


# Attachment C- Presentations



# Session I Presentations

## ESA-listed Indo-Pacific Corals Recovery Planning Workshop May 2021





# Coral Listings & Introduction to Recovery Planning

## ESA-listed Indo-Pacific Reef Corals

Chelsey Young, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

## Outline

- Listing background
- What is Recovery?
- What is a Recovery Plan?
- Types of Plans
- What are Recovery Criteria?
- What is a Recovery Action?
- What if We Don't Know?
- Who implements recovery plans?



*Acropora lokani*  
(Photo by Charlie Veron,  
Corals of the World)

## Listing Background for 15 Indo-Pacific Corals

- CBD petitioned NMFS to list 83 species of reef-building corals in 2009
- These species were selected by the petitioners because they were presumed to be located in U.S. waters and listed on the IUCN Red List
- In 2014 NMFS published a final rule to list 15 Indo-Pacific corals as threatened



*Acropora retusa*  
(Photo by Charlie Veron,  
*Corals of the World*)



## ESA Section 4(a)(1) Listing—Based on 5 Factors

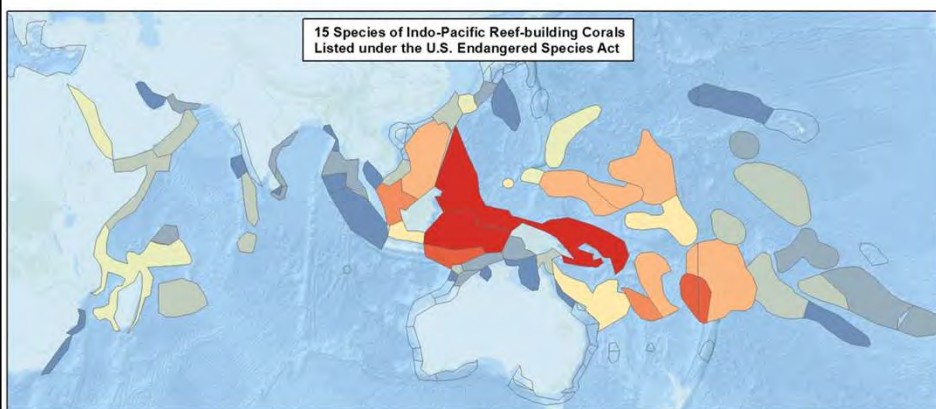
- Present or threatened destruction, modification or curtailment of habitat or range
- Overuse for commercial, recreational, scientific, or educational purposes
- Disease or predation
- Inadequacy of existing regulatory mechanisms
- Other natural or manmade factors affecting its continued existence



## 15 Indo-Pacific Corals listed as T under ESA



15 Species of Indo-Pacific Reef-building Corals Listed under the U.S. Endangered Species Act



The Number of the 15 Species Confirmed or Predicted to be Confirmed in a Single Marine Ecoregion



Map by: R. O'Connor, NOAA Fisheries Service, 04-21-2021.  
 Source: Veron J.E.N., Stafford-Smith M.G., Turak E. and DeVantier L.M. (2016). Corals of the World. Accessed 20 April 2021.  
<http://www.coralsoftheworld.org/page/home/>



## What is Recovery?

- ESA does not define recovery
- ESA purpose: provide a means whereby the ecosystems which listed species depend may be conserved and to provide a conservation program for these species.
- ESA defines conserve as to use all methods and procedures which are necessary to bring any listed species to the point that the measures of the ESA are no longer necessary.



## What is a Recovery Plan?

- ESA requires development and implementation of recovery plans for the conservation and survival of listed species
- We seek the expertise of qualified agencies, institutions, and individuals in developing and implementing recovery plans
- We seek public comment and peer review on draft or revised recovery plans

**\*\*Recovery plans are NOT regulatory \*\***



## What do Recovery Plans do?

- Provide a roadmap and metrics (criteria) to improve species status so it can be delisted
- Help identify, organize, coordinate and prioritize recovery actions to achieve the criteria
- Provide a tool to monitor recovery progress and adapt management
- Identify potential partners and funding sources to facilitate recovery
- Provide communication and outreach



## Recovery Planning Framework

### 3- Part Framework

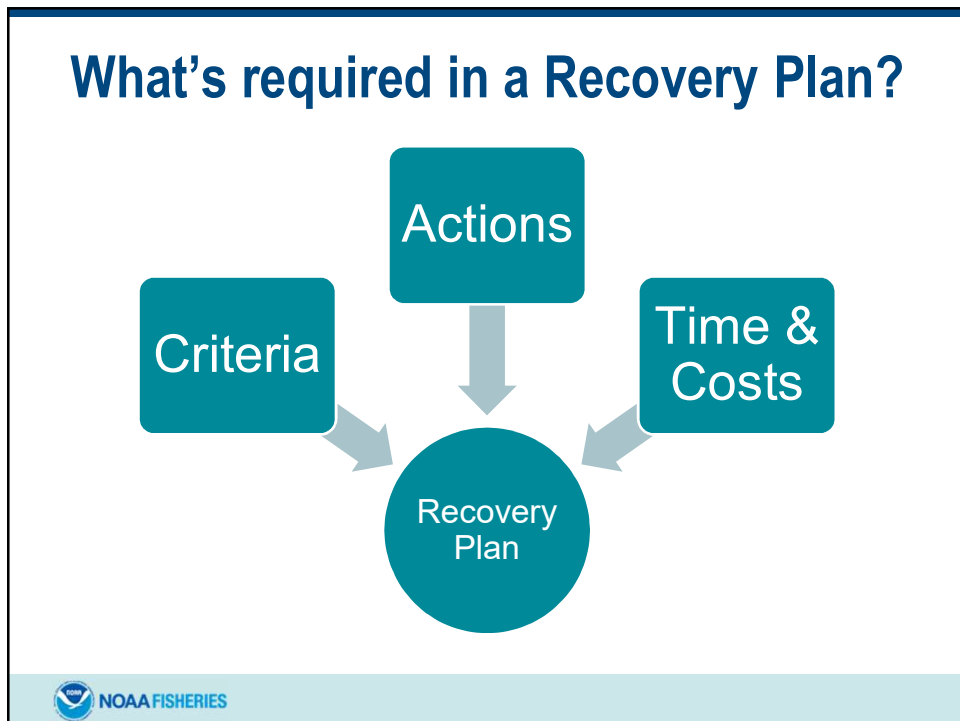


## Types of Recovery Plans

- Single species
- Multi-species
- **Ecosystem**
  - Several listed species in a shared biotic community rely on protection and/or restoration of their ecosystem to reach recovery
  - The biological connection between the ecosystem and the listed species should be clearly described
  - Recovery objectives and criteria must be provided on a species-by-species basis, although ecosystem-based criteria may be included as well

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# CRITERIA



Spell out the anticipated conditions for the species to achieve recovery and for delisting to occur through the rulemaking process.

What does the species and its ecosystem look like when threats have been addressed to the point that it no longer meets the definition of endangered or threatened?



# CRITERIA



## **Must be...**

- Objective
- Measurable

Demographic-based [strongly recommended]

Threats-based [required]



## Demographic/Biological-based Criteria [Strongly Recommended]

*link to the species' status and trends and incorporate fundamental conservation principles:*

- sufficient population trends/productivity, habitat health to withstand natural variation and stochastic events
- sufficient number of populations distributed and connected across different habitat types, where appropriate to withstand catastrophic events
- sufficient population size and diversity (geographic, ecological, genetic, morphological, behavioral, life-history variation) to preserve evolutionary capacity



## Threats-based Criteria [REQUIRED]

*Address the 4(a)(1) factors that led to the listing of the species and (ideally) should be connected to biological-based criteria:*

- Threats-based criteria must be focused on adequate reduction or elimination of a threat and designed to facilitate the species' ability to reach the demographic criteria (i.e., must provide for a species response necessary to achieve recovery)
- Address reduction in both the **level and extent** of the threat needed to reach demographic or habitat-based recovery criteria



## What is a Recovery Action?

**Actions identified in a recovery plan to be taken to conserve, protect, manage, restore, and enhance species and their habitats, and most of all avoid or minimize threats.**

- **Biological-based:** Actions that would achieve the metric identified in the criteria (e.g., actions to monitor, evaluate, and support species life history needs— breeding, feeding, sheltering, nesting, brooding, dispersal, migratory needs).
- **Threats-based:** Actions that address 4(a)(1) factors influencing the species viability (i.e., circumstances that contributed to the listing of the species or have since been negatively affecting the species and or its habitat).



## What is a Recovery Action?

**Recovery actions should be site-specific:**  
Geo-referenced, but lots of flexibility on the scale



## Recovery Actions & Examples

- **Measures to reduce, abate, eliminate threats**
  - Develop and implement environmentally sound mechanisms to reduce local impacts of temp stress
- **Research to fill information gaps**
  - Conduct strategic research of species' biology
- **Monitoring**
  - Monitor species and its environment (population assessment; bleaching events, etc.)
- **Active restoration/interventions**
  - Conduct active population enhancement of coral species
- **Education/Outreach**
  - Implement outreach/education strategies for listed corals
- **International coordination (global & local)**
  - Develop and implement a pilot regional intergovernance plan



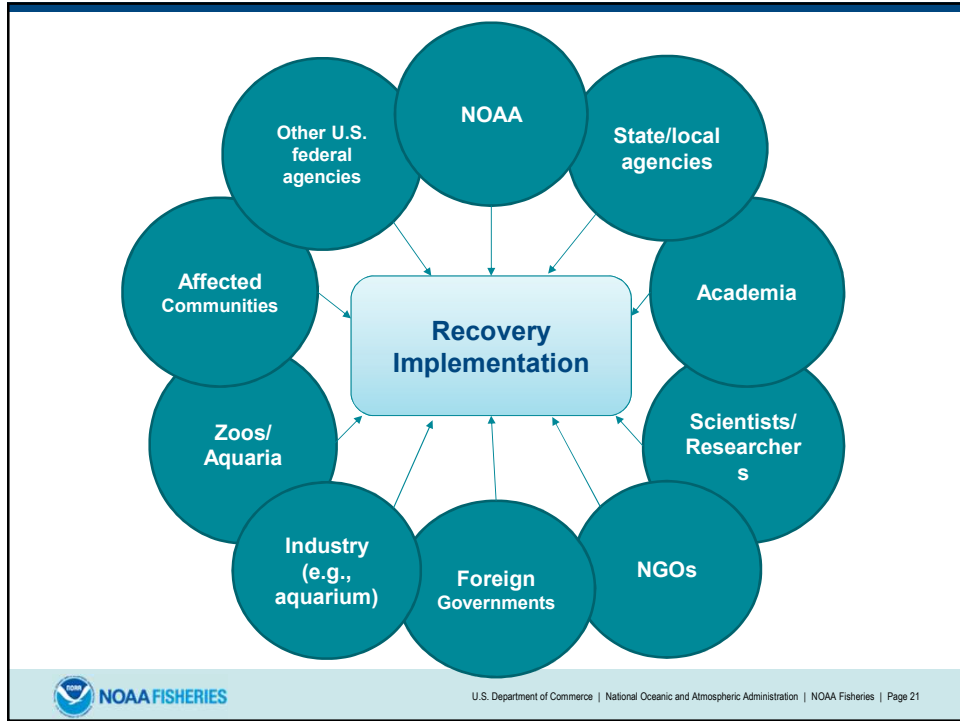
Photo: ©NOAA

## What if We Don't Know?

### Data Uncertainty

- Use interim criteria and actions that clearly identify the assumptions and uncertainties
- Refine those criteria and actions as data are collected and evaluated (adaptive management)
- Use surrogate species, where appropriate







# Threats Evaluation

## ESA-listed Indo-Pacific Reef Corals

Lance Smith, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

## Outline

1. Global Climate Change
2. Threats to the 15 Listed Spp.
3. What is Needed for Recovery



# 1. Global Climate Change

- Increasing concentrations of anthropogenic greenhouse gases (GHGs) in the atmosphere since about 1850, and subsequent warming of the earth, acidification of the oceans, rising sea-levels, and other impacts.
- Root cause of the most important threats to the 15 listed corals.



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Key points:



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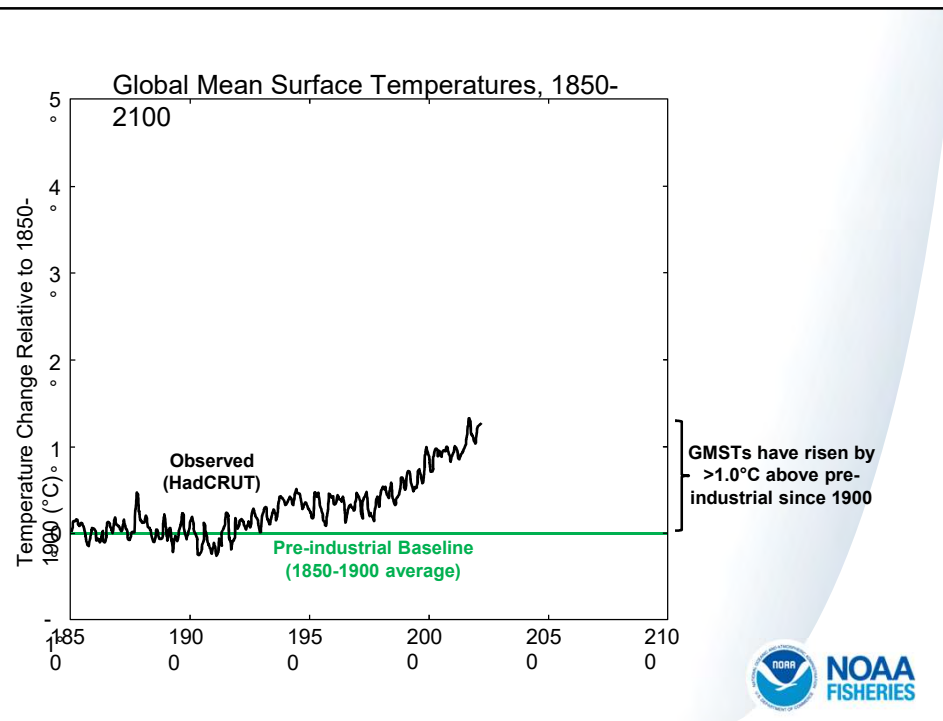


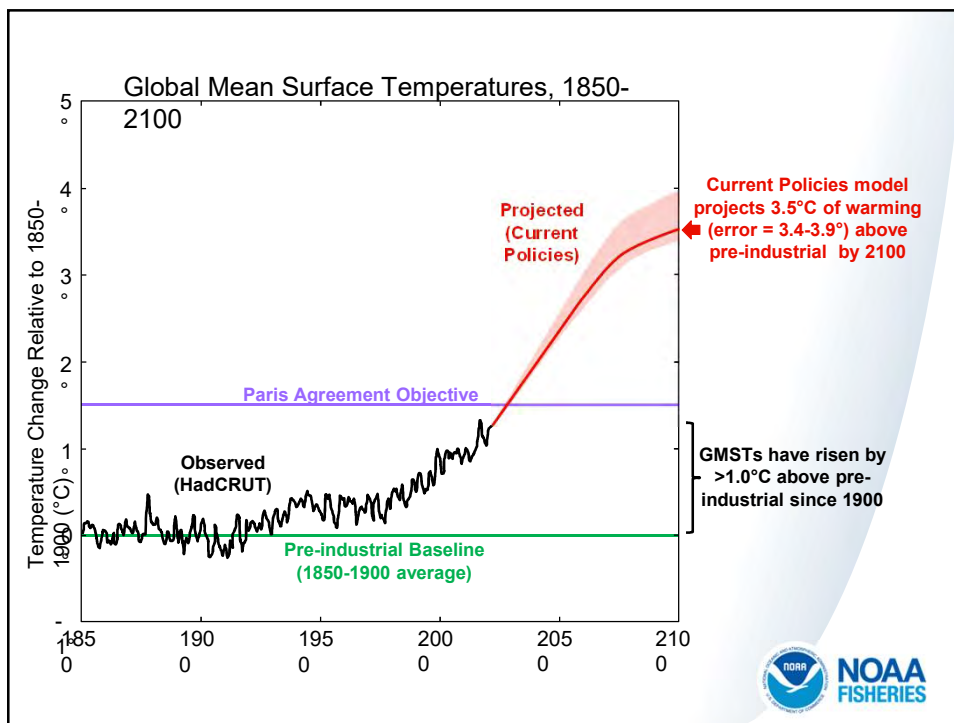
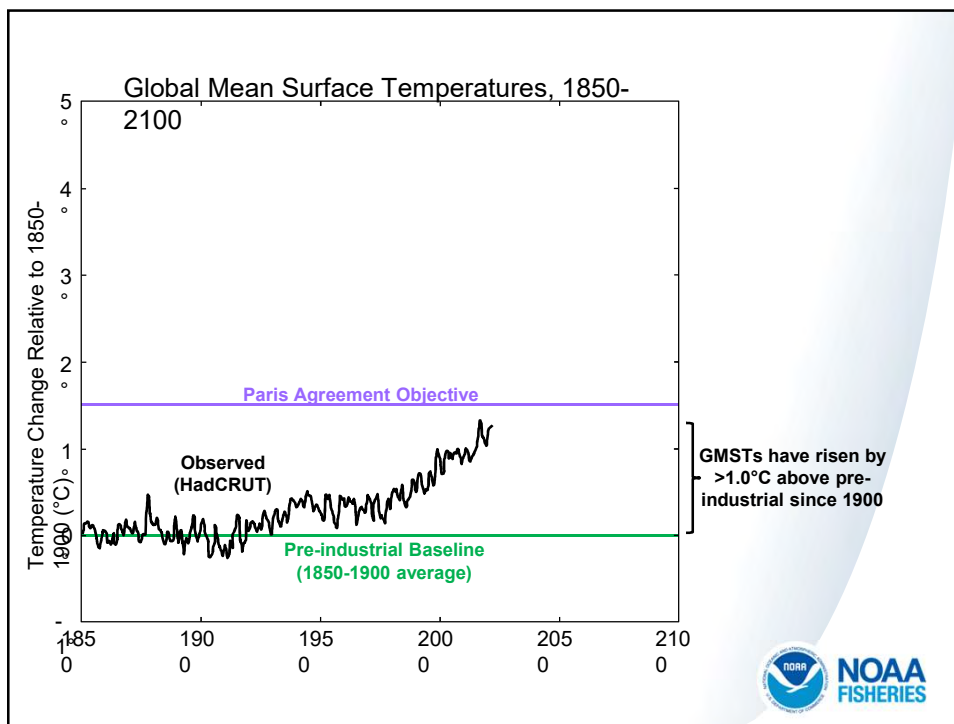


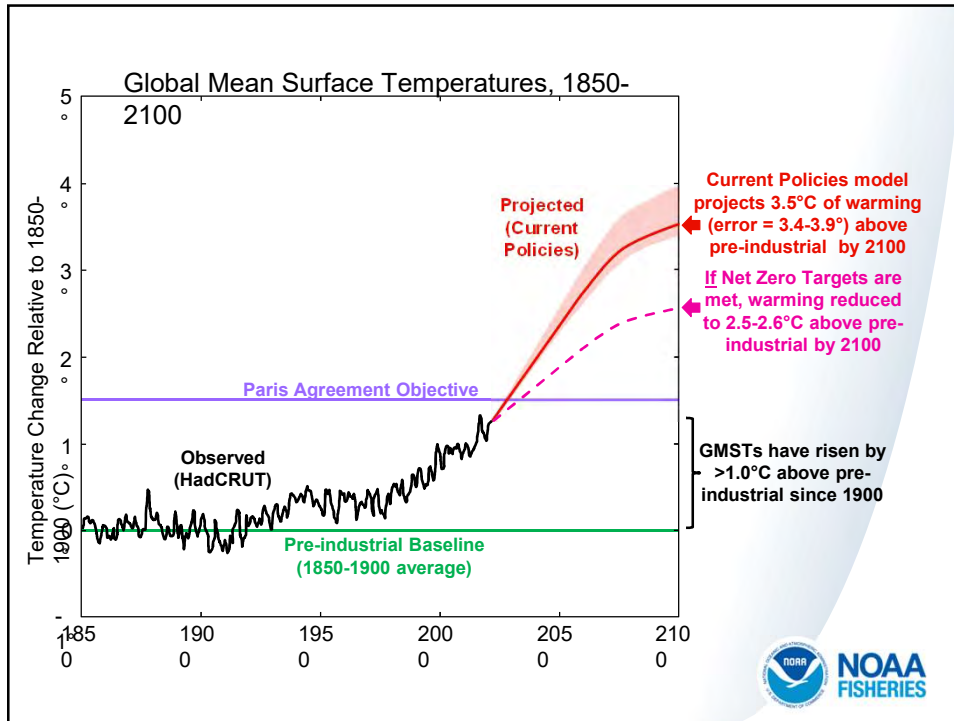
# 1. Global Climate Change

Key points:

1. Observed global warming from the “pre-industrial” period (1850-1900) to 2020.
2. Efforts to control climate change by reducing anthropogenic GHG emissions.
3. Projected additional global warming, 2021-2100.







## 2. Threats to the 15 Listed Spp.

- Ocean warming
- Ocean acidification
- Fishing
- Land-based sources of pollution
- Coral disease
- Predation
- Collection & Trade
- Sea-level rise
- Other threats
- Interactions of Threats

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- Regulatory Mechanisms (treaties, laws, regulations)



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    - Bottom Line: Meeting Net Zero Targets postpones impacts; further reductions in GHG emissions are essential to avoid severe & widespread impacts.



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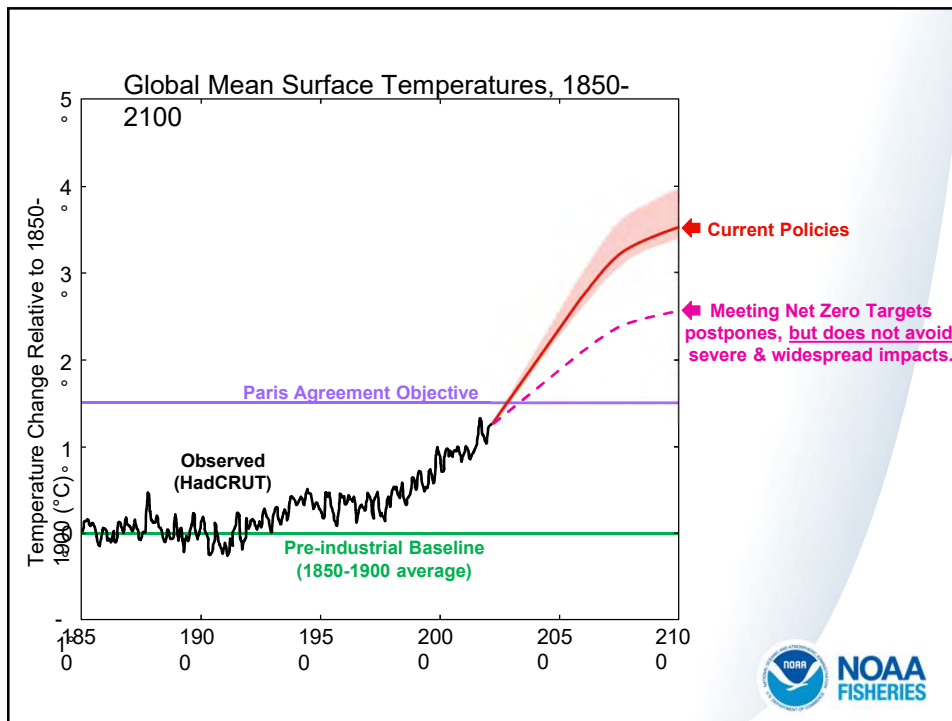
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    - Bottom Line: **Meeting Net Zero Targets postpones impacts; further reductions in GHG emissions are essential to avoid severe & widespread impacts.**

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## 2. Threats to the 15 Listed Spp.

- Ocean warming – **very high**
- Ocean acidification – **high**
- Fishing
- Land-based sources of pollution
- Coral disease
- Predation
- Collection & Trade
- Sea-level rise
- Other threats
- Interactions of Threats

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    - May be partially limited by growing regulatory mechanisms (e.g., bans of destructive fishing, better fishing regulations, and more/larger MPAs).



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  - Projected direct and indirect effects of fishing from now to 2100:
    - May be partially limited by growing regulatory mechanisms (e.g., bans of destructive fishing, better fishing regulations, and more/larger MPAs).
    - Likely exacerbated by continued growth of human populations and demand for fish, as well as numerous technological improvements.
    - Bottom line = **increase in direct and indirect effects of fishing.**



## 2. Threats to the 15 Listed Spp.

- Land-based Sources of Pollution
  - Observed effects of land-based sediment, nutrients, and contaminants (historical).



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  - Projected effects of land-based sediment, nutrients, and contaminants from now to 2100:
    - May be partially limited by growing regulatory mechanisms (e.g., better land management & regulations, terrestrial protected areas).
    - Likely exacerbated by continued growth of human populations, industrialization, and land development.
    - Bottom line = **increases in land-based sources of sediment, nutrients, and contaminants.**

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## 2. Threats to the 15 Listed Spp.

- Ocean warming – **very high**
- Ocean acidification – **high**
- Fishing - **medium**
- Land-based sources of pollution - **medium**
- Coral disease
- Predation
- Collection & Trade
- Sea-level rise
- Other threats
- Interactions of Threats

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- Ocean warming – **very high**
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- Fishing - **medium**
- Land-based sources of pollution - **medium**
- Coral disease - **medium**
- Predation - **low**
- Collection & Trade - **low**
- Sea-level rise - **low**
- Other threats - **low**
- Interactions of Threats

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- Fishing - **medium**
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- Coral disease - **medium**
- Predation - **low**
- Collection & Trade - **low**
- Sea-level rise - **low**
- Other threats - **low**
- Interactions of Threats – **unknown but likely very important**

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- Ocean warming – **very high**
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  - Coral disease - **medium**
  - Predation - **low**
  - Collection & Trade - **low**
  - Sea-level rise - **low**
  - Other threats - **low**
  - Interactions of Threats – unknown but **likely very important**
- Regulatory Mechanisms (treaties, laws, regulations)

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## 2. Threats to the 15 Listed Spp.

A species’ response to a threat currently and in the foreseeable future depends on:

$$\text{Susceptibility} + \text{Exposure} = \text{Vulnerability}$$

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### 3. What is Needed for Recovery

- Recovery implications:
  - Current outlook for threats precludes recovery



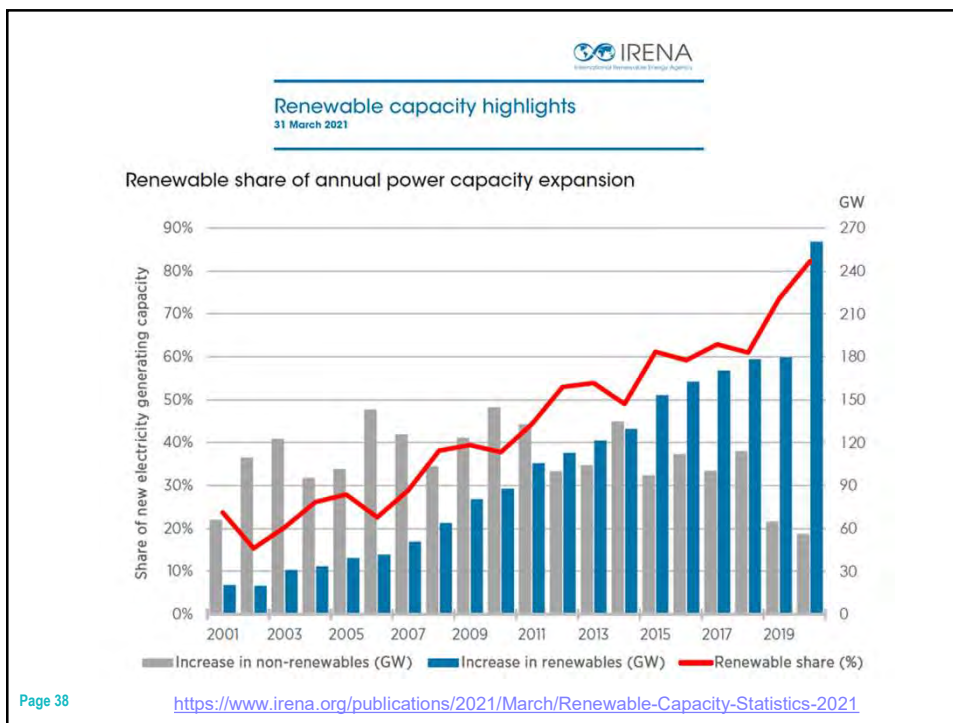
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### 3. What is Needed for Recovery

- Recovery implications:
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- Positive Signs:
  - Sharp increase in renewable energy
  - Real world examples of reductions in GHG emissions



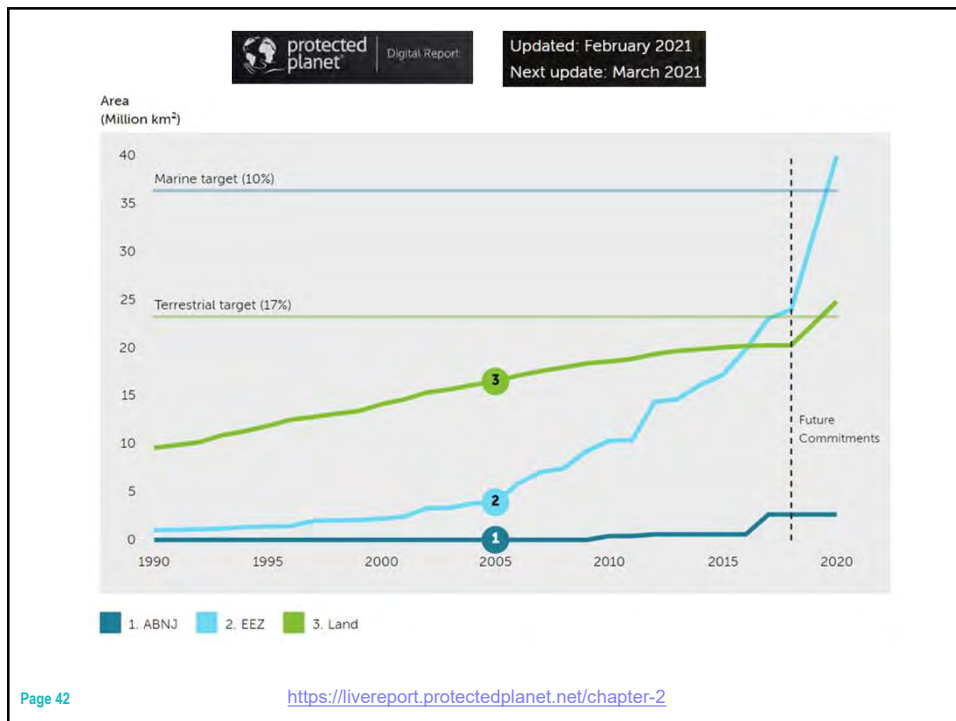
#### Germany's greenhouse gas emissions 1850-2020 and reduction targets



Data: Gütschow, Johannes, Jeffery, Louise; Gieseke, Robert (2019): The PRIMAP-hist national historical emissions time series (1850-1989). V. 2.0. GFZ Data Services. <http://doi.org/10.5880/PIK.2019.001>; Years 1990-2019: UBA, 2021; Year 2020: Estimate based on AGEb, 2020. Emission targets 2030, 2050: Govt. Climate Action Plan 2050 (2016).

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### 3. What is Needed for Recovery

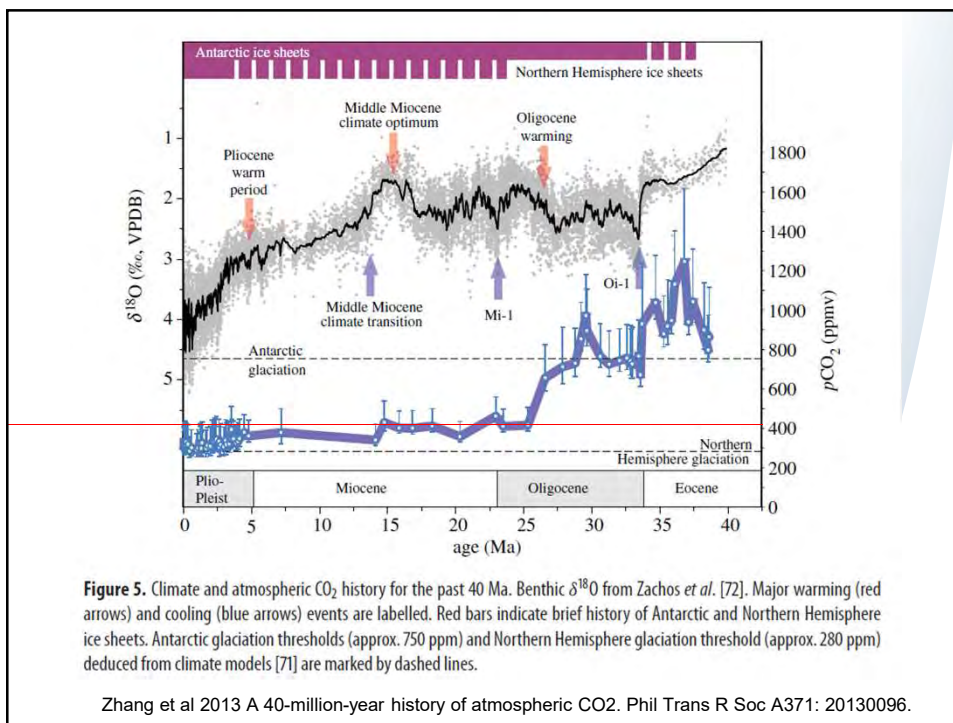
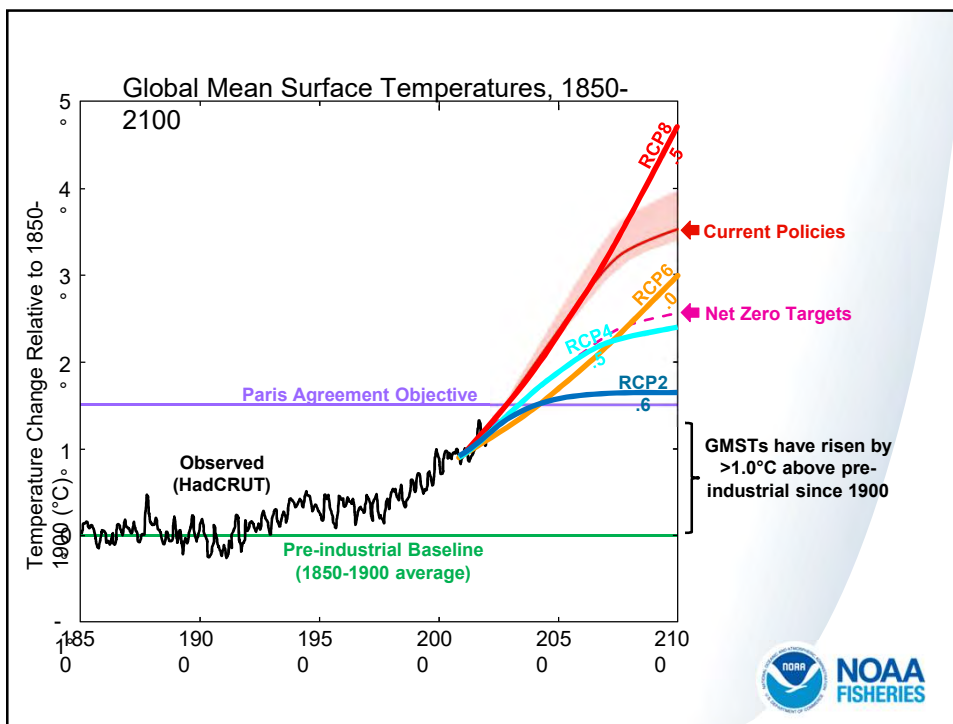
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Questions?



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# Recovery Planning Challenges

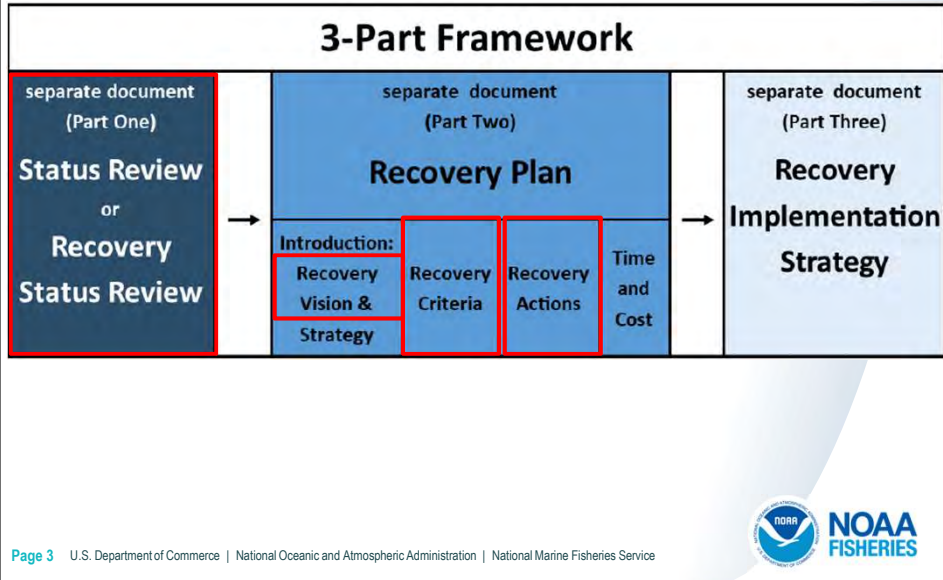
## ESA-listed Indo-Pacific Reef Corals

Danielle Jayewardene, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

## Outline

- \*Working Draft\*
  - Recovery Vision
  - Recovery Goals
  - Recovery Objectives
- Recovery planning challenges
- Proposed approaches to address challenges (intro)

# Recovery Planning for the Listed Corals



## DRAFT Recovery Vision

Populations of listed Indo-Pacific reef corals will be **present and viable throughout as much of their historical ranges** as future global- and local-scale environmental changes will allow, and **may expand their ranges** into new locations with more favorable habitat conditions in the future. The listed corals, and the coral reef ecosystems upon which they depend, **will experience low levels of threats** and will show **increased resilience** to global environmental changes.



## DRAFT Recovery Goals

Protect self-sustaining populations throughout as much of the species' geographic and ecological ranges as possible, and conserve the coral ecosystem upon which the species depend, while sufficiently abating threats to warrant delisting of the species.

**Draft Interim Goal:** Prevent the species from reaching endangered status.



## DRAFT Recovery Objectives

**Objective 1:** Ensure population viability of each species

**Objective 2:** Eliminate or sufficiently abate global and local threats to the species and the ecosystems upon which they depend

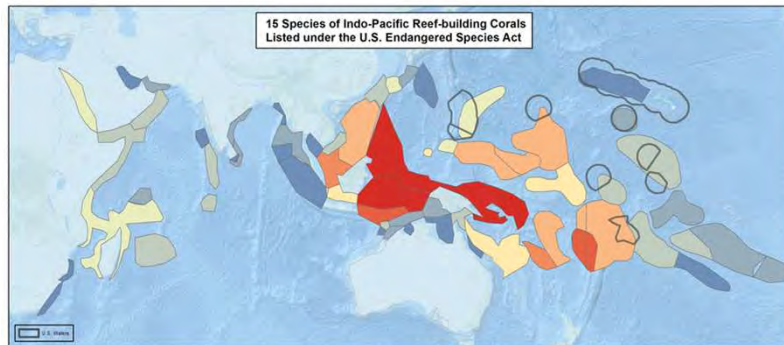


## Corals Recovery Planning Challenges

1. < 1% of collective ranges occurs within US waters
2. Limited species-specific information
3. Species identification uncertainty
4. Changing taxonomy
5. Importance of climate change threats
6. Many additional local threats
7. Recovery timeframe



## < 1% of Collective Ranges Within US



The Number of the 15 Species Confirmed or Predicted to be Confirmed in a Single Marine Ecoregion



Map by: R. O'Connor, NOAA Fisheries Service, 04-26-2021  
Source: Veron J.E.N., Stafford-Smith M.G., Turak E. and DeVantier L.M. (2016), Corals of the World. Accessed 20 Apr 2021.  
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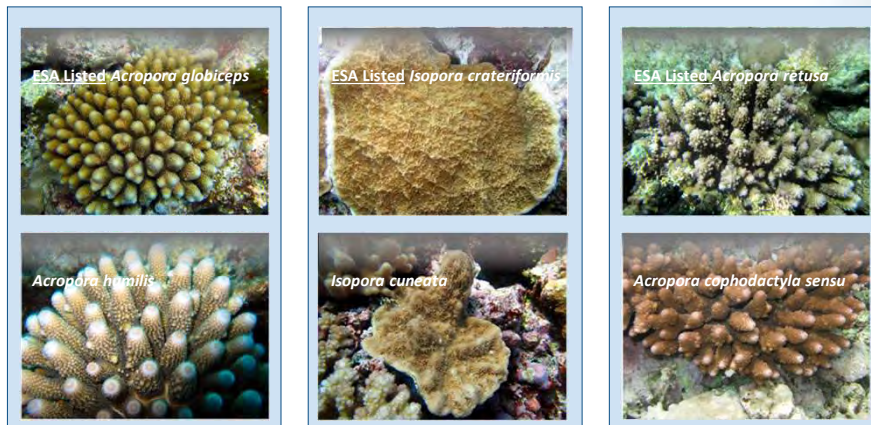


## Limited Species-Specific Information

- Geographic and depth distribution information available, but many ecoregions have not been extensively surveyed
- Some abundance information available for some species in some ecoregions, but almost no time-series abundance data for any
- Most assumptions about susceptibilities, exposures, and vulnerabilities to threats inferred from genus-level information



## Species Identification Uncertainty

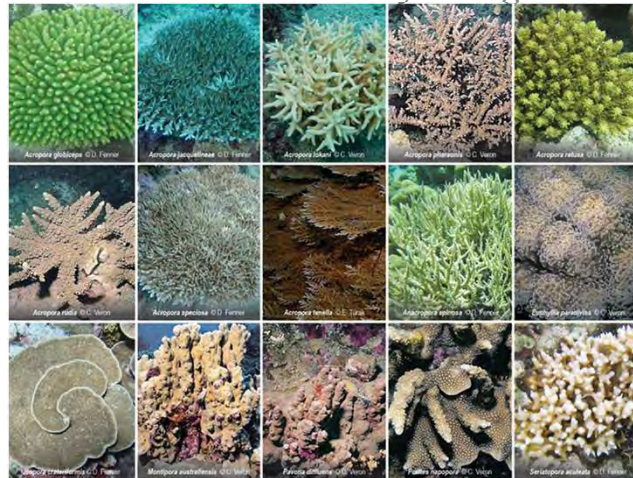


Photos copyright Doug Fenner. Source Fenner and Burdick 2016.



## Changing Taxonomy

The taxonomic classification may change in the future



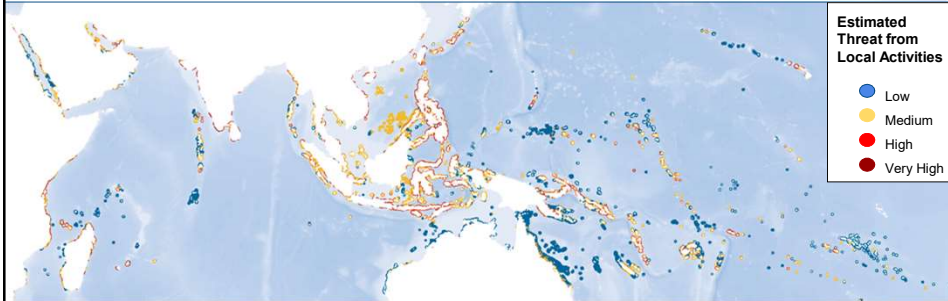
## Importance of Climate Change Threats

Threat	Observed Trend	Projected Trend	Regulatory Mechanisms	Importance to Extinction Risk
<b>Ocean Warming</b>	Worsened over past few decades, esp. 2014-2017	Increasingly frequent, severe & widespread	Substantial progress in GHG mgt, but still very inadequate	<b>Very High</b>
<b>Ocean Acidification</b>	Worsened over at least past few years	Increasingly severe & widespread	Substantial progress in GHG mgt, but still very inadequate	<b>High</b>
<b>Fishing Effects</b>	Worsened over past few decades in many areas	Increasingly severe & widespread	Substantial progress in fisheries mgt & MPAs, but still inadequate	<b>Medium</b>
<b>Land-based Sources of Pollution/LBSP</b>	Worsened over past few decades in many areas	Increasingly severe & widespread	Some improvement in mgt of LBSP sources, but still inadequate	<b>Medium</b>
<b>Coral Disease</b>	No clear trend, but stressors that lead to disease have increased	Increasingly frequent, severe & widespread	Some improvements in managing stressors, but still inadequate	<b>Medium</b>
<b>Predation</b>	No clear trend, but stressors that lead to disease have increased	Increasingly frequent, severe & widespread	Some improvements in managing stressors, but still inadequate	<b>Low</b>
<b>Sea-level Rise</b>	No clear trend	Gradually increase and broaden	Substantial progress in GHG mgt, but still very inadequate	<b>Low</b>
<b>Collection and Trade</b>	Worsened over past few decades in many areas	Increasingly severe & widespread	Some improvements in mgt & MPAs, but still inadequate	<b>Low</b>
<b>Other Threats</b>	All have likely increased in past few decades in some areas	Increasingly severe & widespread	Some improvements in mgt, but still inadequate	<b>Low</b>
<b>Interactions of Threats</b>	Worsened over past few decades, likely underestimated	Increasingly frequent, severe & widespread	Recent improvements in GHG & local threat mgt, but still inadequate	<b>Unknown but likely significant</b>

Summary of Threats Evaluation. Source NMFS 2021.



## Many Additional Local Threats



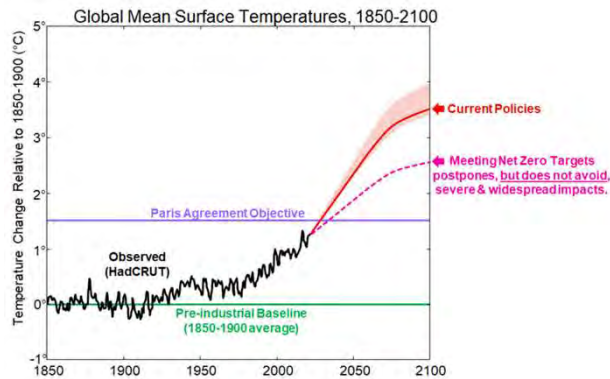
Map modified from <https://www.wri.org/research/reefs-risk-revisited>.

Coral reefs on this map are classified by estimated current threat from local human activities, according to the Reefs at Risk integrated local threat index. The index combines the threat from overfishing and destructive fishing; coastal development; watershed-based pollution; and marine-based pollution and damage. Source: Reefs at Risk Revisited (WRI, 2011)



## Recovery Timeframe

Recovery actions needed immediately, and over long-term



Source Lance Smith.



## Approaches to Address Challenges

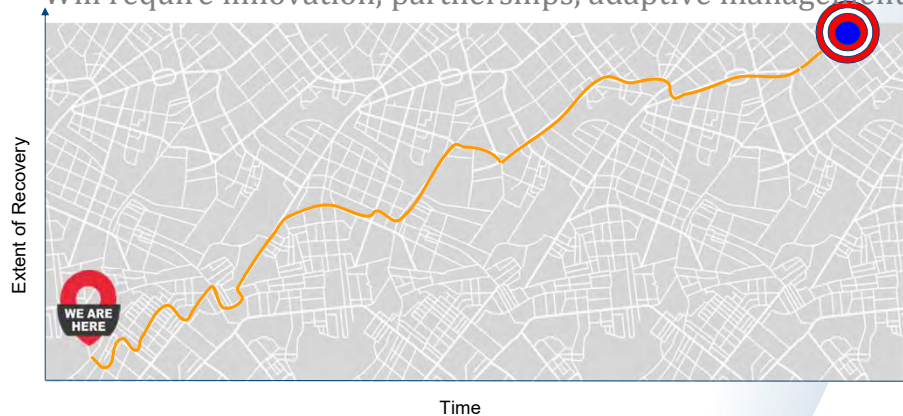
- Develop an Ecosystem Recovery Plan
- Undertake a Two-pronged Approach to Recovery Actions
- Build on Existing Conservation Efforts
- Identify and Prioritize Management Units



## Take-Home Message

Complex recovery planning effort

Will require innovation, partnerships, adaptive management



# Poll

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## Session II Presentations

### ESA-listed Indo-Pacific Corals Recovery Planning Workshop May 2021





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# Recap Session I

## ESA-listed Indo-Pacific Reef Corals

Danielle Jayewardene, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

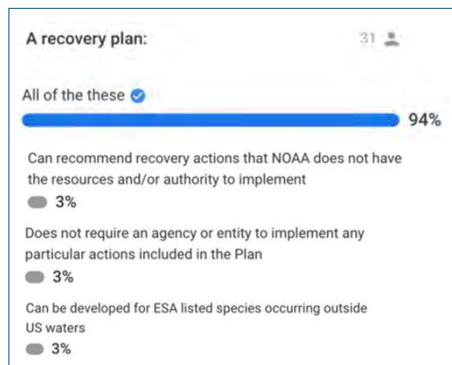
## Recap Session I: Recovery Planning

- The recovery plan is a road-map for the species recovery
- 3 required components in the recovery plan:
  - Recovery criteria
  - Recovery actions
  - Time and cost estimates
- Broad discretion in developing a feasible and practical recovery plan

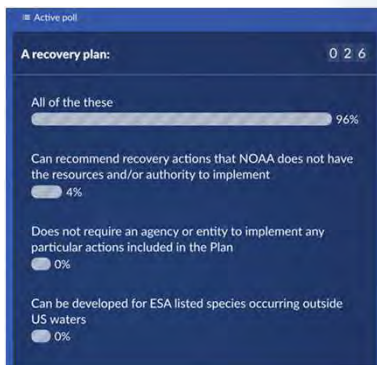


## Recap Session I: Poll Results- A recovery plan

Session I: Option A



Session I: Option B



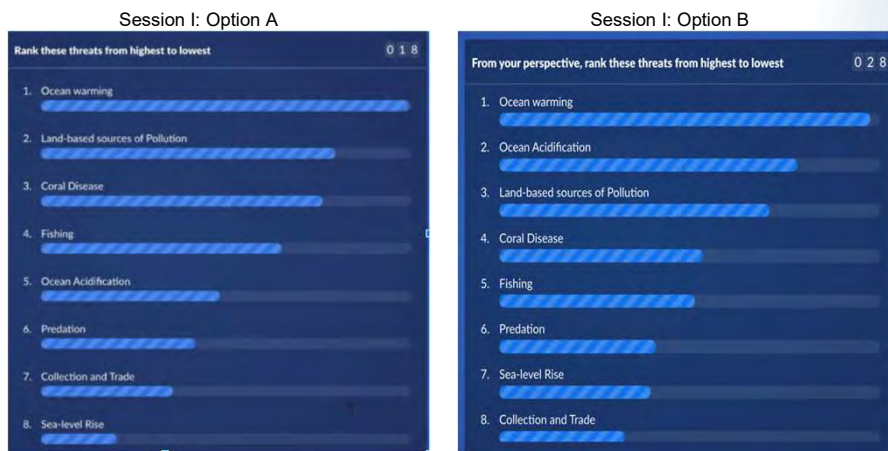


## Recap Session I: Threats

- Threats ranked (all projected to worsen):
  - Ocean warming - **very high**
  - Ocean acidification - **high**
  - Fishing - **medium**
  - Land-based sources of pollution - **medium**
  - Coral disease - **medium**
  - Predation - **low**
  - Collection & Trade - **low**
  - Sea-level rise - **low**
  - Other threats - **low**
  - Interactions of Threats - **unknown but likely very important**
  
- Recovery Requires Controlling Climate Change



## Recap Session I: Poll Results- Your Ranking of Threats



Other: Coastal construction



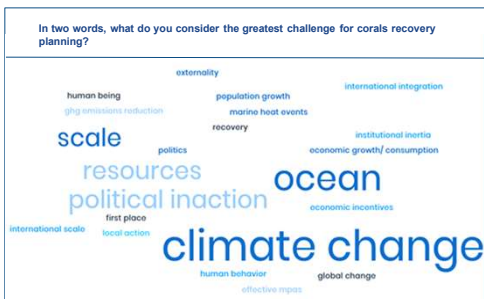
## Recap Session I: Challenges

- Several challenges for corals recovery planning:
  - < 1% of collective ranges occur within US waters
  - Limited species-specific information
  - Species identification uncertainty
  - Changing taxonomy
  - Importance of climate change threats
  - Many additional local threats
  - Recovery timeframe
  
- A complex recovery plan

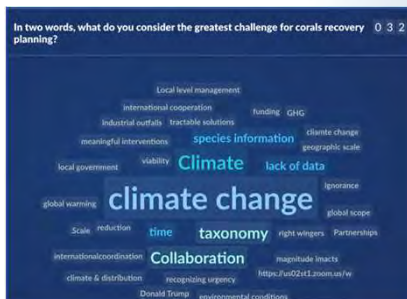


## Recap Session I: Poll Results- Greatest Challenge

Session I: Option A



Session I: Option B



Reference PDF (see link)

Working DRAFT Recovery Vision

Working DRAFT Recovery Goals

Working DRAFT Recovery Objectives





# Recovery Approaches

## ESA-listed Indo-Pacific Reef Corals

Danielle Jayewardene, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

### Proposed Recovery Approaches to Address Challenges:

- Develop an Ecosystem Recovery Plan
- Undertake a Two-pronged Approach to Recovery Actions
- Build on Existing Conservation Efforts
- Define Management Units



## Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US				
Sp. specific data deficiency				
Species ID Uncertainty				
Changing Taxonomy				
Main Climate Change Threat				
Many Additional Local Threats				
Recovery Timeframe				



## Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US				
Sp. specific data deficiency				
Species ID Uncertainty				
Changing Taxonomy				
Main Climate Change Threat				
Many Additional Local Threats				
Recovery Timeframe				



## Develop an Ecosystem Recovery Plan

Promote recovery of the listed corals *also* through the conservation and recovery of the coral reef ecosystems upon which they depend.



## Recovery Plan Approaches:

### ● Single-Species Plan

Species is distinct from other listed species with respect to its habitat requirements and threats, and/or it is the only listed species in its general geographic area

### ● Multi-Species Plan

If **two or more** species occur in the same geographical area or jurisdiction, and share common threats or management needs

### ● Ecosystem Plan

If several listed species in a shared biotic community rely on the protection and/or restoration of their ecosystem to reach recovery

**Note:** Although the ESA focuses recovery on the individually listed species, the purpose of the ESA also includes conserving the ecosystems upon which listed species depend.



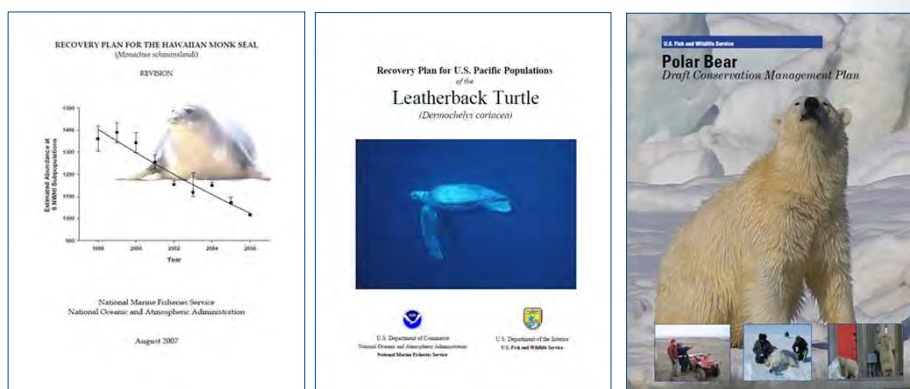
## Why Ecosystem Recovery Plan

- Similar habitat requirements
- Share common threats and management needs
- Species recovery relies on the protection of their coral reef ecosystems (broad scale view)

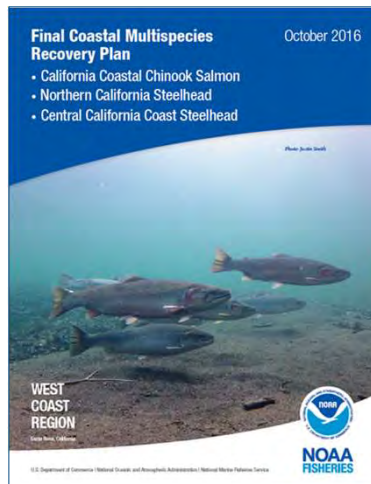
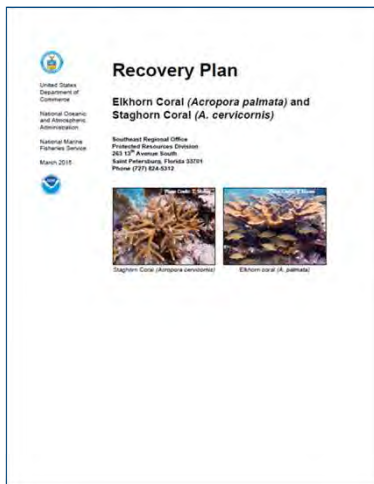
*Note: the biological connection between the ecosystem and the listed species should be clearly described*



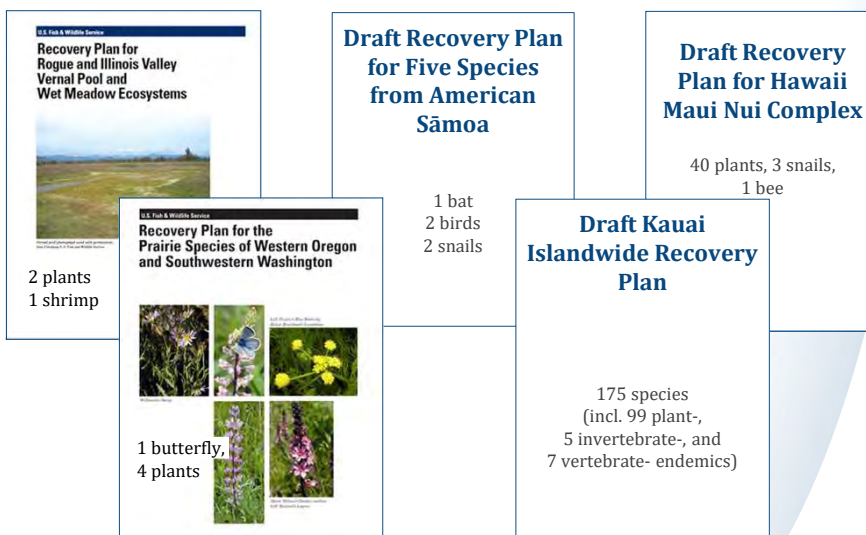
## E.g. Single-Species Plans



## E.g. NMFS Multi-Species Plans



## E.g. US FWS Ecosystem Plans





## Ecosystem Recovery Plan

### ● PROS

- While recovery criteria must be provided on a species-by-species basis, ecosystem-based criteria may be included
- Other reef species in the ecosystems upon which the listed species depend that have not yet been listed may be conserved so that they may not need the protection of the ESA.

### ● CONS

- Potentially less effective because less targeted
- Perception of overreach



## Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US	✓			
Sp. specific data deficiency	✓			
Species ID Uncertainty	✓			
Changing Taxonomy	✓			
Main Climate Change Threat				
Many Additional Local Threats				
Recovery Timeframe				



## POLL

Which recovery plan approach makes most sense to you?

- Multiple, single-species recovery plans
- One multi-species recovery plan
- An ecosystem recovery plan
- Combination



## Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US				
Sp. specific data deficiency				
Species ID Uncertainty				
Changing Taxonomy				
Main Climate Change Threat				
Many Additional Local Threats				
Recovery Timeframe				



## Two-Pronged Approach to Actions



Identify large-scale, long-term recovery actions to limit ocean warming and ocean acidification adequately for coral recovery

**AND**



Identify smaller-scale recovery actions to promote the survival and resilience of these corals in the interim



## Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US				
Sp. specific data deficiency				
Species ID Uncertainty				
Changing Taxonomy				
Main Climate Change Threat		✓		
Many Additional Local Threats		✓		
Recovery Timeframe		✓		



## POLL

For two-pronged approach: what do you think should be the level of emphasis in the recovery plan?

Smaller-scale recovery actions to promote the survival and resilience



Large-scale recovery actions to mitigate climate change effects



## Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US				
Sp. specific data deficiency				
Species ID Uncertainty				
Changing Taxonomy				
Main Climate Change Threat				
Many Additional Local Threats				
Recovery Timeframe				



## Build on Existing Efforts

Recommend and prioritize recovery actions building on existing management, conservation and research efforts to the greatest extent possible (where feasible and logical), while also identifying new recovery actions as needed.



## MURAL- Existing Efforts

- Climate resilient MPA network in eastern Indonesia
- Coral Triangle Initiative (CTI) MPA System action plan
- Network of NT MPAs in Visayan Seas in Philippines
- Arafura Timor Seas Ecosystem Action initiative to develop MPA network
- Data from Guam and CNMI on *A. globiceps*
- National Park Service American Samoa has trend data on *Acropora globiceps*, *A. retusa*, and *Isopora crateriformis* + photos of *Euphyllia paradivisa* park.
- Identification of thermally resilient corals and genotypes in American Samoa.
- Taxonomic uncertainty with *P. diffluens*
- Listed species identification efforts/trainings



## Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US			✓	
Sp. specific data deficiency				
Species ID Uncertainty				
Changing Taxonomy				
Main Climate Change Threat			✓	
Many Additional Local Threats			✓	
Recovery Timeframe			✓	

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## POLL

What are some of the key existing management, conservation and research efforts we might build on?

In a few words

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## Challenges & Approaches

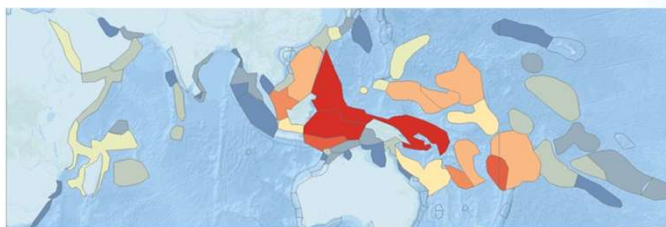
	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US				
Sp. specific data deficiency				
Species ID Uncertainty				
Changing Taxonomy				
Main Climate Change Threat				
Many Additional Local Threats				
Recovery Timeframe				



## Define Management Units

Define management units (MUs) across the collective geographic range of the 15 listed corals.

*A tool; particularly helpful for species that occur across broad geographic ranges in which species might require different management in different regions.*



## Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US				✓
Sp. specific data deficiency				
Species ID Uncertainty				
Changing Taxonomy				
Main Climate Change Threat				
Many Additional Local Threats				✓
Recovery Timeframe				



## SUMMARY: Challenges & Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US	✓		✓	✓
Sp. specific data deficiency	✓			
Species ID Uncertainty	✓			
Changing Taxonomy	✓			
Main Climate Change Threat		✓	✓	
Many Additional Local Threats		✓	✓	✓
Recovery Timeframe		✓	✓	









# Management Unit Options ESA-listed Indo-Pacific Reef Corals

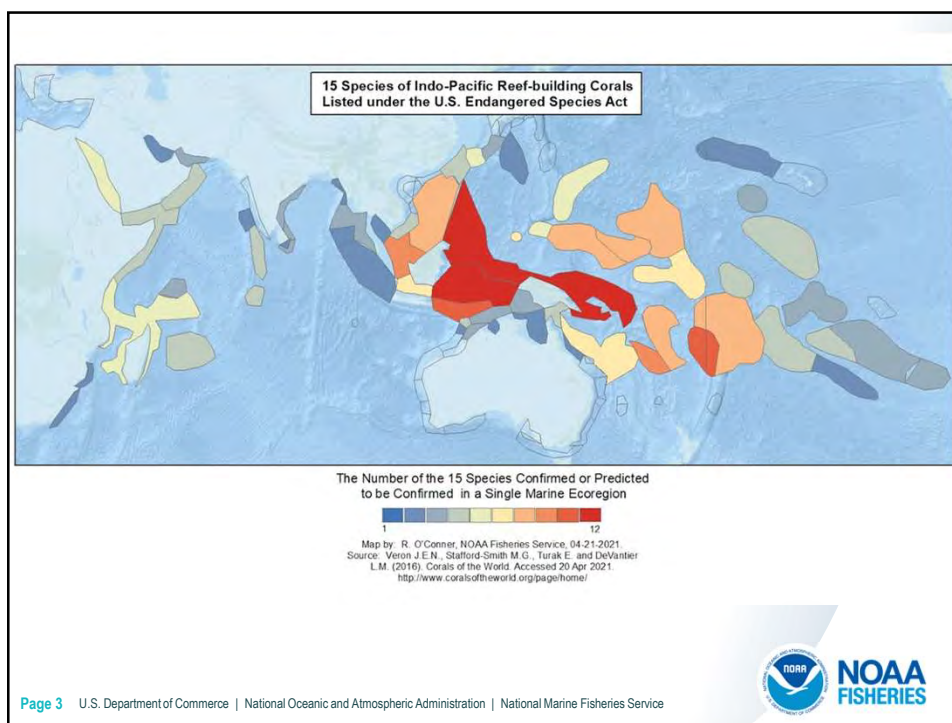
Lance Smith, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

## Management Units Guidance

NMFS Recovery Handbook (2020):

- Threats, management authority, and/or population viability may differ across geographic areas requiring tailored management actions.
- Each Management Unit (MU) is not necessarily essential to the conservation of the species, in contrast to Recovery Units.





## Our Goals for Management Units

- Develop one MU system that can be applied to all 15 listed species.
- The MU system needs to be set up in a way that recovery criteria can be applied to the MUs.
- Keep it practical (e.g., easily explained & understood, not too many MUs, etc.).

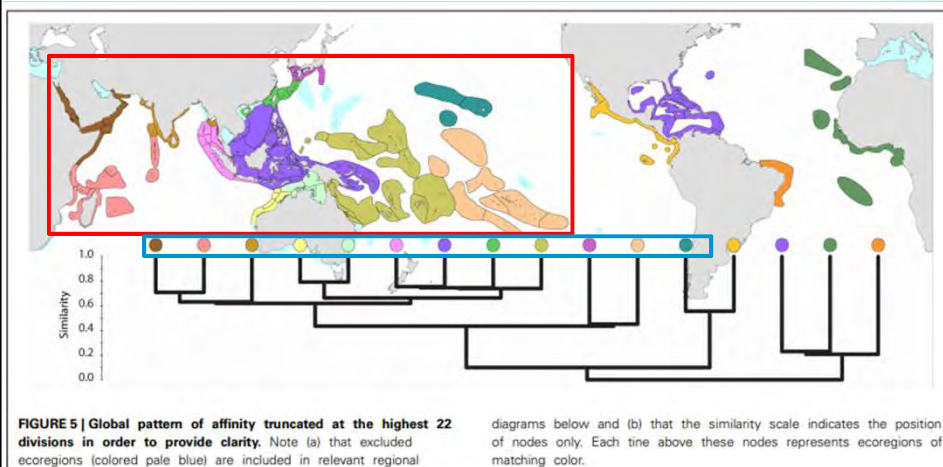
## Some MU Options

- Coral ecoregions
- Coral populations
- Exclusive Economic Zones
- Other possibilities?

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## Veron Ecoregion Groupings

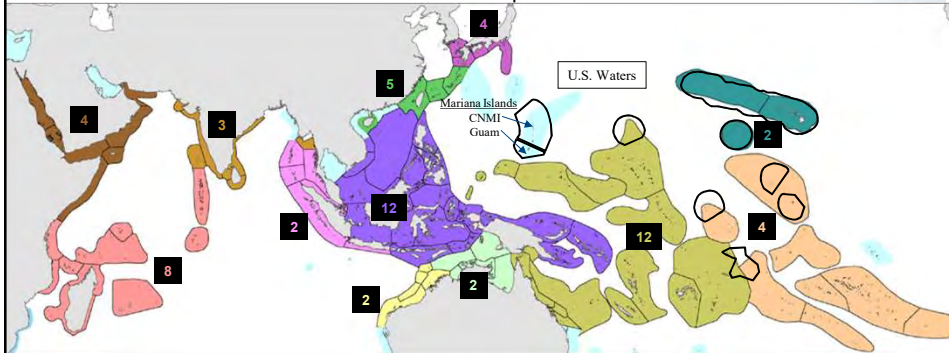


Veron JEN, Stafford-Smith M, DeVantier L, Turak E. 2015. Overview of distribution patterns of zooxanthellate Scleractinia. *Frontiers in Marine Science*. 1:1-19.

Page 6

## Veron Ecoregion Groupings

The 12 ecoregion groups (Veron et al. 2015) where the 15 ESA-listed corals occur, and the numbers of listed species in each.



Veron JEN, Stafford-Smith M, DeVantier L, Turak E. 2015. Overview of distribution patterns of zooxanthellate Scleractinia. *Frontiers in Marine Science*. 1:1-19.

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## Coral Populations

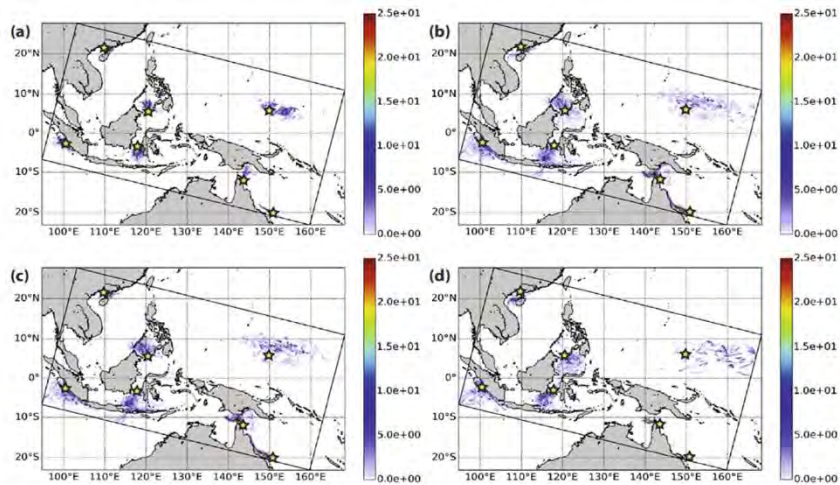


Fig. 2. Lagrangian probability density functions (LPDFs) for a subset of 7 larvae release sites (yellow stars) distributed throughout the CT domain for (a) annual spring and fall spawning after a 10-day pelagic larval duration (PLD) and (b) annual spring and fall spawning, (c) spring spawning (d) and fall spawning after a 30-day pelagic larval duration (PLD). All show the average LPDF pattern over the 47-year historical period.

Thompson, D., J. Kleypas, F. Castruccio, E. Curchitser, M. L. Pinsky, B. Jönsson, and J. Watson (2018). Variability in oceanographic barriers to coral larval dispersal: do currents shape biodiversity? *Progress in Oceanography* 165: 110-122 doi: 10.1016/j.pocean.2018.05.007

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# Coral Populations

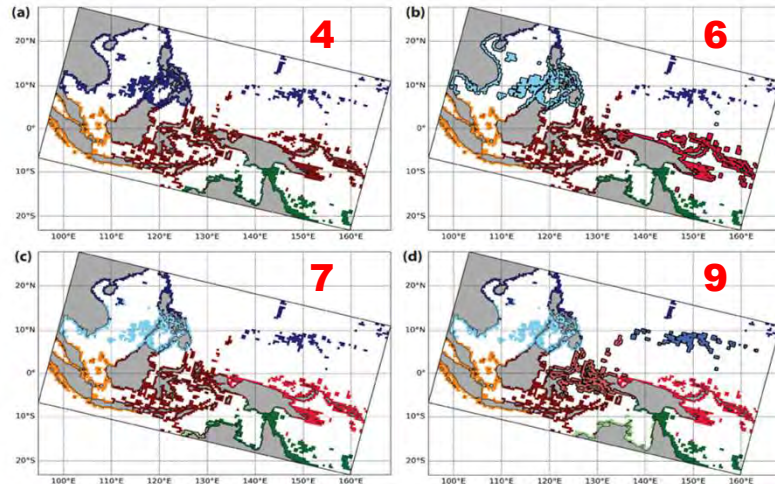
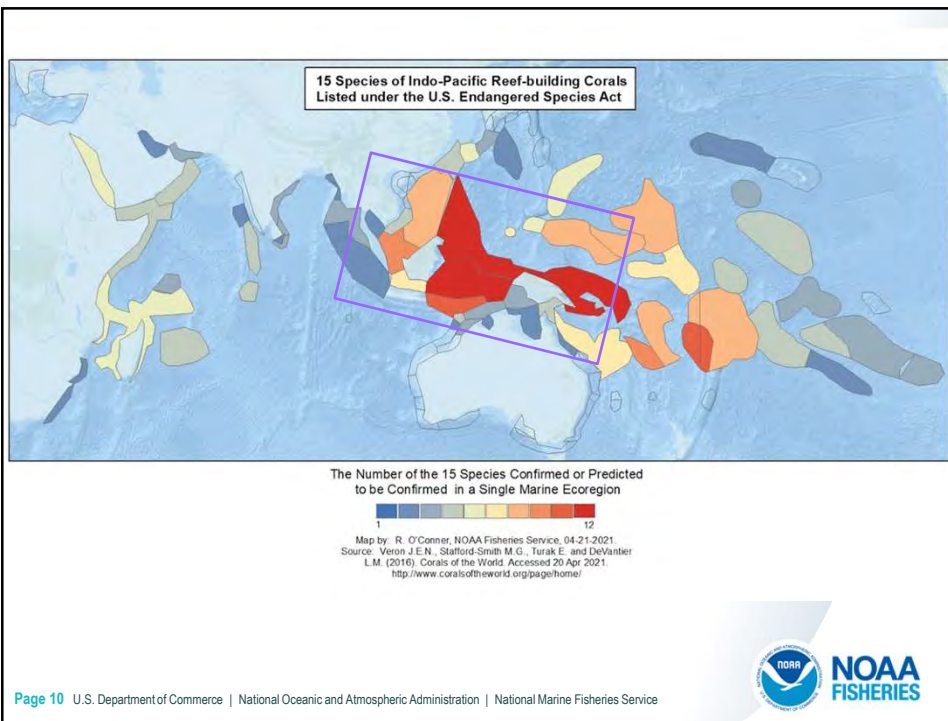


Fig. 8. Coral subpopulations determined from potential connectivity for a 30-day PLD of combined spring and fall spawning events (using methodology of Jacobi et al., 2012): (a) 4 subpopulations (mean connectivity between subpopulations,  $Q = 0.74$ ), (b) 6 subpopulations ( $Q = 0.83$ ), (c) 7 subpopulations ( $Q = 0.85$ ), and (d) 9 subpopulations ( $Q = 0.88$ ). New subpopulations added each iteration are outlined in black.

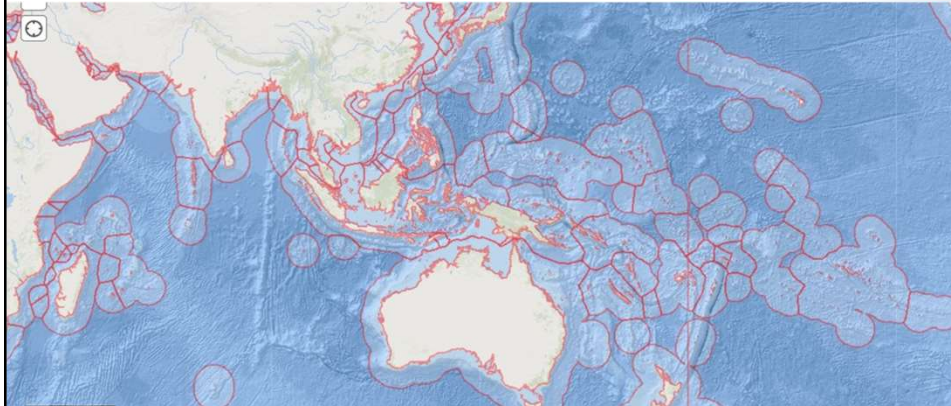
Thompson, D., J. Kleypas, F. Castruccio, E. Curchitser, M. L. Pinsky, B. Jönsson, and J. Watson (2018). Variability in oceanographic barriers to coral larval dispersal: do currents shape biodiversity? *Progress in Oceanography* 165: 110-122 doi: 10.1016/j.pocean.2018.05.007

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# Exclusive Economic Zones (EEZs)



Esri, GEBCO, DeLorme, NatureVue | MarineRegions.org (2019) esri



# Exclusive Economic Zones (EEZs)



[https://en.wikipedia.org/wiki/Exclusive\\_economic\\_zone](https://en.wikipedia.org/wiki/Exclusive_economic_zone)



## Our Goals for Management Units

- Develop one MU system that can be applied to all 15 listed species.
- The MU system needs to be set up in a way that recovery criteria can be applied to the MUs.
- Keep it practical (e.g., easily explained & understood, not too many MUs, etc.).







## Session III Presentations

### ESA-listed Indo-Pacific Corals Recovery Planning Workshop May 2021





The slide features the NOAA Fisheries logo in the top left corner. The main content is as follows:

# Recap Session II

## ESA-listed Indo-Pacific Reef Corals

Danielle Jayewardene, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

## Recap: Overview of Recovery Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US	✓		✓	✓
Sp. specific data deficiency	✓			
Species ID Uncertainty	✓			
Changing Taxonomy	✓			
Main Climate Change Threat		✓	✓	
Many Additional Local Threats		✓	✓	✓
Recovery Timeframe		✓	✓	

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## Develop an Ecosystem Recovery Plan

### Why:

- Listed corals have similar habitat requirements
- Listed corals share common threats and management needs
- Eco plan promotes recovery through protection of the ecosystem
- Eco plan helps address scale and species info challenges

### Pros:

- Can include ecosystem-criteria
- Potential benefit to non-listed species

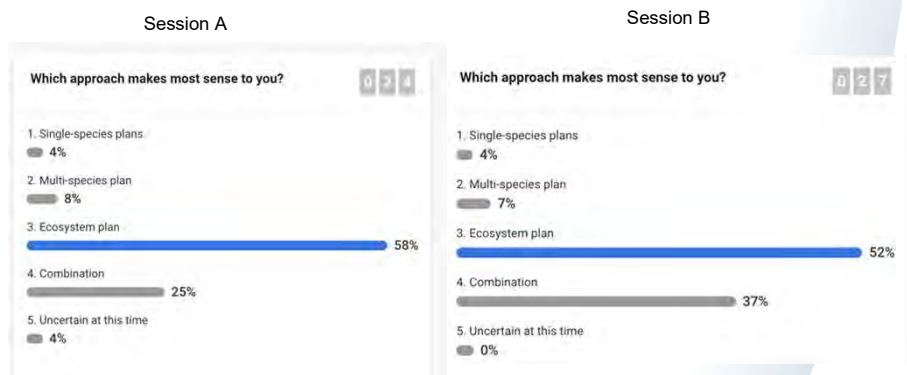
### Cons:

- Potentially less effective because less targeted
- Perception of overreach

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## Poll Results- Recovery Plan Approach



## Two-Pronged Approach to Actions



Identify large-scale, long-term recovery actions to limit ocean warming and ocean acidification adequately for coral recovery

**AND**

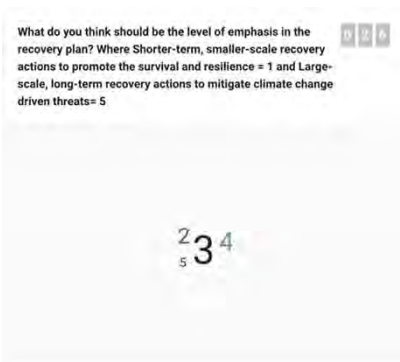


Identify smaller-scale recovery actions to promote the survival and resilience of these corals in the interim



## Poll Results- Emphasis on 2 prongs

### Session A



### Session B



## Build on Existing Efforts

Include and prioritize recovery actions building on existing efforts

+ Identify new recovery actions as needed



## Poll Results- Key Efforts To Build On

- Growing field of knowledge regarding "resist, accept, direct" approaches to managing ecosystem transitions
- RRAP
- Experience of our Australian colleagues in management of the great barrier reef ecosystem
- The American Samoa Ocean Plan has a section about sustainability, It's very action-specific, but there might be parts of it that could inform any actions of the Recovery Plan, such as mapping effort and data collection push. The first goal of the ASOP is healthy coastal and ocean ecosystems.
- Tracking populations trends
- Pacific Jurisdiction Restoration Plans
- Us Climate Fisheries Initiative
- Improve Restoration success
- Public and private restorations efforts
- Vulnerability assessments
- Existing fishery management plans (MSA and local)
- Everglades Restoration project (which includes the Florida Keys and Biscayne Bay coral ecosystems as well as 105 other T/E species)
- Species location identification
- Coral resilience and vulnerability assessments
- Partnering and support with regional recovery efforts
- Coral Reef Conservation Program
- MPA management capacity building outside of the US (e.g. with CTI-CFF)
- Research on optimizing restoration tracking of population trends (need much more of this)
- Elements of the National Academies studies
- Existing MPAs in coral diverse areas
- Biden administration's GHG reduction efforts
- Paris Climate agreement
- Build upon Acropora recovery plan
- Advances in restoration methods for resilience
- Coral Restoration Consortium
- Acropora recovery plan
- Great Barrier Reef efforts
- NAS Active Intervention Report
- US climate inundation Climate Initiative
- Restoration Planning
- MPAs
- Project Phoenix Coral taxonomy work in Pacific Loads of coral restoration projects around the South Pacific- can assist with reading breeding populations
- MPA expansion program in Sri Lanka
- Might look at Maui DOFAW's current effort to ID key habitat areas of 300+ terrestrial species using spatial optimization and key management using return on investment systems
- Increasing community sustainability and resilience- get locals involved
- Reducing sedimentation and overexploitation of herbivores (improve coral recruitment)
- Better information on distributions & abundance
- Citizen science monitoring of reefs in the Philippines Use local plans for the natural resources plan from CNMI, Guam and Kwaj
- Spatial data on variability in coral stress
- Territorial restoration plans
- Monitoring
- Study coral rehab and growth in Australia
- Taxonomic revisions and more accurate population status assessments
- Draft US coral Jurisdiction Coral Restoration Plans
- Range shifts?
- Marine protected areas



## Define Management Units (MUs)

Appropriate when threats, management authority, and/or population viability may differ across geographic areas requiring tailored management actions.

Management Units vs. Recovery Units.

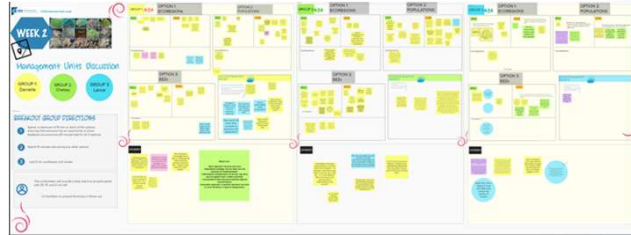


## Mural- screen shots

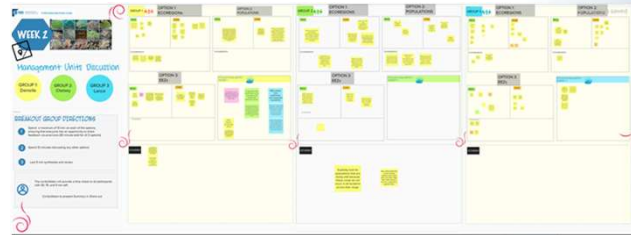
**OPTIONS:**

- Ecoregions
- Populations
- EEZs
- Other?

Session: A

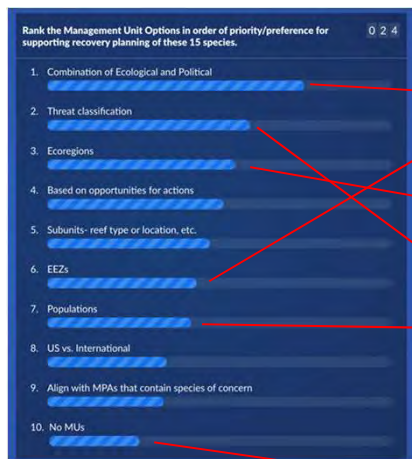


Session: B



## Poll Results- Ranking of MU options

Session A



Session B





NOAA FISHERIES

# Recovery Criteria

## ESA-listed Indo-Pacific Reef Corals

Danielle Jayewardene, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

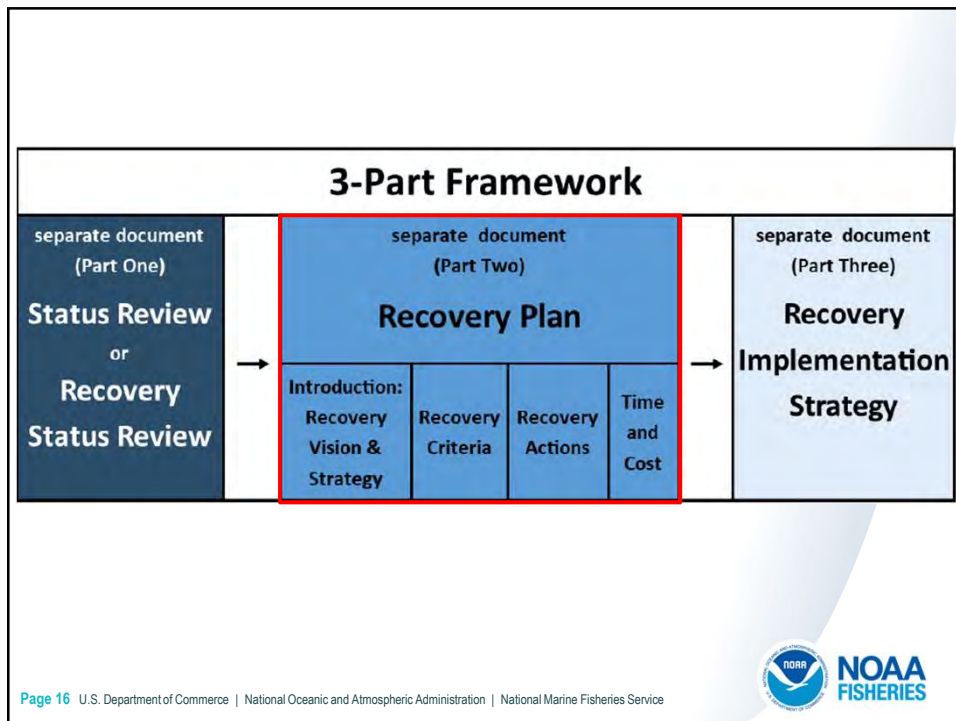


## Recovery Criteria:

Spell out the anticipated conditions for the species to achieve recovery (and for delisting to occur)

Serve as the structuring element of the recovery plan and guide the development of recovery actions

Measure progress toward delisting



**RECOVERY PLAN**

Vision  
Strategy  
Goals  
Objectives  
**Criteria**  
Actions

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**RECOVERY PLAN**

Vision  
Strategy  
Goals  
Objectives  
**Criteria**  
Actions

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## WORKING DRAFT Recovery Vision

Populations of listed Indo-Pacific reef corals will be present and viable throughout as much of their historical ranges as future global- and local-scale environmental changes will allow, and may expand their ranges into new locations with more favorable habitat conditions in the future. The listed corals, and the coral reef ecosystems upon which they depend, will experience low levels of threats and will show increased resilience to global environmental changes.



## RECOVERY PLAN

Vision

Strategy

Goals

Objectives

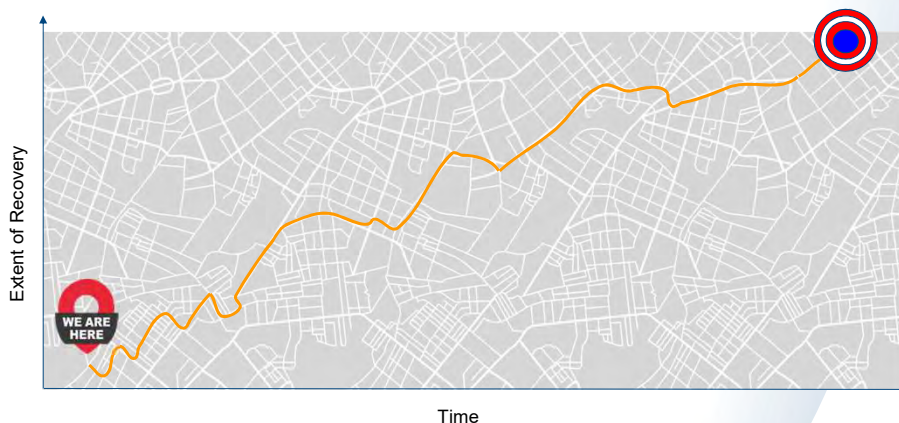
Criteria

Actions



## Recovery Strategy

Describes the overall path.



## RECOVERY PLAN

Vision

Strategy

Goals

Objectives

Criteria

Actions



## WORKING DRAFT Recovery Goals

Protect self-sustaining populations throughout as much of the species' geographic and ecological ranges as possible, and conserve the coral ecosystem upon which the species depend, while sufficiently abating threats to warrant delisting of the species.

**Draft Interim Goal:** Prevent the species from reaching endangered status.



## RECOVERY PLAN

Vision

Strategy

Goals

Objectives

Criteria

Actions



## WORKING DRAFT Recovery Objectives

**Objective 1:** Ensure population viability of each species

**Objective 2:** Eliminate or sufficiently abate global and local threats to the species and the ecosystems upon which they depend

*We need to establish criteria for each recovery objective*



## RECOVERY PLAN

Vision

Strategy

Goals

Objectives

Criteria

Actions



## Recovery Actions

Are the prioritized, site-specific management actions to conserve, protect, manage, restore, and enhance species and their habitats, and most of all avoid or minimize threats, to facilitate the species ability to achieve the recovery criteria



## RECOVERY PLAN

Vision

Strategy

Goals


Objectives

Criteria

Actions



## Development of Recovery Criteria



**FACTSHEET: Recovery Criteria**

**Recovery Criteria:**

- ◆ Spell out the anticipated conditions for species to achieve recovery
- ◆ Need to be established for each recovery objective
- ◆ Must be "objective and measurable" and should be as temporally and spatially specific as possible
  - Objective- based on facts/best available science, unbiased, clear
  - Measurable- quantitative or an easily interpreted qualitative gauge to measure progress

**Demographic or Population-Focused Criteria**

- ◆ Inclusion strongly recommended
- ◆ Should be developed to address each of the Viability Parameters (VP) as provided in the Recovery Status Review
- ◆ Each representative unit (e.g. a management unit) can have unique recovery criteria

**Threats-Based Criteria**

- ◆ Inclusion required
- ◆ Should be developed for the mitigation, reduction or elimination of Threats, as they are the primary route to species recovery
- ◆ Must address stressors/threats assessed in the Recovery Status Review that are relevant to the species current and anticipated future condition
- ◆ Should be directly related to specific demographic or habitat-based criteria, and designed to facilitate the species being able to reach the demographic criteria
- ◆ Each threat must be analyzed for its relationship to other threats

**Criteria for Ecosystem Recovery Plans**

- ◆ May be included in addition to the required species specific recovery criteria

**Justification**

- ◆ Each criteria must have adequate justification addressing how it will improve demographic or threat conditions for the species to lead to recovery

**When Criteria Development is not Practicable**


- ◆ Where incorporation of delisting objectives and criteria are impracticable (not just difficult) at this time:
  - Need a scientifically and administratively defensible explanation about why
  - Consider providing a description of actions necessary and timelines needed in order to obtain the pertinent information to develop

**Criteria and Delisting Species**

- ◆ All Recovery Criteria need not be met to delist a species
- ◆ Meeting criteria does not automatically lead to delisting, instead depend on an evaluation of the "5 factors" outlined in ESA Section 4

NOTE: This factsheet has been developed as reference material for the May 2021 ESA listed Indo-Pacific Corals recovery planning workshop.

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## Recovery Criteria

- ❖ Need to be established for each recovery objective
- ❖ Must be “objective and measurable”, and should be as temporally and spatially specific as possible:
  - *Objective*- based on facts/best available science, unbiased, clear
  - *Measurable*- quantitative or an easily interpreted qualitative gauge to measure progress



## Recovery Criteria

### ***Demographic-Focused Criteria (strongly recommended)***

- ❖ Should be developed to address each of the Viability Parameters (VP) as provided in the Recovery Status Review
- ❖ Each representative unit (e.g. a management unit) can have unique recovery criteria



## Recovery Criteria

### ***Threats-Based Criteria (required)***

- ❖ Should be developed for the mitigation, reduction or elimination of threats, as they are the primary route to species recovery
- ❖ Must address stressors/threats assessed in the Recovery Status Review that are relevant to the species current and anticipated future condition
- ❖ Should be directly related to specific demographic or habitat-based criteria, and designed to facilitate the species being able to reach the demographic criteria



## Recovery Criteria

- ❖ Each criteria must have adequate justification addressing how it will improve demographic or threat conditions for the species to lead to recovery
- ❖ Where incorporation of delisting objectives and criteria are impracticable (not just difficult) at this time:
  - Need a scientifically and administratively defensible explanation about why
  - Consider providing a description of actions necessary and timelines needed in order to obtain the pertinent information to develop



## Recovery Criteria

### *Criteria and Delisting Species*

- ❖ All Recovery Criteria need not be met to delist a species
- ❖ Meeting criteria does not automatically lead to delisting; instead depend on an evaluation of the “5 factors” outlined in ESA Section 4



## Criteria Discussion Today

- 3 rounds of discussions:
  - Demographic Criteria (Round I)
  - Threats-based Criteria
    - Climate Change Threats (Round II)
    - Local Threats (Round III)
  
- High-level; concepts rather than specific language





## Discussion Round I Demographic & Ecosystem Criteria

### Objective

Gain your input on pros, cons and considerations related to species-specific demographic criteria *concepts*, and ecosystem criteria *concepts*

### Goal

Help determine which concepts to develop into criteria for inclusion in the recovery plan

## Discussion Format

- One large group, 35 min
- Add notes (anonymous) in two tables in Mural:
  - Demographic-criteria
  - Ecosystem-criteria
- Poll
- Welcome questions and comment verbally or via chat
- Support team
- Public continue to listen-in

## Tables in Mural

<b>DEMOGRAPHIC</b> species-specific criteria related to:	Pros?	Cons?	Species and/or MU differences?	Considerations:
<i>Population Viability Analysis based thresholds and risks</i>				
<i>Abundance</i>				
<i>Distribution</i>				
<i>Genetic diversity</i>				

<b>ECOSYSTEM</b> criteria related to:	Pros?	Cons?	Species and/or MU differences?	Considerations:
<i>Live Coral Cover (%)</i>				
<i>Habitat (rugosity, complexity)</i>				
<i>Reef Extent</i>				



## Working Draft Recovery Objectives

**Objective 1: Ensure population viability of each listed species**

**Objective 2: Eliminate or sufficiently abate global and local threats to the listed species and the ecosystems upon which they depend**

## Demographic Information

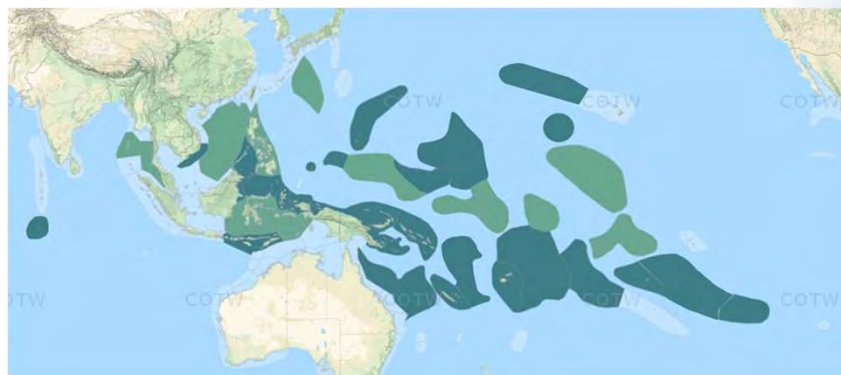
Table 1. Summary of Listed Species Information. Current information on the distributions (geographic, depth, US), abundances (relative, absolute, trend), and key threat information for the 15 listed species (summarized from Section 3).

Listed Species	Distribution			Abundance			Key Threat Susceptibilities (susc.), Exposures (exp.), Vulnerabilities (vuln.) currently and in the foreseeable future (FF, now to 2100) <sup>7</sup>
	Geo <sup>1</sup>	Depth <sup>2</sup>	US <sup>3</sup>	Relative <sup>4</sup>	Absolute <sup>5</sup>	Trend <sup>6</sup>	
<i>Acropora globiceps</i>	33	0-20	Yes	Rare to Common	654 million	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Acropora jacquelineae</i>	19	10-50	Yes	Rare to Uncommon	32 million	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Acropora lokani</i>	21	8-25	No	Rare to Uncommon	19 million	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Acropora pharaonis</i>	20	5-44	No	Uncommon	≥millions	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Acropora retusa</i>	44	0-10	Yes	Rare to Common	540 million	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Acropora rudis</i>	9	3-30	No	Rare	≥millions	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Acropora speciosa</i>	42	12-40	Yes	Rare to Uncommon	19.2 million	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Acropora tenella</i>	32	6-110	No	Rare to Uncommon	5 million	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Anacropora spinosa</i>	20	5-15	No	Uncommon	≥millions	Likely Decreasing	OW/OA/F/LBSP/CD/P: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Euphyllia paradivisa</i>	27	6-75	Yes	Rare to Common	≥tens of millions	Likely Decreasing	OW/C&T: High susc. + increasing exp. in FF = high vuln. in FF OA/F/CD/P: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Isopora crateriformis</i>	30	5-12	Yes	Rare to Common	69.6 million	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Montipora australiensis</i>	37	2-30	No	Rare to Uncommon	30.5 million	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Pavona diffluens</i>	9	5-20	No	Rare to Uncommon	≥millions	Likely Decreasing	OW/OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Porites napolopora</i>	26	3-15	No	Uncommon	≥millions	Likely Decreasing	OW/OA/F/LBSP/CD/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF
<i>Seriatopora aculeata</i>	31	3-40	Yes	Uncommon	≥millions	Likely Decreasing	OW: High susc. + increasing exp. in FF = high vuln. in FF OA/F/LBSP/CD/P/C&T: Some susc. + incr. exp. in FF = incr. vuln. in FF

1. Geo = Geographic distribution in Veron ecoregions; 2. depth distribution in meters; 3. US = confirmed in US waters; 4. relative abundance; 5. absolute abundance in colonies; and 6. likely population trend; and 7. key threat susceptibilities, exposures, and vulnerabilities to threats currently and in the foreseeable future (now to 2100; OW = ocean warming, OA = ocean acidification, F = fishing, LBSP = land-based sources of pollution, CD = coral disease, P = predation, C&T = collection & trade). See RSR.

## Demographic Information

Listed Species	Distribution			Abundance		
	Geo <sup>1</sup>	Depth <sup>2</sup>	US <sup>3</sup>	Relative <sup>4</sup>	Absolute <sup>5</sup>	Trend <sup>6</sup>
<i>Acropora globiceps</i>	33	0-20	Yes	Rare to Common	654 million	Likely Decreasing



Dietzel A, Bode M, Connolly SR, Hughes TR. 2021. The population sizes and global extinction risk of reef-building coral species at biogeographic scales. *Nature Ecology & Evolution*. <https://doi.org/10.1038/s41559-021-01393-4>

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## Ecosystem Information

- Indo-Pacific coral reefs are generally in decline because of increasing anthropogenic disturbance and decreasing recovery times.
- Ecosystem Trends:
  - Reductions in live coral cover.
  - Changes in reef coral species composition.
  - Habitat simplification.

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## Recovery Criteria Examples

- **Demographic example (abundance) from Caribbean *Acropora* plan for Elkhorn coral:**

*Thickets are present throughout approximately 10 percent of consolidated reef habitat in 1 to 5 m water depth within the forereef zone. Thickets are defined as either a) colonies  $\geq 1$  m diameter in size at a density of 0.25 colonies per m<sup>2</sup>, or b) live elkhorn coral benthic cover of approximately 60 percent. Populations with these characteristics should be present throughout the range and maintained for 20 years.*



## Recovery Criteria Examples

- **Demographic example (abundance) from Caribbean *Acropora* plan for Elkhorn coral:**

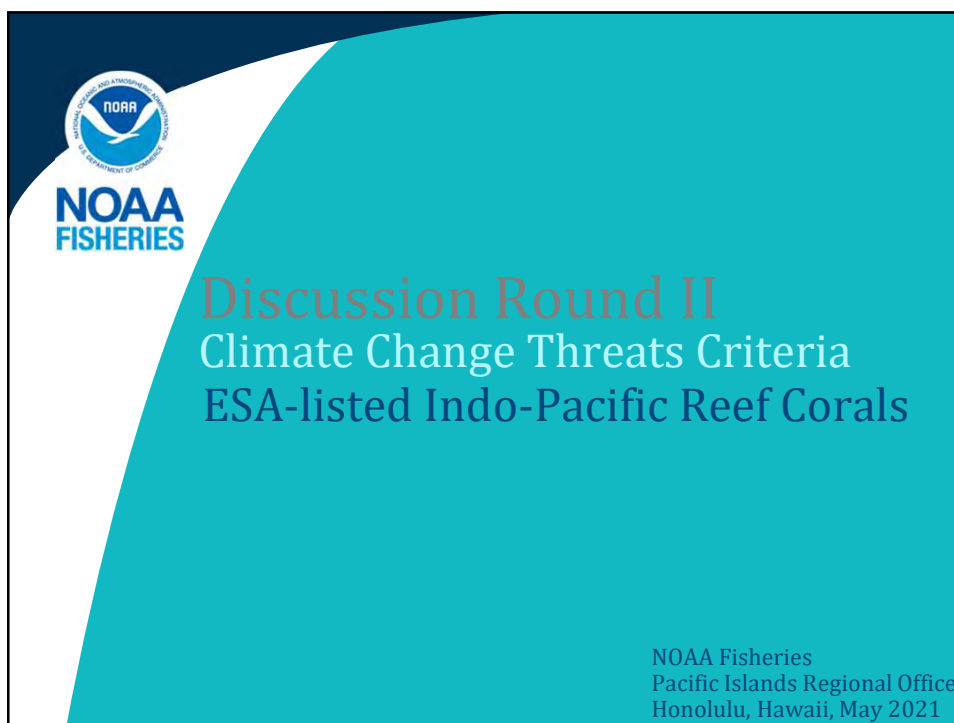
*Thickets are present throughout approximately 10 percent of consolidated reef habitat in 1 to 5 m water depth within the forereef zone. Thickets are defined as either a) colonies  $\geq 1$  m diameter in size at a density of 0.25 colonies per m<sup>2</sup>, or b) live elkhorn coral benthic cover of approximately 60 percent. Populations with these characteristics should be present throughout the range and maintained for 20 years.*

- **Ecosystem example (% live coral cover):**

*Mean % live coral cover within the majority of the species' MUs is  $>X\%$  for X number of consecutive decades, while maintaining X level of reef coral species diversity.*







## Discussion Round II

### Climate Change Threats-Based Criteria

#### Objective

Gain your input on pros, cons and considerations related to climate change threats-based criteria *concepts*

#### Goal

Help determine which concepts to develop into criteria for inclusion in the recovery plan

## Discussion Format

- One large group, 35 min
- Add notes (anonymous) in table in Mural
- Poll
- Welcome questions and comment verbally or via chat
- Support team
- Public continue to listen-in

## Table in Mural

CLIMATE CHANGE THREATS criteria related to:	Pros?	Cons?	Species and/or MU differences?	Considerations:
<b>Global Mean Atmospheric carbon dioxide concentration</b> (parts per million)				
<b>Global Mean Surface Temperature (GMST)</b>				
<b>Ocean Warming</b> (Degree Heating Weeks, degree Celsius)				
<b>Ocean Acidification</b> (aragonite saturation state levels)				



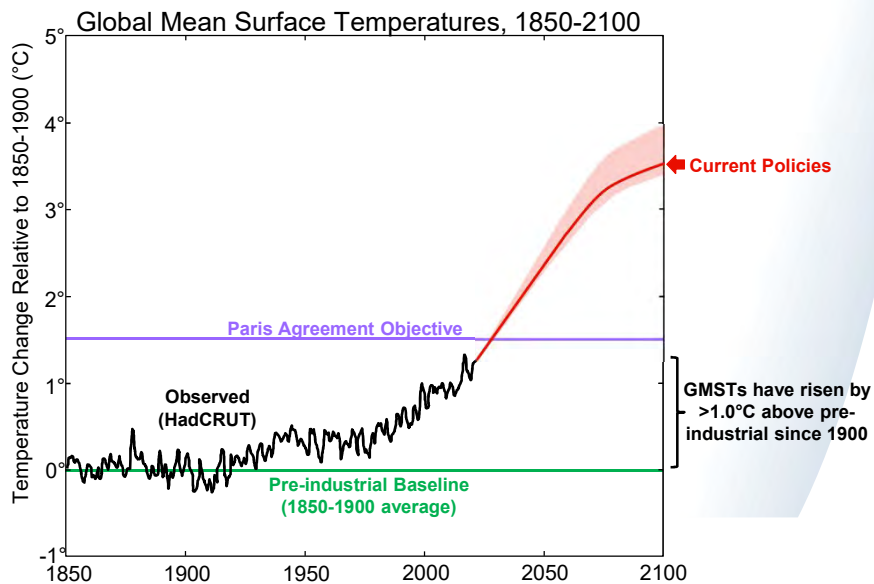
## Working Draft Recovery Objectives

*Objective 1: Ensure population viability of each listed species*

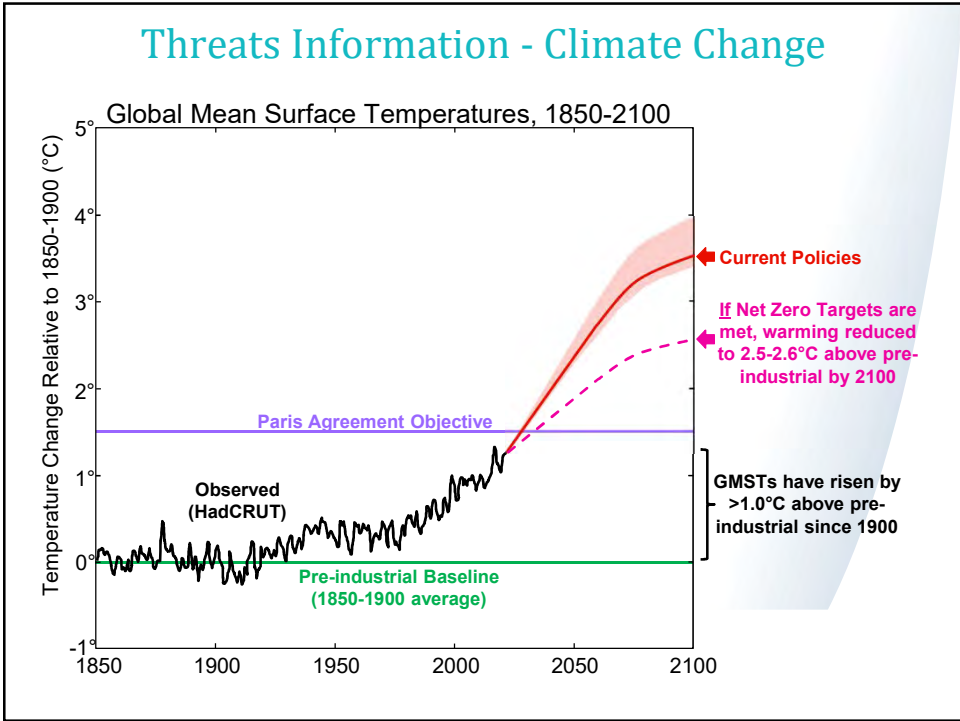
*Objective 2: Eliminate or sufficiently abate global and local threats to the listed species and the ecosystems upon which they depend*

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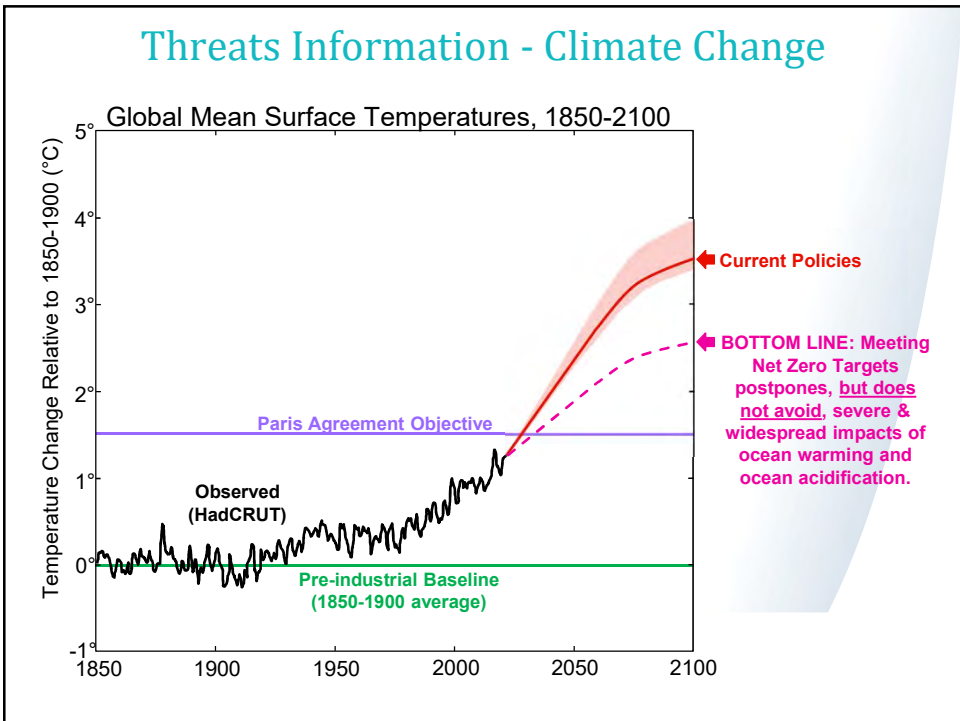
## Threats Information - Climate Change



### Threats Information - Climate Change



### Threats Information - Climate Change



## Recovery Criteria Examples

**1. Global conditions example (atmospheric CO<sub>2</sub>):**

*Mean global atmospheric carbon dioxide concentration is no more than 350 parts per million for at least X consecutive years by year X.*



## Recovery Criteria Examples

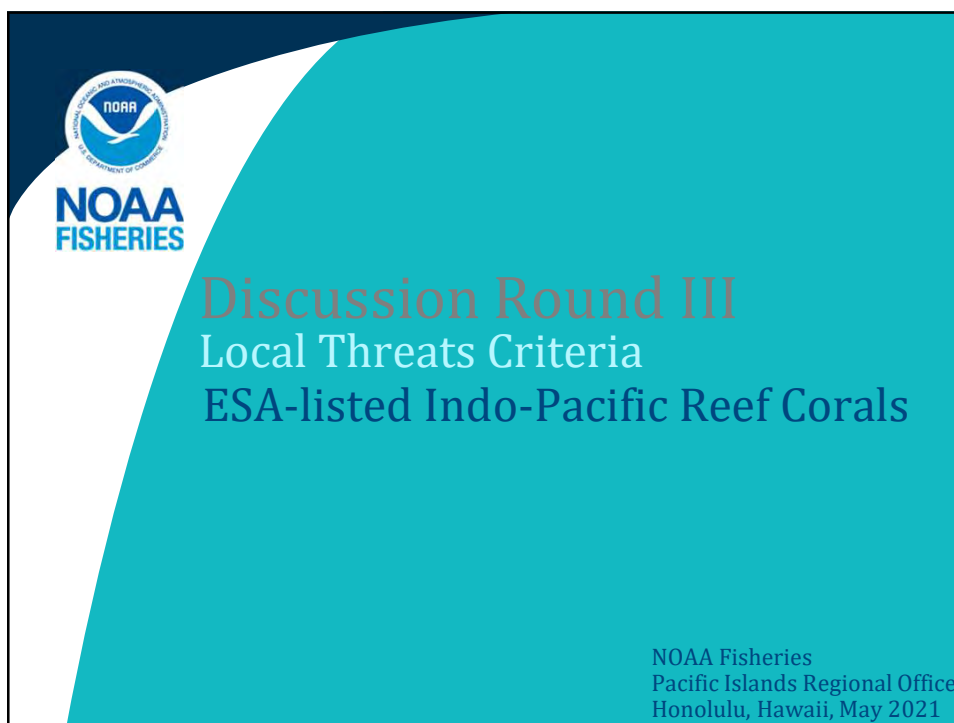
**1. Global conditions example (atmospheric CO<sub>2</sub>):**

*Mean global atmospheric carbon dioxide concentration is no more than 350 parts per million for at least X consecutive years by year X.*

**1. Ocean warming example from Caribbean *Acropora* plan for Elkhorn coral:**

*Sea surface temperatures across the geographic range have been reduced to Degree Heating Weeks less than 4; Mean monthly sea surface temperatures remain below 30°C during spawning periods.*





## Discussion Round III Local Threats-Based Criteria

### Objective

Gain your input on pros, cons and considerations related to local threats-based criteria *concepts*

### Goal

Help determine which concepts to develop into criteria for inclusion in the recovery plan

## Discussion Format

- One large group, 35 min
- Add notes (anonymous) in table in Mural
- Poll
- Welcome questions and comment verbally or via chat
- Support team
- Public continue to listen-in

## Table in Mural

LOCAL THREATS criteria related to:	Pros?	Cons?	Species and/or MU differences?	Considerations:
<b><i>LBSP*: Measurable contaminant thresholds</i></b>				
<b><i>LBSP*: Minimum proportion of ranges well-protected</i></b>				
<b><i>LBSP*: Sufficient evidence not impeding</i></b>				
<b><i>Disease: Minimum prevalence</i></b>				
<b><i>Fishing Effects: Minimum proportion of ranges well-protected</i></b>				



## Working Draft Recovery Objectives

***Objective 1:** Ensure population viability of each listed species*

***Objective 2:** Eliminate or sufficiently abate global and local threats to the listed species and the ecosystems upon which they depend*

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## Threats Information - Local Threats

- LBSP: Sediment, nutrients, and contaminants that run off from land onto coral reef areas.
- Observed and projected effects of land-based sediment, nutrients, and contaminants:
  - Historically, LBSP caused by agriculture, but more recently from logging, urbanization, etc.
  - Projected to worsen because of continued human population growth, urbanization, industrialization, land development, etc.
  - Bottom line = **increases in land-based sources of sediment, nutrients, and contaminants.**

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## Threats Information - Local Threats

- Fishing includes direct (habitat destruction) and indirect (herbivore removal) effects.
- Observed and projected direct and indirect effects of fishing:
  - Both direct and indirect effects of fishing on coral reefs have greatly increased in the last several decades, esp. near dense human populations.
  - Projected to worsen because of continued human population, demand for fish, and technological improvements in gear, boats, etc.
  - Bottom line = **increase in direct and indirect effects of fishing.**

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## Recovery Criteria Examples

### 1. Land-based sources of pollution example from Caribbean *Acropora* plan for Elkhorn coral:

*[Interim Criteria] Develop quantitative recovery criteria through research. Based on 5 years of data, criteria will be established to reduce sources of nutrients, sediments, and contaminants to levels appropriate for recovery.*



## Recovery Criteria Examples

### 1. Land-based sources of pollution example from Caribbean *Acropora* plan for Elkhorn coral:

*[Interim Criteria] Develop quantitative recovery criteria through research. Based on 5 years of data, criteria will be established to reduce sources of nutrients, sediments, and contaminants to levels appropriate for recovery.*

### 2. Fishing example:

*Within at least 80% of the species' MUs: (1) At least X% of the species' habitat is within no-take MPAs; and (2) of the remaining habitat, at least X proportion of the coral reef fisheries are well-managed, as defined by X.*





## Session IV Presentations

### ESA-listed Indo-Pacific Corals Recovery Planning Workshop May 2021





# Recap Session III

## ESA-listed Indo-Pacific Reef Corals

Danielle Jayewardene, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021



## Recovery Criteria

Spell out the anticipated conditions for the species to achieve recovery (and for delisting to occur)



## RECOVERY PLAN

Vision

Strategy

Goals

Objectives

**Criteria**

Actions



## Recovery Criteria

Need to be established for each recovery objective

Must be “objective and measurable”



## Threats-Based Criteria

(Required)

- ❖ Developed for the mitigation, reduction or elimination of threats
- ❖ Must address stressors/threats assessed in the Recovery Status Review
- ❖ Should be directly related to specific demographic or habitat-based criteria

## Demographic-Focused Criteria

(Strongly recommended)

- ❖ Developed to address each of the Viability Parameters (VP)
- ❖ Each management unit can have unique recovery criteria



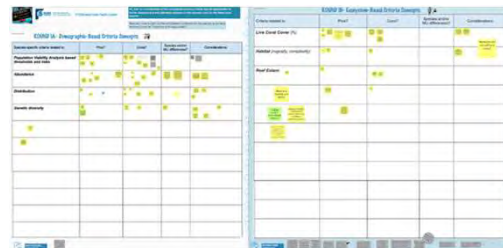
# MURAL

## Demographic & Ecosystem Criteria

Group A



Group B



# POLL RESULTS

## Demographic & Ecosystem Criteria Concepts To Develop

Group A (19 participants)

- 74 % Distribution
- 68 % PVA based thresholds & risks
- 68 % Coral Vulnerability/Resilience
- 53 % Demographic (size-based/reprod size)
- 47 % Live Coral Cover
- 42 % Abundance
- 42 % Genetic Diversity
- 42 % Connectivity/Gene Flow
- 37 % Habitat
- 32 % Community div/sp. richness/abund
- 21 % Conditions that favor sp of interest
- 11 % Reef Extent
- 11 % Function-based: carbon fixation ETC

Group B (16 participants)

- 100 % Abundance
- 81 % Distribution
- 50 % PVA based thresholds & risks
- 44 % Live Coral Cover
- 44 % Genetic Diversity
- 38 % Abiotic Conditions
- 31 % Habitat
- 31 % Species richness/Biodiversity
- 25 % Percent Algae cover (MA/turf)
- 19 % Reef Extent
- 19 % Herbivore Diversity/Density
- 6 % Critical Areas for Herbivore Life hist/bio



# MURAL

## Climate Threats-Based Criteria Concepts

Group A

Criteria related to:	Pros?	Cons?	Species and/or MUs affected?	Considerations
Global Mean Atmospheric carbon dioxide concentration (parts per million)	Yes	Yes	Yes	Yes
Global Mean Surface Temperature (Celsius)	Yes	Yes	Yes	Yes
Ocean Warming (Degree Heating Weeks, degree Celsius)	Yes	Yes	Yes	Yes
Ocean Acidification (regional saturation state levels)	Yes	Yes	Yes	Yes
Global Conditions Criteria	Yes	Yes	Yes	Yes

Group B

Criteria related to:	Pros?	Cons?	Species and/or MUs affected?	Considerations
Global Mean Atmospheric carbon dioxide concentration (parts per million)	Yes	Yes	Yes	Yes
Global Mean Surface Temperature (Celsius)	Yes	Yes	Yes	Yes
Ocean Warming (Degree Heating Weeks, degree Celsius)	Yes	Yes	Yes	Yes
Ocean Acidification (regional saturation state levels)	Yes	Yes	Yes	Yes
Global Conditions Criteria	Yes	Yes	Yes	Yes



# POLL RESULTS

## Which Climate Change Threats Criteria Concepts To Develop

Group A (16 participants)

- 94 % Ocean Warming (DHW, °C)
- 69 % Global Mean Atmospheric CO2 Conc
- 56 % Ocean Acidification
- 25 % Localized based on coral range/distrib
- 25 % Global Mean Surface Temperature
- 6 % Global Conditions

Group B (16 participants)

- 82 % Ocean Warming (DHW, °C)
- 59 % Localized where sp are doing well
- 41 % Global Mean Surface Temperature
- 29 % Global Mean Atmospheric CO2 Conc
- 29 % Ocean Acidification





# MURAL

## Local Threats-Based Criteria

**Group A**

**Group B**



# POLL RESULTS

## Which Local Threats Criteria Concepts To Develop

**Group A (20 participants)**

80 %	Fishing- Min prop of ranges protected
75 %	Local water quality
65 %	LBSP- Measurable contam thresholds
60 %	Disease- Minimum prevalence
35 %	LBSP- Min prop of ranges protected
35 %	Collection and Trade
30 %	Invasive Species presence/absence
25 %	LBSP- Sufficient evid not impeding
20 %	Predation/COTS
15 %	Storm Damage/Breakage
10 %	Presence/extent of hypoxic zones

**Group B (16 participants)**

69 %	LBSP- Min prop of ranges protected
56 %	Fishing- Min prop of ranges protected
50 %	LBSP- Measurable contam thresholds
50 %	Disease- Minimum prevalence
44 %	Coastal Construct/physical damage
38 %	LBSP- Sufficient evid not impeding
31 %	Predation
13 %	Invasive Species
6 %	Mining/ Oil Extraction





# Recovery Actions

## ESA-listed Indo-Pacific Reef Corals

Danielle Jayewardene, NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021



## Recovery Actions

Are the prioritized, site-specific management actions to conserve, protect, manage, restore, and enhance species and their habitats, and most of all avoid or minimize threats, to facilitate the species ability to achieve the recovery criteria

- ❖ *Recovery Criteria* guide the development of recovery actions
- ❖ Recovery actions should reflect the *Recovery Strategy*



## Criteria Concepts:

- Demographic Criteria
  - *Abundance*
  - *Distribution*
  - *PVA Based Thresholds & Risks*
  - *Genetic Diversity*
- Ecosystem Criteria
  - *Live Coral Cover*
- Climate Change Threats-Based Criteria
  - *Ocean Warming*
  - *Ocean Acidification*
  - *Atmospheric CO2 concentration*
- Local Threats-Based Criteria
  - *LBSP- Measurable contaminant Thresholds*
  - *LBSP- Minimum Proportion of Ranges Well Protected*
  - *Fishing- Minimum Proportion of Ranges Well Protected*
  - *Disease- Minimum Prevalence*



# RECOVERY PLAN

Vision

Strategy

Goals

Objectives

Criteria


Actions




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## Recovery Approaches

	Ecosystem-plan	2 Pronged Approach to Actions	Build on Existing Efforts	Define Management Units
Ranges largely outside US	✓		✓	✓
Sp. specific data deficiency	✓			
Species ID Uncertainty	✓			
Changing Taxonomy	✓			
Main Climate Change Threat		✓	✓	
Many Additional Local Threats		✓	✓	✓
Recovery Timeframe		✓	✓	



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**FACTSHEET: Recovery Actions**

**Recovery Actions:**

- Are the prioritized, site-specific management actions to conserve, protect, manage, restore, and enhance species and their habitats, and most of all avoid or minimize threats, to facilitate the species ability to achieve the recovery criteria
- Should be discrete and action oriented, i.e. have a beginning point (the current status of the species with respect to a particular parameter), an endpoint (what the recovered state looks like for that parameter), and a direction (this is the action itself—how to get from the current to the recovered state)
- Can be both near-term and long-term

**Site-Specificity**

- Actions should be site-specific, but there is discretion as to how the geographical component is identified and described (e.g., could be basin-wide)
- The geographical component should capture the geographic extent relevant to the species needs.

**Development of Actions**

- Actions should be identified that alleviate those threats provided in the threats assessment in the Recovery Status Review
- The relative impact of each threat, as identified in the Recovery Status Review, should be used to optimize which threats need to be addressed, and in what order
- The current condition of the species, together with the assessment of the possible future conditions, should be used to move it in the direction of recovery

**Actions vs. Activities**

- Recovery "actions" are high-level, focused on what is needed strategically to achieve recovery (as delineated by the Recovery Criteria), and general enough to allow some flexibility in how they are implemented
- Recovery "activities" are the actual on-the-ground specific activities necessary to complete the site-specific recovery actions (all activities must relate to an action)

**Prioritization of Actions**

- Recovery actions must be prioritized to ensure actions are implemented in an order that is most effective for achieving species recovery


**Action Types**

- Include, but are not limited to, measures to avoid or minimize direct or incidental take, habitat protection and restoration, or population augmentation to reduce vulnerability to small population sizes
- Some may be cross-cutting and address multiple threat factors, such as outreach
- Some may recur under each of the threat categories, such as research, monitoring, or adaptive management


30  
reference material for the  
May 2021 ESA listed  
Indo-Pacific Corals recovery  
planning workshop

Source: NMFS 2020 Recovery Planning Handbook  
Version 1.0 U.S. Department of Commerce  
October 2020

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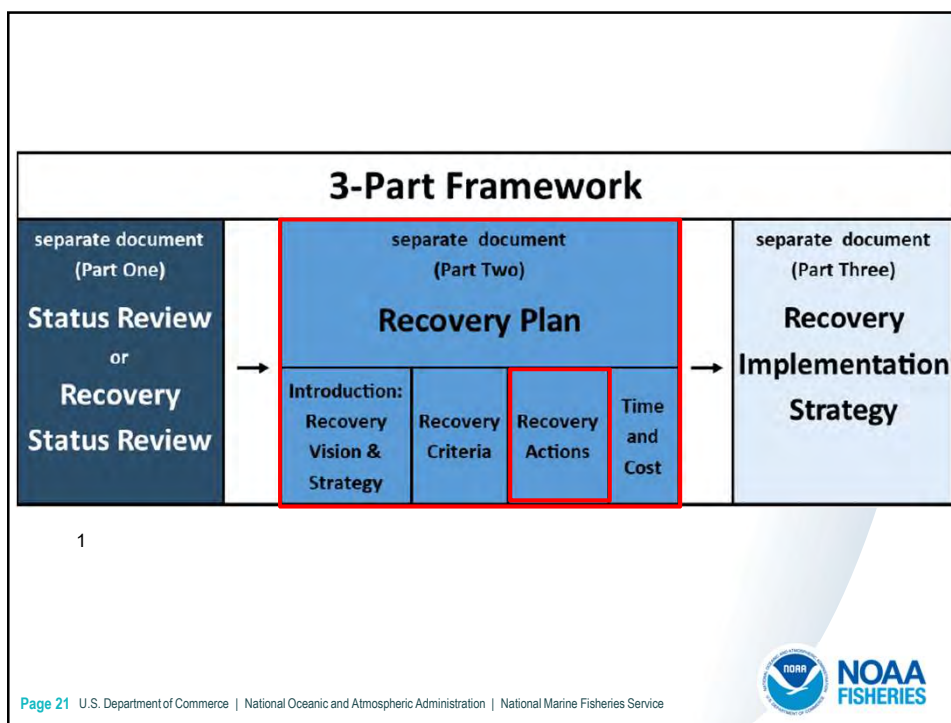
**Recovery Planning Handbook**  
Volume 1A



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## Actions vs Activities

- ❖ **Recovery “actions”** are high-level, focused on what is needed strategically to achieve recovery (as delineated by the Recovery Criteria), and general enough to allow some flexibility in how they are implemented
- ❖ **Recovery “activities”** are the actual on-the-ground specific activities necessary to complete the recovery actions, and will identify the how, when and by whom (all activities must relate to an action)



## Recovery Actions

- ❖ Actions should be identified that alleviate those threats provided in the threats assessment in the *Recovery Status Review*
- ❖ The relative impact of each threat, as identified in the *Recovery Status Review*, should be used to optimize which threats need to be addressed, and in what order

## Threats

- Ocean warming
- Ocean acidification
- Fishing
- Land-based sources of pollution
- Coral disease
- Predation
- Collection & Trade
- Sea-level rise
- Other threats
- Interactions of Threats

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## Types of Recovery Actions:

- ❖ Measures to reduce, abate, eliminate a threat
- ❖ Interventions
- ❖ Restoration
- ❖ Research
- ❖ Monitoring
- ❖ Education and outreach
- ❖ Coordination
- ❖ Adaptive Management

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## Recovery Actions:

- ❖ Should be discrete and action oriented:
  - **Beginning point**
    - The current status with respect to a particular parameter
  - **Endpoint**
    - What the recovered state looks like for that parameter
  - **Direction**
    - This is the action itself—how to get from the current to the recovered state
  
- ❖ All actions must include a verb



## Example of an Action:

- ❖ Implement U.S. and International measures to reduce greenhouse gas emissions to limit atmospheric CO<sub>2</sub> concentrations to the level needed for coral recovery.





## Site Specificity

- ❖ Actions should be site-specific, but there is discretion as to how the geographical component is identified and described (e.g., could be basin-wide)
- ❖ The geographical component should capture the geographic extent relevant to the species needs.



## Prioritization of Actions

- ❖ Recovery actions must be prioritized to ensure actions are implemented in an order that is most effective for achieving species recovery





## Discussion Round I

### Actions to Address Climate Change Threats

#### Objective

Gain your ideas on actions to take to address climate change threats

#### Goal


Help develop a list of recovery actions for inclusion in the recovery plan

## Discussion Format

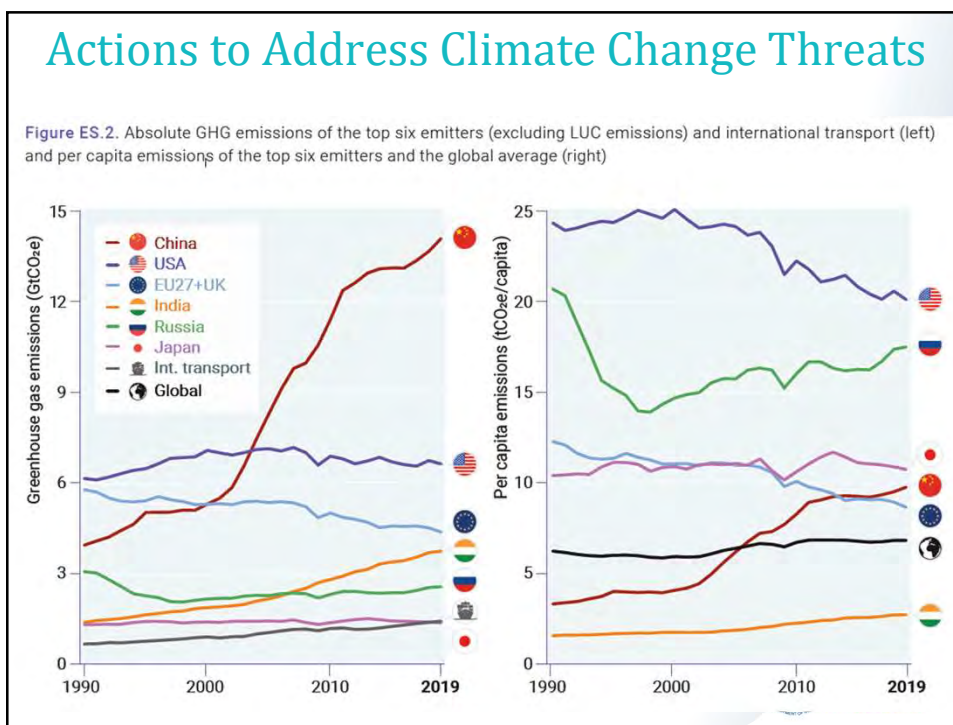
- One large group, 30 min
- Add notes (anonymous) in the table in Mural
- Encourage questions and comments verbally or via chat
- A team to support
- Public continue to listen-in

### Actions to Address Climate Change Threats

Action <i>High level</i>	Activities <i>Specific activities necessary to complete action</i>	Considerations <i>E.g. Partners, Location, Challenges, Time, Cost</i>
Implement U.S. and International measures to reduce greenhouse gas emissions to limit atmospheric CO2 concentrations to the level needed for coral recovery.	<i>E.g.: Work with federal, state, and local government agencies and the private sector to develop and support renewable energy.</i>	
Develop and Implement measures to reduce ocean warming and ocean acidification such as carbon sequestration and geoengineering.		
Research, develop and implement interventions to increase the persistence and resilience of reef-building corals & coral reefs to climate change threats.		
Conduct strategic research to better understand the impacts of thermal stress and acidification on listed corals.		
Implement outreach and education strategies to raise awareness on the importance of controlling climate change for listed corals.		



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## Actions to Address Climate Change Threats

- Reduce GHG Emissions:
  - US is #1 per capita emitter.
  - But US emits 13% of global GHGs.

## Actions to Address Climate Change Threats

- Reduce GHG Emissions:
  - US is #1 per capita emitter.
  - But US emits 13% of global GHGs.
- Other GHG-related Measures:
  - Carbon Sequestration, AKA CO<sub>2</sub> Removal.
  - Climate Engineering, AKA Geoengineering.



<https://qbrrestoration.org/program/cooling-and-shading/>

## Actions to Address Climate Change Threats

- Reduce GHG Emissions:
  - US is #1 per capita emitter.
  - But US emits 13% of global GHGs.
- Other GHG-related Measures:
  - Carbon Sequestration, AKA CO2 Removal.
  - Climate Engineering, AKA Geoengineering.
- Interventions to increase the persistence and resilience of reef-building corals & coral reefs:
  - Many types (genetic, physiological, popn, community, environmental, NASEM 2019).
  - E.g., Australia's Reef Restoration and Adaptation Program's research.

## Actions to Address Climate Change Threats

- Action: Reduce greenhouse gas emissions to limit atmospheric CO2 concentrations to the level needed for coral recovery.

## Actions to Address Climate Change Threats

- Action: Reduce greenhouse gas emissions to limit atmospheric CO2 concentrations to the level needed for coral recovery.
  - Activity: Convert government vehicle fleets (e.g., US federal fleet = 645,000 gasoline vehicles) to electric vehicles by Year X.
  - Activity: Work with federal, state, and local government agencies and the private sector to develop and support renewable energy.



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## Discussion Round II

### Actions to Address Local Threats

#### Objective

Gain your ideas on actions to take to address local threats

#### Goal

Help develop a list of recovery actions for inclusion in the recovery plan

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## Discussion Format


- Two Break-Out Groups (same topic), 30 min
- Add notes in the table in Mural
- Encourage questions and comments verbally or via chat
- A team to support
- Public continue to listen-in

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Actions to Address Local Threats		
Action <i>High level</i>	Activities <i>Specific activities necessary to complete action</i>	Considerations <i>E.g. Partners, Location, Challenges, Time, Cost</i>
Address Sewage Discharges Throughout the Species' Ranges.	<i>E.g.: Identify, determine, and implement appropriate mechanisms for sewage disposal in the U.S. and Caribbean.</i>	
Develop and Implement watershed/land use management plans to control the effects of land-based sources of pollution on the listed coral species and their reef ecosystem		
Study Organismal Response to Nutrients and Contaminants and Implement Appropriate Remedies		
Implement measures to reduce direct and indirect effects of fishing on listed corals.		
Respond to, control, and minimize effects of coral disease events on listed corals.		
Conduct research to better understand the mechanisms, vectors, and impacts of diseases on listed corals.		
Implement measures to reduce the effects of coral collection and trade on listed corals.		

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## Actions to Address Local Threats

- Land-based sources of pollution:
  - Sediment
  - Nutrients
  - Contaminants
- Fishing:
  - Direct Effects
  - Indirect Effects
- Coral disease
- Collection & Trade:
  - International/live
  - Domestic/dead
- Predation

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## Actions to Address Local Threats

- Action: Address Sewage Discharges Throughout the Species' Ranges.
  - Activity: Identify, determine, and implement appropriate mechanisms for sewage disposal in the U.S. and Caribbean.
  - Activity: Develop and Implement Effective Watershed/Land Use Management Plans for the Protection of Coral Reefs.



## Actions to Address Local Threats

- Action: Respond to, Control, and Minimize Effects of Disease Events.
  - Activity: Identify and protect apparently resistant and/or resilient areas.
  - Activity: Develop capacity to respond to disease events.
  - Activity: Develop and test effective mitigation approaches.
  - Activity: Take mitigative action.



## Actions to Address Local Threats

- Action: Remove the snail *Coralliophila abbreviata* from appropriate sites.
  - Activity: Develop guidelines to ensure snail removal projects are conducted at appropriate sites by appropriate experts, and include appropriate data collection and evaluation in order to optimize removal efforts.
  - Activity: Proceed with snail removal projects according to these new guidelines.



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## Discussion Round III

### Actions To Address Demographic & Ecosystem Factors

#### Objective

Gain your ideas for actions to address demographic and ecosystem factors

#### Goal

Help develop a list of recovery actions for inclusion in the recovery plan

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## Discussion Format

- One large group, 30 min
- Add notes (anonymous) in the table in Mural
- Encourage questions and comments verbally or via chat
- A team to support
- Public continue to listen-in

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Actions to Address Species Demographic & Ecosystems Factors		
Action <i>High level</i>	Activities <i>Specific activities necessary to complete action</i>	Considerations <i>E.g. Partners, Location, Challenges, Time, Cost</i>
Develop and support monitoring programs to collect data on the demographic factors of listed species, and on their coral reef ecosystems.	<i>E.g.: Develop and implement a range-wide monitoring program.</i>	
Based on monitoring results, conduct appropriate population enhancement of listed species.		
Restore, Protect, and Enhance Ecosystem Integrity and Function		
Develop coral reef mapping/inventory tools.		
Conduct strategic research on species' biology/ecology.		
Coordinate Recovery Implementation.		


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## Actions to Address Species Demography & Ecosystems

- Species monitoring in most/all of the eventual Management Units.
- If appropriate, population enhancement.

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## Actions to Address Species Demography & Ecosystems

- Species monitoring in most/all of the eventual Management Units.
- If appropriate, population enhancement.
- Monitoring of habitat and/or ecosystem characteristics.
- If appropriate, habitat and/or ecosystem enhancement.

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Application of field treatments to enhance coral survival  
Small to Medium Intervention



Coral seeding by assisted larval movement  
Small to Medium Intervention



Coral seeding by larval/polyp aquaculture  
Large Intervention



Stabilisation by natural bonding  
Medium Intervention



Structure by 3D frames  
Small Intervention



Structure by concrete shapes  
Small Intervention

<https://gbrestoration.org/interventions/>

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## Actions to Address Species Demography & Ecosystems

- Action: Conduct Active Population Enhancement:
  - Activity: Develop and implement a comprehensive restocking plan.
  - Activity: Stabilize/reattach both storm-generated and anthropogenic fragments.
  - Activity: Enhance genotypic diversity in known genotypically depauperate populations.
  - Activity: Develop ex situ conservation of corals and related organisms.
  - Activity: Enhance survival of recruits.
  - Activity: Conduct applied population enhancement research.

## Actions to Address Species Demography & Ecosystems

- Action: Monitor the Species and Their Environments.
  - Activity: Develop and implement a range-wide monitoring program.
- Action: Develop Mapping Products.
  - Activity: Develop remote sensing tools.



**NOAA  
FISHERIES**

# Prioritization of Actions & Next Steps

## ESA-listed Indo-Pacific Reef Corals

NOAA Fisheries  
Pacific Islands Regional Office  
Honolulu, Hawaii, May 2021

## Prioritization of Actions

Recovery actions must be prioritized to ensure actions are implemented in an order that is most effective for achieving species recovery.

- Priority 1- major threats, prevent extinction
- Priority 2- major threats, prevent population decline, fill knowledge gaps
- Priority 3- non-major threats, to maintain increasing or stable population to achieve delisting criteria, fill remaining knowledge gaps, monitoring to demonstrate criteria met

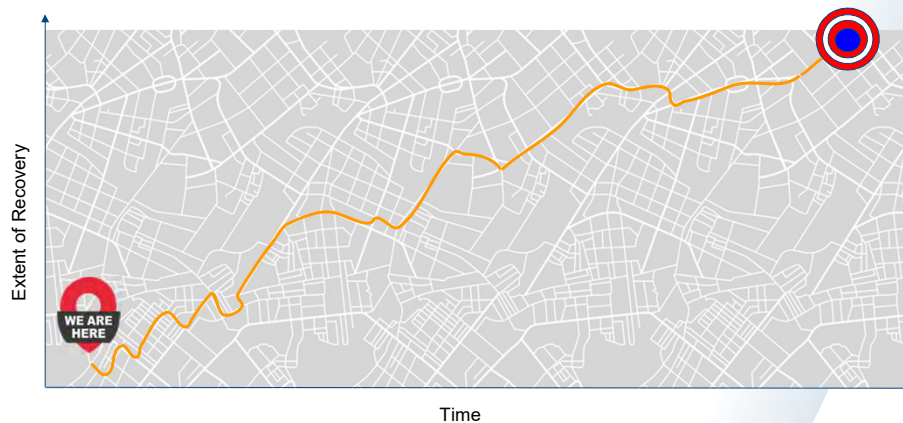


# POLL

## What do you think are the priority actions?



# Now what?



## Workshop Goal

Connect stakeholders and experts to harness their collective expertise, creativity, and ingenuity to inform NMFS development of an effective and practical recovery plan for ESA listed Indo-Pacific corals.



## Desired Workshop Outcomes

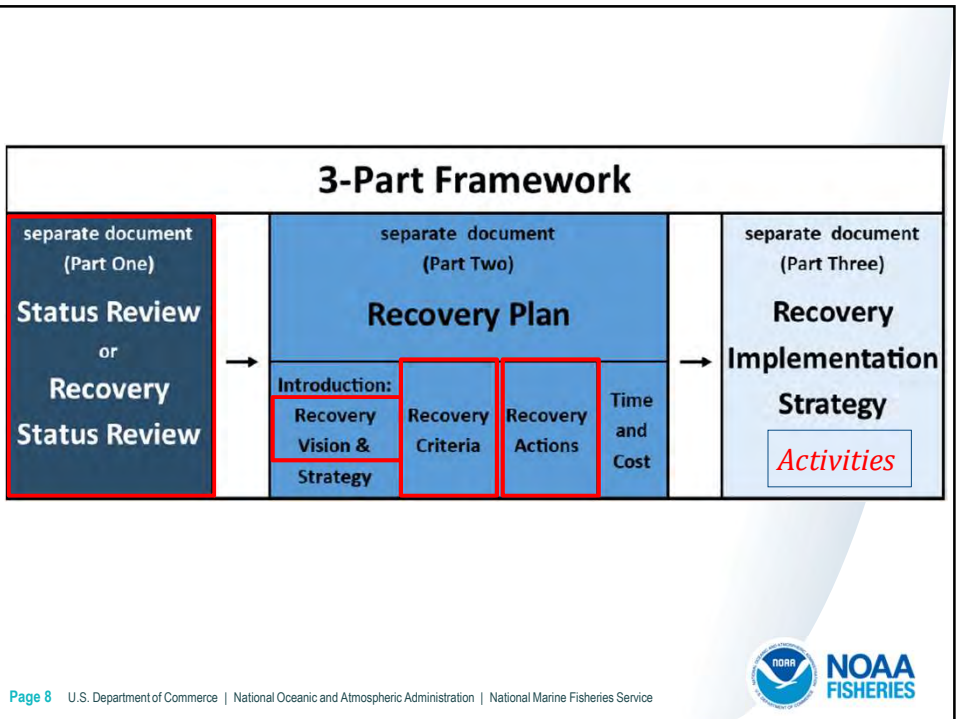
- Participants informed and able to engage in the recovery planning discussions relevant to the ESA listed Indo-Pacific corals.
- Draft list of options for determining management units.
- Draft list of recovery criteria concepts.
- Draft list of recovery actions.
- Draft priority ranking of the drafted list of recovery actions.
- Create connections and relationships with invited participants to enable continued conversations beyond the workshop.



## Next Steps for Recovery Planning

- Solicit expert input
  - Working groups
  - Potentially another “mini” workshop
  - Ad-hoc consultations
  
- Develop the Recovery Plan/s (incl. RSR & RIS)
  - Draft (Public Review & Comment)
  - Final
  
- Implement the recovery actions
  
- Update/Revise

*Throughout, build partnerships*



## Google Form

# If and how would you like to be involved as we move forward?

Post-Coral Recovery Workshop  
Engagement Survey

\* Required

