Crayfish

Jeff Adams

Crayfish are small, freshwater crustaceans that can be found in many parts of the world, including North and South America, Australia, and Europe. These distinctive invertebrates typically have two pincers (chelae) and a flat, fan-shaped tail used for swimming at the bottoms of lakes, streams, rivers, and wetlands. Among the approximately 500 different species of crayfish in the world, a handful of them have been introduced to the west coast.

Left: Red swamp crayfish.

REPORT THIS SPECIES! In **California:** Call 1-916-651-8797, or e-mail invasives@dfg.ca.gov; in **Oregon:** call 1-866-INVADER, or Oregon InvasivesHotline.org; in **Washington:** call 1-877-9-INFEST, or visit www.invasivespecies.wa.gov/; in other states: call 1-877-STOP-ANS.

Species in the news

Invasive Crayfish May Be Class Pets First

Crayfish Invasion, an Oregon Public Broadcasting video (www.opb.org/programs/ofg/segments/view/1777)*

Learning extension

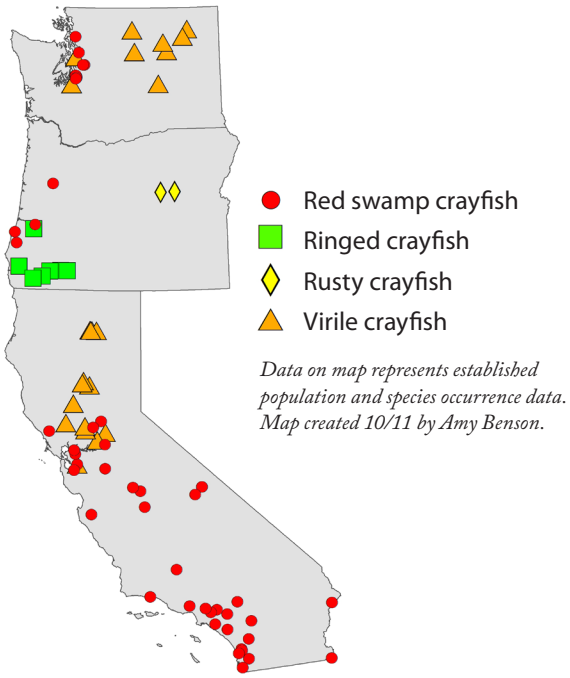
Clawing through the food web.

Resources

Red swamp, ringed, rusty, and native crayfish identification: http://blogs.oregonstate.edu/breakingwaves/2011/10/24/crayfish-native-or-invaders/*

Why you should care

On the west coast, invasive crayfish threaten native fish, amphibians, crayfish, and plants by eating them directly or by competing for food and shelter. Once invasive crayfish are established, they are extremely difficult and costly to eliminate. Removing rusty crayfish from five small bodies of water in Wyoming cost over $34,000 (WGFD 2008).



Data on map represents established population and species occurrence data. Map created 10/11 by Amy Benson.

How they got here and spread

Crayfish have been commonly used in very different settings—from pets to live bait, from restaurants to classrooms, and from research labs to crawfish boils. Sometimes, well-intentioned people will even find live crayfish in a store and release them, and agencies have stocked them for harvest. Each of these uses could introduce or spread crayfish to new habitats. Because female crayfish can store sperm for a long time, just one misplaced crayfish has the potential to establish a population.

What you can do

Never move live crayfish of any kind from one water body to another. Even the native "signal crayfish" can cause harm in water bodies where it did not previously live. Also learn how to identify the native signal crayfish and the species of invasive crayfish.

COOL FACTS

Certain species of crayfish can live for 20 years, and the largest crayfish can weigh 11 pounds.

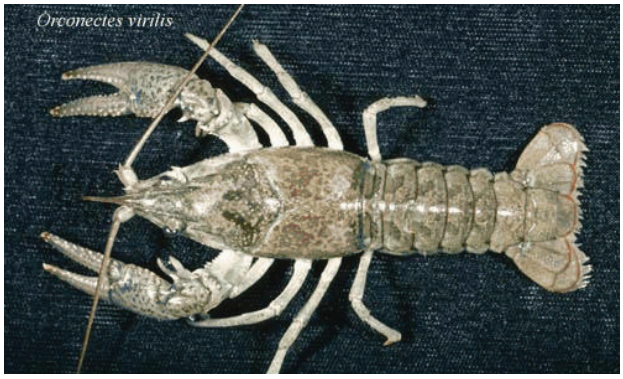
In 2010, Louisiana produced 110 million pounds of crayfish (nearly all red swamp crayfish), worth $168.5 million.

** Last accessed 10/11*

Jessica Siemens

Red swamp crayfish *(Procambarus clarkii)*

Dr. Keith A. Crandall



Virile or northern crayfish *(Orconectes virilis)*

B.McCreary USGS

Ringed crayfish *(Orconectes neglectus)*

Jeff Gunderson

Rusty crayfish *(Orconectes rusticus)*

	California	Oregon	Washington
Red swamp crayfish	P	P	P
Virile crayfish	P	S	P
Ringed crayfish	S	P	
Rusty crayfish		P	S

Invasive crayfish

Crayfish are 10-legged, freshwater crustaceans that resemble miniature lobsters. Their bodies have two main sections—the cephalothorax (fused head and thorax) and the abdomen, which together have 19 segments. Large pincers and a powerful tail (abdomen) are distinguishing features of these invertebrates. Color patterns and texture on their claws and body can sometimes be used to distinguish between species.

Crayfish are one of the most threatened groups of animals in the world. About 45 percent of North American crayfish species (representing about a quarter of all the world's species) are considered to be at risk of extinction. However, a few crayfish species are among the world's most invasive freshwater organisms. Taking into consideration that invasive crayfish are the leading cause of decline in native crayfish populations, it seems that the crayfish's greatest threat is other crayfish.

Small populations of several species of introduced crayfish are present in California, Oregon, and Washington, but four species have been established over a fairly large area (Table 1).

Red swamp crayfish *(Procambarus clarkii)* are typically dark red and range from 2.2 to 4.7 inches in length as an adult. Juveniles are usually a whitish-gray color and much smaller. Adults have long, narrow pincers (chelae) that are bumpy with bright red spots.

Virile or northern crayfish *(Orconectes virilis)* are rust-brown in color with blue-green claws that may have orange tips. In adults, the claws have obvious, whitish bumps. Virile crayfish are some of the largest crayfish in their native range, reaching 5 inches in length.

Ringed crayfish *(Orconectes neglectus)* are olive-green to red-tan in color. Ringed crayfish can often be identified by the combination of prominent black and orange rings at the tips of their claws and a dark bar on the side of the carapace. Generally, ringed crayfish are between 1.6 and 3.6 inches in length as adults, but females can reach 5 inches.

Rusty crayfish *(Orconectes rusticus)* resemble the ringed crayfish, with similar body color and black- and orange-tipped claws. However, the sides of their carapace typically have a large, rust-colored circle. In both species, these markings are not always present or well developed. Rusty crayfish typically reach about 4 inches in length as adults.

Table 1 (left). *West coast distribution of invasive crayfish species. P = established population; S = not currently present but in shared waters.*

Jeff Adams

Signal crayfish

The signal crayfish *Pacifastacus leniusculus* (pictured left) is native to Washington and Oregon but invasive in California. It can be distinguished by its smooth pincers and characteristic white spot on the hinge of the pincers.

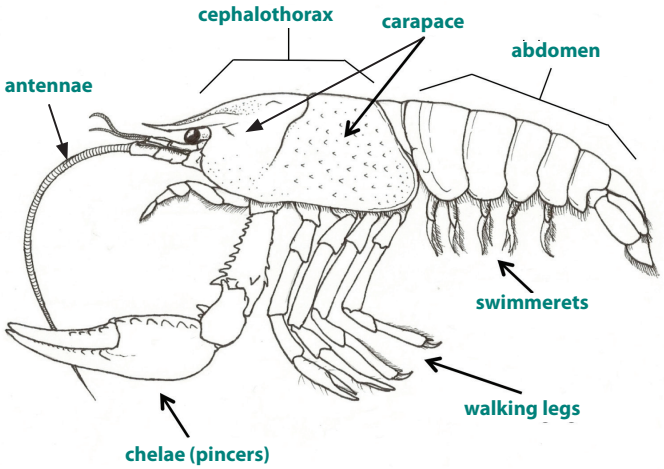


Illustration by Jorge Peñafiel

Figure 1. *Crayfish anatomy*

NATIVE AND INVASIVE RANGE

The red swamp, virile, ringed, and rusty crayfish are all native to areas east of the Rocky Mountains (Table 2). They are also all invasive to other areas of the United States. Red swamp crayfish has been broadly introduced throughout the world, invading the Americas as well as countries in Europe, Africa, and Asia. The virile crayfish has also hopped an ocean, having recently been found in the United Kingdom.

WEST COAST DISTRIBUTION

In the west coast states, the red swamp and virile crayfish have been introduced widely, while the ringed and rusty crayfish are still relatively limited in their distribution. The ringed crayfish has been in the Rogue River Basin of southwestern Oregon for several decades. The Rogue empties directly into the Pacific Ocean, and the ringed crayfish appears to have spread slowly outside of this isolated basin. Only recently has the ringed crayfish been found in the adjacent Umpqua River Basin. In 2005, rusty crayfish were found west of the Continental Divide for the first time. A population in the upper reaches of the John Day River in northern Oregon appears to be spreading rapidly. Unlike the Rogue River, the John Day is a tributary to the Columbia River, giv-

	Native range	Adult size	Claw	Carapace
Red Swamp Crayfish	South-central U.S. and northeastern Mexico	up to 4.7″ (12cm - front of carapace to tip of tail)	Very bumpy; bright red spots	Rough; reddish, may have dark and light bands
Virile Crayfish	South-central Canada, northern U.S.	up to 5.1″ (13cm)	Very bumpy; blue-green may have orange tips	Smooth; faint to few markings
Ringed Crayfish	Central plains and Ozarks regions of the U.S.	up to 4.7″ (12cm)	Bumpy; tips with black and orange rings	Smooth; dark and light bands on either side;
Rusty Crayfish	Indiana, Kentucky, Michigan, Ohio	up to 4″ (10cm)	Bumpy; tips with black and orange rings	Smooth; rust-colored spot on each side
Signal Crayfish	Oregon, Idaho, Washington, and British Columbia (invasive in California)	up to 6.3″ (16cm)	Smooth; white or pale patch over the claw hinge	Smooth; variable color with faint to few markings

Table 2. *Native range and characteristics for crayfish species invasive to the west coast. The characteristics above are of typical adults but there is a lot of variability, particularly in color, within each species.*

ing these crayfish access to waterways throughout the Pacific Northwest.

ECOLOGY

Life cycles and migration patterns

Most crayfish reproduce sexually, usually in open water during late spring or early summer. The female stores the male's sperm until her eggs are ready for fertilization. Incredibly, female crayfish can produce 200 to 800 fertilized eggs per brood, and because of this, even one female released into a body of water can cause an infestation if she is carrying viable sperm.

After fertilization and release, the eggs stay attached to the female's swimmerets, which are on the underside of her tail segment. Eggs typically incubate from just a few weeks to months, after which the hatchlings remain attached to the swimmerets for several more weeks. The hatchlings usually become detached in open water and continue to molt through their juvenile stage.

It takes three months to several years for the hatchlings to reach sexual maturity, depending on the species. Once sexual maturity is reached, crayfish grow more slowly and take on the distinctive color patterns typically associated with their species. Crayfish have a broad range of life spans, with some species living only two years and other species, such as the signal crayfish, living as long as 20 years.

Habitat modification and food webs

Crayfish are freshwater crustaceans, living in freshwater lakes, ponds, rivers, and streams. Typically found on the floor of a water body, known as the benthic zone, crayfish are omnivorous predators and are considered opportunistic feeders. They commonly feed on decaying organic matter, aquatic plants, benthic invertebrates, fish eggs, and small fish.

Jeff Adams

Red swamp crayfish are easily captured in Pine Lake Washington where native signal crayfish are also caught, but at only a fraction the numbers.

To date in Oregon, Washington, and California, the red swamp crayfish tends to be found in ponds and lakes; the ringed and rusty crayfish in rivers and streams; and the virile crayfish in still and moving water. In their native ranges, all have been known to inhabit lakes, ponds, and streams.

Red swamp crayfish use logs or debris as cover, or excavate burrows in soft substrates. They are rather tolerant of drying out (or desiccating) and can survive dry periods of up to four months. They are also tolerant of saltwater, which allows them to inhabit a wide range of ecosystems.

COOL FACTS

When startled, crayfish swim backwards by paddling their tail and streamlining their large claws.

North America has more than 350 species of crayfish—over half of the total species of crayfish in the world.

Crayfish can vary in color depending on species and age. One species native to the Florida Everglades is bright blue!

Crayfish are also known as crawfish, crawdads, crawdaddies, or mudbugs.

Crayfish are experts at the art of bluffing! When fighting, the crayfish with the largest claw wins, even though the larger claws are not always strongest. In an experiment, if the claws of one crayfish were significantly larger than another's, the other would simply turn and run!

HOW THEY GOT HERE

Although some species of crayfish can walk short distances out of water, the red swamp crayfish, for example, clearly did not travel over 2,000 miles on its own to get from Louisiana to the west coast. Humans play a central role in the transportation of invasive species, and crayfish are no exception. Known and suspected crayfish pathways include

- **Deliberate introduction.** Occasionally, agencies or aquaculturists intentionally place nonnative crayfish

in water bodies for farming purposes. The signal crayfish in California is an example of such an introduction.

- **Live bait.** It's OK to fish with locally caught crayfish in the West, but fishing with live, imported crayfish is illegal in California, Oregon, and Washington. Historically, anglers could purchase live crayfish from a bait shop and may have dumped unused bait into uninfested waters. Even locally caught bait crayfish should not be released.
- **Escape or release from schools and aquaria.** Both the rusty crayfish and the red swamp crayfish have been commonly sold to schools by biological supply companies for use in science education. The presence of rusty and red swamp crayfish may be a result of students or teachers releasing their crayfish into the wild, once they are no longer needed in the classroom. Even researchers have accidentally introduced invasive crayfish. The first virile crayfish in California escaped from outdoor ponds at a university. You can also purchase several species of crayfish, including the parthenogenic marmorkrebs, online or in pet stores. Release of these pets presents a risk of introduction.

HOW THEY SPREAD

Crayfish spread easily from one water system to another as long as the suitable habitats are connected. They can travel short distances from stream to stream by swimming, but most medium- to long-distance relocations are the result of human transport, as mentioned above. The ringed crayfish has been stuck in the Rogue River Basin for decades and has only recently been found in the nearby Umpqua River. The rusty crayfish is in the John Day River in Oregon, which gives it access to the Columbia River and its tributaries.

Jennifer England

Fourth grade students in Oregon hold up the rusty crayfish they are studying in the classroom. The rusty crayfish, an invasive species, was ordered by a biological supply house to be used as part of popular science curricula.

ECOLOGICAL IMPACTS

Invasive crayfish can cause significant damage to ecosystems. The omnivorous lifestyle of crayfish allows them to eat a wide variety of foods, including native benthic invertebrates and fish eggs. They also directly compete with native crayfish for food and resources. Invasive crayfish can even bring foreign diseases and transmit them to the native species.

In ecosystems without native crayfish, invasive crayfish usually become a keystone species. They can alter ecosystems by reducing the abundance of plant species and by competing with other organisms for limited food and shelter. By preying on local species, invasive crayfish can remove important members of the food web.

ECONOMIC IMPACTS

Crayfish can be used beneficially as food, bait, and aquarium pets, or for research and education. However, the release of these crayfish can spread them into regions where they might cause ecological and economic harm. Besides being costly to remove, invasive crayfish can threaten local economies that rely on the sport fishing industries. Control and eradication of crayfish can be expensive. Removing rusty crayfish from five small bodies of water in Wyoming cost more than $34,000 (WGFD 2008). In Vilas County, Wisconsin, the damage caused by rusty crayfish to the sport-fishing industry costs an estimated $1.5 million annually (Keller et al. 2008).

CULTURAL SIGNIFICANCE

Cultures throughout the world use crayfish as a source of food. The majority of the world's commercially grown crayfish are produced and consumed in Louisiana, where they are referred to as crawfish or crawdads. Their use as food has led to their introduction outside of their native ranges through stocking for wild catch and aquaculture.

Crayfish are commonly kept as pets in freshwater aquariums. Biological supply companies also sell live crayfish to schools for use in biology classes. Many times, schools will receive crayfish kits that include little to no information on taxonomy or native range. While most crayfish ordered by schools come with general warnings about the risks of invasive species, those warnings are often forgotten or the crayfish may be sent home with students who are unaware of the risks they pose. This has led to the release of live crayfish after their use in class. The introduction of red swamp crayfish in Washington and rusty crayfish in Oregon may have been a result of this practice.

LAWS CURRENTLY IN PLACE

In Oregon and Washington, all crayfish within the family Cambaridae are listed as prohibited species. Live crayfish in this family are not to be imported, transported, possessed, or released unless a permit is obtained and strict standards are met. They can be harvested, as long as they are killed before leaving the water body from which they were collected. Likewise, California requires permits for the possession of all nonnative aquatic fauna, including crayfish.

MANAGEMENT STRATEGIES

The most efficient and effective way of managing invasive crayfish is to prevent their introduction. It is almost impossible to eradicate invasive crayfish once they become established. Only one documented case exists of the rusty crayfish being eradicated from an invaded range. In Wyoming, the rusty crayfish was eradicated from five small bodies of water through the application of the pesticide Rotenone. While the risk Rotenone poses to humans is minimal, it impact to aquatic life is dramatic, killing nearly all fish, amphibians, crayfish, mussels, and other invertebrates that it reaches.

Eradication isn't necessarily possible when invasive species are introduced on a larger scale. Though sometimes costly, control efforts can be worth the investment. In Wisconsin, a massive effort of trapping and encouraging fish that prey on crayfish proved an effective control for rusty crayfish. The investment was large, but the damage the invasive crayfish caused to the local sport fishery justified the effort. Wisconsin has also had recent success in controlling red swamp crayfish in a small pond by trapping and ultimately treating it with sodium hypochlorite (bleach).

Jeff Adams

Capturing transporting live crayfish for either bait or for eating, or "crawdading", is one way crayfish are spread.

Researchers are currently studying sterilization methods, which have shown some success. By selectively capturing male crayfish and releasing sterilized males back into the population, females produce a greater amount of infertile eggs, reducing the overall population.

WHAT YOU CAN DO?

- Never release aquarium pets, classroom animals, or live bait into the wild.
- Inspect, clean, and dry all boats and water-sport equipment before going to another body of water.
- If you come across a crayfish you believe to be invasive, report your find.
  In California: Call 1-916-651-8797 or e-mail invasives@dfg.ca.gov
  In Oregon: Call 1-866-INVADER or OregonInvasivesHotline.org
  In Washington: Call 1-877-9-INFESTor visit www.invasivespecies.wa.gov/
  In other states: Call 1-877-STOP-ANS

INFORMATION GAPS

- Researchers, managers, and education specialists are working together to solve a complicated puzzle of how to use native signal crayfish in classrooms instead of prohibited red swamp and rusty crayfish.

Just a reminder: even the native crayfish should not be released from captivity.

- Raising native crayfish for use in commercial aquaculture has been attempted in our region in the past without much success. Smaller-scale production for classrooms could still be explored.

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ADDITIONAL RESOURCES

Red swamp, virile, and native signal crayfish identification: http://wdfw.wa.gov/fishing/regulations/ [last accessed October 2011]

Identification guide for multiple species: www.fish.washington.edu/research/oldenlab/outreach.html [last accessed October 2011]

Crayfish Invasion, an OPB video: www.opb.org/programs/ofg/segments/view/1777 [last accessed October 2011]