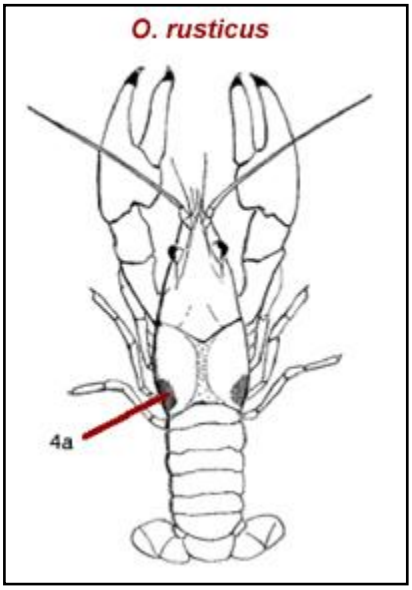
Rusty Crayfish Risk Analysis for Arizona

Name
Rusty crayfish (*Orconectes rusticus*)

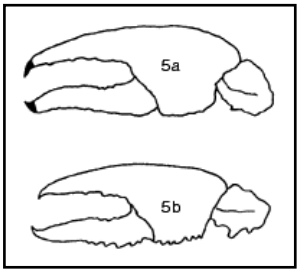
Source information on description, life history, reproductive strategy, preferred habitat, and known/potential impacts from: http://www.seagrant.umn.edu/ais/rustycrayfish_invader

Description
Identifying crayfish can be difficult. Positive identification requires looking at a number of characteristics and having enough experience to interpret them. Here are some general characteristics that you can use to help identify mature adults of rusty crayfish (*O. rusticus*) with northern crayfish (*O. virilis*)—a species that is widespread in North America, including introduced populations in Arizona.



Rusty crayfish can generally be identified by their more robust claws, which are larger than *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 (4a on figure to right). The spots may not always be present or well developed on rusty crayfish from some waters.

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



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

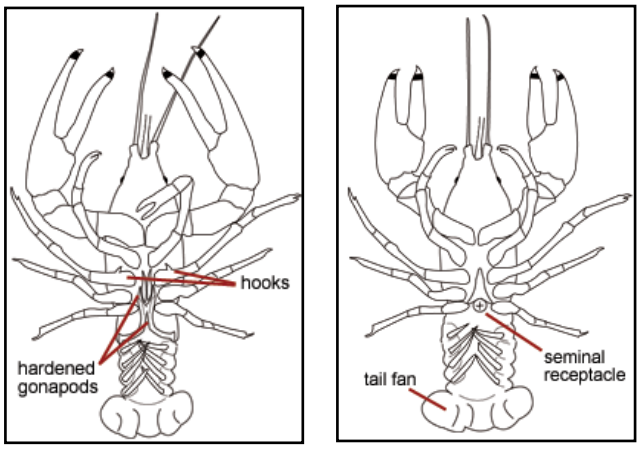
5b: *O. virilis* — No black bands. Gap is a mere slip when claw is closed. White wart-like bumps on claw.

Prepared by: J. Sorensen – July, 2010

Life History
Mature rusty crayfish mate in late summer, early fall, or early spring. Growth slows considerably after crayfish attain maturity. While mature males molt (shed their shells) twice per year, females usually only molt once. A typical rusty crayfish lives three to four years.

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 such as side-swimmers and waterfleas), detritus (decaying plants and animals, including associated bacteria and fungi), fish eggs, and small fish. Juveniles especially feed on benthic invertebrates like mayflies, stoneflies, midges, and side-swimmers.

Reproductive Strategy
The male (left figure below) transfers sperm to the female (right figure below). She stores the sperm until her eggs are ready to fertilize, typically in the spring (late April or May) as water temperatures begin to increase. 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 tail section, especially on the tail fan. These white patches are glair — a mucus-like substance secreted during egg fertilization and attachment. Rusty crayfish females lay from 80 to 575 eggs.



Left Figure: The underside of a Form I male crayfish shows one pair of legs with hooks (copulatory stylets) and hardened gonapods.

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

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 in the following year. Rusty crayfish reach maturity at a total length of one and three-eighths inches (3.5 cm) and reach a maximum length of about four inches (10 cm), not including claws. In Wisconsin collections (Hobbs and Jass 1988), they averaged two and one-half inches (6.4 cm).

It is important to note that it is not necessary to introduce 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 specimens, could produce offspring.

Growth slows considerably after crayfish attain maturity. While mature males molt (shed their shells) 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, 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.

Environmental Tolerances and Restrictions
Unknown. Rusty crayfish use similar habitat conditions that other native and non-native crayfish use, as evidenced by their widespread introduction and invasion beyond their native range of the Ohio River Valley. In the American Southwest, rusty crayfish are occupying aquatic habitats in northern New Mexico and the Yampa River Basin in northwest Colorado.

Preferred Habitat
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 debris, although there have been reports of more substantial burrows. Rusty crayfish need permanent lakes or streams that provide suitable water quality year-round.

Distribution
- **Native Range:** central-southern Indiana, central-southwestern Ohio, northern Kentucky
- **Expanded Range in United States:** New Mexico, Colorado, Wyoming, Oregon, Minnesota, Wisconsin, Iowa, Nebraska, Illinois, Michigan, Indiana, Ohio, Pennsylvania, New York, New Jersey, West Virginia, Virginia, Tennessee, North Carolina, South Carolina, Maryland, Connecticut, Maine
- **Expanded Range in Canada:** Ontario, Quebec

Current Status in Arizona
Presumed not present, but positive identification among known crayfish populations has not been conducted by Department staff, partner agencies, NGOs, or Scientific Collecting Permit investigators (few of which are proficient in identifying various species of crayfish).

Australian crayfish and all freshwater species within the crayfish families Astacidae, Cambaridae, and Parastacidae are already listed as Restricted Live Wildlife in Arizona, per R12-4-406.

Pathways
Crayfish will actively move into connected waterways, reservoirs, and ponds. Overland movement is possible during wet or high humidity conditions (such as at night, during or following rainy weather).

Crayfish experts identify illegal stockings and bait bucket dumping as likely translocation pathways to isolated or new habitats.

Rusty crayfish are also sold to schools by biological supply houses. Even though a warning not to release rusty crayfish into the wild accompanies these crayfish, 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. Larsen and Olden (2008) documented rusty crayfish being used as live classroom specimens in two schools in the State of Washington, during a study of potential pathways for crayfish invasions from schools and golf courses. This pathway is the most likely route for this species to enter Arizona.

Known/Potential Impacts

Rusty crayfish may cause a variety of negative environmental and economic impacts when introduced to new waters. This aggressive species (Capelli and Munjal 1982) often displaces native or existing crayfish species. Displacement of crayfish, such as *Orconectes virilis* and *Orconectes propinquus* has occurred in many northern Wisconsin lakes, northern Ontario, in the Kawartha Lakes region of southern Ontario (Capelli 1982; Hill and Lodge 1994; Lodge et al. 1986; Olsen et al. 1991; Olden et al. 2006), and in Ohio, *Orconectes sanbornii* has been displaced (Mather and Stein 1993).

Rusty crayfish displace other crayfish species through three primary mechanisms:

1. Crayfish-to-crayfish competition: (Hill and Lodge 1994; Garvey et al. 1994). Rusty crayfish are better able to exclude other crayfish from shelters and better able to compete for limited food resources.
2. Increased fish predation: (DiDonato and Lodge 1994; Garvey et al. 1994; Hill and Lodge 1993; Roth and Kitchell 2005). Rusty crayfish can increase fish predation on native crayfish in a variety of ways. They force native species from the best hiding places. As the native crayfish try to swim away from a fish or rusty crayfish attack, this makes them more vulnerable to capture by fish. Rusty crayfish, on the other hand, assume a claws-up defensive posture that reduces their susceptibility to fish predation. Also, rusty crayfish are larger and have larger claws than most native species, which results in fish preying upon native species over rusty crayfish.
3. Hybridization: (Perry et al. 2001a,b). Rusty crayfish do not hybridize with *Orconectes virilis*.

The destruction of aquatic plant beds is perhaps the most serious impact. Rusty crayfish have been shown to reduce aquatic plant abundance and species diversity (Lodge and Lorman 1987; Olsen et al. 1991, Wilson et al. 2004). 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 often from predators–and therefore feed longer (Stein 1977)–attaining high population densities. Estimates suggest that a rusty crayfish might consume twice as much food as similar-sized *O. virilis* because of its higher metabolic rate (Momot 1992). Rusty crayfish are more likely to compete with juvenile game fish and forage fish species for benthic invertebrates than are native crayfish species. Displacement of native crayfish by rusty crayfish could result in less food for fish. Crayfish are eaten by fish, but because of the higher ratio 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.

Rusty crayfish can harm fish populations by eating fish eggs (Horns and Magnuson 1981), reducing invertebrate prey, and through loss of habitat (aquatic plants). Male bass and sunfish protect their nests until the eggs hatch and the advanced fry swim away. University of Wisconsin-Superior fishery scientist Bill Swenson (pers. comm. 2008), has observed rusty crayfish attacking bluegill nests guarded by males. He also observed rusty crayfish in other unguarded nests. He did not know, however, if rusty crayfish caused the bluegills to abandon their nests. It has also been reported that pumpkinseed sunfish do a poor job of defending their eggs from rusty crayfish, especially at night (Wilson et al. 2004). A long-term study showed that fish species that compete for prey with rusty crayfish (like bluegills and pumpkinseeds) decline over time after rusty crayfish invade (Wilson et al. 2004). It was also found that total zoobenthos, larval midges, mayflies, dragonflies, and stoneflies decline as rusty crayfish populations increase (McCarthy et al. 2006).

Walleye reproduction dropped after rusty crayfish invaded Lake Metonga, Wisconsin (Lodge et al. 1985); however, rusty crayfish have not seemed to damage walleye reproduction in most of the Wisconsin lakes they have invaded. Perhaps the lower quality walleye spawning substrate in Lake Metonga compared to other lakes invaded by rusty crayfish allowed the impact on walleye reproduction.

Observations and circumstantial evidence gathered by Wisconsin fishery managers suggest that bluegill and northern pike populations frequently decline following the introduction of rusty crayfish (Harland Carlson and Chris Sand, Wisconsin DNR, pers. 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, pers. comm. 1994). Impacts on other fish species are not as obvious. The cause of bluegill, bass, and northern pike declines is probably reduced abundance and diversity of aquatic plants. Reduced food (such as mayflies, midges, and stoneflies) 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.

Many chemicals kill crayfish and some are even selective for 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 crayfish, but may help reduce adult populations and minimize some impacts. Researchers suggest 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). Recent research seems to support this; a combination of intensive trapping and enhanced fish predation, through regulations that protected smallmouth bass, effectively controlled rusty crayfish in Sparkling Lake, Wisconsin (Hein et al. 2006 and Hein et al. 2007). This whole-lake experiment found that aquatic plants, benthic invertebrates and sunfish increased as a result of rusty crayfish population decreases. Another extensive and successful effort to eradicate rusty crayfish was conducted in Wyoming in 2006-2008 following illegal transport and stockings onto private land. Appendix A provides details on this effort and the reimbursement costs sought by the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service as a violation of the Lacey Act.

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.

Rusty crayfish should not be used to manage Eurasian watermilfoil (*Myriophyllum spicatum*)—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, rusty crayfish could interfere with the effectiveness of control with the freshwater weevil *Euhrychiopsis lecontei* (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.

Benefits

The harvest of rusty crayfish for food and bait may provide the only beneficial use for this exotic.

Effective Treatments

Based on research and recommendations in the U.S. Forest Service Technical Guidelines for AIS Prevention 11-08 document, the following treatment methods are effective at killing crayfish when cleaning equipment from infected waters:

- Direct exposure to ≥140°F wash water
- Dry in direct sunlight for 3 hours
- Exposed to a 20% cleaning solution of bleach sodium hypochlorite (22 oz bleach/1 gallon water) for a minimum of 30 seconds

Note: quaternary ammonia solutions may be effective, but no data was available.

Recommendation

Through Arizona Game and Fish Department Directors Order {A.R.S. §17-255.01(B)}, list rusty crayfish (*Orconectes rusticus*) as an aquatic invasive species in Arizona, with subsequent affected waters listing and mandatory conditions for movement.

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Document revised 8/3/2010

Appendix A. Wyoming Game and Fish Department – news release January 30, 2008:

ILLEGAL CRAYFISH INTRODUCTION COSTS COLORADO COMPANY $100,000

CASPER –The owner of a Colorado company must pay $100,000 in fines and restitution for illegally transporting rusty crayfish into Wyoming, a U.S. District Court judge ruled on Monday.

Thirty-four-year-old Shannon Skelton, owner of Fort Collins, Colorado-based Colorado Fisheries, Inc., a company that creates fish habitats and sells trophy-quality fish to high-end ranches and fishing lodges, pleaded guilty to one count of unlawful transportation of illegally possessed wildlife, a violation of the Lacey Act. Skelton and Colorado Fisheries, Inc. must jointly pay $40,000 in fines for the Lacey Act violation, and $60,000 in restitution to the Wyoming Game and Fish Department. The restitution will pay for expenses incurred to eradicate the illegal crayfish. Chapter 10 of the Wyoming Game and Fish Commission Regulations prohibits the importation of rusty crayfish into the state.

The Lacey Act, 16 U.S.C. §§ 3371-3378, protects both plants and wildlife by creating civil and criminal penalties for a wide array of violations. Most notably, the Act prohibits trade in wildlife, fish, and plants that have been illegally taken, possessed, transported or sold. Thus, the Act underscores other federal, state, and foreign laws protecting wildlife by making it a separate offense to take, possess, transport, or sell wildlife that has been taken in violation of those laws. A violation of the Lacey Act automatically results in a federal case. This case was prosecuted in cooperation with the U.S. Attorney's Office and the U.S. Fish and Wildlife Service.

The case is centered around the illegal importation of rusty crayfish as a forage base for fish in ponds on three private ranches in Wyoming. In May of 2006, a ranch owner who had previously contracted with Colorado Fisheries, Inc. contacted Game and Fish for a permit to move some crayfish from one pond to another on a private ranch near Douglas. Fish biologists requested the identification of the crayfish prior to any movement between the ponds. Upon investigation, biologists identified the prohibited rusty crayfish; a species not previously found in Wyoming. Game and Fish determined that the ranch was unknowingly the victim of illegally stocked crayfish through its dealings with Colorado Fisheries, Inc. Biologists also discovered rusty crayfish had entered a tributary of the North Platte River. Eradication efforts began immediately to remove the unwanted crayfish.

Rusty crayfish (*Orconectes rusticus)* measures two and one-half inches in length (not including claws). They have dark, rusty spots on each side of their carapace (outer body shell). Their claws are grayish-green to reddish-brown and are smoother than most other crayfish. Rusty crayfish can cause a variety of negative environmental and economic impacts when introduced to new waters. They are an aggressive species that often displace native or existing crayfish species. Invading rusty crayfish also reduce the amount and kinds of aquatic plants and invertebrates, and reduce some fish populations. "Rusty crayfish are very aggressive and very prolific," said Al Conder, regional fishery supervisor for the Casper Game and Fish office. "If this species establishes in our waters we could potentially see a loss of our native crayfish species and severe impacts to other aquatic species."

Perhaps the most serious impact from rusty crayfish is the destruction of aquatic plant beds. Rusty crayfish have been shown to reduce aquatic plant abundance and species diversity. Submerged aquatic plants are important 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. "Illegal introductions are the most serious violations in terms of damage to aquatic resources and fishing opportunity," said Mike Stone, chief of fisheries for the Wyoming Game and Fish Department.

To date, Game and Fish has spent $34,424.81 to remove the crayfish from several ponds and a portion of one stream. Additional expenses will be incurred for monitoring the site and any subsequent eradication efforts.

"We're very fortunate that we had the opportunity to get there early and control it," Conder said. "Had we not got there early they would be downstream in the North Platte drainage and upstream toward Casper. If they had made it to the North Platte River we could not have controlled them."

The Game and Fish Department will continue its efforts to prevent the introduction and/or spread of unwanted species in the state. "This case should show the residents of Wyoming that we take the illegal importation of injurious species very serious," said Mike Ehlebracht, Investigative Unit Supervisor for the Game and Fish Department.

- WGFD -