rusty crayfish: a nasty invader

biology, identification, and impacts by jeffrey gunderson **minnesota sea grant**

overview

Rusty crayfish (*Orconectes rusticus*) have invaded portions of Minnesota, Wisconsin, Ontario, and many other areas. Although native to parts of some Great Lakes states, rusty crayfish have spread to many northern lakes and streams where they cause a variety of ecological problems.

Rusty crayfish were probably spread by non-resident anglers who brought them north to use as fishing bait. As rusty crayfish populations increased, they were harvested for the regional bait market and for biological supply companies. Such activities probably helped spread the species further. Invading rusty crayfish frequently displace native crayfish, reduce the amount and kinds of aquatic plants and invertebrates, and reduce some fish populations. Environmentally-sound ways to eradicate or control introduced populations of rusty crayfish have not been developed, and none are likely in the near future. The best way to prevent further ecological problems is to prevent or slow their spread into new waters.

origin and distribution

There are over 350 species of crayfish in North America. Sixty-five of these species, including rusty crayfish, belong to the genus *Orconectes*. Rusty crayfish are thought to be native to the Ohio River Basin and the states of Ohio, Kentucky, Tennessee, Indiana, and Illinois. But, now rusty crayfish are also found in Michigan, Massachusetts, Missouri, Iowa, Minnesota, New Mexico, New York, New Jersey, Pennsylvania, Wisconsin, all New England states except Rhode Island, and many areas in Ontario, Canada (**Figure 1**).

Rusty crayfish were not found in Wisconsin in a 1932 survey, but populations have rapidly expanded throughout Wisconsin lakes and streams since their introduction around 1960 (Capelli and Magnuson 1983). The first observation of rusty crayfish in Minnesota was in 1967 at Otter Creek in southern Minnesota. A statewide study (Helgen 1990) reported their presence in many areas. So far, they have been found in 11 counties and 31 different lakes and streams.

Rusty crayfish populations found in southern Minnesota (Des Moines and Cedar River Basins) and east central Minnesota (St. Croix River and tributaries) may have resulted from the natural dispersal of introduced populations from Wisconsin and Iowa. Rusty crayfish populations in the rest of Minnesota; however, were probably spread there by people.

Although there is no direct evidence, it is thought that people can spread crayfish in several different ways. Anglers using crayfish as bait are thought to be the primary cause. While crayfish never were a significant component of Minnesota live bait sales, they are popular in other states and may have been brought in by non-resident anglers. Rusty crayfish are also sold to schools by biological supply houses. Even though a warning not to release rusty crayfish into the wild accompanies crayfish sold to schools, such warnings may be forgotten, or live crayfish may be given away to students. Crayfish from schools or collected from the wild and placed in home aquariums may eventually be released. Developing a viable commercial harvest of rusty crayfish from natural lakes could be incentive for unscrupulous trappers to plant them in other waters. In fact, this may have contributed to the spread of rusty crayfish in Wisconsin, according to Wisconsin DNR Fisheries Manager, Harland Carlson (per. comm. 1994).

The harvest of rusty crayfish for food and bait may provide the only beneficial use for this exotic. Harvest for bait has been going on for over 30 years in Wisconsin. Commercial harvest for food is more recent and varies from year to year in both Wisconsin and Minnesota. Regulations in both Minnesota and Wisconsin now make it illegal to introduce rusty crayfish into any waters. In Minnesota, it is illegal to sell live crayfish as bait and a Department of Natural Resources permit is required to commercially harvest or culture crayfish.

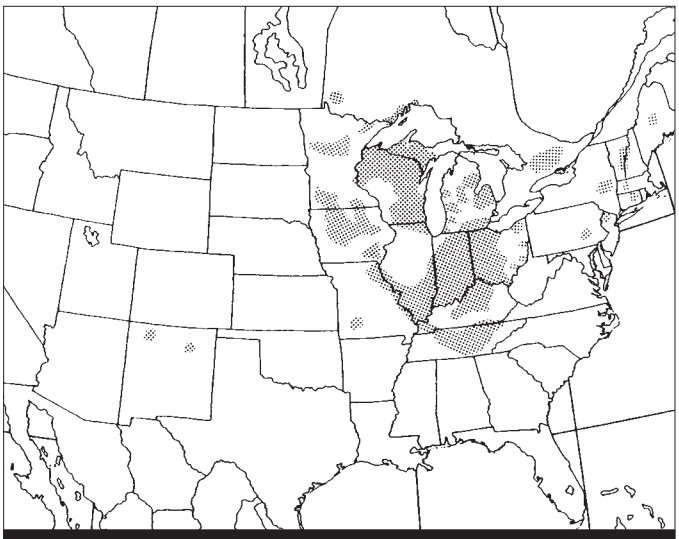


Figure 1. Geographic distribution of *Orconectes rusticus*. Adapted from *The Crayfishes & Shrimp of Wisconsin* by Hobbs and Jass (1988). The expanded range includes new sightings and observations that are both published and unpublished.

life history

Rusty crayfish inhabit lakes, ponds, and streams. They prefer areas that offer rocks, logs, or other debris as cover. Bottom types may be clay, silt, sand, gravel, or rock. Rusty crayfish inhabit both pools and fast water areas of streams. They generally do not dig burrows other than small pockets under rocks and other debris, although there have been reports of more substantial burrows. Unlike some species (such as the papershell crayfish, *O. immunis*) which dig burrows to escape ponds that are drying up or becoming inhospitable, rusty crayfish need permanent lakes or streams that provide suitable water quality year-round.

Mature rusty crayfish mate in late summer, early fall, or early spring. The male (**Figure 2**) transfers sperm to the female (**Figure 3**), which she then stores until her eggs are ready to fertilize, typically in the spring (late April or May) as water temperatures begin to increase. The stored sperm are released as eggs are expelled and external fertilization occurs. The eggs are then attached to the swimmerets on the underside of the crayfish's abdomen ("tail section"). Just prior to egg laying, white patches appear on the underside of the abdomen ("tail section"), especially on the tail fan (**Figure 3**). These white patches are glair, a mucus-like substance secreted during egg fertilization and attachment. Rusty crayfish females lay from 80 to 575 eggs.

Eggs hatch in three to six weeks, depending on water temperature. Once hatched, young crayfish cling to the female's swimmerets for three to four molts (molting is when crayfish shed their old shell to allow growth). Young crayfish may stay with the female for several weeks. She offers them protection during this vulnerable life stage. Eventually, the young leave the female. They undergo eight to ten molts before they mature, which may occur during the first year, but more likely the following year. Rusty crayfish reach maturity at a total length of one and three-eighths inches and reach a maximum length of about four inches (not including claws). They averaged two and one-half inches in Wisconsin collections (Hobbs and Jass 1988).

It is important to note that it is not necessary to have both a male and a female crayfish to begin a new infestation. One female carrying viable sperm could begin a new population if released into a suitable environment. Rusty crayfish readily mate in captivity so it is reasonable to expect that mature females, whether used as fishing bait or as science class study specimens, could produce offspring.

Growth slows considerably after crayfish reach maturity. While mature males molt twice per year, females usually only molt once. Females molt after the release of their young, typically in June or early July. In the spring, males will molt into a sexually-inactive form (called Form II) and then molt back into the reproductively-competent form (Form I) in summer. Form I males are characterized by large claws, a hook on one pair of their legs (**Figure 2**), and hardened gonapods. The hook and the larger claws are used for grasping females during mating. Because males have an additional molt each year, they are usually larger than females of the same age. A typical rusty crayfish lives three to four years.

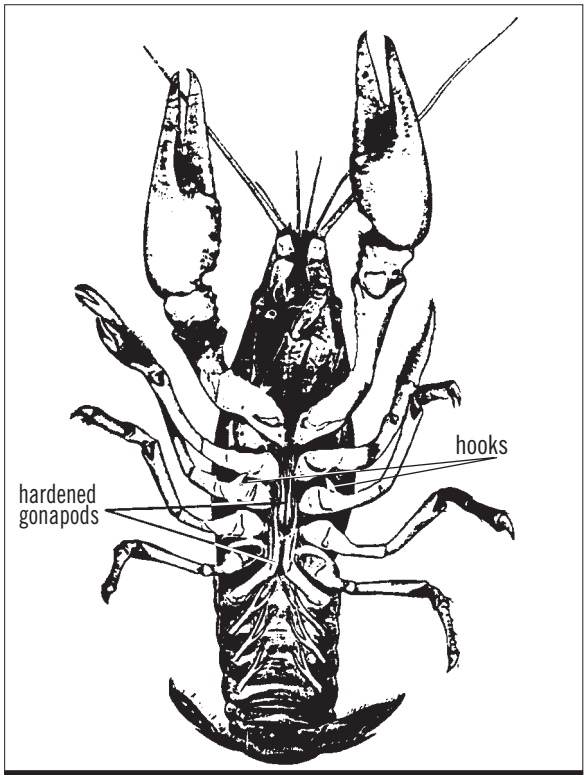


Figure 2. The underside of a Form I male crayfish showing one pair of legs with hooks (*copulatory stylets*) and hardened gonapods.

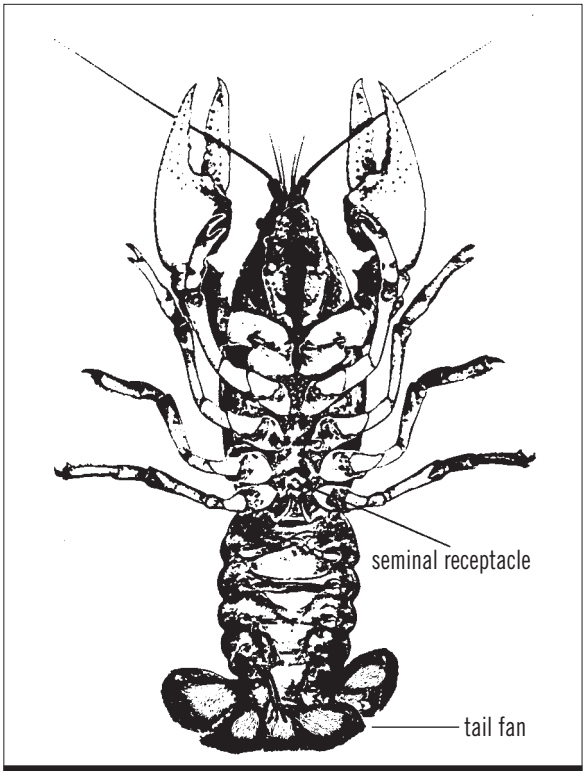


Figure 3. The underside of a female crayfish showing the seminal receptacle where the sperm capsule is held by the female until eggs are fertilized.

food habits

Crayfish are considered opportunistic feeders. Rusty crayfish feed on a variety of aquatic plants, benthic invertebrates (like aquatic worms, snails, leeches, clams, aquatic insects, and crustaceans like side-swimmers and water fleas), detritus (decaying plants and animals including associated bacteria and fungi), fish eggs, and small fish.

potential impacts

Rusty crayfish may cause a variety of negative environmental and economic impacts when introduced to new waters. First, they are an aggressive species (Munjal and Capelli 1982) that often displace native or existing crayfish species. Displacement of crayfish, such as *O. virilis* and *O. propinquus*, has occurred in many northern Wisconsin lakes, northern Ontario, and in the Kawartha Lakes region of southern Ontario (Capelli 1982; Lodge et al. 1986; Olsen et al. 1991). Rusty crayfish displace other crayfish species through a combination of crayfish-to-crayfish competition and increased fish predation (DiDonato and Lodge 1994; Garvey et al. 1994; Hill and Lodge 1993). The reason for increased fish predation on native crayfish is two-fold. First, rusty crayfish force the native species from the best daytime hiding places and second, native crayfish try to swim away from a fish attack, which makes them more vulnerable. Rusty crayfish, on the other hand, assume a claws-up defensive posture which reduces susceptibility to fish predation.

Perhaps the most serious impact is the destruction of aquatic plant beds. Rusty crayfish have been shown to reduce aquatic plant abundance and species diversity (Lodge and Lorman 1987; Olsen et al. 1991). This can be especially damaging in relatively unproductive northern lakes, where beds of aquatic plants are not abundant. Submerged aquatic plants are important in these systems for:

- habitat for invertebrates (which provide food for fish and ducks),
- shelter for young gamefish, panfish, or forage species of fish,
- nesting substrate for fish, and
- erosion control (by minimizing waves).

Although other crayfish eat aquatic plants, rusty crayfish eat even more because they have a higher metabolic rate and appetite (Jones and Momot 1983). They also grow larger, hide less from predators — and therefore feed longer (Stein 1977) — and attain high population densities.

Rusty crayfish, especially juveniles, feed heavily on benthic invertebrates like mayflies, stoneflies, midges, and side-swimmers. It has been estimated that rusty crayfish might consume twice as much food as similar-sized *O. virilis* because of a higher metabolic rate (Momot 1992). So, rusty crayfish are more likely to compete with juvenile game fish and forage species for benthic invertebrates than are native crayfish species. Displacement of native crayfish by rusty crayfish, therefore, could result in less food for fish. Crayfish are eaten by fish, but because of their thick exoskeleton (shell) relative to soft tissue, their food quality is not as high as many of the invertebrates that they replace. Less food or lower food quality means slower growth, which can reduce fish survival.

Finally, it has been suggested that rusty crayfish harm fish populations by eating fish eggs. While rusty crayfish have been observed to consume fish eggs under various circumstances (Horns and Magnuson 1981), there is no scientific study directly linking fishery declines with crayfish egg predation. It's likely that those fish species that lay eggs in relatively warm water (greater than 50° F) are more susceptible to crayfish predation than fish that spawn during colder water periods (Momot 1992). For instance, warm-water spawners like smallmouth bass, largemouth bass and sunfish are more likely to be affected than cool-water

spawners like lake trout, walleye or northern pike. However, Wisconsin DNR Fisheries Manager, Harland Carlson, has observed actively feeding crayfish during lake trout spawning in November (water temperature 46° to 50° F). Reduced reproductive success of walleye in Lake Metonga, Wisconsin was reported following the rusty crayfish invasion (Lodge et al. 1985); however, walleye reproduction in other Wisconsin lakes invaded by rusty crayfish was not similarly impacted. Perhaps the lower quality walleye spawning substrate of Lake Metonga compared to other lakes invaded by rusty crayfish allowed the impact on walleye reproduction. However, there is no evidence proving or disproving this speculation.

Male bass and sunfish protect their nests until the eggs hatch and the advanced fry swim away. Dr. Bill Swenson, University of Wisconsin–Superior fishery scientist, has observed rusty crayfish attacking bluegill nests guarded by males. He also observed rusty crayfish in other unguarded nests. It is not known; however, if rusty crayfish caused the bluegills to abandon their nests or if they eat bluegill eggs on a regular basis.

No detailed research has been done that proves rusty crayfish cause declines in fish populations. Observations and circumstantial evidence gathered by Wisconsin fishery managers suggest that bluegill and northern pike populations frequently decline following introduction of rusty crayfish (Harland Carlson and Chris Sand, Wisconsin DNR, per. comm. 1994). Smallmouth bass in Lake Lenore and largemouth bass in Pounsford Lake, Ontario also seemed to decline following introduction of rusty crayfish (Dr. Walter Momot, per. comm. 1994). Impacts on other fish species are not as obvious. The primary cause of bluegill, bass, and northern pike declines is probably reduced abundance and diversity of aquatic plants. Reduced food (such as mayflies, midges, and side-swimmers) and egg predation may also play a role. Because impacts and population abundance of rusty crayfish vary in lakes that appear similar, it is not possible to predict what will happen when they invade a new lake. Nevertheless, it is clear that rusty crayfish are an aggressive, unwanted exotic.

Cabin owners on heavily-infested northern Wisconsin and Minnesota lakes have even stopped swimming because large numbers of rusty crayfish occupy their favorite swimming area throughout the day. They fear stepping on them and getting pinched by the large-clawed "rustys." Other crayfish species, even if abundant, are usually less conspicuous during daylight hours.

control

Many chemicals kill crayfish. Some even selectively kill crayfish; however, none are currently registered for crayfish control (Bills and Marking 1988). And, none selectively kill rusty crayfish without killing other crayfish species. Intensive harvest will not eradicate or control crayfish, but may help reduce adult populations and minimize some impacts. Some researchers have suggested that nuisance populations of rusty crayfish are the result of poor fishery management and that by restoring a healthy population of bass and sunfish, rusty crayfish would be less disruptive in some lakes (Momot 1984). The best method of control; however, is to prevent their introduction. Educating anglers, crayfish trappers, bait dealers, and teachers about the threats posed by rusty crayfish will help reduce the risk of spreading rusty crayfish to new areas.

Should rusty crayfish be used to control Eurasian watermilfoil?

Eurasian watermilfoil is an exotic plant that forms dense mats and adversely affects swimming, boating and fishing. The use of one exotic species to control another is highly discouraged without proper long-term studies. Rusty crayfish, as well as other crayfish, cut plant stems as they feed. Much of the plant then floats away. Since Eurasian watermilfoil spreads and reproduces by plant fragmentation, crayfish could accelerate its spread. Also, Eurasian watermilfoil is more likely to establish itself in areas where rusty crayfish have disrupted the native plant community. In addition, if a suitable biological control for Eurasian watermilfoil is found, rusty crayfish could interfere with its effectiveness (through predation). Since there is no research into the effectiveness of using rusty crayfish for Eurasian watermilfoil control, and rusty crayfish usually do not become abundant in the lakes most susceptible to Eurasian watermilfoil, their introduction would not likely have the desired effects. No one should introduce this species into any waters.

identification

Identifying crayfish can be very difficult. Positive identification requires looking at a number of characteristics and having enough experience to interpret them. Here are some general, easily-observed characteristics that can be used to help you identify mature adults of four common crayfish species found in the Great Lakes region. (Other species found in the region include *Cambarus diogenes, Procambarus acutus acutus*, and in southern parts of the region *Procambarus clarki*). The following are general identification guidelines and should not be used when positive identification is needed. Contact your local fishery management agency or Minnesota Sea Grant (see address and telephone on last page) if positive identification is required.

Rusty crayfish can generally be identified by their more robust claws, which are larger than either *O. immunis'* or *O. virilis'*, and by the dark, rusty spots on each side of their carapace. The spots are located on the carapace as though you picked up the crayfish with paint on your forefinger and thumb (**Figure 4A**). The spots may not always be present or well developed on rusty crayfish from some waters.

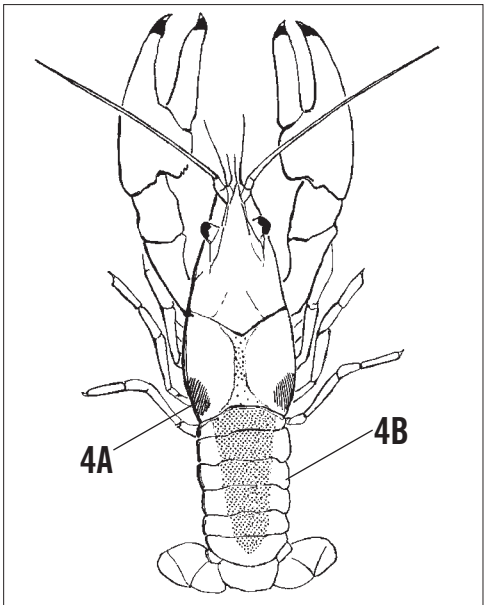


Figure 4. Composite drawing of *O. rusticus* and *O. propinquus*. **4A**: dark spot on carapace of *O. rusticus*. **4B**: dark patch and appearance of light colored stripe on abdomen of *O. propinquus*.

O. propinquus has a claw very similar to the rusty crayfish, but lacks the dark spots on each side of the carapace. Instead, *O. propinquus* has a dark brown to black patch on the top of the abdomen ("tail section"). This gives the impression that a light-colored stripe runs along each side of the abdomen (**Figure 4B**).

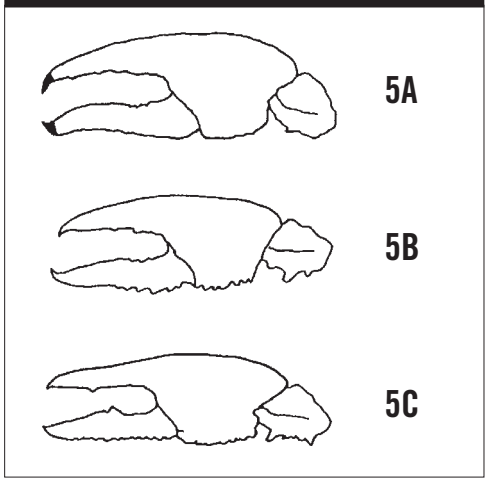
Compared to the rusty crayfish, *O. virilis* can often be distinguished by its claws, which are more blue and have distinct white, wart-like bumps. The rusty claw, by comparison, is grayish-green to reddish-brown and is smoother (**Figure 5**).

Figure 5. Claw shape can help distinguish between the various species.

5A: *O. rusticus-O. propinquus*
Black bands at claw tips. Oval gap when closed. Smooth, S-shaped, moveable claw.

5B: *O. virilis*
No black bands. Gap is a mere slit when claw is closed. White wart-like bumps on claw.

5C: *O. immunis*
No black bands. Gap is a definite notch. Claws are narrower and elongate.



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