.

Captive Breeding There appear to have been only two attempts to keep this species in captivity. Between June and July 1975, 16 individuals were captured in the Camotes Sea and the southern end of Bohol Strait, in the Philippines, and intended for exhibition at Ocean Park, Hong Kong. Six animals refused to eat and were released after ten days, six others died within 14-21 days although feeding was established, and the other four survived between 30 and 100 days (average 45 days). Hammond and Leatherwood (1984) remark that from the size and habits at sea, one might have expected that Fraser's dolphins would adapt to captivity; however, although a few individuals were enticed to eat voluntarily during the first few days of captivity, most specimens refused and had to be force fed for several days or weeks. These dolphins were all maintained in sea pens, where they were subjected to significant changes in depth due to fluctuating tides, and they became visibly distressed during each receding tide. The authors suggest that use of enclosed deep pools might facilitate adaptation to captivity, but conclude that the nervousness and general 'fragility' of this species probably makes it unacceptable for captivity. An adult female captured incidentally in a gillnet lived for 20 days in an oceanarium in Japan (Uchida, 1985).

Although these two attempts were not successful, they are not conclusive evidence that Fraser's dolphin is unsuited to captivity. This is not a large species and conservation through captive breeding might be feasible with appropriate modern husbandry. If any more specimens are brought into captivity every effort should be made to obtain information required for conservation and management, and for captive breeding in case this ever became necessary. In particular the calibration of ageing techniques and details of reproduction are needed.

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NORTHERN RIGHT WHALE DOLPHIN **INSUFFICIENTLY KNOWN**
Lissodelphis borealis (Peale, 1848)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Although there is a small directed take of northern right whale dolphins in Japan, the greatest potential threat to this species is the incidental catch in other fisheries, including squid and salmon gillnet fisheries. The most urgent need is for more accurate information on the total level of take in these fisheries. The measures required to reduce the incidental take are likely to be of a generic nature for small cetaceans in this area rather than specific to this species. No accurate estimates of current abundance are available.

Distribution The northern right whale dolphin is found in the North Pacific, widely distributed in a crescent-shaped region corresponding to moderate temperate currents. It does not appear to enter tropical waters, and only rarely penetrates subarctic or the coldest temperate waters. In the western North Pacific they are known from Cape Najima, northern Honshu, and Cape Inubo, Japan, north to about 51°N. From Japan the distribution gradually tapers east-north-east. In the eastern North Pacific, they range from British Columbia, Canada (about 50°N) to the northern border of Baja California (32°N), with stragglers to 29°N. Eastern and western Pacific populations may be separated by an area of very low density south of the western Aleutians (Leatherwood and Reeves, 1983). Leatherwood and Walker (1979) give a comprehensive review of this species, and very little more has been published since that time.

Population Nishiwaki (1966) estimated the entire population as at least 10,000 individuals. Leatherwood and Walker (1979), however, gave a tentative estimate of 17,800 in their 20,000 square mile study area off southern California. As they observed about 3,400 individuals in a single flight and as many as 2,000 individuals in a single aggregation, Nishiwaki's figure is clearly far too conservative. Leatherwood and Walker (1979) consider the northern right whale dolphin to be one of the three most abundant delphinids (with common dolphins and Pacific white-sided dolphins) in southern California waters during winter. They are reportedly also common in the northern Sea of Japan, and very common off the Pacific coast of Japan, particularly in the north. Most eastern records are from California, but this may reflect a more offshore distribution to the north. Eastern and western Pacific populations may be separated by an area of very low density south of the western Aleutian Islands (Leatherwood and Reeves, 1983).

Habitat and Ecology Males grow to at least 3.1m and females to 2.3m. The males are sexually mature by 2.2m, and females by about 2m. Newborn calves have been estimated to be about 0.8 to 1.0m long. Calves are reported mainly in early spring.

The species occurs in very large herds of up to several thousand. Average group sizes of 200 and 110 have been reported for the western and eastern North Pacific, respectively. In all areas they associate with a variety of other cetacean species, especially Pacific white-sided dolphins, with which they share an extensive common range.

In both the western and eastern North Pacific, the species distribution appears to shift southwards and inshore between October and May or June, and then north and offshore again from summer to autumn.

They appear to favour deep-water habitats everywhere, but do approach shore at the heads of deep canyons, particularly in winter.

At least 17 fish species have been identified in the diet, the most common of which are myctophids and bathylagids. Squid, however, is the most commonly observed food item, and movements have been thought to be related to movements and availability of spawning squid (Leatherwood and Reeves, 1983; Leatherwood and Walker, 1979).

Threats The northern right whale dolphin is taken, for human consumption, in Japanese waters in the small cetacean fishery, although in recent years the number has been low. Of more concern are the numbers taken incidentally in other fisheries, especially squid gillnet fisheries. Japan reported 268 taken and landed in 1988 (Japan, 1990) and similar numbers in preceding years, described as 'partial representations'. No figures are available from fleets of other nationalities. Although the total take is unknown, it could be quite high given the high levels of fishing activity in most of its range. During a six-week period as an observer on board a Japanese squid driftnet vessel in the central North Pacific, Tsunoda (1989) recorded 41 specimens taken, more than any other cetacean species. These numbers could imply total takes if they are typical for such these fisheries. Nine were taken in 1987 in the Canadian offshore flying squid experimental driftnet fishery (Baird, Langelier and Stacey, 1988).

Conservation Measures Countries of origin include: Japan, R Korea, PDR Korea, USSR, USA, Mexico and Canada. The species is listed on Appendix II of CITES. The following international trade is recorded: 1981 - two scientific specimens from Japan to USA (CMC, 1987). No other international legislation refers to this species.

USA and USSR will protect under domestic legislation and Japan has provisions for regulating direct taking.

The IUCN/SSC Cetacean Specialist Group Action Plan does not have any specific projects relating to this species, although it will be included in general projects such as improving monitoring of direct takes and investigation of by-catching (Perrin, 1989).

The most urgent information need is more representative information on the total level of incidental take. There is also a general lack of information on numbers, biology and behaviour through most of the range, which should be remedied as soon as possible. The measures required to reduce incidental take are likely to of a generic nature for small cetaceans in this area rather than specific to this species.

Captive Breeding At least nine northern right whale dolphins have been brought into captivity in the USA. They are difficult to capture as they do not ride bow waves, and survival times have generally been short (maximum 15 months) (Reeves and Leatherwood, 1984). In view of this, conservation through captive breeding may not be feasible, although the animals are sufficiently small to be accommodated, and it should be noted that the majority of the captures took place before 1972, when modern husbandry methods were not available. If any more animals are brought into captivity, the collection of life history, breeding and behaviour information should be given priority.

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SOUTHERN RIGHT WHALE DOLPHIN **INSUFFICIENTLY KNOWN**
Lissodelphis peronii (Lacepede, 1804)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The abundance and status of the southern right whale dolphin is unknown. It is not known to be threatened at present, but information is required on the incidental take in those parts of the range where there are substantial pelagic gillnet fishing operations. Information is required on distribution and abundance to determine the significance of such takes for the species.

Distribution The southern right whale dolphin has a circumpolar distribution in the Southern Hemisphere, almost exclusively in temperate waters. Although there are a few records south of the Antarctic Convergence, most are more northerly, in the West Wind drift. It ranges in the Humboldt Current as far north as 19°S off western South America, and has commonly been reported seaward of the 100 fathom line off New Zealand, in the Falkland Current, offshore from South Africa, and in coastal and oceanic habitats to 450km from the coast of Chile. It has also been reported off New Guinea (Leatherwood and Reeves, 1983).

The IWC/IDCR cruises between 1978 and 1984 report only three groups of southern right whale dolphins in the area south of 58°S in the Antarctic (Kasamatsu *et al.*, 1988).

Population There are no estimates of population size, but the species seems to be reasonably common within the range. Gaskin notes some sightings, the largest being an aggregation of over 1,000 animals (Gaskin, 1972). The species was the fifth most common in the remains found on Tierra del Fuego by Goodall (1978).

Habitat and Ecology Very few specimens of the southern right whale dolphin have been examined, but so far the largest females are up to about 2.30m long and the males to about 2.1m (Perrin and Reilly, 1984).

Very little is known of the natural history. From stomach contents of animals taken off Chile and New Zealand, and net samples near feeding animals off South Africa, it seems that these dolphins feed on myctophids and squid.

Group sizes reported range between 2 and more than 1,000 animals. The IWC/IDCR cruises reported schools of 6, 21 and 30 animals, and these sightings occurred at sea temperatures between 1.4 and 13.8°C.

Southern right whale dolphins are commonly reported in company with other cetaceans, including pilot whales, Pacific white-sided dolphins and hourglass dolphins (Leatherwood and Reeves, 1983; Kasamatsu *et al.*, 1988).

Threats Some have been reported hooked or entangled in nets off South America, and possibly elsewhere (Aguayo, 1975; Goodall, 1978; Leatherwood and Reeves, 1983). It is not known to what extent, if any, it is taken incidentally in areas of extensive pelagic gillnet fisheries within the range, such as the Tasman Sea, but by analogy with the northern right whale dolphin it is reasonable to suspect that it may be vulnerable to capture in such fisheries.

Conservation Measures Countries of origin are: Chile, Argentina, Uruguay, Brazil, South Africa (including Prince Edward Island), Indonesia, Australia, Papua New Guinea, New Zealand, UK (Falkland Islands, South Georgia, South Shetlands, South Orkneys, South Sandwich, Tristan da Cunha), France (Crozets, Kerguelen, Amsterdam, St Paul) and Norway (Bouvet).

The species is included in Appendix II of CITES. No international trade is reported (CMC, 1987). No other international legislation refers to this species.

It is protected under general legislation at least in Argentina, Chile, New Zealand and Australia, although it is known that there are enforcement problems in South America.

The IUCN/SSC Cetacean Specialist Group Action Plan does not have any specific projects relating to this species, although it will be included in general projects such as investigation of South American takes, and monitoring incidental catching (Perrin, 1989). The most urgent information need is for estimates of the level of take in such fisheries, and for more quantitative information on abundance and distribution with which to assess the importance of the regions with intensive fishing to the species as a whole.

Captive Breeding The southern right whale dolphin does not appear to have ever been kept in captivity (IWC, 1984). It is sufficiently small for conservation through captive breeding to be theoretically possible, if necessary, but it may be difficult for this species to adapt to a captive environment (see northern right whale dolphin review). If any specimens are brought into captivity, the collection of life history, breeding and behaviour data should be given priority.

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COMMERSON'S DOLPHIN **INSUFFICIENTLY KNOWN**

Cephalorhynhcus commersonii (Lacepede, 1804)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Except for one area recently surveyed in the Chilean part of the range, there are no estimates of past or present abundance. It is feared that illegal harpooning of dolphins in South America for use as bait in expanding crab fisheries may be seriously affecting the populations. Accidental entanglements in fishing gear also occur. More information is required on distribution and abundance, and on the level of direct and incidental catching. The protective legislation needs to be enforced, and alternative sources of crab bait identified and made available to fishermen. The populations around the Falkland and Kerguelen Islands also need to be surveyed, and any threats identified.

Distribution Commerson's dolphins are found in coastal waters of southern South America and also around some South Atlantic and southern Indian Ocean islands. Goodall *et al.* (1988), in a recent review of the species, give detailed lists of records around South America and distribution maps. These dolphins are more or less continuously distributed along the east coasts of Patagonia and Tierra del Fuego between about 41°31'S and 55°S, at the Strait of La Maire. Within the Strait of Magellan they are found mainly east and north of Punta Arenas, and on the eastern shore of the Strait north of Porvenir. They were frequently seen between Punta Arenas and Porvenir in the 1940s, but are no longer reported from this area. They are present around the Falkland Islands, but probably not at South Georgia. The single second-hand anecdotal report that the species occurs here (Hart, 1935) has not been supported by specimens or by any further records, despite much observer activity (Brown, 1988; Goodall *et al.*, 1988). There are a few scattered records from waters to the south of the main distribution area, but none from the Antarctic continent (Goodall *et al.*, 1988).

A discrete population inhabits all coasts of Kerguelen, except the west, concentrating in the Gulf of Morbihan in summer. There are only two records here from other than coastal waters, despite extensive observer effort (Robineau, 1986).

In Patagonia, Commerson's dolphins are known to ascend as far as 30km into the tidal zones of rivers. There are no confirmed records of this species from other South Atlantic islands, although there have been recent expeditions and surveys at Crozet and Gough Islands (Goodall *et al.*, 1988).

The Kerguelen population differs significantly from the South American population in pigmentation patterns, maximum body size, length at age and certain cranial characteristics. It appears to have no contact with the South American population, and Robineau (1986) has proposed that it be accorded 'subspecific status' but did not formally describe a subspecies or propose a trinomial. The Falkland population(s) have not been studied.

The genus *Cephalorhynchus* was extensively reviewed by the IWC Scientific Committee's subcommittee on small cetaceans in 1984 (IWC, 1985) and many of the revised background papers presented, together with new material, have been recently published (IWC, 1988).

Population The only population estimate based on quantified survey effort is of a minimum of 3,211 (±1,168) dolphins in a portion of the Chilean Strait of Magellan surveyed by aircraft in January/February 1984 (Leatherwood, Kastelein and Hammond, 1988).

Commerson's dolphins are said to be common in southern Tierra del Fuego, Magellan Strait and around the Falklands. Impressions of low abundance in many areas may be based on the frequency with which these animals are seen in small isolated groups (Goodall *et al.*, 1988). More than 100 sightings (reporting more than 600 individuals) were made in Kerguelen in January and February 1983 (Robineau, 1986).

Habitat and Ecology Differences in body size and length at a given age were clearly evident between adult specimens from Kerguelen and those from South America: the Kerguelen animals being larger (IWC, 1985).

The longest specimens reliably reported from South America were a 1.52m female and a 1.49m male live-caught in the Second Narrows of the Strait of Magellan. The largest specimens taken incidentally in net fisheries on the Argentinean side of Tierra del Fuego were a 1.44m male and a 1.46m female. Maximum recorded weight was 66kg for a pregnant female. Adult body weights generally range from 35-60kg, depending on age, sex and reproductive status (Goodall *et al.*, 1988; IWC, 1985). The maximum recorded lengths of specimens from Kerguelen were 1.74m for a female and 1.67m for a male. Maximum weights recorded were 86kg for a 1.72m female and 78kg for the 1.67m male (Robineau, 1986; IWC, 1985).

Sexual maturity occurs by about 1.30m in both sexes off Tierra del Fuego, although a 1.28m lactating female has been reported (Goodall *et al.*, 1988; IWC, 1985). In Kerguelen, both males and females seem to attain sexual maturity by about 1.65m (Collet and Robineau, 1988). The birth season appears to be the austral summer, even in animals living in a Northern Hemisphere oceanarium. Mating behaviour has also mainly been observed at this season, both in the wild and in captivity. Gestation is thought to last approximately 12 months. Birth size is about 0.75m and birth weight about 7.5kg (Goodall *et al.*, 1988; Lockyer, Goodall and Galeazzi, 1988).

Dentinal growth layer groups (GLGs) in teeth seem to provide a satisfactory basis for age determination, with one GLG representing one year of age (IWC, 1985). From this information, the two oldest animals examined at Tierra del Fuego, a 1.45m female and an animal of unknown sex, were both 18 years old. The maximum age from a small sample of 11 Kerguelen animals was 10 years (Collet and Robineau, 1988; Lockyer, Goodall and Galeazzi, 1988; IWC, 1985). At Tierra del Fuego, males are sexually mature between five and six years of age, and females somewhere between four and eight years. At Kerguelen males mature at about eight years, and females from about five years of age (Lockyer, Goodall and Galeazzi, 1988; Collet and Robineau, 1988).

Estimates of survival rates for both sexes combined at Tierra del Fuego are 0.855 for ages 0-18 years inclusive; 0.914 for ages 5-18 years inclusive and 0.673 for ages 0-5 years inclusive, suggesting a higher mortality rate in the juvenile segment of the population (Lockyer, Goodall and Galeazzi, 1988).

In general, off South America, Commerson's dolphins appear to prefer areas where the continental shelf is wide and flat, the tidal range is great and the water temperatures influenced by cool currents. The normal offshore limit is about the 100m depth contour. They are often seen swimming in or along kelp beds off mainland Argentina and around the Falklands. No seasonal or area patterns of movement are apparent which could not readily be explained as an artifact of sampling effort. Seasonality of sightings at Kerguelen Island, on the other hand, might be interpreted as evidence of migration (Goodall *et al.*, 1988).

Stomachs of some 40 specimens from Tierra del Fuego and 11 from the Gulf of Morbihan (Kerguelen) contained mainly crustaceans, squids and coastal fishes, but included algae, and items (sessile tunicates, annelid worms and gravel) indicating bottom feeding (IWC, 1985). No more than three different prey items were present in the stomachs of most of the Tierra del Fuego specimens. There was no significant difference in diet relative to sex, physical maturity or locality, although more algae and sessile benthic organisms were found in the southern areas of rockier coastlines and more kelp communities (Bastida, Lichtschein and Goodall, 1988).

Around Kerguelen, groups usually contain fewer than three and rarely more than 15 individuals. Groups sighted elsewhere have been small (averages about three to five animals), although groups of a hundred or more have been reported occasionally. The larger groups may be temporary aggregations of smaller groups (Goodall *et al.*, 1988; IWC, 1985). External morphology is described and illustrated in detail by Goodall *et al.* (1988).

Threats Native canoe indians of the Fuegian and Chilean channels caught and used some cetaceans. Remains of at least one Commerson's dolphin have been found in 6,000 year old Beagle Channel shell middens. A few specimens were harpooned for scientific study during 19th century expeditions, and in the first half of the 20th century, Spanish, Italian and German sailors took dolphins, probably including this species, for food off Patagonia (Goodall *et al.*, 1988). Weber (1920) hunted Commerson's dolphins for meat and oil in the Strait of Magellan, and lived largely on the meat of these and other dolphins for the duration of his stay in southern South America. He claimed to have killed 100 dolphins in just three hours in one instance and evidently killed large numbers overall.

In recent years Commerson's dolphins have been taken both as a by-catch and directly in Chile and Argentina. Eleven specimens were taken for scientific study in Kerguelen and at least 33 have been removed by live-capture operations in Argentina and Chile. No information is available about direct or incidental takes in the Falklands (Robineau, 1986; IWC, 1985; Goodall and Cameron, 1980; Goodall *et al.*, 1988).

The major problem is the illegal use of small cetaceans, including *C. commersonii*, as crab bait in both Argentina and Chile. Several thousand dolphins and porpoises are harpooned annually, along with seals, sealions, penguins, guanacos and other wildlife. Only four of 26 crab companies operating in the Magallanes area provide bait to crab fishermen, and even in those cases the amount supplied is grossly inadequate. The crab fishery is expanding rapidly, and now extends to the area south of the Beagle Channel, which is being fished heavily at present. The valuable crab catch is exported. The fishery operates in this illegal manner because of the isolation of the area and a lack of enforcement of legislation protecting small cetaceans (Goodall *et al.*, 1988; Cardenas *et al.*, 1986; Cardenas *et al.*, in press; Perrin, 1989).

Occasional sniping at dolphins, including *C. commersonii*, has been reported (Goodall and Cameron, 1980; Leatherwood, Kastelein and Miller, 1988).

Accidental entanglements in gill nets and in tangle nets set to catch centolla (southern king crab *Lithodes antarctica*) are reviewed by Goodall *et al.* (1988). Although the tangle net has been illegal for crab fishing since 1976 in both Chile and Argentina, some of these nets are still in use. The dolphins taken are used for bait in crab traps and, occasionally, for human consumption.

As there are no general estimates of population size or of levels of removals, it is impossible to assess the effects of these takes on the populations. The fact that the demand for dolphin meat for crab bait must be increasing as these fisheries expand is cause for concern (Perrin, 1989).

Conservation Measures Countries of origin: Argentina, Chile, France (Kerguelen) and UK (Falkland Islands).

Commerson's dolphin is listed in Appendix II of CITES. The following international trade is recorded: 1980 - 5 live specimens from Argentina to FRG for zoological purposes; 1981 - 1 scientific specimen originating in Chile, from USA to South Africa; 1983 - 1 skull from FRG to Sweden for scientific purposes, and 12 live specimens from Chile to USA; 1984 - 1 live specimen from Chile to FRG for zoological purposes (CMC, 1987). The 1975 treaty between Argentina and Chile banned the use of the tangle net for crab fishing. These nets had also been incidentally taking dolphins. Unfortunately, the crab fishery then increased the use of traps, for which bait was not supplied, and dolphins are taken to provide bait. No other international legislation relating to this species has been identified. As the species occurs mainly in coastal waters under the control of Argentina, Chile, France (for Kerguelen) and UK (for Falklands), there is probably little scope for further specific international protection, although an Agreement under CMS may be possible. Chile and UK are Parties, but Range States do not have to be Parties to participate in an Agreement. All the States involved are WHC Parties, and there may be a means here to protect important habitat.

Dolphins have been protected in Argentina since 1974 and in Chile since 1977. Permits are required for any taking, but, except in the case of the live-captures, it appears that these provisions are not energetically enforced (IWC, 1985). The hunting of all cetaceans is banned within the Kerguelen EEZ by Order No. 44 of 1981 for ten years. There does not appear to be any legislation protecting small cetaceans in the Falkland Islands. Habitat protection legislation is available in all the countries of origin, and some existing and proposed conservation areas in the Falklands may protect habitat.

The IWC subcommittee on small cetaceans recommended that more information should be collected on distribution and abundance in Argentina during all seasons and in Chile from autumn to spring. They also recommended that the governments of Chile and Argentina investigate incidental and direct catches, initiate research to identify alternative sources of bait, and provide information on such bait to fishermen (IWC, 1985).

Since the IWC meeting in 1984, it appears that the demand for bait has increased with the expanding crab fishery. Projects to reduce this illegal use of small cetaceans are proposed in the IUCN/SSC Action Plan (Perrin, 1989).

The status of the populations at the Falkland and Kerguelen Islands is unknown. At least at the Falkland Islands fishing effort has increased in recent years, and fishing takes place around Kerguelen. It is not known whether any dolphins are incidentally taken. Research is required to investigate these populations and to provide information for their conservation and management.

Captive Breeding At least 33 Commerson's dolphins have been removed from Argentinean and Chilean waters during live-capture operations (Goodall *et al.*, 1988). The first attempt appears to have been made by an Argentinean collector in 1978. These animals (at least two) were later released, although they had been advertised for sale. Later that year applications for live-capture permits were made to the Argentinean Government by oceanaria from Japan, FRG and the Netherlands, when it became clear that no animals would be forthcoming from the original advertised source. In late 1978 a team from FRG removed four females and two males. Half of these animals were intended for an oceanarium in the Netherlands, but the sole survivor, a male, was housed at Duisburg, FRG.

Four animals for an oceanarium in Japan were also taken in late 1978. Some additional animals were alleged to have been killed during this operation. The dolphins were confiscated on arrival in New York *en route* to Japan, because of incomplete documentation. One animal was found to be dead on arrival, and the other three were transferred to Mystic Marinelife Aquarium. One only survived for a further few hours, the remaining male lived for eight days and the last female for two and a half years. A second expedition from FRG removed five animals in early 1980, but again only a single male survived. Japanese collectors were granted a permit in 1983 to take 14 animals, but legal action ensued and it was ruled that no further Commerson's dolphins could be taken from Argentinean waters until more was known about the species (Goodall *et al.*, 1988).

Twelve animals were taken under permit in Chilean waters by a USA collecting team in late 1983, from the population surveyed by Leatherwood, Kastelein and Hammond (1988). Six of these died within the first few weeks after arrival, but three of the surviving females have given birth to calves conceived in captivity. One calf was born in 1985 and two in 1986 (Goodall *et al.*, 1988). Cornell *et al.* (1988) report further confirmed pregnancies. Six animals were removed under permit from the same surveyed Chilean population in early 1984, by the FRG collecting team. Only one male survived, unfortunately leaving Duisburg with a colony of three males and thus no breeding can be expected here (Goodall *et al.*, 1988).

In view of the USA experience, it appears that captive breeding may be feasible for conservation purposes, should this become necessary. The IWC subcommittee on small cetaceans (IWC, 1985) recommended that additional work should be carried out on captive and wild *Cephalorhynchus* spp. to provide information on their vulnerability to net entanglement. If additional animals are removed for this purpose, the opportunity should also be taken for further research into general biology, behaviour and breeding, to provide information for conservation and management of the wild populations.

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BLACK DOLPHIN **INSUFFICIENTLY KNOWN**

Cephalorhynchus eutropia (Gray, 1846)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The black dolphin is endemic to Chilean waters and is the least known of the *Cephalorhynchus* spp. Small direct and indirect takes have been reported for many years, but there is now considerable concern about a fairly new and expanding direct fishery. This takes dolphins illegally for use as bait in developing crab fisheries, and it is feared that the kill rate is high. Information on the size and distribution of the population and on the extent of the take is urgently needed. The protective legislation needs to be enforced, and an alternative source of crab bait identified and made available to the fishermen.

The countries receiving the products of the crab fishery, USA, FRG, France, the Netherlands, Belgium, Japan and Italy, also have special conservation responsibility for this dolphin.

Distribution The black dolphin has been reported in coastal waters of southwestern South America between about 30°S (Valparaiso) and 55°S (southern Isla Navarino, just north of Cape Horn). The species has been reviewed by Goodall *et al.* (1988), and a list of all known specimens and sightings given, together with distribution maps. The easternmost sighting is in the Strait of Magellan, just east of the First Narrows (52°30'S, 60°20'W), and it may occur south to Cape Horn (about 56°S). The suggestion has been made that it is usually allopatric with *C. commersonii*. There is some overlap in the Strait of Magellan and Beagle Channel/Cape Horn region, but these records seem to be at the edges of the respective ranges.

The black dolphin appears to be more or less continuously distributed throughout the range. This comprises three general zones: northern, from Valparaiso to Puerto Montt on fairly open coast with some bays and river mouths; the Chilean channels from Puerto Montt south to the Strait of Magellan; and the Fuegian channels to Cape Horn. It has been seen to enter the Rio Valdivia. A resident group appears to occupy a stream, estuary and channel near a salmon hatchery on Isla Chiloe. The distance ranged offshore is unknown. There do not appear to be any seasonal movements (Goodall *et al.*, 1988; IWC, 1985).

The genus *Cephalorhynchus* was extensively reviewed by the IWC Scientific Committee's subcommittee on small cetaceans in 1984 (IWC, 1985) and many of the revised background papers presented, together with new material, have recently been published (IWC, 1988).

Population No estimates of population size are available (IWC, 1985). The black dolphin has often been considered to be rare, but this may only reflect the lack of known specimens and low observer effort within the range. Goodall *et al.* (1988) report that it was found to be particularly abundant off Playa Frailes, and is in general not rare in the northern part of the range. Sightings are fewest in the middle part of the range, but this area presents the fewest opportunities for observers. Schools seem to be smaller, and very wary of observers, in the southern part of the range.

Habitat and Ecology The limited information available about the black dolphin is reviewed by Goodall *et al.* (1988). They note the many inaccurate descriptions of external morphology in the literature. The appearance of the black dolphin is typical for the genus, with a conical head and a low dorsal fin with a rounded tip and a concave posterior border. The body in the water is often described as tan, brown, lead-coloured or gray. Out of the water the true colour of shades from nearly black to pure white is revealed. There is an obvious lighter lunate mark posterior to the blowhole. The colour darkens quickly after death, especially if the specimen is in the sun.

The length of only 21 specimens is known. It ranges from 1.28 to 1.67m, with females 1.36-1.65m and males 1.40-1.67m. These lengths may not be representative of the species as a whole. A 1.50m female had a foetus but was not physically mature. A physically mature male was 1.52m long, and a 1.67m male (of unknown physical maturity) appeared to be sexually mature. A 1.36m female weighed 32.5kg and a 1.52m male weighed 62kg. Seven other specimens weighed between 33.5 and 63kg. There is no other information on life history parameters. Crustaceans (*Munida subrugosa*), cephalopods (*Loligo gahi*) and fish have been found in the few stomachs examined so far.

The largest aggregations of the black dolphin have been seen on the open coast in the northern parts of the range. Estimates of school size range from about 20 to as high as 400, although the latter observation refers to the total number in several smaller groups in a large, northward moving, feeding aggregation with associated bird flocks. In the complex waterways of southern Chile large aggregations have not yet been reported, and school sizes range from two to about 15 individuals.

The behaviour is generally unobtrusive. In the southern part of the range these dolphins can be very wary and difficult to approach. In the northern area they may occasionally approach boats and bow ride.

Goodall *et al.* (1988) speculate that the black dolphin and Commerson's dolphin ranges are separated by preferred habitat differences, with Commerson's dolphin inhabiting the eastern shallow, turbid waters and the black dolphin the clearer and deeper waters to the west. Tidal ranges are very much less on the west coast than to the east, and the cooler waters in the east are more productive.

Threats Dolphins, including this species, have been exploited 'in a modest way' for thousands of years by Alacluf and Yaghan Indians. Excavations of shell middens along the Beagle Channel have revealed remains of this species dated up to 6,000 years ago. In modern times there has been some direct taking by fishermen in the northern part of the range. Most recently they have been reported to have been taken incidentally in surface gill and seine nets for jurel *Tracharus picturatus* and robalo *Eleginops maclovinus* (a Patagonian blenny), and deliberately by harpoon, to be used as bait (for crab, robalo or broadbill swordfish *Xiphius gladius*). Direct and incidental catches may also be used for oil, rarely for human consumption, and may sometimes be taken to the local fish meal plant.

The major problem is the illegal use of small cetaceans, including *C. eutropia*, as crab bait in the Magellan region. Several thousand porpoises and dolphins are harpooned annually, along with seals, sealions, penguins, guanacos and other wildlife. Only four of the 26 crab companies operating in the Magellan area provide bait to crab fishermen, and even in those cases the amount supplied is grossly inadequate. The crab fishery is expanding rapidly, and now extends to the area south of the Beagle Channel, which is being fished heavily at present. The valuable crab catch is exported. The fishery operates in this illegal manner because of the isolation of the area and a lack of enforcement of legislation protecting small cetaceans (Goodall *et al.*, 1988; Cardenas, *et al.*, 1986; Cardenas, *et al.*, in press; Perrin, 1989).

As there are no estimates of population size or of levels of removals (which are feared to be high), it is impossible to assess the effects of these takes on the population. The fact that the demand for dolphin meat for crab bait must be increasing as these fisheries expand is an additional cause for concern (Perrin, 1989).

Conservation Measures The black dolphin is known only from Chile. The countries receiving the products of the crab fishery, USA, FRG, France, the Netherlands, Belgium, Japan and Italy, also have special conservation responsibility for this dolphin.

The black dolphin is listed in Appendix II of CITES. The only international trade recorded is the movement of a scientific specimen of Chilean origin from USA to Switzerland in 1981 (CMC, 1987). The 1975 treaty between Argentina and Chile banned the use of the tangle net for crab fishing. These nets had also been incidentally taking dolphins. Unfortunately, the crab fishery then increased the use of traps, for which bait was not supplied, and dolphins are taken to provide bait. No other international legislation relating to this species was found. As an apparently coastal species found only within Chilean waters there is probably little scope for further international species-specific protection, although the Ramsar Convention or WHC might be used to protect important habitat.

Dolphins have been protected in Chile since 1977. Permits are required for any taking, but it appears that these provisions are not energetically enforced. There are also legal provisions for setting up protected areas (IWC, 1985).

The IWC subcommittee on small cetaceans recommended that the Chilean government be requested to determine the number of crab boats operating, the number of fishing days per boat and number of dolphins taken, and to take steps to enforce the existing regulations against such take. They also recommended that studies on the life history parameters be undertaken as soon as possible and that qualitative assessment of the distribution and abundance should be made (IWC, 1985).

Since the IWC meeting in 1984, it appears that the demand for bait has increased with the expanding crab fishery. Projects to reduce this illegal use of small cetaceans are proposed in the IUCN/SSC Action Plan (Perrin, 1989).

Captive Breeding The black dolphin does not appear to have been kept in captivity. However, it is a small species, and captive breeding should be a feasible conservation option if necessary.

The IWC subcommittee on small cetaceans (IWC, 1985) recommended that additional work should be carried out on captive and wild *Cephalorhynchus* spp. to provide information on their vulnerability to net entanglement. If any animals are taken for this purpose, the opportunity should also be taken for research into general biology, behaviour and breeding, to provide information for conservation and management of the wild populations and in case captive breeding ever becomes necessary for conservation.

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HEAVISIDE'S DOLPHIN **INSUFFICIENTLY KNOWN**

Cephalorhynchus heavisidii (Gray, 1828)

Suborder ODONTOCETI Family DELPHINIDAE

Summary While not considered to be rare, Heaviside's dolphin is not abundant anywhere in its known and rather restricted range. The species is taken incidentally and directly throughout the range. Two or three other species of dolphin are also involved in this taking, and it is not known what proportion of the catch are Heaviside's dolphins. It is important that the level of incidental take for this species is established, and an abundance estimate made, in order to evaluate the effect of these removals. Very little is known about Heaviside's dolphin in general, and information on biology, range and behaviour is also required, to facilitate conservation and management.

Distribution Heaviside's dolphin appears to be continuously distributed along approximately 1,000n.miles of the west coast of southern Africa, from Cape Point (*ca.* 34°20'S) in South Africa, northward to at least Bosluisbaai (*ca.* 17°23'S) in Namibia, possibly to 17°09'S and perhaps even further northward into southern Angola (IWC, 1985; Best, 1988; Best, 1984; Rice and Saayman, 1984).

Repeated sightings of recognisable individuals indicate that there may be local home ranges within that distribution (Rice and Saayman, 1984). The species occurs primarily in waters of less than 150m depth and within 5n.miles of the coast. There were no sightings in water greater than 200m depth, or further offshore than 45n.miles. Water temperatures where sightings occurred ranged from 9-10°C, although most were in waters less than 15°C (IWC, 1985; Best, 1988; Best, 1984).

The genus *Cephalorhynchus* was extensively reviewed by the IWC Scientific Committee's subcommittee on small cetaceans in 1984 (IWC, 1985) and many of the revised background papers presented, together with new material, have recently been published (IWC, 1988).

Population No reasonable population estimate is possible from available data, but Best (1984) states that the species should not be considered rare, although it is not abundant anywhere within the known range. Since 1969, seventeen research cruises have been made by South African scientists, with the main objective of obtaining cetacean (or marine mammal) sightings. On the west coast of southern Africa these have ranged from about 19°30'S to 30°S. Within the survey area approximate population densities are: 4.69 sightings per 100n.miles within 5n.miles of the coast, 1.58, 1.47 and 1.22 sightings per 100n.miles at the 6-10, 11-15 and 16-20n.mile strata, with very few sightings further from the coast (IWC, 1985).

Habitat and Ecology Best (1988) provides the first detailed description of external morphology, and comments on the errors in the previous published descriptions. Heaviside's dolphin has the general short, robust body form typical of the genus. The head is slightly less conical than in the other species, and the border between rostrum and melon is demarcated by a groove. The dorsal fin is triangular, not rounded and concave at the trailing edge as are those of the other *Cephalorhynchus* spp. The colour is basically blue-black above with a grey 'cape' over the head and thorax, and with four distinctive non-pigmented areas ventrally. At least one albino animal has been reported.

From examination of 18 specimens, maximum length appears to be 1.68 to 1.70m for both sexes. Weights ranged from 9.5 to 74.4kg. Two of the largest males examined (1.74 and 1.69m) were physically mature; no physically mature females were examined. Immature females ranged from 1.66 to 1.68m in length. Sexually mature females were 1.59m or more in length; two males were sexually mature at 1.59 and 1.69m; and four other males (1.23-1.57m) were immature. This suggests that both sexes may reach sexual maturity at about 1.57-1.59m in length.

Of the five mature females examined for which uteri were available, two were pregnant. One, killed in April, had a foetus 0.29m in length, the second, killed in October, had a foetus 0.22m long. The occurrence of similar-sized foetuses six months apart would suggest that the breeding season may not be very restricted in duration. Four of the six mature females were lactating; one was both pregnant and lactating. The smallest animal examined had an unhealed umbilicus, and was presumably newly born. This male was 0.85m in length, and stranded in January 1986 (Best, 1988; Best, 1984; IWC, 1985).

Group sizes are small, usually between 1-10 animals and averaging about three individuals. Small groups may combine to form larger aggregations of up to 30 animals. Repeated sightings of easily recognisable individuals (including albinos) in relatively restricted areas indicates that some individuals or groups may not range far. Calves (usually found in larger groups) comprised 9.9% of all animals seen. The species seems to be attracted to moving vessels, but is difficult to spot at sea (Best, 1988; Best, 1984; Rice and Saayman, 1984).

Stomach contents have been examined from 13 animals, 10 of which were collected at sea, one was beach-of 5cast, and two were incidentally caught. The weight of stomach fills was generally small, and the contents highly digested. This suggests that either feeding normally takes place at night, or that animals with full stomachs do not tend to approach ships and are thus less vulnerable to capture. The food comprises a mixture of bottom-dwelling organisms (*Congridae, Octopoditae*), demersal species that may migrate off the bottom (even to the surface) at night (*Merluccius* spp.), mesopelagic species that may exhibit vertical migration to the surface (*Gonostomatidae, Myctophidae*), and pelagic species that can be found from the surface to near the seafloor on the continental shelf (*Sufflogobius, Trachurus*) (Best, 1984). Surface feeding activity was not reported by Best (1984), but Rice and Saayman (1984) cited records of feeding in shallow inshore waters. More information is required on the diving and other daily activity patterns of these dolphins before their feeding strategy can be fully understood.

Threats Heaviside's dolphins are taken incidentally in inshore net fisheries (trawls, purse seines and set-nets) off the west coast of South Africa and Namibia. There is also some directed take.

There is an unconfirmed report that two animals were taken in a bottom trawl in water 366m deep, but no catches were made in 152 observed drags by research and commercial bottom trawls from 1977-1981 off South Africa and Namibia (Best, 1984). There are confirmed reports of takes in purse-seine operations off Namibia. Best (1984) estimated a catch of 5.26 dolphins/100 throws and a mortality rate of 0.96/100 throws, based on 209 throws observed between 1979 and 1983. Estimated total catches and kills of dolphins in 7,013 throws off Namibia in 1983 were 369 caught and 67 killed (*C. heavisidii* and *Lagenorhynchus obscurus* combined). Estimates of catch rates are not available for vessels operating out of South Africa, but if the rates for Namibia are applied, an estimate of 310 captured and 57 killed is obtained (*C. heavisidii, L. obscurus* and *Delphinus delphis* combined). The relative proportions of the species taken are not known (IWC, 1985).

Best (1984) reports that a more significant source of mortality in Heaviside's dolphins may be set nets in waters close inshore off Namibia. In 1982, fourteen beach-cast specimens were found in an 18km stretch of beach shortly after three fishing vessels had been operating set nets close offshore. There were 25 such vessels in 1984, authorised to use a maximum of 200 nets. There are no data on catch rates or mortality (IWC, 1985).

Other net fisheries off South Africa include a limited number of drift nets and anchored St Joseph shark *Callorhynchus capensis* nets. These nets are either continuously attended or left for relatively short periods of time. Best (1984) considers that these fisheries do not pose a threat to the dolphin population.

Best and Ross (1977) estimated that about 100 dolphins a year (of at least three other known species, but probably also including *C. heavisidii*) might be taken directly by hand harpoons and used for human consumption. They believed that the deliberate catching of animals with beach-seines or 'trek' nets was rare; the meat was used for human consumption. This fishery appeared to take whatever animals were available at the time. They estimated that, if this practice still continued, the total take would be small, probably less than 50 animals of all species annually. Both these fisheries are traditional and have been illegal since 1973. The lack of information on catch levels and species taken probably results from fear that the fishermen admitting catches will be prosecuted. It is believed that instead of landing at least part of the catch for butchering ashore (as happened before the protective legislation was introduced), the fishermen now cut up any animals that are taken at sea and only bring the meat ashore. Rice and Saayman (1984) report some more recent incidents, which appear to indicate that at least some *C. heavisidii* may still be used in this way. They were also informed that fishermen operating out of Cape Town (at least up to 1978) particularly sought Heaviside's dolphin, as the meat made the finest biltong.

Eleven individuals have been taken under permit for scientific purposes (mainly to provide information on feeding habits and other biological data): 1970 - 1; 1977 - 3; 1978 - 1; 1979 - 1; 1980 - 1; 1982 - 1; 1984 - 3 (Best, 1988).

Conservation Measures Known countries of origin are South Africa and Namibia, although the range may extend to Angola.

Heaviside's dolphin is included in Appendix II of CITES. The following international trade is recorded: 1981 - one scientific specimen and one skeleton for museum use, from South Africa to USA; 1984 - one scientific specimen from South Africa to USA, and one commercial specimen of South African origin recorded as moving from USA to USA (*sic*) (CMC, 1987). No other international legislation covers this species, but as it occurs only in the coastal waters of South Africa and Namibia (and possibly southern Angola), there may be little scope for further international protection, although a bilateral or trilateral conservation agreement between the countries of origin would be useful.

Under the Sea Fisheries Act of 1973, it is forbidden, without permit, to kill, catch, attempt to kill or catch or disturb any member of the Superfamily Delphinoidea in the 200 mile South African fishing zone and the 12 mile zone of Namibia. Some prosecutions for dolphin harassment and for being in possession of dolphin meat may have reduced the level of deliberate killing (IWC, 1985). In general, young animals and females accompanied by young may not be hunted in Angola. There are also some conservation areas which might protect habitat.

In the absence of estimates of past or present population size and total removals, the IWC subcommittee on small cetaceans were unable to comment on the status of Heaviside's dolphin, beyond noting that although the species should no longer be considered 'rare', it is not abundant anywhere in its known range. Individuals or small groups are reported often to approach and swim close to vessels, and are thus vulnerable to directed take (IWC, 1985). The subcommittee noted, however, that the species has a relatively restricted geographical range and that, in common with other species in which groups may have a restricted range of movement, groups may be vulnerable to localised effects from pollution and development of intensive fisheries (IWC, 1985). They suggested that more information is required on the level of the incidental take of this species in set nets off Namibia. Additional information is needed on the northern limit of distribution, and an abundance estimate is required, so that the effect of any incidental take may be evaluated. Further studies of life history parameters are also required (IWC, 1985).

The IUCN/SSC Action Plan does not contain any specific projects for this species, but it will be covered by general projects such as monitoring incidental takes (Perrin, 1989).

Captive breeding Five individuals were illegally live-captured in 1975 off South Africa. One animal died at capture, and the other four were released by the authorities after spending about a week in a nearby cemented-in rock pool. The opportunity was taken to film behaviour and record underwater sounds before the animals were released (Watkins, Schevill and Best, 1977; IWC, 1985).

As this is a small species, captive breeding should be feasible, if necessary, for conservation purposes. The IWC subcommittee on small cetaceans recommended that additional work should be carried out on wild and captive *Cephalorhynchus* spp. to explore the problem of vulnerability to entanglement in monofilament gillnets (IWC, 1985). If any animals are taken into captivity for this purpose, the opportunity should also be taken to obtain information on biology, breeding and behaviour, which is needed for conservation and management of the wild populations, and in case captive breeding ever becomes necessary for species conservation.

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HECTOR'S DOLPHIN **INDETERMINATE**

Cephalorhynchus hectori (van Beneden, 1881)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Hector's dolphin is endemic to New Zealand coastal waters. A survey of distribution and abundance in 1984/5 indicated a total population of only 3,000-4,000. Entanglement in gill nets may be a threat to the continued existence of the species: in an area for which comprehensive data were collected, a high proportion of the estimated population may be killed annually. This area has recently been declared a Marine Mammal Sanctuary, and use of gill nets there is likely to be severely restricted. Management strategies are also required (e.g. net modifications and/or fishing regulations) to reduce this kill throughout the range. The species is, in general, not well known, and further information on reproductive rate, abundance, movements and fishing mortality is needed for effective conservation and management. In view of the comparatively small total population, it may also be prudent to explore the feasibility of captive breeding, in case this should ever be required for conservation.

Given its low estimated total abundance, the species could at best be listed as Rare, but may be Vulnerable if the population has already been substantially reduced by incidental takes: there is also a case for classifying it as Endangered on the grounds of a critically low population size. It is therefore listed here as Indeterminate, which means that it is known to be Endangered, Vulnerable or Rare, but there is insufficient information to judge which of the three categories is most appropriate.

Distribution Hector's dolphin is found only in New Zealand coastal waters between about 35°15'S (mainly from 41°S) and 46°35'S. A boat survey in 1984/5 of the distribution area revealed that abundance is similar on both the east and west coasts of South Island. In general, the distribution is highly clumped, even within larger areas of relative high abundance. The dolphins are apparently absent from Fiordland, at the southwestern tip of South Island, and are rare along the southeast coast, although they are locally abundant there in Te Wae Wae Bay (46°26'S, 167°31'E). In North Island they are regularly reported only between Kawhia (38°06'S, 174°48'E) and the Manukau Harbour (37°04'S, 174°32'E) but are occasionally seen around Cape Egmont (39°17'S, 174°45'E) and as far north as Kaipara (36°21.5'S, 174°11'E). Fishermen from Palliser Bay (41°36.8'S, 175°17'E) and Wellington Harbour (41°21'S, 174°52'E) very occasionally report seeing the species (Dawson and Slooten, 1988). Distribution maps are given by Dawson and Slooten (1988) and by Cawthorn (1988).

The survey found that about 45.5% of the dolphins were sighted within 800m of the shore in summer, and all sources agree that they are rarely seen further offshore than 5n.miles. The most consistent factor influencing the distribution of Hector's dolphin appears to be their preference for shallow waters. If this is the case, it would explain their absence from Fiordland, where depths in excess of 300m are very common near shore, and an apparent gap in distribution between North and South Islands across the Cook Strait (Dawson and Slooten, 1988).

Marked and naturally recognisable dolphins have been resighted in the same locality in all seasons for up to five years, suggesting that the population may consist of small sub-populations resident in particular areas. The dolphins move close inshore in spring and summer, and there is a general reduction in numbers inshore during winter (Morzer-Bruyns and Baker, 1973; Baker, 1978; Baker, 1984; Dawson and Slooten, 1988; Slooten and Dawson, 1988; Cawthorn, 1988; Slooten and Dawson, in press).

The genus *Cephalorhynchus* was extensively reviewed by the IWC Scientific Committee's subcommittee on small cetaceans in 1984 (IWC, 1985) and many of the background papers presented, together with new material (particularly on Hector's dolphin), have recently been published (IWC, 1988).

Population Calculations based on a boat survey of a 800m coastal strip (covering in total an estimated distance of 4,500n.miles in two-way surveys of the entire known present distribution), indicated a total population of between 3,000 and 4,000 animals. Hector's dolphins are extremely rarely or never sighted in the areas not covered by the survey. Offshore transects as well as simultaneous cliff-top and boat survey counts were also conducted in order to provide correction factors for animals missed on the main survey (Dawson and Slooten, 1988; Slooten and Dawson, in press). This estimate similar to Baker's (1984) guess of 3,000 to 4,000, made on the basis of a rough extrapolation of the Cloudy Bay (41°26'S, 174°10'E) population of some 300 individuals to other similar localities where the dolphin has been recorded. Cawthorn (1988) speculated that the total population might be between 5,000 and 6,000 animals, from available incidental sightings records and rough estimates of effort and sighting efficiency (given as 20-30%). Since Dawson and Slooten (1988) found their sighting efficiency to be 78%, an over-correction for sighting efficiency might account for Cawthorn's larger speculative population estimate.

There are no estimates of past population, nor do there appear to be any parts of the main range which have been abandoned. Gaskin's (1976) 'subjective impression' of a rapid decline in numbers, and some other similar suggestions were rejected by Baker (1978) and by Cawthorn (1988). Dawson and Slooten's (1988) survey has provided base-line information from which any future changes in abundance might be estimated.

Habitat and Ecology Baker (1984) lists maximum length of females as 1.53m, and maximum weight as 57.27kg. The maximum length of males was 1.38m, and the maximum weight 52.72kg. In Slooten and Dawson's (in press) sample the animals were somewhat smaller (maximum for females 1.40m, 47kg, and for males 1.29m and 36kg).

Sexual maturity is reached in females between 1.35m and 1.39m in length, and in males between 1.17m and 1.27m. Analysis of growth layer groups (GLGs) in teeth and examination of ovaries, indicates that females may be approximately seven years old at first ovulation and eight years old when they give birth to the first calf. Calves are 0.6 to 0.75m long at birth, and are born during spring and early summer (early November to February). Long-term observations on a population of over 300 photo-identified Hector's dolphins indicate that females have at most one calf every two years, but the average birth interval could be longer (Slooten and Dawson, 1988; Slooten, 1988).

Predation by sharks (sevengill sharks *Notorhynchus cepedianus* and blue sharks *Prionace glauca*) is a known source of natural mortality, but there is no information on overall natural mortality rates (Slooten and Dawson, 1988; Cawthorn, 1988).

The previous food records for *C. hectori* are summarised by Baker (1978) and include horse mackerel *Trachurus novaezealandiae*, red cod *Physiculus bachus*, sand stargazer *Crepatalus novaezelandiae* and engraulids. Slooten and Dawson (1988) report that Hector's dolphins appear to feed mostly in small groups. They feed opportunistically, both at the bottom and throughout the water column. These authors' food records include surface-schooling fish (e.g. kahawai *Arripis trutta* and yellow-eyed mullet *Aldrichetta fosteri*), arrow squid *Nototadarus* spp. and benthic fishes such as red cod *Pseudophycis bacchus*, ahuru *Auchenoceros punctatus* and stargazer, and the occasional swimming crab *Ovalipes catharus* and other small crustacea. However, the crustacea appear to be mostly derived from the stomach contents of the fish taken by the dolphins. They have sometimes observed Hector's dolphins chasing and catching mullet and kahawai at the surface.

Threats Historically, Hector's dolphins have been subject to a low directed take, mainly for use as bait in traps for rock lobster *Jasus edwardsii*. This take appears to have ceased in recent years, following the introduction of protective legislation in 1978 and changes in public attitudes to dolphins (Slooten and Dawson, 1988).

The apparent level of incidental catches in coastal gill nets is causing concern. Dawson and Slooten (1988) report that highly-valued commercial fish species move inshore in summer, resulting in increased inshore gill netting effort at this time of year, when the Hector's dolphins are also concentrated inshore. The main fisheries are for two elasmobranchs, rig *Mustelus lenticulatus* and elephant fish *Callorhynchus milii*, although catches of these two species have greatly declined in recent years through overfishing and reduced quotas.

Reported incidental catch of Hector's dolphins in set-nets in Pegasus Bay, Banks Peninsula and Canterbury Bight waters (from Motunau to Timaru) from 1984 to 1988 is shown in Table 1 (New Zealand, 1988). The commercial fishermen were systematically interviewed about dolphin takes (except for two who could not be contacted in 1985/86), but it was impossible to interview all the hundreds of amateur gill-netters who use the Banks Peninsula area each summer. These figures are therefore minima (New Zealand, 1988; Slooten, 1988).

Table 1. Reported incidental takes of Hector's dolphins near Banks Peninsula.

Sources of Entanglement	1984/85	1985/86	1986/87	1987/88
Commercial	61	88	32	18
Amateur	2	2	9	7
Unknown*			3	1
Total	63	90	44	26

Unknown* refers to beach-cast specimens with marks consistent with net entanglement.

New Zealand (1988) quotes an estimate of 526 dolphins in this area, from the 1984/5 survey, and quotes a figure of 300 in 1986, based on a survey by Slooten and Dawson in December 1986. As there are no confidence limits given for either estimate, it is not possible to assess whether there has been a real decline in abundance. However, the minimum reported takes are high for an apparently local population of only a few hundred animals.

Other estimates of incidental catch around New Zealand have been very much lower, although not collected with the same concentration of effort. Baker (1978) reports that incidental catches which came to his notice were up to 11 per year and involved the South Island east coast elephant fish and moki *Latridopsis* gill net fisheries and the bottom trawl fishery in the same area. In two separate instances, four and three individuals were taken in trawl nets. Baker notes (1984) 18 recorded incidental takes since 1973 and says that although no information is available on catches not officially reported, 'fishermen's rumours' indicate a low level of incidental captures each year. New Zealand (1986) reports three Hector's dolphins taken in shallow-water gill nets set inshore in 1984-85, one at Te Wae Wae Bay, one at Le Bons Bay and one at Nelson.

Cawthorn (1988), however, says that the Ministry of Fisheries biologist responsible for the rig fishery believes that the unreported catch of Hector's dolphins in the Canterbury and Pegasus (Banks Peninsula) fisheries is probably 100 plus per year, and expects proportionally high catches in other inshore set-net fisheries for rig. Cawthorn (1988) estimates a total incidental take in all New Zealand fisheries of 100 to 200 Hector's dolphins each year, and gives a Table showing that the Canterbury/Pegasus area accounts for just under half of the average length of rig fishery net deployed.

The rig fishery had developed rapidly around South Island and on the west coast of North Island by the mid-1970s. Trawlers working inshore take rig as a by-catch and the inshore set-net fishery targets most effectively on this species. The fishery, which peaked around South Island in the middle to late 1970s, has subsequently shown signs of being over-exploited and is now declining in most areas. Because of the high market value of rig and the low capital investment required to enter the fishery, it has benefitted fishermen still involved to increase gill net lengths worked as other vessels drop out. Consequently, effort has remained high. Currently, 57% of the total rig catch of about 3,000 tonnes is taken in monofilament gill nets, with a 15-16cm stretched mesh measurement, set close inshore, often in the surf zone. Gill nets are worked seasonally in all the coastal waters known to be inhabited by Hector's dolphin. The height of the fishing season coincides with the season when dolphin sightings are highest inshore (Cawthorn, 1988; Slooten and Dawson, 1988).

Slooten (1988) says that up to 200 vessels were involved in the Canterbury/Pegasus fishery at its height in the late 1970s, but currently between three and seven boats are active each year. The Banks Peninsula area, however, is a favoured holiday destination for the inhabitants of Christchurch, the largest city in South Island. The level of amateur set-netting is thus particularly high.

All sources agree that very few incidentally-taken dolphins are officially reported, although such takes have not been illegal in New Zealand since 1978, provided that they are promptly officially reported.

Contaminants have been reported in tissue samples (Baker, 1978; Slooten and Dawson, in press). However, without details of the physical condition of the animals sampled or standardization of the measurement techniques, such reports are of limited value in assessing any risk to the population as a whole (IWC, 1986; Aguillar, 1985).

Adult and juvenile Hector's dolphins are strongly attracted to small boats, especially those travelling slowly (less than 10 knots). They avoid faster vessels by diving. Mothers with newborn calves are shy and seldom approach stationary or moving boats. Slooten and Dawson (1988) also report that the dolphins do not appear to be disturbed by boat traffic. The animals continue to use favoured areas regardless of the level of traffic.

Conservation Measures Hector's dolphin is found only in New Zealand. The species is listed in Appendix II of CITES. The following international trade is reported: one scientific specimen of New Zealand origin, from USA to Switzerland in 1981; one commercial and one scientific specimen from South Africa to USA in 1984 (CMC, 1987). No other international legislation protecting this dolphin was found, and, as it occurs entirely within New Zealand waters, there is probably little scope for further specific international protection, although the Ramsar Convention or WHC might help to protect habitat.

In New Zealand, the 1978 Marine Mammal Protection Act gives full protection to all marine mammals within the 200 mile Fisheries Waters and also provides for the setting up of marine mammal sanctuaries. No animals may be taken without permits, although accidental catches are not illegal, provided that they are promptly officially reported. The Marine Reserves Act 1971, could provide protection for important habitat. The IWC subcommittee on small cetaceans (IWC, 1985) recommended that population studies should be continued and that the interactions with fisheries be investigated. Since that meeting, further information on the level of incidental catching has emerged (see above).

The IUCN/SSC Action Plan (Perrin, 1989) calls for the development of management strategies (e.g. net modifications and/or fishing regulations) to reduce incidental taking, and for continued studies of reproductive rate, abundance, movements and fishing mortality.

In response to the increasing evidence of excessive incidental takes of Hector's dolphins in the Banks Peninsula area, the New Zealand Department of Conservation, after extensive consultations with the various interested parties, produced a discussion paper in 1988. This outlined the problem, gave a number of options for the protection of the dolphins, and invited public comment (New Zealand, 1988).

The Department made known in this document that it believed the situation of the dolphin populations in this area was sufficiently serious to warrant the introduction of controls on all set-netters, and that the introduction of a Marine Mammal Sanctuary (the first in New Zealand), under the Marine Mammals Protection Act, would be the most appropriate way of doing this. This option would also serve to protect the threatened yellow-eye penguin, which is also prone to entanglement in set-nets. The option of gear modification was rejected, on the grounds that no passive or active devices have yet been shown to have more than a very marginal effect on dolphin entanglement rates (New Zealand, 1988).

The Sanctuary provisions came into effect on 9 February 1989 (Slooten, 1989) and the use of set-nets during the summer from November to February is likely to be forbidden, although no final decision has been taken. During the other months of the year nets no longer than 30m could be used, and then only if set in daylight hours and constantly attended. Such action would effectively stop commercial gill netting in the area, and severely restrict the amateur set-net fishery.

These initiatives should go far towards protecting the Banks Peninsula population of Hector's dolphin, and similar action should be taken to investigate the effects of incidental takes throughout the range.

Captive Breeding Four specimens (two males and two females) were captured alive in Cloudy Bay for Napier Marineland, New Zealand, between 6-12 February 1970. One male survived for two and a half years. A female was killed after a couple of months by a rampaging leopard seal *Hydruga leptonyx*. A male died a few weeks after this episode, although not hurt by the seal, and one female survived for only six weeks (Baker, 1978; Cawthorn and Gaskin, 1984; Abel, Dobbins and Brown, 1971; Slooten and Dawson, 1988).

As Hector's dolphin is a small species, captive breeding should be feasible for conservation, should it become necessary. The lack of success in the single attempt to keep these animals almost 20 years ago should not be taken to indicate that they could not be kept under modern husbandry.

The IWC subcommittee recommended that additional work should be carried out on captive and wild *Cephalorhynchus* spp. to provide information on their vulnerability to net entanglement (IWC, 1985). Some work with sound production in wild animals is in progress (Dawson, 1988). If any animals are taken into captivity for this purpose, the opportunity should also be taken for research into general biology, behaviour and breeding, to provide information for conservation and management of the wild populations, and in case captive breeding ever becomes necessary for conservation.

The IUCN Policy Statement on captive breeding, prepared by the IUCN/SSC Captive Breeding Specialist Group, recommends that management to best reduce the risk of extinction requires the establishment of supporting captive populations at an early stage, preferably when the wild population is still in the thousands (IUCN, 1988). In view of the comparatively small total population of Hector's dolphin, it may therefore be prudent for the feasibility of captive breeding to be explored.

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MELON-HEADED WHALE **INSUFFICIENTLY KNOWN**
Peponocephala electra (Gray, 1846)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The melon-headed whale is little known. There is no information on abundance or status, but it seems to have a wide oceanic range. The main need is for more information on range, abundance, biology, behaviour and levels of incidental take in all areas.

Distribution The melon-headed whale seems to be distributed worldwide in tropical and subtropical waters. It is pelagic, ranging from the continental shelf seaward and around oceanic islands, and appears to stay mainly in equatorial water masses (Leatherwood and Reeves, 1983).

Population There are no population estimates for any part of the range. The only area where the melon-headed whale has so far been described as common is near Cebu Island in the Philippines (Hammond and Leatherwood, 1984). Leatherwood and Reeves (1983) consider the species to be rare elsewhere. Others are under the impression that it may be more common than the sparse records so far indicate (Dawbin, Noble and Fraser, 1970; Nishiwaki and Norris, 1966; Rancurel, 1973; Bryden, Harrison and Lear, 1977).

Habitat and Ecology The longest female so far reported was 2.75m (Lodi, Siciliano and Capistrano, 1988) and the longest male 2.73m (Perrin and Reilly, 1984). Sexual maturity is reached in females between 2.29 and 2.57m, and in males between 2.12 and 2.64m, with an average of 2.68m. The average age of sexually mature males was 14 Growth Layer Groups (GLGs) in teeth, possibly representing 14 years of age. The oldest female so far reported also had 14 GLGs. The oldest immature male had 3 GLGs and the oldest immature female 4 GLGs. The youngest mature female had 12 GLGs and the youngest mature male 7 GLGs. The length at birth is between 0.65 and 1.12m (Perrin and Reilly, 1984). These data are based on very few specimens from scattered localities. Newborn animals have been seen in the Southern Hemisphere from August to December, and gestation may last for a year (Bryden, Harrison and Lear, 1977).

These animals are social, living in schools of 100 to 500 or more animals. These may contain subgroups of 30-40 as viewed from on shore, or two to eight, as seen in another school viewed from a boat (Bryden, Harrison and Lear, 1977).

The species feeds on squid and a variety of small fish species (Leatherwood and Reeves, 1983).

Threats Small numbers are occasionally taken in general small cetacean fisheries, for example in Japan, Indonesia, the Caribbean and Sri Lanka. Small numbers may be taken incidentally in the eastern tropical Pacific by tuna purse seines. They are also sometimes caught incidentally by gillnets off Sri Lanka (Leatherwood and Reeves, 1983; Leatherwood *et al.*, 1987). There is no information on the level of bycatches in other pelagic fisheries within the range.

Conservation Measures Potential countries of origin include all those with coastlines in tropical and subtropical waters. Locations reported so far include: India, USA, Senegal, Guinea, Indonesia, Australia, Japan, Pakistan, Sri Lanka, South Africa, Brazil, the Philippines, the Maldives, the Seychelles, St Vincent and the Grenadines, France (Marquesas, Tuamotus) and UK (Aldabra).

The melon-headed whale is listed in Appendix II of CITES. The following international trade is reported: 1985 - 1 specimen from Saudi Arabia to USA (CMC, 1987).

The IUCN/SSC Action Plan does not contain any specific projects for the melon-headed whale, but it will be covered by general projects such as the monitoring of direct and indirect takes (Perrin, 1989). More information on range, abundance, biology and behaviour is required in all areas.

Captive Breeding At least 14-15 have been kept in captivity: two to three in Hawaii, ten in the Philippines and two in Japan (IWC, 1984). The catches in the Philippines were made in 1974 and 1975 between Siquijor, Balicosog and Pamilican islands. The animals were intended for exhibition at Ocean Park, Hong Kong. Four of the animals were released within two weeks, the remaining six survived for 30-45 days in a combination of sea pens and above ground pools. The animals were aggressive when released into the pens. Several handlers were injured when they were hit by a whale's head or raked by the teeth. On one occasion when a handler was swimming in the sea pen, a whale repeatedly dived to the bottom and surfaced at high speed, striking the swimmer on his abdomen or back (Hammond and Leatherwood, 1984). These authors mention that similar problems with aggression were encountered with the Hawaii specimens. There is no information on the behaviour of the Japanese animals, which were obtained from a drive fishery in Taiji in 1980 (Kasuya, Tobayama and Matsui, 1984).

In view of the aggressive behaviour of the melon-headed whale in captivity, it appears that conservation through captive breeding is unlikely to be feasible, despite the fact that this is a relatively small animal. If any more specimens are brought into captivity information relevant to conservation and management should be collected. In particular the calibration of ageing techniques and details of reproduction are required. Information relevant to captive breeding should also be collected, in case conservation by this method ever became necessary.

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PYGMY KILLER WHALE **INSUFFICIENTLY KNOWN**
Feresa attenuata Gray, 1875

Suborder ODONTOCETI Family DELPHINIDAE

Summary Little is known about the pygmy killer whale, nor are there any known major threats.

Distribution The pygmy killer whale appears to be widely distributed in tropical and warm subtropical waters worldwide, but the range is not well-known (Leatherwood and Reeves, 1983; Leatherwood *et al.*, 1987).

Population No population estimates are available. So far the species does not appear to be abundant in any region (Leatherwood and Reeves, 1983) but this may only reflect observer activities.

Habitat and Ecology The longest male so far recorded was 2.87m (Odell and Asper, 1986) and the longest female 2.43m (Perrin and Reilly, 1984). The smallest sexually mature male was 2.01m (Odell and Asper, 1986) and the smallest mature female 2.21m (Perrin and Reilly, 1984). Length at birth is somewhere between 0.53 and 0.82m (Perrin and Reilly, 1984). These data are from very few specimens reported from scattered localities.

The only information on food habits appears to be that a captive specimen accepted live sardines after rejecting squid, saurel and mackerel pike (Nishiwaki *et al.*, 1965).

Pygmy killer whales may form large herds of several hundred individuals, but groups of 50 or fewer are more common (Leatherwood and Reeves, 1983).

They have been reported to herd and attack other small cetaceans in the eastern tropical Pacific (Perryman and Foster, 1980).

Threats There are no specific fisheries for pygmy killer whales, but they are sometimes taken in general small cetacean fisheries, for example in Japan, the Lesser Antilles, Senegal, Peru and Indonesia. A few are also known to be taken incidentally, for example in gillnets off Sri Lanka and in the eastern tropical Pacific tuna purse seine fishery (Leatherwood and Reeves, 1983; Cadenat, 1958; Perrin and Hubbs, 1969; Caldwell and Caldwell, 1975; Leatherwood *et al.*, 1987; Van Waerebeek and Reyes, 1988). The main objectives of direct fisheries are meat for human consumption and some oil for cooking and medicinal purposes. Incidental takes and stranded animals may also be used for these purposes in some areas.

Conservation Measures Potential countries of origin include all those with coasts in tropical and subtropical waters. Specific locations reported so far include: USA, Japan, Senegal, St Vincent and the Grenadines, South Africa, Indonesia, Oman, Sri Lanka, Peru and Costa Rica. CITES Appendix II listing is the only international protection provision. No international trade is reported (CMC, 1987). The species is covered by general legislation in several countries.

The IUCN/SSC Action plan does not contain any specific projects related to the pygmy killer whale, but it will be covered by general projects such as monitoring direct and indirect takes of small cetaceans (Perrin, 1989).

The main need is for more information on distribution, abundance, biology and behaviour throughout the range. More details of direct and indirect takes are also required.

Captive Breeding Three specimens were captured alive and held for short periods in Hawaii. The animals proved to be aggressive towards both keepers and to other small cetaceans in the pool. They did not adapt well (Reeves and Leatherwood, 1984; Pryor, Pryor and Norris, 1965). A group of 14 animals, captured by driving in Japan, was taken to the Ito Aquarium in 1963. During the drive the animals were described as obedient, but slow. One animal died while being transported to the aquarium. Except for one male which accepted food, all the others died within a week. The cause of death could not be determined. The male which accepted food died after 22 days, of pneumonia. No mention is made of aggressive behaviour (Nishiwaki *et al.*, 1965).

Since there appears to have been only two attempts to keep this species, and these were many years ago, it is possible that modern husbandry techniques would have more success. The species is a reasonable size for conservation through captive breeding to be feasible, if necessary. If any more specimens are brought into captivity, information required for conservation and management should be collected. In particular, calibration of ageing methods and details of reproduction are needed. Information relevant to captive breeding should also be collected, in case conservation through this method ever became necessary.

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FALSE KILLER WHALE **INSUFFICIENTLY KNOWN**
Pseudorca crassidens (Owen, 1846)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The false killer whale is not well known and possibly not very abundant. It does have a wide oceanic range and there are no known major threats to the species as a whole at present. However there are conflicts with other fisheries in several parts of the range, as well as some direct and indirect taking. Further information on range, abundance, biology, behaviour and removals is required. This should be done with some urgency in areas where there are fishery conflicts and where there are known takes.

Distribution The false killer whale is found in tropical and warm temperate waters worldwide. There are occasional records of vagrants in cool temperate waters. The species is believed to be mainly oceanic, rarely approaching land except near oceanic islands and land masses with deep water nearby. Migrations have not been described, but the most northerly reports in the northeastern Pacific appear to be related to seasonal warming of the waters (Leatherwood and Reeves, 1983).

In the Atlantic Ocean they are reported from Maryland, USA south through the Caribbean Sea to Venezuela, and to northern Argentina. On the eastern side they have been recorded as far north as central Norway and south to South Africa. They are also known in the Mediterranean Sea, and occasionally from the Baltic Sea. However, the most northerly sightings reports have been in water with a mean surface temperature between 14° and 18°C (McBrearty, Message and King, 1986; Gordon, Arnbom and Deimer, 1988). In the North Pacific Ocean they are reported from Alaska to southern California in the east and from northern Japan, PR China and Taiwan southwards (Wang, 1984). In the South Pacific they are reported as far south as Australia and New Zealand. Tasmania appears to be on the southern extreme of the range (Nichol, 1987). False killer whales are found throughout the Indian Ocean (Leatherwood and Reeves, 1983: Leatherwood *et al.*, 1987).

Population There is no information on numbers in any part of the range, but Leatherwood and Reeves (1983) suggest that on current evidence the species is nowhere abundant. McBrearty, Message and King (1986) report that it was one of the least frequently sighted species in the eastern North Atlantic, and then mainly from southern areas. Gordon, Arnbom and Deimer (1988) only report one encounter off the Azores. The publicity given to the occasional group strandings of this species may give the impression that it is abundant, but the relationship between numbers stranded and numbers alive at sea has not been established for any cetacean species (IWC, 1986).

Habitat and Ecology The longest recorded male false killer whale was 5.96m and the longest female 5.06m. Males attain sexual maturity somewhere between 3.66m and 3.72m and females between 3.64m and 3.49m in length. The average length of sexually mature males in the eastern North Atlantic is 5.32m and in the western North Atlantic 5.20m. The average length of sexually mature females is reported to be 4.47m in the eastern North Atlantic, 4.58m in the western North Atlantic and 4.30m in the western North Pacific. Both males and females appear to be sexually mature at between 8 and 14 Growth Layer Groups in the teeth, probably representing 8 to 14 years of age. The length of gestation is assumed to be 16 months, and lactation appears to last for 18 months. The length at birth is between 1.57 and 1.83m. (Perrin and Reilly, 1984). Calves have been seen throughout the year, indicating that there is no fixed breeding season (Leatherwood and Reeves, 1983).

The false killer whale feeds primarily on cephalopods and large fish, the relative proportions probably depending on area and season. They have acquired a bad reputation in some areas because they are known to steal fish from the lines of commercial and sport fishermen. They are one of several species of 'blackfish' reported to attack smaller cetaceans escaping from tuna purse-seine nets in the eastern Tropical Pacific (Perryman and Foster, 1980).

False killer whales are gregarious, often forming herds of more than a hundred individuals. These herds usually contain individuals of both sexes and all age groups, and appear to have strong social cohesion (Leatherwood and Reeves, 1983). McBrearty, Message and King's (1986) records show comparatively small group sizes, ranging from one to ten animals.

Threats In several areas in the Pacific this species is blamed for damaging fisheries. At Iki Island, off the northern coast of Kyushu, western of Japan, there is a conflict between dolphins (including *Pseudorca crassidens*) and a hook-and-line fishery for yellowtail tuna. This conflict has been apparent since around 1910, but seemed to increase from the early 1960s. Various solutions to the problem were explored, but culling began in 1976. A total of 953 false killer whales were taken up to 1982 (Kasuya, 1985). Further details of this situation, which is still unresolved, are given in the bottlenose dolphin review.

The tuna long-line fishery in the tropical Pacific also suffered from dolphin (mainly *Pseudorca crassidens*) depredations. Sometimes two or three years passed without damage, but in some years an estimated 5% of the catch, worth $25,000,000 to $30,000,000 was lost (IWC, 1980).

False killer whales are taken in the Pacific tuna purse seine fishery (IWC, 1980), but in small numbers. They were also taken in small numbers by the Taiwanese pelagic gillnet fishery which operated in the northern waters of the Australian Fishing Zone (Harwood and Hembree, 1987). The Taiwanese fishery has now moved elsewhere (Australia, 1988a) and information on any incidental takes is no longer available.

The species is occasionally taken in the Japanese and Taiwanese small cetacean fisheries and used for human consumption. There have also been some captures in PR China. Some are taken in the Caribbean small cetacean fisheries, and also used for human consumption (Wang, 1984; Leatherwood and Reeves, 1983). Some are accidentally killed in gillnets off Sri Lanka (Leatherwood *et al.*, 1987). They may also be accidentally taken in tuna long-line fisheries (Leatherwood and Reeves, 1983).

Conservation Measures Potential countries of origin include all those with coastlines in warm temperate and tropical waters. Reported locations so far include: USA, Canada, Cuba, St Vincent and the Grenadines, Venezuela, Argentina, South Africa, Norway, FRG, UK, Italy, Japan, PR China, Taiwan, Mexico, Brazil, USSR, Ecuador (Galapagos), Chile, France, Australia, New Zealand, Peru, Portugal (Azores), Sri Lanka, India, Tanzania and Indonesia. The species is listed in CITES Appendix II. The following international trade is reported: 1982 - 100 scientific specimens from Japan to Australia, 50 scientific specimens from South Africa to Australia; 1983 - 64 pairs of scientific specimens from Japan to Austria, 50 scientific specimens from South Africa to Australia, 8 live specimens for zoological purposes from Japan to Hong Kong, 4 live specimens for commercial purposes from Japan to R Korea, 4 live specimens for zoological purposes from Japan to USA; 1984 - 2 live specimens for scientific purposes from Japan to USA (CMC, 1987). The species is listed in Appendix II of the Berne Convention. No other international agreements relate to the species. The false killer whale is protected by general legislation in several countries. The IUCN/SSC Action Plan does not have any special projects for this species, but it will be included in the general projects for monitoring small cetacean fisheries, incidental taking and fisheries conflicts (Perrin, 1989). More information on range, abundance, biology and behaviour is required throughout the range. In particular more information about food habits and behaviour is needed in areas where the species is blamed for damage to fisheries.

Captive Breeding At least 18 specimens had been kept in captivity up to 1983: including at least 10 in Hawaii, one taken off the Pacific coast of the USA, five in Japan and two in Australia (IWC, 1984). It is not clear when the live specimens mentioned in the Conservation Measures section above were taken, nor the specimens imported into the Netherlands mentioned below. Six were imported to the Netherlands from USA in 1988, and displayed at the Harderwijk dolphinarium (Klinowska, 1988). Three females were captured for Sea World, Queensland, Australia in the Gulf of Carpentaria (12°05'S, 142°50'E) in 1985/86 (Australia, 1987). They were still alive as of 4 April 1988 (Australia, 1988b). Four hybrids between a male false killer whale and female bottlenose dolphins were recorded at Kamogawa Sea World, Japan. Three were still-born and the fourth lived for 276 days (Sylvestre and Tasaka, 1985). Another hybrid between a male false killer whale and a female bottlenose dolphin was born at Sea Life Park, Hawaii in 1985. This animal was still alive as of November 1988 (Manton, 1988). Although they are said to adapt well to captivity, false killer whales are probably too large for conservation through captive breeding to be feasible. Existing captive animals should be studied to provide information required for conservation and management. In particular ageing techniques need to be calibrated, and details of reproduction studied. Information relevant to captive breeding should also be collected in case this should ever become necessary for conservation.

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KILLER WHALE **INSUFFICIENTLY KNOWN**
Orcinus orca (Linnaeus, 1758)

Suborder ODONTOCETI Family DELPHINIDAE

Summary Although the global status of the orca or killer whale is not a source of concern, it is widely perceived as a competitor for fish resources. There have been attempts in Icelandic and Norwegian waters to cull this species for the purpose of fishery protection, and the pressure for more such culls is liable to mount. There is no evidence that culling ameliorates perceived fisheries conflicts. Fortunately, there is considerable research interest in this species in several parts of the range, and changes in public attitudes have led, in at least one documented case, to protection instead of destruction as a perceived competitor for fish resources. Appropriate public education in other parts of its range must form an integral part of any conservation strategy for this species.

Distribution Killer whales are genuinely cosmopolitan, occurring from among the ice floes in polar latitudes through to the equatorial regions. The only limits to their distribution seem to be ice cover and shortage of prey. Although said to be most abundant within 800km of coasts, they can be encountered in all oceans and major seas at any time of year.

There are a number of recent reviews of the species. Heyning and Dahlheim (1988), in a comprehensive paper, give details of world distribution, and a map of records to date. They note that areas without records so far are likely to be part of the normal range. IWC (1987) discusses the North Atlantic distribution, and provides a map of known sightings and strandings here. The majority of the papers presented at this meeting, together with a further six invited papers, have been published together (Sigurjonsson and Leatherwood, 1988). IWC (1982) gives a useful summary of knowledge up to that time, and Kasamatsu *et al.* (1988) the most recent information on distribution in the Antarctic. Leatherwood *et al.* (1987) summarise information from the Indian Ocean. Hoyt (1984) describes work with the Vancouver killer whales in some detail, and provides a number of useful lists of data. Much behavioural and biological data is included in Kirkevold and Lockard (1986).

The genus *Orcinus* is considered monotypic by most authorities, with geographical variation noted in size and colour pattern, but a worldwide review of systematics is needed. Two recently described Antarctic species *Orcinus nanus* (Mikhalev *et al.*, 1981) and *O. glacialis* (Berzin and Vladimirov, 1982; 1983), both seem to refer to the same population of smaller individuals in the Antarctic, with more yellowish-pigmented lighter areas. The data presented to support the new species indicate modal differences in several aspects of morphology and ecology, but are based on small samples. Until more substantial data are presented, a conservative view of recognising only one highly variable species is probably warranted (Heyning and Dahlheim, 1988).

Population Killer whales were the second most frequently sighted cetacean species (after minke whales) in the IDCR Antarctic whale sightings cruises conducted from 1978/79 through 1985/86, (Kasamatsu *et al.*, 1988). Butterworth and DeDecker (1989) derived a preliminary population estimate of 70,000 (c.v. 0.2) from these data, which cover 64% of the water south of 60°S. Studies conducted off the Icelandic east coast in autumn 1985 and 1986, incorporating a few photographs taken in 1981 and 1984, have resulted in the photo-identification of a total of 143 whales, leading to population estimates of about 190 (range 40-205), although some of the assumptions on which the calculations were based have been questioned (IWC, 1987). Preliminary results of the 1987 North Atlantic Sightings Survey indicate a population of 6,618 (95% confidence limit: 3,500-12,500) in the area covered by the Icelandic and Faeroese vessels (Gunnlaugsson and Sigurjonsson, 1990).

Questionnaire surveys, followed up by photo-identification studies, have been employed to estimate populations in the Pacific Ocean, off southern Alaska. Questionnaire surveys in 1982 and 1983 indicated that there were at least 289 whales in Shekilof Strait, Prince William Sound and southeast Alaska. Subsequent field work in 1984 resulted in a total of 286 whales identified in these areas, including 173 from Prince William Sound, where work in later years has raised the total of known animals to 211, and thus the total for southern Alaska to 324. Questionnaire surveys and tallies of photo-identified animals can provide conservative estimates of population size, although reservations have been expressed about estimates made from questionnaire surveys alone (IWC, 1987).

Photo-identification work from 1973 off Vancouver Island, Canada, and Washington State, USA, resulted in the identification of about 30 pods containing a total of about 350 whales (Bigg, 1982; IWC, 1987).

Other photo-identification catalogues for this species exist for at least: Argentina about 35 individuals); Marion Island, South Africa (10); Gulf of California, Mexico (30) (IWC, 1990).

It should, however, be noted that killer whales occur in many areas other than those few in which studies have been conducted; thus totalling results of concurrent localized studies will still underestimate the aggregate population (IWC, 1987).

Elsewhere, estimates of numbers are more subjective, and are likely to reflect the efforts of observers as much as the real distribution of killer whales. Areas of concentration are reported in waters off Tasmania, New Zealand and along the western coast of South America. They are regularly seen near South Georgia and the South Shetland Islands, as well as off the Antarctic Peninsula and south to the ice edge. Observations have been made off South Africa, but reports decrease northwards along both coasts of Africa (probably representing a lack of observation effort). The seasonality of the reports is very likely only to reflect the seasonality of effort (IWC, 1982).

The Indian Ocean population has been casually estimated to contain 'a few thousand' animals, but abundance there has not really been studied. Sightings indicate that killer whales occur in virtually all parts but are not sufficient to give details of distribution and movements (Leatherwood *et al.*, 1987).

More recent information (IWC, 1987) indicates that earlier reviews suggested more limited distribution and numbers than can now be documented. For example, for the northwest coast of Africa, sightings are now recorded from Mauritania, Senegal, Ghana, Liberia and 'commonly' off the Moroccan coast. The question of whether killer whales are resident in the Mediterranean Sea, or enter only occasionally, is not yet resolved. The most easterly sighting here is of a 5m animal in the Aegean Sea (McBrearty, Message and King, 1986). There is a relatively large number of sightings records for the Spanish and Portuguese coasts, particularly northwest Spain. Killer whales also occur near Madeira and the Azores at least in summer. Off the British and Irish islands, killer whales are widely distributed, but much more common along the Atlantic seaboard and in the northern North Sea than in the southern North Sea and English Channel. The animals appear to be continuously distributed north and west of Scotland to the Faeroes. Distribution in French, Belgian and Dutch waters appears to be sparse (IWC, 1987).

Killer whales are described as occurring frequently along the coast of the USSR in the Bering Sea, the Sea of Okhotsk, off the eastern side of the Kurile Islands and off Japan and PR China. There have also been occasional sightings in mid-Pacific. Sporadic occurrence is noted for the coasts of Washington, Oregon and California in the USA, as well as in the Gulf of California, Mexico. Two clusters of observations: from 7° to 14°N, 127° to 139°W; and within a band between the equator and 5°N from the Galapagos Islands to 115°W are noted, but again likely to reflect observer effort as much as real distribution (IWC, 1982).

The killer whales in inshore waters of Washington and British Columbia have been classified in a hierarchy of groupings. The categories include (from broadest to narrowest): community, clan, pod and individual. Pods and individuals have been designated as 'residents' or 'transients'. The areas frequented by the various categories overlap. Work in the North Atlantic is less advanced, but acoustic recordings have revealed differences at the 'clan' level, and it is expected that further work will find similar population sub-groups to those in the Northeast Pacific. Molecular techniques for examining genetic variation (including paternity) within and between groups are being developed. If successful, this will provide information on relationships between the various proposed groupings, and possibly provide information of value for conservation and management (IWC, 1987; Kirkevold and Lockard, 1986).

Habitat and Ecology Male killer whales grow to about 8.2m (maximum 9.8m). Females generally grow to 7m (maximum 8.5m). In mature males the dorsal fin is very tall and may reach 1.8m.

Breeding cycles seem not to be fixed worldwide, with mating and calving seasons often spanning several months. It was thought that gestation lasted somewhere between 12 and 16 months, but behavioural and hormonal data from captive females has established that pregnancy lasts approximately 17 months. Length of lactation is difficult to establish in free-ranging animals, but a calf born in captivity began mouthing solid food at three months, eating at five months and was consuming food equivalent to 5% body weight (the adult rate) by nine months. It continued to nuzzle the mother (possibly nursing) until age 15 months. However, the behaviour of a single captive animal may not be representative of that of the wild population (IWC, 1987).

The average size of males at sexual maturity ranges from 5.2 to 6.2m, and a growth spurt is reported at about this time. Females attain sexual maturity between 4.6 and 5.4m, with northeastern Atlantic animals (from a harvested population) maturing at shorter lengths and Antarctic animals at somewhat longer lengths. Estimates of annual pregnancy rates vary from 13.7% to 39.2%, with the lower estimates probably more reliable. Estimates of annual birthrate range from 4 to 5%. Estimates of calving intervals range from three to eight years, with observational data indicating that the higher estimates are more typical, although some evidence suggests that the birth rate may be density dependent within pods.

The maximum reported size of foetuses differs regionally, and has been documented as 2.55m for the North Atlantic, 2.74m for the North Pacific and 2.5m for the Antarctic. The smallest neonates recorded are 1.83m for the North Atlantic, 2.28m for the North Pacific and 2.27m for the Antarctic. Sex ratios at birth appear to be 1:1, but the overall ratio of males to females has been reported at 0.48:1 and 0.83:1 for the northeast Pacific and 1.34:1 for the Marion Islands, off South Africa (Heyning and Dahlheim, 1988).

Bigg (1982) reported substantially different natural mortality rates for cropped (0.46-2.5%) and uncropped (1.52-4.35%) pods in British Columbia. However, other calculations which estimated the variances of these values found the differences not to be statistically significant (IWC, 1987).

Killer whales are top-level marine carnivores and opportunistic feeders, with diets that differ seasonally and regionally. There seems to be almost no marine organism of any size which is safe from attack. Virtually all oceanic cetaceans and pinnipeds, penguins and other seabirds, sea turtles, many types of fish (especially herring and salmon) and even their own kind are eaten at times (Matkin and Leatherwood, 1986). Although there are no documented instances of wild killer whales eating humans, a few unsuccessful attacks have been reported (Notarbartolo di Sciara, 1978). Lists of reported foods are given in IWC (1987) and Hoyt (1984). To these can be added dugong (Anderson and Prince, 1985). From work off British Columbia, it appears that there are two 'types' of killer whale: so-called residents which are almost entirely piscivorous, travel in comparatively large groups, and are vocal during foraging; and the so-called transients (which, contrary to their name, are present throughout the year), and appear to rely more on marine mammals for food. Transient pods are smaller than resident pods, and are generally silent during foraging. They may beach themselves temporarily in pursuit of pinnipeds, and attack even large whales as a pack. The feeding strategy appears to be to bite and tear pieces from the prey, sometimes for up to several hours before the prey dies or escapes. It is not known whether transients take fish as well as marine mammals, although in other areas stomachs containing both fish and marine mammal remains are reported (IWC, 1987; Hoyt, 1984; Baird and Stacey, 1988).

The daily food intake in the wild is unknown, but captive adult animals consume 4-5% of their body weight per day (IWC, 1987; Heyning and Dahlheim, 1988).

Work is in progress on calibration of growth layer groups in teeth, to provide a firm basis for age determination. There are technical problems in reading growth layer groups in older animals, and possibly systematic biases in reading from teeth prepared by different methods. At present, the oldest completely documented age is 12.5 years, and the highest count from a wild specimen is 52 layers in cementum, although the authors are not confident that this count is the equivalent of age in years (Myrick, Yochem and Cornell, 1988). The technical problems encountered mean that previously published age-related life history parameter values may need to be recalculated (IWC, 1987).

Pod size can vary between about one and 75 to 100 animals, although larger groupings, probably representing aggregations of pods, are reported. Most pods, however, contain something between 5 and 20 animals. It is thought, from observational work off British Columbia and Washington, that killer whales remain with their maternal pod throughout life. Pods may gradually split on the death of the matriarch, with daughters and their offspring becoming more independent. Each pod has a distinctive call, and pods which associate together tend to share certain signals. The mating pattern, whether within or outside the pod, is not known, but is under investigation using molecular techniques to examine genetic variation and parentage (IWC, 1987; Heyning and Dahlheim, 1988; Kirkevold and Lockard, 1986; Bigg, 1982).

Threats Commercial whalers throughout the world have captured killer whales fairly regularly, but no fishery primarily aimed at killer whales has developed. Most of the small cetacean fisheries take killer whales from time to time, but they are not particularly sought. Of the 2,661 documented catches in the North Atlantic in the twentieth century, 2,455 were taken by Norway between 1938 and 1981; 31 by Canada, 66 in the Faeroe Islands, 76 in Greenland, 3 in Iceland, 8 in Spain and 27 in the West Indies. However, these are very much minimum numbers (except for Norway), because records were not kept in most areas before the 1950s. A bounty system operated in

Greenland, with DKr 200 per whale during 1960-69 and DKr 750 per whale until 1976, when the bounty system was abolished because there were so few claims as to render the system unnecessary. Killer whales are considered pests in Greenland, and they are killed there as much for control purposes as for their meat and other products. Killer whales became protected in the Faeroes in 1986, but were previously taken by driving for human consumption. At St Vincent, in the West Indies, the killer whales were taken as part of the local fishery for meat for human consumption (IWC, 1987).

Shore-based commercial whalers operating from Durban, South Africa, reportedly took an average of about ten killer whales per year, but only a total of 36 between 1971 and 1975. The fleet ceased operations in 1976. Killer whales are sometimes taken by subsistence whalers at Lamalera, Lembata in Indonesia (Leatherwood *et al.*, 1987).

The main commercial fishery was that of the USSR in the Antarctic. Catches from 1969 to 1978 ranged from two (1970) to 77 (1978), and 916 were taken in the 1979-80 season. Fifty to 170 are taken each year in the Japanese coastal fishery. The meat is used for human consumption and the oil, described as similar in market value (in 1958) to sperm whale oil, can be used in the same way as this oil (Nishiwaki and Handa, 1958). The USSR catch was processed for oil and animal food (IWC, 1980), the meat was not considered fit for human consumption, although the Commander Island inhabitants ate the blubber (Tomilin, 1957).

From time to time attempts have been made to reduce killer whale populations because of accusations of damage to fish and pinniped stocks. Tomilin (1957) was particularly vehement, calling for large-scale hunting in both the north of Europe and the Far East. In Icelandic waters the US Navy was called in to deal with killer whales which 'threatened to cut the fish catch in half'. 'Hundreds' were destroyed with machine guns, rockets and depth charges (Mitchell, 1975 - quoting a press report). In Norway a killer whale fishery almost died out in the early 1970s but the Norwegian government licensed and subsidised a killer whale hunt from 1976. This followed complaints from fishermen that the herring population in offshore waters had been much reduced by fishing and the remaining stocks were now concentrated near fjords and considered vulnerable to killer whale predation: 221 were taken in 1979 (Hoyt, 1984). Killer whales are not hunted commercially by Canada or Norway at present (IWC, 1987).

Tomilin (1957) gives a yield of 750-950kg oil from a single carcass, quoting a 1940 reference. Nishiwaki and Handa (1958) say that oil, at that time, was as valuable as sperm oil and used for the same purposes. No published information on the exact composition of killer whale oil has so far been found.

Killer whales have often been implicated in conflicts with other fisheries, although the level of detailed available information concerning these conflicts varies. In the North Atlantic, they have been blamed for disturbing herring shoals (Faeroes and Iceland), killing herring and not eating all the kill (Norway) and affecting the recovery and migration of herring (Norway/Iceland). It is also said that they eat halibut and other fish from lines (Faeroes and Iceland); scare fish from fishing grounds (Iceland); drive tuna from fishing grounds (USA), disturb tuna and scare them from fishing vessels (Iceland); scare salmon from nets (Iceland); disturb the pilot whale hunt (Faeroes); eat captured baleen whales (Newfoundland, Canada); scare seals and other whales (Greenland); and scare minke whales from fishing grounds (Iceland) (IWC, 1987).

It is reported that tuna longline fishermen in the Indian Ocean suffered from killer whale predation on their hooked fish. This increased steadily from the opening of the fishery in 1952 through 1963, by which time the situation was regarded as serious. The percentage of operations during which killer whales were sighted on the fishing grounds increased from 0.4% in 1955 to 9.6% in 1963, suggesting that the whales may have learned to seek out tuna boats. During a given 'attack' 55 to 100% of the catch would be lost. Overall, of the 80,000 tons of tuna and related species caught annually by these fisheries, at least 4% by weight was lost to killer whales and sharks. In some instances it appeared that the whales scared the fish away, but in others that they may have scared the tuna onto the lines. Features of this interference are similar to that in the black cod fishery in the eastern North Pacific, a phenomenon which has increased rapidly in geographical area and frequency of occurrence since it was first reported in 1984 (Leatherwood *et al.*, 1987).

Killer whales can become entrapped in fishing gear, at least off Norway, Mauritania and Iceland, and in the Mediterranean. They are also blamed for damaging fishing gear off Iceland and in other parts of Europe. Fishermen and hunters using small, open boats are commonly afraid of killer whales and may leave fishing and hunting areas when the whales appear e.g. in Newfoundland and Labrador, Greenland, Iceland and the Canadian Arctic. Attempts may be made to destroy or drive off killer whales with rifles or explosives e.g. at Jan Mayen, Newfoundland and Labrador, and Greenland (IWC, 1987).

On the other hand, native hunters in the western Canadian Arctic believe that killer whales herd or frighten other whales, such as bowheads, narwhals and white whales, and seals into confined areas, making them easier to catch. In the past, whalers sometimes scavenged whales killed by killer whales, although usually scavenging took place the other way round (IWC, 1987). Killer whales and whalers cooperated in the symbiotic herding and killing of humpback and right whales off Twofold Bay, eastern Australia (Mitchell and Baker, 1980). There are thus very different attitudes towards killer whales, especially among fishermen, and any efforts to develop management strategies need to take into account how competition, real or perceived, affects fishermen's actions towards the whales (IWC, 1987). Two were recorded killed in the Canadian experimental squid driftnet fishery in the eastern North Pacific in 1986 (Baird, Langelier and Stacey, 1988). It is not known how many are killed annually in total in pelagic driftnet fisheries in the North Pacific and worldwide.

Conservation Measures Potential countries of origin include all those with coastlines, as the killer whale is a cosmopolitan species. However, any country could have special conservation responsibilities through exhibition of live animals and/or international trade.

The killer whale is included in Appendix II of CITES. The following international trade is recorded: 1980 - 1 live specimen, for commercial purposes, from Iceland to Switzerland: 1981 - 1 live specimen, of Icelandic origin, from Switzerland to Argentina, purpose not stated; 3 live specimens, for zoological purposes, from Iceland to UK; 1 live specimen, for zoological purposes, from Canada to Japan; 1 live specimen, for zoological purposes, from Canada to USA: 1983 - 1 tooth (illegal, seized on entry) of unstated origin, to Canada; 1 carving, purpose unstated, of unstated origin, from Switzerland to UK: 1985 - 2 carvings, personal effects, from Greenland to Denmark; 1 carving, of unstated origin, from Switzerland to UK; 1 live animal, for commercial purposes, from FRG to Japan; 2 live animals, for commercial purposes, from Iceland to Japan (CMC, 1987).

The position of the International Whaling Commission with regard to this species is complicated by the difficulty over the exact interpretation of the 1946 Convention with regard to smaller cetaceans. The killer whale is named in the Schedule and has been for some years, but no management decisions have been made by the Commission, despite recommendations from the Scientific Committee in 1979 and 1980. In 1980, however, the Commission did extend the moratorium on factory ship whaling to include killer whales and adopted a resolution which, without prejudice to the position of the Contracting Governments, requests the Commission and its members to consider the advice of the Scientific Committee with regard to small cetaceans (IWC, 1981).

The 1980 Scientific Committee recommendations included classification of the Antarctic stock(s) as Initial Management Stocks with zero catch limit in view of the lack of information. The North Atlantic stock was recommended to be classified as Sustained Management Stock in view of the long history of catching, with a limit of 52, pending stock assessment, but this was not endorsed by the Commission (IWC, 1981). The killer whale is included in Appendix II of the Berne Convention.

Norway set a national catch limit of 52 for 1980. This number was taken in January 1980 and no more catching was permitted. This followed an IWC Scientific Committee recommendation of 1979, which although not taken up by the Commission, was put into operation by Norway (IWC, 1981). The killer whale will be protected by general national legislation in several countries.

More information of life parameters, population and distribution is needed before any real assessment of the status of this species worldwide can be made. Local food habits should also be checked, to find out exactly whether the animals are causing damage to fisheries, in areas where this is perceived to be a problem.

The live-capture industry should be required to carry out proper population surveys before starting operations in any area, and to continue them as long as the area is used. If the capture area is outside the jurisdiction of a state or of an international agreement such surveys can be made part of import conditions either under CITES provisions or under national legislation.

The IUCN/SSC Cetacean Specialist Group Action Plan contains no specific projects relating to this species, although it will be included in general projects, such as monitoring the effects of disturbance on coastal cetacean populations (Perrin, 1989).

Captive Breeding The main centres of the live capture fishery were in British Columbia, Canada and Washington, USA. A total of 62 were reported to have been taken between 1962 and 1973 (Bigg and Wolman, 1975) (i.e. kept for display plus those dying during capture): 263 were captured, 12 died, 50 kept and 201 released. Captured whales are very valuable; prices of 8,000 dollars in 1965, 20,000 in 1970 and 72,000 in 1974 (this animal probably at least semi-trained) have been quoted, although most sale prices are closely kept secrets. Hoyt (1984) gives a full list of captured animals, and their histories. The North American fishery has now ceased, mainly because of strict regulations. A live capture fishery has been conducted sporadically off Iceland since 1975. Collections have been made using herring purse seines and animals held locally until export. Collections are authorised by permit from the Ministry of Fisheries based on advice from the Marine Research Institute, Reykjavik, concerning population size and status, and with the conservative proviso, following the advice of the IWC Scientific Committee, that any removals be less than 2% of the population per annum (IWC, 1987). Early removals are listed by Hoyt (1984). By 1983, some 107-115 killer whales were known to have been live-captured. Of these 58-66 were taken on the west coast of North America, nine in Japan and 39 off Iceland (IWC, 1984). Removals from 1981 through 1986 were: 1982, 5; 1983, 3; 1984, 5; 1985, 0; and 1986, 0 (IWC, 1987). Four were taken in 1987 (IWC, 1989). Although live-stranded animals which are subsequently exhibited are not counted by IWC as live-captures, it is perhaps worth noting that two such animals are exhibited at the Mundo Marino Aquarium in Argentina (Lichter and Goodall, 1988).

There are often claims that the exhibition of cetaceans has stimulated public interest in the animals, and concern for their conservation. These are usually made by supporters of dolphinaria, although occasionally opponents may also hold such views. The only clearly documented example of a change in public attitudes is for killer whales off the British Columbia coast in Canada. In the early 1960s the animals were considered to be undesirable predators and competitors to fishermen. Whales were shot at indiscriminately and the Federal Department of Fisheries considered mounting machine guns between Vancouver Island and mainland British Columbia to kill the animals. In 1964 and 1965, the first killer whales were captured and maintained in captivity. This created enormous popular interest, and a mood of protection and conservation followed. Protective regulations were brought in by 1970 (Klinowska and Brown, 1986).

In general, captive killer whales have had few opportunities to breed, being frequently kept singly, in single-sex groups or have been immature. There have been a few births, where appropriate groups have been kept, but so far only one surviving calf (born in 1985) (Klinowska and Brown, 1986). It is not yet clear whether sufficiently high survival rates amongst captive animals can be achieved for to enable the maintenance of self-sustaining populations in captivity.

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LONG-FINNED PILOT WHALE **INSUFFICIENTLY KNOWN**
Globicephala melas (Traill, 1809)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The long-finned pilot whale is still the subject of a drive fishery in the Faeroes taking 2,000 animals annually in recent years. Population estimates from the 1987 NASS indicate a population in Icelandic and Faeroese waters in the range 50,000 to 150,000, but the estimate is subject to unknown degrees of bias in either direction due to the problems of surveying a species which forms large schools. Incidental catches occur in the mackerel fishery in the western North Atlantic. Although still abundant in the North Atlantic, the status of the species there should continue to be monitored. The species is presumed extinct in the North Pacific, being known there only from sub-fossil remains. The species is not subject to exploitation in the southern hemisphere, but meaningful estimates of abundance there cannot be derived from the available data. The methodology for surveying this species requires further development.

Distribution It has recently been recognised that the correct name for this species should be *Globicephala melas*, in accordance with Traill's original (1809) description, although it has usually been referred to as *G. melaena* in recent years (IWC, 1989).

Long-finned pilot whales are found in the cold temperate waters of the North Atlantic Ocean and in the Southern Hemisphere. The two populations are geographically separated and have sometimes been referred to as separate species or subspecies: the southern form being known as *edwardii* and the northern form as *melas* (Leatherwood and Reeves, 1983). There was considerable confusion about the taxonomy of pilot whales in the past, but van Bree (1971) demonstrated osteologically that there are two clearly defined species of *Globicephala*, *G. melas* (including *edwardi*) and *G. macrorhynchus*. The latter is found in tropical and warm temperate waters (see separate review).

In the North Atlantic the long-finned pilot whale ranges from Greenland, Iceland and the Barents Sea in the north, to Cape Hatteras in the west and to northwest Africa, including the Mediterranean at least as far east as southern Greece, in the eastern Atlantic. It is not yet clear whether there are any separate stocks in the North Atlantic, but sightings information seems to indicate a more or less continuous distribution across the temperate waters of this ocean (IWC, 1987; IWC, 1988a; Leatherwood and Reeves, 1983; McBrearty, Message and King, 1986).

In the Southern Hemisphere these whales are found near all major land masses, and in pelagic waters of the temperate and subarctic regions, especially the cold Humboldt, Falklands and Benguela Currents, associated with the West Wind Drift (Leatherwood and Reeves, 1983). It is not yet clear whether any separate stocks exist. The IWC/IDCR cruises collected sightings data both in the survey areas and in transit. A gap in this data between about 45°S and 50°S was noted, although it is not clear whether this is a real gap in distribution, or an artifact caused by the methodology. Most sightings were made away from the ice edge. The highest latitude of any sighting was 67°41'S, 05°44'W. The sea temperature here was -1.0°C, the coldest for any sighting (Kasamatsu *et al.*, 1988; IWC, 1988a).

Kasuya (1975) describes sub-fossil remains excavated from hunting settlements indicating the presence of this species in the North Pacific off Japan at least until about the 10th century. No later records have been found in the North Pacific. The author dismisses the idea that this represents a population exterminated by whaling, on the grounds of insufficient technology and demand at that time, preferring the hypothesis that a small immigrant population failed to establish itself because of competition from existing species with similar niches, such as the Dall's porpoise. There appear to be two plausible dates and routes for such an immigration: through the eastern equatorial Pacific during the Wurm Glacier Age, or from the North Atlantic through the Arctic Ocean during the warmer periods between 8,000 and 2,000 years BP. A further speculation, that the species still exists in some remote part of the western North Pacific, seems less and less likely as knowledge of the cetacean fauna of these areas increases.

Both pilot whale species have recently been reviewed by the IWC Scientific Committee's subcommittee on small cetaceans, and the papers are to be published as a Special Issue of the Reports of The International Whaling Commission (IWC, 1987; 1988a; 1990).

Population During the NASS survey of 1987, estimates of pilot whale abundance were obtained for Icelandic and Faeroese waters using line-transect methodology. Few pilot whales were seen in Norwegian waters or in the Barents Sea. An estimate of 72,000 (c.v. 0.4) was obtained for the Faeroese survey, and two alternative estimates of 18,950 (c.v. 0.5) and 12,945 (c.v. 0.25) for Icelandic waters (IWC, 1990). However, the IWC Subcommittee on Small Cetaceans noted various possible sources of bias in these estimates: in particular, failure to count all individuals in each school encountered would produce a downward bias, while the tendency to measure the distance to the nearest part of the school instead of the centre would produce an upward bias. Further development of survey techniques for this species is clearly required.

An average 4,280 whales were taken in the Newfoundland fishery each year between 1951 and 1961, about 30,000 of which were taken between 1953 and 1957. Catches declined in the 1960s to a few hundreds. Mitchell (1975) used the cumulative catch data of 47,078 from 1951 to 1961 to estimate an initial population (in 1947) of about 50,000. Mercer (1975), in a comparative study of the whale and squid relationships, estimated the initial population of the Newfoundland stock at less than 60,000, which is of the same order of magnitude as the previous estimate. Hay (1982) gave a population estimate of 13,167 (6,731-19,603) for long-finned pilot whales off east Newfoundland, based on sightings surveys in 1980. The highest densities were recorded around the old whaling grounds, and these areas provided almost all the total population estimate (12,615 from these survey blocks). No estimates of the population remaining at the cessation of catching from 1972 are available, and it is therefore not possible to estimate the extent to which the population may have recovered.

Catch records in the Faeroe Islands go back to 1584, but the fishery is undoubtedly much older. Analysis of catch statistics from 1709 show three peak periods: from 1720 to 1740 with ten year average catches between 700 and 800 whales; from 1820 to 1850 with ten year averages between 1,000 and 1,900 whales; and from 1930 to 1960 with ten year averages between 1,000 and 1,900 whales. The effect of exploitation is probably difficult to detect, because of the large residual variation in the catch series. This variation could be the result of a number of factors, including long-term environmental fluctuations (IWC, 1987). Preliminary examination of historical catch records in the British and Irish Islands from the early 18th century revealed exploitation of a similar order of magnitude to that in the Faeroes at this period, as well as indications of similar fluctuations. These fisheries died out around the turn of this century (Klinowska, 1987).

The IWC/IDCR cruises have collected data on long-finned pilot whales in the Southern Ocean, but given that only eight schools have been sighted and the difficulty of determining the effective distance from the survey trackline of the sighted schools, one of which was rather large, it is difficult to produce meaningful estimates of abundance from these data.

The International Whaling Statistics list all pilot whale catches under the name of *Globicephala melaena*, but the catches listed for Japan and British West Indies are in fact of *G. macrorhynchus*.

Habitat and Ecology The maximum recorded length for a male long-finned pilot whale is 7.62m, and for a female 5.70m (Perrin and Reilly, 1984). Males are sexually mature at 4-5m and females at 3-4m (IWC, 1987). Gestation is estimated to last 14.5 months. Reproduction is diffusely seasonal, with a peak of conceptions from April to June and of births from July to October in the North Atlantic. The calving interval has been estimated at between 3.3 and 3.5 years, although individuals are likely to have a calving interval of a whole number of years. Lactation may last 23-27 months on average, and 20% of the pregnant females in the Faeroese sample were also lactating. A gross annual reproductive rate of approximately 11% was calculated for this sample (IWC, 1988a). Average length at birth is 1.77m (Perrin and Reilly, 1984).

Lack of standardisation of ageing techniques is still a problem, and some older material has been re-examined (Kasuya, Sergeant and Tanaka, 1986). There appears to be a 'missing' portion in age distributions in catches from about 5 years to 15 or 20 years. It is possible that reproductive or mortality rates have varied greatly, that there is segregation by age, with juvenile schools unavailable to fisheries, or there is a systematic bias in the age determination methods. The age of female sexual maturity has been variously estimated between six and ten years. Spermatogenesis begins in males at the age of five years, but functional maturity is not attained before about 15 years of age (IWC, 1988a).

Squid of various species are the main prey of the long-finned pilot whale. Geographical associations between squid and these whales are widely reported (IWC, 1987).

The usual school size is of about 50 animals, but aggregations of several hundred to a thousand or more are reported. McBrearty, Message and King (1986) note a rather low school size reported by their amateur observers. Two thirds of schools contained fewer than ten animals from the British Isles area, with a similar size in winter in the Mediterranean. However, in summer schools averaged 23 animals in the Mediterranean. Hay (1982) reports the average school size off Newfoundland as 26 (range 7-56). In the Southern Ocean the IDCR cruises reported a mean school size of 65, with a range between two and 249 animals (Kasamatsu *et al.*, 1988). No consistent pattern of age or sex segregation in schools has been found, although it appears that many more females than males survive to adulthood (Leatherwood and Reeves, 1983).

Mate (1989) describes the satellite tracking of a long-finned pilot whale re-introduced into the wild. The animal covered at least 7,588km in the 95 days before lack of battery power in the apparatus carried by the whale terminated the study. Daily movements of up to 234km were recorded, with a mean of 80km per day. The mean number of dives was 2,020 per day, and their average duration 40 seconds. Swimming speeds averaged 3.3km/hr, and speeds in excess of 16km/hr were observed for periods exceeding three hours. Deep diving occurred mainly at night, when the squid prey are nearer the surface. Travel was in areas where the sea surface temperature ranged from 14 to 30°C. Surface resting behaviour bouts exceeding 15mins were most common during the first three hours after sunrise on a four to seven day cycle. The animal was repeatedly sighted within a pod of untagged conspecifics, and behaviour was reasonably consistent throughout, suggesting that the recorded behaviour may be typical of untagged wild animals.

Threats In 1951 this whale was described by Gilmore (1951) as perhaps the most commercially important small whale in the world, but today the only major fishery is that in the Faeroes. Further information on catches in the North Atlantic is given in the Population section above. The vast majority of catches were made by the driving method, although some harpooning of large animals at sea took place, at least in the Newfoundland fishery (Sergeant, 1962). The apparent effects of these catch methods on pilot whales are discussed in the short-finned pilot whale review. Incidental takes occur in the western North Atlantic mackerel fishery: 141 reported in 1988 from the US EEZ (IWC, 1990). There may be higher incidental takes in un-monitored fisheries. The Southern Hemisphere populations have never been commercially exploited.

Relatively high cadmium and mercury levels have been reported in animals taken in the Faeroes, raising doubts about the suitability of the products for human consumption. Organochlorine residues have also been reported (IWC, 1988a). However, there is no information on possible sources of heavy metals in the food chain of such animals living mainly offshore, nor is there any information on the possible effects of organochlorine residues or of heavy metals on the animals at the levels reported.

Conservation Measures Potential countries of origin include all those with coastlines in the cold temperate waters of the North Atlantic and Southern Hemisphere. Specific locations so far reported include: USA, Canada, Denmark (Greenland and Faeroes Islands), Iceland, Norway, Sweden, FRG, Netherlands, Belgium, Ireland, UK, France, Spain, Portugal, Italy, Argentina, Australia, New Zealand, UK (Falkland Islands), South Africa, Uruguay, France (Kerguelen Islands), and Chile.

The long-finned pilot whale is listed in CITES Appendix II. The following international trade (all for scientific purposes) is recorded: 1980 - 4 skeletons from Canada to USA; 1981 - 4 specimens from France to USA, 18 specimens from unknown source to USA; 1982 - 4 specimens of French origin from USA to France, 18 specimens of unknown origin to USA; 1984 - 1 specimen of unknown origin from France to USA; 1985 - 1 specimen from Peru to USA (CMC, 1987). The North and Baltic Seas populations are listed in CMS Appendix II and the species in Appendix II of the Berne Convention. No other international legislation refers to this species. The Faeroese catch is covered by various local regulations (but not generally related to numbers taken). The species is also covered by general legislation in several countries.

The IUCN/SSC Action Plan notes some concern about the population exploited in the Faeroe Islands: the situation is to be monitored, together with direct and indirect taking elsewhere (Perrin, 1989). Attempts to regulate exploitation through the IWC have foundered on the question of whether the IWC has competence to regulate (or even discuss) small cetacean species (e.g. IWC, 1988b).

Captive Breeding Two long-finned pilot whales were kept briefly in the UK in the 1960s. One very young animal came from the Faeroes fishery and survived only a few days. Nothing is known about the other animal. There have been other plans to obtain display animals from the Faeroes which have not been implemented (Klinowska and Brown, 1986). Collet (1984) quotes Defran and Pryor (1980) as reporting that a few long-finned pilot whales were kept in British institutions in the first half of this century.

However, although it is mentioned in a Table that *Globicephala* sp. have been maintained in captivity in England, Defran and Pryor (1980) give no further information. Extensive searches of the scientific and popular literature have so far failed to find any other references to UK pilot whale keeping than those given by Klinowska and Brown (1986) (Klinowska - unpublished observations). Several animals from Newfoundland were held at Aquarama, Philadelphia, USA in 1964 (Brownell, 1989). Some stranded specimens have been kept briefly in the eastern USA, and 'several' are said to have been live-captured off New England before 1973 (Reeves and Leatherwood, 1984). An immature animal, which stranded in December 1986, was rehabilitated by the New England Aquarium and released on 22 January 1987 off Cape Cod. The whale was fitted with a radio-tag and tracked for 95 days (Mate, 1989).

In view of the reputed popularity of the short-finned pilot whale for display purposes, it is perhaps surprising that no serious attempts have been made to keep long-finned pilot whales. The species is probably too large for conservation through captive breeding to be feasible, but if any more animals are brought into captivity the opportunity should be taken to obtain information relevant to conservation and management. In particular, ageing techniques need to be calibrated and detailed data on reproduction obtained.

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SHORT-FINNED PILOT WHALE **INSUFFICIENTLY KNOWN**
Globicephala macrorhynchus Gray, 1846

Suborder ODONTOCETI Family DELPHINIDAE

Summary There is some confusion about the exact range of the short-finned pilot whale and little information about the populations, except off Japan, where very rough population estimates are available. There is an active fishery in Japan which has taken a catch of about 600 animals per year in recent years, and which is regulated by quotas in some areas.

There are unregulated fisheries in other parts of the range, especially in the Caribbean, which appear likely to be selective for larger animals. Nothing is known about the Caribbean short-finned pilot whale populations and there are no reliable catch statistics. The subcommittee on small cetaceans first expressed concern about these populations in 1975, but no information on status has yet been forthcoming. St Lucia, and St Vincent and the Grenadines are IWC members but appear to have taken no steps to fulfil the IWC's recommendation to report all catches. Nor have any steps been taken to regulate the catches, or to investigate the exploited populations. France, another IWC member, has not fulfilled the IWC's recommendation to report all catches with respect to Martinique. Catches are also made in Dominica and possibly in Cuba. Elsewhere small catches are known from Indonesia and a few incidental takes from Sri Lanka. It is also subject to unknown levels of take in pelagic driftnet fisheries in both hemispheres.

The status of this species in the Caribbean requires urgent attention, because of the general exploitation of populations of unknown status. More information is also required from all areas on range, abundance, stock identity, biology, behaviour and any direct or indirect takes.

Distribution The short-finned pilot whale is found in tropical and warm temperate waters of the world. The exact range is not clear because this species is difficult to distinguish at sea from the long-finned pilot whale, because there has been much taxonomic confusion about the identification of specimens, and because there is some overlap between the ranges of the two species in areas of transition between tropical and cool temperate water masses. It has been recorded as far north as Delaware Bay and France in the North Atlantic, but it generally ranges no further north than Bermuda and Cape Hatteras and south to Venezuela in the west. In the east it is usually found from Madeira and northwestern Africa south to South Africa. It is said to be common in the Caribbean Sea and Gulf of Mexico. Distribution in the Southern Hemisphere is poorly known, but it is reported from the warmer waters of the Indian Ocean, Australia and New Zealand (Leatherwood and Reeves, 1983; Leatherwood *et al.*, 1987; Nichol, 1987).

In the eastern North Pacific short-finned pilot whales are reported from northern waters but are more common from central California south to Peru. They are also known from around Hawaii. In the western North Pacific they are known from Japan, PER China and Taiwan southwards (Leatherwood and Reeves, 1983; Wang, 1984).

There are two populations off Japan which appear to be genetically distinct from each other. The northern form is found off the Pacific coast of northern Japan between 35° and 43°N. Most sightings were concentrated in an area between 40°N and 43°N and west of 143°E. This population is found in cold coastal waters between the Kuroshio and the Oyashio Currents, with surface temperatures from 12°C to 24°C. The southern form is found in Japanese coastal to offshore waters south of 37°N, but no sightings were made south of 25°N and no whales were found east of 152°E. This suggests that this form inhabits a restricted area off the Pacific coast of Japan. There is scattered evidence of similar geographical separation of northern and southern forms in the eastern Pacific. It is not yet known which form(s) inhabit the central Pacific (IWC, 1987; Kasuya, Miyashita and Kasamatsu, 1988; Wada, 1988).

Both pilot whale species have recently been reviewed by the IWC Scientific Committee's subcommittee on small cetaceans. The contributed papers are to be published as a Special Issue of the Reports of the International Whaling Commission (IWC, 1987).

Population The only population estimates available are for the area off Japan, but the species is generally considered abundant within the range (Leatherwood and Reeves, 1983). Provisional population estimates based on sightings data (ten primary sightings from five cruises in the summers of 1984 and 1985) give a total population of 5,344 (range 819-9,669) for the northern Japanese form. Sightings data collected with similar effort for the southern form produced 18 primary sightings from which a population of 53,003 (range 18,409-87,597) was calculated (IWC, 1987). A photo-identification project is in progress off the northern Pacific coast of Japan, with 100 animals catalogued so far (IWC, 1990).

Habitat and Ecology The longest recorded male short-finned pilot whale was 6.10m and the longest females between 5.25 and 5.50m. These animals were from the Indian Ocean (Perrin and Reilly, 1984). The northern Japanese form reaches an asymptotic length of 5.5m in males and 3.9-4.0m in females, while the southern form reaches only 4.74m in males and 3.64m in females - a difference of 1-2m between the two populations (IWC, 1987).

In the southern Japanese form the deposition of dentinal growth layers in teeth is annual, with the haematoxylin-stainable layer being formed from May to October and the unstainable layer from December to February (Kasuya and Matsui, 1984).

The life history and reproductive biology of the southern Japanese form has been extensively studied by Kasuya and Marsh (1984). A single calf is born after 14.9 months of gestation and nursed for a minimum of about two years. Calves of older cows may be nursed for considerably longer periods. Females are sexually mature on average at 9 years (range 7-12), produce an average of four to five calves, and have their last calf before the age of 40 years, even though they may live for up to 63 years. Males have a maximum longevity of only 46 years, and probably continue to be capable of reproduction until death. In males puberty begins on average at 14.6 years (range 7-17) and social maturity at an average of 17 years.

The age composition in catches from this population suggests that the total mortality rate is lowest in the post-pubertal stage and that it increases after age 28 (male) or age 46 (female). Males have a higher mortality rate than females at any given age. The juvenile total mortality rate is probably higher than that of post-pubertal animals. These differences in total mortality rates may reflect differences in natural mortality rates. The total annual mortality rate over all age classes was estimated to be 8.3% (male) and 4.5% (female). Thus there are more reproductive females than adult males. The mating system is polygynous.

The birth length for the Japanese northern population is 1.85m and for the southern population 1.40m, a difference of about 0.45m. The peak mating season appears to be in September for the northern form, four months later than the May peak for the southern form. The northern breeding season also seems to be shorter in duration. The peak parturition season of the northern form was December, compared to July/August in the southern form (IWC, 1987; Kasuya, Miyashita and Kasamatsu, 1988).

It has been suggested that the mating season of the northern form has evolved so that calves can switch their major source of nutrition from milk to solid food during the productive summer to autumn season. The larger neonatal size of the northern population might increase the changes of survival for young born in winter. The different breeding patterns of the two forms decrease the chances of interbreeding (IWC, 1987; Kasuya, Miyashita and Kasamatsu, 1988).

Short-finned pilot whales feed mainly on squid (Seagars and Henderson, 1985), but detailed feeding habits do not yet appear to have been studied in any part of the range. The basic social unit is the school, of somewhere between 15 and 50 animals, with an average size of between 20 and 25. The schools aggregate from time to time, possibly for feeding, mating or the exchange of individuals, and when alarmed. The school is composed of adult males, adult females of various reproductive stages (including post-reproductive individuals), and immature and pubertal individuals of both sexes. Males may migrate between schools after weaning. However, females probably stay in their mother's school for life, so that the breeding schools are essentially matrilineal kinship groups (Kasuya and Marsh, 1984).

There are some reports that short-finned pilot whales herd and perhaps attack *Stenella* spp. and common dolphins escaping from tuna purse seine nets in the eastern tropical Pacific (Perryman and Foster, 1980).

Threats The major known fisheries take place off Japan and in the Caribbean Sea. Small takes are also reported elsewhere in the range. The number of incidental takes is unknown, but it was taken in the Japanese/Canadian experimental squid driftnet fishery in the northeast Pacific, indicating that it is vulnerable to such fisheries (Jamieson and Heritage, 1987).

Japanese Fisheries Japanese small-type whaling vessels exploited the northern form in the late 1940s and early 1950s, but annual catches declined rapidly from 400 to less than 50 whales, with an accompanying decline in the proportion of males in the catch. Several socio-economic factors may be related to the decline in catch during this period. After approximately 25 years of no exploitation, whaling resumed in 1982. Five to seven vessels harpooned and landed their catch at three Ayukawa land stations. The fishery was selective for large animals. The 1985 season was characterised by a decline in both whale density and in the proportion of old and large individuals in the catch, particularly of adult males, which declined from 23-39% in 1983 and 1984 to 2% of the adult catch of both sexes in 1985. The total reported catch was 519 whales between 1982 and 1985, and the mean annual catch was 2.4% of the estimated mean population size (IWC, 1987).

Since the re-opening of the fishery, the Japanese regulations have changed several times. There was no regulation in 1982, but annual quotas of 175 whales were set for 1983 and 1984. No quota was set for 1985, but the whaling season was fixed for seven weeks in October and November. The IWC subcommittee on small cetaceans expressed considerable concern that the available data suggested that this population had declined, and that this situation appears similar to that in the earlier fishery. The population appears to be small and the reproductive rate of this species low. It was considered desirable, from a biological point of view, that no more animals be taken until the status of the stock is more clearly understood (IWC, 1987). It was reported that 28 animals of the northern form were taken in the 1986 season (Japan, 1988a) and that small-type whaling on this stock was suspended in 1987 (Japan, 1988b).

The southern form has been exploited since the 1930s by Japanese fishermen from three isolated areas. Okinawa (Nago) fishermen have a long history of taking short-finned pilot whales in a drive fishery, but statistics have only been available from 1960. The annual catch has fluctuated between 0 and 500 whales. Since 1975 the fishermen have used 5-7 fishing vessels to harpoon the whales, and recently this type of hunting has replaced the drive fishery. The hand harpoon fishery off Nago, Okinawa is not regulated (IWC, 1987). A crossbow fishery in Okinawa was investigated in 1988 (Japan, 1988b).

Kasuya and Marsh (1984) have reviewed the Taiji (Kii Peninsula) fishery, which started before the 17th century. From the late 1940s, both small-type whaling and a drive fishery operated off Taiji. The annual catch by small-type whaling between 1949 and 1951 was between 200 and 300 whales. Lower catches were taken after this period and a single vessel continued operations because of local demand for meat. Driving was re-introduced from 1969, and the small-type whaling ceased in 1980. Between 1975 and 1985 the annual catch ranged from 90 to 605 whales. In 1982 the Japanese government placed all drive fishermen under the control of the relevant prefectural governments. The catch limit imposed by Wakayama Prefecture (Taiji) was 500 (IWC, 1987).

Various villages have operated a drive fishery for short-finned pilot whales along the Izu peninsula from the early part of this century. Annual catches from 1950 to 1956 were between 31 and 650, and from 1972 to 1985 between 0 and 80. The statistics are incomplete from 1957 to 1971. The only drive fishery still operating here is from Futo (IWC, 1987).

The subcommittee on small cetaceans noted that recent annual total catches had increased to between 500 and 700 whales, or about 1% of the estimated population. This is close to the high catch levels in the immediate post-war period. Given the low productivity of the species, it was considered that exploitation should not be intensified, and that the status of the stock be closely monitored. The relationship between the stocks fished by the three different fishing areas should be investigated (IWC, 1987). Takes of 349 animals by these fisheries are reported for 1986, plus one taken by small-type whaling off Wadura (Japan, 1988a) and 395 in 1987 (Japan, 1988b).

Caribbean Fisheries There are several fisheries taking 'blackfish' in the Caribbean. It appears that during the 1800s whaling technology was transferred to the area by USA whaling vessels, through the training of local people as crew members. In St Vincent, St Lucia, and, to a lesser extent, in Martinique and Dominica it has evolved into an artisanal fishery taking various smaller species, and the occasional large whale (Price, 1985). The short-finned pilot whale is one of the main quarries, but since the fishermen appear to have no consistent terminology for the various species, all visiting observers have had difficulty in estimating the full extent of the take.

At Barrouilie on St Vincent, 'blackfish' boats began operating about 1910. From 1931 the fishery increased, particularly through the enterprise of one fisherman, and by the late 1960s a fleet of a dozen boats was operating. Each boat was equipped with a light harpoon gun, hand harpoons, hand lances and a crew of about five men. In the early 1970s diesel powered boats were obtained, and far greater catches achieved, but shortly thereafter the fleet size and catches dropped. One major factor in the decline was the increasing incapacity of the aging leader of the enterprise, but loss of the USA oil market and the increasing costs of maintaining the diesel engines were also important. It is estimated that a total of 2,367 animals were taken between 1962 and 1970 and about 2-300 a year in the early seventies. The high-grade melon oil was sold to the USA, but this trade ended with the USA 1972 Marine Mammal Protection Act. The meat and other edible products have always been used for human consumption, and the oil for cooking and sometimes for medicine. In the early 1980s it was reported that the melon oil was mixed with whatever body oil was produced, and exported to Trinidad or Barbados. The sale of teeth to tourists and traders was also becoming an increasingly lucrative aspect of the fishery. The catch records are neither complete nor consistent (Price, 1985).

The fishery at Castries in St Lucia is believed to have started in the late 1800s, supplying local villages with meat. The fishery in Vieux Fort was started in the 1950s by fishermen from the Barrouille enterprise of St Vincent. When they left in the late 1950s the fishery continued to operate on a small scale to supply meat for the local market. Two boats operated out of Vieux Fort and six to eight from Castries in the early 1980s. Besides these special boats, most of the fishing canoes carried harpoons and took any small cetaceans encountered (Price, 1985). Reeves (1988) visited St Lucia in 1987. He reports two boats still operating from Vieux Fort and three from Castries. Most fishermen of all types who go to sea in canoes continue to have hand harpoons and to take whatever small cetaceans are encountered. No satisfactory system for monitoring or reporting cetacean catches had yet been set up in St Lucia. Officially reported landings are given only in pounds, with cetacean and shark products combined. One fisherman at Vieux Port estimated a current annual catch of 60 to 80 short-finned pilot whales, but the others could give no clear idea of the order of magnitude of their catch. Only a small quantity of oil is produced for local use as a tonic and laxative, but there is still local demand for cetacean meat.

In the early 1980s it was reported that the whaling activities in Dominica and Martinique were limited to the occasional catch when the opportunity presented itself. Fresh cetacean meat was very popular with the villagers and was occasionally also sold in other towns. The oil was used locally for cooking and not exported. Teeth were occasionally sold to tourists (Price, 1985).

Short-finned pilot whales have also been taken off the coast of Cuba (Mitchell, 1975a), but no recent information is available on this fishery.

Although no catch statistics are available, from the accounts given above it appears that there is likely to be a general take of short-finned pilot whales in this area of some hundreds a year. It also appears that effort has declined since the early 1970s and that consequently catches will be somewhat lower. The loss of the USA oil market from 1972 seems to have had a major influence, at least on the level of take in St Vincent. There appears to be little evidence of a shortage of whales, but in view of the history of the Japanese harpoon fisheries, and the lack of information on the exploited Caribbean populations, research is urgently needed here.

Indian Ocean Leatherwood *et al.*, (1987) collected information on pilot whale takes in the Indian Ocean IWC Sanctuary area. In the late 1800s the logbooks of some whaling vessels mention takes of 'blackfish' which have been interpreted as meaning pilot whales. They were also possibly directly taken at Besuki, eastern Java in Indonesia at least in the 1920s. There are no known fisheries in the Indian Ocean itself today, although the fishery at Lamalera, Indonesia (in the Savu Sea) is within the Sanctuary. It is reported that from four contacts involving 254 pilot whales between 3 July and 18 September 1979, the Lamalera subsistence whalers killed two animals. These whales are also taken incidentally in gillnets, at least off Sri Lanka, where a total of nine were reported in 1984 and 1984.

Conservation Measures Putative countries of origin include all those with coastlines in tropical and warm temperate waters. Locations reported so far include: USA (Puerto Rico, Virgin Islands), France (Martinique, Guadeloupe), UK (Bermuda, Virgin Islands), St Lucia, St Vincent and the Grenadines, Dominica, Venezuela, Mexico, Guatemala, Canada, Senegal, Haiti, Portugal (Madeira), South Africa, Peru, Ecuador, Australia, New Zealand, India, Sri Lanka, Seychelles, Indonesia, Japan, PER China and Taiwan.

The short-finned pilot whale is listed in CITES Appendix II. It is reported that 150 specimens were moved from Australia to USA in 1981 (CMC, 1987). The species is not covered by the IWC moratorium on commercial whaling because of the disputes as to whether the Commission is competent to regulate the taking of small cetaceans. No other international agreements mention this species. The Japanese regulations are mentioned in the Threats section above. The species is protected by general legislation in several countries.

The IUCN/SSC Action plan notes that there is some concern about the exploited population in northern Japanese waters, because of the lack of information about its status. The situation is to be monitored (Perrin, 1989). The subcommittee on small cetaceans (Mitchell 1975b) has also called for population assessments for the Caribbean stocks, so that the effect of the fisheries can be determined, but nothing has been done so far about this situation.

It is particularly disappointing that the IWC members St Lucia, St Vincent and France (for Martinique) have not fulfilled the IWC's recommendation to report all catches to the IWC Scientific Committee. The other countries taking this species should also be encouraged to report catches. The Japanese evidence of isolated local populations, of low productivity, and of the apparently more damaging effects of selective fisheries for large animals makes it more imperative that all harpoon fisheries are properly monitored and research carried out on the exploited populations.

In view of the almost complete lack of information on this species (except off Japan), the most urgent need is for further study to determine the identity, status and biology of the populations.

Captive Breeding At least 226 specimens have been held in captivity: 20 in Hawaii, 50 taken from the USA Pacific coast, and 156 in Japan (IWC, 1984). They are described as 'popular display animals' although no regular breeding is recorded. Antrim and Cornell (1981) report a hybrid near-term foetus from a female short-finned pilot whale and a bottlenose dolphin. In view of the number of specimens taken into captivity it is unfortunate that the opportunity has not been taken to undertake substantive studies.

This species is probably too large for conservation through captive breeding to be feasible.

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IRRAWADDY DOLPHIN **INSUFFICIENTLY KNOWN**
Orcaella brevirostris (Gray, 1866)

Suborder ODONTOCETI Family DELPHINIDAE

Summary The exact status of the Irrawaddy dolphin is unknown. The species has a fairly wide range but inhabits the very vulnerable tropical riverine, estuarine and coastal habitats. There have been almost no surveys, but where these have taken place they have revealed exclusion from previous habitat by industrial developments. The Irrawaddy dolphin does not appear to be particularly common within the range. There are reports of indirect and possibly directed catching throughout the range. There are thus grounds for serious concern. The major needs are for more information on the species throughout the range and for the education of governments and the public about the existence of this dolphin and its potential problems, so that conservation and management can be organised.

Distribution The Irrawaddy dolphin is found in the Bay of Bengal and throughout the Indo-Malay Archipelago to northern Australia, particularly in the major rivers, such as the Ganges, Mekong and Irrawaddy, and frequenting warm shallows. An exact map by Lloze (1973) showing the location of known specimens at that time, gives India, Bangladesh, Burma, Thailand, Malaysia, Indonesia, Kampuchea, Viet Nam, Papua New Guinea and Australia (north) as countries of origin. This should be regarded as a minimum list: Singapore and Brunei are within the known range, and it is also possible that animals may be found in the rivers of the Lao PDR and in the Philippines. The species has recently been reviewed by Marsh *et al.* (1989).

There have been few surveys of any part of the range. Lloze (1973) spent three years studying the Mekong and Kampuchean areas in the mid 1960s. Unfortunately, his work was interrupted by the wars which have rendered this part of the world more or less unavailable to scientific study ever since.

In eastern Borneo (Kalimantan), the Irrawaddy dolphin was formerly distributed in coastal waters near the mouth of Mahakam river and up-stream in the Mahakam and major tributaries to a distance of at least 200km. From surveys conducted by the Jaya Ancol Oceanarium in February 1974, a significant population was confirmed to inhabit Semayang Lake, Pela river and the adjacent Mahakam river. Although previously reported as far down the river as Tengarong and Samararinda, the dolphins apparently now remain above Murarakamen, presumably excluded from the lower river by extensive activity associated with the timber industry (Tas'an and Leatherwood, 1984).

Too little is known to enable other past and present distribution to be compared, except that the barrages near the mouth of the Ganges will have at least cut off the population above the dam, if not eliminated the species from this area. (For full description of the dams see review of the Ganges river dolphin). It has not yet been ascertained whether other rivers in the region also have dams or barrages. Seasonal movements within the Mekong are described by Lloze (1973).

Population The 1974 survey reported that Semayang Lake, the Pela river and adjacent Mahakam river contained at least 100-150 animals. Similar groups were reported for Melintang and Jempang lakes (Tas'an and Leatherwood, 1984). Fishermen in Burma believe that the species is more common in the lower part of the Irrawaddy river (Leatherwood *et al.*, 1984). It is also said to be common in northern Australia (Marsh *et al.*, 1989). There is no other information on population levels anywhere. It may be presumed not to be particularly common within most of its distribution, because of the lack of reports, although Leatherwood and Reeves (1983) do point out that the animal is very unobtrusive and difficult to observe in the field.

Habitat and Ecology Few animals have been measured, but the longest male so far recorded was 2.75m and the longest female 2.32m. Up to 28 growth layer groups have been counted in teeth, possibly indicating a maximum age of around 30 years. The age of sexual maturity is unknown, but adult size of approximately 2.1m is reached by about 4-6 growth layer groups (Marsh *et al.*, 1989). A full-term foetus was 85cm long (Leatherwood and Reeves, 1983). Two females at Jaya Ancol Oceanarium gave birth to live, healthy young after a presumed gestation of 14 months (Tas'an and Leatherwood, 1984). The sonar signals have been studied by Kamminga, Wiersma and Dudok van Heel (1983).

Lloze (1973), describing the Mekong population, says that the animals are found usually near sand banks where the lakes meet the river and where streams flow into the lakes. During the high-water season the dolphins are found in the smaller streams. They have also appeared from time to time in the temple pools in the Angkor complex. There may be greater seasonal migrations, as the relations between the populations found at sea and in the rivers are not known.

The Semayang population in Kalimantan, occurring in small herds of 3-10 individuals, migrates from the lake to Mahakam river in early morning (05.00 - 09.00) to feed, principally on carp (*Cyprinidae*), and moves back into the lake in the evening (18.00 - 20.00) (Tas'an and Leatherwood, 1984). Marsh *et al.* (1989) list food species found in the stomachs of dolphins caught in the sea off Townsville, Australia. Various fish species form the bulk of the diet, but cephalopods and crustaceans are also taken. Feeding seems to occur both on the bottom and in the water column.

Lloze (1973) relates an anecdote about a 'tame' dolphin which would come at call and accept caresses. It was said to aid fishermen by driving fish into their nets.

Threats The tropical river, estuary and coastal habitat is particularly vulnerable. The example of exclusion from part of the Mahakam river, possibly by the activities of the timber industry, is unlikely to be unique (Tas'an and Leatherwood, 1984). The problems of the riverine habitat are fully discussed in the *Inia* review.

At least in the Irrawaddy, the species is protected by the belief that it aids fishing. Khmer and Vietnamese fishermen regard Irrawaddy dolphins as sacred animals, and release them when they become entangled in fishing nets. Khmer-Islam fishermen, however, kill them for food (Marsh *et al.*, 1989). The dolphin is sometimes taken in fish traps but, at least in the Mekong area, the carcasses are described as given ceremonial cremation with prayers by the local religious community to prevent the spirits of the dead animals from troubling local people (Lloze, 1973).

No organised fishery is reported in Bangladesh, because fishermen are said to be friendly to this species. They are, however, sometimes accidentally trapped in fishing nets. Aboriginal people in Australia are reported to eat animals which have either been directly taken or died after entanglement in fish traps. Some are taken in other fishing operations in the Gulf of Papua, and they are the most common species taken in shark nets set for bather protection near Townsville, Australia (Marsh *et al.*, 1989). In Burma and elsewhere the oil may be used as a cure for rheumatism (Kellogg, 1940; Leatherwood *et al.*, 1984).

Recent reports from Australia mention at least 150 dolphins a year (Irrawaddy, bottlenose or humpback dolphins) taken in the barramundi fishery and about 40 dolphins per year (bottlenose, Irrawaddy and false killer whales) taken by small scale shark fisheries (IWC, 1987).

Conservation Measures Countries of origin: India, Bangladesh, Burma, Thailand, Malaysia, Indonesia, Kampuchea, Viet Nam, Papua New Guinea and Australia. Singapore and Brunei are also within the known range, and it is possible that animals may be found in the rivers of the Lao PDR and in the Philippines. The Irrawaddy dolphin is listed on Appendix II of CITES. The only international trade recorded is the movement of an unrecorded number of specimens from Australia to Canada for scientific purposes in 1984 (CMC, 1987). No other international legislation refers to the species, although the Ramsar Convention and WHC could serve to protect habitat, and conservation agreements could be made between countries of origin. These could be particularly important where rivers are controlled by more than one country.

No specific national legislation protecting the species in countries of origin has so far been located, although general legislation protecting cetaceans exists at least in Australia and India. The Directorate General for Forest and Nature Conservation of the Forestry Ministry of Indonesia has proposed that Semayang lake in east Kalimantan be made a national park for protection of this dolphin. Local conservationists are pressing for the nearby Berambai Forest, which constitutes the watershed of the lake, to be included to protect the lake from water depletion and pollution (Perrin, 1985). There are a number of protected areas within the range, particularly existing and proposed wetlands conservation areas, which may serve to protect habitat.

This little known, and possibly not very abundant, species has a particularly vulnerable habitat and suffers from at least some accidental capture throughout the range. It will be particularly vulnerable to division of the populations by dams in the rivers (see *Inia* review). While local beliefs may protect part of the range, there is considerable danger that dams designed in ignorance of the needs of the species, heavy local by-catching or industrial development may quickly exterminate at least local populations.

The main need is for increased awareness of the potential problems of the species, and consideration for them at national and international level, as well as for research into distribution, population and biology, to identify any problems, and provide information for conservation and management.

The IUCN/SSC Action Plan (Perrin, 1989) calls for conservation of Irrawaddy dolphin habitat in Indonesia, as well as proposing a number of general projects relevant to this species.

Captive Breeding Eight dolphins were caught in Semayang lake, in Indonesia, in 1974 and 12 in 1978. Four of these were released at the site and 16 transported to Jaya Ancol Oceanarium after a period of acclimatization. No animals were killed during the capture, acclimati or transport. Seven animals were still alive in 1983, and an eighth, a 2.20m male, transferred to Surabaya Zoo, was also still alive. Some animals have been show-trained, others are part of a continuing captive breeding programme. Two females conceived and gave birth to healthy young, which were still alive in 1983 (Tas'an and Leatherwood, 1984). A specimen possibly of this species (but described as 'white river dolphin') was kept at King Neptune Park, New South Wales, Australia, from 1974 to 1981. It was said to have been captured at Harvey Bay. No other specimens are mentioned in the Australian Report on Dolphins and Whales in Captivity (Australia, 1985) or in Cawthorn and Gaskin's (1984) list of small cetaceans in captivity in Australia and New Zealand. However, Mitchell (1975) and Marsh *et al.* (1989) say that specimens have been kept successfully in captivity at Cairns, Australia, and Leatherwood and

Reeves (1983) show a photograph of one animal here. This establishment closed some years ago.

Captive breeding could, therefore, be a conservation option, if necessary. If any animals are taken into captivity, for this or any other reason, the opportunity should also be taken for research into biology, breeding and behaviour, to provide more information for the conservation and management of the wild populations.

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SHEPHERD'S BEAKED WHALE **INSUFFICIENTLY KNOWN**
Tasmacetus shepherdi Oliver, 1937

Suborder ODONTOCETI Family ZIPHIIDAE

Summary Shepherd's beaked whale is a very little known Southern Hemisphere species. There is no information on exact range, or on abundance or threats.

Distribution Shepherd's beaked whale is found only in the Southern Hemisphere, and seems to be associated with cooler waters from 33° to 50°S. The species has recently been reviewed by Mead (1989) and by IWC (1989).

Population There is no information on abundance, and the species is only known so far from about 20 strandings and a few sightings (IWC, 1989). However, the number of records has increased with increasing interest in cetaceans in Southern Hemisphere countries, and it may be less rare than the number of known records suggests at present.

Habits and Ecology Adults range from 6 to 7m in length, the largest female was 6.6m long and the largest male 7m. The female was sexually mature. There is insufficient evidence to determine whether there is any sexual dimorphism (IWC, 1989; Mead, 1989). One stranded specimen had primarily bottom living fishes in the stomach (Mead and Payne, 1975). The sparse information on distribution and food habits appears to indicate that this is a deep feeding oceanic species.

Threats There are no records of direct or incidental takes. If this is a mainly oceanic species feeding in deep water in the Southern Ocean it would be unlikely to have any major habitat problems.

Conservation Measures So far Shepherd's beaked whale has been reported from New Zealand, Australia, Chile (Juan Fernandez Archipelago), Argentina and South Africa, but this list is unlikely to give a complete picture of the distribution.

CITES Appendix II listing is the only international protection provision. Two scientific specimens of unknown origin are recorded as being moved from USA to UK in 1982 (CMC, 1987). The species is covered by general protective legislation in several countries.

The IUCN/SSC Action Plan does not mention this species, but it will be covered by general projects (Perrin, 1989). The obvious conservation requirement is for more information. The IWC/IDCR cruise records should be re-examined for any sightings which could be referred to this species. Countries within the distribution area should also take further steps to ensure that any stranded specimens are fully investigated.

Captive Breeding This species is too large for conservation through captive breeding to be feasible.

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BAIRD'S BEAKED WHALE **INSUFFICIENTLY KNOWN**
Berardius bairdii Stejneger, 1883

Suborder ODONTOCETI Family ZIPHIIDAE

Summary Baird's beaked whale has a long history of exploitation off the Japanese coast, but there is insufficient information available to show whether this population is stable or declining. Through the disputes in IWC about their competence to regulate catches of certain cetacean species, including Baird's beaked whale, this fishery is not covered by the current moratorium on commercial whaling. Japan, however, had set a national catch limit of 40 animals a year, which was increased to 60 in 1988. Although there has been some exploitation elsewhere in the wide North Pacific range, it has been at a low level and has now ceased. Research is in progress which should provide more information on the species in general, and on the exploited section of the population.

Distribution Baird's beaked whale is found in the offshore (deeper than 1,000m) waters of the North Pacific, from the Pribilof Islands and Alaska south to southern Californian waters in the east and from Kamchatka and the Sea of Okhotsk to southeast Japan in the west. Baird's beaked whale has recently been reviewed by Balcomb (1989) and by IWC (1989).

It appears that there may be separate stocks in the western North Pacific, Sea of Japan and Sea of Okhotsk, because sightings records show that each area is inhabited concurrently in summer and autumn. The whales are not known to cross the relatively shallow straits between the regions or to enter the East China Sea. The stock living off the Pacific coast of Japan probably inhabits continental slope waters between the fronts of the Kuroshio and Oyashio Currents north of about 34°N. The mid-winter distribution of these putative stocks is unknown (IWC, 1989).

There is no recent information available about Baird's beaked whales around the Kurile islands, but it has been reported that the species is found from the Kamchatka peninsula and the western Bering Sea along the ice edge as far north as Cape Navarin (56°N) in summer months. Strandings have been reported from the Commander Islands and St. Matthew Island in the Bering Sea as well as the Aleutian Islands and Siberia. The whales in this region may represent another stock or population (IWC, 1989).

The eastern North Pacific stock(s) of this species occur in summer and autumn from Alaska and Vancouver Island as far south as the tip of Baja California, Mexico (23°N) (IWC, 1989).

The distribution of Baird's beaked whale across the mid-latitudes of the entire North Pacific Ocean was mapped by Ohsumi (1983) from sightings reports. There appeared to be notable concentrations near the Emperor Seamount Chain and north of Hawaii. However, the accuracy of the identifications has been questioned. It was reported that a survey is planned for the summer of 1988 which should resolve the question of whether Baird's beaked whale is in fact found in oceanic waters far offshore (IWC, 1989).

Population Miyashita (1985) calculated an abundance estimate of 4,220 for the western North Pacific, from sightings data. The catch per unit effort data do not show a clear annual trend from 1947 to 1983, and it is therefore not known whether the population is decreasing or stable. Surveys planned for this area in 1988 may help to resolve this problem. There is not sufficient information from other areas to allow estimates of world abundance, although the species is not considered to be rare (IWC, 1989; Balcomb, 1989).

Habitat and Ecology Baird's beaked whale is the largest member of the beaked whale Family, with adults growing to 10-12m. Females are slightly longer than males. It appears that one growth layer group in the teeth represents one year. On this basis males attain sexual maturity between six and ten years, at a length of about 9.1 to 9.7m. Females are sexually mature at 10-14 years, and 9.8 to 10.6m. The sex ratio of juveniles in catches is approximately 1 : 1, but for whales with more than 20 growth layer groups in the teeth it is strongly biased towards males, although there seem to be no obvious differences in the catchability of males and females. Stranded schools also show a lack of older females. The oldest female so far reported had 54 growth layer groups, and the oldest male 84. There is a correspondingly unusual age distribution, suggesting a significantly higher mortality rate in females. The annual pregnancy rate for adult females has been estimated at 0.30 (IWC, 1989). Gestation is estimated to last about 17 months. The calving season extends from November to July, with a peak in March and April, giving a mating season in October and November. The length at birth is about 4.5m (Balcomb, 1989).

These whales feed on benthic fishes and cephalopods in the western Pacific, indicating deep water feeding in this area. The diet in the shallow waters of the northwest Okhotsk Sea is not known (IWC, 1989). Balcomb (1989) gives a more detailed list of prey species, which includes epibenthic and pelagic creatures.

Baird's beaked whales usually travel in schools of three to 20 animals, although solitary animals and groups of 30 or more have been reported. Larger groups may disperse into smaller groups and re-aggregate over the course of a day, suggesting some social organisation within the groups. The deep and long diving habits of this species are well known among whalers. Dive times can range up to 67mins, and depths of up to 2,400m are reported. From the benthic habits of some prey species, it appears that feeding dives of 1,000m and more are routine (Balcomb, 1989).

Seasonal movements are not well understood, but the whales do seem to leave the Pacific coast of Japan in winter months. The Sea of Japan stock may remain isolated there in all seasons. The Okhotsk Sea stock apparently inhabits waters near Hokkaido in late spring and autumn, moving to the north during the summer. The winter distribution is unknown, but it is suggested that at least some animals may move to the east of the Kurile Islands in winter when the southern Okhotsk Sea is filled with ice. However, Baird's beaked whales have been seen in small open leads in the northwestern Okhotsk Sea in winter months. They are present along the continental slope of the California coast in summer and autumn, but absent in winter (IWC, 1989).

Threats A Canadian fishery off British Columbia took 35 between 1950 and 1966, a Californian fishery took 14 between 1959 and 1966, and the USSR took about 150 between 1934 and 1964 (Mitchell, 1975).

The main fishery is in Japan, and takes there have ranged from 13 to 322 per year. The major recorded catches off Japan took place in the 1950s, when over 200 were taken in most years. The catches were between one and two hundred a year until 1971, and have been generally under 50 a year since that time. The Government of Japan has set an annual national quota of 40 in recent years, which the industry has divided into 35 from the western Pacific and five from the Okhotsk Sea (IWC, 1989). The quota was increased to 60 in 1988, and 57 were taken (IWC, 1990). The catch-per-unit-effort series for the western Pacific do not show a clear trend. It is therefore not known whether the population is diminishing or stable (IWC, 1989).

Conservation Measures Countries of origin include Japan, USSR, Canada, USA and Mexico.

The IWC definition of 'bottlenose whale' includes Baird's beaked whale, but as only North Atlantic stocks (of the northern bottlenose whale *Hyperoodon ampullatus*) are given provisional Protection Stock status, Baird's beaked whale (living in the North Pacific) has no classification. Baird's beaked whales were first extensively considered by the IWC Scientific Committee in 1982. Several problems with the catch and sightings data presented were identified, and the Committee were unable to recommend a classification on the basis of current knowledge. They noted that if the Commission wished to establish a catch limit on the basis of recent catches, the annual average was 39 whales. They believed that catches at this level over a short period would not seriously affect the stock and recommended further research to provide the information necessary for a full assessment (IWC, 1983a). However, discussions by the Commission were inconclusive, because no agreement could be reached on the Commission's competence to set catch limits for this species. Japan noted that although the fishery dated back to the 17th century, it had declined in recent years because of market factors. Whaling vessels were licensed, and Japan offered to set a voluntary catch limit of 40 through domestic legislation (IWC, 1983b). Although the species has been considered several times since then by the Scientific Committee and has remained on the Commission's Agenda, no further progress towards catch regulation by IWC could be made in the absence of any agreement on the Commission's competence with regard to this species (and with regard to 'small cetaceans' in general). The Japanese catch limit, however, has been respected (IWC, 1989). Because the IWC could reach no agreement on whether catches of this species could be regulated, the current exploitation is not covered by their moratorium on commercial whaling.

Baird's beaked whale has been listed in CITES Appendix I from 1986. Japan, USSR and Austria have registered reservations against this listing, and for them the previous Appendix II listing applies. No international trade involving this species has been recorded (CMC, 1987). No other international agreements refer to this species, but Baird's beaked whale is protected by general legislation in some countries of origin, and the Japanese catch limit is discussed above.

The IUCN/SSC Action Plan notes the status of Baird's beaked whales off Japan as a situation to be monitored, because of continuing exploitation of a population of unknown status (Perrin, 1989). More information on abundance, distribution, stock identity, behaviour and biology is needed, and as noted above, research is in progress to this end. The Japanese catch limit was based on average catches. Although this figure did emerge from the Scientific Committee, it was also stated there that catches at this level would probably not be harmful in the short term (although this was in 1982, and sufficient data for a full assessment have still not been obtained). It is therefore to be hoped that the 1988 research cruises will at last provide sufficient data for a full population assessment.

Captive Breeding Baird's beaked whale is too large for conservation through captive breeding to be feasible.

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ARNOUX'S BEAKED WHALE | **INSUFFICIENTLY KNOWN**

Berardius arnuxii Duvernoy, 1851

Suborder ODONTOCETI | Family ZIPHIIDAE

Summary Arnoux's beaked whale is very little known. Information on numbers, distribution, biology and behaviour is required to identify potential conservation needs, especially in view of the increasing fishing effort in the Southern Ocean.

Distribution Arnoux's beaked whale is found in circumpolar cool temperate subantarctic and Antarctic waters. The northernmost stranding was at 34°S in South Africa, and the southernmost was at 64°S on the Antarctic Peninsula. Sightings of these whales have been made very near the ice edge and amongst ice floes in the Antarctic pack. Some have been known to become entrapped in pack ice.

The species has recently been reviewed by IWC (1989) and Balcomb (1989). There is some dispute as to whether Arnoux's beaked whale and Baird's beaked whale are separate species, but for the present purpose they are reviewed separately in accordance with current practice.

Population Nothing is known about the absolute abundance of Arnoux's beaked whales, although they are said to be much less common than southern bottlenose whales (IWC, 1989). The species has been recorded during IWC/IDCR cruises in Antarctic Areas II, IV, V and VI (see Introductory section for map of IWC Areas), but in the earlier cruises some sightings may have been simply logged as 'unidentified ziphiid' or not logged at all. Unfortunately, therefore, the IDCR cruise data seems unlikely to be able to provide population estimates, at least at present. Sightings recorded from Japanese whale scouting ships before 1975 (included in the map given by Balcomb, 1989) may also not be completely accurate (IWC, 1989). The relative frequency of strandings and sightings reports around New Zealand may indicate an area of concentration, or may simply reflect relatively greater observer effort there (Leatherwood and Reeves, 1983; Balcomb, 1989).

Habitat and Ecology The largest male specimen reported was 9.6m long and the largest female 8.85m. Both specimens were mature. Nothing is known of the life history of Arnoux's beaked whales, although it is presumed to be similar to that of Baird's beaked whales (IWC, 1989; Balcomb, 1989; Leatherwood and Reeves, 1983).

Arnoux's beaked whales are usually very shy creatures. They are capable of diving for an hour or more, and hence are difficult to observe and to identify positively. They are often seen in groups of 6-10 and occasionally of up to 50 or more. A group of about 80 animals was followed for several hours, after which time it split up into subgroups of 8-15 animals which dispersed among windows in the pack ice. The usual dive duration was 15-25 mins, although one group was observed to dive for over an hour and travel for about four miles underwater before resurfacing. Water depth in this area ranged from 136-200 fathoms, and surface water temperature was -0.8°C (Balcomb, 1989). Leatherwood and Reeves (1983) note that recorded sightings of free-swimming animals are all from pelagic waters, but often near seamounts or other significantly steep bottom slopes.

Most strandings have been recorded in summer, but seasonal shifts in distribution have not been confirmed (Leatherwood and Reeves, 1983; IWC, 1989).

Threats No threats to this species are known at present. The increasing fishing effort in the Southern Ocean may entail a risk of by-catching. A very few specimens have been taken in the Antarctic, mainly for study purposes. It is not known whether ice entrapment is a significant factor for natural mortality, but one trapped specimen remained alive for about six months before it was shot (Leatherwood and Reeves, 1983).

Conservation Measures Putative countries of origin include all those with coastlines in the southern hemisphere, in cool temperate, subantarctic and Antarctic waters. Locations so far recorded include: New Zealand, Australia, Argentina, UK (Falkland Islands, South Georgia, South Shetlands), South Africa and the Antarctic Peninsula.

Arnoux's beaked whale was included in Appendix II of CITES from 1979, and was transferred to Appendix I in 1986. USSR and Austria have entered reservations against the latter listing, and for these countries this species is treated as Appendix II. No international trade is recorded for Arnoux's beaked whale (CMC, 1987). The IWC definition of 'bottlenose whale' includes Arnoux's beaked whale, but as only North Atlantic stocks of 'bottlenose whales' are given provisional PS status and a zero catch limit, Arnoux's beaked whale, living in the Southern Ocean, has no classification. No other international agreements refer to Arnoux's beaked whale, but the species is protected by general legislation in some countries within the range.

The IUCN/SSC Action Plan contains no specific projects relating to Arnoux's beaked whale, although it will be included in general projects such as improving the reporting of accidental catches (Perrin, 1989).

Although there are no known threats to this species at present, it is very little known indeed. It would be prudent to collect information on numbers, distribution, biology and behaviour in case any problems arise in future, particularly in view of the increasing fishing effort in the Southern Ocean.

Captive Breeding No specimens of Arnoux's beaked whale are reported to have been kept in captivity, and the species is too large for a captive breeding colony to be feasible. There is therefore no practical possibility for conservation through captive breeding.

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LONGMAN'S BEAKED WHALE **INSUFFICIENTLY KNOWN**
Mesoplodon pacificus Longman, 1926

Suborder ODONTOCETI Family ZIPHIIDAE

Summary Evidence for the existence of Longman's beaked whale comes only from two skulls found on beaches in the Indian and South Pacific Oceans. There is also a possible sighting in the Seychelles. More information on this species is required, particularly on external appearance, so that living and whole captured or stranded specimens can be more easily identified.

Distribution The species was first described from a weathered skull found at Mackay, eastern Queensland, Australia in 1882 (Longman, 1926). A second skull has been described, which was found on a beach at Danane, Somalia in 1955 (Azzaroli, 1968). This suggests an IndoPacific distribution.

There have been some differences of opinion on the taxonomic status of this species. Longman (1926) pointed out a number of unique features in support of his opinion that the Mackay skull represented a separate species. Raven (1937) and Nishiwaki and Kamiya (1958) considered it to be a subspecies of *Mesoplodon mirus*, although Moore (1960) stated that the differences between *M. pacificus* and *M. mirus* were too great to be considered as only subspecific. McCann (1962), however, thought that this was the skull of a female southern bottlenose whale (*Hyperoodon planifrons*). Moore (1968) studied the Mackay skull and presented evidence that it is a male specimen of a valid species, but he found it sufficiently different from the other *Mesoplodon* species to warrant its own genus, *Indopacetus*. Azzaroli (1968), however, described the Danane specimen as *M. pacificus*. This skull, although somewhat incomplete, was in sufficiently good condition to add new information to the species description and served to confirm the validity of the species. The small cavities at the tip of the lower jaw left by the missing pair of teeth indicate that this specimen is likely to be a female. Moore (1972) later published further information on Longman's beaked whale. Moore's (1968) designation of a separate genus does not seem to have been widely accepted in general use (e.g. Mead, 1989; IWC, 1989), and Longman's beaked whale is still usually known as *Mesoplodon pacificus*.

Keller, Leatherwood and Holt (1982) photographed a group of four animals, three adults estimated to be 4.6m long and a juvenile estimated to be 2.4m long, at 4°03'S, 56°07'E in the Seychelles. The animals were gray on the back, lighter on the ventrum, slender, and with a shark-like pointed dorsal fin. The photograph is included in the paper. They were identified as either Gray's beaked whale or Longman's beaked whale. The latter possibility cannot be ruled out, particularly because of the finding of the Danane skull. They also report seeing two light gray whales, one estimated to be 20-25 feet long (up to 7.5m) and one 12-15 feet long (up to 4.6m) breaching at 04°12'S, 53°1''E on 27 April 1980. These whales had elongated beaks and broad flukes with a flat posterior margin, characteristic of beaked whales.

The Genus has recently been reviewed by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population The few reports may indicate that Longman's beaked whale is rare, but, as there is no information on external appearance, reports of sightings of unidentified ziphiids cannot yet be attributed to this species. This also applies to strandings and to any catches, which may consequently be discarded without full examination.

Habitat and Ecology There is no information on the way of life of this species, but it is likely to be pelagic and to have the unobtrusive habits of the other members of this genus. The Mackay skull is 1.186m long and the Danane skull reconstructed as 1.130m (Azzaroli, 1968). From the proportions of the Mackay skull, Longman (1926) thought that the animal may have been at least 25 feet (approx. 7.5m) long, which would make it the longest *Mesoplodon* species. Such a length would rule out the possibility that the Seychelles sighting was of Longman's beaked whale, as these animals were only estimated to be 4.6m long. However, the size might fit the second Seychelles sighting of two animals (Keller, Leatherwood and Holt, 1982).

Threats The second skull was found on the floor of a fertilizer factory near Mogadishu but had been picked up on the beach at Danane by local fishermen (Azzaroli, 1968). Both known skulls thus appear to have come from stranded animals. Although there are no reports of accidental or direct catches, it is probable that any which did occur would go unremarked because the external appearance of the species is not known. This is particularly the case in the Seychelles, where it appears that the legal prohibition on cetacean taking has resulted in the butchering at sea of animals taken by hand harpoon and the discarding of the bones (Leatherwood *et al.*, 1984).

Conservation Measures The only known specimens originate from Queensland in northeastern Australia and Somalia in northeast Africa. There is also the tentative sighting in the Seychelles. It therefore seems likely that other countries in the area will be found to have this species in their waters.

Longman's beaked whale is covered by CITES Appendix II, despite the fact that it was inadvertently omitted from the list of species reviewed in support of the UK's proposal for this listing (Klinowska, 1980). No international trade is reported for Longman's beaked whale, or for any material identified only as Ziphiidae spp. (CMC, 1987). Further information on this species is required before any other international protective actions can be usefully suggested. The IWC has agreed to recommend Parties to report takes of all cetaceans, although few have so far responded. Better reporting by IWC Parties could greatly improve our knowledge of species such as those of the genus *Mesoplodon*, where every possible piece of information is valuable.

The species will be covered by the general protective legislation in Australia, and in other countries, although the protective legislation in Seychelles does not appear to be very effective. No specific information on Somalia national legislation has been found, although it appears that the wildlife protective legislation is currently under review, and in any case introduction from the sea and international movements of specimens will be covered by Somalia's CITES membership.

The main requirement is for further information on this species. Photographic or video records of any possible beaked whales encountered at sea are always worth making and seeking expert opinion upon. While it will not be possible to identify many of these at present, in time this will contribute to our knowledge of these elusive cetaceans. Coastal residents, sailors, fishermen and visitors should be aware that very little is known about most smaller beaked whale species and be alert for any possible specimens. These should be safeguarded, intact if possible, until they can be examined by experts. In emergency a set of careful photographs (including some kind of scale, some taken at 90° to the length, and some of the mouth and any teeth), or measurements (taken parallel to the body, not along the contours) and sketches, together with preservation of the skull and lower jaw (without which the identification cannot be confirmed) would suffice. Preservation of the reproductive organs and of the stomachs with their contents is also very helpful. As the smaller beaked whales are covered by CITES Appendix II, permits will be required for international movement of specimens and for introduction from the sea if the specimen originates outside national waters.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding No information, but see Sowerby's beaked whale review.

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SOWERBY'S BEAKED WHALE **INSUFFICIENTLY KNOWN**

Mesoplodon bidens (Sowerby, 1804)

Suborder ODONTOCETI Family ZIPHIIDAE

Summary Although it is now represented by quite a number of records in comparison with some other members of this genus, Sowerby's beaked whale is still little known: there is little information on abundance, status or threats.

Distribution Records of Sowerby's beaked whale indicate a range in the cold temperate waters of the North Atlantic, with the majority of records from around the British Isles. There are now about 80 records from the eastern North Atlantic and less than ten from the western side. Thc northernmost record is from Faeo Island, Norway and the southernmost from Port Saint Joe, Florida. There has been some controversy over the presence of this species in the Mediterranean, but a report of a specimen from Italy has now been supported (Mead, 1989). A specimen was caught at Greifswalder Oie, on the Baltic coast of Germany (Schulze, 1973) and another specimen is reported from Wolin Island, which is now in Poland (Koepcke, 1936). There are several records from the Skagerrak and Kattegat coasts of Sweden and Denmark. The species has also been reported from Canada, Iceland, the Netherlands, Belgium, France, Ireland, Madeira and the Azores (Mead, 1989; Aguayo, 1978; Moore, 1966; Fraser, 1974; Leatherwood and Reeves, 1983; Maul and Sergeant, 1977; Reiner, 1986).

This apparent distribution is mainly based on records of stranded animals (partly because the species is difficult to identify with certainty at sea) and may reflect the efficiency of strandings and sightings recording as much as the real distribution of the animals.

McBrearty, Message and King (1986) report two recent sightings of single animals on the 100m depth contour to the north of the Scottish mainland and west of the Orkney Islands, one in June and one in October. Evans (1980) notes a sighting in the Minch, off northwest Scotland in August 1977. Both McBrearty *et al.* and Evans run schemes for the recording of cetacean sightings. If the main range of this species is indeed in the North Sea, as suggested by Moore (1966), it is somewhat surprising that no sightings have been reported there, as both schemes have many reports of other species from this area, indicating that there is no lack of sightings reporters. An alternative explanation for the apparent difference between the sightings and strandings distribution might be that the stranded animals were vagrants from a population normally living further offshore in the northeastern North Atlantic. Aguayo (1978) considered the records he found for the Baltic Sea, which included a sighting recorded on film, to show that Sowerby's beaked whale was a rare visitor to these waters. Mead (1989) believes it unlikely that any ziphiid habitually dwells in the shallow Baltic Sea. Perhaps the same will turn out to be true for the North Sea when more information on the population at large emerges.

The genus has recently been reviewed by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus often considered rare or very rare. Whether numbers are in fact low or whether the mode of life of these species results in few sightings, catches and strandings is not clear. There are no population estimates for any species.

Habitat and Ecology Despite the comparatively large number of records, very little is known about the biology and ecology of this species. Besides the fact that a number of records are simply skulls or other characteristic bones found on beaches, one reason for this lack of information is that species recognition frequently requires museum preparation of the skull, by which time the rest of the specimen may no longer be available. Another problem is that specimens have been identified initially as more common ziphiids and only later have some been recognised as this species, again too late for detailed examination. A final problem seems to be that where the species is recognised at once, in the anxiety to secure a rare specimen with a view to permanent exhibition of at least the skull, the routine examination of such important ecological evidence as stomach contents has been overlooked. These seem to be problems common to all the *Mesoplodon* spp. although not where modern well organised specimen recording schemes exist.

The maximum length of female Sowerby's beaked whales is recorded as 5.05m, and of males 5.5m, although the longest male which was certainly measured, and not estimated, was 4.78m. The longest foetus so far recorded was 1.57m long and the smallest calf 2.45m. This calf showed traces of the umbilical cord, leading to an estimated length at birth of 2.4m (Mead, 1984). A 2.7m calf weighed 185kg (Dudok van Heel, 1974).

Adult males have two teeth in the middle of the lower jaw; females may have smaller teeth or they may not erupt at all. Some very limited data may indicate that birth occurs in late winter and spring. In common with most other *Mesoplodon* spp. Sowerby's beaked whales appear to live in small groups or singly, behave unobtrusively, and do not approach ships. They are generally thought to be cephalopod feeders (Leatherwood and Reeves, 1983). Reiner (1986) notes that his specimen was one of three animals (possibly all of the same species) which were seen swimming from north to south near Vila Franca do Campo on San Miguel Island. This specimen stranded on a shallow reef; the others seem to have continued on their southern route. Moore (1968) provides a key for the identification of skulls.

Dudok van Heel (1974) describes the swimming behaviour of a calf during an attempt at rehabilitation in captivity. He says 'Most remarkable, however, were the tiny flippers for which there are hollow recesses in the body enabling the flippers to be drawn in completely and lying within the body contours. The moment the little one started to swim she pressed her flippers against her sides....(and) lost almost all the manoeuvrability for which the delphinids... are famous.' He also notes that the calf made curves with sideways strokes of the tailstock, not employing the flippers at all for steering. (Recesses in the side of the body for the flippers are usual for the genus, perhaps indicating that this calf was demonstrating the normal mode of swimming, and not behaving aberrantly through stress or injury.) The calf spent the night resting on the bottom of the pool, remaining there for up to 20 mins at a time.

Threats This species is not known to have been specifically commercially hunted, although it may be subject to incidental takes in other fishing operations (Mitchell, 1975; Schulze, 1973). Maul and Sergeant (1977) refer to the capture of their specimen near the port of Machico in Madeira on 14 August 1941. Reiner's (1986) specimen was harpooned some time after it stranded.

Conservation Measures Known countries of origin are: USA, Canada, Iceland, Norway, Sweden, Denmark, Poland, GDR, the Netherlands, Belgium, France, UK, Ireland and Portugal (Azores and Madeira), but any other country within the North Atlantic might record specimens in future.

Mesoplodon spp. are included in Appendix II of CITES. No international trade is reported for Sowerby's beaked whale (CMC, 1987). Sowerby's beaked whale is listed in Appendix II of the Berne Convention. No other international agreements refer to the genus, and without more information no further international protective actions can usefully be proposed. The IWC has resolved to recommend that Parties report takes of all cetaceans, although few Parties have so far responded. If all Parties did follow this recommendation much valuable information, particularly for rarely recorded species, would be generated.

The genus is protected by general legislation in several countries, but no specific provisions were found, except those made through membership of the Berne Convention.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information. Further information on recognition characteristics is urgently required, so that sightings at sea can be more readily identified.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding Beddard (1900) says that a specimen of this whale was captured at Havre in August 1828 and lived for two days out of water. It was offered 'soaked bread and other alimentary substances' and 'emitted a cavernous sound like the lowing of a cow'. This specimen had no teeth, and was thus either a female or juvenile male.

Dudok van Heel (1974) describes an attempt to keep a female calf in captivity after it was found on a beach in Belgium together with a dying adult female. He mentions the difficulty the calf experienced in turning in his small treatment pool and moved her first to a larger pool, where the lack of turning ability still resulted in contacts with the pool wall which damaged the skin, and then through a 40m channel to the main pool. This seemed a more satisfactory arrangement, although the introduction of an older female bottlenose dolphin as a companion frightened the calf to such an extent that this animal was withdrawn and the calf left alone. After several feeds administered by tube, the calf regained strength and swam more and more vigorously. Unfortunately this behaviour resulted in a severe crash against the pool wall; the rostrum was broken, and the calf died. The problem seems to have been the lack of fine steering ability, as described above. The author concluded that this species is designed to swim fast and straight, as might be expected from the pelagic habits, and that his 30m pool was not large enough to give the animal a fair chance of adaptation.

There appear to have been no other attempts to keep Sowerby's beaked whale in captivity, and, in view of the reported behaviour problem, it appears that this species could be unsuitable for maintenance in captivity, which would preclude captive breeding as a conservation option. Nevertheless, a single unsuccessful attempt to maintain this species some years ago does not necessarily mean that the case is hopeless and should certainly not deter any attempts to rescue and rehabilitate live stranded or accidentally caught animals. So little is known about this species that any information is valuable.

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BLAINVILLE'S BEAKED WHALE **INSUFFICIENTLY KNOWN**
Mesoplodon densirostris (Blainville, 1817)

Suborder ODONTOCETI Family ZIPHIIDAE

Summary Blainville's beaked whale is little known: there is little information on abundance, status or threats.

Distribution Blainville's beaked whale may be the most widely distributed member of this genus, being reported from tropical and warm temperate waters of all oceans. The species is thought to live further offshore than any of the other *Mesoplodon* spp. (Moore, 1966; Mead, 1989).

There are now a number of records from the western North Atlantic, from Nova Scotia to Florida, the Bahamas, Cayman Islands and the Gulf of Mexico. Records from the eastern North Atlantic are sparse, with one from Madeira, one from Portugal, two from the Canary Islands and one from the Mediterranean coast of Spain (Moore, 1966; Harmer, 1924; Casinos and Filella, 1981; Mead, 1989; Vonk and Martel, 1988; Mead, Heyning and Brownell, 1988). These beaked whales have been reported from South Africa, the Seychelles, Mauritius and Nicobar Islands in the Indian Ocean; from northeastern Australia, Tasmania, and the northern Tasman Sea in the South Pacific; and from Taiwan, PER China, Japan, and the Midway Islands in the subtropical mid-Pacific. Some sightings and a stranding are known from Hawaii, a stranding from the Galapagos Islands and two strandings from California (Mead, 1989; Mead, Heyning and Brownell, 1988; Leatherwood and Reeves, 1983). There is also a record for the southwestern Atlantic, at Cassino, Rio Grande do Sul in southern Brazil (Castello and Pinedo, 1980).

The genus has recently been reviewed by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus often considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few sightings, catches and strandings is not clear. There are no population estimates for any species.

Habitat and Ecology The maximum reported lengths are 5.8m for a male (Australia, 1988) and 4.71m for a female. (IWC, 1989 give maximum length for a male as 4.73m, while Mead, Heyning and Brownell (1988) list the Cayman Island male as an estimated 6.40m.) The minimum age at sexual maturity is nine growth layer groups (GLGs) in the teeth. It is not known how many GLGs may be laid down each year, but usually assumed that one GLG represents one year. The length of the longest foetus was 1.9m and of the shortest calf 2.61m (Mead, 1984). Calves are probably less than 2.40m long at birth. The oldest physically immature male had seven GLGs and the youngest physically mature female 10 or 11 GLGs (IWC, 1989).

Males have a characteristic large pair of teeth in the middle of the lower jaw, growing from the top of heavy bulges in the bone. The teeth do not erupt in females, although there are marked bulges in the jaw. They are believed to have the unobtrusive habits common to other members of the genus (Leatherwood and Reeves, 1983). Moore (1968) provides a detailed key for the identification of skulls. Leatherwood and Reeves (1983) give photographs of swimming and of dead stranded animals. Mead, Walker and Houck (1982) note depressions in the body wall to accommodate the flippers. Ross *et al.* (1988) describe the external appearance in detail.

Examination of the stomachs of several South African specimens showed remains of the fish genera *Cepola*, *Scopelogadus* and *Lampanyctus* and, in one case, two squid beaks of *Todarodes sagittatus* and *Octopoteuthis* spp. (Ross, 1984). Mead (1989) reports trace quantities of squid beaks but no fish remains in three specimens. This seems to indicate that Blainville's beaked whale has a varied diet although the genus is usually thought to be mainly squid eating. However, the stomach contents of a few animals from one area may not be representative of the feeding habits of the whole population.

Threats Aguillar, Jover and Nadal (1982) and Taruski, Olney and Winn (1975) report DDT and PCB contamination in the blubber of stranded animals from the Mediterranean and from the northwest Atlantic, respectively. The levels reported, however, were lower than those reported in other small cetaceans. Aguilar, Jover and Nadal (1982) say that these lower levels may be related to other biological factors, not to the lower position of squid eaters in the food chain, because of the South African evidence for a more varied diet.

No directed commercial fishery is known, although the occasional specimen may be taken during other operations, for example in the general small cetacean fisheries of Taiwan, Japan and the Korean peninsula (Kasuya and Nishiwaki, 1971; Mitchell, 1975; Mead, 1989; IWC, 1989). It is also possible than specimens may be taken indirectly in other un-monitored fisheries (IWC, 1989). The Japanese fishery, however, is comparatively well monitored and unusual specimens generally reported. This does not appear to be the case for the vast majority of other fisheries, where nothing is known about takes. At the least this will result in loss of specimens and at worst in damage to local cetacean populations, possibly including this species.

Conservation Measures Known countries of origin include: Canada, Bahamas, Portugal (Madeira), Spain (Canary Islands), Brazil, South Africa, Seychelles, Mauritius, India (Nicobar Islands), Australia, PER China, Cayman Islands, Ecuador (Galapagos Islands), Taiwan, Japan and USA (Hawaii, Midway Islands). Any country within the general distribution area could produce records in future.

Mesoplodon spp. are included in Appendix II of CITES. No international trade in Blainville's beaked whale is reported (CMC, 1987). No other international agreements refer to the genus, and without more information no further international protective actions can usefully be proposed, although the IWC Parties which do not already regularly report their direct and indirect takes of all cetacean species should implement the Commission's recommendation that they do so.

The genus is protected by general legislation in several countries, but no specific provisions were found.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding Two attempts have been made in the USA to keep Blainville's beaked whale in captivity. A young stranded male, in poor condition, was taken to Marineland of Florida, but only lived for a day. Another male, which stranded on 3 January 1973, was taken to the New York Zoological Society's Aquarium at Coney

Island, New York on 5 January. The animal appeared to be recovering and accepted food on 6 January, but died soon afterwards (Mead, 1989). This is not a large species, but may be unsuited to a captive environment (see Sowerby's beaked whale review). Conservation through captive breeding may thus not be a feasible option.

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GERVAIS' BEAKED WHALE **INSUFFICIENTLY KNOWN**

Mesoplodon europaeus (Gervais, 1855)

Suborder ODONTOCETI Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, Gervais' beaked whale is little known: there is little information on abundance, status or threats.

Distribution *Mesoplodon europaeus* was named from a specimen found floating in the English Channel and taken to France (Gervais, 1855). For many years this remained the only specimen reported in the eastern Atlantic, although there are now records from the Canary Islands (four), Guinea-Bissau in west Africa and from Ascension Island (three), south of the equator. In the western North Atlantic over 60 records are now known from the USA and from the Bahamas, Jamaica, Cuba and Trinidad (Mead, 1989; Mead, Heyning and Brownell, 1988; Vonk and Martel, 1988).

With such little known species the finding of a few new specimens can greatly change our picture of their distribution. Moore (1966) thought that this species was concentrated in the Antillean region. It does still seem that Gervais' beaked whale is mainly found in the southwestern North Atlantic, although perhaps with the main population more central than the earlier records indicated.

The genus has recently been reviewed by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus usually considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species, but Gervais's beaked whale is the commonest species of *Mesoplodon* stranded along the southeastern Atlantic coast of the USA (Mead, 1989).

Habitat and Ecology Maximum known length for females is 5.2m and for males 4.56m. The mean length at sexual maturity for females is 4.5m. Maximum known age for females is 27 growth layer groups (GLGs) in teeth. The length of the longest foetus so far reported is 2.18m, and that of the shortest calf 1.96m, leading to an estimated length at birth of 2.1m (Mead, 1984).

Males have two teeth set somewhat back from the tip of the jaw. In females and young the teeth are not erupted. Mead (1989) gives further details of the external appearance. True (1910) and Mead, Walker and Houck (1982) note 'flipper pockets', depressions in the side of the body in which the flippers can be placed so as to be almost in the same general plane as the surrounding body surface. Moore (1968) gives a key for recognition of skulls. Trace quantities of squid beaks were found in the stomachs of three USA specimens (Mead, 1989).

Threats A few of the recorded specimens (e.g. two in Jamaica and one last century in New Jersey, USA) were directly or indirectly caught (Moore, 1966), but the species is not, nor known to have been, specifically commercially hunted. The meat is apparently palatable, and Mead reports having eaten some without ill effects (Mead, Walker and Houck, 1982). It is thus possible that occasional specimens encountered might have been taken in the local small cetacean fisheries in the Caribbean for human consumption (Mitchell, 1975).

Conservation Measures Known countries of origin include: Guinea-Bissau, UK (Ascension Island), Spain (Canary Islands), Bahamas, USA, Jamaica, Trinidad and Tobago, and Cuba. The type specimen was found floating between UK and France, perhaps adding them to the list, but any country of the general mid-Atlantic might record specimens in future.

Mesoplodon spp. are included in Appendix II of CITES. All recorded international movements of Gervais' beaked whale are of scientific specimens: two from UK to USA in 1981, four (of undeclared origin) from USA to UK in 1982, and one skeleton from South Africa to USA in 1985 (CMC, 1987). No other international agreements refer to the genus, and without more information no further international protective actions can usefully be proposed. The IWC did resolve to recommend that Parties should report all takes of all cetacean species, although few Parties have so far responded. Improved reporting by Parties would provide much useful information, particularly for rarely recorded species such as Gervais' beaked whale.

The genus is protected by general legislation in several countries, but no specific provisions were found.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding There are no reports of attempts to keep Gervais' beaked whale in captivity. It is not a large species, but may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding conservation through captive breeding.

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STRAP-TOOTHED WHALE **INSUFFICIENTLY KNOWN**
Mesoplodon layardii (Gray, 1865)

Suborder ODONTOCETI Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, the strap-toothed whale is little known: there is little information on abundance, status or threats.

Distribution The strap-toothed whale appears to have a circumpolar distribution in the Southern Hemisphere between about 30°S and the Antarctic convergence. There are records from Southern Africa, Uruguay, the Falkland Islands, Argentina, Chile, New Zealand (eastern South Island, Cook Strait, Chatham Island, Great Barrier Island), Heard Island, southeastern Australia and Tasmania, with a concentration of records (or of recorders) in Australia and New Zealand (Goodall, Folger and Lichter, 1988; IWC, 1989; Mead, 1989; Gaskin, 1972; Baker, 1972; Dixon, 1980; Australia, 1986, 1988; Nicol, 1986; Goodall, 1978; Lichter, 1986; Guiler, Burton and Gales, 1987).

Kasamatsu *et al.* (1987) report sightings of 480 schools (1,087 animals) of unidentified ziphiids during the IWC IDCR Southern Hemisphere cruises between 1978 and 1984. Most of these sightings occurred in Areas III and IV (see map of IWC Management Areas in introductory section), with a little overlap into the west of Area V. There was also some concentration on the borders of Areas I and II, south of South America, and a comparative gap between about 150°E east to about 110°W. While most of these sightings were at the ice edge, and thus probably not involving strap-toothed whales on present evidence, a band of sightings further north, associated with sea surface temperatures between about 9° and 16°C may be of interest. Unfortunately, there is little more information about these sightings in warmer water, as they were made during transits to the main survey areas. Other sightings records from Japanese research vessels and catcher boats (e.g. Japan, 1988) tend to confirm this distribution pattern.

The species has recently been reviewed by Goodall, Folger and Lichter (1988), and the genus by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus usually considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species.

There are now at least 50 records for New Zealand (including a sighting) (Gaskin, 1971; Goodall, Folger and Lichter, 1988). Dixon (1980) reports 28 Australian records, Nicol (1986) adds nine more and Australia (1986; 1988) another three. The influence of active observers on the accumulation of records is evidenced in Tasmania, where Dixon (1980) notes five records, and Nicol (1986) after giving an account of the increase in interest in recording strandings, particularly from the late 1970s, is now able to note nine more, including a group of three females which stranded alive. Goodall (1978) produced five records for southern Argentina on Tierra del Fuego in her first beach surveys, when the only previous records for this part of the world were one from Uruguay and three from the Falkland Islands. Lichter (1986) can now add another five new records for southern Argentina and reviews four records from southern Chile. There are also around 40 records for Southern Africa. The world total is now about 140 records, making this species the most commonly reported *Mesoplodon* in the Southern Hemisphere and second only to *M. bidens* worldwide (Goodall, Folger and Lichter, 1988; IWC, 1989). However, this is not necessarily an accurate reflection of the relative abundance of the populations alive at sea.

While the IWC IDCR and Japanese (Kasamatsu *et. al.*, 1987; Japan, 1987) sightings may not refer to the strap-toothed whale, they are substantial evidence for the existence of the offshore populations of ziphiids which have been postulated from the sparse specimen records. The ziphiid category in the IDCR cruise records contained the second most frequently sighted number of schools (after the minke whale) and the fourth largest number of animals sighted (after the minke, killer and pilot whales).

Habitat and Ecology This is the largest *Mesoplodon* species as far as is known, with the largest male recorded at 5.84m and the largest female at 6.15m. The shortest reported calf was 2.8m long and the longest reported foetus 0.76m long (Mead, 1984). Nicol (1986) now reports a 2.5m male calf, but there is still insufficient information for the length at birth to be estimated. Lichter (1986) reports the first male gonad weights for the species. Gaskin (1972) suggested that calving occurs in spring or early summer. The finding of the very small calf in Tasmania in January 1983 (Nicol, 1986) and of a 3.6m suckling juvenile in New South Wales in March 1985 (Australia, 1986) tends to confirm a spring-summer calving period.

The adult males have a strap-shaped pair of teeth emerging from the lower jaw, behind the tip. These teeth extend upwards and backwards, eventually curling over the upper jaw and preventing the mouth from opening more than a few centimetres. This does not appear to interfere with feeding. The teeth in females and young males are not erupted. Ross *et al.* (1988) give a detailed description of the external appearance. The only information so far on feeding habits is that the stomach of one male specimen contained one squid beak and one small piece of algae (Goodall, Folger and Lichter, 1988). Moore (1968) provides a key for the identification of skulls.

From the sightings and strandings evidence, the group size appears to be up to three animals (Gaskin, 1971; Nicol, 1986). Gaskin (1971) describes two basic behaviours when ziphiids are approached by a vessel: they either sink slowly beneath the surface, rising and blowing again when about 180m from the vessel, or they dive with a lateral half roll, bringing one flipper clear of the water but not the flukes. The latter behaviour indicated a relatively long dive, the animal either not being seen again or surfacing about 10-15 minutes later at least 0.4km from the ship. Kasamatsu *et al.*, (1987) also remark on the inconspicuous behaviour, long diving times and wariness of vessels exhibited by ziphiids.

Threats The species is not, nor known to have been, commercially hunted. It may be subject to take in the course of other fishing activities, but so far no specimens have been reported.

Conservation Measures Known countries of origin are: South Africa, Namibia, Uruguay, UK (Falkland Islands), Argentina, Chile, New Zealand and Australia (Heard Island). It is quite possible that any country within the general apparent distribution area could record specimens in future.

Mesoplodon spp. are included in Appendix II of CITES. No international trade is reported for the strap-toothed whale (CMC, 1987). No other international agreements refer to the genus, and without more information no further international protective actions can usefully be proposed. In this context, the IWC resolved to recommend that Parties report all takes of all species of cetacean, although few Parties have responded so far. If all Parties would respond to this recommendation, the increase in information would be significant, and of particular importance for rarely reported species like the strap-toothed whale.

The genus is protected by general legislation in several countries, but no specific provisions were found.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding The only report of an attempt to care for a specimen of the strap-toothed whale is of a suckling juvenile, which stranded alive at Kiola Beach in New South Wales, Australia in March 1985. It is not clear exactly what steps were taken, but the animal stranded on 13th March. 'Feeding was attempted, but the animal finally died on 1 April' (Australia, 1986).

This is not a particularly large species, but it may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding captive breeding as a conservation option.

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HECTOR'S BEAKED WHALE **INSUFFICIENTLY KNOWN**
Mesoplodon hectori (Gray, 1871)

Suborder ODONTOCETI Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, Hector's beaked whale is little known: there is little information on abundance, status or threats.

Distribution Hector's beaked whale was thought to be confined to temperate latitudes of the Southern Hemisphere, with specimens reported from New Zealand, Tasmania, South Africa, the Falkland Islands, Chile and Argentina (Gaskin, 1972; Goodall, 1978; Leatherwood and Reeves, 1983; Seilfeld, 1979). However, Mead (1981) reported the species from southern California, adding the temperate North Pacific to the known range.

The species has recently been reviewed by Mead and Baker (1987) and by Goodall and Lichter (1988), and the genus by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus usually considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species.

Even by *Mesoplodon* standards the number of known specimens is rather sparse, but it is increasing rapidly as interest and recording schemes are developed in more countries. Lichter (1986) adds five new specimens to the 15 known to him worldwide, and Goodall and Lichter (1988) add another two, to give a world total of 22. This list does not include the live stranding of two animals in New Zealand on 12 February 1985, when both animals were refloated (Cawthorn, 1986). Mead (1981) reports two probable sightings, both of two animals, off California.

Habitat and Ecology The largest reported female was 4.43m long and the largest male estimated to be 4.30m long. The length of the shortest reported calf was 2.1m (Mead, 1984). Lichter (1986) reports the stranding of a group of two females and two calves in the Province of Buenos Aires, Argentina. One of these calves was 1.9m long, the other 2.02m long, smaller than the smallest calf previously known. These specimens stranded on 23 January 1985. Mead (1981) reported that the 2.1m calf was freshly dead on 22 May 1975. It is thus beginning to appear that calving may take place in spring and summer. Two physically mature specimens (a male and a female) had nine growth layer groups in their teeth (Mead and Baker, 1987).

The only information so far available on food species comes from the California specimens. One stomach contained some material from the squid *Octopoteuthis deletron* as well as a small fragment of an unidentified invertebrate; another contained a squid eye lens (Mead, 1981).

The adult males have two teeth in the lower jaw, situated on each side a little way from the tip. The teeth in females and juvenile males are not erupted (Leatherwood and Reeves, 1983). Moore (1968) provides a key for the identification of skulls.

Mead (1981) notes two sightings which were probably of this species. Two animals were seen off Catalina Island, California in July 1976; one passed very close to the boat. One was scarred and may thus have been a male; the other was not and could have been a female or juvenile male. The second sighting was west of San Diego, California in

September 1978, again of two animals, one of which approached the boat. While the small group size is typical of *Mesoplodon* species, approaching boats is not. If this turns out to be typical of Hector's beaked whale it would provide a recognition cue, but it could also make the species more vulnerable to occasional taking.

Threats At least one of the recorded specimens (last century in New Zealand) was directly caught (Flower, 1878), but the species is not, nor known to have been, commercially hunted. The boat-approaching behaviour mentioned in the previous section might render the species more vulnerable to occasional taking than other members of the genus.

Conservation Measures Known countries of origin include: New Zealand, Australia, South Africa, UK (Falkland Islands), Argentina, Chile and USA. It is quite possible that other countries within or outside the presently known range will record specimens in future.

Mesoplodon spp. are included in Appendix II of CITES. No international movements of Hector's beaked whale are recorded (CMC, 1987). No other international agreements refer to the genus, and without more information no further international protective actions can usefully be proposed. However, the IWC resolved to recommend that Parties report takes of all cetacean species. Few have so far responded, but if all Parties did respond to this recommendation the increase in available information would be significant, and of particular importance for rarely reported species such as Hector's beaked whale.

The genus is protected by general legislation in several countries, but no specific provisions were found.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding There are no reports of attempts to keep this species in captivity. It is not a large species, but it may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding captive breeding as a conservation option.

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GRAY'S BEAKED WHALE **INSUFFICIENTLY KNOWN**
Mesoplodon grayi von Haast, 1876

Suborder ODONTOCETI Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, Gray's beaked whale is little known: there is little information on abundance, status or threats.

Distribution The species appears to be circumpolar in the Southern Hemisphere, with many records from New Zealand (over 60), including a live stranded animal which was refloated on 27 March 1985. Other records are known from the Chatham Islands (a school of 25 and another of eight animals stranded), Tasmania, Western Australia, New South Wales, South Australia, Argentina, Chile, and South Africa. Sightings indicate that the species may be common in the Indian Ocean south and east of Madagascar in waters deeper than 1,000 fathoms, and there is a possible sighting in the Seychelles (Gambell, Best and Rice, 1975; Goodall, 1978; Leatherwood and Reeves, 1983; New Zealand, 1986; Australia, 1986, 1987, 1988; Seilfeld, 1979, 1980; Keller, Leatherwood and Holt, 1982; Goodall, Galeazzi and Sobral, 1983; Nicol, 1986; Lichter, 1986; Delhon, Crespo and Pagnoni, 1987; Mead, 1989).

There is one well documented record from the Northern Hemisphere in the Netherlands (Boschma, 1950), probably a vagrant as there has been no other indication of a North Atlantic population.

The genus has recently been reviewed by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species.

It was thought (e.g. Gaskin, 1972; Guiler, 1978; Leatherwood and Reeves, 1983) that the concentration of records in New Zealand indicated a population concentration in these waters. However, with increasing interest in other countries the number of records elsewhere is growing quickly, and it may turn out that the New Zealand concentration of records only represents an early concentration of recorders. For example, Australia (1986, 1987, 1988) lists six new records for Australia between 1984 and early 1987, while New Zealand (1986) lists only one from mid-1984 to mid-1985. Guiler (1978) knew of only three records for Tasmania, but Nicol (1986), who comments on the increase in interest in Tasmania in recent years, could list eight. Goodall (1978) could add five records, the first for Tierra del Fuego, to the five known from elsewhere in Argentina, and later added three more (Goodall, Galeazzi and Sobral, 1983), while Lichter (1986) and Delhon, Crespo and Pagnoni (1987) add a specimen each from Buenos Aires Province and the Sealion Reserve in Chubut, Argentina, respectively. Sielfeld (1979; 1980) provides the first two records for Chile, from the Strait of Magellan and Tierra del Fuego.

Gambell, Best and Rice (1975) positively identified four groups of Gray's beaked whales between 31° and 33°S, 47° to 65°E, in January 1974. One sighting was of a single animal, two were of five animals and one was of six animals. One animal (a female) was taken for research purposes from one of the groups of five animals. These authors remark that sightings of *Mesoplodon*-like animals were restricted to the sector 30-35°S, where they were widespread. The list of sightings shows six encounters with groups ranging from two to six animals. The authors also remark on the difficulties in spotting and maintaining contact with beaked whales at sea and say that because they are rarely recognised and reported, it should not be assumed that the animals are correspondingly few in number.

Keller, Leatherwood and Holt (1982) provide a photograph of four animals, three adults and a juvenile, taken in the Seychelles. These have been tentatively identified as Gray's beaked whales, although the possibility that they could be Longman's beaked whales cannot be ruled out.

Habitat and Ecology The maximum reported length of a female was 5.33m and of a male 5.64m (Mead, 1984). The shortest reported calf was 2.37m long (IWC, 1989). Goodall, Galeazzi and Sobral (1983) report a 1.857m foetus and Delhon, Crespo and Pagnoni (1987) give the weights and histology of the testes of a sexually mature male with active spermatogenesis. Some of the recent Australian specimens are also yielding biological material (Australia, 1987; 1988).

Considering that, for a species of *Mesoplodon*, so many specimens are known, it is unfortunate that there appears to be so little information available on ecology and life history, although the improved recording in many areas seems likely to remedy this in future.

The species has a long narrow beak. The adult males have two comparatively small triangular teeth set well back from the tip of the lower jaw. Both sexes also have a number of small teeth in the upper jaw; more than are found in other species of *Mesoplodon*. Ross *et al.* (1988) give details of external appearance. From the evidence of the large group stranding mentioned above it might appear that this species lives in larger groups than other members of the genus, but sightings at sea seem to indicate that the usual group size is from 2-6 animals. The behaviour at sea is unobtrusive (Gambell, Best and Rice, 1875; Leatherwood and Reeves, 1983). Moore (1968) gives a key for the identification of skulls.

Threats Only one of the recorded specimens is described as having been directly caught (for research purposes), and the species is not, nor known to have been, commercially hunted. It is always possible that a specimen may be taken during other fishing operations, but, in general it appears that the main populations are well outside these areas, or more specimens would probably have been reported. If the Seychelles sighting indicates that the species frequents these waters, specimens might be taken in their small-cetacean fishery, which appears to continue although now illegal (Leatherwood *et al.*, 1984).

Conservation Measures Known countries of origin include: New Zealand (Chatham Islands), Australia, South Africa, Chile, Argentina, the Netherlands and perhaps Seychelles. It is quite possible that specimens could be reported in future from other countries within or outside the presently known range. In particular, the sightings south and east of Madagascar raise the probability that specimens will be found on southern Indian Ocean beaches.

Mesoplodon spp. are included in Appendix II of CITES. One commercial specimen and one scientific specimen of Gray's beaked whale are recorded as moving from South Africa to USA in 1984 (CMC, 1987). No other international agreements refer to the genus, and without more information no further international protective actions can usefully be proposed. The IWC has agreed to recommend Parties to report takes of all cetaceans, although few have so far responded. Better reporting by IWC Parties could greatly improve our knowledge of this, and the other *Mesoplodon* species.

The genus is protected by general legislation in several countries, but no specific provisions were found. The provisions in the Seychelles appear to be somewhat ineffective.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding There are no reports of attempts to keep this species in captivity. It is not a large species, but it may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding captive breeding as a conservation option.

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STEJNEGER'S BEAKED WHALE **INSUFFICIENTLY KNOWN**
Mesoplodon stejnegeri True, 1885

Suborder ODONTOCETI Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, Stejneger's beaked whale is little known: there is little information on abundance, status or threats. It is known to be vulnerable to incidental take in gillnets, but there is insufficient information on the level of such takes, and no information on their potential significance for the species.

Distribution Stranding records indicate that Stejneger's beaked whale inhabits the cold-temperate waters of the North Pacific Ocean. It appears to be distributed across the deep waters of the southwest Bering Sea, south to the northern Sea of Japan in the west and to southern California in the east. Except for some overlap between British Columbia and California, the range seems to be generally to the north of that of *Mesoplodon carlhubbsi* (Moore, 1966; Loughlin and Perez, 1985; IWC, 1989; Mead, Heyning and Brownell, 1988; Mead, 1989).

Loughlin *et al.* (1982) report observations at sea of a total of 52 animals primarily near the Andreanof Island group of the central Aleutian Islands. The encounters were made during a survey of northern sea lions in 1979. They believe the animals sighted represented Stejneger's beaked whale. They also refer to five other confirmed sightings of 14 animals in the Gulf of Alaska and the Bering Sea and to records of 25 stranded individuals in Alaska.

The distribution picture has been greatly confused, because much re-identification of specimens previously described as other *Mesoplodon* species has occurred, and other specimens previously assigned to this species have been re-identified to other species. Mead, Walker and Houck (1982) list the specimens previously described as Stejneger's beaked whale and now recognised as Hubbs' beaked whale, and Miyazaki *et al.* (1987) give a corrected list of the Japanese specimens of Stejneger's beaked whale and a distribution map of the known specimens. This does not appear to include more than seven of the 25 Alaskan specimens referred to by Loughlin *et al.* (1982), probably because many of the positions had not then been published. Mead, Heyning and Brownell (1988) provide a full list of the approximately 50 specimens reported so far.

The species has recently been reviewed by Loughlin and Perez (1985), and the genus by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species.

From the comparatively large number of sightings and strandings records for Alaska quoted by Mead, Heyning and Brownell (1988) it would appear that there is some population concentration there. However, the authors note that the frequency of reports from Adak Island, Alaska, is due in part to the presence of a US Fish and Wildlife Service office on that island, and does not necessarily indicate that the species is more common here than off the other islands of the sparsely populated Aleutian chain. Other parts of the northern North Pacific have received comparatively little observer attention, and the pattern of records tends to reflect the level of observer activity.

Habitat and Ecology The largest reported female was 5.25m long and the largest male the same length (Mead, 1984). The three known calves averaged about 2.45m in length. They stranded near the southern limit of the range, two in California and one in Oregon (IWC, 1989).

Adult males have a massive pair of teeth in the lower jaw, protruding from conspicuous elevations. Females and young males have no erupted teeth (Loughlin and Perez, 1985). Mead, Walker and Houck (1982) note recesses in the body wall for the flippers. Moore (1963; 1966; 1968) provides keys and other information for the identification of skulls, and Mead, Walker and Houck (1982) give further useful identification information.

The primary food is probably squid, although the two stomachs so far examined contained only trace quantities of squid remains and no fish (Mead, 1989). Observations and catches of this species in areas where salmon fishing takes place seem to have led to the idea that they feed on salmon, although there are no descriptions of stomach contents to confirm this (Nishimura and Nishiwaki, 1964; Mitchell, 1975; Miyazaki *et al.*, 1987). It is possible, for example, that both salmon and whales were exploiting the same food resource, or that salmon fishing happened to be taking place while the whales were present for other reasons.

From the strandings and sightings information in other reports (Nishimura and Nishiwaki, 1964; Miyazaki *et al.*, 1987) it was thought that group size was from one to three animals. Loughlin *et al.* (1982) report seven encounters at sea with pods which ranged from five to 15 animals. Most sightings were made near the Adreanof Islands, except for seven animals seen near the Rat Islands and four observed near the Fox Islands. The animals were seen in waters ranging in depth from 730 to 1,560m on the steep slope of the continental shelf as it drops off into the Aleutian Basin, which exceeds 3,500m in depth.

The beaked whales reported by Loughlin *et al.* (1982) varied in colour from pale brown to black. They make some speculations about the reasons for differences in colour in living and stranded animals. Loughlin *et al.* (1982) suggest that these whales have some type of social structure, because the animals in each pod were seen to swim and dive in unison, were tightly bunched suggesting social cohesiveness, and the groups were composed of both small and large animals, suggesting intermingling of ages and sexes.

Threats At least two of the recorded specimens from Japan were incidently taken by salmon drift gill nets (Nishimura and Nishiwaki, 1964). As with all of the rarer cetacean species, it is not known whether the low reported incidental catches reflect a relatively low vulnerability to this threat or whether they merely reflect the relative rarity of the species. The meat was sold through the normal markets for human consumption after scientific specimens were taken.

There is no reported direct fishery for this species, although specimens may be taken if they are encountered by the Japanese and possibly other small cetacean fisheries. Makah Indians from Washington State in the USA, however, report that the blubber and flesh causes diarrhoea (Mitchell, 1975), although Tomilin (1957) says the opposite. Mead reports tasting the meat of other *Mesoplodon* species without ill effect but had not so far tested Stejneger's beaked whale (Mead, Walker and Houck, 1982).

Miyazaki *et al.* (1987) report organochlorine contamination in the blubber of their specimen, at a level which is within the (low) range reported for other beaked whales (see Blainville's beaked whale review).

Conservation Measures Known countries of origin include: Japan, USSR, Canada and USA. It is quite possible that other countries in the area will report specimens in the future.

Mesoplodon spp. are included in Appendix II of CITES. Two scientific specimens of Stejneger's beaked whale, of undeclared origin, are reported moving from USA to UK in 1982 (CMC, 1987). No other international agreements refer to the species, and without more information no further international protective actions can usefully be proposed, although the IWC Parties which do not already regularly report their direct and indirect takes of all cetacean species should implement the Commission's recommendation that they do so. In this case information from IWC members PR China and R Korea would be useful to gain further insight into the range of the species.

The genus is protected by general legislation in several countries, but no specific provisions were found.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding There are no reports of attempts to keep this species in captivity. It is not a large species, but it may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding conservation through captive breeding.

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ANDREWS' BEAKED WHALE **INSUFFICIENTLY KNOWN**

Mesoplodon bowdoini Andrews, 1908

Suborder ODONTOCETI Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, Andrews' beaked whale is little known: there is little information on abundance, status or threats.

Distribution Andrews' beaked whale is known from about 20 specimens from the Southern Hemisphere, primarily from strandings in New Zealand and Australia. Mead (1989), in his review of the genus, reports the re-identification to other *Mesoplodon* spp. of several specimens originally published as belonging to this species. He also disagrees with the identification of Robineau's (1973) Kerguelen specimen as *M. bowdoini*, although he says that this author's second specimen (from an unknown locality) 'looks very much like *M. bowdoini*'. The extension of the known range to Kerguelen is therefore doubtful at the moment. The genus has also recently been reviewed by the IWC Scientific Committee's subcommittee on small cetaceans. Their report notes that this species may be conspecific with *M. carlhubbsi* (IWC, 1989), although Mead (1989) believes that a good argument can be made for considering *M. carlhubbsi* a subspecies of *M. bowdoini*.

Population All *Mesoplodon* spp. are known from only a few records and are thus considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species.

Records of Andrews' beaked whale are still very sparse. This continuing lack of records might indicate that Andrews' beaked whale is particularly rare, that the recorded specimens are stragglers from a main population in areas without good recording schemes, that the main population lives so far from land that specimens rarely survive to appear on beaches, or even that there are particular difficulties in identifying specimens, leading authorities to assign specimens to other species.

Habitat and Ecology The longest known specimens are a 4.57m physically mature female and a 4.67m adult male (IWC, 1989).

The adult males have two teeth in the lower jaw, approximately at mid-beak. They may protrude outside the mouth in adult males and do not erupt in females and young. Although Gray's beaked whale has similar teeth, they are much less massive and conspicuous than those of Andrews' beaked whale (Mead, 1989). Moore (1968) gives a key for identification of skulls.

Threats The species is not, nor known to have been, commercially hunted and none of the known specimens appear to have been directly or indirectly taken.

Conservation Measures Known countries of origin include: Australia, New Zealand and perhaps France (Kerguelen Island). It is possible that other countries in the temperate South Pacific and Indian Ocean may record specimens in future and that specimens may turn up in other areas, as has happened with some other *Mesoplodon* species.

Mesoplodon spp. are included in Appendix II of CITES. No international movements of Andrews' beaked whale are reported (CMC, 1987). No other international agreements refer to the species, and without more information no further international protective actions can usefully be proposed. The IWC have agreed to recommend Parties to report takes of all cetaceans, although few have so far responded. Better reporting by IWC Parties could greatly improve our knowledge of species such as Andrews' beaked whale, where every possible piece of information is valuable.

The genus is protected by general legislation in several countries, particularly in Australia and New Zealand, and all cetacean hunting is forbidden in Kerguelen waters, but no specific provisions were found.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding There are no reports of attempts to keep this species in captivity. It is not a large species, but it may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding conservation through captive breeding.

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TRUE'S BEAKED WHALE **INSUFFICIENTLY KNOWN**
Mesoplodon mirus True, 1913

Suborder ODONTOCETI Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, True's beaked whale is little known: there is little information on abundance, status or threats.

Distribution True's beaked whale was previously believed to be endemic to the North Atlantic, but is now known from several strandings in the Southern Hemisphere. In the western North Atlantic the species ranges from the Bahamas to Nova Scotia. In the northeast Atlantic most strandings are reported from Ireland, but there are also records for northern UK, France and the Canary Islands (IWC, 1989; Mead, Heyning and Brownell, 1988; Vonk and Martel, 1988; Mead, 1989). Moore (1966) considers that *M. bidens* and *M. mirus* may be allopatric in this ocean.

Southern Hemisphere strandings include specimens from South Africa, Australia and New Zealand (IWC, 1989). Slight cranial and pigmentation differences between North Atlantic and Southern Hemisphere specimens have been documented and discussed by Ross (1984). These differences suggest that the two groups are distinct breeding populations (IWC, 1989).

The genus has recently been reviewed by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species.

True's beaked whale is so far known from rather few specimens. Mead, Heyning and Brownell (1988) provide an updated list of the (about 30) known specimens in the Northern Hemisphere. Mead (1989) notes six records from South Africa and two from Australia. IWC (1989) mentions New Zealand, but gives no information on the number of records. This lack of records may indicate that the species is rare, that the main populations frequent waters without specimen recording systems, that they normally live so far from land that carcasses rarely survive for long enough to be washed up on beaches, or that there are recognition problems leading authorities to assign specimens to other species.

Habitat and Ecology The largest reported female was 5.1m and the largest male 5.33m long. The shortest reported calf was 2.33m long and the longest foetus 1.05m (Mead, 1984). Length at birth is estimated to be about 2.33m (IWC, 1989).

Ross (1984) found two upper and four lower beaks of the inshore squid *Loligo reynaudi* in the stomach of an adult female *M. mirus*. Mead (1989) reports trace quantities of squid beaks, but no fish remains, in one specimen.

The external appearance is described in detail by Ross *et al.* (1988). Adult males have two teeth in the tip of the lower jaw. They angle forward and can be seen outside the mouth, somewhat resembling those of Cuvier's beaked whale. There are recesses in the body wall for the flippers (Mead, Walker and Houck, 1982). Moore (1966) and Mead, Walker and Houck (1982) give information for identification of skulls and specimens.

Threats At least one specimen was directly caught (off Nova Scotia in 1938) (Moore, 1966), but the species is not, nor known to have been, commercially hunted. The meat is apparently palatable (Mead, Walker and Houck, 1982), but there are no general small cetacean fisheries for meat for human consumption within the presently known range.

Conservation measures Known countries of origin include: USA, Canada, UK, Ireland, Bahamas, France, Spain (Canary Islands), New Zealand, South Africa and Australia. It is quite possible that specimens will be reported from other countries within or outside the presently known range.

Mesoplodon spp. are included in Appendix II of CITES. For True's beaked whale, two scientific specimens of undeclared origin were moved from USA to UK in 1982 (CMC, 1987). True's beaked whale is also included in Appendix II of the Berne Convention. No other international agreements refer to the genus, and without more information no further international protective actions can usefully be proposed, although the IWC Parties which do not already regularly report their direct and indirect takes of all cetacean species should implement the Commission's recommendation that they do so.

The genus is protected by general legislation in several countries, but no specific provisions were found, except for those made by Berne Convention members.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive breeding There are no reports of attempts to keep this species in captivity. It is not a large species, but it may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding captive breeding as a conservation option.

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GINKGO-TOOTHED BEAKED WHALE — INSUFFICIENTLY KNOWN

Mesoplodon ginkgodens Nishiwaki and Kamiya, 1958

Suborder ODONTOCETI — Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, the ginkgo-toothed beaked whale is little known: there is little information on abundance, status or threats.

Distribution The ginkgo-toothed beaked whale is known from the warm temperate and tropical Pacific and the Indian Oceans. Existing records are from southeastern and western Japan, Taiwan, PR China, Sri Lanka, Galapagos Islands, Indonesia, Australia, Mexico, Chatham Islands and southern California (Mead, 1989; IWC, 1989; Wang, 1984; Moore and Gilmore, 1965; Nishiwaki and Oguro, 1972; Nishimura and Nishiwaki, 1964; Miyazaki *et al.*, 1987; Leatherwood *et al.*, 1982).

The genus has recently been reviewed by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population All *Mesoplodon* spp. are known from only a few records and are thus considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species.

This species is known from rather few specimens so far. Mead, Heyning and Brownell (1988) list the 12 known specimens from the Northern Hemisphere, and Mead (1989) notes half a dozen specimens from the Southern Hemisphere. There have been many changes in the species designation of *Mesoplodon* specimens, making the older literature somewhat confusing unless reference is also made to recent papers.

The lack of specimens may indicate that the species is rare, that the main populations frequent waters without efficient specimen recording systems, that the main populations live so far from land that few specimens survive to arrive on beaches, or that there are recognition difficulties leading authorities to assign specimens to other species.

Habitat and Ecology The maximum reported length of a female was 4.9m and of a male 4.77m (Mead, 1984). No information on food habits seems to be available.

There is a raised area to the rear of the lower jaw in mature males, with a pair of teeth shaped like the leaves of the ginkgo tree (Nishiwaki and Kamiya, 1958). They are somewhat set back from the tip of the jaw. In females and young the teeth are not erupted, nor do they appear to erupt in adult males. The adult males are also less scarred (Heyning, 1984). Moore (1966; 1968), Moore and Gilmore (1965) and Mead, Walker and Houck (1982) give useful information for the identification of skulls and specimens.

Threats A few of the recorded specimens (e.g. three in Taiwan and one in PR China) were directly caught, but the species is not, nor known to have been, specifically commercially hunted (Mitchell, 1975; Wang, 1984; IWC, 1989). It appears that the occasional specimen which strays into general small cetacean fishery areas may be taken. One Japanese specimen is reported to have been entangled in a set net (Miyazaki *et al.*, 1987).

Conservation Measures Known countries of origin include: Japan, Taiwan, PR China, Mexico, Ecuador (Galapagos Islands), Indonesia, Australia, New Zealand

(Chatham Islands), USA and Sri Lanka. It is likely that other countries in the general distribution area will report specimens in future, and it is also possible that specimens could be found elsewhere.

Mesoplodon spp. are included in Appendix II of CITES. No international movements of the ginkgo-toothed beaked whale are reported (CMC, 1987). No other international agreements refer to the genus, and, without more information, no further international protective actions can usefully be proposed, although the IWC Parties which do not already regularly report their direct and indirect takes of all cetacean species should implement the Commission's recommendation that they do so.

The genus is protected by general legislation in several countries, but no specific provisions were found.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding A live specimen was taken into captivity from a stranding on 3 August 1982 on the Pacific coast of Japan, but no further information is given (Kasuya, Tobayama and Matsui, 1984). Another specimen, a juvenile female, described as captured in a set net off Hiyoriyama in the Sea of Japan on 16 March 1984, seems to have been taken to Hiyoriyama Aquarium, but no further details are given (Miyazaki *et al.*, 1987). It is not a large species, but it may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding conservation through captive breeding.

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HUBBS' BEAKED WHALE INSUFFICIENTLY KNOWN
Mesoplodon carlhubbsi Moore, 1963

Suborder ODONTOCETI Family ZIPHIIDAE

Summary In common with the rest of the species in this genus, Hubbs' beaked whale is little known: there is little information on abundance, status or threats. Given the high levels of fishing activities in much of its known range, it is particularly important to obtain information on the level of incidental take.

Distribution Hubbs' beaked whale inhabits the cold temperate North Pacific. Off Japan it appears to be mainly restricted to an area off the northeast coast of the main island Honshu, near the confluence of the cold, southerly flowing Oyashio current, and the warm, northerly flowing Kuroshio current at about 38°N. The lack of records to the north might be related to a lack of cetological activity in the area. Mead, Walker and Houck (1982) thought that the southern limits may be real because there are records of other *Mesoplodon* species here. The map given by Miyazaki *et al.* (1987) shows another specimen further south, at about 35°N in the Yokohama area, but this is not listed by Mead, Heyning and Brownell (1988). The most likely explanations are a mistake in the symbols used on the map or, in common with many *Mesoplodon* reports, a change in opinion on the species identification. There are quite a number of unidentified ziphiid sightings in the general area, but it is not known whether this species is represented or whether the main distribution is beyond the 150°E survey limit (e.g. Japan, 1988).

The distribution of records of Hubbs' beaked whale along the Pacific coast of North America extends from San Clemente Island, California (33°N) to Prince Rupert, British Columbia (54°N). The known northern limit probably represents the actual northern distribution of this species, as there are many records of Stejneger's beaked whale north of here. The southern limit, on the other hand, may be the result of a lack of cetological investigation, as there are few *Mesoplodon* records along the Pacific coast of Central America from the USA border southwards, except for observations at sea of an unidentified *Mesoplodon* spp. in the eastern tropical Pacific (Pitman, Aguayo and Urban, 1987).

The distribution along the Japanese coast coincides with the origins of the Subarctic Current System, formed from the mixing of deep elements of the Kuroshio and Oyashio currents. Along the coast of North America, the distribution corresponds with the confluence of the Subarctic Current and the California Current systems at depth. The distribution of the species is probably not directly related to the character of the water mass, but rather follows the distribution of the prey species upon which it feeds (mesopelagic squid and fish) (Mead, Walker and Houck, 1982). It is not clear, however, whether the known records indicate two fairly separate populations, or whether they represent the extremes of a more centrally distributed population.

The species has most recently been reviewed by Mead, Walker and Houck (1982). Mead (1989) and the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989) have reviewed the genus, and Mead, Heyning and Brownell (1988) give the most recent list of specimens. Mead (1989) says that a good argument can be made for considering *M. carlhubbsi* a subspecies of *M. bowdoini*, based on cranial and pigmentation similarities. IWC (1989) notes that the two nominal species may be conspecific.

Population All *Mesoplodon* spp. are known from a comparatively few records and are thus considered rare or very rare. Whether numbers are in fact very low or whether the mode of life of these species results in few recorded sightings and strandings is not clear. There are no population estimates for any species.

Mead, Walker and Houck (1982) give an annotated list of specimens, including many re-identifications. Mead, Heyning and Brownell (1988) list just under 40 records known to them, including a possible sighting of a live animal off the Scripps pier, La Jolla, California. From the fact that only four of these are from Japanese waters, where any small cetacean is liable to be taken in the general fishery and unusual specimens reported, it would appear that there is not a large population in these particular waters. The number of dead strandings recorded in North America, on the other hand, might indicate a population somewhat closer to this coast.

Habitat and Ecology The largest specimens of both sexes were 5.32m in length. It is estimated that length at physical maturity is about 5.0m. Growth thereafter occurs at a presumably much slower rate until the maximum length is reached. The length at birth is estimated to be about 2.5m, and calving appears to take place in early summer (Mead, Walker and Houck, 1982; Mead, 1984; IWC, 1989).

The stomachs of four adult animals contained only squid of various species. The fifth stomach also contained the remains of a variety of mesopelagic fish. However, because stomach contents can contain not only remains of prey species but also the remains of whatever the prey has itself been feeding upon, only two of the largest squid species (*Onychoteuthis borealijaponicus* and *Gonatus* spp.) and two fish species (*Chauliodus macouni* the Pacific viperfish and *Icichthys lockingtoni*) are considered likely to have been consumed directly by the whales (Mead, Walker and Houck, 1982).

Hubbs' beaked whale presumably has the unobtrusive behaviour characteristic of the genus. The adult male has a distinctive white patch on the front of the head, and the front of the beak is also white. Females and juveniles have a lighter front to the beak. Adult males have a fairly massive pair of teeth at each side of the jaw. Females and young have unerupted teeth. The bodies of males can be extensively scarred; the long narrow scars and puncture wounds are almost certainly the result of aggression between adult males. Recesses for the flippers are present in the body wall (Heyning, 1984; Mead, Walker and Houck, 1982).

Heyning (1984) and Mead, Walker and Houck (1982) reproduce a number of photographs, particularly showing the remarkable degree of scarring in males. The latter authors also give much useful information for field recognition of this and the other North Pacific *Mesoplodon* species. They also list other published studies associated with each specimen in their list and include the (sometimes many) previous species attributions. Moore (1963; 1968) provides keys for the identification of skulls.

Threats All four of the Japanese specimens listed by Mead, Heyning and Brownell (1988) were taken by commercial whaling vessels from the Ayukawa whaling station and, given the reasonably well-recorded nature of the Japanese coastal whaling probably indicates that the species is not common in these waters. The rest of the records given are all strandings (but see below), except for one sighting, from North America.

Incidental catches in offshore gill nets have occurred and are a problem of unknown magnitude. Most of the known range is subject to extensive pelagic driftnet fishing. At least one confirmed *M. carlhubbsi* has been caught in this way off southern California (Diamond, Scholl and Hanan, 1987; Heyning, 1988).

Conservation Measures Known countries of origin are: Japan, USA and Canada. In view of the fact that the range is not well known, other countries within the general distribution area may be expected to record specimens in future.

Mesoplodon spp. are included in Appendix II of CITES. For Hubbs' beaked whale, two scientific specimens of undeclared origin were moved from USA to UK in 1982 (CMC, 1987). No other international agreements refer to the genus, and without more information no further international protective actions can usefully be proposed. The IWC has agreed to recommend Parties to report takes of all cetaceans, although few have so far responded. Better reporting by IWC Parties could greatly improve our knowledge of this and the other *Mesoplodon* species.

The genus is protected by general legislation in several countries, but no specific provisions were found.

There is much room for improvement in recording strandings, sightings and any accidental catches, which can provide valuable information.

Mead, Walker and Houck (1982) have provided one of the first biological (as opposed to osteological) accounts of a *Mesoplodon* species, including much data which was in the possession of others but had not previously been published. In particular, the details of external appearance should assist identification of sightings. Similar reviews seem likely to increase our knowledge of the other *Mesoplodon* species. This approach may encourage the finders of specimens to record and publish more of the biological information needed for conservation and management in future.

Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which are necessary at present (Perrin, 1989).

Captive Breeding There are no reports of attempts to keep this species in captivity. It is not a large species, but it may be unsuited to the captive environment (see Sowerby's beaked whale review), thus precluding conservation through captive breeding.

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UNIDENTIFIED MESOPLODON SP. — INSUFFICIENTLY KNOWN

Unidentified *Mesoplodon* sp.

Suborder ODONTOCETI — Family ZIPHIIDAE

Summary An unidentified species of *Mesoplodon* has been sighted in the eastern tropical Pacific. The lack of recorded specimens in comparison with the number of positive sightings suggests that incidental taking may not be a major problem, despite the high levels of fishing activities in the range, but until more is known about the species its status cannot be assessed.

Distribution Pitman, Aguayo and Urban (1987) have recently published their observations of an unidentified beaked whale in the eastern tropical Pacific, which they believe is a *Mesoplodon*. The unidentified whale has two colour morphs: a conspicuously marked black and white form, with extensive scarring (judged to be larger, and possibly representing adult males) and a smaller grey-brown unscarred form, which may represent females and young. The maximum length is estimated to be 5-5.5m. The 24 positive and eight tentative sightings are relatively inshore, from southern Baja California in Mexico to northern Peru.

The identity of the whale will remain undefined until specimen material is available. The IWC Scientific Committee's subcommittee on small cetaceans reviewed the genus, and concluded that the appearance of the unidentified species was not identical to that of any species of Ziphiid for which the colour pattern is known (IWC, 1989).

Population From the number of sightings collected so far, this species does not appear to be rare (Pitman, Aguayo and Urban, 1987).

Habitat and Ecology Pitman, Aguayo and Urban (1987) have only counted sightings of their unidentified beaked whale where the distinctive putative males were present. From the 24 positive sightings the group size ranged from one to eight, with groups of two and three being the most common. From 16 sightings the colour morph information was obtained for all the animals present. These comprised five lone 'males', six 'male/female' or possibly 'male/juvenile' pairs, and five with single 'males' and two or more 'females/juveniles'.

At sea, the whale behaved similarly to other *Mesoplodon* species. It was usually seen rolling over slowly at the surface or travelling at a moderate pace and in fairly tight groups when more than one animal was present. It was generally not seen to engage in any sort of 'playful' activity, such as breaching, tail slapping or spy-hopping, though on one occasion a lone male was seen to breach clear of the water three times in a row. Under normal circumstances there is no visible blow.

Threats Since no specimens have become available despite the considerable fishing activity in this area, it would appear that by-catching is not a major problem for this species. There are no reports of any threats to habitat.

Conservation Measures This species has so far been reported in waters off Mexico, Guatemala, El Salvador, Nicaragua, Costa Rica, Panama, Colombia, Ecuador and Peru (see map in Pitman, Aguayo and Urban, 1987).

The unidentified eastern tropical Pacific *Mesoplodon* will be covered by CITES Appendix II even though it has not yet been formally described. No international trade is reported for any material identified only as Ziphiidae spp. (CMC, 1987). Further information on this species is required before any other international protective actions can be usefully suggested. The IWC has agreed to recommend Parties to report takes of all cetaceans, although few have so far responded. Better reporting by IWC Parties could greatly improve our knowledge of species such as those of the genus *Mesoplodon*, where every possible piece of information is valuable. The species will be covered by general protective legislation in several countries.

The main conservation requirement is for further information on this species. Except in general terms, such as monitoring accidental and directed catches, the IUCN/SSC Action Plan does not specifically note any conservation activities which may be necessary at present (Perrin, 1989).

Captive Breeding No information, but see Sowerby's beaked whale review.

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CUVIER'S BEAKED WHALE | **INSUFFICIENTLY KNOWN**

Ziphius cavirostris G. Cuvier, 1823

Suborder ODONTOCETI | Family ZIPHIIDAE

Summary Cuvier's beaked whale is very widely distributed. Although numerous specimens are known, and there are some sightings data, there is little information available on abundance, biology or behaviour. There has been some exploitation in the past, mainly off Japan, but no systematic direct takes at present. One specimen was taken incidentally in the Canadian/Japanese experimental driftnet fishery, and there may be incidental takes in other driftnet fisheries.

Distribution Cuvier's beaked whale is a cosmopolitan species, known from strandings along most coasts and many oceanic islands within all ocean basins from tropical to sub-polar waters. It is also found in the Mediterranean Sea. Sightings data from the eastern tropical Pacific indicate that the species is found offshore to beyond the continental slope in this region. The species has recently been reviewed by Heyning (1989) and by IWC (1989). Heyning (1989) gives a map of known records, but remarks that gaps in distribution are probably artificial because of lack of data. There is a great deal of morphological variation between specimens from different areas, and a review is required to determine whether any separate stocks exist.

Population There are no abundance estimates for any region. Strandings data for the Northern Hemisphere indicate that strandings of Cuvier's beaked whale are about as frequent as the strandings of all other ziphiid species combined. It is the most frequently sighted medium sized cetacean in the eastern tropical Pacific (IWC, 1989).

Habitat and Ecology The maximum lengths recorded from precisely measured specimens are a 6.6m female and a 6.93m male. Contrary to previous reports, there appears to be no significant sexual dimorphism, and the average adult size (of western North Pacific animals) is 6.13m (Heyning, 1989).

Males seem to sexually mature at about 11 growth layer groups (GLGs) in the teeth. The shortest sexually mature specimen was 5.26m long, and was also physically mature. The shortest sexually mature female was 5.12m in length. Males reach an age of up to 47 GLGs, but females only up to 28 GLs. It is not known whether the difference in maximum ages is real, or a sampling artifact, but such differences are also known from the southern bottlenose whale and from Baird's beaked whale (IWC, 1989). There is insufficient information to indicate a calving season. The average size at birth has been estimated at 2.7m, based on the size of the largest foetus and smallest calf (Heyning, 1989).

Heyning (1989) gives a list of known food species. Most prey are either open ocean, mesopelagic, or deep-water benthic organisms, possibly indicating that Cuvier's beaked whale is an offshore deep-diving species. Off Japan, specimens taken in waters less than 1,000m deep mainly contained squid. Fish was the most abundant prey found in animals taken in deeper waters. Single animals were the most frequently sighted in the eastern tropical Pacific, with a range of pod size from one to seven animals. Their habits are unobtrusive, and there is some evidence that they avoid vessels by diving. This may account for the relatively few sightings at sea (Heyning, 1989). There are no known habitat problems.

Threats Cuvier's beaked whale was formerly taken in Japan by small-type whaling operations. This take has largely ceased, but an occasional animal may still be caught. A few were taken in the former small cetacean fishery off the Lesser Antilles island of St. Vincent. There are no known systematic fisheries at present. Animals may be taken incidentally in offshore fisheries, but there is little available information (IWC, 1989). Three specimens were reported as shot in France between 1971 and 1976 (Duguy, 1977).

In Japan and the Lesser Antilles the meat was used for human food. Tomilin (1957) reported that stranded specimens were used for dog and fox food in the Commander Islands. One specimen was recorded taken incidentally in the Canadian/Japanese experimental driftnet fishery (Baird, Langelier and Stacey, 1988).

Conservation Measures Potential countries of origin include all those with coastlines, except in polar waters. Reported locations so far include: UK, Ireland, France, Spain, Portugal, Italy, USA, Bahamas, St. Vincent, Mexico, Argentina, South Africa, Canada, Mexico, USSR, Japan, Brazil, Venezuela, Uruguay, UK (Falkland Islands), PR China, Taiwan, Chile, Ecuador (Galapagos Islands), New Zealand, Australia, Indonesia, Sri Lanka, Seychelles and Comoros. This list is likely to be very incomplete.

Cuvier's beaked whale is listed in CITES Appendix II. The following international trade is recorded: 1981 - two scientific specimens from France to USA; 1982 - two scientific specimens of unknown origin from USA to UK, two scientific specimens of French origin from USA to an unknown destination (CMC, 1987). The species is listed in Appendix II of the Berne Convention. No other international agreements relate to this species, but it is covered by general legislation in several countries.

The IUCN/SSC Action Plan does not refer to this species, although it will be covered by general projects such as monitoring by-catches (Perrin, 1989). In order properly to assess the status and needs of this species more information is required, particularly on biology, abundance, distribution and any by-catching.

Captive Breeding An immature female was maintained in captivity for a few days in the USA. The specimen was apparently dying when caught (Norris and Prescott, 1961). There are no other reports of attempts to keep this species, which is in any case too large for conservation through captive breeding to be feasible.

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NORTHERN BOTTLENOSE WHALE **INSUFFICIENTLY KNOWN**
Hyperoodon ampullatus (Forster, 1770)

Suborder ODONTOCETI Family ZIPHIIDAE

Summary Pending fuller examination of recent survey results, the status of the northern bottlenose whale is subject to considerable uncertainty. The evidence suggests that it remains at a low proportion of its pre-whaling abundance, although exploitation has now virtually ceased.

Distribution Northern bottlenose whales are distributed in the North Atlantic from Nova Scotia to about 70°N in Davis Strait, along the east coast of Greenland to 77°N, and from the UK to the west coast of Spitzbergen. There is a single record from the White Sea. A few strandings have been recorded from the North Sea, and there are a few records from the Mediterranean. In the western North Atlantic there are two main centres of distribution. One is in the area called 'The Gully' just north of Sable Island, Nova Scotia and the other is in Davis Strait off northern Labrador. Strandings have been reported from as far south as Rhode Island, USA (IWC, 1989).

This is a deep-water species, rarely found in waters less than 1,000m deep. There is evidence from the distribution of catches that a northward movement occurs in the eastern Atlantic in April-July and a southward movement from July to September (IWC, 1989). In the northeastern areas the species is seen off the Faeroes about March, and by the end of April most sightings occur between Iceland and Jan Mayen and (perhaps a separate group) between Bear Island and Spitzbergen. The southward migration begins in July, and most animals have passed the Faeroes by September (Benjaminsen and Christensen, 1979).

The northern bottlenose whale has recently been reviewed by Mead (1989) and by the IWC Scientific Committee's subcommittee on small cetaceans (IWC, 1989).

Population Results from the 1987 North Atlantic Sightings Survey yield a population estimate of 4,925 (c.v. 0.16) for the Icelandic part of the survey, and 902 (c.v. 0.45) for the Faeroese part (Gunnlaugsson and Sigurjónsson, 1990). Results from the NASS-89 surveys have not yet been worked up, but the data suggest that there may be a similar number of bottlenose whales in waters south and west of the 1987 survey areas (Sigurjónsson *et al.*, 1990). These estimates are liable to be biassed downwards due to lack of adjustment for the long dive times of the species. Only one bottlenose whale was seen in the Norwegian part of the survey (covering the waters off the north-western and Northern Norwegian coasts, the Jan Mayen area, Svalbard and the Barents Sea) (Øritsland *et al.*, 1989). Øien (1990) reports seven sightings (31 individuals) at Jan Mayen in the western part of the Norwegian Sea in July 1988.

There have been two main periods of high bottlenose catches in the North Atlantic: about 50,000 were taken in the period 1882-1914, with a further catch of about 2,500 up to 1927 (Holt, 1977). 800 were taken in the period 1938-54 and a further 5,000 were taken in the period 1955-72 (Jonsgård, 1977a). The catch per boat in the early period showed a significant decline, but since the relationship between such an index and actual abundance is not clear, it is hard to quantify the extent of the decline from such data. Christensen (1976) suggested that the recorded catches in the first period should be adjusted upwards by 25-35% to allow for struck and lost whales.

Mitchell (1977) cited various evidence including the geographical expansion of the fisheries westward to suggest that the species was further depleted by the 1955-69 fishery. Mitchell's observations at sea indicated that the species was not abundant in the western North Atlantic. A major discussion of the problem took place at the IWC meeting in 1976 and a number of papers were submitted, not all of which were published. The discussion resulted in two statements from the Scientific Committee: one based on papers by Scandinavian experts, attributed the cessation of the bottlenose whaling to economic factors, including loss of the British market for pet food from 1972, loss of the similar market in Norway due to the availability of cheaper fur animal foods and the increasing value of the minke whale. Their calculations indicated a decrease in stock size between 1969 and 1971, but no depletion. The second statement pointed out some calculation errors in the Scandinavian paper showing some decrease in stock size and quoted Holt (1977) showing that the early fishery had reduced the stock to 30% of an initial 130,000 in 1885 by 1913. The stock appeared to have declined further between 1914 and 1927, with an average catch of 190 per year. Between 1927 and 1966 the average catch was 50 per year, and the stock might have made some recovery.

Extreme caution was advised in considering any further exploitation (IWC, 1977). Subsequent IWC actions are summarised in the 1979 small cetaceans subcommittee report (IWC, 1980). In 1976 the subcommittee discussed the question and pointed out the need for management action, the Scientific Committee proposed a full discussion in 1977 and the Commission stated that the species should be considered for immediate action by the Scientific Committee. In 1977 the subcommittee referred the matter to the full Scientific Committee, who recommended Protection Stock status with zero catch limit. The Commission approved, and the 'bottlenose whale' was added to the Schedule (but see Conservation Measures section below).

Although this was done 'pending accumulation of sufficient evidence' no further research was undertaken, despite constant pleas from the Scientific Committee and the Commission. In 1984, Christensen and Ugland (1984) presented new calculations to the IWC subcommittee on small cetaceans. They suggested that an initial population of 90,000 in 1882 had been reduced to about 30,000 in 1914, but that since then the population had increased, in spite of continued taking up to 1973, to a 1983 population of 54,000. Their estimate of the extent on depletion was based on the assumption that the catch per boat index would have been linearly proportional to abundance, an assumption for which there is little empirical or theoretical support. Their conclusion of a continued recovery of the population after 1914 to the present is based on projections from a simulation model using more or less arbitrary parameters; there is no empirical evidence to suggest a recovery of this magnitude. The preliminary sightings results from the 1987 survey, although not corrected for diving animals, suggest a current population size considerably less than the pre-whaling level, which must have been over 50,000, being the numbers taken in the first period of intense whaling.

Habitat and Ecology Northern bottlenose whales can reach lengths of up to 9.8m and weigh several tonnes. They are robust, with recorded girths up to 6m. Adult males are on average 8.5 to 9.0m long and adult females 7.5m long. One growth layer group in the teeth is assumed to correspond to one year of age. On this basis the oldest female so far recorded was 27 years old and the oldest male 37 years old.

Minimum length at sexual maturity in females is 6.0m and in males 7.3m. Minimum age at sexual maturity has been estimated at 7 years for both sexes. Gestation is estimated to last 12 months, and the length at birth is about 3.5m. Lactation is thought to last for one year, and the mean calving interval to be two years. Calving takes place in spring (Benjaminsen and Christensen, 1979; IWC, 1989, Mead, 1989).

The major food is squid, particularly *Gonatus fabricii*, but several species of deep-water and other fish are also reported to be taken (Mead, 1989).

The northern bottlenose whale avoids shallow waters such as the continental shelf, the Barents Sea and the North Sea. In the Arctic Ocean this whale stays mainly between the cold polar currents and warmer Atlantic currents. The exact temperature of water most frequented is a matter of some dispute in the older literature, but modern observations show that at least east and northeast of Iceland the species was seen most frequently in waters of between -1.3° and -0.9°C. It may penetrate up to ten nautical miles into the ice, but is more frequently found in open water (Benjaminsen and Christensen, 1979). There appear to be no particular threats to habitat, although a surprising number of plastic objects were found in stomachs.

Indications, mostly from catches, have been found of some geographical segregation between males and females. The whales are most frequently seen in groups of two to four. Groups of two and three whales seem to consist of animals of the same sex and the same or nearly the same age. Diving times of 14 to 70 minutes have been recorded (Benjaminsen and Christensen, 1979).

Bottlenose whales are known to approach ships and to remain with wounded companions. Mitchell (1977) cites these behaviours as facilitating catching.

Threats The early commercial fishery has already been mentioned above. This was started in the 1850s by Scottish whalers in a small way, but greatly increased from the 1880s. About this time Norwegian whalers joined and soon came to dominate the hunt. The Scottish catches had more or less ceased by the turn of the century. The main objective was the 'spermaceti' or head oil. This fishery had declined by the 1920s (Mead, 1989).

The modern Norwegian fishery lasted from the 1930s to 1973. Foote (1975) conducted a very comprehensive investigation of the small-whale hunting industry in northern Norway in 1964, covering the ships, and product preparation and retailing, with economic assessments at every stage. While some points have been criticised and much is out of date, this represents the only such survey in depth of any modern whaling operation.

The market for Norwegian bottlenose whale meat was almost entirely for pet food in the United Kingdom and for feeding fur animals in Norway. Toothed whale meat is not allowed for human consumption in Norway. In 1972 the organization of British pet food importers asked their members to ban whale meat imports voluntarily. In March 1973 an official veto was put on these products. Only 17 northern bottlenose whales were caught in 1972, three in 1973, and none in Norway since. In Norway the meat was used for fur animals, but by 1973 the price was too high in comparison with other foods, and the total requirement for food had dropped because of changes in the type of animals kept. A further reason for the end of catching is said to be the increased relative value of minke whales, which were caught by the same vessels (Jonsgård, 1977b; Christensen and Ugland, 1984). Small fisheries existed from time to time in Canada, Iceland, Faroes and the northern British and Irish islands. (Mitchell, 1975). Canada may have been planning some increase in whaling in the early 1960s, but Foote's report (1975) concluded that it would be very difficult to make such expansion profitable.

Tomilin (1957) describes the products in some detail, although the USSR does not appear to have exploited this species. The figures in the International Whaling Statistics, although listed for this species, all come from the Antarctic, so that *H. planifrons* must be the species taken. The largest bottlenose whales (about 9m) yield up to two tonnes of oil and 200kg of 'spermaceti'. In many respects this resembles sperm whale spermaceti;

Gilmore (1951) says that the oil is known as Arctic sperm oil or doegling oil. Oil from the lower jaw was used for lubricating precision instruments. Boiled meat can be used to feed dogs and fur animals. Mead (1989) reports the meat to be quite palatable to humans, but says that the oil is strongly purgative.

Conservation Measures The major countries of origin are: Canada, USA, Denmark (Greenland, Faeroes), Iceland, Norway (Spitzbergen, Jan Mayen), UK and Ireland, although specimens have been reported from a number of other North Atlantic and Mediterranean countries.

The IWC defines 'bottlenose whale' as any whale known as Baird's beaked whale (*Berardius bairdii*), Arnoux's whale (*Berardius arnuxii*), southern bottlenose whale (*Hyperoodon planifrons*) or northern bottlenose whale (*Hyperoodon ampullatus*), and stocks in the North Atlantic are given provisional IWC Protection Stock status and zero catch limit. Although at first glance this appears to protect four species, in fact, because the northern bottlenose is the only North Atlantic species, it is the only one with any protection.

The northern bottlenose is included in CITES Appendix I, as are the other three species. No international trade in this species is recorded (CMC, 1987). It is listed in Appendix II of CMS and the Berne Convention. By virtue of its IWC protection status, the species will also be protected from catching by a number of other international agreements. None of the countries of origin appear to have specific legislation protecting the northern bottlenose whale, although it will be protected fairly widely under general legislation and through membership of the various international agreements. The northern bottlenose whale has almost total protection from catching, from trade, and at present from market pressure. The population is generally agreed to be depleted, but the degree of depletion is disputed. The new survey data have provided abundance estimates for part of the summer range, and suggest that it remains at a low proportion of the pre-exploitation abundance. There do not appear to be any other major threats to this species.

The IUCN/SSC Cetacean Specialist Group Action Plan for Conservation of Dolphins, Porpoises and Whales mentions elucidation of the status of the northern bottlenose whale as a topic to be monitored (Perrin, 1989).

Captive Breeding This species appears to be too large to keep in captivity, and there are no reports of such attempts. Captive breeding, therefore, could never be a conservation option.

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SOUTHERN BOTTLENOSE WHALE **INSUFFICIENTLY KNOWN**
Hyperoodon planifrons Flower, 1882

Suborder ODONTOCETI Family ZIPHIIDAE

Summary The southern bottlenose whale has never been the subject of targeted exploitation, although a few have been taken for research purposes. Some incidental take is reported in pelagic driftnet fisheries in the Tasman Sea, and there may be other unreported by-catching. There is limited information on distribution and relative abundance, but little on biology, behaviour or the extent of threat from by-catching. More information is required, especially on the extent of incidental take.

Distribution The southern bottlenose whale occurs through the entire Southern Ocean and north to about 30°S. The IWC/IDCR sightings, which covered the area south of 60°S, indicate that this species (and ziphiids in general) was most frequently encountered within 60n.m of the ice-edge (Kasamatsu *et al.*, 1988). It is possible that some sightings records involve mis-identifications, as it is difficult to distinguish between this species and *Berardius arnuxii* at sea. The most northerly published sighting (5°42'S and 34°1'W) off northeast Brazil (Best, da Rocha and da Silva, 1986) may be doubtful for this reason (IWC, 1989). The published record from Sri Lanka is erroneous, and the specimen reported is in fact a *Ziphius cavirostris* (Mead, 1989). The species has recently been reviewed by Mead (1989) and by IWC (1989).

Population The first circumpolar survey series of the IWC/IDCR cruises, from 1978/79 through 1983/84, circumnavigated the Antarctic continent. A total of 64 sightings (175 individuals) were identified as southern bottlenose whales. However, beaked whales could only be identified to species with confidence in the later cruises. Data from 1984/85 onwards suggest that the majority (up to 90%) of the 480 schools (1,087 animals) of unidentified ziphiids may have been southern bottlenose whales (Kasamatsu *et al.*, 1988). By 1987, 407 confirmed records of schools had been accumulated (IWC, 1989). This research continues, and when the data are analyzed it may be possible to estimate the population within the cruise area.

Habitat and Ecology Information on biology and behaviour is very limited. The longest specimens so far reported are a 7.14m male and a 7.8m female. The male had more than 50 growth layer groups (GLGs) in the teeth. A 5.76m female had 37 GLGs. A 7.8m female contained a 1.85m foetus and a 5.7m female was lactating. The smallest calf so far recorded was 2.91m. It had foetal folds, indicating that birth had been relatively recent. Stomach contents have included the remains of squid of several species and krill (which may have been eaten by the squid) (IWC, 1989).

Threats The southern bottlenose whale has never been exploited, although a few specimens have been taken during pelagic whaling operations for research purposes (Tomilin and Latyshev, 1967; Zemskii and Budylenko, 1970). It has been recorded as a bycatch in pelagic driftnet fishing operations in the Tasman Sea, but no estimates of the total annual take are available (Coffey and Grace, 1990).

Conservation Measures Countries of origin include: Argentina, UK (Falkland Islands), Chile, Australia, New Zealand, South Africa, Brazil and the Antarctic coasts.

The IWC definition of 'bottlenose whale' includes the southern bottlenose whale, but as only North Atlantic stocks (of the northern bottlenose whale *Hyperoodon ampullatus*) are given provisional Protection Stock status, the southern bottlenose whale has no protection or classification.

The southern bottlenose whale has been included in CITES Appendix I from 1986. USSR and Austria have registered reservations against this listing, and for them the previous Appendix II listing applies. One skull is recorded as imported into Australia from an unknown source in 1985, for scientific purposes (CMC, 1987). No other international legislation refers to the southern bottlenose whale, but it is protected by general legislation in several countries.

The IUCN/SSC Action Plan does not mention this species, but it will be covered by general projects such as monitoring by-catches (Perrin, 1989). The major conservation need for this species is for more information on abundance, biology, distribution and behaviour. Stranded animals provide the major source of information on the biology of this species, and efforts should be made to obtain full suites of data from every possible specimen throughout the range.

Captive Breeding This whale is too large for conservation through captive breeding to be feasible.

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Unidentified *Hyperoodon* sp.

Suborder ODONTOCETI Family ZIPHIIDAE

Summary Beaked whales resembling *Hyperoodon* spp., but differing from the known species of this genus, have been reported from the tropical Pacific Ocean. Very little is known about its range or abundance. As an oceanic species of comparative rarity it is unlikely to become the target of any directed take. Threats - and the measures required to counteract them - are likely to be related to cetaceans in this area in general. However, a more precise description of the species is required to facilitate its identification in sightings, strandings and incidental take.

Distribution Evidence has grown concerning the existence in the tropical Pacific Ocean of a beaked whale of unknown identity which seems likely to prove to be a species of *Hyperoodon*. This whale may be *Hyperoodon planifrons*, or a new species. However, *H. planifrons* is believed to be mainly a Southern Hemisphere cold water species (although the type specimen is from northwestern Australia) and is so far not known from the tropical Pacific Ocean.

This whale has been reported from the equator at 166°W (central tropical Pacific), in the western North Pacific in the area bounded by 130-142°E and 20-34°N, and in the area bounded by 80-170°W and 5°N - 15°S, with a concentration in the area 90-120°W and 5-15°S during 1965-88 (Leatherwood, Reeves, Perrin and Evans, 1982; Miyashita and Balcomb, 1988; Pitman, Au, Scott and Cotton, 1988; IWC, 1989).

Population Miyashita and Balcomb (1988) report eight sightings of a total of about 280 individuals. These authors do not give any estimates of relative abundance, but imply that the species is relatively rare. Pitman *et al.* (1988) report that the species is rare, being involved in only seven of 946 sightings of ziphiids. However the rarity of reports is not always a reliable indication of absolute rarity - observers may not have visited the main distribution area for example. Beaked whales are also very difficult to sight and identify at sea.

Habitat and Ecology Maximum length is estimated at about 8m by Miyashita and Balcomb (1988), who provide some photographs. Leatherwood *et al.* (1982) also reproduce some photographs taken by Balcomb. Pitman *et al.* (1988) report sightings scattered throughout the year. Herd sizes average 10.6, which is very high for ziphiids. Nothing is known of movements or life history (IWC, 1989).

Threats There is no information on whether or not this species has ever been exploited. There are no reports of by-catches, nor is there information on any other threats.

Conservation Measures So far sightings reports have come from Mexican, USA (Hawaiian) and Panamanian or Colombian waters, as well as from waters outside the jurisdiction of any state.

The species will be covered by CITES Appendix I if it turns out to be a *Hyperoodon*. USSR and Austria have registered reservations against the listing of *Hyperoodon* spp. in Appendix I, and for these countries the Appendix II listing remains in force. If it turns out to be any other ziphiid species, except *Berardius* spp. which is also on Appendix I, it will be covered by Appendix II provisions because this listing simply covers all cetacean species not listed in Appendix I. Although an illegal consignment of meat described as *Hyperoodon* spp. originating in Japan was confiscated on entry to the USA in 1983, there is no reason to link this to the unknown species (CMC, 1987). No other international legislation appears to apply, but some general national legislation covers this species.

The IUCN/SSC Action Plan does not mention this species, but it will be included in general projects such as monitoring by-catching (Perrin, 1989).

The main conservation need is for the identity of this species to be established as quickly as possible. The IWC Scientific Committee recommended that an attempt be made to collect two adult specimens (a male and a female) in the western Pacific Ocean. The possibility of collecting biopsy materials was also raised, but there would probably be difficulty in collecting a sufficient number of samples from both the Antarctic and the western Pacific to resolve the identity of these whales. Even if such studies suggested differences, specimens would still be required for taxonomic analysis and type material (IWC, 1989).

Captive Breeding This species is rather large for conservation through captive breeding to be feasible.

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SPERM WHALE **INSUFFICIENTLY KNOWN**

Physeter macrocephalus Linnaeus, 1758

Suborder ODONTOCETI Family Physeteridae

Summary Although the populations have been reduced by commercial whaling, actions (particularly by the IWC, CITES and the EC over the past 20 years) have ended commercial catching. The species is still widespread and existing conservation measures relating to direct catching are adequate at a global level, provided that they are maintained and enforced. However, the level of indirect take, through entanglement in fishing gear, is causing concern in some areas, and requires further investigation. Although population estimates abound in the published literature, the actual worldwide abundance of the species is not known with any precision, hence the extent to which populations have been reduced by commercial catches is also very uncertain.

Distribution The sperm whale has been reported from all deep oceans of the world, from the equator to the edges of the polar pack ice and, more rarely, from semi-landlocked regions such as the Mediterranean. Only mature males range into the higher latitudes. In the Southern Hemisphere, females and younger males range south as far as the Subtropical convergence (about 40°S). In the Northern Hemisphere they range north as far as the Subarctic boundary (about 42°N) in the North Pacific and the Subpolar Convergence (about 45° to 50°N) in the North Atlantic. There is a general movement towards the poles in summer. The upper latitudinal limits in mid-winter are roughly 40°N and 30°S. The distributional limits during winter, and the limits of females and younger males during the summer, correspond approximately with the 15°C sea surface isotherm. The species has been recently reviewed by Rice (1989), although the population estimates provided are not reliable.

The geographical distribution of the sperm whale is continuous around the world, but the populations in the Atlantic, Indian and Pacific Oceans are partially isolated from each other by the major continental land masses. Between the Atlantic and Indian Oceans movement of both sexes is possible around the southern tip of Africa (35°S). Between the Indian and Pacific Oceans movement can take place through the passages between the Lesser Sunda Islands, which span the 935km gap between the Sunda and Sahul shelves. There may also be movement of both sexes around the south of Tasmania (43°S). Between the Pacific and Atlantic Oceans movement is almost entirely restricted, except for the possibility that males might travel around Cape Horn (57°S).

Northern and Southern Hemisphere populations may be isolated from each other; the six-month difference in their reproductive cycles would seem to offer little opportunity for gene exchange. No data are available on the relationship of the equatorial populations to those in higher latitudes, although it has been suggested that the apparent year-round concentration here might simply represent the northern populations on winter grounds from October to March, and the southern populations on winter grounds from April to September.

Local populations of sperm whales in the Indian and Pacific Oceans have been found to differ among themselves in some morphological, immunogenic and enzyme characteristics, but not enough data are yet available to estimate rates of gene flow. However, mark recovery data indicate extensive north-south movements in both the Northern and Southern Hemispheres, as well as some longitudinal dispersal, giving a potential for wide gene-flow within each major ocean basin.

North Atlantic The range of the sperm whale includes the deeper basins of the Caribbean Sea and the Gulf of Mexico in the west, and the Mediterranean Sea in the east. Adult males range north during summer into the Davis Straits, the waters west of Jan Mayen, and Nordkapp, Norway. Occasionally they wander into the areas east of Svalbard, and into the Barents Sea as far east as the Kanin peninsula (69°N). The limits of females in the North Atlantic are poorly documented, but they probably range north to the Subpolar Convergence between the Gulf Stream and the Labrador Current at 45° to 50°N.

North Pacific Sperm whales range north into the deeper waters of the South China Sea, the East China Sea, the Sea of Japan, the Sea of Okhotsk, the Bering Sea, the Gulf of Alaska, and the Gulf of California. The shallow continental shelf apparently bars their movement further northward into the northeastern Bering Sea and Arctic Ocean. Females regularly range only about as far as the Transitional Domain, which lies just north of the Subarctic Boundary, where the Kuroshio and the Oyashio Currents converge. Occasionally they have been found as far north as Kamchatka (53°N), the Commander Islands (55°N), the Aleutian Islands and to 60° in the Gulf of Alaska.

Southern Hemisphere In the Southern Ocean, adult males occur during summer south to Antarctica (65° to 70°S). Pelagic whaling expeditions caught very few females south of 40°S, but many north of that latitude in the southern Atlantic, Indian and Pacific Oceans.

Indian Ocean Both sexes range north into the Gulf of Aden, the Arabian Sea, the Bay of Bengal, and the Andaman Sea. The Red Sea and Persian Gulf do not appear to provide suitable habitat, and there are no documented reports from these areas (Rice, 1989).

Population The IWC Scientific Committee has made various attempts to estimate the size of sperm whale populations from catch data. Up until 1980 the primary method used was based on the use of Catch Per Unit Effort (CPUE) data from whaling fleets as an index of abundance. This method has subsequently been shown to be unreliable because it fails to take into account the geographical pattern of whaling operations (Cooke and de la Mare, 1983). Subsequent methods based on inferences from the changing distributions of sizes of animals in the catches have also been shown to be sensitive to certain unverifiable assumptions (de la Mare and Cooke, 1985). Survey data can be used to estimate relative changes in abundance but visual surveys have to date only been able to provide a very approximate indication of absolute abundance because of uncertainty over the length of time sperm whales spend on the surface: different survey procedures than have hitherto been employed would be needed to resolve this. Recent developments in acoustic survey techniques are promising (Conservation Research Group, 1989) but have not yet been applied over a wide area.

North Pacific About 290,000 sperm whales have been caught in the North Pacific in the 20th Century, more than in any other ocean. The heaviest catches occurred in the 1960s and 1970s, peaking at over 16,000 in 1968. Substantial catches were taken by pelagic fleets from 1950 onwards. Pelagic catches were initially in the far north (north of 50°N), but the fleets moved gradually south and east until by the end of pelagic whaling in 1979 the catches were mainly south of 30°N. The composition of the catch shifted accordingly, from consisting virtually exclusively of large males in the 1950s to medium-sized males and females in the 1970s. Scouting boat observations suggested a decline in abundance of about fourfold in the area north of 40°N between the periods 1965-70 and 1975-80 (Cooke, 1985), during which period pelagic catches totalled about 100,000. However since the population in this area consists mainly of males, it is not clear what effect the depletion will have had on the total population. Kasamatsu and Ohsumi (1985) estimate an abundance of at least 40,000 and probably over 80,000 sperm whales from a partial survey of the western North Pacific south of 40°N.

There was an earlier period of exploitation of sperm whales in the North Pacific in the first half of the eighteenth century. Based on an analysis of ships' logbooks, Tillman and Breiwick (1983) estimate that sperm whale abundance declined by about five-fold over the period 1825-58 in the western North Pacific south of 40°N as a result of catches totalling less than 40,000 animals. A number of hypotheses have been put forward to explain the apparent discrepancy between this finding and modern estimates of abundance, but there is insufficient evidence to choose between them.

Southern Hemisphere Using a combination of data from the 1978/79 to 1985/86 IWC/IDCR Surveys and Japanese scouting vessel data from 1965/66 to 1987/88, Borchers, Butterworth and Kasamatsu (1990) estimated the abundance of sperm whales in January and February south of 30°S at 32,000 (c.v. 0.70). This estimate is not corrected for animals which are submerged when the vessel passes: a correction factor of at least two may be required (Cooke, 1985). The absolute abundance of sperm whales in the Southern Hemisphere remains highly uncertain until surveys covering a wider range of latitudes using techniques more suitable for sperm whales have been carried out.

Analyses of the size distribution of male sperm whales in the commercial catch suggest that the populations in IWC sperm whale Divisions 2 and 3 (the Southern Hemisphere between 60°E and 30°W, see IWC stock maps) were reduced by whaling in this century from a population of about 200,000 "exploitable" (animals' length 30ft and over), when substantial catches began off Southern Africa in 1912, to about half this level by the cessation of pelagic catches in 1979 (Cooke, de la Mare and Beddington, 1983). However, subsequent analyses have shown the method used to be sensitive to several assumptions, hence these figures should only be used as a very rough indication of the order of magnitude of the populations (de la Mare and Cooke, 1985).

A similar method indicated a decline in Division 9 (Southern Hemisphere between 60°W and 100°W [southeast Pacific]), where there has been a long history of whaling off the coasts of Chile and Peru, from about 130,000 exploitable in 1912 to 45,000 exploitable in 1981 (IWC, 1981). In the other areas of the Southern Hemisphere, the impact of catches did not seem to be clearly discernible from the size distributions (Cooke *et al.*, 1983), hence population sizes cannot be inferred.

North Atlantic Over 20,000 sperm whales have been caught in the North Atlantic since 1950, mainly off Iceland, the Azores, Madeira, and Spain. Sightings data exist from the 1987 and 1989 North Atlantic Sightings Surveys, but these have not yet been published or analy with respect to sperm whales.

Habitat and Ecology The sperm whale differs in many respects from other large cetaceans. There is significant sexual dimorphism, females growing to 11 to 12 metres and males to 15 to 18 metres. This has enablcd the IWC to set catch limits by sex.

Ages are estimated from growth layer groups (GLGs) in teeth, although the closure of the pulp cavity makes age estimates unreliable for the oldest animals. Maximum age appears to be at least 60-70 GLGs, interpreted as 60-70 years. Full size is reached at about 25 years for females and 30 years for males. Females are sexually mature at 7 to 11 years of age, at which time they are 8.3 to 9.2m long; 50% have ovulated by the age of nine. In males the attainment of sexual maturity is prolonged. Puberty commences at age 7-11, at a body length of 8.7 to 10.3m, and testes growth continues until a body length of 13.7 to 14.0m is reached, at about 25-28 years. At this point the testes begin to grow more rapidly, reaching their maximum weight in physically mature animals. The animals are regarded as sexually mature when the internal development of the testes is complete at age 18-21 and a body length of 11.0 to 12.0m. This point marks the start of a second spurt in growth of body size (Rice, 1989).

Sperm whales are seasonal breeders, with a prolonged mating season extending from late winter through early summer. In the Northern Hemisphere conceptions occur from January to August, with something of a peak between March and June. In the Southern Hemisphere conceptions occur from July through March, with a peak between September and December. There is some evidence of synchronisation of oestrus within breeding schools, although it is not known how this may be accomplished. Females normally come into oestrus every three to five years. Males show little, if any, evidence of a seasonal sexual cycle. Agonistic behaviour between mature males is evidenced by the frequent presence of tooth-rake scars, particularly on the head (Rice, 1989).

The overall pregnancy rate in various populations has been estimated at 16-33%; in other words, each female bears a calf once every three to six years. Mean calving interval declined from 6.0 to 5.2 years between 1962 and 1975 in the south-western Indian Ocean, possibly as a response to a decrease in population density (Best, Canham and MacLeod, 1984). These authors also report that the pregnancy rate rose to a maximum of 25% at 10-14 years of age, then gradually declined to only 7% in females aged 40 and over.

Gestation lasts 14-15 months, with the calving season falling between May and September in the Northern Hemisphere and between November and March in the Southern Hemisphere. Calves are between 3.5 and 4.5m in length at birth. The foetal sex ratio is unity. Twin foetuses have been reported in about 0.5% of all pregnancies, and triplets were found in one case. However, there is no evidence that multiple conceptions survive (Rice, 1989).

Lactation appears to continue for two years in most areas, although Best, Canham and MacLeod (1984) found that females in their sample aged less than 10 years lactated for only 1.6 years, whereas those aged 40 or older lactated for 3.5 years. This increase in lactation period is related to the increasing interval between pregnancies in the older animals. Although calves begin taking solid food before the end of the first year, and are usually weaned at about two years at a mean body length of 6.7m, there is evidence that females may continue to nurse sporadically until 7.5 years and males until 13 years of age. These calves might be the offspring of older females, they may have been adopted by another female who lost her calf, the entire school may engage in communal nursing, or calves may retain sufficient contact with their own mothers to permit occasional nursing. Two calves have been observed nursing from the same female (Rice, 1989).

After the end of lactation, females enter a resting period and remain in anoestrus at least until the next mating season and possibly longer. The average female reproductive cycle thus consists of 1.25 years of pregnancy, 2 years of lactation and 0.75 to 2.75 resting years, for a total of 4-6 years (Rice, 1989).

Sperm whales associate in two types of schools: breeding schools and bachelor schools. Breeding schools (also called mixed schools or, before the relationship of mature males to these schools was observed, harem schools) consist of females of all ages, together with immature and younger pubertal males. Large adult males attend these schools only during the breeding season and appear to be occasional visitors, not 'harem masters' herding or guarding the females and young as had previously been thought. Some schools appear to be segregated according to reproductive status or age; others do not appear to be segregated. It is possible to reconcile these observations if the larger social units segregate into subgroups according to reproductive status and age at some times, with the subgroups mixing freely at other times. Pubertal males leave the breeding groups between the ages of 15 and 21, just before attaining physiological sexual maturity. Breeding group size ranges from four to 150 or more animals, but the larger groups appear to be aggregations of several schools. The usual group size is 20-40, with a mean of about 25 whales. Female membership of breeding schools may be permanent (Rice, 1989).

Bachelor schools consist entirely of older pubertal males and sexually mature males. They are usually segregated so that all the members of a school tend to be similar in age and size. Observed school size ranges up to 50 animals, although school size varies according to age. Groups of males up to 12m long contain an average of 22 animals, whereas the largest males are frequently solitary and are almost never seen in groups of more than six. It is these largest males which visit the breeding schools during the mating season. They appear to remain with a given breeding herd for only a few hours and may consort with a number of such schools during a given mating season. The membership of bachelor schools may be transient (Rice, 1989).

The sperm whale is primarily a mesopel'agic macroteuthophage (large-squid eater). It is virtually the only occupant of this niche. It often preys on the largest squid species, with mantle lengths exceeding 1.0m, although medium sized species with mantle lengths of 0.2 to 1.0m form much of the diet. In general, older males take larger prey than do females and younger males. Other cephalopods regularly consumed include the mesopelagic vampire- squids and benthic octopuses. Demersal fishes of medium to large size are a minor but regular part of the diet in all parts of the world, except in high northern latitudes (northern Gulf of Alaska and Iceland), where they may constitute 67-98% of the food taken by large males. Fishes commonly eaten include rays, various sharks and many teleosts. Crustaceans are rarely eaten, although the giant mesopelagic mysid *Gnathophausia*, and larger benthic crabs have been found in a few stomachs.

Non-food items are occasionally found in the first chamber of the stomach. These include stones, sand, sponges, gorgonians, mollusc shells, kelp holdfasts, and various items of rubbish discarded by humans. Claws and vibrissae of phocid seals have occasionally been found, and there is even a report of a human corpse being swallowed by a sperm whale.

It has been estimated that sperm whales consume a quantity of food equivalent to 3.0-3.5% of their body weight per day. Sperm whales appear to feed regularly throughout the year. Further details of food and feeding are given by Rice (1989).

Sperm whales usually swim quietly while at the surface. Especially in calm weather, they may remain almost motionless for long periods. If suddenly alarmed they can swim for brief periods at up to 30km/h. Sperm whales perform prolonged and deep dives. Although most dives are of less than 45 minutes, some large males have been observed to remain below the surface for at least 138 minutes. Maximum diving depths include 1,135m (animal found entangled in cable), 1,827m (tracked by active sonar), 2,250m (tracked by passive acoustics) and 3,195m (inferred from field observations and stomach contents). However, from sonar tracking, it appears that the vast majority of dives are to less than 1,000m (Rice, 1989).

Threats Sperm whales do not generally appear to have been taken by local people for their own use to any extent in early times. The first commercial fishery began from the USA in 1721. Right whales also formed an important part of this fishery. At first activities were confined to the Atlantic Ocean, but regular voyages to the Pacific Ocean began in 1791 and to the Indian Ocean in 1830. Several other nations, particularly UK and France, engaged in this fishery to a lesser extent. Between 1804 and 1876, USA whalers killed an estimated 225,521 sperm whales worldwide. The peak year was 1837, with the oil of an estimated 6,767 animals delivered to USA ports. (This would represent many more animals killed, because not all could be retrieved or fully processed.) The fishery declined for economic reasons towards the close of the 19th century, as petroleum came to replace sperm oil as a lubricant and lamp fuel. The last successful old-style voyage was made in 1925 (Rice, 1989).

Several minor shore-based fisheries for sperm whales developed out of this fishery, possibly through the return of international whaling crew members to their homes, or through whaling crew members leaving their ships in various parts of the world. The main surviving such fishery operates from two villages, Lamalera on Lambata Island and Lamakera on Solor Island in Indonesia, taking a few animals with hand harpoons for local use each year. (However, it may be that this fishery has a longer history, and is a rare example of an aboriginal sperm whale fishery.)

The modern whaling industry was initially based mainly on rorquals, particularly blue and fin whales in the early years, although some sperm whales were taken. Before 1939 the annual world catch of sperm whales was of the order of 2-3,000 animals. By the 1950s, new uses for sperm oil (particularly for lubricants, leather tanning and in the chemical industry) had increased demand. Catches rose to a world peak of 29,255 in 1964, although the peak year in the North Pacific was 1968, when 16,357 were reported killed (Rice, 1989).

From 1971 increasingly restrictive catch limits set by the IWC progressively reduced the world catch. In 1979, the IWC banned pelagic catches of sperm whales, leaving only the coastal fisheries in Japan, South America and the North Atlantic (Spain, Iceland, Madeira and the Azores). From 1982 the IWC set sperm whale catch limits to zero everywhere except in the western North Pacific, where catches from Japanese land stations continued until 1988.

The fisheries at Madeira and the Azores, which are not subject to IWC regulations, closed in 1981 and 1987 respectively (Rice, 1989; Deimer, Gordon and Arnbom, 1988).

The primary products of value from commercial sperm whale catches have been oil and waxes obtained from the body tissues and head cavity. At first these materials were used mainly for general lighting and lubrication, and demand fell as cheaper replacements became widely available. The special properties of these oils were increasingly exploited for a wide variety of industrial purposes from the 1950s, raising demand and the commercial value of the products. A very large and valuable international trade developed, with a complicated processing and marketing system, mainly based in Europe. Considerable details of sperm whale products and trade up to the late 1970s are given by FOE (1978) and Mearns (1980). Over 70 trading countries and territories are listed, with many consignments of over 100 tonnes. Uncertainties over supply, resulting from the reduced IWC quotas, availability of cheaper substitutes and the activities of conservation pressure groups in persuading consumers to choose alternative products, are said to have contributed to the depression of the sperm oil market by the late 1970s (Frost, 1978). Later conservation actions, described below, brought about the ending of both commercial catching and large-scale commercial demand for oil-based products. Substitutes are now available for all sperm oil industrial uses. Although there may still be a few very special applications for which the oils are preferred, demand for these alone is unlikely to be a significant factor in any pressure for the re-opening of large-scale commercial sperm whaling.

The protein-rich solid and liquid residues left after the oil had been extracted were used as additives in the formulation of livestock feeds. However, the material is rich in mercury (for unknown reasons, but probably connected with the physiology and ecology of the animals rather than a reflection of human pollution of the oceans) and resulted in unacceptable mercury levels in meat and other products for human consumption (e.g. Plummer and Bartlett, 1975). Sperm whale meat has been little used for human consumption, except in Japan and a few other local areas. In view of the mercury levels, there seems little potential for any demand to resume commercial catching for human or animal consumption purposes.

Ambergris, which is formed in the digestive system of sperm whales and can be found washed ashore or inside whales killed by whalers, was once highly valued, mainly as a fixative for perfumes. It is no longer used for this purpose because cheaper substitutes are available. There is still some commercial demand in the Middle East, for medicinal purposes. This appears to be satisfied now through material found on beaches (e.g. Anderson, 1990).

The teeth may be used for carving, for ornaments and jewellery, known as scrimshaw work. They are still valued, particularly examples produced by 19th century whalers, but plastic substitutes are now widely available. Bones may also be used for carving, but the products are not so distinctive and hence less valued.

Some conflicts with fisheries have been reported. In the Gulf of Alaska, sperm whales are said to have taken sablefish from longlines being retrieved by fishermen (Rice, 1989). An Italian drift gillnet fishery for swordfish in the Mediterranean killed a number of animals, threatening the survival of what is believed to be a small local population. Italy banned this fishery in 1990. Some takes in other fisheries worldwide are also reported (IWC, 1990).

Conservation Measures Because it is a cosmopolitan oceanic species, the sperm whale is of conservation concern to every country with a sea coast, every country registering shipping and every country which could import products or use material treated with products.

The sperm whale is currently protected from whaling by IWC members through the IWC's general moratorium on commercial whaling which came into force in 1986, although catches from whaling stations in Japan continued until 1988, when Japan withdrew its formal Objection to the moratorium decision. If pressure to restart catching became strong, the future of the species would depend on the IWC being able to resist this pressure until a satisfactory procedure for regulating catches based on regular direct monitoring of population abundance has been developed (see Introductory sections).

The sperm whale has been listed in CITES Appendix I from 1985. Japan and Norway (and also Austria, for technical reasons not related to this species) have entered reservations against this listing, and for these countries the previous Appendix II listing applies. A European Community regulation prohibited trade in sperm whale oil, articles treated with such oil, and other sperm whale products (but not teeth) from 1981. Many international movements of sperm whale material have been recorded since the species was first listed in the CITES Appendices (CMC, 1987). They clearly illustrate the decline in the international oil trade. The EC regulation seems to have made a significant contribution, with no more large consignments recorded by the member states, which were at the centre of the international trade, after 1981. The development of practical methods for the detection of sperm oil in proprietary products and treated leather in the late 1970s provided customs officials and industrial consumers with a powerful means to monitor such materials, helping to prevent covert or inadvertent use of sperm oil. Only 14 international movements are listed for this species in 1985, consisting almost entirely of small quantities of teeth or carvings.

Although IWC regulations have been the primary conservation instrument for the sperm whale, the restrictions on trade imposed by the EC and CITES, and the efforts of the conservation organisations to persuade consumers to choose alternative products, provided significant assistance. Against such a background, the IWC may have had less difficulty in achieving agreement on the phasing out of catches by operations dependent on the international oil market. These efforts are also likely to have played their part in the ending of catches by non-members of the IWC.

National legislation protecting the sperm whale is mainly derived from the international agreements. Oceanic populations of sperm whales appear to be adequately protected from commercial whaling provided IWC, CITES, EC and other controls on flag countries continue to be effective. There is, however, concern that some populations, such as that in the Mediterranean, are vulnerable to entanglement in fishing gear. This question requires further investigation.

Captive Breeding Because of their large size, sperm whales have never been deliberately captured for maintenance in captivity. Single newborn sperm whales that stranded in Bermuda in 1932, in Maine (USA) in 1976, in Oregon (USA) in 1979, and in Florida in 1964, 1974 and 1989, have been held in captivity, but none survived more than a few days. A 7.62m debilitated animal (possibly a male) named 'Physty' stranded at Fire Island, New York on 16 April 1981. The whale was confined to a boat basin until it appeared to regain health, and was released on 25 April (Rice, 1989). However, there is no practical possibility of maintaining a breeding group in captivity, and captive breeding is thus not a conservation option for this species.

Remarks *Physeter macrocephalus* is the correct scientific name for this species, although it is often described in the older literature as *Physeter catodon* (Rice, 1989).

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PYGMY SPERM WHALE **INSUFFICIENTLY KNOWN**
Kogia breviceps (de Blainville, 1838)

Suborder ODONTOCETI Family PHYSETERIDAE

Summary The abundance and status of the pygmy sperm whale is unknown, but the species does not appear to be subject to any significant known threats at present. The major need is for more information on distribution, numbers, ecology and behaviour.

Distribution The genus *Kogia* has only been separated into the two currently recognised species comparatively recently (Handley, 1966). Identification at sea, particularly to species, is difficult. Thus most reliable records of either species are based on stranded individuals or on the occasional specimens taken in general small cetacean fisheries or accidentally killed in fishing nets.

The pygmy sperm whale appears to be a cosmopolitan species, recorded from nearly all temperate, subtropical and tropical waters. A map of records is given by Caldwell and Caldwell (1989), who have recently reviewed the species. However, the distribution of currently confirmed records may reflect observer activity as much as the real distribution of the species.

Stomach contents indicate that the pygmy sperm whale is principally oceanic in distribution, staying most often seaward of the continental shelf (Leatherwood and Reeves, 1983). It is not known whether the populations are continuous or discontinuous across the world. Nor is there any information on the ecological relationships of the two species, which have never been seen together in life.

Population Nothing is known about abundance or stock identity, but in areas where they are frequently reported stranded, they are considered to be one of the most common species to come ashore. Caldwell and Caldwell (1989) note that more pygmy sperm whales than dwarf sperm whales strand in Florida, by a factor of several times. Ross (1979), however, examined more or less equal numbers of each species in his South African sample. There has been a great increase in records of this species in recent years, probably reflecting an increase in observer activity. The lack of records at sea appears to be more because of unobtrusive behaviour than absolute rarity (Handley, 1966; Leatherwood and Reeves, 1983; Caldwell and Caldwell, 1989).

Habitat and Ecology Pygmy sperm whales grow to a maximum body length of at least 3.4m. Males and females are similar in size and appearance. The height of the dorsal fin is less than 5% of total body length, a feature which distinguishes this species from the dwarf sperm whale, which has a higher dorsal fin.

Females reach sexual maturity at a length of 2.6 to 2.9m, males at 2.7 to 3m. Calves are about 1.2m long at birth. Most calving appears to take place between autumn and spring, after a gestation period believed to last about 11 months. Females have been observed both pregnant and lactating, suggesting that they are capable of annual reproduction or that lactation is prolonged (Leatherwood and Reeves, 1983; Caldwell and Caldwell, 1989).

Madsen and Herman (1980) report that the pygmy sperm whale feeds on cephalopods from the disphotic zone as its primary food, with euphotic benthic invertebrates and disphotic pelagic and demersal fish as supplementary or secondary components of the diet.

Tomilin (1957) reports some observations indicating that *Kogia* are non-social, staying alone or in mother-calf groups. Leatherwood and Reeves (1983) also note that the pygmy sperm whale is not gregarious, and six or seven animals together would constitute a large group. Most reliable sightings have occurred when the seas were flat and visibility conditions excellent, and have involved from one to five rafting animals. This habit of basking at the surface is said to make then easy to harpoon (Yamada, 1954).

Threats There are no known past or present major threats to this species. It is possible that some casual exploitation occurred at the hands of the early whalers, and a few appear from time to time in local general small cetacean fisheries off southern Japan and in Indonesia. They have also occasionally been seen in the fish markets in Sri Lanka, possibly accidentally taken in other fisheries. In general, there are few reports of accidental takes in other fisheries (e.g. Omura, Shirakihara and Ito, 1984). Tomilin (1957) regards the potential industrial yield as small: a 2.98m. male weighing 417kg and another male 1.885m weighing 109kg. The main use is for meat for human consumption.

Some specimens have been reported with plastic bags in the stomach, which may have prevented digestion of food, and ultimately brought death (Leatherwood and Reeves, 1983; Caldwell and Caldwell, 1989). Some have been taken for scientific study (Allen, 1941).

Conservation Measures Putative countries of origin include all those with temperate, subtropical and tropical coastlines. Specific locations so far reported include: South Africa, New Zealand, USA (Hawaii), UK, Netherlands, France, Australia, Mexico, Fiji, Peru, Japan, Cuba, Puerto Rico, Uruguay, Indonesia, Sri Lanka, Spain (Canary Islands), Portugal, Pakistan, Ireland, Senegal, Canada and India. This list, however, is likely to be very incomplete.

The pygmy sperm whale is listed in CITES Appendix II. The following international trade has been recorded: 1981 - 1 scientific specimen from France to USA; 1982 - 1 scientific specimen of French origin from USA to France (CMC, 1987). The species does not appear to be specifically covered by any other international legislation, but it will be protected by general legislation in several countries, although no specific provisions were found.

Hardly any basic information about the species is available, and the major need is for more data on distribution, abundance, biology and behaviour. The IUCN/SSC Action Plan has no specific projects relating to the pygmy sperm whale, but it will be included in general projects such as the monitoring of general small cetacean fisheries, and monitoring accidental catches (Perrin, 1989).

Captive Breeding The pygmy sperm whale does not appear to have been taken deliberately for captive display (but see below), although a number of unsuccessful attempts to keep stranded specimens have been made (at least in USA, Japan, New Zealand and Australia). The maximum survival period appears to be about three months, by a juvenile stranded in Florida (Caldwell and Caldwell, 1989). Sylvestre (1983) gives details of many of these cases.

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DWARF SPERM WHALE **INSUFFICIENTLY KNOWN**

Kogia simus (Owen, 1866)

Suborder ODONTOCETI Family PHYSETERIDAE

Summary The abundance and status of the dwarf sperm whale is unknown, but the species does not appear to be subject to any significant known threats at present. The major need is for more information on distribution, numbers, ecology and behaviour.

Distribution The genus *Kogia* has only been separated into the two currently recognised species comparatively recently (Handley, 1966). Identification at sea, particularly to species, is difficult. Thus most reliable records of either species are based on stranded individuals, or occasionally on those taken in general small cetacean fisheries or accidentally killed in fishing nets.

The dwarf sperm whale appears to be a cosmopolitan species, recorded from nearly all temperate, subtropical and tropical waters. A map of records is given by Caldwell and Caldwell (1989), who have recently reviewed the species. However, the distribution of currently confirmed records may reflect observer activity as much as the real distribution of the species.

Stomach contents indicate that the distribution may be somewhat more inshore than that of the pygmy sperm whale, perhaps concentrated along the edge of the continental shelf (Leatherwood and Reeves, 1983). Ross (1979) observes that in small cetacean fisheries where *Kogia* appear with any frequency, the dwarf sperm whale is the species usually taken, tending to support the inference that they live somewhat more inshore. Ross (1984) suggests that the juvenile and immature animals live closer inshore than the adults, with the younger animals living over the outer part of the continental shelf and upper part of the slope, while the adults live over deeper water. It is not known whether the populations are continuous or discontinuous across the world. Nor is there any information on the ecological relationships of the two species, which have never been seen together in life.

Population Nothing is known about abundance or stock identity, but in areas where they are frequently reported stranded, they are considered one of the more common species to come ashore. Caldwell and Caldwell (1989) note that fewer dwarf sperm whales than pygmy sperm whales strand in Florida, by a factor of several times. Ross (1979), however, examined more or less equal numbers of each species in his South African sample. There has been a great increase in records of this species in recent years, probably reflecting an increase in observer activity. The lack of records at sea appears to be more because of unobtrusive behaviour than absolute rarity. The dwarf sperm whale, while not generally abundant, does appear to be more common than was thought (Handley, 1966; Leatherwood and Reeves, 1983; Caldwell and Caldwell, 1989).

Habitat and Ecology Dwarf sperm whales grow to about 2.7m, with adults ranging from 2.1 to 2.7m. Length at birth is about 1m. Males and females are similar in size and appearance. The height of the dorsal fin is more than 5% of total body length, a feature which distinguishes this species from the pygmy sperm whale, which has a low dorsal fin.

Both males and females apparently reach sexual maturity at a length of 2.1 to 2.2m. The calving season appears to be prolonged, covering at least six months. Pregnant females accompanied by unweaned calves are not uncommon, suggesting the possibility of an annual reproductive cycle or of prolonged lactation (Leatherwood and Reeves, 1983; Caldwell and Caldwell, 1989). Pinedo (1987) demonstrates that gestation lasts for about 9.5 months.

The diet of the dwarf sperm whale consists primarily of squid, although fish and crustaceans are also eaten. Stomach contents indicate that the species can dive to depths of at least 300m (Leatherwood and Reeves, 1983).

The dwarf sperm whale is usually encountered in groups of no more than ten animals. There may be three kinds of pods, one consisting of females and calves, one of immatures, and another of adults of both sexes unaccompanied by calves (Ross, 1979; Leatherwood and Reeves, 1983).

Behaviour at sea is unobtrusive, and most sightings have occurred when the sea was flat and visibility conditions excellent and have involved animals rafting at the surface (Leatherwood and Reeves, 1983). This habit is said to make them easy to harpoon (Yamada, 1954).

Threats It appears that there are and have been no major threats to this species. It is possible that some casual exploitation occurred at the hands of the early whalers, and a few appear from time to time in general small cetacean fisheries off southern Japan, Indonesia and St Vincent in the Lesser Antilles. They are also occasionally seen in fish markets in Sri Lanka, possibly accidentally taken in other fisheries. The main use is as meat for human consumption.

Some specimens have been reported with plastic bags in the stomach, which may have prevented digestion of food and ultimately brought death (Leatherwood and Reeves, 1983; Caldwell and Caldwell, 1989).

Conservation Measures Putative countries of origin include all those with temperate, subtropical and tropical coastlines. Specific locations so far reported include: USA (Hawaii, Guam, Mariana Islands), France (New Caledonia), Canada, St Vincent, South Africa, India (Andaman and Nicobar Islands), Sri Lanka, Japan, Australia, Brazil, Indonesia, Mexico, Senegal, Chile and Oman.

The dwarf sperm whale is listed in Appendix II of CITES. The following international trade is recorded: 1984 - 1 commercial specimen of South African origin from USA to USA, 1 scientific specimen from South Africa to USA; 1985 - 200g scientific specimens from South Africa to Switzerland (CMC, 1987). The species does not appear to be specifically covered by any other international legislation, but it will be protected by general national legislation in several countries, although no specific provisions were found.

Hardly any basic information about the species is available, and the major need is for more data on distribution, abundance, biology and behaviour. The IUCN/SSC Action Plan has no specific projects relating to the dwarf sperm whale, but it will be included in general projects such as the monitoring of general small cetacean fisheries and monitoring accidental catches (Perrin, 1989).

Captive Breeding The dwarf sperm whale does not appear to have been taken deliberately for captive display, although a few unsuccessful attempts have been made to keep specimens which have stranded alive in the USA (Sylvestre, 1983). None survived for more than a few days. The potential for survival in captivity cannot be effectively judged from the performance of live-stranded specimens, which may already be ill or damaged. All the four specimens described by Sylvestre (1983) appear to have been moribund when removed from the beach. The dwarf sperm whale is small enough for captive breeding to be feasible, if necessary. If any specimens are brought into captivity in the future, collection of biological and behavioural information relevant to conservation and management should be given priority.

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BOWHEAD VULNERABLE

Balaena mysticetus Linnaeus, 1758

Suborder MYSTICETI Family BALAENIDAE

Summary All the four currently recognised bowhead stocks were seriously depleted by commercial whaling in previous centuries and, despite 50 years of protection, it is possible that only the Bering/Chukchi/Beaufort Seas is large enough to be viable in the long term. Recent research indicates that this stock is larger than previously thought (7,800, with a 95% confidence interval of 5,700 to 10,600). The compromise between the survival of this stock and the interests of local people, which allows a limited take, may be successful, particularly as the local people have become deeply involved in the management of this fishery. Although previously listed as Endangered, the species has been upgraded to Vulnerable because the revised population estimates for the Bering/Chukchi/Beaufort Seas stock implies either that the stock has increased or that it was not as severely depleted originally as had been feared. Even if continued monitoring over the next few years reveals an increasing trend in this stock, the ultimate survival of the species cannot be considered secure until a recovery is evident in more of its range.

Distribution Bowhead whales inhabit arctic and sub-arctic waters between latitudes 55° and 80°N. Four stocks are currently recognised by the IWC (1983): Spitzbergen, Hudson Bay/Davis Strait, Bering/Chukchi/Beaufort Seas and Okhotsk Sea. Much of the historical range is no longer used by the depleted populations. The animals migrate to northerly feeding grounds in spring and summer, returning to the southern parts of the range in late autumn.

Spitzbergen Bowheads from this stock wintered in the area of the east coast of Greenland, Iceland and Jan Mayen Island. Their northwesterly spring migration was associated with the recession of the ice front. In summer, most of the population was found between Greenland, Spitzbergen, the Barents Sea and north to latitude 80°N (Braham, 1982).

Hudson Bay/Davis Strait The wintering area continues to be in southern Davis Strait and Hudson Strait from Disko Bay southwest to approximately 60°N. The summering areas and migration routes included Hudson Strait into northwest Hudson Bay, northeast Baffin Bay as far north as Smith Sound, Lancaster Sound and Prince Inlet, and the waters between the islands of the Canadian Arctic as far west as Barrow Strait (Braham, 1982; Eschricht and Reinhardt, 1866)

Okhotsk Sea Bowheads were formerly found in the northern and western Okhotsk Sea during spring and summer, occurring as far north as Pezhinskaya Inlet (north Okhotsk Sea) and as far west as Tchantar Bay. During spring, they were found as far south as the Korean peninsula and Japan. This stock may once have been part of the Bering/Chukchi/Beaufort Seas stock. Their seasonal movements are unknown today (Braham, 1982).

Bering/Chukchi/Beaufort Seas This stock once ranged from the southwestern Bering Sea to the Arctic Ocean in spring and summer, and may have been continuous with the Okhotsk Sea stock. The northward migration seems to have been protracted;

whales wintering south of the Aleutian Islands may not have reached the high Arctic waters in summer, but by the end of the 19th century whales were no longer found in open water south of the pack ice in spring. The southern limit of this stock appears now to be further north in the Bering Sea and the migration earlier in the year than when commercial whaling began. The present wintering area is in the vicinity of the ice edge in the Bering Sea from St. Lawrence Island to south of St. Matthew Island and into Anadyr Gulf. The spring northward migration occurs from April to June, through the eastern Chukchi Sea to the Beaufort Sea, which serves as the primary feeding ground in summer. From late spring to autumn they frequent areas south and southwest of Banks Island to the coast from Amundsen Gulf to west of Herschel Island. The autumn migration begins in August and continues into November; from Point Barrow the animals move west across the Chukchi Sea towards Herald and Wrangel Islands, and then south and east along the Chukchi Peninsula to the wintering grounds (Braham, 1982).

Population The bowhead whale was one of the earliest targets of the commercial whaling industry and all stocks were hunted to commercial extinction over the 18th, 19th and early 20th centuries. Local people have taken animals for their own use throughout the range from the earliest times. This species has been intensively studied in recent years, providing improved population estimates and much information on biology and habits. Historical records of all stocks have been studied. Most field work has been done on the Bering/Chukchi/Beaufort Seas stock (the only stock still regularly hunted), some surveys made of the Okhotsk Sea stock, and information on the other stocks obtained from a variety of sources.

Spitzbergen Initial stock in 1679 about 25,000; present stock at a very low level, with only 24 animals (one dead) seen in the southern part of the range since 1958 (IWC, 1983). Jonsgård (1979) has speculated that the original stock may have become extinct and that the recent sightings may represent immigration from another stock. Belikov (1985) takes a more optimistic view, noting 11 possible sightings in post-war years off Franz Josef Land.

Hudson Bay/Davis Strait Initial stock about 6,700 to 11,700; present believed to be only a few hundred (Braham, 1982). However, the estimates of initial population are based on historical catch records which do not include those of the Danish land stations on the Greenland coast or of some of the international fleet (e.g. the UK records are not complete). The higher figure refers to the stock in 1825 (Mitchell and Reeves, 1980), which had already been subject to exploitation from about 1719 by the international fleets and the Danish land stations. The initial population is thus likely to have been rather larger than 11,700 (Ross and MacIver, 1982; De Jong, 1983; Gad, 1971; 1973; 1976). The present population is unknown, but of the order of a few hundred only (Braham, 1982). Recent sightings have been mainly in the north Baffin Island area, although in 1982 at least 11 were seen near Disko Island and at least 6 along the coast of West Greenland. From May-July 1986, 13 animals were seen in Admiralty Inlet, northern Baffin Island (Born and Heide-Jorgensen, 1983; IWC, 1983; IWC, 1987a).

Okhotsk Sea Initial stock about 6,500 in 1860 (IWC, 1978), or up to 10,000 (Ivashin, 1982) - although this estimate may be based on catch records which include some right whales (IWC, 1983). The present population is unknown but of the order of a few hundred whales only (Braham, 1982). Three surveys resulted in sightings of 54

(June-July 1967), 35 (August 1974) and 55 (August 1979), mainly in the southern Okhotsk Sea in Academy Bay and adjacent areas (Berzin and Doroshenko, 1981). In 1986, aerial surveys off the Shantar Islands suggest that about 20-25 animals inhabit that area; 18 animals were recorded off Point Michael in September, and a further 17 were recorded off Gizhiga Bay (northern Okhotsk Sea) in June and July (IWC, 1987a).

Bering/Chukchi/Beaufort Seas Initial population about 14,000-20,000; current population calculated as 7,800 (with a 95% confidence interval of 5,700 to 10,600) in 1986, from much improved population censuses. A stock trajectory simulation was carried out, using these estimates, and assuming an age of first parturition of 10 years, recruitment at 4 years, and a natural mortality rate of 0.05 per year, to calculate replacement yields (RY). The simulation runs suggested that the population had probably increased under an estimated average annual removal of 27 animals since 1910, although the rate of increase is uncertain, and the increase has so far not been empirically corroborated. Estimates of Replacement Yield (i.e. the catch from the recruited stock which, if taken in 1987, would leave the recruited population in the same position at the beginning of the next (1988) season) ranged from 41 to 196 depending on assumptions. The IWC aboriginal whaling scheme allows only a proportion of these animals to be taken, to enable the stock to recover (IWC, 1987a; IWC, 1989).

Habitat and Ecology The biology and behaviour of the bowhead have recently been reviewed by Reeves and Leatherwood (1985); Wursig, Dorsey, Fraker, Payne and Richardson (1986) and Ljungblad, Moore and Van Schoik (1986). The bowhead lives mainly in and at the edges of ice fields and is the best adapted of all baleen whales for life amidst the ice. It travels easily through ice crevices (called 'leads') and can break holes through ice with its head. Sometimes individuals are trapped and frozen into the ice (Tomilin, 1957). Breeding areas include Spitzbergen Bay, Disko Bay, and the Chukchi and Okhotsk Seas (Shantarskii Bay) (Harmer, 1928; Eschricht and Reinhardt, 1866). Vibe (1967) presents the hypothesis that long-term distribution and occurrence may have been determined to a large extent by the movement of drift ice, which at certain periods has restricted access to feeding grounds. Braham, Fraker, and Krogman (1980) and Fraker (1984), however, have observed that these animals are adept at finding, and using, leads in the ice, even when these are far from the usual migration routes, as well as at exploiting the most productive areas of the feeding grounds. It therefore appears that their behaviour is sufficiently flexible to accommodate year-to-year changes in ice conditions, although adaptation to long-term climatic changes may depend on the productivity and availability of new feeding areas.

The main food of the bowhead whale is euphausiids, but *Calanus finmarchicus*, pteropod molluscs and ctenophores are also included. Fish are not present in the diet (Tomilin, 1957; Lowry, Frost and Burns, 1978).

Nerini *et al.* (1984) have reviewed reproduction in this species and describe new material collected from the Alaskan hunt. The length at birth is estimated to be 4-4.5m, length at one year 8.2m, length at sexual maturity 14m in females and maximum attainable length 20m. Conception is likely to occur in late winter, with peak calving in May. Gestation is therefore likely to be longer than one year but less than two. By analogy with other Balaenidae, and from sparse data on this species, lactation is assumed to be one year, although this is not certain. The pregnancy rate of mature females calculated from ovarian data is 0.15, indicating a calving interval of 3-6 years.

The gross annual reproductive rate (GARR) generated from field data is 0.065 and 0.092, for 1985 and 1986 respectively. This is consistent with calf counts, but the considerable variability in recent estimates may be caused by age or size segregation, sampling error, or year to year variability in recruitment (IWC, 1987a). The findings of a more recent study by Tarpley, Weeks and Stott (1988), based on material from 15 sexually mature females obtained during the Alaskan hunt, were similar to those of Nerini *et al.* (1984), although the pregnancy rate (calculated from the observation that four of the 15 animals were pregnant) estimate was somewhat higher at 0.27. The sex ratio of the harvested animals is 0.83:1.0, although this may not reflect that of the whole population (IWC, 1987b).

Unfortunately, as yet there is no age determination method for this species. The earplugs (where growth lines are used to estimate age in other baleen whales) are unreadable in bowheads, methods using the baleen are not yet considered reliable, routine examination of the animal's physical maturity is impractical and there is (for unknown reasons) poor correlation between body length and corpora counts in ovaries. As a long-term alternative, natural marking data could provide age-specific reproductive information, particularly since 1,400 animals have now been individually identified (IWC, 1990).

Bowhead whales generally live alone, in twos or in groups of 3-5, with the younger groups remaining separate from the older ones. When migrating or in areas of high food concentration, schools may be formed (Scoresby, 1820; Tomilin, 1957; Ljungblad *et al.*, 1986).

Threats While the species was seriously depleted through harvesting for whalebone and oil in earlier times, present catching is entirely by local people for human and possibly, in some areas, for animal consumption. Local people throughout the range have hunted bowheads for their own use from earliest times. Today, only those with access to the Bering/Chukchi/Beaufort Seas stock make regular catches. Evidence was presented to the IWC that there has been some shooting at bowheads by Canadian Inuit using rifles (IWC, 1980), although requests for permits to hunt bowheads have been refused (IWC, 1983). One or two bowheads have been taken in recent seasons by Soviet Inuit (IWC, 1978).

The importance of whaling to the Alaskan Inuit culture goes beyond nutrition; it is perceived as one cultural ritual little affected by contact with outside culture. However, from the early 1970s, technology and the role of the whale hunter have changed. Increasing industrial activity and employment in the area enabled many more Inuit to outfit their own whaling crews, resulting in an increase in the landed catch and reports of high struck-but-lost rates. The hunt was brought to the attention of the IWC. In 1977 concern about the effect of the hunt on this stock was such that the exemption allowing a subsistence take was deleted. At the request of the USA, and in view of the cultural needs of the local people, it was decided later that year to allow a take in 1978 of 12 whales landed or 18 struck (Tillman, 1980). Since that time great efforts have been made by the Alaskans, the USA, the IWC and others to manage the hunt and to obtain more information on the populations.

The IWC Scientific Committee have recommended for several years that any catch limits should be set with caution, and that catches should be restricted to smaller animals (under 13m). Given the population estimates now available, there is less cause for concern. Based on a submission by the USA that the aboriginal need was for 41 landed whales, and in the light of the population assessments reported above, the IWC in 1988 set an annual aboriginal catch limit of 41 landed or 44 struck for the years 1989-91 (IWC, 1989).

There are fears that industrial developments in the area may affect the Bering/Chukchi/Beaufort Seas stock. Many studies have been conducted to address these concerns (reviewed by Fraker, 1984). A major difficulty for such studies is that there is considerable variability in the distribution of bowheads on their summer range (where most industrial activity takes place) among different years (Wursig *et al.*, 1986). In some years they have been common near dredging, island construction, drilling and associated activities, and they have been uncommon in other years. Local people in Alaska strongly believe that seismic operations have led to changes in bowhead distribution during the autumn migration. The IWC Scientific Committee called for additional research on this question, which is in progress (IWC, 1987b). The concerns about the consequences of contact with spilled oil are also difficult to resolve, partly because there has never been a documented case of death or injury to any kind of whale from contact or ingestion of oil. Geraci and St. Aubin (1982) conclude that although whales in particular circumstances (trapped in heavy oil in an enclosed area) might be harmed or killed, for most animals a spill probably would not pose a serious threat.

CITES records a number of international movements: 1979 - 3 carvings from Canada to USA; 1982 - various specimens for scientific purposes from USA to Canada; 1983 - various scientific specimens, and 5 personal items from USA to Canada, 2 items from Canada to UK and one from Canada to USA; 1984 - scientific specimens from USA to Canada, 3 items from Canada to UK and 1 consignment of oil, of unknown origin, to USA; 1985 - one specimen USA to Canada and an illegal consignment of 5 bone products from Canada to USA, seized on entry (CMC, 1987). There are also quite a number of movements, mainly from Canada and to various countries, recorded under *Balaenidae* spp. and *Balaena* spp., mostly consisting of bone carvings. These may be bowhead materials, or from right whales (which are sometimes described as *Balaena* rather than the correct *Eubalaena*). The lists do not indicate whether the material is old, or from newly caught or stranded specimens, nor the size of the carvings (one skeleton could furnish very many small carvings). The *Balaenidae* spp. tooth recorded as exported from UK to Australia in 1981 must be a mistake, as these whales have no teeth.

Conservation Measures Countries of origin are: Japan, R Korea, DPR Korea, USSR, USA, Canada, Denmark (Greenland), Norway (Spitzbergen and Jan Mayen) and Iceland.

The bowhead is given full protection under CRW, ARW, IWC, NPWH and CITES. All countries of origin, except DPR Korea, are IWC parties; all except Iceland and DPR Korea are CITES parties, and all except USSR, DPR Korea and Iceland are CRW parties. The USA is also party to NPWH. More than 100 countries protect the bowhead under the five agreements. Aboriginal taking, however, is the present form of exploitation, and most of these agreements, except IWC, are, for practical purposes, inoperative at this level. All the countries of origin (except DPR Korea) have protective national legislation, mainly through their membership of international agreements.

Wrangle Island State Reserve and Sikhote-Alinsky State Reserve in the USSR are within the range of this species. The National Parks in the Norwegian Spitzbergen Islands may protect the Spitzbergen breeding area. The Greenland National Park may also protect critical habitat; any form of hunting and fishing there is prohibited. The participation of the hunters in managing the whale population and the hunt, through the Alaska Eskimo Whaling Commission, is probably the most important development for the conservation of this species. If this level of control and research can be maintained or improved, the species and the traditional whale hunting may survive.

Captive Breeding The problems of providing suitable habitat and nutrition are insurmountable for all practical purposes. Captive breeding could therefore never play a part in the conservation of this species.

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NORTHERN RIGHT WHALE | **ENDANGERED**

Eubalaena glacialis (Muller, 1776)

Suborder MYSTICETI | Family BALAENIDAE

Summary The northern right whale may be the most endangered of the large whale species. It was hunted in the North Atlantic from the 10-11th centuries. Catches peaked between the 13-17th centuries but continued, at a low level, into the 20th century. Catching in the North Pacific from about 1840 had depleted the populations by the turn of the century. Tens of thousands of whales were caught over the years, but records are not sufficiently complete for original populations to be estimated accurately. Although right whales have been increasingly widely protected for the last 50 years, these populations have so far shown no evidence of recovery.

There may be only a few hundred individuals in the North Atlantic, and even fewer in the North Pacific. The catches of a few animals after the main exploitation ceased are likely to have had a significant detrimental effect on such very small populations. Collisions with shipping and entanglement in nets may be a source of mortality, and ship and boat traffic may also be excluding them from some former calving areas. In order to give the species the best possible chance of recovery, it is important that protection is extended and enforced to ensure that no more animals are taken. More research is required to identify and counter any continuing threats to its survival. Critical habitat, such as calving and feeding areas, should also be protected.

Distribution The question of how many species of *Eubalaena* should be recognised is not yet fully resolved. The Workshop on the Status of Right Whales (IWC, 1986) recommended that further study of the morphological differences between the Northern Hemisphere *E. glacialis* (Muller, 1776) and Southern Hemisphere *E. australis* (Desmoulins, 1822) be undertaken. *E. japonica* (Lacepede, 1818), sometimes used to refer to the North Pacific populations, is a junior synonym of *E. glacialis*.

Because of geographical barriers, differences in timing of breeding between the Northern and Southern Hemispheres, and a possible discontinuity across the Equator, there appears to be no significant mixing between North Atlantic, North Pacific and Southern Ocean populations of *Eubalaena*. For the present purpose, following recent practice (e.g. Cummings, 1985), *Eubalaena* spp. are reviewed by Hemisphere.

Northern right whales are found between about 25°N and 60°N. They move to northern feeding grounds in spring, returning to temperate waters in autumn and winter. They are separated from the ice-dwelling bowhead (*Balaena mysticetus*), whose southern limit is the northern limit of the northern right whale. It has been suggested, from observations of the southern right whale (*E. australis*), and from the catch history, that these whales do not travel the long distances indicated by the full north-south range of the species. Relatively small population units may exploit particular north-south summer and winter areas, relatively close together. Bays and other sheltered areas are used for calving (IWC, 1986).

North Atlantic The northern right whale occurs in the Atlantic Ocean, from the north-west coasts of Africa, Madeira, the Azores, Bermuda and Florida to Spitzbergen, Jan Mayen, Iceland, Newfoundland and the Davis Strait. The general limits of this whale are said to be 30°N to 62°N, although there is some historical evidence that they were found further south, in the Gulf of Mexico. There was also a fishery in a calving area off the northwest coast of Africa (Cintra Bay area) at 23°N, 19°15'W. Catches may have been made a little further north, but it is difficult to distinguish between northern right whale and bowhead catches in the early records (IWC, 1986). The Gulf of Maine, the Bay of Fundy and the Cape Cod area are now important feeding areas (Reeves *et al.*, 1978; Cummings, 1985), and there is possibly a calving area off Florida (IWC, 1988).

North Pacific In the North Pacific, the northern right whale is found within the temperate zones from Alaska and the Aleutians to Oregon and California, and from the Gulf of Anadyr and the Sea of Okhotsk to the Yellow and China Seas. The northern limits are the St. Lawrence and St. Matthew Islands and Cape Prince of Wales, at about 60°N. The southern limits are roughly 28°N along the coast of America, 25°N along the Asian coast and 20°N along the coast of Hawaii (Tomilin, 1957). Evidence from catch records indicates a continuous distribution across the North Pacific north of 35°N, which calls into question the conventional division of the populations into eastern and western stocks. Although no evidence of coastal calving grounds in the North Pacific has yet emerged, it seems unlikely, in view of the behaviour of *Eubalaena* spp. in other areas, that calving takes place here in open waters (IWC, 1986).

Population The catch histories for most areas are very long and incomplete. It is therefore difficult to estimate initial populations. However, tens of thousands of whales have been caught over the years, and only a few hundred are now left, in total. There have been no real signs of any population increase.

North Atlantic The North Atlantic population is usually regarded as divided into at least eastern and western stocks, although it has been suggested that *Eubalaena* spp. should be separated into relatively small stock units for management purposes (IWC, 1986).

There are no estimates of initial population, because the catch history is incomplete, with the highest catches occurring before 1800. Current population estimates for the Northwest Atlantic from line transect aerial surveys between Nova Scotia and Cape Hatteras in 1979-81 are 380-688 and 493-1100 (95% confidence limits) (IWC, 1986). The northeast Atlantic population is believed to be near extinction, possibly represented by no more than a few individuals (IWC, 1986).

Three individuals caught off Madeira and a few sightings - one in 1977 in the Bay of Biscay being the only sighting known there this century - have been the only indications in the past 30 years of the survival of the eastern stock (IWC, 1978; IWC, 1981). At least 150 individuals in the northwest Atlantic have been individually identified, but no trends in abundance can be discerned (IWC, 1986).

North Pacific There are no estimates of original or current population. The stock in the northeast Pacific is believed to be near extinction, possibly represented by no more than a few individuals. There are no trends unrelated to effort in the available sightings data (IWC, 1986). Wang (1984) records two animals taken by Japan in the Yellow Sea in 1944 and unspecified captures by Taiwan. In January 1973, two were sighted in the northern Yellow Sea, and another a little farther south in December 1977. Thirteen animals were taken under Scientific Permit by Japanese scientists in the 1960s (Omura *et al.*, 1969). In 1974, 40-45 were observed in a vessel survey of the Okhotsk Sea in August (Berzin and Doroshenko, 1981). Four animals stranded on the Commander Islands in the northwest Pacific between 1976 and 1984 (IWC, 1988).

Habitat and Ecology Maximum reported lengths for females are: North Atlantic - 18m (Thompson, 1928 - probably measured along the body contour) or 16.5m (Andrews, 1908); North Pacific - 18.3m (Klumov, 1962). Maximum reported lengths for males are: North Atlantic - 12.9m (Allen, 1916); North Pacific - 16.4m (Omura *et al.*, 1969) or 17.1m (Klumov, 1962). North Pacific animals are consistently larger than those in other oceans. There are no estimates of natural mortality rates (IWC, 1986).

Northern right whales feed mainly on copepods, for the most part from the genus *Calanus*. Collett (1909) identified *Thysanoessa inermis* in the stomach contents of whales killed in the northeast Atlantic. Prey species in the North Pacific, based on stomach contents, include *Calanus plumchrus*, *C. crisatus*, *Euphausia pacifica* and *Metridia* spp. (Omura, 1958; Klumov, 1962; Omura *et al.*, 1969). Observations near the Massachusetts coast indicate that these whales feed on aggregated food; slicks at the surface and patches underwater. For the most part they do not feed at the surface, except on calm days. They have been observed feeding on zooplankton with *Balaenoptera borealis* while ignoring abundant fish being eaten in the same vicinity by *B. physalus* and *Megaptera novaeangliae* (IWC, 1986; Watkins and Schevill, 1976).

Few data exist on the reproductive biology of the right whale. One study indicates that, in the North Pacific, males are sexually mature at 15m, and females at 15.5m (Omura *et al.*, 1969). One identified cow from the western North Atlantic is known to have had a three-year calving interval. Mean length at birth is of the order of 6m, and births occur mainly from December-April (IWC, 1986). Females have a very strong protective maternal instinct, which was sometimes exploited by early whalers, who secured the calf first, knowing that the mother was then unlikely to escape. Right whales generally travel alone or in groups of 2-3, except in areas of high food concentrations, where they herd (Tomilin, 1957).

Groups of northern right whales have been observed to alternate at the surface, with only one animal visible at any one time although several individuals may be present. Unless the identity of each animal is verified at each sighting, such behaviour could lead to underestimates of the number of animals in the vicinity (Watkins and Moore, 1983).

Threats - Historical This species has a very long history of exploitation for whalebone, meat and oil, which developed from catching by local people for their own use into the first commercial whaling industry.

North Atlantic The Basque fishery in the Bay of Biscay began in the 10th or 11th centuries, taking, it is estimated, less than 100 per year. It more or less ended in about 1720, although four animals were caught in this area as late as the 20th century. It is generally said that scarcity of whales in the Bay of Biscay led the Basques to move their whaling activities to Newfoundland and Labrador from about 1530. This is also usually regarded as the beginning of commercial whaling. It is estimated that 25,000 to 40,000 whales were taken between 1530 and 1610. The fishery more or less ceased after 1620, but small catches were made up to 1713. The hunt then moved north, where the main catch was bowhead whales, although northern right whales were also taken. It is estimated that between 1613 and 1718, a minimum total of 2,214 were caught off Spitzbergen and in the seas around Iceland by French whalers. The catches by Spanish, Dutch, German and British whalers are not known. After 1719, the hunt was mainly in the Davis Strait, where French whalers took an estimated 598 between 1719 and 1766. The catches by Dutch, German, Danish and British vessels are unknown. Whaling also took place from Long Island (New York) from 1656. The estimated annual catch from

1650-99 is 20-25. Catches of 111 are recorded for 1707, 17 for 1708, *circa* 27 for 1711, 40 for 1721 and 11 for 1732/33. Although whaling continued, no data are available from 1750-1820. Whaling along the Massachusetts coast began in the early 17th century, reaching a peak in the early 18th century. The average catch from 1800 to 1913 was three whales a year. A total of 144 are recorded from 1820 to 1924. Whalers from the USA took an additional 175 animals in the North Atlantic from 1855 to 1899 (IWC, 1986).

In the northeastern Atlantic 137-140 animals were taken between 1900 and 1967. Most of these animals were taken by land stations on the UK coasts between 1900 and 1914. This small stock was one of the last groups remaining on the eastern side of the Atlantic (Thompson, 1928). The last northern right whales to be taken in the North Atlantic appear to be one animal taken in Madeira in 1959, and two in 1967 (IWC, 1986).

North Pacific A minimum of 15,451 were taken in the North Pacific between 1840 and 1969, by whalers from the USA, France, UK, Germany, Hawaii and USSR. Japan, Norway, the Netherlands and Taiwan were also involved, but the level of catch is not known (IWC, 1986).

Threats - Present The main exploitation was ended by about the 1920s, although even at the end of this era right whales were more valued by whalers than blue whales. Northern right whales have been increasingly widely protected for 50 years, yet the populations have given little indication of recovery. The Workshop on the Status of Right Whales considered a number of factors which may potentially affect recovery (IWC, 1986).

It had been suggested that the depletion of right whale stocks allowed the sei whale (*Balaenoptera borealis*), a copepod specialist, to expand its range and increase its population size, effectively preventing the right whale from recovering. However, it was concluded that too little is known about the feeding behaviour of both species to address this question properly (IWC, 1986).

Because so many populations of right whales occur (or occurred) in coastal waters of temperate regions and appear to depend on inshore areas for reproductive activities, they may be more vulnerable to the detrimental effects of human activity than are many other cetaceans. Right whale mortality or serious injury through several human activities is known. Off eastern North America, seven animals are known to have become entangled or trapped in fishing gear, and one animal may have died. Collisions with ships or ship propellers may have been involved in the death of two animals, and scars on other animals in the North Atlantic may have been caused by propellers. The whales may now be effectively excluded by shipping, geological change and other factors from some bays known or suspected to be former calving areas (for example Delaware Bay in eastern North America, and certain former lagoons in southern France, Spain and North America). An alternative explanation for the absence of animals in former calving areas is that the whole stock was exterminated by whaling (IWC, 1986).

The effects of activities associated with offshore oil and gas development on northern right whales remain largely unknown, although they are being studied for other cetacean species. Several areas were identified off North America in both the Atlantic and Pacific Oceans where these activities take place, or are planned, and may affect right whale habitat (IWC, 1986).

The proposed tidal power generating plant in the Bay of Fundy would involve damming a bay which is important habitat. Concern was also expressed about thermal pollution from the nuclear power plant at Pt. Lepreau, New Brunswick, adjacent to an important summering ground (IWC, 1986).

Although the exact magnitude and nature of disturbance from increasing levels of boat traffic cannot be assessed, the Workshop was concerned about the potential effect of ship and small boat traffic in Cape Cod Bay (IWC, 1986).

The following transactions appear in CITES records under *Balaena glacialis*: 1979 - bone pieces from USA to Canada for scientific purposes; 1981 - 15 carvings from Canada to Israel. Quite extensive trade is recorded under *Balaena* spp., mainly carvings from Canada to other countries. There are further movements listed under *Balaenidae* spp., again mainly originating in Canada. It is not clear whether these are northern right whale materials, or from the bowhead (*Balaena mysticetus*), or mixed consignments. It is also not stated whether the material is from old, newly caught or stranded specimens, or the size of the items (one whale skeleton could furnish a large number of small carvings). The record of a *Balaenidae* spp. tooth exported from the UK to Australia must be a mistake, as these whales have no teeth (CMC, 1987). The species is relatively easy to catch with primitive equipment, and can be in danger of occasional catching wherever it appears. The distinctive appearance in the water leaves little excuse for accidental catching through mistaken identity.

Conservation Measures Potential countries of origin include all those with coastlines between about 25°N and 60°N. Reported locations so far include: Belgium, Canada, China, DPR Korea, R Korea, Denmark (Greenland, Faroes), France, FRG, GDR, Iceland, Ireland, Italy, Japan, Mexico, Morocco, Netherlands, Norway (Spitzbergen, Jan Mayen), Portugal (Azores, Madeira), Spain (Canaries), USSR, UK (Bermuda), Bahamas and USA.

CRW, ARW, IWC, NPWH and CITES fully protect the northern right whale. The earliest prohibition on catching was under CRW in 1935. The species is listed as PS by IWC and is on Appendix I of CITES. More than 120 countries protect under these agreements.

The vast majority of national legislation protecting this species is derived from membership of international agreements, and comparatively few countries appear to have no provisions for protection. At least USSR, USA and Canada have National Parks in relevant areas.

In spite of the very wide national and international protection for over 50 years, the species has shown little sign of recovery. In this respect, the taking of a few individuals in recent years by countries not at that time party to international protective agreements, or under Scientific Permit, may have been critical setbacks to the extremely depleted stocks.

The Workshop (IWC, 1986) recommended that no killing of northern right whales should be permitted, because the stocks have so few individuals that even a small kill would adversely affect the rate of recovery. They also noted that, because the coastal distribution makes right whales especially vulnerable to industrial and other disturbances, areas critical to their survival and continued recovery, particularly calving and feeding grounds, should be managed to exclude the effects of such disturbances. Much research was also recommended, directed at obtaining information on calving interval, age at sexual maturity, movements, population segregation and behaviour, population trends, feeding strategies and the effects of disturbance. Much of this work relies upon photo-identification techniques.

Further work on historical catch records was recommended, in order to obtain information on stock identity, initial population size and locations of calving grounds.

To give the northern right whale the best chance of recovery, comprehensive protection is essential. The keys to this lie in control via the flag country of exploiting ships on the high seas, through national controls to prevent taking or disturbance within territorial waters and EEZs or by land based operations catching on the high seas, and by trade controls in all countries. Every country in the world, therefore, should be encouraged to have adequate legislation for these purposes.

Captive Breeding It is quite impractical to keep these animals in captivity, therefore there is no scope for conservation through captive breeding.

Remarks This species is sometimes, incorrectly, described as *Balaena glacialis*.

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SOUTHERN RIGHT WHALE **VULNERABLE**
Eubalaena australis (Desmoulins, 1822)

Suborder MYSTICETI Family BALAENIDAE

Summary Although still small compared with their original levels, there is evidence of recovery in at least two populations of the southern right whale. Nearly 40,000 are recorded caught between 1785 and 1939, of which over 25,000 in the period 1820-1840 alone, but records may be incomplete. The current population is thought to total at least 1,500. In order to give the species the best possible chance of recovery, it is important that protection is extended and enforced, to ensure that no more animals are taken, and that critical habitat, such as calving and feeding areas, is protected. Despite the encouraging signs of recovery in some areas, this is not yet sufficient to justify removing the species from the Vulnerable category.

Distribution The question of how many species of *Eubalaena* should be recognised is not yet fully resolved. For the present purpose, following recent practice (e.g. Cummings, 1985), *Eubalaena* spp. are reviewed by Hemisphere (see northern right whale review for further discussion).

The southern right whale has a circumpolar distribution, from about 20° to 50°S. The summer is spent in the Southern Ocean, and the whales return to warmer waters in winter. Information on right whales was extensively reviewed by the Workshop on the Status of Right Whales (IWC, 1986). They attempted to identify the stock structure of the southern right whale from historical catch records, and from recent observations.

South Pacific/Indian Ocean Information available from catch records on southern right whale distribution off the Chilean coast indicates that the population here is disjunctive from that near New Zealand and from those along the east coast of South America. It has been provisionally recognised as a separate stock.

The population found near the Campbell and Auckland Island groups may also be distinct, as it has a separate catch history from the New Zealand stock. Peak catches were made from mid-May to the end of September, which corresponds with the breeding season. However, the timing of appearance of animals at Campbell Island overlaps considerably with that of the more northerly whaling grounds near New Zealand. This stock may be in a similar situation to those centred on other small mid-ocean island groups, such as Tristan da Cunha, in that it may be distinct, but it is difficult to know whether to assign offshore catch records to such local stocks or to adjacent major stock units.

The whales found near New Zealand and the Kermadecs may be a stock unit. There is the same seasonality of occurrence between the two areas, and a discontinuity in catches between them and the Australia/Tasmania coast, especially either side of Cook Strait.

The whales occurring in coastal waters of Tasmania, Victoria, eastern Australia, New South Wales and South Australia appear to form a single stock unit, the Southeast Australia Stock. Calving takes place in embayments, and there are summer movements offshore. There is no discontinuity in distribution or catch records to suggest a partitioning of stocks between this region and the coast of western Australia, although an arbitrary boundary at 135°E is useful for statistical purposes when analyzing catch records. The westward limit of this Southwest Australian Stock is taken to be 90°E.

The central and western Indian Ocean catches were concentrated near sub-Antarctic island groups. There is no information available at present on calving grounds. Three provisional stocks were recognised: 1. Crozet, 2. Kerguelen (summer) and 3. Amsterdam/St Paul/Central Indian Ocean (late spring). The populations around these islands do not appear to be connected to Delagoa Bay and other known calving grounds (IWC, 1986).

South Atlantic Although the calving grounds off South Africa and eastern South America are traditionally regarded as belonging to separate populations, movement of identified individuals (through natural markings) from Peninsula Valdes, Argentina to Tristan da Cuñha, and from Gough Island (near Tristan da Cuñha) to the South African coast suggest that at least some interchange occurs (Best, 1990). Although catch records may support a case for dividing the stocks off South Africa into two (dividing at about 20°E), there is at present a generally continuous string of calving bays linking the populations on the east and west sides of the Cape of Good Hope.

The well documented off-shore whaling grounds in the South Atlantic are difficult to assign to particular major stocks: for example, if Tristan da Cuñha is a separate calving area, catches between here and South Africa can be assigned to either stock.

There are two views about stock identity off eastern South America: the case for a single stock is based on observations of identified individuals, and the case for recognising more than one stock is based on analysis of catch data (IWC, 1986).

Population There are no good estimates of initial population for any stocks of southern right whale, because the catch histories are incomplete. However, the populations were reasonably large, and are now very small indeed. For example, at least 17,400 right whales were taken in the South Atlantic during the 10-year period 1830-1839. If this were assumed to indicate an initial population of at least 17,000 whales, the combined best estimates of the present population off South America and South Africa would be a small fraction of the initial level.

South Atlantic Sightings from annual systematic aerial surveys of the South African coast show a positive trend in the number of whales sighted and in the number of calves sighted from 1971 to 1982. The observed annual rate of increase in calves was 7.3 ± 1.3% (IWC, 1986). The population of mature females off South Africa has been estimated as 289 (range 279-302). It has increased exponentially since 1971 at an estimated annual rate of 6.8% (± 1%) (IWC, 1988).

Based on techniques using re-sightings of known individuals, the population wintering off Peninsula Valdez, Argentina has been estimated at about 1,200 in 1986, increasing at the rate of 7.6% (± 1.7%) p.a. Since not all individuals appear in the area every year, the number present in any given winter are considerably less than this figure. Annual calf production in the population is estimated at 99 per year (± 18) in total, but these do not necessarily all occur in the study area, since the number actually observed is only about half this figure (Payne *et al.*, 1990).

The history of the Tristan da Cunha population has recently been described (Best, 1987). Exploitation began here about 1819/20, but the main phase was from 1830/31 to 1834/35, when an estimated 2,500 animals were taken by French and American whalers. Despite obvious depletion, catches continued to be taken from this stock throughout the remainder of the 19th century, some perhaps incidental to the use of Tristan da Cunha as a refreshment station. Southern right whales may have begun to reappear at the islands in the 1890s, and by the 1940s and 1950s whales were numerous enough to be considered a nuisance or 'almost a pest'. Three episodes of illegal exploitation of southern right whales in Tristan waters by USSR fleets in the 1960s are reported. Shipboard surveys of the archipelago in the early 1970s, and aerial surveys from 1983 to 1986, indicated that the population was small, and much reduced from the level reported in the 1950s.

The apparent abundance of right whales at Tristan da Cunha in the 1940s and 1950s is in strong contrast to the condition of nearly all other southern right whale stocks. This recovery seems to have been possible because this population was not subjected either to a shore-based fishery in the late 19th century, or to a phase of coastal modern whaling in the early 20th century. The first decade of modern whaling in the Southern Hemisphere seems to have been particularly destructive for right whales (which were still more valuable at that time than any other species), and an estimated total of 1,230 were killed between 1904 and 1936. The apparent failure of other right whale stocks to recover under protection may therefore have been the result of extreme depletion in 1935, so that any subsequent recovery was initially undetectable (Best, 1987).

South Pacific/Indian Ocean Incidental sightings off Australia show an increase, particularly since 1975, but effort cannot be standardized. Aerial survey results from the south coast of western Australia seem to indicate an overall increase since 1976 (IWC, 1986). Aerial surveys off Western Australia reported 148 animals (including 59 calves) in 1986 (but including some animals recorded more than once) (IWC, 1988). The largest number seen on an individual survey flight in 1987 was 79, including 13 calves. Since 1977, the stock has appeared to increase at an annual average rate of 5.2-16.2% (IWC, 1989).

At least 50, and possibly double that number visited the South Australian coast in 1985 and 1986. More than 200 animals have been identified so far off southern Australia from head callosity photographs (IWC, 1987). There were 57 sightings here in 1987, including 16 calves. Calving was also recorded off New South Wales in September 1987, and for the first time in recent years off Tasmania, where more than 40 other sightings were made between June and October (IWC, 1988).

There has been an apparent increase in sightings off New Zealand and the Auckland Islands, but the nonsystematic observer effort prevents any definite conclusions about trends in stock size (IWC, 1986). Four hundred and fifty two sightings are reported at Campbell Island and around New Zealand between January 1986 and December 1987 (but it is not clear whether some animals were recorded more than once) (IWC, 1988).

No information is available for the central Indian Ocean.

Southern Ocean Japanese sightings data from the Southern Hemisphere provide interesting information on summer distribution (IWC, 1986). Four southern right whales were sighted by Japanese research vessels on the 1986/7 IDCR cruise, in Area II. Cruises from 1978/79 to 1983/84 recorded two animals very close to each other in Area I, in early January, and one off Argentina in December (IWC, 1987). One was sighted in Area III on the 1987/88 cruise (IWC, 1988). (See maps of IWC Management Areas in Introduction).

Habitat and Ecology Maximum reported lengths for females in the Southern Hemisphere are 16.5m (IWC, 1986) or 15.6m (Whitehead and Payne, 1981). The maximum reported length for males is 15.2m (Lonnberg, 1906).

Using individuals which have been individually identified as calves in the population wintering of Peninsula Valdes, Argentina, and which are therefore of known age, Payne *et al.* (1990) found that the youngest age at first calving was 7 years, but that the majority of first calvings occur at 9 years of age. The mean interval between calvings for mature females was 3.3 - 4.1 years: the most common inter-birth interval was 3 years, while shorter intervals were rare. Not all mature females in the population visit the area between calving years, and it is not certain that all visit the area even in years when they calve.

The data were insufficient for the estimation of natural mortality rates for adults and sub-adults in the Peninsula Valdes population (95% confidence limits 0-5% annually). However, an average natural mortality rate of less than 0.6% is required to account for the apparent rate of increase in the population if it is assumed to be generated entirely by the population's own production (Payne *et al.*, 1990).

There appears to have been a change in the migration pattern of southern right whales around Campbell Island. They now arrive two months later in the year than they did in 1911-1912: July instead of May (Gaskin, 1972).

There is relatively little information on food and feeding behaviour in the Southern Hemisphere. The only two prey species identified in the literature are *Euphausia superba* (Matthews, 1938) and *Munida gregaria* (Matthews, 1932). Lonnberg (1906) mentions 'krill' in the diet of southern right whales. Several recent observations have been made of these whales apparently feeding on *Munida gregaria* and ichthyoplankton at Campbell Island; *Calanus* spp. at Peninsula Valdes and *Munida gregaria* larvae and ctenophores at Golfo Nuevo (IWC, 1986).

Threats - Historical This species has a long history of exploitation for whalebone, meat and oil.

South Atlantic Whaling in the South Atlantic began in 1775, but catches before 1785 are not known. Between 1785 and 1939 a minimum of 38,609 animals were taken by French, USA, and South African whalers (including 386 taken by the international whaling fleets in the 20th century). Other catches are known to have occurred, e.g. by UK and Brazil, but have not yet been investigated. The largest catches were made before about 1840, although the fishery continued up to (and, in some cases beyond) the beginnings of international protection in 1935 (IWC, 1986). The history of the fishery at Tristan da Cunha is given above.

South Pacific Whaling began here in the 1790s, but only records from 1815 onwards have so far been investigated in detail. A minimum total of 38,860 southern right whales were taken between 1815 and 1969. Most catches occurred before about 1850. France, USA, UK and Germany were mainly involved, and much whaling took place from Australia and New Zealand. Catches from Chile and Peru continued from about 1915 to the late 1960s, with a total of 161 whales taken. A few animals were also caught from New Zealand until the late 1950s (IWC, 1986).

Indian Ocean There was some local whaling around Madagascar in the mid-1750s, but the main exploitation began in the late 1780s. Whalers from at least France, USA, UK, South Africa and western Australia were involved. Most catches took place before about 1840. A minimum total of 12,596 animals are known to have been taken between 1830 and 1939 (this does not include catches by UK and French whalers) (IWC, 1986).

Threats - Present Southern right whales have now been protected for almost fifty years and yet their recovery, such as it is, could hardly be compared to the remarkable recovery of the gray whales (see review), which have been protected for a similar length of time. The Workshop considered a number of possible factors which may potentially affect recovery (IWC, 1986). These are discussed in detail in the northern right whale review.

Some of the problems noted for the northern right whale also affect the southern right whale. They suffer from entanglement in fishing gear, collisions with ships or with ship propellers, and habitat problems. They may now be effectively excluded by shipping from some bays known, or suspected, to be former calving areas; for example Table Bay in South Africa, Wellington Harbour in New Zealand and Derwent River in Tasmania. An alternative explanation for the absence of whales in these areas is that the entire population was exterminated by whaling. The Peninsula Valdes area in Argentina may eventually be developed, but efforts at oil and gas exploitation there are not yet under way. There is also a proposal to dam this bay to provide electrical power through a tidal generating plant. The Workshop was concerned about the potential effect of increasing levels of ship and small boat traffic in certain South African bays, and in the waters of Peninsula Valdes (IWC, 1986).

Southern right whales have other problems too. Wounds thought to have been made by harpoons or hand lances are occasionally seen on southern right whales off Argentina and Brazil. A missile testing range is being planned by South Africa for an area immediately adjacent to a southern right whale area in which 25-30% of the known calving off South Africa occurs. Annual shelling exercises on Peninsula Valdes have recently been modified to prevent disturbances to the whales during the calving season (IWC, 1986).

The stranded animal killed in Brazil in 1972 (IWC, 1977) was probably used locally for meat and oil. The CITES trade records do not mention *E. australis*, and as most trade originates in the Northern Hemisphere it seems unlikely that any entries under *Balaena* spp. or *Balaenidae* spp. refer to the southern right whale, except possibly for one bone carving sent from Indonesia to Canada in 1984 (which appears to have been recorded twice). However, since a carving was sent from Canada to Indonesia in 1983, it is possible that the 1984 transaction was merely the return of a Canadian specimen (CMC, 1987).

The species is easy to catch with primitive equipment, and can be in danger of occasional catching wherever it appears. The illegal whaling in the 1960s off Tristan da Cunha illustrates the difficulties of enforcing protection in remote areas. The distinctive appearance in the water leaves little excuse for accidental catching through mistaken identity.

Conservation Measures Potential countries of origin include all those with coastlines from about 20°S to 50°S. Reported locations so far include: Argentina, Australia (including islands), Brazil, Chile (Easter Island), France (Crozet Islands, Kerguelen, St Paul, Amsterdam Islands), New Zealand (Campbell Island), Norway (Bouvet Island), South Africa (Marion Island, Prince Edward Island), UK (Tristan da Cunha, Falklands Islands, South Georgia, South Shetlands), Uruguay.

CRW, ARW, IWC, NPWH and CITES fully protect the right whale. The earliest prohibition on catching was under CRW in 1935. They are on Appendix I of CITES and listed as PS by IWC. More than 120 countries protect under one of these agreements.

The vast majority of national legislation protecting this species is derived from membership of international agreements, and comparatively few countries appear to have no provisions for protection. Under the South African National Parks Act 1962 three areas are protected within the range of the southern right whale. Marion Island Reserve, established in 1947, and the adjacent Prince Edward Island, 1948, are strict reserves. Prince Edward Island is uninhabited. The Tsitsikama Forest and Coastal National Park on the Indian Ocean Coast, a strict reserve established in 1964, mentions *Eubalaena australis* among the fauna (IUCN, 1975). The entire Peninsula Valdes coast in Argentina is now a provincial nature reserve (IWC, 1986).

The Workshop (IWC, 1986) recommended that no killing of southern right whales should be permitted, because the stocks are so low that even a small kill would adversely affect the rate of recovery. They made a number of other recommendations for habitat protection and additional research, which are summarised in the northern right whale review.

The IUCN/SSC Cetacean Specialist Group Action Plan notes that the status of southern right whales in the western South Atlantic, the recovery of this species in the eastern South Atlantic and off East Africa, and stock identity in the Indian Ocean require monitoring. This species will also be included in general projects, such as monitoring local subsistence fisheries, interactions with other fisheries and the effects of pollution on cetaceans (Perrin, 1989).

To give the southern right whale the best chance of recovery, comprehensive protection is essential. Continued protection and strong discouragement of occasional takes are important, as the history of the Tristan da Cunha stock illustrates. The keys to this lie in control via the flag country of exploiting ships on the high seas, through national controls to prevent taking or disturbance within territorial waters and EEZs, or by land based operations catching on the high seas, and by trade controls in all countries. Every country in the world, therefore, should be encouraged to have adequate legislation for these purposes.

Captive Breeding It is quite impractical to keep these animals in captivity, therefore there is no scope for conservation through captive breeding.

Remarks The species is sometimes, incorrectly, described as *Balaena australis*. It is also sometimes not treated separately from the northern right whale, and both are reviewed under *Eubalaena glacialis*.

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PYGMY RIGHT WHALE **INSUFFICIENTLY KNOWN**
Caperea marginata (Gray, 1846)

Suborder MYSTICETI Family NEOBALAENIDAE

Summary Although the pygmy right whale is rarely reported from observations at sea, stranding records indicate that it may be more common. Little is known about its abundance or status. It is protected under IWC and CITES, and does not appear ever to have been a target of directed exploited, although some incidental takes have been recorded.

Distribution The pygmy right whale is found in temperate waters of the Southern Hemisphere, between about 31°S and 52°S. It is circumpolar in distribution, north of the Antarctic Convergence. The 20°C summer isotherm may mark the northern limit of distribution, and the 5°C isotherm the southern limit. Most records are from strandings in New Zealand, South Africa and southern Australia. There are also reports from the Falkland Islands and South America, as well as a few sightings from the South Atlantic and Indian Oceans (Baker, 1985; Leatherwood and Reeves, 1983). Pygmy right whales may be confused at sea with minke whales (Ivashin, Shevchenko and Yukov, 1972).

It has been thought that there may be some seasonal migrations, perhaps juveniles moving into inshore waters in spring and summer in South Africa (Ross, Best and Donnelly, 1975), but the number of dated records is too small to indicate any definite migratory pattern. Nicol (1987) reports that strandings occur in Tasmania over much of the year; he reviews the Tasmanian records, and provides a distribution map. The species has recently been reviewed by Baker (1985), who gives a map of known records up to that time.

Population There are no population estimates, and the species has been regarded as comparatively rare. However, many sightings of this whale at sea have probably been incorrectly logged as minke whales, since the key field marks differentiating between the two species (the jaw configuration of the pygmy right whale and the white flipper band present in some Southern Hemisphere minke whales) may not always be readily observable (Leatherwood and Reeves, 1983). Pygmy right whales have not, so far, been mentioned in reports from the IWC/IDCR cruises, perhaps because of the identification problems. Unfortunately, therefore, it would appear that this data base will be unable to provide any population estimates.

Nicol (1987), after carefully collecting all known stranding records in Tasmania, found that the pygmy right whale was the most frequently stranding species on these coasts, with 32 events representing 34 animals. He also notes one capture, which represents the only known sighting in these waters. This analysis supports the idea that the pygmy right whale may be more common than previously thought, and also confirms the under-reporting of sightings at sea.

Habitat and Ecology The longest recorded female was 6.45m, the longest recorded male 6.09m, perhaps indicating sexual dimorphism (Baker, 1985). Very little is known about the life history and behaviour. Ross, Best and Donnelly (1975) summarised information available at that time, including theoretical calculations of lengths at birth and weaning. They also described a series of underwater films and photographs of the living animal. Baker (1985) summarises more recent information. Pregnant females

6.00-6.45m long have stranded on the Tasmanian coast in June and September and have been captured in the South Atlantic in November and December. The foetuses from these females ranged from 24 to 600cm in length. The length at sexual maturity is not known (Ivashin, Shevchenko and Yukov, 1972; Munday, Green and Obendorf, 1982).

Length at birth is not known, but the 2.7-3.5m juveniles so far reported have not been newborn. Calculations based on data from other baleen whales indicate lengths of 1.6-2.2m at birth and 1.9-3.5m at weaning (Ross, Best and Donnelly, 1975). A 2.0m foetus was reported from a 6.0m female (McManus *et al.*, 1984).

Two pygmy right whales caught in the South Atlantic had copepods of the genus *Calanus* in the stomach (Ivashin, Shevchenko and Yuchov, 1972). No other information on food habits is available.

Schools of up to eight animals have been observed, but most encounters have been with lone individuals or pairs. Association with dolphins and with a female sei whale with a calf was reported by Ivashin, Shevchenko and Yuchov, (1972). Hector (1875) described a female pygmy right whale captured with a large group of pilot whales.

Speculation that the whale is a very long diver (Davis and Guiler, 1957) is discounted by the observations of Ivashin, Shevchenko and Yuchov, (1972) and by those of Ross, Best and Donnelly (1975). The behaviour is generally inconspicuous, another factor which may account for the rarity of observations at sea (Leatherwood and Reeves, 1983).

Most discussions of the interspecific relations of the southern baleen whales neglect the pygmy right whale (e.g. Kawamura, 1978) but, sharing the copepod food species, reduction of the larger baleen whale populations in the area might have improved the situation for the pygmy right whale, favouring population growth.

Threats Some incidental mortality from coastal netting operations has been reported in South Africa (Leatherwood and Reeves, 1983), but otherwise there are no known threats. There are no records of exploitation, and only two specimens have been taken for research (Ivashin, Shevchenko and Yuchov, 1972).

Conservation Measures Putative countries of origin include all those with coastlines between about 31°S and 52°S. Locations so far reported include: South Africa, New Zealand, Australia, UK (Falkland Islands), Chile, France (Crozet Islands) and Argentina. The pygmy right whale is fully protected under CRW and IWC. It is included in CITES Appendix I. No international trade is recorded (CMC, 1987).

The pygmy right whale is expressly protected by national laws at least in Australia, New Zealand, Argentina and the Falkland Islands. Strict reserves in South Africa protect areas where it has been reported. Very many other countries throughout the world protect the pygmy right whale through their membership of CRW, IWC and CITES.

The IUCN/SSC Action Plan contains no specific projects relating to the pygmy right whale, but it will be included in general projects, such as monitoring incidental takes (Perrin, 1989). The pygmy right whale has been given complete protection by many countries for many years, although it seems never to have been exploited.

Captive Breeding Two animals were temporarily restrained with nets, examined, and later released in South Africa (Ross, Best and Donnelly, 1975). This appears to be the nearest any members of this species have been to captivity. The pygmy right whale may be perhaps small enough for a few specimens to be maintained in captivity, although providing suitable food may be an insurmountable problem. It does not appear likely that maintaining a colony of sufficient size for conservation through captive breeding would be feasible.

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GRAY WHALE **UNCLASSIFIED**

Eschrichtius robustus (Lilljeborg, 1861)

Suborder MYSTICETI Family ESCHRICHTIIDAE

Summary Although the North Atlantic stocks of the gray whale are Extinct, and the western North Pacific stock has been reduced to extremely low levels, the eastern North Pacific stock has recovered well under partial protection, while sustaining a regular take by a coastal whaling operation in the Chukchi Sea. Since only one viable stock of this species now remains, particular care is needed to prevent any encroachment on critical habitat such as the breeding areas, as well as to monitor any other potential threats. The western North Pacific stock is still at an extremely low level and there is no definite evidence of any recovery. The strictest protection throughout the western stock range is required if there is to be any chance of sustained recovery. Although two of the three former gray whale populations are Endangered or Extinct, the species as a whole is not listed as Threatened because of the satisfactory recovery of the main population.

Distribution The gray whale has recently been reviewed by Wolman (1985) and in the volume edited by Jones, Swartz and Leatherwood (1984).

North Atlantic There is subfossil and literary evidence that gray whales once existed on both sides of the North Atlantic and were present on the coasts of North America up to the seventeenth century. A report of a live gray whale off Newfoundland in the early 1970s turned out to refer to an emaciated fin whale which had lost the dorsal fin and was scarred over large portions of the body (Mead and Mitchell, 1984; De Smet, 1981).

North Pacific In the North Pacific two apparently geographically isolated populations are recognised: an eastern or California stock, and a western or Korean stock.

The western stock migrated from winter calving grounds off the Korean peninsula and Japan to summer feeding grounds in the northern Okhotsk Sea (Omura, 1984). This stock is now at such a low level that it has been suggested that vagrants from the eastern stock may have been providing the occasional sightings reported in the western stock area (Omura, 1984; Wolman, 1985). However, a number of more recent observations in the Okhotsk Sea and south of Kamchatka in spring and summer make it unlikely that these animals were from the eastern stock (IWC, 1986).

The eastern stock migrates along the western North American coast between winter calving areas in Baja California and summer feeding areas in the Bering Sea and adjacent waters of the Arctic Ocean (Jones, Swartz and Leatherwood, 1984; Wolman, 1985).

Population *Atlantic stock* There is no information on the possible size of the North Atlantic populations, although Mead and Mitchell (1984) conclude that the gray whale was, at some time, common in North American waters, since nine incomplete specimens, dated (by carbon 14) from 10,000 to 275 years ago, had been reported up to that time. A total of seven European specimens were known, dated (by geological context) from 6,000 to 1,400 years ago. Although it is reasonable to suppose that the extinction of the North Atlantic stock was caused by early whaling activities (Mitchell, 1974), the evidence of pre-historic gray whaling in the Atlantic is very scanty, particularly in comparison with the extensive ethnological, historical and archaeological data available on early Pacific whaling (O'Leary, 1984; Krupnik, 1984). The question of whether the Atlantic specimens might represent occasional vagrants from the Pacific via the Arctic Ocean does not appear to have been explored so far (see long-finned pilot whale review for discussion of the feasibility of such movements).

Eastern North Pacific stock Estimates of the population before the start of whaling by Europeans vary between 30-40,000 (subjective impression - Scammon, 1874) and from around 15,000 to certainly not more than 20,000 (based on known catches - Henderson, 1972). There were catches by local people from the earliest times, commercial pursuit took place between 1845 and 1946, and since that time something under 200 a year have been taken mainly by, or on behalf of, local people. Most recent catches have been made from the USSR, but a few have been taken from the USA (including 316 under IWC Scientific Permit) and Canada (including 10 under IWC Scientific Permit) (Wolman, 1985; Jones, Swartz and Leatherwood, 1984).

Reports of reduction by commercial whaling to a few hundred animals (e.g. Andrews, 1916; Howell and Huey, 1930; Gilmore, 1955) cannot be substantiated, and would in any case imply an unfeasible rate of increase in order to achieve the estimated current population of 21,113 (20,425 - 21,801) in 1987/88 (IWC, 1989). This stock is relatively easy to monitor, because it migrates within visible distance of the shore along parts of the California coast. Surveys have been conducted near Monterey, California from 1967/68 through 1987/88, although not every year.

The status of the stock has recently been reviewed by IWC (1990a), with the following conclusions: The estimated rate of increase over this 20-year period is 3.2% p.a. (s.e. 0.5%). There is no evidence yet of any levelling off of the rate of increase that would signal a stock approaching its carrying capacity. Simulation studies imply that the stock has either increased above the level it had before the start of commercial whaling, or catch records are incomplete; the latter is considered the most likely explanation.

Western North Pacific stock Yablokov and Bogoslovskaya (1984) mention an estimated original population between 1,500 and 10,000 animals prior to the beginning of commercial whaling, and a current population of the order of 100-200 animals, although there are few hard data with which to estimate the current population. Kato and Kasuya (1990) document a take of 1,700 gray whales off Japan over the period 1910-60, and estimate a total take of 1,800-2,000. There is not yet enough information available to demonstrate any trends in stock size, although there is now increasing observation effort in this area. Wang (1984) summarises observations in PR China waters.

Habitat and Ecology The majority of available information on the gray whale comes from the eastern North Pacific stock. In particular, the biological data are mainly from a sample of 316 animals taken off central California, under IWC Scientific Permit, between 1959 and 1969 (Reilly, 1984). Maximum reported lengths are 14.6m for a male and 15.0m for a female, although the average body length at physical maturity (at about 40 years of age) is 13.0m for males and 14.1m for females. Newborn calves are about 4.6m long and weigh about 500kg. The median age at sexual maturity for both sexes is eight years, with a minimum of 5 years and a maximum of 11 years. The mean pregnancy rate is estimated at 0.467 (s.e. 0.045), and gestation at something over 12 months (Reilly, 1984) or about 13.5 months (Wolman, 1985). Lactation lasts for about 7 months, giving a total minimum calving interval of two years, although since a few simultaneously pregnant and lactating females have been reported, an annual cycle may be possible. Female adult survival rate was estimated to be 0.945, corresponding to a mortality coefficient of 0.056. Juvenile survival was estimated to be within the range 0.878-0.924, with a best estimate of 0.893, corresponding to a mortality coefficient of 0.113. Adult male survival appears to be somewhat higher than adult female survival.

However, there are considerable problems in reading and interpreting laminae in ear plugs. Ear plugs are only readable in about half of the individuals, and there may be fading of juvenile deposited layers later in life. It is usually considered that one layer is deposited per year, except during the first year of life, when two layers are deposited (Reilly, 1984; Wolman, 1985).

Females come into oestrus during about a three-week period in late November and early December. Parturition occurs within a five to six week period from late December to early February. In mature males there is a peak of spermatogenic activity in late autumn and early winter, closely relating to the oestrous period of the females. Courtship behaviour observed during the summer in the Bering Sea is thus unlikely to result in conceptions (Wolman, 1985).

The gray whale feeds on benthic amphipods and other bottom dwelling organisms. Most feeding takes place between about May and September in the northern waters, with the animals more or less fasting during migration and at the breeding grounds. The disturbance of the benthos by feeding gray whales is thought to increase the productivity of these areas. Feeding behaviour has been observed in all parts of the range, although little or no significant quantities of food may be available. Gray whales are present throughout the year off Vancouver Island, where they are known to feed on dense epibenthic mysid concentrations. Occasionally individuals may not move south in winter and remain in ice-free northern waters (Wolman, 1985; Jones, Swartz and Leatherwood, 1984; Leatherwood and Reeves, 1983).

The main calving grounds are Laguna Ojo de Liebre (Scammon's Lagoon), Laguna Guerro Negro, Laguna San Ignacio and Estero Soledad, in Mexico. A few animals continue round Cape San Lucas to the southeastern shore of the Gulf of California, as far north as Yavaros, Sonora. Females generally migrate earlier than males, and adults earlier than sexually immature whales. Southbound, pregnant females appear first, followed in sequence by recently ovulated females, by immature females and adult males, and by immature males. Northbound, newly pregnant females travel first, followed by anoestrus females, adult males, and immatures. Females with calves travel north last (Wolman, 1985).

The habits of the western stock are almost undocumented, except for some historical information from Japan. Omura (1984) presents evidence that, prior to the turn of the century, two populations of gray whales migrated to the coastal waters of Japan, one along the western coasts of Hokkaido and Honshu, and the other from the Korean peninsula east to Kyushu. Both populations appear to have used the Seto Inland Sea as a calving ground. Virtually no gray whales have been observed in Japanese waters since about the 1890s, although from about 1675 to 1890 roughly 50-60 gray whales per year had been taken. Omura (1984) has speculated that increased boat traffic and industrial development drove the gray whale from the Seto Inland Sea calving ground sometime before the turn of the century, but now believes that the matter is more complicated and additional material is required before final conclusions can be drawn. Even less is known of gray whales elsewhere in this area, except that shore whaling by modern methods began in 1899 off the Korean peninsula. Almost 1,500 whales were taken from 1910 to 1933. A further 67 were reported taken in R Korea waters between 1948 and 1966 (Wolman, 1985). It is not known whether any catches have been made in DPR Korea waters.

Gray whales are known as 'devil fish' in many languages because of their unpredictable behaviour, difficulty in catching and habit of turning on a boat once struck (Mitchell, 1979). They sometimes react to aircraft noise and have tried to 'attack' low flying planes (Hubbs, 1959). However, gray whales are now known to interact in a sociable manner with whale watchers and their vessels in the breeding lagoons (Wolman, 1985).

Threats - Historical Local people have taken gray whales for food and oil from the earliest times. It is still a matter for speculation as to whether such takes played a key role in the extinction of the North Atlantic stock, whether early commercial whaling was responsible, or whether habitat destruction may have been the main problem (Mitchell, 1974; De Smet, 1981).

Although Japanese whaling seems to go back at least to the 10th century, it took on a more commercial character from about the 17th century. As noted above, Kato and Kasuya (1990) document a take of at least 1,700 off Japan in the 20th century. Henderson (1984) has collated information on commercial gray whaling in the Sea of Okhotsk, which began in the late 1840s. The low reported oil yields indicate that many young whales were taken here. The hunt continued into the mid-1880s, and it appears that similar numbers to those taken from the California stock on its summering grounds were removed. Since the western stock may possibly have been much smaller than the eastern stock, this level of take would have been even more damaging. It seems therefore that although the level of catch in Japanese waters and loss of habitat are likely to have played some part, a major cause of the decline of the western Pacific gray whale population was excessive commercial whaling at the northern end of the migration. The whaling from the Korean peninsula from 1899 to 1933 appears to have almost exterminated the remaining population, and the small catches from 1948 to 1966 in R Korean waters would at least have hindered recovery and at worst served to drive the stock further towards extinction.

Whales from the eastern North Pacific stock were also taken by local people from the earliest times, but it appears that this was only in the summering areas and on the northern part of the migration route. The calving areas seem to have been more or less undisturbed until the first catches were made in Bahia Magdalena in 1845. In the early days, this commercial whaling was mainly a profitable way to spend the winter, between the major whaling seasons in northern waters. The fact that the oil was considered to be of poorer quality, the baleen almost worthless as it was too short and difficult to work, and the animals dangerous to approach, may explain why this was regarded as a secondary fishery. However, the sheltered calving bays provided much safer anchorages for the ships than the Southern Hemisphere whaling grounds which were available at this time of year, and this factor together with the short travelling time, may have increased the attractions of winter gray whaling. Within a few years shore stations grew up all along the migration route. These whalers not only had the advantage of access to whales twice a year as the migration passed, but also could farm or fish during the rest of the year. The major whaling period was from 1854 to 1865, with catches throughout the range, but by about 1874 so few were left that the whalers more or less abandoned the southern whaling grounds. The shore whalers, who had alternative means of support, continued to operate in some cases until the turn of the century. There were some takes of gray whales by modern pelagic expeditions (Norway, USSR, Japan and USA) up to the time of commercial protection, which began from 1937 but was not complete until 1946 (Jones, Swartz and Leatherwood, 1984).

Threats - Present Each winter in California hundreds of thousands of people watch the gray whale migration either from the shore or from commercial whale-watching boats. Considerable trade is generated by these visitors in the area. Visitors to the calving lagoons and at other points on the migration route generate similar trade. The watching of the gray whale is often cited as a classical example of a non-consumptive use of whales. There has been some concern that pressure from visitors may disturb the whales, particularly in the calving lagoons, but so far monitoring does not appear to indicate any problems (Jones, Swartz and Leatherwood, 1984).

The annual catches taken by, or on behalf of, local people in the USSR have averaged about 175 per year over the last 30 years have not prevented the population from increasing. Sixty-one gray whales have been documented entangled in gillnets along the southern California coast in the 1980s, even though only a small proportion of the nets were examined (IWC, 1990b).

Conservation Measures Present countries of origin are: Canada, USA, Mexico, PR China, Japan, DPR Korea, R Korea and USSR.

The gray whale is listed in CITES Appendix I. The following international trade is reported (all for scientific purposes, except where noted): 1980 - 400 specimens from USA to Canada, 32kg specimens from USA to Canada; 1981 - 2 specimens from USA to France, 1 bone item (commercial) from Netherlands to USA; 1984 - 20kg specimens from USA to Canada, 1 specimen from Canada to USA (40 specimens reported as arriving); 1985 - 42 specimens from USA to Canada (CMC, 1987).

Under older legislation, the 1937 and 1938 Agreements (ARW) give the gray whale protection from whaling: Canada, Mexico and USA are parties. Under the 1931 Convention (CRW), calves and mothers are protected: Canada, USA and Mexico are parties.

IWC classifies the eastern stock as a Sustained Management Stock, and allows 179 animals a year to be taken by local people, or on behalf of local people, for their own use. The western stock is a Protected Stock. R Korea, Japan, PR China, Mexico, USSR and USA are parties.

All the countries of origin (except possibly DPR Korea, for which no information on national laws has so far been found) have domestic legislation protecting gray whales. Mexico has particularly detailed legislation protecting the breeding lagoons from disturbance by visitors.

The eastern North Pacific stock appears to have wide protection throughout the range, given that the legal provisions are enforced. Care is needed, however, that industrial development, fisheries or tourism do not encroach on critical habitat.

Very little information is available about the western North Pacific stock, but it would be of great importance to identify and protect the breeding areas to assist recovery. Extra precautions are required throughout the range to ensure that no direct or accidental takes occur. Increased and sustained survey effort, if possible including individual identity techniques, is needed to monitor this population and any changes in abundance.

The IUCN/SSC Action Plan draws attention to the situation in the western North Pacific stock. The species will also be included in general projects, such as the monitoring of subsistence fisheries (Perrin, 1989).

Captive Breeding Two young gray whales were captured under permit in Laguna Ojo de Liebre, and transported to Sea World, San Diego in the early 1970s. Both were known as Gigi. The first animal did not survive. Gigi II arrived in March 1971, 5.84m long and weighing 1,952kg. A year later on release, she was 8.6m long, weighed

6,500kg, and was consuming 900kg of squid a day. The animal was radio tagged, and contact was maintained for over six weeks. Gigi II was also resighted in later years (Wolman, 1985; HSWRI - undated; Reeves and Leatherwood, 1984). Obviously, given the quantity of food required to maintain even a yearling, conservation through captive breeding would be quite impractical for this species, even if suitably large accommodation could be found.

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Balaenoptera acutorostrata Lacepede, 1804

Suborder MYSTICETI Family BALAENOPTERIDAE

Summary Minke whales are widely distributed, and reasonably abundant, with a world population in the hundreds of thousands, but some stocks have been depleted by commercial whaling. There is particular concern about the West Greenland stock, where catches by local people for their own use continue. The Sea of Japan-Yellow Sea-East China Sea stock and the Northeastern North Atlantic stock are also depleted but, at the time of writing, very little catching is taking place here. Considerable resources have been devoted to surveying and assessing populations, particularly in the Southern Hemisphere, in the last ten years. There are still many problems to be solved, but with the currently increasing level of research, it may become possible to achieve a basis from which sustainable exploitation could be effectively managed. The species is nevertheless listed as Insufficiently Known in the absence of knowledge of trends in abundance for most of the populations.

There is particularly strong pressure to re-open commercial exploitation of this species in the North Atlantic, North Pacific and Southern Ocean in 1991 or soon afterwards; it is therefore important that a satisfactory international procedure for regulating catches in a manner that ensures sustainability be implemented under the auspices of the IWC before this occurs.

Distribution The minke whale is a cosmopolitan species, widely distributed in the tropical, temperate and polar waters of both hemispheres. In general, these whales move between summer feeding grounds in polar waters and wintering grounds in warmer waters, but overall the species appears to be widely distributed in all seasons and to migrate in a manner hard to predict from year to year. Some groups of animals in the North Pacific appear to reside in one place throughout the year, and some individuals have even been shown to have exclusive home ranges. At least three geographically isolated populations are recognised: North Pacific, North Atlantic and Southern Hemisphere, which have sometimes been described as subspecies: *B. a. acutorostrata* Lacepede 1804 in the North Atlantic, *B. a. davidsoni* Scammon, 1872 in the North Pacific and *B. a. bonarensis* Burmeister, 1867 in the Southern Hemisphere (Stewart and Leatherwood, 1985). A diminutive or dwarf form has also been described from South Africa, Australia, New Zealand and Brazil (Arnold, Marsh and Heinsohn, 1987), and it is suggested that this form might be accorded subspecific status when more information is available. There are many other unresolved questions of specific, subspecific and population identity, and until comprehensive comparative studies worldwide are undertaken, a single species is generally recognised. The minke whale has been recently reviewed by Stewart and Leatherwood (1985). Maps showing the boundaries of the IWC stock management units are given in the Introduction. It should be noted that there is little or no biological basis for any of these stock divisions, which were set primarily for administrative convenience.

North Atlantic Minke whales are distributed from the Lesser Antilles and eastern Gulf of Mexico in the west, and the central and western Mediterranean Sea in the east, northward to the edge of the pack ice. In winter they appear to be most abundant in temperate waters across the entire North Atlantic, infrequently entering tropical waters. There is a general movement northwards in summer, to Svarlbard, the Barents

Sea, the coast of Norway, and waters off Iceland, Greenland and Newfoundland. They occasionally enter the Baltic Sea and the Mediterranean Sea. It appears that sexual and age segregation occurs at least during summer, with males moving further north in open seas, females remaining in more southern and coastal areas, and immatures occurring slightly further south. IWC recognises four management stocks in the North Atlantic: Canadian East Coast, West Greenland, Central North Atlantic and Northeastern Atlantic (Stewart and Leatherwood, 1985).

North Pacific The majority of minke whales winter from central California in the east, and 40°N in the west, to near the equator, with major concentrations between 20°N and 25°N. In summer there is a northward movement, and they can be found from northern Baja California in the east and 35°N in the west, through the Bering Sea, with a few individuals reaching the Chukchi Sea, as well as throughout much of the North Pacific. The species may be encountered throughout the year in some eastern Pacific areas, and some individuals have been shown to have exclusive home ranges here. Immature animals appear to remain in more southerly waters of the eastern North Pacific in summer, with the adults travelling to the more northerly feeding grounds. Adult males and females may also segregate on the feeding grounds. The IWC recognises two major management stocks in the western North Pacific: Okhotsk Sea-West Pacific and Sea of Japan-Yellow Sea-East China Sea. Other stocks in the area are not yet distinguished and are described as 'Remainder' (Stewart and Leatherwood, 1985).

Southern Hemisphere The distribution is pelagic and circumpolar, from the pack ice to the tropical South Atlantic, Indian and South Pacific Oceans, although geographical abundance may not be uniform. Minke whales move from temperate waters south to the Antarctic continent in spring and summer, and return in autumn and winter. Adult males appear to move further south than adult females, but smaller animals remain in waters between about 50°S and 20° S. The mature males appear to arrive earlier on the Antarctic whaling grounds than the mature females. The IWC manages the Southern Hemisphere minke stocks on the basis of the traditional six baleen whale Areas (see maps in Introduction) in the absence of information on the real structure of the populations, which has yet to be elucidated. Minke whales in the northern Indian Ocean are treated as a separate management stock, although it is not clear whether they are indeed separate from the Antarctic stocks (Stewart and Leatherwood, 1985).

Population Although minke whales may be regarded as reasonably abundant, with a world population in the hundreds of thousands, some stocks have been depleted by commercial whaling. Modern surveys, particularly the IWC/IDCR Antarctic series, are providing current abundance estimates, although there are still some methodological problems to be solved. Because the methodology is still being developed, abundance estimates calculated each year by the IWC Scientific Committee tend to fluctuate, even when derived from the same data. The figures given below therefore reflect only IWC deliberations up to the time of writing and are likely to be changed at future meetings. Readers are referred to current IWC reports for the latest information on populations.

North Atlantic The complicated and poorly documented history of catching has led to considerable difficulties in assessing and managing these stocks. However, the 1989 North Atlantic Sightings Survey provided data from which an abundance estimates have been obtained. The IWC Scientific Committee conducted an assessment of North Atlantic minke whale stocks in 1990. For the Northeastern IWC management area, Schweder, Øien and Høst (1990) presented an estimate of 81,500 (95% confidence limits 55,000-125,000). The IWC Scientific Committee identified some potential biasses in this estimate, and the estimate was recalculated to account for them, resulting in an adjusted estimate of 54,900 (37,000-84,200). There was no consensus as to which estimate should be used (IWC, 1991a). An estimate of 28,000 (21,600-31,400) was accepted for the Central stock area, as was an estimate of 3,266 (1,790-5,950) for the West Greenland stock area. No estimate was available for the Canadian East Coast stock area.

The adjusted sightings estimate for the Northeastern stock area is broadly similar to previous estimates based on mark-recapture experiments which were used in an assessment by Holt (1985), on which the IWC's current classification of the stock as a Protection Stock is based. The stock estimates used by Holt (1985) were 22,000 and 30,000 for the 'available' stock, or 44,000 and 60,000 for the total stock in 1978. The sightings estimates above refer to the total stock. According to the 1985 assessment, which used catch and effort data to estimate the rate of decline of the stock, the available stock was in the range 20-30% of its initial size at the start of whaling in the 1930s.

Schweder, Ulltang and Volden (1990) presented an new analysis of catch and effort data which indicated that the Northeastern stock had been stable over the period 1952-83. An alternative analysis by Cooke and Holt (1991) failed to corroborate these findings, and indicated a decline of about 50% in the recruited stock over the same period. The Committee was unable to resolve the issue at its 1990 meeting, and it has been proposed that the Committee review the matter again in 1991.

Various assessments were conducted by the Committee in 1990 using a range of assumed values for the MSY rate (productivity) of the Northeastern stock as an alternative to the use of catch and effort data to estimate the extent to which the stock has declined under whaling. Most of these indicated that especially the mature female stock was severely depleted and below the level at which a Protected Stock classification would be warranted under current IWC procedures (IWC, 1991a).

Similar assessments were carried out for the Central stock, which indicated that the stock is currently at 62-96% of its 1941 level. Iceland had requested that the Committee predict the effect on the stock of a catch of 200-400 whales annually over the period 1991-95. The simulations conducted to address this question all indicated that the stock had increased since the moratorium on commercial whaling came into effect in 1986, but that it would decline again if the proposed catches were taken, although in some cases only slightly (IWC, 1991a).

There is substantial evidence, relating to the absence of calves and lactating females and to the continuing high proportion of females in the catch, that minke whales off West Greenland do not constitute a separate biological stock. Resolving this question is of crucial importance to the assessment of minke whales off West Greenland in relation to management of the local subsistence take in this area, especially since assessments by the Scientific Committee conducted on the assumption that it is a separate stock had implied that the stock was severely depleted (IWC, 1989a). New genetic analyses found significant differences between whales captured off West Greenland and those captured off Iceland, but in the absence of samples from more locations it was not possible to determine the most appropriate locations for stock boundaries (IWC, 1991a).

North Pacific Information on North Pacific minke whale stocks is still comparatively poor. Simulations based on such data as is available indicate that both the

Okhotsk Sea-West Pacific stock and the Sea of Japan-Yellow Sea-East China Sea stock are depleted: the former possibly at 25-40% of initial, the latter at 18-43% of initial. The depletion level calculation for the Sea of Japan-Yellow Sea-East China Sea is considered the more robust, and it was agreed that this stock is a Protection Stock (IWC, 1988a). The Scientific Committee plans to undertake a comprehensive assessment of North Pacific minke whale stocks in 1991 (IWC, 1991b).

Southern Hemisphere Considerable resources have been devoted to obtaining information on Southern Hemisphere minke whales. The IWC/IDCR cruises have completed one circumnavigation of Antarctica in the years between 1978/79 and 1983/84, and will complete another by 1989/90. Extensive work on survey methodology has also taken place. This flow of information has resulted in many revisions of calculated stock size. The most recent figures at the time of writing are given in Table 1, but the reader is referred to current IWC reports for more recent information. For comparison, the total catch that has been taken from each area to 1990 is also shown. This indicates that the stocks in Areas V and VI have only been lightly exploited so far, but that the stocks in Areas III and IV have been more heavily exploited (IWC, 1991c).

Table 1. 1990 estimates of Antarctic minke whale populations

Area	Estimate	c.v.	Total catch to 1990
I	73,302	0.254	12,108
II	122,156	0.190	19,739
III	88,735	0.273	27,541
IV	74,692	0.257	34,586
V	294,610	0.138	15,165
VI	106,901	0.277	4,999

Habitat and Ecology The minke whale is the smallest member of the genus *Balaenoptera*. Maximum length is about 10.7m for the female and 9.8m for the male, with a weight of ten tons in the Southern Hemisphere. A length of 9.2m is maximum in the Northern Hemisphere. In Korean waters, body lengths are reported to vary between 5.8 and 6m, and weights between 2.0 and 2.7 metric tonnes. Newborn calves in California waters are reportedly 2.69 to 2.84m long. Maximum age seems to be between 30 and 40 years in the North Atlantic and something less than 50 years in the Southern Hemisphere (Stewart and Leatherwood, 1985). Annual survival in Antarctic Areas III+IV+V was estimated to be between 0.902 and 0.933, from marking data (IWC, 1989b).

Minke whales are frequently found as single animals or in groups of two or three, although they may congregate in areas of food concentration in polar seas during spring and summer. In all areas, minke whales appear to segregate by age/sex classes more than any other baleen whale, a factor which has hindered attempts to estimate abundance from catch data. They can approach close to shore and enter bays, inlets and estuaries. In some areas they may approach boats, confounding efforts to estimate population from sightings data, but in others their movements appear unaffected by the presence of boats.

In the North Atlantic, capelin *Mallotus villosus* is the predominant prey species in Newfoundland, the Barents Sea and East Greenland; off West Greenland sand eel and krill are mainly taken. Dogfish, herring, cod, whiting, Norway haddock and pollock are also reported in the diet. Icthyophagy is also marked in the North Pacific stocks, with walleye pollock, saffron cod, herring, capelin, sand lance and anchovy *Engraulis mordax* reported. Some pelagic crustaceans are also taken, particularly in the Okhotsk Sea, where fish seem to be less important in the diet. In contrast, the Southern Hemisphere stocks feed predominantly on krill, (*Euphausia superba, E. spinifera, E. crystallorphia*), although they also consume various species of myctophid fishes.

Killer whales have been reported to attack and kill minke whales in the Antarctic and in waters off British Columbia, Canada. In Antarctic waters minke whale parts were identified in 84% of killer whale stomachs in one sample, and in 70-85% of stomachs in another sample. It has been estimated that minke whales constitute 85% of the killer whales' diet in the Antarctic (Stewart and Leatherwood, 1985), although this figure does seem rather too high in the light of the relative abundances of the two species (see also killer whale review).

It was formerly believed that in the Antarctic the reduction in the populations of other baleen whales may have caused the minke whale populations to increase prior to commercial exploitation. The evidence is based on apparent declines in the mean age at sexual maturity from about 15 years in 1950 to around 6 years in 1970 (Masaki, 1979). Since age readings were not collected from minke whales before 1970, the age at maturity in earlier years was back-calculated using an indirect method based on layers in ear plugs. Later analyses suggest that the method is liable to produce apparent reductions in age at maturity with time even when this has not occurred in reality (Cooke, 1985).

Southern Hemisphere In the Southern Hemisphere mating occurs from June through December, with a peak in August and September. Gestation is about ten months, and peak numbers of births occur during late May and early June in warm waters north of the Antarctic Convergence. The minimum average calving interval has been calculated as 14 months. (This is more likely to indicate that in the sampled population most females bred every year, than that individual animals produced calves at 14 month intervals). There is usually one calf, but in a study of 10,675 pregnant females, 60 (0.56%) carried twins and 3 (0.03%) carried triplets. Newborn animals are about 2.8m long. They are weaned at about 5.7m and attain about 7-8m by the end of their first year. Lactation lasts from three to six months. Females are sexually mature at about 7.9m and 6-8 years of age; males at 7.3m and 5-8 years of age. These ages at maturity are liable to be biassed downwards due to catch selectivity. Although pregnancy rates of 0.80-0.90 and 0.95-0.96 have been reported in the higher latitudes, this figure may be affected by segregation of pregnant and non-pregnant females. The pregnancy rate of the population visiting South African waters seasonally has been estimated at 0.78 (Stewart and Leatherwood, 1985).

North Atlantic In the North Atlantic mating occurs from October to March and gestation is approximately 10 months. Mature females may give birth every year. Calving occurs from November to March and calves are 2.4 to 2.8m long at birth. Lactation lasts 4-5 months. Pregnancy rates of 0.90 and 0.97 have been reported for the West Greenland and Barents Sea populations, respectively, and a pregnancy rate of 0.86 was reported for the Newfoundland population, but, again, these observations may be biased by schooling segregation.

Age at sexual maturity has been estimated at 7.1 years in females and 6 years in males. The mean length at sexual maturity is 7.15m for females and 6.75m for males, while mean length at physical maturity is 8.5m for females and 7.9m for males (Stewart and Leatherwood, 1985).

North Pacific In the southwest Sea of Japan breeding occurs from December through March. Calves are born approximately 10 months after conception and are 2.4 to 2.7m long at birth. It is reported that breeding occurs throughout the year in the eastern North Pacific, but calving peaks in December and June. Females attain sexual maturity at 7.3m and males at 6.7 to 7.0m. The age at sexual maturity is unknown (Stewart and Leatherwood, 1985).

Threats Although minke whales appear to have been taken in small numbers in many parts of the range from the earliest times, they did not become a major target for modern whalers until the 1930s in the Northern Hemisphere and about 1970 in the Antarctic, following the depletion of the larger species. The larger species came under increasing protection, so that by 1980 the minke whale was the most important species for modern whaling.

The minke whale is hunted for meat and oil. Much of the meat is used for human consumption, particularly in Japan, Norway and Greenland. Tomilin (1957) reports that an 8.7m female weighing five tons yielded 2,400kg of meat and that fat specimens yield up to one ton of oil or more. Foote (1975) gives a very comprehensive account of the Norwegian industry and its economics, and Norway (1987) gives more recent information.

The considerable resources devoted to survey efforts since 1978 in the Antarctic, and since 1987 also in the North Atlantic, has greatly improved knowledge of this species. There are still, however, many outstanding problems to be solved before reliable management strategies can be developed.

North Atlantic In the North Atlantic there is a long history of catching, but records are not complete and are complicated by the fact that the boats involved were also taking other whale species and sometimes engaging in other fishing operations as well. Fishermen in Norway have trapped minke whales in bays and fjords, by netting off the entrances, since at least the middle ages. Sailing ships on whaling and sealing expeditions also appear to have taken minke whales occasionally. Modern minke whaling began in Norwegian waters in the 1920s, with substantial catches from the 1940s, and expanded to the Barents Sea, Faeroe Islands, Jan Mayen, West Greenland and Newfoundland areas. The Norwegian fishery is reported to have taken about 106,000 minke whales between 1938 and 1988. As discussed in the Population section above, the population in the northeastern Atlantic stock area, in which the bulk of Norwegian catches have been taken, may be severely depleted.

Whaling along the Icelandic coast from shore stations began in 1914 and increased steadily, especially after 1945, supplying meat for the local people. Special licences for hunting minke whales in Icelandic waters were first issued in 1974, and catch records have been maintained since that time. Minke whale meat has been a traditional component of the local diet, and export of products to the Faeroe Islands, Norway and Japan only began in the 1970s. About 6,000 minke whales were taken from this area between 1945 and 1986. Small catches were also made from the Canadian east coast, but this fishery ceased in 1972 (Stewart and Leatherwood, 1985).

At the time of writing, with the IWC moratorium on commercial whaling now effective, the only catches in the North Atlantic are those taken by local people in Greenland for their own use and those taken by a Norwegian research programme under

Scientific Permit. In 1990 Norway proposed to the IWC that the Protection Stock classification for the northeastern stock be changed to Sustained Management Stock. Iceland proposed that the classification of the central stock be changed to Initial Management Stock. Although neither proposal was accepted, they indicate a wish or intention to reopen commercial whaling on these stocks. The majority view in the IWC was that the moratorium should be maintained until a satisfactory system for relating allowable catches to the size and productivity of the stocks has been elaborated (see Introductory sections) (IWC, 1991b). There is also considerable interest in the culling of minke whales for the purposes of fishery enhancement, although it has not been demonstrated that reducing minke whale populations further would benefit specific fisheries.

Unfortunately, the West Greenland stock of minke whales appears to have been overexploited by commercial whaling in the past and may now be severely depleted. The IWC Scientific Committee had no data with which to determine the maximum catch that would not impede recovery of the population. Evidence has been presented to the IWC in support of the needs of the West Greenlanders for 670 tonnes of edible whale products each year. This can be supplied by minke (one whale yields 2 tonnes) or fin (one whale yields 10 tonnes) whales. As a compromise between the needs of the people and conservation of the stocks, catch limits of 190 minke whales and 42 fin whales were agreed for the two-year period 1990-91 (IWC, 1990). A catch limit of 12 animals per year was set for the East Greenland area for the period 1990-92, this being the stated aboriginal subsistence need.

North Pacific Historically, minke whales were taken in very small numbers by natives of the Pacific Northwest of North America. They are still occasionally taken by American Inuit at Savoonga on St Lawrence Island for subsistence purposes, although whaling efforts are directed primarily at bowheads. Minke whales have been exploited in Japanese coastal waters for several centuries, mainly for meat for human consumption. The Norwegian method of whaling using small catcher boats, introduced to Japan in about 1890, was used for minkes, although they were not the primary species pursued. Modern catcher boats were first used in the 1920s.

Pelagic whaling fleets of the USSR began taking minke whales in 1933 off the east coast of Kamchatka, in the Bering Sea, and in the Arctic Ocean. The Japanese pelagic vessels began exploiting minkes of the Okhotsk Sea-West Pacific stock in 1930. Minke whales have been taken by shore-based catcher boats off the Korean peninsula since the late nineteenth century. From 1978, when the Republic of Korea joined the IWC, the whaling season was limited to six months, from March to September. The small-scale experimental whaling by PR China ceased in 1981 (Wang, 1984).

At the time of writing no minke whale catches are being made in the North Pacific. The Japanese coastal fishery, which had been taking 300-400 whales a year under an objection to the IWC moratorium on commercial whaling, ceased in April 1988. There was no take by the Republic of Korea under Special Permit in 1988. The Korean research programme had been severely criticised and produced no useful information (e.g. IWC, 1988b).

Japan has put forward a case for special consideration of small-type whaling within its 200 mile EEZ. It believes that this activity shares some features of both commercial and aboriginal subsistence whaling but is not properly characterised by either description. Japan claimed that the cessation of coastal whaling has caused hardship to the affected communities in the form of socio-cultural, religious, occupational and psychological stresses. The report of an international workshop held to evaluate the socio-economic aspects of the small-type whaling was submitted in support of this claim (Freeman, 1988). The IWC responded by setting up a Working Group to investigate this matter, and report back to the 1989 meeting. Japan then called for an interim relief allocation of 210 minke whales for the balance of the 1988 whaling season, and for a further allocation of 160 for the first part of the 1989 season. The working group reported in 1989 but the IWC considered on the basis of their report that the fishery was primarily commercial in character and did not grant an exemption (IWC, 1990). The request was repeated again in 1990 and refused on the same grounds (IWC, 1991b).

Southern Hemisphere Although the first two minke whales were reported to be taken in 1894-95 in the Southern Hemisphere, very few were caught until active commercial exploitation began in the early 1950s and substantial catches were not recorded until 1972. Minke whales have occasionally been taken in coastal South African fisheries near Cape Province and Natal. They were also occasionally taken by whaling ships operating off Durban before 1968. After that year the proportion of minkes increased until the station closed in 1975. This species became the main target of the Brazilian whaling station at Costinha from 1966 (Stewart and Leatherwood, 1985). Commercial pelagic whaling continued in the Antarctic until the 1986/87 season. From 1987/88 onwards the Japanese pelagic fleet has caught about 300 per year in Areas IV and V under a Special Permit for scientific purposes. The IWC has passed several resolutions requesting Japan to refrain from such takes until it can be demonstrated that they will provide information of material value for the future conservation and management of the stocks (e.g. IWC, 1990; 1991b).

Conservation Measures Because the minke whale is a cosmopolitan species, discussion of international and national protection status involves every country with a sea coast and every country registering shipping (since catch control on the high seas can only be exercised through the flag country). Other countries could become involved in conservation through international trade.

The minke whale is on Appendix I of CITES (except for the West Greenland stock, which remains on Appendix II). Austria, Brazil, Japan, Norway, Peru and USSR have all registered reservations against this listing of the minke whale. These countries should therefore recognise the previous listing in Appendix II. The following international trade is recorded: 1980 - 50kg meat from Norway to FRG of unspecified status, 1 body introduced from the sea into Denmark for educational purposes, 240kg meat from Norway to Denmark of unspecified status; 1981 - 67 scientific specimens originally introduced from the sea from Japan to UK, 3kg of scientific specimens of unstated origin from UK to USA, 5 scientific specimens from an unstated country to USA; 1982 - 1 scientific specimen from USA to Canada, 3,224 bodies introduced from the sea into Japan of unstated status, 419,859kg meat of unstated status from Norway to Japan, 3kg scientific specimens of unstated origin from UK to USA, 5 scientific specimens of unstated origin to USA; 1983 - 2kg scientific specimens from Australia to Japan, 1,260,190kg meat for commercial purposes from Norway to Japan; 1984 - 65,287kg meat for commercial purposes from Greenland to Denmark, 6,354kg meat as personal effects from Greenland to Denmark, 248,584kg meat for commercial purposes from Norway to Japan; 1985 - 3 carvings as personal effects from Greenland to Denmark, 1 meat (*sic*) as personal effects from Greenland to Denmark (CMC, 1987).

The taking of minke whales is regulated by the IWC. CCAMLR will protect the Southern Hemisphere habitat. Minke whales are protected under general national legislation in a number of countries.

The most urgent requirement seems to be for more information on the depleted West Greenland stock, where there is a subsistence take. Provided that the present international restraint on other taking is maintained until a sufficient basis for reliable sustainable management has been elaborated, the situation of the other stocks does not give rise to undue concern.

Captive Breeding On three occasions, minke whales have been captured and maintained alive in Japan: one for 37 days, one for three months and a calf for two weeks. They were kept in a large tidal pool with a sea gate at the Mito Natural Aquarium. One unsuccessful attempt to keep a minke whale was made in the USA (Stewart and Leatherwood, 1985). While it may just be feasible to keep a few minke whales for captive breeding, it is unlikely that sufficient resources would ever be available for enough animals for species conservation by this method.

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SEI WHALE **VULNERABLE**

Balaenoptera borealis Lesson, 1828

Suborder MYSTICETI Family BALAENOPTERIDAE

Summary The sei whale populations were depleted by over-exploitation, but by 1980 commercial whaling had ceased in all areas except the North Atlantic. In the North Pacific and Southern Hemisphere, sei whale populations were reduced rapidly over a relatively short period in the 1960s and 1970s when they bore the brunt of pelagic whaling. In the North Atlantic they appear to have been depleted in different areas at different times during this century, although it is not known whether separate populations exist. Although the threat from whaling has been has now been largely contained, at least for the present, the species remains listed as Vulnerable pending evidence of sufficient recovery.

Distribution Sei whales have been reported from most oceans and seas, although they appear to favour temperate and oceanic waters. They are deep-water animals, rarely found in marginal sea areas. The winter months are spent in temperate waters, and the summer on higher latitude feeding grounds. Their movements are not as regular and predictable as those of some other whale species. Information on distribution in warmer waters has been complicated by confusion over the identification of sei and Bryde's whales. The irregular movements and confusion about the southern extent of the range render it very difficult to document changes in past and present range, although sei whales, once common off north Norway, have not been found there in recent years. The species has recently been extensively reviewed by Horwood (1987), who gives distribution maps, and more briefly by Gambell (1985). It should be noted that the drawings of the skull reproduced in Gambell's review are of a specimen which has been re-identified as a Bryde's whale (Mead, 1977).

North Pacific In summer, sei whales can be found from California to the Gulf of Alaska in the east, across the Bering Sea and down to the coasts of Japan and the Korean peninsula in the west. However, there is some doubt about the southern part of the summer range, because of past confusion with Bryde's whales. There have been few confirmed records south of 30°S in summer. Catch and sightings records indicate concentrations in some areas, although the general distribution is continuous across the entire ocean. In winter the main area of abundance is further south, around 20°N (Horwood, 1987; Gambell, 1985; Leatherwood and Reeves, 1983).

North Atlantic In the North Atlantic sei whales inhabit the coasts of New England, Labrador, East Iceland, the British Isles and Norway to the Arctic Ocean, wintering at low latitudes perhaps as far south as Florida, Mexico, Spain, Portugal and northwest Africa. They have also been reported from the western Mediterranean Sea. However, the southern limits of distribution are unclear, because of confusion with Bryde's whales (Horwood, 1987; Gambell, 1985; Leatherwood and Reeves, 1983).

Indian Ocean There are some reports of sei whales in the northern Indian Ocean, but they are more likely to refer to Bryde's whales (Horwood, 1987).

Southern Stocks Sei whales in the Southern Hemisphere occur in all oceans from about 30° southward in summer and spend winter north of about 40°S. The

Antarctic Convergence appears to act as a barrier, with only the larger animals moving further south. Pregnant females move south earlier than other age and sex classes (Horwood, 1987; Gambell, 1985; Leatherwood and Reeves, 1983).

Population The IWC Scientific Committee has not reviewed sei whale populations in depth since 1979, hence most published estimates are derived from methods which have since been found to be problematic. The assessments then carried out are summarised by Horwood (1987). Maps showing the IWC management stock divisions are given in the Introduction to this volume. However, an estimate of the Southern Hemisphere populations is now available from recent analyses of sightings data.

North Atlantic Stocks Sei whales in the North Atlantic have been divided into three stocks for management purposes: Nova Scotia, Iceland-Denmark Strait and Eastern. No estimates exist for the original populations. The 1989 North Atlantic Sightings Survey provided good coverage of much of the summer range: nearly 200 were seen in the Icelandic survey of the central North Atlantic north of 50° in July-August 1989 (Sigurjónsson *et al.*, 1990). Only one sei whale was seen in the Norwegian surveys of the northeastern Atlantic in 1987-89 (Christensen, Haug and Øien, 1990), which provides important negative information about current abundance in an area containing important former whaling grounds. In the Faeroese surveys, which covered the waters around the Faeroes and the northern and western British Isles, none were seen in 1987 and only one in 1989 (Joyce, Deportes and Bloch, 1990). This is also interesting negative information, since both these areas supported sei whale fisheries until the 1950s (Jonsgård, 1977).

To date, these data have not been worked up to provide a comprehensive population estimate, so that it is not possible to provide a figure here for the current abundance of sei whales in the North Atlantic, although it appears to be of the order of a few thousand.

Mitchell and Chapman (1977) give tentative total population estimates for the Nova Scotia stock of between 1,400 and 2,200, based on data collected between 1966 and 1972. A photo-identity study is in progress in the Gulf of Maine. So far 60 animals have been added to the catalogue (IWC, 1990).

Gordon and Steiner (1990) sighted five sei whales in the Azores on 16 July 1989, but believed this to be an untypical occurrence.

About 13,300 sei whales are recorded as having been taken in the North Atlantic by modern whaling (Jonsgård, 1977). Until the current range has been delineated and existing survey data fully analyzed, it is not possible to ascertain how depleted the sei whale is in the North Atlantic as a whole, although its apparent virtual absence from some former major whaling grounds is suggestive that some populations may have been severely depleted and not yet have recovered to any significant extent.

North Pacific Stock The question of stock identity within the North Pacific has not been resolved, although available evidence does point to some segregation, and abundance estimates apply to the whole area. The latest IWC assessments, described by Horwood (1987), indicate that the population in the North Pacific was reduced from about 63,000 in 1963 to 13,000 in 1974, when catches ceased. However, this assessment was based partly on catch per unit effort data, and has not been revised in the light of what is now known about the properties of such data (IWC, 1989). Sightings records of sei whales collected since 1974 have not been analyses or published in detail, so it is not known whether the population has begun to recover.

Antarctic Stocks The IWC managed the Southern Hemisphere populations on the basis of their six baleen whale Areas. Although there is evidence of segregation within the populations, it is not clear whether these or other boundaries would be more appropriate. The latest IWC assessments, conducted in 1979, suggested an 'exploitable' (= animals above the minimum allowed length at capture) population size before 1930 of about 100,000, which by 1979 had been reduced to about 24,000. Because the assessments were based partly on CPUE data, which is now considered to be liable to under-represent declines in whale stocks, the assessments would now be regarded as likely to be over-optimistic (see fin whale review).

Sightings data from Japanese scouting vessels collected in 1965/66-1987/88 have recently been made available. Analyses of these data by Borchers, Butterworth and Kasamatsu (1990) together with data from IWC/IDCR cruises conducted since 1978/79 provide an estimate of 40,000 (c.v. 0.57) for the total population south of 30°S in January and February, a time when virtually all of the stock is believed to be in these zones (see Distribution above). However, most of the sei whale sightings were made in the early part of this period, before some of the very substantial catches were taken, so that the estimate might be rather overoptimistic.

Although the two estimates, after correcting the sightings estimate to reflect the exploitable (rather than total) population, turn out to be numerically almost identical, they are both subject to considerable uncertainties of different natures, and should not be interpreted too literally.

Another problem with the 1979 assessments, which may have led to underestimation of the pre-whaling population size, and hence of the extent of depletion, is that they were based on the assumption that sei whales had begun to increase prior to their exploitation, due to reduced competition from other whale species. The evidence for this was increasing apparent pregnancy rates and declining age at sexual maturity. Later studies suggest that both those changes may have been artifacts (Mizroch, 1980; see also minke whale review).

Habitat and Ecology Male sei whales grow to 17.1m in the Northern Hemisphere, and females to 18.6m. In the Southern Hemisphere males can reach 17.7m in length and females 21m. Northern Hemisphere males reach sexual maturity between 12.7 and 12.9m, females between 13.1 and 13.7m. In the Southern Hemisphere the lengths are 13.0 to 13.9m for males and 13.6 to 14.5m for females. There are unresolved problems in estimating the ages of sei whales, but in general females appear to ovulate for the first time at between five and six years of age. Conception takes place in late autumn to early winter, and gestation lasts somewhere between 10.5 and 12.5 months. Newborn are 4.5 to 4.8m in length. Lactation lasts for five to nine months, and at weaning calves are 8 to 9m long. The maximum life span may be up to 60 years (Horwood, 1987; Gambell, 1985; Leatherwood and Reeves, 1983).

Sei whales feed on plankton, which are taken by swallowing or skimming behaviours. A number of other prey species have been recorded, but those most often taken are surface- swarming plankton living in waters of about 5-15°C. In the Southern Hemisphere krill is the major food although, unlike the blue, fin, humpback and minke whales, copepods and amphipods are also taken. In the North Pacific copepods are the major food, with krill forming only about 10% of the diet. There is thus an overlap with the prey of right whales, which appear to feed exclusively on copepods (Horwood, 1987). Sei whales usually travel in groups of two to five individuals, although larger aggregations can be seen on feeding grounds (Horwood, 1987; Gambell, 1985; Leatherwood and Reeves, 1983).

Threats - Historical Sei whales were taken by shore-based fisheries in Japan from about the seventeenth century, but the main exploitation did not begin until modern whaling methods were developed in the late nineteenth century.

In the North Atlantic substantial catches of several hundred a year were made off northern Norway in the 1880s and 1890s, and off the UK and Ireland from 1905 to 1920. Catches off western Norway were in the low hundreds each year from about 1920 to 1940, and some tens each year until the late 1950s. Sporadic catches off Canada took place from the 1900s, and reached the low hundreds for a few years in the late 1960s and early 1970s. Sporadic catches were also made off the Faeroe Islands, Iberia and elsewhere throughout the period. Icelandic catches became more regular from the 1950s, and still continue under Scientific Permit.

Modern whaling methods were introduced into the eastern North Pacific in 1905, from land stations in Canada and Alaska, but it appears that few sei whales were taken in the early years. The main Canadian catches were made in the 1960s, with several hundred animals taken each year. The USA land stations took some tens of animals per year up to the 1970s. In the western North Pacific modern whaling was introduced by Russia (now USSR) from the 1860s, and pelagic operations began in 1903, but information on the numbers taken in the early years is not available. Catches off Kamchatka peaked in the 1960s, when around a thousand animals a year were being taken. Modern whaling began in Japan in 1898, and figures available from about 1910 show takes of several hundred a year, rising to around a thousand a year in the 1950s and 1960s. Some compilations of catch statistics do not differentiate between sei and Bryde's whales, and the species were only separated in the International Whaling Statistics from about 1964. The major sei whale catches were made in the North Pacific by pelagic operations from USSR and Japan. Up to several thousand animals a year were taken between 1964 and 1974.

Exploitation in the Southern Hemisphere began from land stations in the early 1900s, but the sei whale was not an important component of the catch until the stocks of the other large whales had been depleted by the 1950s. Again, some of the early catch statistics refer to both sei and Bryde's whale takes in warm waters. Although pelagic operations were taking 10-15,000 animals a year at the peak of the fishery, substantial catches were also made from land stations at South Georgia and South Africa. Some were taken from stations in Peru, Australia and New Zealand. Catches recorded from Chile and Brazil include Bryde's whales, and those recorded from Peru were probably all Bryde's whales. Catches of sei whales were especially high after blue and fin whales had become scarce.

Threats - Present Sei whale populations in all oceans have been depleted by over-exploitation. The IWC progressively shut down sei whaling operations in the North Pacific and Southern Hemisphere during the 1970s, but catches of sei whales off Iceland continue to this day as part of a joint fin/sei whale fishery of which fin whales are the primary target. Until 1986 the sei whale quota for Iceland was 100 whales per year, but since the IWC moratorium on commercial whaling came into effect, Icelandic catches have been at a reduced level between 10 and 40 per year under an exemption from IWC regulations granted by the Icelandic government for scientific research. The Icelandic government favours a re-opening of fully commercial fin whaling in 1991, but it is not clear whether this also applies to sei whales. The main objective of commercial whaling was formerly oil, but meat for human consumption, mainly in Japan, is now the most important product (Horwood, 1987; Gambell, 1985).

Conservation Measures Putative countries of origin include all those with sea coasts. Other countries may also have conservation responsibilities through international trade or the registration of shipping.

CITES formerly listed all stocks on Appendix II, except for those in the North Pacific and in the Southern Hemisphere from 0° longitude to 70° E, from the Equator to the Antarctic Continent. From 1986 all stocks are listed on Appendix I. Japan, Norway, USSR and Austria have entered reservations against this, and for them the previous listing applies. The following international trade is recorded: 1980 - 54kg bones from France to Switzerland, 1 body introduced from the sea to Denmark for educational purposes, 3,600kg scientific specimens from Iceland to Canada; 1981 - 50kg bones imported by Switzerland from France, 105kg bones of Japanese origin exported by France to Switzerland, 200kg bones, 30kg specimens and 100 pairs of specimens all for scientific purposes from Iceland to UK, 9 live specimens for zoological purposes from FRG to USSR, 3 live specimens of Danish origin from Netherlands to USSR for zoological purposes, 50g specimens for scientific purposes from UK to USA; 1982 - 25kg scientific specimens from Iceland to Canada, 40kg bones from France to Switzerland (commercial), 216kg bones from France to FRG (commercial), 15kg oil from France to FRG (commercial), 50g scientific specimens from UK to USA; 1984 - 19kg bones of Japanese origin from France to Switzerland; 1985 - 42kg specimens of Icelandic origin from USA to Iceland (CMC, 1987). It is also probable that some of the consignments listed under 'Cetacea spp' included sei whale material. The movements of live specimens listed above are very improbable, given the size of this species, and must be errors of some kind. The commercial movements of 'bones', in particular the regular imports to Switzerland, are interesting but so far no information on the use to which this material might be put has been forthcoming.

All stocks are listed as Protected Stocks by IWC, except for Iceland-Denmark Strait and the Eastern North Atlantic Stocks, which have no classification because of lack of information on the populations. Commercial whaling is currently prohibited under the IWC moratorium. No other international agreements mention the sei whale, but it is protected under general legislation in a number of countries.

Captive Breeding Notwithstanding the reports of trade in live animals given in the CITES records (which must be some mistake), the sei whale is far too large to be kept in captivity. There is thus no prospect of conservation through captive breeding.

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BRYDE'S WHALE INSUFFICIENTLY KNOWN
Balaenoptera edeni Anderson, 1878

Suborder MYSTICETI Family BALAENOPTERIDAE

Summary The current status of Bryde's whale is probably better than that of any of the other larger baleen whales, mainly because it inhabits tropical and low latitude waters, most of which had been closed to pelagic whaling since the 1930s by measures originally intended to protect the breeding grounds of other baleen whale species, at a time when Bryde's whale was not of major interest to pelagic fleets. However, it has been subject to coastal whaling off Peru, Chile, southern Africa, Japan, and other areas, and to pelagic whaling in the North Pacific, as well as some illegal pelagic catches in the South Atlantic. Coastal whaling in the western North Pacific continued until 1987.

Distribution Bryde's whale is found in tropical and warm temperate waters around the world, bounded approximately by latitudes 40°N and S (or the 20°C marine isotherm). Confusion with sei whales has been widespread, leading to uncertainties about the exact distributions of both species in their areas of overlap. Bryde's whale has recently been briefly reviewed by Cummings (1985), who gives a very incomplete distribution map. The IWC reports contain much useful original material, although the reasons for the revisions in the data and analyses over the years are not well documented and can be confusing.

The tropical and temperate distribution of Bryde's whales raises the question of whether it is appropriate to consider northern and southern populations separately. However, since it appeared that offshore stocks in each Hemisphere conceived in their respective autumns, it seemed reasonable at first to consider the northern and southern populations as separate for management purposes (IWC, 1977). This idea has been questioned several times in later years, but the problem has not been resolved, because of lack of information. In general Bryde's whale shows quite a lot of variation from one locality to another. There seems to be a larger offshore form and a smaller inshore form in many areas, with the offshore form showing some seasonal movements and the inshore form appearing to be sedentary (IWC, 1977; Cummings, 1985; Leatherwood and Reeves, 1983; Best, 1977).

Pacific Ocean In the western Pacific, Bryde's whales occur from Japan to New Zealand and Australia. In the eastern Pacific they are found from Baja California to northern Chile. They are also present in the equatorial Pacific. Two forms of Bryde's whales seem to exist in the North Pacific, an offshore form and a smaller inshore form, but Bryde's whales from the Bonin Islands, belonging to the offshore form, have been linked by mark returns with those of Sanriku and Oshima on the coast of Japan. Pelagic catches in the central Pacific can also be referred to the offshore form. The inshore form off Japan may perhaps be similar to the form present off Baja California, Mexico, although the evidence is very limited (IWC, 1977; Cummings, 1985; Leatherwood and Reeves, 1983).

Atlantic Ocean Little is known of the distribution of Bryde's whales in the northern part of this region. From evidence of strandings, there appears to be a resident population in the Caribbean and Gulf of Mexico, which may extend to the Atlantic coast of the USA as far as north Chesapeake Bay. Sightings have been recorded off northern Venezuela (Notarbartolo di Sciara, 1983), and there was a fishery off Brazil. In the eastern Atlantic they have been reported from Morocco southward to the Cape of Good Hope. They have also been reported from the central equatorial Atlantic (IWC, 1977; Cummings, 1985; Leatherwood and Reeves, 1983).

Southern Hemisphere There appear to be two forms of Bryde's whales off the west coast of South Africa, a larger offshore form with relatively broader baleen plates than sei whales and a smaller inshore form with baleen plates resembling those of sei whales in shape. Two similar forms probably exist off the Brazilian coast, and Bryde's whales of the offshore form have been recorded from Chile and the Natal coast of South Africa. Animals from western Australia seem to be different. The year-round tropical and temperate distribution of Bryde's whales of the offshore form suggests that the South Atlantic, South Pacific and Indian Oceans contain separate stocks (Best, 1977; IWC, 1977; Cummings, 1985; Leatherwood and Reeves, 1983).

Indian Ocean The range here is from the Cape of Good Hope north to the Persian Gulf, east to Burma and south to Shark Bay, Western Australia. There are also animals in the central Indian Ocean (Best, 1977; IWC, 1977; Cummings, 1985; Leatherwood and Reeves, 1983).

Population Until the 1970s, catches of Bryde's whale were recorded with those for the sei whale. When, as a result of reductions in quotas for other baleen whales in the mid-70s, demand arose for increased catches of Bryde's whales, great difficulty was encountered in separating the statistics of past operations and hence in deriving population estimates on which to base catch quotas. The problems with the catch statistics have not yet been fully resolved, and the difficulties in identifying specimens at sea have not facilitated sightings surveys. In 1975 the Scientific Committee concluded that not enough was known about stocks to justify increased exploitation (IWC, 1977).

Some Bryde's whales were taken under Scientific Permit in the 1970s in the areas south of Madagascar, near north New Zealand, in the eastern Indian Ocean and off the Solomon Islands (IWC, 1980a). The Southern Hemisphere Bryde's whale stocks were fully classified and catch limits set by the IWC in 1979 (IWC, 1980b). Some subsequent changes have been made. For many stocks, no animals were taken, apart from the Scientific Permit catches, because these areas were closed to pelagic whaling or were included in the Indian Ocean Sanctuary even though catch limits had been set (see Conservation Measures section below for further details).

Population estimates for the Southern Hemisphere are derived mainly from sightings data from whaling fleet scouting vessels, using methods which would probably not now be regarded as adequate for the purpose of obtaining reliable population estimates. *The population figures quoted below should therefore be treated with great caution.* Since the raw data have not been published, it has not been possible to reanalyse them using modern techniques. Maps of the IWC stock divisions can be found in the Introduction to this volume. Although the discussion of populations below is structured according to the IWC stock divisions, it should be recognised that there is little basis for regarding these as delineations of discrete populations.

Northern Indian Ocean No information is available on status, distribution, number of stocks or abundance in the Indian Ocean north of the equator, although there have been some sightings off Sri Lanka reported in 1982 (IWC, 1983a). This stock was classified as IMS (Initial Management Stock) with zero catch limit, pending satisfactory estimates of stock size, in 1979 (IWC, 1980a). In 1980 it was decided to treat the whole Indian Ocean as a single stock area, defined as from 20°E to the coast of Australia and north to the coast north of the Equator. The total population was estimated at 13,854 and the exploitable population as 9,144. The Maximum Sustainable Yield (MSY) was calculated as 219, and the catch limit as 197 (90% of MSY), from sightings data (IWC, 1981).

Although there was no evidence of stock separation across the Equator in the Indian Ocean, a stock boundary was placed there for the time being in 1981 for management purposes, by analogy with the Pacific Ocean. A division of the northern stock area at 80°E is shown on the accompanying map but not mentioned in the text. The catch limit calculated the year before for the whole Indian Ocean was quoted for the southern area only, and despite a note in the text agreeing to classify the stock in the northern Indian Ocean as IMS with zero catch quota, the accompanying Table shows the northern Indian Ocean stock as unclassified with zero quota (IWC, 1982). The map with the unexplained division in the northern Indian Ocean, and the 'unclassified with zero quota' have been quoted throughout subsequent IWC material. These problems were noticed in 1984, and it was explained that the dotted lines of the Indian Ocean stock areas represented the opinions of some members of the Scientific Committee at the time which were not recorded in the text. Beyond noting the fact that incorrect classifications had been adopted, no further action was taken (IWC, 1985a).

North Atlantic The species has probably not featured greatly in commercial catches in this area, and no data on abundance from sightings is available (IWC, 1977). In 1978 the stocks were classified as IMS with zero quota pending satisfactory estimates of stock size (IWC, 1979). Since that time no further information on the abundance of North Atlantic Bryde's whales has emerged.

North Pacific The management of North Pacific Bryde's whales as three stocks was first put forward in 1979 (IWC, 1980a).

Western North Pacific This stock has a long history of catching, and various population estimates have been put forward over the years. The most recent full assessment was made in 1985, and mark-recapture data gave an exploitable population of just over 32,000 in 1946, and of around 23,500 in 1987, indicating a classification as IMS. Similar calculations, but based on sightings data, gave the 1946 exploitable population as around 26,000, and the 1987 population as just over 17,000, indicating a classification as SMS (IWC, 1986a). However, the Commission retained the IMS classification (IWC, 1986b).

In 1988 evidence was put forward suggesting that animals taken off the Pacific coast of Japan and off the Bonin islands were separate stocks, one inhabiting the coastal Kuroshio current area and the other the offshore Kuroshio counter-current area. Other evidence suggested segregation, but not necessarily stock separation. An analysis of sightings data gave a total population estimate of 18,000 animals. A revised catch series, going back to 1899, was also available. When further recommended work on the sightings and stock identity data is completed, a new assessment of this stock is to be attempted (IWC, 1989).

Eastern North Pacific There is so far no information on the status or abundance of this stock, although it does not appear to have been exploited to any great extent. It was classified IMS with zero catch limit pending satisfactory estimates of stock size in 1978 (IWC, 1979). No further information has been forthcoming, although there is a photo-identification study in progress in the Gulf of California, Mexico and the eastern North Pacific, which has a catalogue of 180 animals so far (IWC, 1990).

The population in the area between 10°N and 7°S and from 90° to 110°W was estimated as about 10,000 in total (IWC, 1979). The boundary between the IWC Eastern and Western stocks is 160°W and the southern boundary is the Equator. Thus, although quoted under Eastern Stock, this estimate in fact refers to the Peruvian stock (see below).

East China Sea This stock was first recognised in 1979. It was also pointed out that catches here reported as Bryde's whales by R Korea were in fact fin whales. However, Bryde's whales in this area were known to have been exploited by Japanese coastal operations for many years and catch statistics were available from 1955. In view of the long history of low-level whaling on this stock it was classified as SMS with a catch limit of 19 (the average reported yearly take), pending data analysis (IWC, 1980a). No whales were reported to have been taken from this stock between 1975 and 1980, but R Korea reported taking one in 1981. In response to enquiries about any catches, PR China responded that it does not undertake commercial whaling. There was some discussion as to whether the stock should be unclassified or not, but the Commission agreed to unclassified status, and lowered the catch limit to 10 (IWC, 1983a and b). In 1983 there was further discussion as to whether the catch limit should be zero or unchanged, although no catches had been reported. The Commission finally agreed to a zero catch limit, PR China commenting that this is a small stock from which any catch poses a serious threat in an area where some fish stocks are also seriously depleted (IWC, 1984a and b). Although no further debates on this stock had taken place in the Scientific Committee, and no further information was available, the Commission adopted the proposal of PR China in 1985 that it should be a Protected Stock, because the proponent believed the stock to be depleted (IWC, 1986a).

Wang (1984) however, mentions captures of this species in PR China: in October 1977 in Fu Jian Province, as well as (undated) captures 'quite often' on the coast of Guang Dong Province where the season extended from November to March. He says that 'some' have been recorded from Taiwan. Tonnessen and Johnsen (1982) also mention whaling activities by PR China from the mid-1950s, and Holt (1982) remarks on catches from Taiwan at an unknown level. It therefore seems that there may have been somewhat more exploitation of this stock than would appear from the records considered by IWC.

Southern Hemisphere These stocks were first classified in terms of the Southern Hemisphere baleen whaling Areas, but new stock divisions were introduced in 1980 and 1981 (IWC, 1981 and 1982).

South Atlantic This population appears to comprise a pelagic stock and a Brazilian coastal stock (and a coastal South African stock listed separately from 1981 - IWC, 1982). Very little information is available about these stocks and they were all initially classified as IMS with zero catch limits, although there was evidence of past exploitation. Particular concern has been expressed about the pelagic stock, which was exploited by the *Sierra*. (The *Sierra* was part of an enterprise whaling under flags of convenience outside the jurisdiction of the IWC - see Carter, 1979.) The 2,563 whales taken between 1969-1976 were reported as sei whales, but they were more likely to have been mainly Bryde's whales, given the location of capture (IWC, 1980a). It was estimated that 10% of the sei whales taken by the Brazilian land station were Bryde's whales, giving a total take of about 350 since 1947. However, this operation concentrated on minke whales from 1966 and only an average of three 'sei' whales were taken in later years (IWC, 1980a). In 1981 the Scientific Committee did not assess the South Atlantic stocks and did not attempt to revise their advice on them. However, in a Table summarising management recommendations the South Atlantic and South African Inshore stocks were shown as unclassified with zero catch limits - and this listing has been quoted in all subsequent IWC publications (IWC, 1982). (See above under Northern Indian Ocean for further details.)

South African Inshore Stock The cumulative catch between 1950 and 1967 was 808 whales, which included some small proportion of Bryde's whales from the pelagic stock. The coastal stock has not been exploited since that time. No information on status is available, although fears have been expressed that they may be adversely affected by competition with a purse seine fishery which takes pelagic fish species upon which the whales feed. This stock was classified as IMS with zero catch limits (IWC, 1980a). It has been listed as unclassified with zero catch limit from 1981 through an error in a Table (IWC, 1982). (See above under Northern Indian Ocean Stock for further details.) A cruise in 1983 provided data on which a population estimate of 519 (s.e. 84) was based, although it was remarked that this estimate would be biased downwards because of the many secondary sightings. In the light of the survey data the boundary of this stock was revised to read 'South African coast west of 27°E and out to the 200m isobath' (IWC, 1984a). This proposed change in stock boundary was overlooked by the Commission in 1983, but adopted by them in 1984 (IWC, 1985a and b). A photo-identification study is in progress on this stock, with a catalogue of 50 animals so far (IWC, 1990).

Peruvian Stock This stock was surveyed most recently in December 1982, and the exploitable population (animals over 10.7m in length) in 1983 estimated as in the range 5,723-25,550, with a central value of 15,638. The best estimate for the 1968 population was 19,426 (range 9,692 to 29,519). These figures indicated a classification of IMS (80-86% of initial), or in the worst case, Sustained Management Stock (SMS) (58% of initial). However, an analysis of catch data provided very much lower exploitable population estimates of between 5,000 and 6,000 in 1968 and between 1,400 and 2,400 in 1983, indicating that the stock should be classified as a Protection Stock (29-41% of initial) and no catches allowed. This led to much debate, but as Peru indicated that commercial whaling was to be phased out, a catch limit of 165 for 1984 was agreed, on the understanding that it would be lower the next year and zero thereafter. No classification was mentioned by the Commission, and the stock was listed as unclassified (IWC, 1984a and b). In 1984 disagreements in the Commission led to no catch quota or classification for this stock, although a footnote referring to a catch limit of less than 165 was unchanged in the Schedule (IWC, 1985b). No change in classification was made in 1985, but a zero catch limit introduced as a result of the moratorium on commercial whaling entering into force (IWC, 1986a).

Southern Indian Ocean It was estimated in 1980 that the Bryde's whale population of the whole Indian Ocean was 13,854, with an exploitable population of 9,144, from sightings data. An MSY of 219 gave a catch limit of 197 (90% of MSY). The recommended classification was IMS (IWC, 1981). When the Indian Ocean stocks were divided at the Equator in 1981 this catch limit was assigned unaltered to the Southern Indian Ocean stock and the classification remained IMS (IWC, 1982). (The broken line dividing this stock area on the IWC stock map is explained above under Northern Indian Ocean Stock.) There was some discussion at the 1982 meeting as to whether the sightings data were indeed such as to provide satisfactory population assessments, and in view of doubts about this the catch limit was reduced to zero pending further analyses (Holt, 1982; IWC, 1983a and b). No further discussion of this stock has taken place.

Solomon Islands Stock Japanese research work in the western South Pacific revealed a population of Bryde's whales in the Solomon Islands area where the adults were much less than 12.2m in length. The total population was estimated as about 1,800, but this figure was considered highly unreliable because of the limited number of sightings on which it was based. Since the pelagic limit for the taking of Bryde's whales is 12.2m, no whales could be exploited here. The proposed classification was IMS with zero catch limits (IWC, 1980a). Doubts were raised in 1982 about the quality of the work on which these conclusions were based, particularly as the stock was identified on the basis of a very small sample. It was proposed that this stock be re-integrated with the rest of the Western South Pacific stock pending further investigations, but this was not taken up by the Commission (IWC, 1983a and b). No further information has become available on this stock.

Western South Pacific Stock Sightings data from Japanese vessels were used to calculate a total population estimate of 59,400 (exploitable population 53,900). However, as this was based on only 214 sightings for 37,952 miles searched, doubts were expressed about the reliability of this estimate, and the stock was classified as IMS with zero quota (IWC, 1980a). Revised sightings data were used in 1980 to calculate a total population estimate of 16,585 and exploitable population estimate of 10,940. This gave an MSY of 219 and a catch limit of 237 (90% of MSY), although there were calls for improvements in the data before catch limits were set (IWC, 1981). The catch limit was reduced to zero in 1982, after further doubts about the data were expressed, until new information could be obtained (Holt, 1982; IWC, 1983a and b). No further information has been forthcoming, although it is known that operations from the Philippines took Bryde's whales in recent years.

Eastern South Pacific This stock was said never to have been substantially exploited (IWC, 1981), but according to Tonnessen and Johnsen (1982) 'substantial' baleen whale catches were made from Chilean and other operations, and in this area Bryde's whales could well have been included but not reported as such. Various population estimates were calculated in 1980, from sightings data. The estimate adopted was a total population of 13,194 and an exploitable population of 8,708. This gave a MSY of 200, a catch limit of 188 (90% of MSY) and a classification of IMS (IWC, 1981). Doubts were raised about the validity of the data on which this estimate was based in 1982, and the catch limit was reduced to zero (Holt, 1982; IWC, 1983a and b). Gallardo, Arcos, Salamanca and Pastene (1983) reported that the Chilean whaling industry started around the 1880s, and that records have been kept since 1929. They believed that most 'sei' whales caught were actually Bryde's whales. Gallardo and Pastene (1983) attempted to separate the catch statistics for the two species for the years 1946-1979, assuming (on the basis of the ratio in recent catches off Peru) that 90% of the recorded 'sei' whales were Bryde's whales. This gave a total take of 1,380 Bryde's whales, with an annual mean of 43 animals. The total sei whale take would have been 153 animals, with an annual mean of five. Considerable doubt was expressed about the use of the ratio derived from the recent Peruvian catches, but the IWC subcommittee did agree that a substantial number of Bryde's whales had probably been removed from this stock. It was believed that these catches had had an effect on the stock, and it was consequently proposed that the stock be unclassified with zero catch limit (IWC, 1984a). The Commission, however, did not debate this and merely approved the existing classification of IMS and the zero catch limit (IWC, 1984b). No further information on this stock has been forthcoming.

Habitat and Ecology The average body length of Bryde's whales is about 13m, with a maximum of 15.5m. Females tend to be slightly larger than males of the same age. Females are sexually mature at about 12.5m, males at about 12.2m. However, the inshore forms are slightly smaller than the offshore forms, and the putative Solomon Islands stock has been reported to be all well below the 12.2m limit for pelagic commercial exploitation (see above under Population).

Assuming that one lamination in the ear plug occurs each year, females reach sexual maturity at 10 years of age and males between the ages of 9 and 13. It appears that inshore populations may breed throughout the year, but that pelagic stocks give birth in autumn and winter. Gestation lasts about a year, lactation probably less than a year, and females usually give birth every second year. Newborn calves are about 3.4m in length.

Though euphausiids may be an important component of the diet in some areas, both coastal and offshore forms seem to prefer schooling fish, including pilchards, anchovies, herring and mackerel. Bonito and cephalopods have also been reported in the diet, as well as sharks, but it appears that the penguins reported from one stomach are much more likely to have been ingested inadvertently while feeding on fish (Cummings, 1985; Leatherwood and Reeves, 1983; Omura, 1966; Kuzmin, Ivashin and Vladimirov, 1979; Best, 1977).

Bryde's whales are usually seen singly or in small groups of up to seven animals (Rice, 1979; Kuzmin, Ivashin and Vladimirov, 1979; Cummings, 1985).

Threats Much of the available information on the exploitation of Bryde's whales has already been given in the Population section above. Besides the operations mentioned here, catches of Bryde's whales have also been made from the Philippines and from Taiwan in the Western North Pacific stock area. Some of the earlier land and pelagic operations by various countries in tropical and warm temperate waters may also have caught this species (Tonnessen and Johnsen, 1982). However, with larger species the main target, the earlier operations are unlikely to have inflicted great damage on the populations. Except for the Pacific and southern African populations, most stocks of Bryde's whales have not been exploited to any great extent.

There was interest in the possibility of exploiting Bryde's whale stocks more widely in the 1970s, as the quotas for other species were reduced or terminated. Japan conducted several research cruises (including taking 225 whales in the Indian Ocean and 234 in the western Pacific under Special Permit between 1976 and 1979) in areas closed to pelagic baleen whaling (Ohsumi, 1980). The USSR also made some limited investigations south of Madagascar in 1977 (including taking five animals under Special Permit) (Kuzmin, Ivashin and Vladimorov, 1979). Ohsumi (1980) lists the products obtained from the experimental Bryde's whale catch in the Indian and Pacific Oceans as oil, collagen peptide, various types of frozen meat and blubber, and other frozen products. Production of oil was about 9% of that of a blue whale (1.660 tons per animal). An average of 9.346 tons of products suitable for human consumption were obtained from each whale. As the average body weight was estimated at 13.66 tons, 68.4% of the total body weight could be used for human consumption.

There was no further exploitation of Bryde's whales in the Southern Hemisphere following the IWC moratorium on pelagic whaling (other than for minke whales) adopted in 1979, apart from the existing coastal fisheries in Peru and Chile, perhaps because there were no other major concentrations near to a coast that would have rendered coastal exploitation practicable.

Conservation Measures Putative countries of origin are all those with coastlines in tropical and warm temperate waters. In view of the confusion with sei whales, a list of previously published Bryde's whale records is unlikely to provide any accurate representation of those countries with responsibility for the Bryde's whales in their waters. All countries within or near the general distribution area should therefore investigate whether or not this species is present, and publish their records and other findings. Other countries may also have conservation responsibilities through trade or the registration of shipping. The latter is particularly important, in view of the *Sierra* episode (Carter, 1979).

CRW and PCSP protect mothers and calves, but the major international protection for this species originates with the ARW in 1937. This agreement closed certain areas to pelagic baleen whaling, with the intention of protecting the species on their winter grounds to provide better catches in the summer whaling season. At that time Bryde's whale was of little interest to the industry, and its distribution and habits more or less unknown. However, it so happened that the areas closed to pelagic baleen whaling covered much of the Bryde's whale distribution. The ARW provisions restricting pelagic baleen whaling were included in the IWC provisions. The declaration of the Indian Ocean Sanctuary by IWC in 1979 extended full protection to all species in this area (IWC, 1980b). IWC now protects Bryde's whales in all waters, through the current moratorium on commercial whaling.

Bryde's whale was listed in Appendix II of CITES, but was moved to Appendix I in 1986. Austria, Brazil, Japan, Peru and USSR have entered reservations against this listing, and for these countries this species remains on Appendix II. The following international trade is recorded: 1984 - 1 bone from Pakistan to UK, 1 skull from Pakistan to UK (CMC, 1987). It is, however, reasonable to assume that some of the large consignments reported as 'Cetacea spp.' contained Bryde's whale products (e.g. Holt, 1982). Thus the transactions recorded under the species name give very little indication of the true scale of international trade and it is therefore very important for conservation through CITES that the practice of declaring consignments in such broad terms ceases. No other international agreements mention Bryde's whale, but the species is protected by general national legislation in several countries.

The recent exploitation history of Bryde's whale is unique in that much of the distribution area was closed to pelagic baleen whaling from the 1930s, and that full harvesting was delayed while stock assessments were made. This is in contrast to the exploitation of the other large whales, where quotas were assessed during harvesting or no quotas at all were used until a very late stage in the exploitation. The activities of the *Sierra*, and other catching outside the IWC system has threatened the IWC policy, but these operations have now ceased. However, this does illustrate the importance of full international cooperation if such conservation measures are to be fully effective.

Concern has been expressed about the stocks off South Africa and in the East China Sea because of depletion of food fish species (see above under Population), as well as off the western coast of South America (Holt, 1982), and this should be investigated.

The major conservation need is for more information on distribution, abundance, stock identity, biology and behaviour throughout the range.

The IUCN/SSC Action Plan has no specific projects relating to Bryde's whale, but it will be covered by general projects such as interactions with fisheries (Perrin, 1989).

Captive Breeding Bryde's whale is too large for conservation through captive breeding to be feasible, although one specimen was recently held at Sea World Florida and later released alive (Brownell, 1989).

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BLUE WHALE **ENDANGERED**

Balaenoptera musculus (Linnaeus, 1758)

Suborder MYSTICETI Family BALAENOPTERIDAE

Summary The blue whale has been severely depleted throughout the range by commercial whaling, but protected by IWC since 1964. There are reports of increased sightings in some areas, but insufficient information to confirm any population increases. Recent surveys in the North Atlantic and the Antarctic have provided new data on the surviving populations. Of greatest concern are the small remaining numbers of the Antarctic blue whale: an estimated 660 (c.v. 1.07) as compared with an original population of between 160,000 and 240,000. The species is listed as Endangered, pending evidence of recovery, because the major sub-species, *B. m. musculus*, is considered to have been depleted to a critical level. Further clarification of the range of each of the recognised sub-species, enabling them to be listed separately, would be desirable. Continued comprehensive, and effective, national and international protection is necessary.

Distribution The blue whale is virtually cosmopolitan, occurring in all major oceans of the world. It prefers cold waters and open seas, and does not concentrate in coastal areas. For all practical purposes the Northern and Southern Hemisphere stocks do not mix. An occasional animal may stray into the other area, but the six month difference in breeding cycles probably precludes interbreeding. The Northern and Southern Hemisphere stocks are sometimes regarded as separate sub-species: *B. m. musculus* (Linnaeus, 1758) and *B. m. intermedia* (Burmeister, 1871). Doubts have also been expressed about the taxonomic status of the pygmy blue whale, *B. m. brevicauda* Ichihara, 1966 (sometimes attributed to Zemsky and Boronin, 1964), although the IWC (1980; 1981) have accepted the separation. The detailed measurements on which Ichihara (1966) based his diagnosis were published posthumously (Anon., 1984). Pygmy blue whales are known mainly from the subantarctic waters of the Indian Ocean and southeast Atlantic, although they have been reported in other parts of the world (e.g. northern Indian Ocean, Chile, Peru) (Yochem and Leatherwood, 1985).

Yochem and Leatherwood (1985) have recently reviewed the blue whale in detail. For the present purpose their practice of referring to blue whales (*B. m. musculus* and *B. m. intermedia*) and pygmy blue whales (*B. m. brevicauda*) is followed.

Northern stocks The North Atlantic population is regarded as two stocks (Jonsgård, 1966); a West Atlantic stock found from the coast of the Carolinas in winter to the pack ice of the Davis Strait and Southern Greenland in summer (Allen, 1916) and an East Atlantic stock wintering at the Cape Verde Islands (Kirpichnikov, 1950) and moving to Spitzbergen, as far north as 80°N (Scoresby, 1820) and the Barents Sea in summer.

The North Pacific population is also regarded as having eastern and western stocks (Nishiwaki, 1966). The western stock winters around Ogasawara Island, Taiwan, Japan and the Korean peninsula and migrates in summer to the north of Japan, Kamchatka, the Kurils and Chukotka. The eastern stock moves close to the central and eastern Aleutian Islands and the coast of Alaska in summer and migrates to Southern California and Baja California, Mexico in winter, to within 8° of the equator. There may be a pygmy stock resident near California and possibly linked with the population off Peru (IWC, 1981).

Reilly and Thayer (1990) report the majority of sightings in the Eastern Tropical Pacific as off Baja California and in the vicinity of the Costa Rica Dome (a large, stationary eddy centred near 9°N 89°W) with the rest made along the equator near the Galapagos Islands, the coasts of Ecudor and northern Peru. These authors, however, consider it premature to designate these animals as to sub-species. Individuals sighted off Baja California have also been re-sighted in the Gulf of the Farallones or Monterey Bay (Calambokidis *et al.*, 1990). Both studies provide further evidence for resident blue whale populations in this area.

Southern stocks In the Southern Hemisphere, the blue whale summers in the Antarctic and winters near South Africa, South-West Africa, in the Indian Ocean and off the coasts of Australia and South America. Most blue whales have been harvested in the South Atlantic, between South Africa, South Georgia and the Weddell Sea (Gaskin, 1972).

There are a small number of blue whales near the West Australian coast (Chittleborough, 1953) and New Zealand. Little is known about blue whales in the northern Indian Ocean (Daniel, 1963; Mackintosh, 1965), although there have been some recent sightings, possibly of pygmy blue whales off Sri Lanka. The reports from the northern Indian Ocean cover almost all the year, perhaps indicating that this is a separate, non-migratory, stock (Yochem and Leatherwood, 1985).

The pygmy blue whale has an almost entirely separate distribution (Ichihara, 1966). The main herd of pygmy blue whales lives in the waters off Marion Island, the Kerguelen Islands and the Crozet Islands. The principal distribution zone extends from 80°E to 0° in the Antarctic summer to north of 54°S. A small group has been reported on two occasions 8°S near the Galapagos Islands (Berzin, 1978) and a number of reports from other areas are given by Yochem and Leatherwood (1985), although Reilly and Thayer (1990) consider these reports premature for lack of adequate evidence.

Population Various estimates of original and current abundance of blue whales are tabulated by Yochem and Leatherwood (1985). However, few of these can be considered reliable, not being based on direct surveys. Estimates from direct survey data are only available for the North Atlantic and the Southern Ocean (see below).

North Atlantic Stocks Original estimates for this group are in the region of 15,000; with about 10,000 of these from the Denmark Strait stock, around 3,500 from northern Norway (FAO, 1978; Yochem and Leatherwood, 1985) and 1,100-1,500 from the Canadian coastal area (Gambell, 1976). Results from the North Atlantic sightings survey (NASS87) yield an estimated population of 442 from the Icelandic part (Gunnlaugsson and Sigurjónsson, 1990), but this is described as an 'upper estimate' by the authors because track-widths appropriate for fin whales had been used, and no confidence interval is given. One blue whale was seen in the Norwegian part of the survey (Øritsland *et al.*, 1989), two off Greenland (Larsen, Martin and Nielsen, 1989) and none in the Faeroese or Spanish parts (Lens, Quiroga and de Sola, 1989). Rorvik and Jonsgård (1981) calculated an increase in blue whales in the North Atlantic of 15.6% per annum from 1957 to 1971, from sightings data reported from the Icelandic whaling grounds. However, such a high rate of increase does not seem consistent with what is normally believed about the life cycle and vital rates of blue whales. A more detailed analysis of similar, more recent, data by Sigurjónsson and Gunnlaugsson (1990) yields an average rate of increase over the areas covered of 5.2% per year, but the rates in different sub-areas range from a 14.7% p.a. *decrease* to a 23.4% p.a. increase. It is not clear that monitoring the trend in a limited area provides a consistent guide to the rate of change in the population as a whole; a sequence of surveys covering most of the summer range of the North Atlantic blue whale would be required to ascertain whether the population is increasing. Over 190 individuals have now been identified using pigmentation patterns within the Gulf of St Lawrence, over some 11 years, with 25% returning regularly to the same area (IWC, 1988; 1989).

North Pacific Stocks This group has been estimated to have numbered about 5,000 in 1910 (FAO, 1978; Gambell, 1976). Present estimates range from 1,400 to 1,900 (Yochem and Leatherwood, 1985). Ninety seven individuals have now been identified, using pigmentation patterns, from the Sea of Cortez, and four of these animals were resighted off Monterey, California. Sightings from the Gulf of California and the Mexican Pacific suggest that the stock in this area may be one of the least depleted. About 220 animals have so far been individually identified in the California/Mexico area (IWC, 1988; 1989). Up to 20 pygmy blue whales at a time were seen in March and June 1975 in the eastern Pacific; in 1980 about 40 were seen off California (IWC, 1988).

Antarctic stock There were 22 primary sightings of blue whales from the first IWC/IDCR circumpolar series of sightings cruises, conducted over the period 1978-84, resulting in an estimated population of 453 (c.v. 0.836) (IWC, 1990b). This estimate has subsequently been extended to cover all the waters south of 50°S in January and February using Japanese scouting vessel data (Borchers, Butterworth and Kasamatsu, 1990), to yield a revised estimate of 660 (c.v. 1.00). They considered sightings of blue whales north of 50°S in these months to consist primarily of pygmy blue whales (*B. m. brevicauda*), the population of which they estimated at 6,500 (c.v. 1.01). The relative variances are high because of the very low density of both forms of this species. The range of uncertainty spans a factor of approximately five-fold in each direction. Because of the inevitable imprecision of population estimates of such rare animals, it would require well over 50 years of such surveys before an increasing trend in the 'true' blue whale (*B. m. musculus*) could be detected. The pre-whaling stock (i.e. at the beginning of this century) was between 160,000 and 240,000, based on the catches taken and a reasonable range of values for the productivity of the stock (Butterworth and DeDecker, 1989).

Other sightings of blue whales include one reported off Kangaroo Island, South Australia in April 1987, six sightings off New Zealand in 1986 and 13 there in 1987 (IWC, 1989).

Indian Ocean stock Little is known about blue whales in the northern Indian Ocean, although there have been sightings reports, possibly of pygmy blue whales, off Sri Lanka. These reports cover almost all the year, perhaps indicating that this is a separate, nonmigratory stock (Yochem and Leatherwood, 1985). Some 32 animals have been individually identified off northeastern Sri Lanka between 1983 and 1984 (IWC, 1990a).

Habitat and Ecology The blue whale is the largest animal ever to have lived on Earth. The longest recorded blue whale was a female from the Antarctic of 33.58m (Risting, 1922), and the longest pygmy blue was 24.4m (Ichihara, 1966). Females are slightly larger than males of the same age (Gaskin, 1972).

Blue whales feed almost exclusively on a few species of euphausiids or krill. In the North Pacific *Euphausia pacifica*, several *Thysanoessa* spp., *Nematoscelis megalops*, copepods of *Calanus* and *Sergestes* spp., amphipods, squid and possibly 'red crabs' *Pleuroncodes planipes* are taken. In the North Atlantic *Thysanoessa* spp., *Meganyctiphanes norvegica* and the copepod *Temora longicornis* are recorded as prey. In the Southern Hemisphere blue whales feed almost exclusively on *Euphausia superba*, although *E. crystallarophias*, copepods and amphipods are additional prey items. The preferred food of the pygmy blue whale in the Antarctic is *Euphausia vallentini*; off South Africa *E. recurva* and *E. diomedeae*, in the proportion 3:1, were found in the stomach of one pygmy blue whale. Although blue whales have been reported to feed on small fish, such as sardines and capelin, it has been suggested that such fish are probably ingested accidentally (Yochem and Leatherwood, 1985).

Blue whales feed in summer in polar waters, apparently fasting after leaving the feeding grounds, although there are a few reports of blue whales feeding in sub-tropical waters (Yochem and Leatherwood, 1985; Reilly and Thayer, 1990; Calambokidis *et al.*, 1990). Nemoto (1957) observed that whales migrate into feeding areas earlier in years when the krill bloom occurs early in the season. Analyses of stomach contents suggest a feeding peak during the evening and early morning, apparently coinciding with the vertical daily movements of the prey.

Female blue whales become sexually mature at 21 to 23m in the Northern Hemisphere, and 23 to 24m in the Southern Hemisphere. Length at physical maturity is 25m in the Northern Hemisphere and 26 to 27m in the Southern Hemisphere (Yochem and Leatherwood, 1985). Female pygmy blue whales are sexually mature at about 19m and physically mature at about 22m (Ichihara, 1966). Male blue whales are 20-21m at sexual maturity and 24m at physical maturity in the Northern Hemisphere; 22m at sexual maturity and 24-25m at physical maturity in the Southern Hemisphere (Yochem and Leatherwood, 1985). Male pygmy blue whales mature sexually at less than 19m, and are physically mature at 21m (Ichihara, 1966).

Age is determined in baleen whales by analysis of growth layers in the waxy ear plug (Purves, 1955). Unfortunately, so few blue whales were caught after this method was developed that information on the age structure of stocks is inadequate, presenting a major problem for estimates of population parameters (Chapman, 1974). A further problem is that, in the past, it was assumed that two growth layer groups were formed each year, but it is now believed that one layer is formed. The estimate by Ruud *et al.* (1950) of sexual maturity at five years for both sexes and hemispheres should therefore be doubled to ten years. Maximum age estimates range from 30 to 80-90 years, but should be treated with some caution because of the methodological problems mentioned above (Slijper, 1962; Nishiwaki, 1972; Brown, 1978).

After attaining sexual maturity, female blue whales give birth to a single calf every 2 to 3 years, following a gestation period of 10-11 months. Multiple embryos have been reported, but are apparently rare. Calves are 6-7m long at birth, and are weaned at 7 months, by which time they are 16m long (Yochem and Leatherwood, 1985).

Mating and calving take place in the warmer waters, but no specific breeding grounds have been identified. The wintering and breeding grounds of the pygmy blue whale are also unknown (Ichihara, 1966). The blubber of the newborn is thought not to be sufficiently thick to tolerate the cold waters.

Blue whales are generally not gregarious, usually travelling in twos or threes. Mother and calf pairs are often observed away from schools of males and other females (Nemoto, 1964). Most large aggregations of blue whales tend to be associated with feeding grounds (Yochem and Leatherwood, 1985).

Threats - Historical As the largest and most valuable rorqual, the blue whale was the preferred target of the modern whalers. From the late 1800s the major hunt was in the North Atlantic and North Pacific. These stocks were quickly depleted, and in the early 1900s the main hunt moved to land stations in the Antarctic, although land stations were also active in many other parts of the world. In the 1920s the introduction of the floating factory ship opened up the entire Antarctic, and other oceans, to whalers (Tonnessen and Johnsen, 1982). The blue whale harvest peaked in the 1930-31 season, with nearly 30,000 taken worldwide. It is estimated that over 280,000 blue whales (including pygmy blues) were taken between 1924-25 and 1970-71 (Chapman, 1974). Whaling before the 1940s was extremely wasteful, with only the blubber removed for processing into oil. It was even possible for one company in South Georgia to make a living through processing some of the stripped carcasses. The industry became very much more efficient after 1946, because IWC required the full utilization of all whales caught (Tonnessen and Johnsen, 1982).

In the past, the primary objective of blue whaling was oil, which was used as a cheap base for glycerine, margarines and soaps. Today, the most valuable product would be meat for human consumption, with the oil as a comparatively low-value by-product. The multitude of other secondary products; bone meal, solubles etc. arise from the IWC requirement to utilize all the carcass, and are not sufficiently valuable in themselves to justify hunting. Except for choice cuts, the meat, oil and other products are not traded on the basis of species of origin and would, in the majority of cases, be mixed with similar products from other whales.

The concentration of effort on blue whales in the past was simply because of their large size. Whaling quotas were set by IWC in Blue Whale Units (BWU) from 1946 to 1972. The BWU represented 1 blue whale, 2 fin whales, 2 1/2 humpbacks or 6 sei whales, and was based on the approximate relative oil yield. Very much less effort was required to catch one blue whale than six sei whales, therefore, even when blue whales became scarce, it was still of great advantage to take any animal which was encountered. Although doubts were expressed in many quarters, almost from the beginning of modern whaling, as to whether the stocks could withstand such heavy catching, the first clear evidence that blue whale stocks were being over-exploited was presented in the 1930s (Laurie, 1937). Concern about the state of blue whale stocks emerged within IWC in the 1950s, but it was not until 1964 that there was agreement to stop taking blue whales (FOE, 1978).

Threats - Present The International Whaling Statistics show no catches after 1971, but except for IWC, ICRW and ARW members, the registration of such information is voluntary. At least three animals were taken more recently by non-IWC members in the North Atlantic (IWC, 1980). The report (Seychelles, 1979) on whaling under flags of convenience describes these enterprises, which went to great lengths to operate outside national and international controls, using the flag of countries not party to agreements. These enterprises are now closed, but as long as there are countries which do not control whaling it is possible for such catching to start again.

In the past, almost all trade would have been covered by the CITES definition of International Trade, since the vast majority of blue whales were taken outside territorial waters and therefore fell into the category of Introduction from the Sea. Only animals taken in national waters and used within the country would not have been recorded. The following transactions appear in the CITES records: 1983 - 3 unspecified consignments from Indonesia to USA and 9 consignments of meat from Japan to USA (illegal, seized on entry), original country of origin unknown; 1984 - 7 specimens from Norway to USA (illegal, seized on entry); 1985 - 1 specimen USA to Canada (CMC, 1987). The sizes of these consignments and specimens are not stated, so it is not clear what quantities were involved. Nor is it stated whether these were items which had been obtained at some earlier date, originated from strandings or from newly caught specimens.

Conservation Measures Because the blue whale is a cosmopolitan, oceanic species, discussion of national and international protection status involves every country with a sea coast and every country registering shipping, since catch control on the high seas can only be exercised through the flag country. Some of the international agreements, such as IWC, also cover catches in territorial waters. Countries without coasts or shipping may also be involved where products enter international trade. In general, the blue whale is very widely protected throughout the world, often through incorporation of international agreements into domestic legislation. It is listed on Appendix I of CITES, has been completely protected (PS) by IWC since 1964 (IWC, 1966), and is mentioned by more or less all the other international agreements with provision for protecting named species.

In view of the great value of a specimen, particularly as meat, the incentive to take any animal encountered on a whaling expedition must be great. Although this species is too rare to be the main target species of any fishery, it is vulnerable to generic baleen whaling operations, especially 'pirate' whaling operations operating under flags of countries not members of the IWC or CITES.

To give the blue whale the best chance of undisturbed recovery, comprehensive protection from catching is essential. The keys to this lie in control via the flag country of exploiting ships on the high seas, through national controls to prevent taking within territorial waters and EEZs or by land based operations catching on the high seas, and by trade controls in all countries. Every country in the world, therefore, should be encouraged to have adequate legislation for these purposes. Because the blue whale is an oceanic species, there would appear to be little practical scope for aiding recovery of the populations through habitat protection. Except in certain limited areas, such as the Gulf of St Lawrence, the population density is too thin to enable any recovery to be detected from surveys except over a very long period.

The IUCN/SSC Cetacean Specialist Group Action Plan contains no specific projects relating to this species, although it will be included in general monitoring (Perrin, 1989).

Captive Breeding The potential for live capture and maintenance is nil, in view of the insurmountable problem of feeding even if suitable accommodation could be found. Consequently captive breeding could never play a role in conserving this species.

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FIN WHALE VULNERABLE

Balaenoptera physalus (Linnaeus, 1758)

Suborder MYSTICETI Family BALAENOPTERIDAE

Summary Fin whale populations in all oceans have been greatly reduced by commercial whaling, but the species has been protected from commercial whaling in all areas except the North Atlantic since 1975. There is so far no evidence of recovery in any of the protected stocks. The plans to recommence commercial fin whaling in the North Atlantic in 1991 or 1992 will become a source of concern if they are realised before a satisfactory procedure for regulating catches with sufficient conservation safeguards has been implemented by the IWC. Because most or all populations have been depleted by over-exploitation, the species remains listed as Vulnerable pending evidence of satisfactory recovery. Continued and improved national and international protection is required to allow depleted stocks to recover and to prevent any uncontrolled catching.

Distribution The fin whale has been reported from all the oceans of the world. It makes regular seasonal migrations between temperate waters, where it mates and calves, and the more polar feeding grounds occupied in the summer months. Evidence for the seasonal migrations is available from recoveries of marked whales, the seasonal pattern of whaling, and sightings of whales at particular times of the year from survey vessels. Because the seasons are opposite in the two hemispheres, the northern and southern populations of whales do not move towards the equator at the same time, although it is possible that occasional interchanges of individuals can occur sufficient to prevent the genetic isolation of the northern and southern populations. However, because the form in the Southern Hemisphere grows slightly larger than that found in the Northern Hemisphere, some authorities recognise a northern subspecies *B. p. physalus* distinct from the southern *B. p. quoyi* (Fischer, 1829; Gambell, 1985), but for the present purpose a single species of *B. physalus* is recognised, following current practice (e.g. Gambell, 1985).

North Atlantic Fin whales summer from the North American coast to the Arctic, around Greenland, Iceland, north Norway, Jan Mayen, Svarlbard and the Barents Sea. The wintering areas extend from the ice edge southwards to the Caribbean and the Gulf of Mexico in the west, and from southern Norway, the Bay of Biscay, and Spain in the east. Some fin whales migrate into the Mediterranean, although the species is present there throughout the year (Gambell, 1985).

There appear to be a number of small independent stocks of fin whales in the North Atlantic (Mitchell, 1973; Sergeant, 1977). The evidence of catch histories and length frequencies has led to the adoption of the stock divisions shown in the IWC maps in the introduction for management purposes. However, this subdivision has been questioned, and the suggestion made that there is in fact only a single stock, which has become focused in certain areas as the numbers were reduced by whaling. In addition, Kellogg (1929) suggested that the stock(s) are stratified, the summer feeding grounds of some fin whales being occupied during the winter by whales which have spent the summer further north.

North Pacific In summer fin whales are found in the Chukchi Sea, around the Aleutian Islands, in the Gulf of Alaska and down to California in the east. In the west they occur from the Sea of Okhotsk down to the coast of Japan. The winter grounds extend from California southward in the east, and from the Sea of Japan, the East China and Yellow Seas, through the Philippine Sea in the west. There appears to be a resident population of fin whales in the Gulf of California (Gambell, 1985).

There is evidence from whale marking, blood typing and morphological analyses for three stocks, although those on the eastern and western sides of the ocean intermingle and overlap to varying extents in the Aleutia area. The eastern and western stocks have been arbitrarily divided at 130° for management purposes. The third stock is that in the East China Sea, which is typified by longer head and shorter tail regions than are observed in the other Pacific Ocean stocks (Ichihara, 1957) and in which sexual maturity may be reached at a smaller size (Fujino, 1960).

Southern Hemisphere Fin whales are broadly distributed south of 50°S in the summer months, although they do not occur right up to the ice edge. They migrate into the southern Atlantic, Indian and Pacific Oceans in winter, along both coasts of South America as far north as Peru and Brazil, along both coasts of Africa north of South Africa and to the islands north of Australia and New Zealand, as well as to the central ocean areas far from shore. The fin whales tend to enter and leave the Antarctic after the blue whales, but before the sei whales. The bigger and older animals generally penetrate further south than the younger whales. Also, pregnant females arrive in advance of the other classes, males precede non-pregnant females, and the immature animals arrive last (Laws, 1961). This pattern of travel is not so apparent in the Northern Hemisphere (Gambell, 1985). It is not known, however, just what percentage of whales take part in migration. At one time, harvesting of whales continued throughout the winter at South Georgia, suggesting that not all of the whales migrated northwards in the autumn (Laws, 1961). Similarly Brown (1957) has reported that some fin whales appear to remain in equatorial waters for the duration of the summer.

From whale mark recoveries, iodine values of whale oil, the length composition of catches, and serological studies, it is thought that separate breeding stocks exist broadly on each side of the three oceans, and that in addition there are stocks in the central Pacific and Indian Oceans. These proposed stocks overlap and intermingle to a limited extent on the Antarctic feeding grounds (Ivashin, 1969; Gambell, 1985).

Population Because of the need to provide quantitative advice as the basis for management decisions, the IWC Scientific Committee placed considerable emphasis on estimating the population sizes of fin whale stocks while they were being harvested. However, as more and more stocks were put under protection, or were not fished for other reasons, the analyses were not updated. As a result, many published estimates of fin whale stocks are based on methods since found to be unreliable, particularly methods based on crude analyses of Catch Per Unit Effort (CPUE) data. The most widely quoted figures for the current population in the Southern Hemisphere and the North Pacific are 103,000 and 20,000 respectively (Allen, 1980; Gambell, 1985), both of which are liable to be over-optimistic.

Direct survey data from the first circumpolar series of IDCR cruises have now been analyses, and a preliminary estimate of the abundance of fin whales south of 60°S during the survey periods (mainly mid-December to mid-February), is 2,096 (c.v. 0.47) (IWC, 1990a). However, it is probable that a considerable number of fin whales remain north of this area throughout the summer. Using Japanese scouting vessel data in addition to the IWC/IDCR data, Borchers, Butterworth and Kasamatsu (1990), estimated the total population south of 30°S in January and February at 24,000 (c.v. 0.55). Based on the numbers caught, a pre-exploitation population (i.e. the population at the beginning of this century) of between 300,000 and 650,000 can be presumed for the Southern Hemisphere (Butterworth and DeDecker, 1989). Because of the high exploitation rates, estimates of the initial populations are relatively insensitive to the current abundance estimates.

Population estimates for parts of the North Atlantic are available from the NASS87 sightings surveys: Icelandic part - 5,879 (c.v. 0.159); Faeroese part - 1,288 (c.v. 0.266) (Gunnlaugsson and Sigurjónsson, 1990); West Greenland - 1,985 (c.v. 0.46) (Larsen, Martin and Nielsen, 1989); Spanish part - 4,466 (c.v. 0.485) (Sanpera and Jover, 1989). 58 fin whales were seen in the Norwegian part but a population estimate was apparently not calculated (Oritsland *et al.*, 1989). Various estimates for various parts of the North Atlantic have been published at various times using methods of dubious reliability, and these are not reviewed here. A total of about 75,000 fin whales have been recorded caught in the North Atlantic by modern whaling, but in the early years of modern whaling there was probably considerable extra mortality due to whales struck and lost (Tonnessen and Johnsen, 1982). It therefore seems likely that current abundance is a low proportion of the pre-exploitation size, but the status of North Atlantic fin whales is due to be comprehensively reassessed by the IWC in 1991.

The Gulf of St Lawrence photo-identification catalogue contains 196 individuals (collected between 1979 and 1988). The catalogue for the eastern North Pacific, Gulf of California and Mexico contains 200 individuals (plus over 300 to be catalogued), collected between 1982 and 1986 (IWC, 1990b).

Habitat and Ecology The fin whale is second in size to the blue whale. The mean length and age at maturity and sexual maturity, based on catches, appears to vary from stock to stock. The average length of a Southern Hemisphere female is 22m, with a maximum of 27m, whilst that for a male is 20.5m, with a maximum of 25m. Icelandic fin whales are slightly smaller, the average length for a female being 18.5m and the males averaging 18m (Lockyer and Brown, 1979). Maximum sizes in the Northern Hemisphere are 22m for males and 24m for females. These figures, being based on catches, exaggerate the differences, since size limits are different in different areas and may only be reflections of past exploitation rates.

In the Southern Hemisphere, female fin whales become sexually mature at 19.9m and males at 19.2m. In the Northern Hemisphere, sexual maturity occurs at 18.3m in females and 17.7m in males. Age at maturity is estimated at 6-7 years (Ohsumi, 1972), but this figure may be biassed downwards somewhat by the selectivity of the catch against smaller animals. Analyses by Lockyer (1972) had suggested that the age at maturity of fin whales had declined from over 10 years in year classes born up to 1930 to only six years in recent times. However, these apparent declines are now thought to be artifacts of the method used, which involved a back-calculation of the age at maturity using data from older animals. There were also reports of increases in the pregnancy rate of fin whales, supposedly also a response to exploitation (Laws, 1961) but recent re-analyses of the data show that these apparent changes were an artifact arising from inappropriate pooling of data across the season (Mizroch and York, 1984). Although conceptions and births can occur at almost any time of year in the fin whale, most activity is confined to relatively short peak periods. In the Southern Hemisphere, 77% of conceptions take place in the four autumn and winter months between April and August (Laws, 1961). In the Northern Hemisphere, conceptions peak around the winter months of December and January. The female carries a single foetus for 11.25 months. At birth the southern calf averages 6.4m and weighs 1.9 tonnes (Laws, 1959). Lactation lasts for 6 or 7 months, and the calf is weaned in the summer feeding grounds, at about 12m in length. It appears that all newly weaned calves take crustaceans. The mother then passes through a resting stage before mating again in the winter. This stage may last another year if conception does not take place. More than one ovulation may occur during a breeding season (Gambell, 1985).

Fin whales may be found singly or in pairs. They commonly form larger groupings of 3 to 10 or 20, which may in turn coalesce into a broadly spread concentration of a hundred or more individuals, especially on the feeding grounds (Gambell, 1985). They form denser concentrations when feeding on gregarious fish but disperse when feeding on crustaceans. Herds have definite patterns, with the young and non-breeding whales oriented around mature males and the breeding females widely dispersed in small groupings (Tarasevich, 1967).

Fin whales tend to change their distribution in latitude and longitude according to their food distribution (Hjort and Ruud, 1929). In the Southern Hemisphere, the main food in the Antarctic is *Euphausia superba*. Other euphausiids may also be taken, particularly in lower latitudes (Gambell, 1985). In both the North Atlantic and North Pacific Oceans fish are commonly taken. Near the coast of Finmark, fin whales have been observed following and feeding on spawning shoals of capelin. Similarly, they followed spawning herrings in their migration to the south west coast of Norway (Ingebrigtsen, 1929). Cod, mackerel, pollock and sardine, together with squid, euphausiids and copepods are also taken. Food items may depend on availability as much as on preference in these northern areas (Gambell, 1985).

Breeding grounds are mainly in temperate or sub-tropical waters off the coasts of major land masses (Mackintosh, 1966; Clarke, 1962; Ivashin, 1969).

Threats - Historical The fin whale has been a major subject of commercial whaling since the late 19th century. The history of the fisheries is given by Tonnessen and Johnsen (1982). The stocks in the eastern North Atlantic were heavily fished, and the stocks off Newfoundland and Labrador exploited. There were similar coastal fisheries on both sides of the North Pacific. These northern stocks were relatively small and quickly depleted. Land-based whaling began in the Southern Hemisphere at South Georgia in 1904, but with the introduction of factory ships in the 1920s, catching spread all over the Southern Ocean.

The fin whale became increasingly important in the catches, especially after the blue whale had become relatively less abundant in the 1930s. Catches were also taken at the winter end of the migration routes by land stations in South Africa, Chile and Peru. The fin whale formed the mainstay of the Antarctic fishery through the 1950s and into the 1960s, but the declining stocks were protected from whaling in the 1970s. Commercial catching continued in the North Pacific until 1975, and until 1985 in parts of the North Atlantic.

Threats - Present With the IWC moratorium on commercial whaling from 1985/86, no commercial catches of fin whales should be made by IWC Parties. However, IWC allows 23 fin whales per year to be taken by local people in Greenland for their own use. Insufficient information is currently available on this stock for the effects of this level of catch to be evaluated, although research is in progress (see Population section above). A whaling operation in Iceland took up to 80 fin whales a year during 1986-90 under an permit granted by the Icelandic government for catches for the purpose of scientific research. Whether the purpose of this operation is genuinely scientific has been a matter of considerable controversy. There are plans to return to fully commercial catches of fin whales with this operation from the 1991 season, following a review of the status of the North Atlantic fin whale to be conducted by the IWC in 1991.

In the Mediterranean, heavy metal ions from waste dumped by industrial barges pollute the waters around Corsica, which are rich in euphausiids. Fin whales following these euphausiids become contaminated, and either die or become debilitated and more susceptible to being struck by the increasingly large numbers of boats in the area (Viale, 1974; Viale *et al.*, 1973).

Fears have been expressed about the potential effects of the exploitation of euphausiids in the Southern Ocean on the food supply of the whales. The northern fin whale has a much wider food range, and although some prey species may be over-exploited, the whales are likely to be able to switch to other, more readily available, foods.

In 1979 the IWC considered evidence that the East Greenland/Iceland stock abundance was changing because of the reported removal of up to 500 fin and sei or Bryde's whales by flag of convenience whalers. It was considered that the stock most likely to have been affected was that designated Spain/Portugal/British Isles, which was also exploited by Spain at that time (IWC, 1980). These operations have now ceased (see blue whale review).

Conservation Measures Because this is a cosmopolitan, oceanic species, discussion of national and international protection status involves every country with a sea coast, and every country registering shipping (since catch control on the high seas can only be exercised through the flag country). Some of the international agreements, such as IWC, also cover catches in territorial waters. Countries without coasts or shipping may also be involved where products enter international trade.

The fin whale is presently listed on Appendix I of CITES. Most of the international trade recorded by CITES under *Balaenoptera physalus* consists of scientific specimens taken from Iceland and Spain to the UK (CMC, 1987). However, it is likely that at least some of the large commercial shipments, for example between Iceland and Japan, recorded under Cetacea spp. contain fin whale products (mainly meat for human consumption). Reservations against listing certain fin whale stocks in Appendix I have been made by Norway, USSR and Austria. Commercial catching of fin whales has been prohibited by IWC, under their moratorium on commercial whaling. There are a number of other relevant international agreements, particularly those such as CCAMLR which protect food resources.

Much of the protection for this species under national legislation is given through incorporation of the provisions of international legislation into domestic legislation.

This species requires wide protection from unregulated catching, both in territorial waters and on the high seas. The Mediterranean population may be in some danger from pollution.

The major requirement is for the IWC to develop a satisfactory management programme, with catches outside this system firmly discouraged.

The CITES listing, which should be of considerable assistance in discouraging unregulated catches through denial of markets for products, appears to be less effective because commercial shipments do not declare the species included in mixed consignments. Detailed declaration of such consignments would greatly assist in discouraging unauthorised trade.

Reassessment of all the populations, on the basis of information from recent surveys, is long overdue. The IUCN/SSC Cetacean Specialist Group Action Plan contains no specific projects relating to fin whales, although this species will be included in general projects, particularly for monitoring subsistence and research fisheries (Perrin, 1989).

Captive Breeding This species is very large, and is quite impractical to keep in captivity. Therefore captive breeding could never play any role in conservation.

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HUMPBACK WHALE **VULNERABLE**
Megaptera novaeangliae (Borowski, 1781)

Suborder ODONTOCETI Family BALAENOPTERIDAE

Summary The humpback whale populations were greatly reduced by commercial whaling, but some stocks are showing encouraging signs of recovery under protection. Continued comprehensive protection from catching is required, as well as identification and protection of critical feeding and breeding habitat, to allow recovery to proceed unhindered. Despite the signs of recovery, the species is still very depleted on a world level, especially in the Southern Hemisphere, hence the humpback whale remains listed as Vulnerable until numbers have recovered to a more satisfactory level.

Distribution Humpback whales are found in all oceans from the Arctic to the Antarctic, with local changes in distribution according to fairly distinct migration patterns. The Northern and Southern Hemisphere populations are regarded as separate, but not usually accorded separate specific or sub-specific status. The earliest available name for the Southern Hemisphere humpback would be *Megaptera australis* (Lesson, 1828). The species was recently reviewed by Winn and Reichley (1985), and further details, particularly on acoustics and photo-identification, are given in Payne (1983).

Humpbacks feed in colder waters during spring, summer and autumn, then travel to a winter range over shallow tropical banks, where they calve and presumably conceive. It is usually said that the migration routes and feeding and breeding areas are coastal, but Winn and Reichley (1985) believe, on the basis of sightings reports, that the majority of whales travel beyond the 200m line, over the deeper oceans, for example in the western North Atlantic and off the west coast of South America. They explain that the animals disperse more widely in deeper water, moving through coastal waters during migrations when a land mass (such as New Zealand) is in their direct route, or when the 100 fathom line is near shore. Occasionally young stray animals can be found inshore, away from the main groups. Evidence from historical catch statistics does not support this view (e.g. Mackintosh, 1942; Best, 1986), although catches from land stations may not give a complete picture of whale distribution far offshore. The idea that these whales may travel more widely than previously thought is supported by acoustic and photo-identification work (e.g. Payne and Katona, 1986; Payne, 1983).

Traditionally, the oceanic populations have been thought to be divided into various stocks, with little interchange. Two stocks were postulated, one on each side, in both the North Pacific and North Atlantic Oceans, and seven in the Southern Hemisphere. These stock divisions were based on catch results, as well as on practical management considerations (Winn and Reichley, 1985). Recent work, however, has shown that there is at least considerable contact, if not interchange, between breeding groups in different areas within each ocean basin. Payne (1983) and Payne and Katona (1986) have shown that songs recorded from male humpback whales during the mating season vary from year to year, but that, within each ocean, the same song is sung in different breeding groups in any given year. They also record some examples of individually identified males reappearing in different wintering and summering areas.

The main known western North Atlantic breeding areas are in the Antilles: Silver and Navidad Banks near the Dominican Republic; Mouchoir Bank; Mona Passage (Puerto Rico); the Virgin Islands and the Southern Grenadines. Bermuda appears to be, like New Zealand, an island group which lies in the path of the migration. In the past, breeding grounds were known around several eastern North Atlantic island groups, but only the

Cape Verdes have been surveyed in recent years. Sound recordings were obtained, but no sightings (Winn and Reichley, 1985). Some individuals are known to have moved between some western North Atlantic breeding areas (Payne and Katona, 1986).

There appears, however, to be less interchange between western North Atlantic feeding areas. One research group reports no movements of identified animals between the Iceland, West Greenland, Newfoundland/Labrador and Nova Scotia/Gulf of Maine feeding areas, although another group report three individuals moving between the Gulf of St Lawrence and Gulf of Maine areas. In general, therefore, it seems that at least in the western North Atlantic, individual humpback whales use distinct feeding areas in summer but may visit several winter breeding grounds (Payne and Katona, 1986). The evidence of low exchange between feeding areas led the IWC to manage the 'feeding aggregations' as separate fishing stocks (IWC, 1986).

In the North Pacific, there appears to be a slightly different pattern, with more mixing on the feeding grounds off Alaska. There is some interchange between the breeding grounds off eastern Mexico and Hawaii. Detailed observations of individuals indicate that at least a percentage of the population returns to Hawaii each year, although fluctuations in numbers through the season, as well as a continued high rate of discovery of 'new' animals, indicate that whales move in and out of particular parts of this wintering ground (Darling, Gibson and Silber, 1983). It appears that humpback whales have used Hawaiian waters only during the last 200 years; the reason for this extension in range is not known (Herman, 1979).

Population All the stocks of humpbacks were seriously depleted by commercial whaling, but estimates of initial populations are less reliable than for some other baleen whales because of incomplete historical catch statistics. On currently available data (adding and roughly rounding the figures given below), it looks as if there were of the order of 150,000 humpback whales worldwide initially and possibly of the order of 25,000 today.

North Atlantic By 1985, 3,219 individual humpback whales had been identified in the northwest Atlantic by fluke photographs, and a population estimate of 5,561 calculated (IWC, 1986). New estimates from photo-identifications gave a best estimate of 5,505 ± 2,617 (95% confidence interval) for the years 1979-1986 for the total population. A separate estimate based on the rate of discovery of new individuals was 6,570 ± 148 (standard error). Slopes for population increase of 9.4% (95% confidence interval: -12% to 30%, not significantly different from zero) and 10.3% (95% confidence interval: 2% to 23%) for estimates based on all northern photographs (1979-86) and Gulf of Maine photographs (1981-1986) respectively were obtained (IWC, 1990a).

Stocks in the eastern North Atlantic are generally agreed to be very low, possibly at a few hundred animals or less, although the initial population may have been of the order of 5,000 (Winn and Reichley, 1985). However, 14 animals were seen in aerial surveys of Svalbard in July-August 1987, three were seen off Svalbard and one off Finnmark in shipboard surveys in July, and several in survey blocks to the east of Iceland by Icelandic vessels during the 1987 North Atlantic Sightings Survey. Sigurjónsson and Gunnlaugsson (1990) calculate a population estimate of 1,816 (c.v. 0.18) for the waters covered by the Icelandic part of the survey.

North Pacific The original population size for this area is unknown, but Allen (1980) estimated 13,000, Winn and Reichley (1985) at least 15,000, and Berzin and Vladimirov (1981) 10-15,000. Present figures for this stock range from 895 (95%

confidence intervals 592-1,837) based on re-sightings of known individuals at Hawaii (Darling, Gibson and Silber, 1983), through 1,200-1,600 (Gambell, 1976) to 2,500 (Wada, 1975). The Wada estimate is an index of abundance, not an estimate of total population, because only part of the North Pacific was surveyed.

The presence of humpbacks on the Pacific coast of Costa Rica has recently been reported (Rudge, 1989). It does seem clear that the present population on the eastern side of the ocean is much larger than that on the western side, which may contain only a few hundred animals (Winn and Reichley, 1985). However, very much less effort has so far been invested in studies of humpbacks on this side of the Pacific Ocean. Three were seen off the coast of Japan by whaling vessels in 1987/88. Forty-four were seen on a joint USSR/USA cruise in autumn 1987, one in the South Okhotsk Sea, the remainder off the Kodiak Islands (IWC, 1989). Again, the taking of a few animals over the years since the main exploitation ceased may have hindered recovery (IWC, 1980).

Southern Hemisphere Using a combination of IWC/IDCR surveys from 1978-1984 and Japanese scouting vessel data from 1965-88, Borchers, Butterworth and Kasamatsu (1990) obtain an estimate of 12,000 humpback whales (c.v. 0.4) south of 30°S in January and February, which probably covers virtually all of the Southern Hemisphere population based on what is known about humpback whale distribution. About 140,000 humpbacks have been recorded as caught by modern whaling in the Southern Hemisphere (IWC, 1990b), implying that the current population is still at a very low proportion of its original abundance.

Shore-based counts off eastern Australia recorded 302 animals in 1987, with an estimated rate of increase of 10% per year over the period 1983-87, while aerial counts of Western Australia show an annual rate of increase of 4.8% per year over the period 1963-88 (IWC, 1990b). However, it is not clear what steps, if any, were taken to standardise effective search effort in these surveys, therefore the apparent rates of increase, especially for the shore-based surveys, should not be interpreted too literally. In 1986, 120 animals were seen around New Zealand, with 64 sightings in 1987 and 27 in the first months of 1988. They have not been reported from Cook Strait or Foveaux Strait, two of their main former migratory routes, for over ten years (IWC, 1990a).

Northern Indian Ocean It appears that there may be a small, possibly resident, population in the northern Indian Ocean (Payne and Katona, 1986), although this could be a wintering area for a component of the population summering in the Antarctic. There are no estimates of an initial population, but Winn and Reichley (1985) give 500+ as a current population estimate.

Habitat and Ecology The humpback is a relatively eurythermic animal, residing from the ice edge to the equator, but all individuals may not inhabit both extremes during their lifetime. For unknown reasons, some groups of animals remain in the usual feeding or breeding areas out of phase with the normal six months cycle (Townsend, 1935; Tomilin, 1957).

The diet of the northern humpback consists of crustaceans, sand lance, herring, capelin, pink salmon, Arctic cod, walleye pollack, and pteropod and some cephalopod molluscs. This is somewhat similar to the fin whale diet, but differs from other whale diets in that it contains both pelagic and benthic layer animals of the coastal zone. In the Antarctic, however, the diet is restricted almost exclusively to krill (*Euphausia* spp., *Thysanoessa* spp., *Calanus propinquus* and *Parathemisto gaudichaudi*) (Tomilin, 1957; Gaskin, 1972). Like other rorquals, humpbacks fast on migration. Chittleborough's (1965) evidence for this was the amount of oil recovered in north and southbound whales; four to five times more oil was found in humpbacks northbound in the Southern Ocean than in southbound whales.

Both males and females mature sexually at around four or five years of age at a length of 11.5m and 12m, respectively (Nishiwaki, 1959; Gaskin, 1972). Gestation and lactation lasts roughly two years, but as pregnancy and lactation can occur simultaneously, the calving interval is commonly two years, although there can be one or more resting years between cycles. Humpbacks grow to around 15m and, at any given age females are 40 to 70cm longer than males. The oldest animal reported was 48 years old, indicating that the average life span is likely to be considerably less than this (Tomilin, 1957).

The humpback is found in large schools at times, the size of which depends on the amount and density of food. Large groups may be made up of several small groups. Much new information on behaviour has been obtained in recent years. The songs of the males are discussed above, in relation to stock identity. Further information on social and feeding behaviour is given in Payne (1983) and in Winn and Reichley (1985).

Allen (1916) reported killer whales and swordfish as possible predators, and Gaskin (1976) suggested that calf mortality may, at least in part, be due to sharks as well as to killer whales.

Threats Heavy commercial exploitation began in the North Atlantic from the 1860s, although some catching is recorded from at least the 18th century, and local people were taking small numbers of these whales from much earlier times (Mitchell and Reeves, 1983). The populations here were depleted by the turn of the century and few catches made after about 1910, although the continued catches in the eastern area may have hindered recovery. From about 1910, exploitation moved to the Southern Hemisphere and Pacific Ocean stocks. Over 60,000 animals were taken in the Southern Hemisphere between 1910 and 1916, and a further 80,000 or so until the humpback whale was protected by the IWC in 1963 (IWC, 1990b). Catches peaked in the North Pacific in the early 1960s (Winn and Reichley, 1985).

Humpbacks are easily exploited near shores, on banks and on continental shelves where they travel (Dawbin, 1966). This also implies that they are vulnerable to shoreline pollution, boat traffic, entanglement in fishing gear, and to other human coastline activities. Humpbacks have been entangled in cod traps and other fishing gear on the eastern seaboard of Canada and to a lesser extent in the United States. Since the late 1970s, about ten animals a year have died in this way, although many more were successfully released. About five more animals are reported to be incidentally taken each year in other areas (e.g. IWC, 1980; IWC, 1988a).

Probably the only remaining direct humpback fishery today is in St Vincent and the Grenadines. In 1987 the IWC officially recognised this local fishery, and agreed to allow three animals to be taken in each of the seasons 1987/88 and 1989/90, but only when the meat and products are used exclusively for local consumption (IWC, 1988b).

Catching of humpbacks was prohibited in the Antarctic in 1939, but the seasons were reopened in 1949, and catching was only completely prohibited here from 1963 by IWC. Hunting in the North Atlantic was prohibited from 1956, and in the North Pacific from 1966 (Winn and Reichley, 1985). A few animals are known to have been taken by non-IWC operations since that time (IWC, 1980).

There is increasing tourist interest in observing this species, particularly on the breeding and feeding grounds, with attendant possibilities for disturbance. However, it appears that whales can habituate to careful visitors (Watkins, 1986).

In late 1987, 15 dead humpback whales stranded off Cape Cod and New York. They included several individuals previously photo-identified. The reason for this mortality was believed to be the ingestion of mackerel tainted with biotoxins from 'red tide'. It was reported that four dead humpbacks were also washed ashore in the Dominican Republic, and further animals may have died at sea. The degree of mortality from the USA alone represented 6.25% of the estimated size of the Gulf of Maine feeding aggregation (240 ± 93), although it is suggested that this stock size is an underestimate (IWC, 1990a).

Conservation Measures Because this is a cosmopolitan, oceanic species, discussion of international and national protection status involves every country with a sea coast and every country registering shipping (since catch control on the high seas can only be exercised through the flag country). Some of the international agreements, such as IWC, also cover catches in national waters. Countries without coasts or shipping may also be involved where products enter international trade. The humpback is protected under IWC (all PS) and CITES (Appendix 1). The only international trade recorded for this species is: 1979 - scientific bone specimens from USA to Canada; 1985 - one bone of Greenland origin from Denmark to Switzerland as a personal item, and one bone from Greenland to Denmark as a commercial item (CMC, 1987). CRW protects mothers and calves, not insignificant protection where the traditional catch method is to secure the calf to ensure that the mother remains to be caught, and where the species breeds fairly close to shore. The humpback is also listed in Appendix I of CMS.

The island and archipelago states are particularly important for protection, as most feeding and breeding grounds are in shallow areas within EEZs. The coastal and shallow water habits of the humpback whale make national protection particularly important, especially in view of the increased opportunities for control through 200 mile EEZs, unlike the situation for most of the other large whales (except the gray and right whales). The use of coastal and shallow water feeding and breeding areas presents the opportunity for protection (or destruction) of critical habitat.

To give the humpback whale the best chance of full recovery, comprehensive protection is essential. The keys to this lie in control via the flag country of exploiting ships on the high seas, through national controls to prevent taking within territorial waters and EEZs or by land stations catching on the high seas, and by trade controls in all countries. Feeding and breeding areas may also require protection from habitat destruction and disturbance. Every country in the world, therefore, should be encouraged to have adequate legislation for these purposes.

Reassessment of populations, on the basis of the new information available, is overdue. Until this is done, it is not possible to know to what extent the populations may have recovered.

In the meantime, four problems need attention: accidental catching, habitat disturbances, occasional catches during other whaling operations and any catches by local people for their own use which are not under IWC control. The growing popularity of whale watching, with the increase of boat traffic in feeding and breeding areas, may require some control.

The IUCN/SSC Action Plan for Conservation of Dolphins, Porpoises and Whales (Perrin, 1989) calls for more research into the entrapment of large whales in the North Atlantic, and for more information on population identity in the North Pacific and North Atlantic Oceans.

Captive Breeding The species is too large for there to be any possibility of conservation through captive breeding. At least one calf has been briefly held. This was an attempt to rehabilitate a live stranded animal in poor health. The animal died after a few days (Glockner and Venus, 1983).

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Appendix

Abbreviations

ABFF	Agreement between Argentina and Bolivia on the Protection of Forests and Fauna and on the Development of Border Parks. La Paz, 16 March 1976. Potentially important for conservation of riverine dolphins and their habitat.
ACCN	African Convention on the Conservation of Nature and Natural Resources. 15 September 1968, Algiers. In force 7 May 1969. If re-activated, would have wide potential powers for protecting cetaceans in African waters.
ACMRR	Advisory Committee of Experts on Marine Resources Research (FAO).
ARW	International Agreement for the Regulation of Whaling. London, 8 June 1937. In force 7 May 1938. Extended 29 June 1938. The second international attempt to regulate whaling, superceding CRW. Includes baleen and sperm whales, and gives complete protection to all right whales and gray whales. Still in force, but now superceded by ICRW.
ASCN	ASEAN Agreement on the Conservation of Nature and Natural Resources. Kuala Lumpur, 9 July 1985.
ASEAN	Association of South East Asian Nations.
Berne	Convention on the Conservation of European Wildlife and Natural Habitats. Berne, 19 September 1979. In force 1 June 1982. To conserve wild fauna and flora and their natural habitats, especially where the cooperation of several States is needed to achieve this. Appendix I lists strictly protected plants; II, strictly protected animals (including 19 species of cetacean); III, protected animals, (including all other cetacean species); IV, prohibited means or methods of killing, capture and other exploitation.
BIWS	Bureau of International Whaling Statistics. Originally set up by Norway at the instigation of ICES in 1929. Ceased operating from 1984, when the IWC Secretariat took over responsibility for the collection and publication of all cetacean directed catch data.
Bonn	Convention on the Conservation of Migratory Species of Wild Animals (CMS). Bonn, 23 June 1979. See CMS.
BS	Convention Between the Government of the People's Republic of Bulgaria, the Romanian People's Republic and the Union of Soviet Socialist Republics concerning Fishing in the Black Sea. Varna, 7 July 1959. In force 21 March 1960. The Parties have imposed a moratorium on industrial taking of the three endemic Black Sea cetacean species since 1966 (see harbour porpoise review).

BWU	Blue Whale Unit. Based on relative oil yield, and consisting of either one blue whale, two fin whales, two and a half humpbacks or six sei whales, or an appropriate combination. Used by IWC to set catch quotas from 1946 to 1972 (see IWC, NMP and blue whale review).
CAT	Agreement for the Conservation of the Flora and Fauna of the Amazon Territories of the Republic of Colombia and the Federal Republic of Brazil. Bogota, 26 June 1973.
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources. Canberra, 20 May 1980. In force 7 April 1982. Particularly important for the protection of cetacean food resources.
CEP	Agreement between USA and USSR on Cooperation in the Field of Environmental Protection. Moscow, 23 May 1972. Protocol on scientific cooperation to study and protect sea mammals in the northern Pacific, signed 8 July 1978.
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora. Washington, 3 March 1973. In force 1 July 1975. Regulates international trade (which is defined to include all international movements for whatever purpose) in species listed on three Appendices. Appendix 1 lists species threatened with extinction which are or may be affected by trade, requires special permits from both exporting and importing countries and such trade must not be primarily for commercial purposes. Appendix II includes species which may become threatened with extinction unless trade is regulated, and species which must be subject to regulation in order that trade in threatened species of similar appearance may be brought under effective control. At the second conference in 1979 it was agreed that all cetaceans not listed on Appendix I should be listed on Appendix II. Since the most recent amendments in 1986, a total of 23 cetacean species are listed in Appendix 1. The EC treats all cetaceans as if they were listed in Appendix 1 (see EC).
CMC	IUCN Conservation Monitoring Centre, now World Conservation Monitoring Centre (WCMC).
CMS	Convention on the Conservation of Migratory Species of Wild Animals. Bonn, 23 June 1979. In force 1 November 1983. (Also known as the Bonn Convention). Two Appendices list species presently endangered and needing immediate protection (I) and species which have an unfavourable conservation status as well as those which would benefit from the international cooperation which could be achieved by an International Agreement (II). These Appendices cover certain species or North and Baltic Seas populations of cetaceans.
CNSP	Convention on Conservation of Nature in the South Pacific. Apia, 12 June 1976. Not yet in force. Potential for protecting cetaceans and their habitat in the South Pacific Commission area.
CP	Agreement for the Conservation of the Flora and Fauna of the Amazonic Territories of Colombia and Peru. Lima, 1979. Potentially important for protection of riverine dolphins and their habitat.
CPPS	Convention for the Protection of the Marine Environment and Coastal Areas of the South-East Pacific. In force 19 May 1986. Mainly concerned with combating pollution and hence of potential importance for protecting cetacean habitat and food resources.
CPUE	Catch per unit effort.

CRW	Convention for the Regulation of Whaling. Geneva, 24 September 1931. In force 16 January 1935. The first international attempt to regulate whaling. Still in force, although superceded by ARW and ICRW. Applies to baleen whales and gives complete protection to all right whales (defined to include bowheads and pygmy right whales).
DDT	Dichloro-diphenyl-trichloro-ethane.
D Kampuchea	Democratic Kampuchea.
DPR Korea	Democratic People's Republic of Korea.
EC	European Community. The EC is a party, in its own right, to Berne, CMS, MCEA and NAFO. It may also make regulations, binding on all Member States. Regulation EEC No. 3848/81 prohibits all imports of certain cetacean products for commercial purposes (see sperm whale review). Council Regulation 3626/82, Commission Regulation 3418/83 and amendments implement CITES within the community, treating all cetaceans as Appendix 1 species, and providing additional control of the accommodation, use, sale or disposal of live specimens after import.
EEZ	Exclusive Economic Zone. See UNCLOS.
ETP	Eastern Tropical Pacific.
FAO	Food and Agriculture Organisation of the United Nations.
GDR	German Democratic Republic.
GFR	German Federal Republic.
IATTC	Inter-American Tropical Tuna Commission and Convention for the Establishment of an Inter-American Tropical Tuna Commission. Washington, 31 May 1949. In force 3 March 1950. The Commission monitors cetacean populations and mortality incidental to tuna purse-seine fishing in the ETP, and implements a variety of programmes aimed at reducing this mortality.
ICES	International Council for the Exploration of the Sea and Convention for the International Council for the Exploration of the Sea. Copenhagen, 12 September 1964. In force 22 July 1968. The 1964 Convention gave a formal legal basis to the Council, which was established in Copenhagen in 1902, covers the Atlantic Ocean and adjacent seas and has a Marine Mammals Standing Committee. ICES was the first international body to promote rational regulation of the exploitation of whale stocks, and instigated the collection of world whale catch statistics (see BIWS).
ICRW	International Convention for the Regulation of Whaling. Washington, 2 December 1946. In force 10 November, 1948. The current international whaling legislation, superceding ARW and CRW. Parties agreed to establish international regulations for whaling, to ensure that all species of whales are protected from over-fishing and that whaling operations are confined to species able to sustain exploitation, to allow for the recovery of presently depleted species and thus make possible the orderly development of the whaling industry. (There is debate as to whether the term "whale" includes all cetacean species). Established the International Whaling Commission (see IWC).
ICSEAF	International Commission for the South East Atlantic Fisheries and Convention on the Conservation of the Living Resources of the Southeast Atlantic. Rome, 23 October 1969. In force, 24 October

1971. Applies to all living resources, but activities relating to cetaceans have so far consisted only of accepting the presence of an IWC observer at meetings.

IDCR International Decade of Cetacean Research. Research programmes sponsored by IWC, particularly cetacean population surveys in the Southern Hemisphere.

IMS Initial Management Stock. According to the current IWC Schedule: a stock more than 20% of MSY stock level above MSY stock level. Commercial whaling shall be permitted on Initial Management Stocks according to the advice of the Scientific Committee as to measures necessary to bring the stocks to the MSY stock level and then to optimum level in an efficient manner and without risk of reducing them below this level. The permitted catch for such stocks will not be more than 90% of MSY as far as this is known, or, where it will be more appropriate, catching effort shall be limited to that which will take 90% of MSY in a stock at MSY stock level. In the absence of any positive evidence that a continuing higher percentage will not reduce the stock below the MSY stock level, no more than 5% of the estimated initial exploitable stock shall be taken in any one year. Exploitation should not commence until an estimate of stock size has been obtained which is satisfactory in the view of the Scientific Committee. (Note: these provisions are in abeyance during the current moratorium on commercial whaling. See IWC, NMP and Introduction).

INPFC International North Pacific Fisheries Commission and International Convention for the High Seas Fisheries in the North Pacific Ocean, 9 May 1952. In force 12 June 1953. An *ad hoc* Committee on Marine Mammals and a Scientific Subcommittee coordinate and review activities relating to the incidental take of marine mammals and prepare annual reports. A Memorandum of Understanding between the USA and Japan provides for study of the effects (and reduction or elimination) of incidental takes of marine mammals (particularly Dall's porpoise) in the Japanese salmon fishery.

IUCN World Conservation Union, formerly International Union for the Conservation of Nature and Natural Resources.

IWC International Whaling Commission. Established by ICRW, and empowered to amend the provisions of the Schedule (containing the detailed regulations and an integral part of ICRW), encourage and organise research, collect and analyze statistical information, publish reports and disseminate information, and make recommendations to any or all Contracting Governments on any matters relating to whales or whaling. Although the debate over species jurisdiction continues (see ICRW), the Scientific Committee and its standing subcommittee on small cetaceans, acting on the authority of Commission recommendations, have considered the status of all cetacean species since the early 1970s, provide scientific advice, and collect statistics on direct and incidental captures. Management methods are being reviewed as part of the comprehensive assessment of whale stocks undertaken during the present moratorium on commercial whaling. The current Schedule describes a management regime known as the New Management Procedure (NMP), adopted in 1974, which is in abeyance during the moratorium (see NMP and Introduction).

Libya Libyan Arab Jamahiriya.

MARPOL International Convention for the Prevention of Pollution from Ships, 1973. In force 1978. Annex V, regulating discharge of plastics and other persistent materials, is particularly important for preventing harm to cetaceans.

MCEA Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region. Nairobi, 21 June 1985. Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region. Nairobi, 21 June 1985. The Protocol applies to the waters of the region, providing protection to listed species, including migratory species, and ecosystems. Blue and humpback whales are currently listed.

MSY Maximum Sustainable Yield. The maximum rate of catch (direct or incidental) that a cetacean population can sustain indefinitely. The MSY level is the population size at which the population would (in theory) eventually stabilise if the MSY were regularly taken, provided that the population was initially at or above the MSY level (= maximum net productivity level).

NAFO Northwest Atlantic Fisheries Organisation and Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries. Ottawa, 24 October, 1978. In force 1 January 1979. Applies to almost all fishery resources in the Convention area, including cetaceans not covered by IWC. No proposals concerning cetaceans appear to have yet been made.

NASS North Atlantic Sightings Survey.

NCC Nature Conservancy Council, the UK CITES Scientific Authority for Animals (and the government body which promotes nature conservation in Great Britain).

NMP New Management Procedure. Adopted by the IWC in 1974, currently in abeyance (see IWC). Whale stocks were classified and managed according to three categories: Initial Management Stock (IMS), Sustained Management Stock (SMS) and Protection Stock (PS). (Recent simulation studies have revealed that the NMP is flawed, with an inherent risk of exterminating stocks so managed. See Introduction). A "stock" is generally taken to mean "a convenient management unit" and is not necessarily synonymous with any genetically defined population unit.

NOAA National Oceanic and Atmospheric Administration (US Department of Commerce).

NPWH Convention on Nature Protection and Wild Life Preservation in the Western Hemisphere. Washington, 12 October 1940. In force 30 April 1942. Open to members of the OAS. Five baleen whale spe cies were originally listed as in special need of protection. Despite moves to re-activate implementation of the Convention in the late 1970s, no substantive activities have taken place since 1940.

OAS Organization of American States. See NPWH.

OAU Organization of African Unity. See ACCN.

PB Agreement between Peru and Brazil for the Conservation of the Flora and Fauna of the Amazon Territories of the Republic of Peru and the Federal Republic of Brazil. 1975. Particularly relevant to riverine dolphin protection and research.

PCBs Polychlorinated biphenyls.

PCSP Permanent Commission of the Conference on the Use and Conservation of the Marine Resources of the South Pacific and Agreements of the Conference on the Use and Conservation of the Marine Resources of the South Pacific. Initiated 18 August 1952. The first international agreement to claim jurisdiction over all marine resources (including the sea floor and sub-soil) within 200 nautical miles of the coast. Mainly concerned with regulating catching of large baleen and sperm whales. In abeyance since Chile and Peru joined IWC in 1979, and Colombia and Ecuador ceased taking regulated species, but has potential for dealing with the conservation and management of any cetacean species in PCSP waters.

PDR Lao Lao People's Democratic Republic.

PR China People's Republic of China.

PS Protection Stock. According to the current IWC Schedule: a stock which is below 10% of MSY stock level below MSY stock level. There shall be no commercial whaling on Protection Stocks. (Note: these provisions are in abeyance during the current moratorium on commercial whaling. See IWC, NMP and Introduction).

Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat. Ramsar, 2 February 1971. In force 21 December 1975. Can protect wetlands (including marine water of not more than 6m deep at low tide) of international importance to riverine and coastal cetaceans and to more pelagic species using inshore areas, for example for breeding or feeding. Many proposed or existing wetlands conservation areas already listed in Appendix II do, or are likely to, contain cetacean habitat, although all have been listed for other reasons.

RDB Red Data Book.

R Korea Republic of Korea.

SMS Sustained Management Stock. According to the current IWC Schedule: a stock which is not more than 10% of MSY stock level below MSY stock level, and not more than 20% above that level; MSY being determined on the basis of the number of whales. When a stock has remained at a stable level for a considerable period under a regime of approximately constant catches, it shall be classified as a Sustained Management Stock in the absence of any positive evidence that it should be otherwise classified. For stocks at or above the MSY stock level, the permitted take shall not exceed 90% of the MSY. For stocks between the MSY stock level and 10% below that level, the permitted catch shall not exceed the number of whales obtained by taking 90% of the MSY and reducing that number by 10% for every 1% by which the stock falls short of the MSY stock level. (Note: these provisions are in abeyance during the current moratorium on commercial whaling. See also IWC, NMP and Introduction).

SSC Species Survival Commission (IUCN).

Somalia Somalia Democratic Republic.

TAC Treaty for Amazonian Cooperation. Brasilia, 1978. Potentially important for the conservation of riverine dolphins and their habitat.

UNCLOS United Nations Convention on the Law of the Sea. New York, 30 April 1982. It will enter into force one year after ratification by 60 countries.

Coastal states are given jurisdiction over all living resources within their 200 mile Exclusive Economic Zones (EEZ). Requires cooperation with a view to the conservation of marine mammals and, for cetaceans, working through appropriate international organisations. Marine mammals are specifically exempted from the general requirement to promote optimum utilisation of living resources within the EEZ and on the high seas.

UK United Kingdom of Great Britain (comprised of England, Wales and Scotland) and Northern Ireland.

UNEP United Nations Environment Programme.

UNESCO United Nations Educational, Scientific and Cultural Organisation.

USA United States of America.

USSR Union of Soviet Socialist Republics.

WCMC IUCN World Conservation Monitoring Centre.

WHC World Heritage Committee and The Convention Concerning the Protection of the World Cultural and Natural Heritage. Paris, 16 November 1972. In force 17 December 1975. The Committee is responsible, among other things, for using the World Heritage Fund to help protect the most important natural habitats of threatened animals, and sites of outstanding scientific or conservation value, included in the World Heritage List and the List of World Heritage in Danger. A number of sites already listed do, or are likely to, contain cetacean habitat, although all have been listed for other reasons.

Yemen AR Yemen Arab Republic.

D Yemen Democratic Yemen.

Few species capture mankind's imagination to the extent of the dolphins, porpoises and whales. The 79 species of cetacean occur throughout the world's oceans, but many are in severe decline. Fortunately, mankind has not yet driven any cetacean species to extinction. This may change, however, and soon. For some species, particularly among the great whales and the river dolphins, only a few hundred individuals remain. For others, populations of larger or unknown size may be declining rapidly. Although there is currently a moratorium on commercial whaling, many cetaceans are being killed in huge numbers in drift nets in many parts of the world, possibly with devasting effects on their populations. This book describes the status of all the cetacean species and discusses options for their conservation.

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