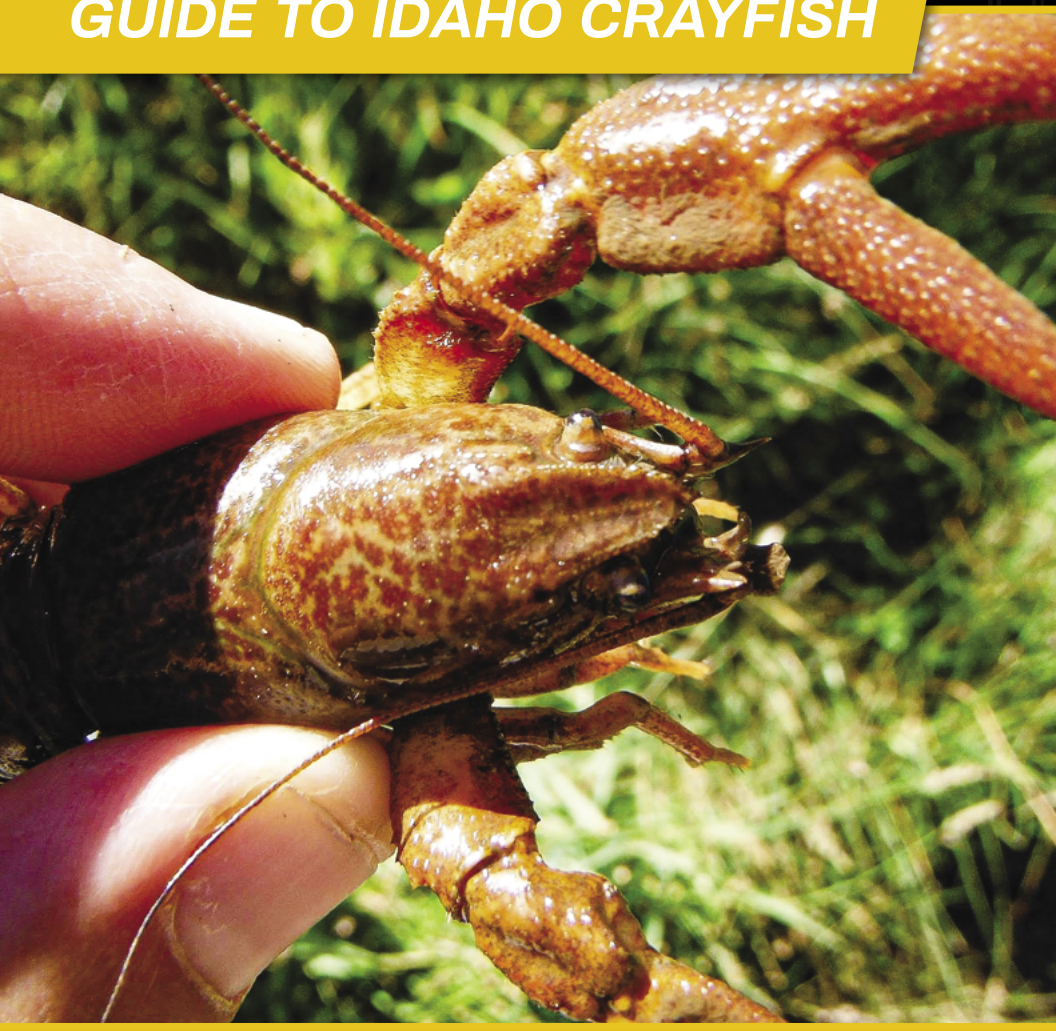
GUIDE TO IDAHO CRAYFISH



University of Idaho Extension

BUL 1072

Guide to Idaho Crayfish

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Moscow, Idaho

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Purpose and Scope

Crayfish (sometimes called crawfish, crawdads, or mudbugs, depending on where you live) are freshwater **crustaceans** commonly found throughout Idaho waterways ranging from small mountain streams to big rivers, lakes, and reservoirs. They are distantly related to lobsters. Crayfish are a fascinating group of species, but many people don't know much about them. This publication provides broad-based information about Idaho crayfish and science-based resources that offer more in-depth information.

Crayfish are important species because they strongly affect aquatic plant and animal ecosystems. They eat a wide variety of foods from varying trophic levels. That is, they are "generalist consumers" ("polytrophic") and are a species that links these lower energy sources with higher-level aquatic and terrestrial predators. Idaho crayfish alter organic matter, like fallen leaves in streams and lakes, by shredding and consuming coarse particulate matter. They also predate other aquatic macroinvertebrates (water bugs), small fish, and even smaller crayfish. Population densities can increase significantly, strongly affecting local waterway ecology. An indicator species of moderately clean water quality, they are fairly pollution-tolerant.

Crayfish are relatively abundant, easy to catch, and are large enough to be an important food source for all five Idaho tribes. An economically viable crayfish fishery once existed in the Clark Fork and Pend Oreille Rivers; currently, the nearest one to Idaho is located down the Columbia River.

Three **native species** of crayfish exist in Idaho: signal crayfish (*Pacifastacus leniusculus*) (Figure 1) are found mostly in north Idaho, pilose crayfish (*P. gambelii*) (Figure 2) in portions of southeastern and far southern Idaho, and Snake River pilose crayfish (*P. connectens*) (Figure 3) generally in far southwestern Idaho counties. At least two non-native, **invasive species** of crayfish inhabit portions of Idaho waterways: virile (a.k.a. northern) crayfish (*Faxonius virilis*) (Figure 4) and red swamp crayfish (*Procambarus clarkii*) (Figure 5). Rusty crayfish (*Faxonius rusticus*) have invaded the nearby John Day River in Oregon and could easily make their way into Idaho waters.

Figure 1. Signal crayfish, native to the Pacific and Inland Northwest, near Plantes Ferry Park, Spokane, Washington.

Figure 2. Pilose crayfish, found in Cassia County, Idaho.

Figure 3. Snake River pilose crayfish, found in southeast Idaho.

Figure 4. Virile (northern) crayfish are non-native to Idaho, but are moving into several areas in the state.

Figure 5. Red swamp crayfish, non-native to Idaho. Their initial invasion in stormwater ponds in Lewiston, Idaho, was documented by high school science students.

Figure 6. Rusty crayfish, non-native to Idaho.

Although signal crayfish are native to much of the inland northwest, including North Idaho, they have been introduced to many areas globally, sometimes with disastrous results. Their introduction to parts of northern California resulted in the global extinction of the sooty crayfish (*Pacifastacus nigrescens*) and endangered the Shasta crayfish (*P. fortis*). These two species formerly represented 40% of native western US crayfish species. Crayfish species endemic to the eastern United States have been introduced to the northwestern part of the country, causing similar disruptions to native crayfish species populations and upsetting long-stable stream and lake ecologies. See Larson and Olden (2011) for more detailed information. Despite their ecological and economic impact and historical importance, population studies of native and invasive crayfish species are few and far between.

This guide aims to fill in some of those gaps. Along with scientific information related to the specific crayfish species found in Idaho (Figure 7), it provides pathways through which non-native crayfish have been and can be introduced to Idaho, important public health

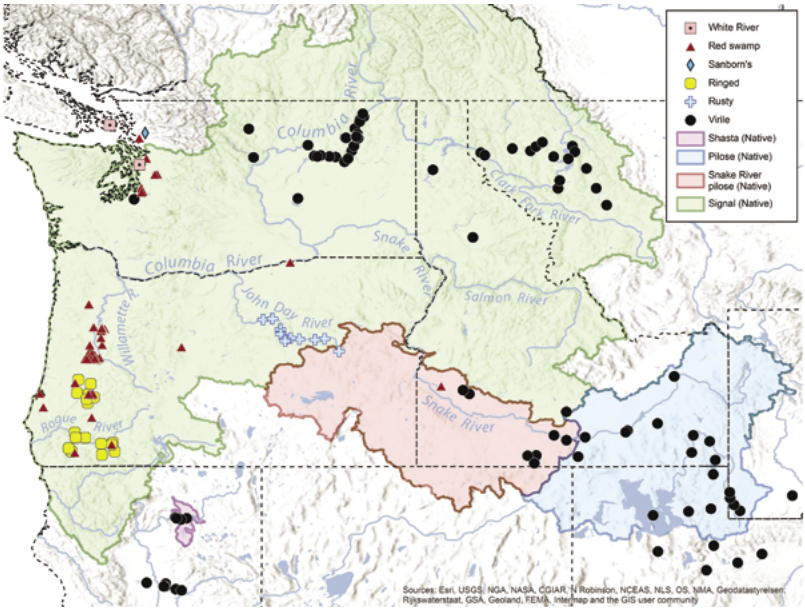

Figure 7. Crayfish data from The River Mile's Crayfish poster.

information about crayfish consumption, an overview of Idaho fishing rules and regulations, and a favorite recipe written and tested by one of the authors' mentors. It is not an exhaustive crayfish guide, but instead an overview of these amazing creatures in Idaho, one that points the interested reader to more in-depth informational sources.

Pathway/Vectors for Introducing Non-Native Crayfish

No matter how cute your pet crayfish is, releasing them into the wild spells disaster for the dozens to hundreds of native critters that inhabit a local pond or stream. Although a handful of relocations, like moving warmwater crayfish to warm springs, have proven ecologically harmless, most are harmful. Indeed, introducing new crayfish species severely disrupts an aquatic ecosystem and the dozens to hundreds of species living there.

A few ways that **non-native species** invasions begin include the following:

- Deliberate or accidental release of laboratory animals after use in schools as science projects, originally having been shipped from biological supply stores
- Warmwater fish stocking and use as bait
- Deliberate stocking to serve as forage for warmwater fisheries
- Deliberate stocking for aquaculture or wild harvest
- Escapes from laboratory ponds (*F. virilis* escaped from lab ponds at Chico State University circa 1959)
- Hitchhikers in shipments of aquarium products (Figure 8)

Consequently, whenever working with live crayfish, do not allow them to escape alive. Humane euthanasia is possible by first refrigerating them (which causes them to go into a state of suspended animation), then freezing them solid. Pithing them with a knife to the base of the head, which severs their central nervous system, is also quick. Throw carcasses of any non-native crayfish species or any crayfish from any aquarium into the garbage; do not use them as bait or

fish feed. Cook and eat any wild-caught crayfish (Figure 9), pending any relevant fish-consumption advisory. All of these practices lessen the possibility, however small, of a live crayfish's accidental release, that of a pregnant female's eggs, and/or the spread of disease.

Idaho fishing regulations are similar to most other states regarding unlawful release of any species of live fish (including crayfish). According to the Idaho Administrative Procedures Act, section 36-1404(b): "'unlawfully releasing any fish species' means a release of any species of live fish, or live eggs thereof, in the state without the permission of the director of the department of fish and game; provided, that no permission is required when fish are being freed from a hook and released at the same time and place where caught or when crayfish are being released from a trap at the same time and place where caught" (Figure 10).

Figure 8. Accidental inclusion of a non-native crayfish with shipment of goldfish at a pet store.

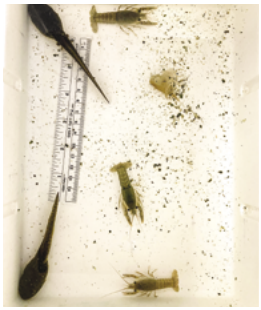

Figure 9. Sometimes people dump live crayfish from bait buckets into local waterways.

Figure 10. Red swamp crayfish is one of two crayfish invaders in Idaho.

Non-Native Crayfish Impacts

Non-native crayfish can replace native species throughout an entire **watershed**. For example, virile (northern) crayfish (*F. virilis*), has replaced the signal crayfish, *P. leniusculus*, in many Oregon, Washington, and western Montana rivers and reservoirs. In turn, the signal crayfish, native to the entire Pacific Northwest and much of Idaho, was introduced into the San Francisco Bay area, which technically led to the global extinction of the sooty crayfish

(*P. nigrescens*) by the mid-1970s. Signal crayfish have become terrible invaders in Japan and parts of Europe as well. And they are threatening the Shasta crayfish (*P. fortis*), a listed US endangered species, found only in northern California's Pit River.

Another example of the invasive effect of released crayfish is the intentional release of an elementary classroom crayfish project into the John Day River circa 1999 (Olden et al. 2009; Larson and Olden 2011; Messager and Olden 2018). Since then, rusty crayfish (*F. rusticus*) have moved downstream, taking over habitat by eliminating native crayfish species and growing in much greater densities as a population. Their prolific appetite is depleting the food sources that other species of **invertebrates** and fish rely on, driving fisheries into decline. As of the time of this writing, the rusty crayfish continue moving downstream, poised to enter the Columbia River system, where their invasive impact will likely continue.

A few other detrimental effects of moving crayfish species around to new areas:

- The spread of disease from non-native crayfish to new populations
- Predation on amphibians and other sensitive, threatened, or endangered species
- Predation on food otherwise used by fish and other aquatic animals
- In some cases, transformation of lakes and wetlands from clear to turbid water by crayfish excessively burrowing and consuming large areas of aquatic plant beds

In general, the ecological function of non-native crayfish differs strongly from that of native species. The wider the evolutionary separation between crayfish species, the more radically different the interaction with the ecosystem. That is, the Cambarid species found in eastern North America greatly differs in activity, feeding, and other effects from the Astacid species from western North America.

Everyone can play a part in ensuring that non-native species are not transported to new areas. Use crayfish only as live bait when they are caught in an immediate waterway during fishing activities. Report your catches: the University of Idaho Extension's Water Outreach program, partnering with The River Mile, provides a citizen-science crayfish documentation and monitoring module, complete with an online form; bookmark the site and enter your information after you catch one.

Considerations and/or Health Advisories Regarding Consuming Crayfish

Anyone who consumes wild crayfish should follow fish consumption advisories, especially for pregnant women and children. Find current advisories at https://healthandwelfare.idaho.gov/Health/EnvironmentalHealth/FishAdvisories/tabid/180/Default.aspx. Always cook crayfish thoroughly! Never eat raw crayfish because they potentially contain parasites, whose ingestion can make you sick. One terrible illness is lung fluke, caused by the parasite *Paragonimus kellicotti*. Another is *Vibrio parahaemolyticus*, a bacteria that causes acute gastroenteritis. A 2010 report of *paragonimiasis* in Missouri stresses that "although crayfish commonly is regarded as food in survival situations, persons who learn or practice survival skills should be cautioned that eating raw or undercooked crayfish carries a risk for paragonimiasis and other diseases" (Patrick et al. 2010). Parasites are normally found in crayfish located in southern states, but those in the Pacific Northwest are possible carriers too, so be extra careful when trapping crayfish for eating.

Often, crayfish are not included in fish advisories. Crayfish are not the longest-lived, nor are they the top aquatic predators; therefore, they are usually less prone to the bioaccumulation of toxins. Then again, you never know what a crayfish has consumed, so follow the strictest precautions advised. Similar to the guidelines for bottom-feeding types of fish, it is safe to eat the muscle of crayfish caught during a cyanobacteria bloom (harmful algae bloom), but discard its internal organs and any liquid fat.

As long as you understand that fish and shellfish can contain contaminants, you can protect yourself by choosing their sourcing carefully and thus not miss out on the nutritional benefits that crayfish and fish in general provide. Indeed, fish [and crayfish], as the Oregon Health Authority states, "are an important part of a healthy diet, especially migratory fish like salmon, steelhead and shad that are low in contaminants. Fish are high in protein, low in fat, and rich in nutrients like omega-3 fatty acids. Omega-3s provide protection from heart disease and are an important brain food for adults, children and fetuses."

> *"Fish are an important part of a healthy diet, especially migratory fish like salmon, steelhead and shad that are low in contaminants. Fish are high in protein, low in fat, and rich in nutrients like omega-3 fatty acids. Omega-3s provide protection from heart disease and are an important brain food for adults, children and fetuses."* Source: *Oregon Health Authority*

Sometimes small worms, a millimeter or two in size, attach to crayfish. Some crayfish species are a symbiotic host for little worms that help to clean their **exoskeleton** (Skelton et al. 2013). Ectosymbiotic worms remove dead tissue, **detritus**, and parasites from the **carapace** (exoskeleton) and gill area. In return, the worms get the food they need and a free ride on the crayfish (Williams et al. 2009). The worms' presence is normal on wild crayfish, so eating cooked crayfish with the worms is not harmful. For a well-researched article about these worms, see Skelton et al. (2013).

Idaho Fishing Regulations and Other Regulatory Considerations

Idaho Department of Fish and Game (IDFG) regulates crayfish. Even though crayfish are a "game fish" in Idaho, the IDFG does not track population numbers or trends for crayfish nor are they aware of any overexploited populations of crayfish in the state. Please keep in mind that fishing regulations change periodically, so check with the IDFG for updated requirements related to crayfish.

More specific IDFG regulations regarding crayfish capture include the following (IDFG 2013):

- Non–game fish (minnows), yellow perch, and crayfish may be taken only in waters open to fishing, provided the seine or net does not exceed 10 ft in length or width and either must have ⅜-inch square or smaller mesh; also, the minnow or crayfish trap must not exceed 2 ft in length, width, or height. If the trap is of irregular dimension, its volume must not exceed the volume of an 8 ft^3 trap to be of legal use. Do not leave nets and seines unattended. Check them at least every forty-eight hours (Figure 11).
- All traps must have a tag attached bearing the owner's name and address.
- Crayfish capture in a body of water can occur only during the season for game fish in those same waters and kept alive to be used as bait only in the water where captured.
- Only five crayfish traps can be fished with a valid fishing license. If more than five are used at one time, obtain a commercial fishing license and trap tags. Currently, a resident commercial license is $111.75 and must be obtained from IDFG headquarters or a region office.
- It is illegal to destroy, disturb, or remove any traps belonging to others.

Figure 11. A kick-net, a seine net, and three different crayfish traps.

Life Cycle and Anatomy of Crayfish

(adapted from Reynolds 2022, pp. 33–34; see Glossary for anatomical terms)

Crayfish have adaptations that help them survive at each life-cycle stage. They start out as one out of fifty to five hundred eggs or more, which their mothers typically carry with them in their **swimmerets**, small appendages on the ventral side (underside) of their abdomen.

They undergo incomplete **metamorphosis** during three distinct life-cycle stages (egg » juvenile » adult). Unlike many other invertebrates, such as butterflies, which endure complete metamorphosis with distinct larval and pupal stages, crayfish hatch from eggs directly into tiny crayfish and suffer roughly eleven **molts**, in which they shed their exoskeleton and then replace it with a new one, while growing into adults.

Crayfish are generally nocturnal. Being most active at night helps them to hide from predators and stay sheltered from the hot sun. They continue to seek protection during the day. When they venture out from the shelter beneath rocks or burrows they do so in well-shaded areas.

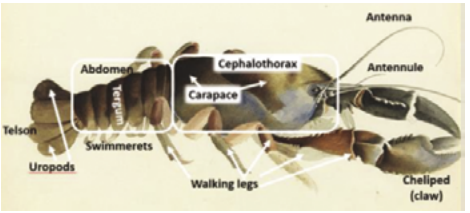

Figure 12. Crayfish top/side view.

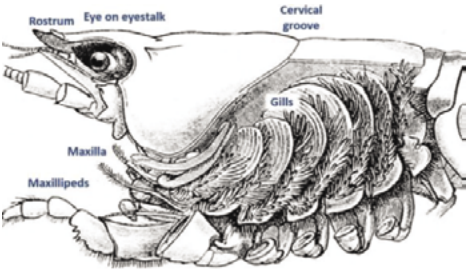

Figure 13. Crayfish cephalothorax illustration, side view [originally from Huxley 1896].

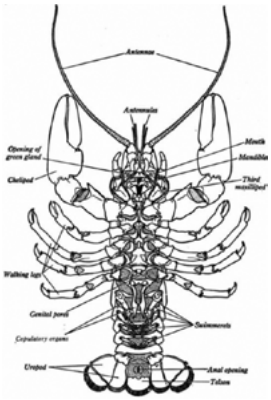

Figure 14. Crayfish underside illustration.

Figure 15. Determining crayfish sex is relatively easy for adults. Males (left) have small extra legs (swimmerets) used to help hang onto the female during reproduction. Females (right) lack these extra swimmerets.

Catching and Collecting Crayfish

You can catch crayfish in a number of ways. The simplest is to wade into a stream or pond and look under rocks, submerged logs, and other suitable hiding places. Sometimes you can see them scurrying around on the bottom. Kick-nets or seine nets (Figure 16) used by water-quality and stream habitat professionals when they study other macroinvertebrates (water bugs, snails, and such) are effective. Crayfish tend to swim backwards when spooked, so place the net close behind one and then use a stick or your hand to make it scoot backwards into the net. The use of a kick-net for collecting macroinvertebrates in Idaho is allowed without a fishing license if you just release them back into the waterbody. And this method works best in wadeable streams and smaller waterbodies. Scientists use "timed searches" of a specific area of a stream or lake when conducting formal research collections. The timed searches follow specific protocols and are helpful for understanding the relative size of crayfish populations in an area.

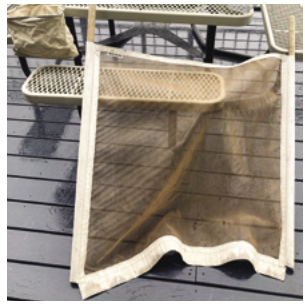

Figure 16. A seine net, with part of a D-shaped kick-net at its right.

Traps (Figure 17) can also be used to catch crayfish in Idaho, but the IDFG requires those using them to have a valid state fishing license. Traps are a better method for collecting crayfish in larger waterbodies. The trap bait encourages the crayfish to crawl in through a funnel-shaped opening, whose shape does not allow it to creep back out. You can use a variety of baits, including hot dogs, bacon, and canned cat food. Poke holes in the top of the cat food can, but don't open it, to make it less messy. The crayfish will smell the bait, but it won't be able to spread it all

Figure 17. Three different types of crayfish traps. The middle one is collapsible and easy to pack into a distant stream or pond.

around inside the trap. Check the traps every forty-eight hours, ideally no longer than twenty-four hours. Do not use them if there are any threatened or endangered aquatic species in the area because it is illegal to capture listed, threatened, or endangered species, like bull trout, in crayfish traps. Also, keep in mind when using nets that females tend to hide under rocks and are less active hunters/foragers during winter. Consequently, the use of traps, instead of rock turning or kick-netting, might overestimate males in the populations.

Shoreline walks or "carapace surveys" can be used to determine whether crayfish might be in the vicinity. The practice involves walking along the high watermark of a drawn-down lake or along the shoreline at low water (also called a "wrack-line") and looking for identifiable pieces of crayfish. The authors have found crayfish claws on the shores of Lake Pend Oreille and on the dock at the University of Idaho Coeur d'Alene Center, where animals or birds have caught and eaten the rest of the crayfish. This technique does not necessarily reveal precise locations or populations of crayfish and can result in false positive results (e.g., there's no crayfish in a lake, but someone had a crayfish boil with food brought in from elsewhere). So while a shoreline walk survey can't identify direct cause-effect relationships, it can indicate crayfish presence or predation with little preplanning and no equipment.

If you are interested in helping to understand where different crayfish populations are located and how they move around, join The River Mile Network's Crayfish Study ("Craw Data") citizen science program as a volunteer: https://therivermile.org/network-projects/the-river-mile-crayfish-study/. This northwestern US-wide program uses established monitoring protocols, an online data upload form, and an interactive map that identifies where crayfish have been monitored and which species are located in what places. UI Extension Water Outreach staff (idah2o@uidaho.edu) are the Idaho coordinators for the study. Note that the program does not operate between December and April, to allow eggs carried around by females time to hatch.

If you find a suspect species, document the exact location and time/date. If possible, take detailed photos of what you find. Clear, focused photos of identifying features like the claws and cephalothorax and undersides of the abdomen are helpful for identification. Then call one or more of the following numbers for further instructions:

- Idaho Invasive Species Hotline 1-877-336-8676
- United States Department of Agriculture's National Invasive Species Information Center: https://www.invasivespeciesinfo.gov/ (for information about discovering an invasive species)
- UI Extension Water Outreach: 208-292-1287; idah2o@uidaho.edu

A Recipe: North Idaho Crayfish Étouffée

Serves 4 or 2 very hungry Extension Educators.

- 2 tbsp Nick's Creole Seasoning (see on upcoming page)
- 4 tbsp unsalted butter

The Holy Trinity:

- 1½ cup yellow onion, very finely chopped
- ¼ cup celery, finely chopped
- ½ cup bell pepper, finely and evenly diced

- 2 lb crayfish meat (about 6–7 lb of live or whole crayfish)
- ¼ cup white flour
- 1½–2 cups crayfish stock (see below)
- ¼ cup very finely chopped or crushed garlic
- 2 tbsp fresh thyme leaves, chopped
- 2 tsp Worcestershire sauce
- 2 tsp thai fish sauce
- 1 tsp hot sauce (NOT tabasco) or more to taste. Something not too vinegary!

- Salt and freshly ground black pepper, to taste
- ½ cup green onions, very thinly sliced
- 2 tbsp Italian parsley, minced
- 3 tbsp unsalted butter, softened
- 1 tbsp fresh lemon juice

Directions

Make the creole seasoning and set aside.

Melt the butter in a large cast iron skillet over medium/low heat; add the onions, celery, and bell pepper and 1 tbsp of the creole seasoning and sauté until onions are translucent. Drink a beer (or the beverage of your choice) while you wait.

Add the crayfish and the remaining creole seasoning and sauté until the crawfish give off some of their liquid; cook for 5–7 minutes more. Add the flour, stirring constantly for about 3–5 minutes.

Add a small amount of the crayfish stock, stir well to form a gooey paste, and then slowly add the remaining stock, stirring constantly. Bring to a gentle boil then reduce to a simmer. You may need a little more stock, but the end result should be the consistency of gravy, not too thick.

Add the garlic, thyme, Worcestershire sauce, fish sauce, hot sauce, and a little salt and black pepper. Simmer covered very gently for 20–30 minutes. Add in the green onions and parsley and simmer for 5–10 minutes.

Gently stir in the butter and lemon juice and adjust the seasonings to taste, especially the heat of the spicier ones.

Serve over Creole Boiled Rice (see on upcoming page).

Nick's Creole Seasoning

- ½ cup salt
- ⅓ cup smoked paprika (sweet [dulce] or hot)
- ¼ cup *granulated* garlic
- 4 tbsp onion powder
- ⅓ cup freshly ground black pepper
- 3 tbsp white pepper
- 2 tbsp cayenne pepper or other hot pepper powder
- 2 tbsp dried thyme
- 2 tbsp dried basil
- 1 tbsp dried oregano

Directions

Mix all ingredients well and place in an airtight jar. Makes about 10 oz.

Crayfish Stock

- 2 qt crayfish or *shrimp shells* or white fish bones (NO salmon)
- 1½ qt cold water (clam juice makes up for a shortage of shells)
- 1 large onion, roughly chopped
- 3 ribs of celery, roughly chopped
- 1 head of garlic, well smashed
- 1 bunch of fresh thyme
- 2 bay leaves
- 1 lemon, quartered (skin and all)
- 1 tbsp whole black peppercorns
- Healthy pinch of red pepper flakes

Directions

In a large saucepan, cover the crayfish shells with cold water and bring them to a boil, then reduce to a simmer. Skim off any crud that comes to the surface. Add the rest of the ingredients and let simmer for 30–40 minutes. Strain through a fine sieve or cheesecloth.

You will only need about 2 cups of the stock for the crayfish recipe; the rest can be frozen.

Creole Boiled Rice

- 2 cups of water
- 2 bay leaves
- 1 tbsp salt
- 1 tbsp unsalted butter or olive oil
- 1 cup basmati or other long grain rice

Directions

Bring the water and bay leaves to a boil. Add the salt, butter/oil, and rice; stir ONCE. Cover and cook over LOW heat for about 15 minutes. Let stand OFF HEAT for 5–10 minutes. Remove the bay leaves.

Recipes courtesy of Nick Sanyal, professor emeritus, College of Natural Resources, University of Idaho.

Species-Specific Information for Crayfish in and Near Idaho

The following descriptions of crayfishes found in Idaho are abbreviated and adapted from a variety of scientific papers and other trusted sources. Eric Larson and Julian Olden's (2011) "The State of Crayfish in the Pacific Northwest" (with the American Fisheries Society) is a great resource. The Washington Department of Fish and Wildlife offers a very abbreviated white paper "Brief Guide to Crayfish Identification in the Pacific Northwest" (2009) by Olden (https://wdfw.wa.gov/sites/default/files/2019-04/Brief%20Guide%20to%20Crayfish%20Identification%20in%20the%20Pacific%20Northwest.pdf) and a "Crayfish Found in Oregon" poster guide (https://www.dfw.state.or.us/conservationstrategy/invasive_species/docs/Crayfish_Comparison.pdf). Lastly, the United States Geological Survey published a useful fact sheet, "Invasive Crayfish in the Pacific Northwest" (2011) (https://pubs.usgs.gov/fs/2011/3132/pdf/fs20113132.pdf), which provides information about three native Idaho crayfishes and the three non-native species of concern.

Figure 18. Crayfish caught near Plantes Ferry Park, Spokane River.

Native Idaho Crayfish

Pilose Crayfish

(Pacifastacus gambelii)

Figure 19

Distinguishing Features

- Patches of setae or little hairs on the edges (dorsal surfaces) of their claws.
- Broader, less-pointed, more obtuse rostrum.
- Long palms relative to overall chela length, making the chelae look stubbier relative to those of *P. connectens*.
- Lines on the back between the head and tail do not touch at the middle of the back, they separate far from each other.
- Found in the upper Snake River watershed, upstream of south-central Idaho and in the neighboring Bonneville Basin.

Status: Pilose crayfish are native to the upper Snake River watershed and the Bonneville Basin of Idaho, Nevada, Utah, and Wyoming (including parts of Yellowstone National Park). Pilose means “hairy,” referring to patches of setae (little hairs) on the edges of their claws. Very little research has been conducted on them and Snake River pilose crayfish. Both pilose species have experienced serious (70%–80%) reductions in their native ranges, usually because of displacement by invasive species and habitat loss.

Figure 20. Pilose crayfish, found in Cassia County, Idaho.

Figure 21. Pilose crayfish with a red-orange life color.

Figure 22. Pilose crayfish with a greenish-brown life color.

Snake River Pilose Crayfish

(Pacifastacus connectens)

Figure 23

Distinguishing Features

- Patches of small hairs or setae on the edges (dorsal surfaces) of their claws.
- Narrow, acute, pointed rostrum.
- Long, movable finger relative to overall chela length, making the chelae look more slender than those of the *P. gambelii*.
- Lines on the back between the head and tail do not touch at the middle of the back they separate far from each other.
- Found in the middle Snake River watershed downstream of south-central Idaho and in the neighboring Harney Basin of southeastern Oregon.

Status: Snake River pilose crayfish are native to the middle Snake River watershed and nearby Harney Basin of Idaho, Nevada, and Oregon. Like pilose crayfish, the species has experienced serious (70%–80%) reductions in their native ranges, usually because of displacement by invasive species and habitat loss. Even less is known about this species than the other pilose crayfish. Hopefully more research on it and the pilose crayfish will help it to avoid **extinction** (e.g., *P. nigrescens* in the San Francisco Bay area) or listing under the Endangered Species Act (ESA) (e.g., *P. fortis* near Mount Shasta).

Figure 24. Snake River pilose crayfish with mottled orange color.

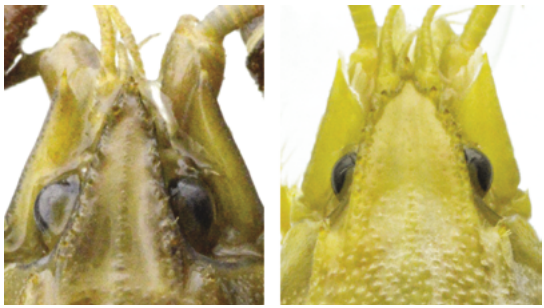

Figure 25. Comparison of rostrums of the Snake River pilose crayfish (*P. connectens*, left) and pilose crayfish (*P. gambelii*, right).

Signal Crayfish

(Pacifastacus leniusculus)

Distinguishing Features

- Body and claws are smooth; no little bumps or hairs.
- Lines on the back (between the head and tail) do not touch at the middle of the back, they separate far from each other.
- White or turquoise or otherwise light-colored patch usually (but not always) found at the base of each claw joint; some will not have this light-colored patch.
- Highly variable coloration. Dark brown to orange to red to drab green to blue—life color is not a very helpful diagnostic trait. See photos.
- Usually found in rocky crevices or woody debris in streams. Generally does not burrow nor live in large populations in muddy/clay-banked streams (but sometimes does).

Status: Signal crayfish are native to the majority of the Pacific and Inland Northwest United States, specifically from the Klamath River of northern California into the southern reaches of British Columbia, Canada, and throughout the Columbia River tributaries as far as western Montana.

Note: Signal crayfish exhibit a wide range of life colors. Figures 26–28 display three signal crayfish that have distinctively different coloration: from left to right, reddish brown, greenish brown. They can even be blue in color.

Figure 26. Orange-brown-colored signal crayfish.

Figure 27. Brown-greenish-colored signal crayfish.

Figure 28. Orangish-colored signal crayfish.

Non-Native (Invasive) Crayfish

Red Swamp Crayfish

(Procambarus clarkii)

Distinguishing Features

- Lines that meet on back in the middle between head and tail.
- Tend to be deep red in color.
- Body and top of the claws are covered with small bumps.

Status: Red swamp crayfish are non-native to the western United States although they have recently been found in Lewiston, Idaho's big stormwater ponds (Morton et al. 2022). There is concern in southern Idaho that they may be moved into waterways in the greater Boise area. They are native to the southeastern United States and have been introduced in several parts of the world. They occupy a larger trophic range than the native Idaho crayfish; that is, they eat more stuff, use a wider range of habitats, and live in larger population densities. Their 1974 introduction into Europe in turn introduced a mold called *Aphanomyces*. European species of crayfish don't have immunity, so entire populations were locally exterminated. Red swamp crayfish also dig into stream and pond banks, causing erosion, and have triggered drastic fish population declines in parts of Africa. The phenomena have been observed after their introduction in parts of the United States too.

Figure 29. Red swamp crayfish found in Lewiston, Idaho, stormwater ponds in 2021.

Figure 30

Rusty Crayfish

(Faxonius rusticus)

Distinguishing Features

- Reddish-brown (rusty-looking) patches on the sides of the body plates.
- Claws have little bumps, especially on the inside edges, and often have orange tips.
- Wide gap in the claw pincers when closed.

Status: Originally from Ohio and Kentucky, rusty crayfish are non-native to the western United States. Presently they are found in the John Day River of Oregon and are heading toward the Columbia River. They tend to live in higher densities within streams than native crayfish. Invasions in the Great Lakes resulted in well-documented serious impacts to aquatic ecosystems.

Figure 31

Figure 32. Rusty crayfish on rock (note rusty spot).

Virile (Northern) Crayfish

(Faxonius virilis)

Distinguishing Features

- Brown, tan, or olive-green body; several different shades of those colors can be present on one crayfish.
- Lines on the back between the head and tail come close together, but do not touch at the middle of the back.
- Claws tend to be green or blue green with large, yellow bumps. Tips of the claws may be light orange.

Status: Virile crayfish are non-native to the western United States. They are native to a large area of the Midwest, east of the Continental Divide. Currently they are widespread throughout the West and are found in pockets in Idaho. Commonly used as bait, they can be purchased from biological supply stores. Virile crayfish have replaced signal crayfish in some rivers of western Montana and have replaced *Pacifastacus gambelii* throughout much of the Upper Snake River in southeastern Idaho (Egly and Larson 2018), the latter being sites historically occupied by pilose crayfish (Shaw et al. 2021). Their spread to northern California is likely contributing to the decline of Shasta crayfish in northern California.

Figure 33

Figure 34

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This guide was made possible with generous assistance from many people who are more familiar with crayfish than I. A lifetime of thanks to the following people who made big contributions to this publication:

Eric Larson, University of Illinois (and a proud Vandal alumni from our College of Natural Resources in 2004), is a top crayfish researcher in the western United States and provided the bulk of the research-based information used in this publication. Eric's data populates the crayfish maps. I leaned heavily on his and his faculty peers' work to write this guide.

Rick Reynolds, founding director of Engaging Every Student, has developed many amazing investigative curricula, including Investigating Crayfish + Freshwater Ecosystems (he wrote the section about crayfish anatomy as a part of a larger lesson used by K–12 teachers). From those materials, along with coteaching workshops with Rick, I've learned a ton about crayfish and how they inhabit our waterways.

Janice Elvidge, retired Park Ranger and founding director for The River Mile, fostered my love and interest in crayfish. Indeed, she's developed a rich network of crayfish-loving K–12 teachers over the years. Janice also created The River Mile's Crayfish Observation study, in part to help understand where non-native crayfish invasions are happening but also to teach the general public about population dynamics. She commissioned the graphic design and crayfish species population mapping work by Rick Reynolds that is presented in the first section of this guide.

High school students and teachers from Columbia High School, Hunters, Washington, were instrumental in fostering my interest in crayfish. Debra Berg (retired) and Ky Turner (current science teacher there) started studying Lake Roosevelt's crayfish when the park didn't have the staff capacity to do so. This led to the development of The River Mile's crayfish citizen science project, now followed by many schools throughout the Columbia River Basin. UI Extension's own IDAH$_2$O Master Water Stewards program has partnered with

The River Mile to extend water-quality citizen-science options for crayfish study participants and crayfish citizen-science options for $IDAH_2O$ Master Water Stewards who are particularly interested in aquatic biology. Deb provided photos in the "how to determine crayfish sex" section.

High school students and teachers from Lewiston High School found Idaho's first verified and recorded invasion of red swamp crayfish in Lewiston's stormwater ponds. Jamie Morton, a high school environmental science teacher, has been taking her students to the ponds and Snake Rivers to collect water-quality data via $IDAH_2O$ Master Water Stewards and crayfish population data via The River Mile for several years. In 2020, two students found an unusual crayfish in their trap. This early detection prompted the Army Corps of Engineers, who manages the ponds, to develop a management plan in short order. So far this has kept these invasive crayfish out of the Snake and Clearwater Rivers, home to ESA-listed anadromous salmon, trout, lamprey, and other important fishes. Jamie and her students are authors on a refereed journal manuscript in *BioInvasion Records* about how citizen science can stand in as an early warning system for introduced species invasions.

Chris Lukhaup is a professional photographer specializing in crayfish. Several of his amazing photos are used in this guide with permission. Thank you, Chris, for your enthusiasm for these critters. I hope you keep up your good work.

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Appendix

Glossary

abdomen. The section behind the thorax; covered in six plates.

antennae. Long thin organs used to touch, taste, and smell; helps to sense prey and predators in murky water.

antennule. Shorter organs also used to touch and taste, as well as for balance.

arthropod. An animal with jointed limbs, a chitin-covered body, and no backbone. A large phylum that includes arachnids, crustaceans, insects, and many others.

carapace. The protective shell (**exoskeleton**) of the head and thorax (cephalothorax) combined.

cephalothorax. The joined thorax and head of crayfish and other arthropods (such as spiders and other arachnids).

cervical groove. An indentation that separates the head and thorax, which are connected in crayfish.

chelae. Claws, used for defense and food handling (note, *chela* is the singular term). Chelae are sometimes broken off but grow back over time. The size of the gap between the pincers can be an identifying feature. Some species have a larger gap than others. Also look for bumps (**tubercules**) or little hairs (setae) on the claws as another identifying feature.

crayfish. A freshwater crustacean that is distantly related to lobsters. There are about four hundred species of crayfish in North America, but only nine that are native to the western United States.

crustacean. A group of arthropods that includes crayfish, crabs, shrimp, and isopods (pill/sow bugs). Most have paired appendages and two pairs of antennae.

detritus. Waste or debris, usually partially broken-down bits of plants; an important food for crayfish and other aquatic invertebrates (water bugs, snails, and clams/mussels).

exoskeleton. The shell that protects and supports the body of arthropods like crayfish, composed primarily of chitin.

extinction. When a species completely dies out everywhere; the end of birth.

extirpate. To locally remove completely; **extinction** in a localized area.

eyestalk. A column that attaches a crayfish compound eye to its head. Allows independent movement of the eyes and a wider field of view.

genital pores. Minute bodily openings used by adults to reproduce.

gills. Breathing organs that extract oxygen from water and exhaust/exchange carbon dioxide into the water.

green glands. Organs that help to filter waste products and balance salt levels in the blood; similar to kidneys in humans.

invasive species. A species of plant or animal, usually introduced to an area from somewhere else. They outcompete native species and cause severe disruptions to ecosystems and possibly great ecological/economic harm or risk to human health.

invertebrate. An animal without any bones, including backbone. Includes crustaceans, insects, snails, worms, and bivalves (clams and mussels). Often important prey for fish, birds, and other animals. Some are microscopic, like plankton. Others are macroscopic and can be identified without magnification.

mandible. Jaws used to crush and eat food.

maxillae. Two pairs of appendages that help hold, tear, and pass food to the mouth or draw water over the gills.

maxillipeds. Crustacean appendages that hold food; can touch and taste.

metamorphosis. The biological process of changing form from an egg to a larva (sometimes to a pupa) and to an adult. Some species skip one or more phases. Crayfish, for instance, hatch from the egg looking like a miniature adult, then grow through about eleven instars (shedding their **exoskeleton** each time) before becoming an adult.

native species. A plant or animal naturally found in an area.

non-native (introduced) species. An organism brought into an ecosystem from somewhere else by humans, sometimes intentionally, sometimes accidentally. Some non-native species become invasive and cause problems. Others live in their new ecosystem without causing major harm. Others fail to establish a viable population and eventually are extirpated.

rostrum. A small, pointy beak-like structure above and between the eyes. Sometimes called the supraorbital spine.

sternum. A protective plate on the underside of the crayfish abdomen and cephalothorax.

swimmerets. Five pairs of short legs or appendages in the bottom of a crayfish abdomen that help with swimming. They are also used by females to hold the eggs or young crayfish.

tail fan. Used for swimming backwards, a posterior fin made up of the “telson” and four “uropods.”

telson. The center segment of the tail.

tergum. The name for the thickened plates on each segment of the dorsal side of a crayfish body and that of other arthropods; helps to protect the soft interior.

tubercules. Bumps found on the surface of some crayfish.

turbidity. A measure of the cloudiness of water and/or suspended solids in water. Excess turbidity is one indicator of poor water quality.

uropod. The last pair of abdominal appendages of crayfish and related crustaceans; found on the sides of the **telson**, completing the **tail fan** used for swimming.

walking legs. Crayfish have five pairs of walking legs to move along river or pond bottom (locomotion) attached to the cephalothorax.

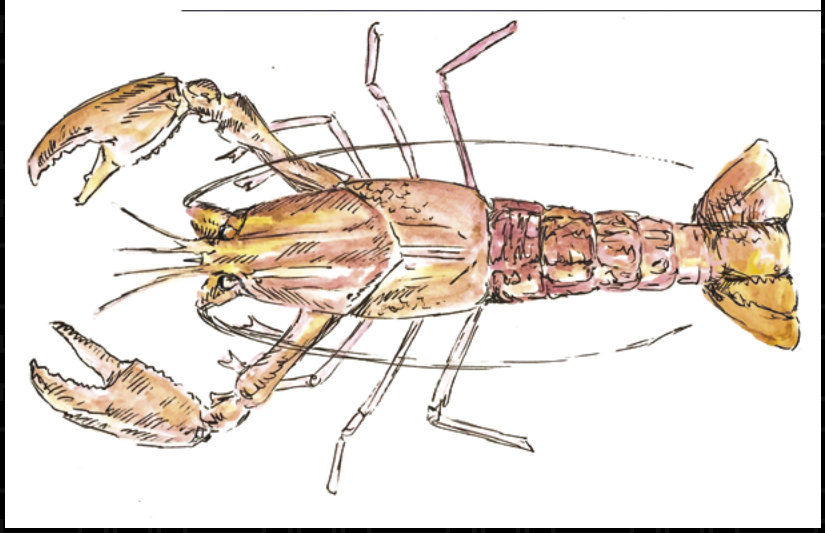
watershed. All the land that drains to a specific point into a stream or lake.

Crayfish Facts

Adapted from Lake Roosevelt National Recreation Area (youth activity handout):

- These crustaceans have good eyesight and, like other related species (lobsters, prawns), they move their eyes independently from one another and without moving their body.
- Crayfish molt at the end of June. They often eat their old exoskeleton in order to recover the calcium and phosphates. On the sides of their stomach, crayfish have two limestone grains, filtered from the water, which impregnate its newly forming exoskeleton with calcium.
- These crustaceans eat plant material and algae, snails, clams, insect larvae, small fish, and carrion (decaying organisms).
- Crayfish walk forward; they move backward only when swimming with their abdomen movements. Swimming backward is the fastest way for them to escape predators.
- Crayfish are most active at night. In the southeastern United States populations can reach twenty per square meter.
- Adults reach their full size in the wild in 2–4 years. They can live for over twenty years.
- During the breeding season, males fight for the right to impregnate the female and in these competitions they may lose a leg or claw. The lost limb slowly grows back.
- Females lay 200–400 eggs and attach them under their tail. They carry them until they hatch.
- Crayfish are prey for raccoons, otter, mink, turtles, heron, cranes, bass, channel catfish, and many more fish and animal species. Louisiana harvests over one hundred million pounds per year for human consumption not including those caught in traps by recreational fishermen. They are a popular food in Europe; Norway catches the most and France consumes the most.

- You can often determine if a body of water is contaminated or not by its crayfish population. If they are plentiful, it is likely uncontaminated. Crayfish help purify the water by feeding on algae, bacteria, and decaying materials.
- Did you know that crayfish come in different colors? They can come in blue, white, and red. Red is the most common type and white is the least.
- There are many different names for crayfish, including crawdads, crayfish, river crab, and mudbugs.
- In North America, there are over three hundred thirty different species. Idaho only has three native species. There are only nine species native to the western United States. Three of these are extinct or endangered.
- Some recorded crayfish fossils are thirty million years old! However, the homes or burrows of the crayfish that have been fossilized date back much further.
- Some crayfish fossils found in Australia are one hundred million years old.



Your Guide to Fascinating Creatures Found in Idaho's Waterways

Crayfish are freshwater crustaceans, distantly related to the lobster. Their aquatic impact is significant and fascinating, yet their profile and presence remain mysterious to many. Using broad-based information and scientific resources, this guide spotlights the basics about these furtive creatures. Along with providing profiles of the six types found in Idaho (three native and three non-native), you'll learn how to catch and collect them in an ecologically responsible way; their life cycle and anatomy; tips for consuming them safely; state fishing regulations; a scrumptious recipe; and more. Copiously illustrated, this handbook also provides more in-depth informational sources for those who want to know even more.

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