State of Michigan's

Status and Strategy for Rusty Crayfish Management

Scope

The invasive rusty crayfish (*Orconectes rusticus*) threatens the State of Michigan's waterways. The goals of this document are to:

- Summarize current level of understanding on the biology and ecology of the rusty crayfish.
- Summarize current management options for the rusty crayfish in Michigan.
- Identify possible future directions of rusty crayfish management in Michigan.

Biology and Ecology

I. Identification

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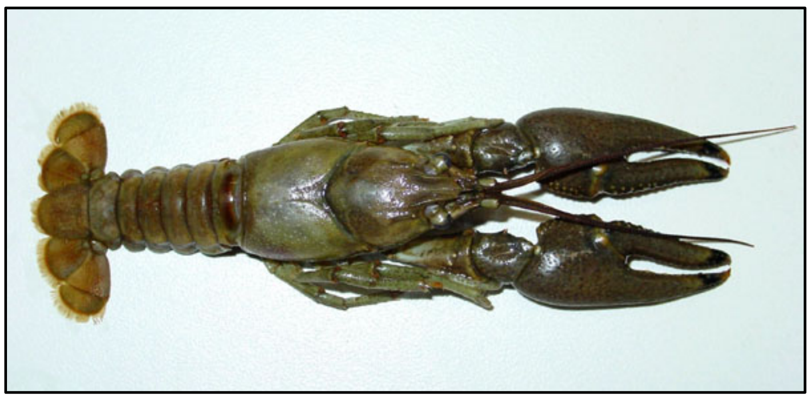

The freshwater crustacean known as the rusty crayfish can be difficult to identify and can be confused for other common crayfish species found in the Great Lakes Region. One distinguishing characteristic is the rusty crayfish's claws, which are larger, more robust claws when compared to other crayfish, such as the papershell (*O. immunis*) and the northern crayfish (*O. virilis*) (Gunderson 1998). Furthermore, the rusty crayfish has smooth, grayish-green to reddish-brown claws; this is unlike the northern crayfish, which has blue colored claws with white bumps (Gunderson 1998). The dark, rusty spots on each side of the rusty crayfish's carapace are a distinguishing characteristic, even though these spots are absent or not as distinct on individuals from some waters (Gunderson 1998). Rusty crayfish also have a rust-colored band down the center of the back side of the abdomen, black bands at the tips of their claws, and a gap in their claws when closed (Wetzel et al. 2004). While they share similar claws, the northern clearwater crayfish (*O. propinquus*) has a dark brown/black patch on the top of the tail section and lack the rusty crayfish's side carapace spots (Gunderson 1998). The golden crayfish (*O. luteus*) can be distinguished by its light olive green appearance as opposed to the rusty crayfish's tan color (Wetzel et al. 2004).

II. Life History

Mating occurs in late summer, early fall, or early spring; females carry male-transferred sperm until eggs mature, and external fertilization occurs (Gunderson 1998). At this time, the female secretes a white mucus-like substance called glair that attaches the 80 to 575 eggs to the swimmerets on the underside of her abdomen (Gunderson 1998). Water temperature determines hatching time, which varies from 3 to 6 weeks (Gunderson 1998). Newly hatched crayfish may continue to cleave to the female's swimmerets for 3 to 4 molts. The young linger with the female for protection for about 2 weeks (Lodge et al. 1985). Juveniles tend to grow faster than juveniles of other crayfish species (Lodge et al. 1985). Rusty crayfish reach maturity within 1 to 2 years (after 8 to 10 molts) and usually live 3 to 4 years old. At maturity, they measure 1.375 to 4 inches excluding claws, which add approximately 2 inches (Lodge et al. 1985). Males of the same age are usually larger than the females because they molt twice a year instead of once (Gunderson 1998). Females molt after their young are released and males molt into a sexually inactive form in the spring and sexually active form in the summer (Gunderson 1998). When sexually active, males have large claws used to pin down females during copulation, a hook on one pair of the legs for grasping females, and hardened gonapods (Berrill and Arsenault 1984, Gunderson 1998). Populations of rusty crayfish can reach higher densities than compared to other crayfish (Lodge et al. 1985).

III. Diet

Both juvenile and adult rusty crayfish are omnivorous (Gunderson 1998). Juvenile rusty crayfish principally feed on benthic invertebrates such as mayflies, stoneflies, midges, and side-swimmers (Gunderson 1998). Adult crayfish are opportunistic and also consume benthic invertebrates like aquatic worms, waterfleas, clams, and snails (Lodge and Lorman 1987, Hanson et al. 1990, Momot 1992). In addition to benthic invertebrates, adults will eat macrophytes, detritus, small fish, and fish eggs (Lorman 1980, Gunderson 1998).

IV. Habitat

Native to the Ohio River Basin, rusty crayfish need suitable water quality from lotic and lentic environments year-round (Charlebois and Lamberti 1996, Gunderson 1998, Peters et al. 2008, GISD 2010). They live in lakes, ponds, and streams with beds of clay, silt, gravel, or rock that provide natural cover such as logs and other debris (Gunderson 1998). Areas with cobble and carbonate substrates are likely inhabited by rusty crayfish while gravel substrates and woody debris are sometimes utilized (Kershner and Lodge 1995, Flynn and Hobbs 1984, Taylor and Redmer 1996, Gunderson 2008). Within its native range, rusty crayfish can withstand seasonal water temperatures ranging from freezing to over 100°F, but prefer 68-77°F temperatures in well oxygenated, clear water (Capelli 1982, Mundahl and Benton 1990). Rusty crayfish are usually found at depths of less than a meter, but in Lake Michigan, have been collected in much deeper waters (Taylor and Redmer 1996).

V. Effects from Rusty Crayfish

Rusty crayfish have most likely spread from their native ranges by anglers who use them as bait. Populations are harvested as regional bait, for biological supply companies, and for food; these activities likely extend the reach of the species. Invading rusty crayfish have been known to displace native crayfish, decrease the composition and abundance of aquatic plants and invertebrates, and reduce fish populations (Gunderson 1998).

The aggressive rusty crayfish have been known to displace *O. virilis* and *O. propinquus* in many northern Wisconsin lakes and Ontario (Capelli 1982, Hill and Lodge 1994, Lodge et al. 1986, Olsen et al. 1991, Olden et al. 2006). In Ohio, Sanborn's crayfish (*O. sanbornii*) has been displaced (Mather and Stein 1993). Rusty crayfish outcompete other crayfish for shelter and limited food resources (Hill and Lodge 1994, Garvey et al. 1994). Rusty crayfish are less likely to be preyed upon by fish because they force native crayfish from hiding places and are generally larger than native individuals. Rusty crayfish also assume a claws-up defense posture instead of swimming away, making them less vulnerable to fish (DiDonato and Lodge 1994, Garvey et al. 1994, Hill and Lodge 1993, Roth and Kitchell 2005). Rusty crayfish hybridize with *O. propinquus* and this eventually results in the decline of *O. propinquus*; the competitive advantages of the hybrids genetically exclude pure *O. propinquus* faster than what would occur without hybridization (Perry et al. 2001a,b). Rusty crayfish can also hybridize with the spinycheek crayfish (*O. limosus*), but not with *O. virillis* (Smith 1981, Perry et al. 2001a,b).

Rusty crayfish have higher metabolic rates and appetites when compared to other crayfish and can cause significant reductions in an environment's aquatic plant composition and abundance (Jones and Momot 1983, Lodge and Lorman 1987, Olsen et al. 1991, Wilson et al. 2004). Rusty crayfish cut plant stems as they feed and disrupt the native plant community, accelerating the spread of Eurasian watermilfoil (*Myriophyllum spicatum*), which reproduces by plant fragmentation (Gunderson 1998). Areas with already low abundance of aquatic plants would be impacted the most since rusty crayfish invasion could deplete habitat for invertebrates, diminish fish shelter and nesting substrate, and lead to erosion problems (Gunderson 1998). Rusty crayfish compete with juvenile game and forage fish species for benthic invertebrates as a food source, which could lead to a reduction in fish survival (Gunderson 1998). Growing populations of rusty crayfish result in the reduced abundance of zoobenthos, larval midges, mayflies, dragonflies, and stoneflies as well as the decline of fish species, like bluegills, which compete for the same prey (Wilson et al. 2004, McCarthy et al. 2006). Bass and northern pike are also frequently impacted by rusty crayfish invasion (Gunderson 1998). Egg predation may play a role in the reduction of fish species in some situations (Gunderson 1998). Rusty crayfish reduce the abundance and richness of snails where invaded as well (Lodge et al. 1994).

Current status and distribution in Michigan

Native to the Ohio River Basin in Indiana, Ohio, Kentucky, and southern Michigan, rusty crayfish have invaded many other states and are believed to be established in all Great Lakes (Lodge et al. 2000**,** GISD 2010, Figure 1). Rusty crayfish have expanded rapidly in Wisconsin after their introduction to the state around 1960 (Capelli and Magnuson 1983). Natural dispersal of introduced rusty crayfish in Wisconsin could have resulted in some populations found in Minnesota, where the species was first observed in 1967 (Gunderson 1998). It is illegal in both Wisconsin and Minnesota to introduce rusty crayfish into any waters and sell live crayfish as bait or pets (Gunderson 1998). Michigan law (NREPA Part 413) prohibits the rearing, sale and possession rusty crayfish as bait or pets in Michigan (Peters and Lodge 2009). According to the United States Geological Survey (USGS), rusty crayfish have been found in the middle branch of the Ontonagon River, Cedarville Bay, Mismer Bay, Brule River, Munuscong River, St. Mary's River and Lake Huron (Figure 2). The State of Michigan fishery database also documents rusty crayfish in Wolf, Little Wolf, Rice, Wright, Deer, Milligan and Stony Creeks, Salt, St. Joseph, Van Etten, Pigeon, Boardman, Thunder Bay and Brule Rivers, and Houghton, Long, Blue, Benway, Budd, Starvation and McCollum Lakes (Figure 2). The species has also been found in Lake Leelanau, Bellaire, Lancer and Clark Hills Impoundment (Figure 2).

Management of Rusty Crayfish

Efforts in Michigan should be focused on preventing rusty crayfish introductions from spreading to inland water bodies. For established rusty crayfish populations already present in Michigan and for those populations that may become established, measures to extirpate or reduce the population in order to promote native species need to be taken. An integrated management framework, likely using a combination of management methods to minimize damages while keeping rusty crayfish at insignificant levels, should be adopted (Hart et al. 2000).

I. Prevention

Prevention of accidental or deliberate introductions of rusty crayfish and further establishment of the current rusty crayfish populations should be top priority. Given the lack of environmentally sound ways to eradicate populations of rusty crayfish, prevention and population mitigation efforts are key. Monitoring fishing areas, boat docks, etc. could be effective in preventing the use of rusty crayfish as bait around the state (Keller et al. 2008). To help reduce the risk of spread in Michigan, more educational outreach could be given to citizens about the threats of rusty crayfish invasion (Olden et al. 2006). Great Lake jurisdictions should be a united front in delivering regulatory consistency in order to be truly effective in slowing the spread of rusty crayfish (Peters and Lodge 2009).

II. Management/Control

a. Physical

While it will not eradicate rusty crayfish from Michigan, intensive harvest of rusty crayfish could reduce adult populations and minimize the effects. Baited traps are efficient when harvesting; rusty crayfish can quickly detect carrion odors in slow currents attracting them to the traps (Byron and Wilson 2001). Manual removal of crayfish has been attempted, but neighboring crayfish were startled while collecting individuals, therefore manual harvest is not a recommended method (Byron and Wilson 2001). Frequent emptying of traps will increase capture rates since previously captured crayfish prevent other crayfish from entering the trap (Ogle and Kret 2011). Restoring or bolstering fish predators along with trapping efforts have been effective means to reduce negative impacts of rusty crayfish (Hein et al. 2006, Hein et al. 2007). For example, restrictions on the harvest of fish species known to prey on rusty crayfish (i.e. largemouth bass) have resulted in increased crayfish predation. However, fish predation is not specific to rusty crayfish and could further reduce native crayfish populations.

Electrofishing can remove a moderate amount of crayfish but is limited to relatively shallow non-turbid waters and some crayfish may still be able to escape capture under large rocks and deep burrows (Gherardi et al. 2011). Physical barriers and electric fences could be used, but may impact aquatic plant restoration (Peters et al. 2008). Draining of small water bodies and channels has been attempted, but showed limited success when used alone. Combination of drainage used with chemical treatments (i.e. applying biocides to exposed burrows) may increase efficacy of drainage treatments.

b. Chemical

Known chemicals that kill rusty crayfish are not selective and impact other crayfish (Gunderson 2008). A synthetic pyrethroid, Baythroid, has proven most selective for crayfish in laboratory tests and was most effective at concentrations of 25mu g/L for completely killing crayfish in an environment (Bills and Marking 1992). Sub-lethal concentrations of metolachlor at 80ppb could interfere with the ability of the rusty crayfish to receive or respond to social signals (Cook and Moore 2008). Other possible chemicals include but are not limited to: Baytex PM 40, BETAMAX VET, Pyblast, and Rotenone. Pyblast in particular is cost effective and methodically simple to apply; it also brakes down quickly, has low toxicity to mammals and birds, has no toxic residues, and produces high mortality rates (Gherardi et al. 2011). However, Pyblast is toxic to fish and other crustacean, making isolation of treated waters a requirement before treatment can take place. Pyblast used on invasive red swamp crayfish showed 90% mortality at concentrations of 0.05 mg/L 12 hours after treatment and 95% by 72; laboratory tests showed 100% mortality (Cecchinelli 2012). Research may be needed to determine effective concentrations for rusty crayfish. BETAMAX VET showed similar results as Pyblast; it also has low toxicity to humans and birds, short persistence, and high toxicity to fish and crustaceans (Sandodden and Johnsen 2009). However, BETAMAX VET may be more expensive than Pyblast and higher concentrations could be required. Pyblast and BETAMAX VET are both pyrethroids.

Future Directions for Michigan and Rusty Crayfish Management

With the lack of current management options available, prevention is the most effective approach in mitigating the impacts of rusty crayfish and should be top priority for Michigan. A prevention strategy that identifies and targets areas most at risk to invasion should be the first goal when moving forward. A cohesive monitoring and reporting system for the public and management agencies needs to be established and reinforced. This will increase knowledge of aquatic invasive species locations and possibly enable early detection responses to new occurrences. There are critical knowledge gaps in which scientific research is warranted. Environmentally sound methods to control invasive rusty crayfish are in desperate need of development in order to effectively eradicate the species from infested areas. Once treatments are developed and employed, monitoring of treated sites should be in place to ensure treatments were successful.

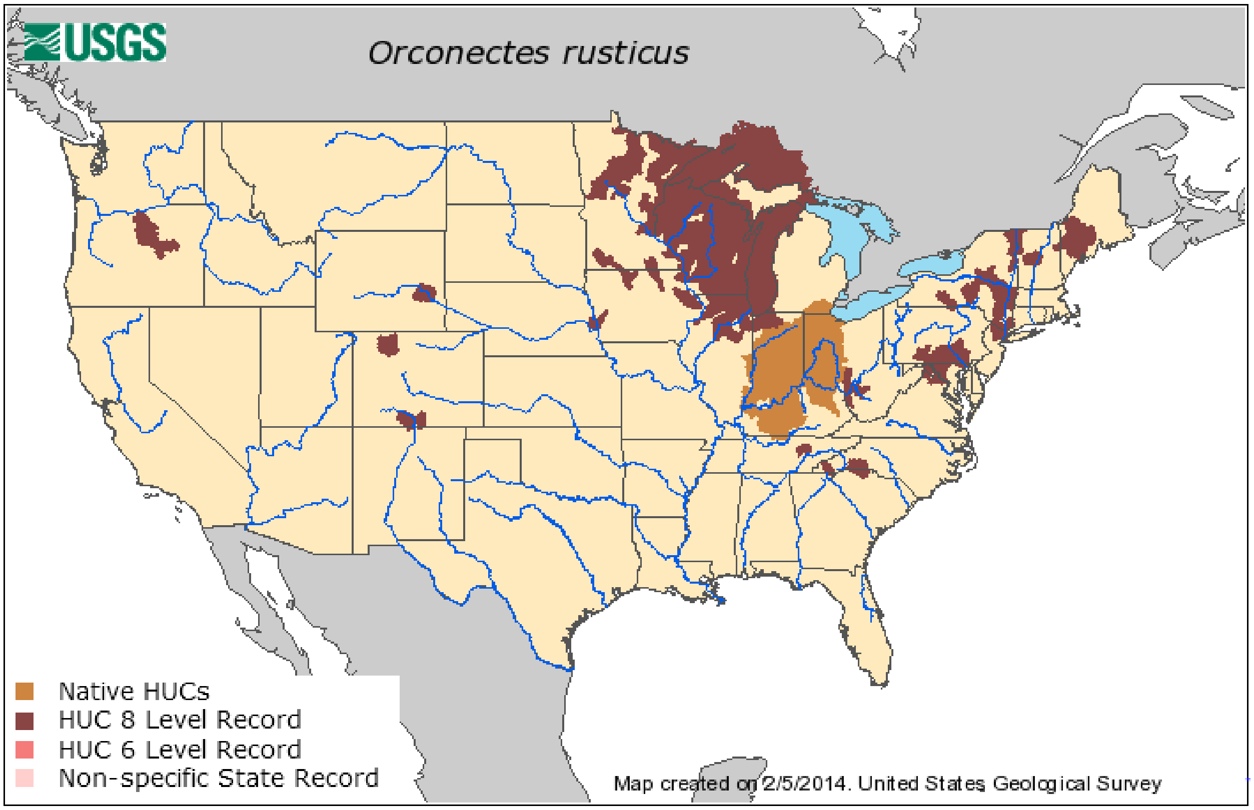

Figure 1. Distribution of rusty crayfish in the United States (USGS 2014). Accessed February 25, 2014.

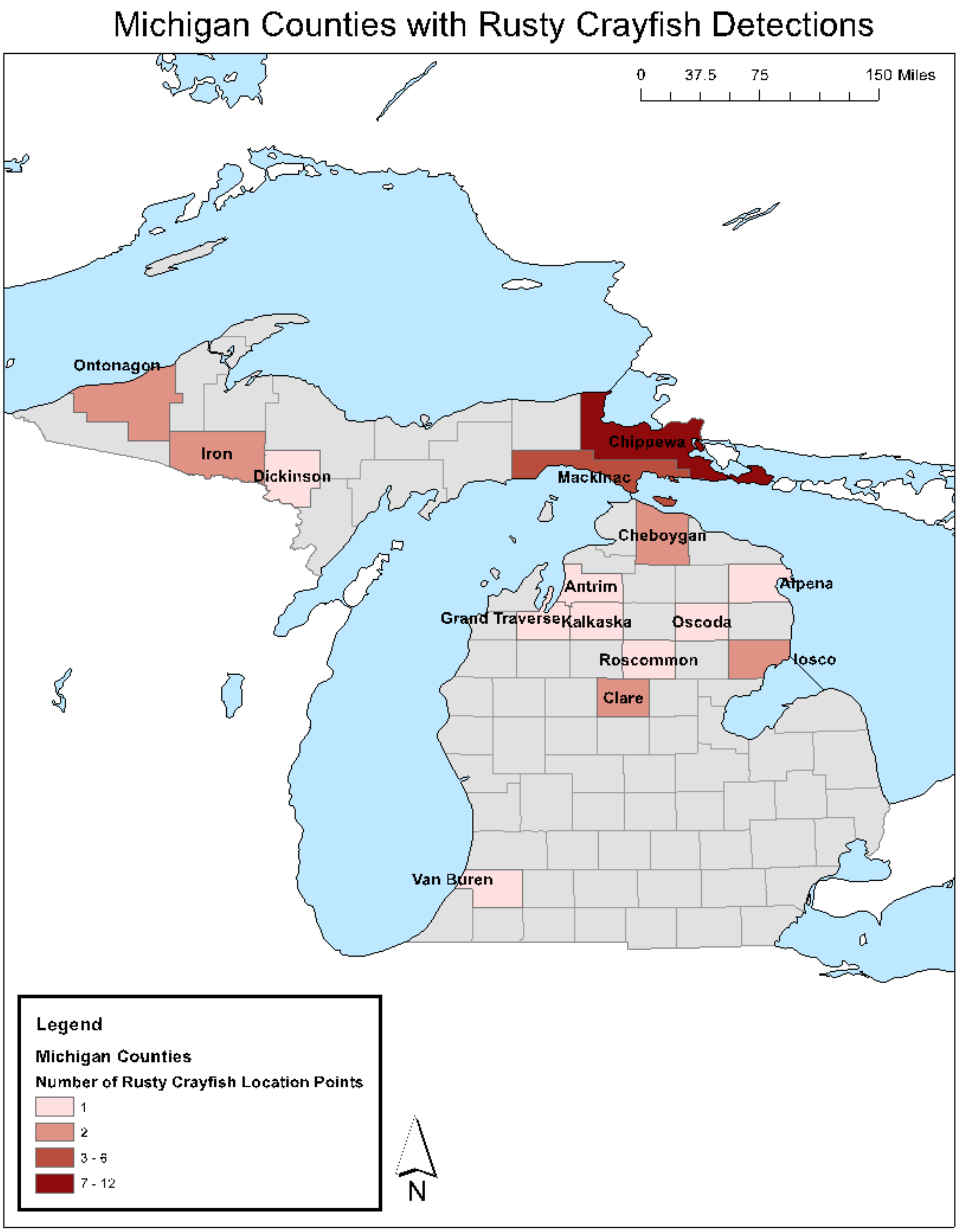

Figure 2. Number of unique coordinate location points within Michigan counties at which rusty crayfish were detected. This data is according to the United States Geological Survey (USGS), Midwest Invasive Species Information Network (MISIN), Biodiversity Information Serving Our Nation (BISON), and the State of Michigan fishery databases.

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