Rusty Crayfish (*Orconectes rusticus*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, February 2011
Revised September 2014
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Photo: © Amy Benson - USGS

1 Native Range, and Status in the United States

Native Range
From Conard et al. (2015):

"Ohio River basin, spanning tributaries in Western Ohio, Indiana, Kentucky, and Northern Tennessee; cryptogenic in Lake Erie (Creaser 1931, Hobbs 1974, Momot et al. 1978, Page 1985, Hobbs et al. 1989, Taylor 2000)"

Status in the United States
From Conard et al. (2015):

"*Orconectes rusticus* has been collected in 20 states beyond its native range spanning the entire US, including Colorado, Connecticut (Titicus River), Illinois (Illinois River at Peoria and Peoria Lake; Taylor and Redmer 1996, Page 1985), Indiana (upper West Fork White River near Muncie; dominant in tributaries extending from the Ohio state line west to Indianapolis, including Whitewater and Maumee River basins; Simon et al. 2005), Iowa, Maine (Adroscoggin

and Kennebec drainages), Maryland (Conowingo Creek, Cecil County; upper portion of Monocacy River, Frederick County), Massachusetts, Michigan, Minnesota (Carlton, Cook, Itasca, Lake, Pine, and St. Louis counties; Gunderson 2008; D. Jenson, MN Sea Grant, pers. comm.), Nebraska (Lakeside Lake, Omaha, Douglas County, J. Katt, pers. comm.), New Hampshire, New Jersey, New York (Hudson River drainage; Mohawk watershed; Otsego Lake; Harman 1976, Phillips 1977, Crocker 1979, Daniels 1998 , Kuhlmann and Hazelton 2007), North Carolina, Oregon (Dixon Creek, Benton County; John Day River, Grant County; Olden et al. 2009), Pennsylvania, Vermont, West Virginia (Kanawha River), Wisconsin (Amnicon River, G. Czypinski, pers. comm.; Big Lake, Villas County, Capelli and Magnuson 1983), and Wyoming (eradicated after found to have been illegally stocked; Wyoming Game and Fish Dept., press release)."

Means of Introductions in the United States

From Conard et al. (2015):

"Angler bait bucket emptying is thought to be the primary cause of introduction and species spread (Berrill 1978, Crocker 1979, Butler and Stein 1985, Lodge et al. 1986, Hobbs et at. 1989, Lodge et al. 1994, Kerr et al. 2005). The rusty crayfish is also commonly sold to schools and biological supply houses, leading to the potential for uninformed release into the wild (Gunderson 2008). Intentional release into water bodies by commercial crayfish harvesters is another suspected cause of its range expansion (Wilson et al. 2004). A further mechanism of human facilitated introduction is the intentional establishment of this species in lakes as a means of removing nuisance weeds (Magnuson et al. 1975)."

Remarks

From Conard et al. (2015):

"Found in streams, lakes, and ponds with varying substrates from silt to rock and plenty of debris for cover; needs permanent water, they generally do not burrow to escape dry periods. Breeding occurs in the fall and eggs laid the following spring, hatching within several weeks. The introduction of one female carrying viable sperm could start a new population."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2014):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Protostomia
Superphylum Ecdysozoa
Phylum Arthropoda
Subphylum Crustacea
Class Malacostraca
Subclass Eumalacostraca

Superorder Eucarida
Order Decapoda
Suborder Pleocyemata
Infraorder Astacidea
Superfamily Astacoidea
Family Cambaridae
Subfamily Cambarinae
Genus Orconectes
Subgenus Orconectes (Procericambarus)
Species *Orconectes rusticus*

Taxonomic Status: Valid"

Size, Weight, and Age Range

From ANSIS (2011):

"Reach a maximum size of roughly 4 inches from head to tail plus about another 2 inches for the length of their chelae (claws) [Lodge et al. 1985]"

"Reach maturity after about 1 year [Lodge et al. 1985]"

Environment

From ANSIS (2011):

"Prefer cobble habitat, which allows them to hide if necessary [Hill and Lodge 1994, Taylor and Redmer 1996]. Found in both lotic (running water; streams, rivers) and lentic (standing water; lakes) environments [Taylor and Redmer 1996]. Show a tendency to favor clear water [Capelli 1982]. Usually found at water depths of less than 1 m, although in Lake Michigan they have been collected at a depth of 14.6 m [Taylor and Redmer 1996]. Adults prefer deeper (>20 cm) pool areas, juveniles normally occupy shallow (<15 cm) areas bordering stream edges [Butler and Stein 1985, Mundahl and Benton 1990]."

Climate/Range

From ANSIS (2011):

"Prefer temperatures between 20 °C and 25 °C [Mundahl and Benton 1990]. In native range, specifically Ohio, they may be seasonally exposed to water temperatures ranging from near 0° C to 39° C [Mundahl and Benton 1990]. Adults can force juveniles into warmer waters, causing them to often be found in water 1.5° C to 6.8° C warmer than adults [Mundahl and Benton 1990]. At temperatures >30° C adults have been observed digging burrows in sand and gravel beneath rocks near the shore to escape the heat [Mundahl 1989]."

Distribution Outside the United States

Native
This species is not native outside the United States.

Introduced
From Maezo et al. (2010):

"The rusty crayfish is native to the Ohio River basin but its use as live bait has permitted it to colonize up to 20 states in the United States as well as the Canadian provinces of Ontario and Quebec (Hobbs and Jass 1988; Taylor and Redmer 1996; Dubé and Desroches 2007)."

From Fetzner (2015):

"Now known from Falcon Lake, MB according to 2007 report by Manitoba Water Stewardship."

Means of Introduction Outside the United States
From ANSIS (2011):

"Escaped or released from anglers using them as bait [Byron and Wilson 2001, Taylor and Redmer 1996]."

Short description
From ANSIS (2011):

"Prominent rusty-colored spot on each side of the carapace. Rust-colored band down the center of the back side of the abdomen. Overall tan color, especially on legs. Tips of claws have black bands. Oval gap on claws when closed [Wetzel et al. 2004]."

Biology
From ANSIS (2011):

"Larger and more aggressive than most similar species. Better competitor for food and habitat than similar species [Byron and Wilson 2001]. Adult males molt at least twice a year, some populations can reach higher densities (up to 13 adults per square yard) than those of similar species [Berrill and Arsenault 1984, Lodge et al. 1985]."

"Juveniles are omnivorous and have similar diets to adults, but tend to feed on benthic invertebrates more often than adults (Hanson et al. 1990, Momot 1992). Adults are omnivorous and their diets include macrophytes (large submersed algae particles), invertebrates, and periphyton (algae and microbes attached to objects submersed in water) (Lorman 1980). Of the invertebrates, snails are especially targeted as food (Lodge and Lorman 1987)."

Human uses

From Conard et al. (2015):

"This species may have value as a recreational bait species in the Great Lakes. The rusty crayfish is also commonly sold to schools and biological supply houses (Gunderson 2008)."

"This species has been intentionally established in some lakes as a means of removing nuisance weeds (Magnuson et al. 1975). It has been shown to effectively control weeds in many northern Wisconsin lakes (Magnuson et al. 1975, Lorman and Magnuson 1978, Capelli 1982)."

Diseases

There are no known OIE reportable diseases listed for this species.

Threat to humans

From Conard et al. (2015):

"*Orconectes rusticus* has the ability to cause a reduction in many native fish populations, creating a variety of negative socio-economic impacts … While an official study has not yet been conducted, personal observations of fisheries managers have suggested frequent decline of bluegill, northern pike, and bass populations following the introduction of rusty crayfish."

"Due to its conspicuousness during daylight hours relative to native crayfish species, *O. rusticus* has resulted in a decline in recreational swimming in areas where present, as swimmers fear stepping on it and being pinched by its large claws (Gunderson 2008)."

From GISD (2010):

"*O. rusticus* introduction is also believed to reduced sport fish populations especially pan-fish *Lepomis macrochirus* and *L. gibbossus* by either egg predation or competition with juveniles. Researchers have calculated fisheries damages of *O. rusticus* in Vilas County, Wisconsin to be about 1.5 million annually (Keller et al, 2008)."

3 Impacts of Introductions

From Olden et al. (2006):

"The rusty crayfish *O. rusticus*, is one of the most well-known non-indigenous crayfish species, having been identified as extirpating native crayfish species and disrupting local ecosystems. Over the past 40-50 years, rusty crayfish have spread from its historical range in the Ohio River drainage (U.S.A), to waters throughout much Illinois, Michigan, Wisconsin, and Minnesota and parts of 11 other states, Ontario (Canada) and the Laurentian Great Lakes. Rusty crayfish has successfully invaded the entire state of Wisconsin and now constitutes a significant component of the crayfish fauna. Long-term occurrence records from 1870 to 2004 show that (1) rusty crayfish occurrences have increased from 7% of all crayfish records collected during the first 20 years of their invasion (1965–1984) to 36% of all records during the last 20 years, and (2) rusty crayfish have replaced the northern clearwater crayfish (*O. propinquus*) and virile crayfish (*O. virilis*) as the most dominant member of the contemporary crayfish fauna."

From GISD (2010):

"*Orconectes rusticus* has a range of ecological impacts on introduced environments that include competition and displacement of native crayfish, increased predation on snails, native and threatened bivalves, reduction of macrophyte abundance, reduction of sport-fish abundance, reduction of macroinvertebrate abundance, increases in periphyton activity, and other cascading trophic interactions. The wide range of impacts associated with *O. rusticus*, its aggressive nature, rapid expansion rates, dense populations, and ability to spread through bait trade make it a very problematic aquatic invasive."

"O. rusticus aggressive nature, greater fitness, and large chelae and body size allow it to displace native crayfish from food and habitat (Byron & Wilson, 2001; Garvey et al, 2003; Garvey & Stein, 1993; Hill & Lodge, 1999; Klocker & Strayer, 2004). Displacement from food causes reduced fitness to its cogeners and displacement from habitat increases predation pressure (Hill & Lodge, 1994). *O rusticus* displaces native crayfish, *O. virilis*, and previous invader, *O. propinquus*, from lakes throughout northern Wisconsin (Byron & Wilson, 2001; Garvey & Stein, 1993; Hill & Lodge, 1994). Along with direct competition and displacement, research indicates that fish and other predators avoid *O. rusticus* because of its larger chelae and body size and this selective predation pressure is likely an important driver in the replacement of crayfish species by rusty crayfish (Roth & Kitchell, 2005; DiDonato & Lodge, [1993]). *O. rusticus* is known to hybridize with native crayfish *O. propinquus* in Lake Michigan (Jonas et al, 2005). In northeastern United States, *O. rusticus* may pose a threat to native crayfish *O. limosus*, which it was found to dominate in shelter competition and aggression trials (Klocker & Strayer, 2004)."

"Rusty crayfish prey on threatened, native bivalves in northeastern United States. Although native crayfish also prey on these bivalves, *O. rusticus* can live at very high densities so the threat of increased predator populations can harm already threatened unionid populations (Klocker & Strayer, 2004; Kuhlmann & Hazelton, 2007). *O. rusticus* also preys on snails and in Trout Lake, Wisconsin snails declined from >10,000 to <5 snails/m^2 in one of the initially invaded areas (Wilson et al, 2004). Relative to control treatments, rusty crayfish were found to reduce the biomass of northeastern US native *Lymnaea* and *Physa* snails by >90% (Johnson et al, 2009). Furthermore, *O. rusticus* has been found to co-occur with *Bellamya chinensis*, an invasive snail with a thick shell that prevents predation by *O. rusticus*, in northern temperate lakes throughout the United States. The predation pressure of *O. rusticus* on native snail communities combined with competition and displacement by the *B. chinensis* has resulted in the reduction of native snail biomass (Johnson et al, 2009)."

"The reduction of macrophyte abundance is another important impact of *O. rusticus*. Small-scale, comparative, and multi-lake studies confirm that macrophyte species richness and abundance decline significantly in lakes invaded by *O. rusticus* (Alexander et al, 2008; Rosenthal et al, 2006; Roth et al, 2007; Wilson et al, 2004). In northern Wisconsin, studies found the proportion of sites with no macrohpyte cover to increase from 40-73% (Roth et al, 2007), and submerged macrophyte species richness to decline by as much as 80% with the invasion of *O. rusticus* (Wilson et al, 2004)."

"*O. rusticus* introduction is also believed to reduced sport fish populations especially pan-fish *Lepomis macrochirus* and *L. gibbossus* by either egg predation or competition with juveniles. Researchers have calculated fisheries damages of *O. rusticus* in Vilas County, Wisconsin to be about 1.5 million annually (Keller et al, 2008)."

"Additional cascading ecological impacts have been associated with *O. rusticus*. Decreasing macroinvertebrate densities and increasing periphyton productivity have been found to correlate with increasing *O. rusticus* densities (Charlebois & Lamberti, 1996). In Trout Lake, Wisconsin, mean abundance of Odonata, Amphipoda, and Trichoptera decreased significantly lake-wide with the invasion of *O. rusticus* (Wilson et al, 2004)."

"**Location Specific Impacts**:

Lake Michigan (North America)
Hybridisation: *Orconectes rusticus* is known to hybridize with native crayfish *O. propinquus* in Lake Michigan (Jonas et al, 2005).
Predation: *Orconectes rusticus* preys on the eggs of lake trout, *Salvelinus namaycush*, in Lake Michigan and are known to do so at a higher rate than native crayfish (Jonas et al, 2005).

Illinois (United States (USA))
Competition: Field observations suggest that *Orconectes rusticus* displaces and outcompetes *O. propinquus* and *O. virilis* in the Rock River and most likely other locations in Illionois (Taylor & Redmer, 1996).

Michigan (United States (USA))
Ecosystem change: *Orconecetes rusticus* reduces macrophyte abundance in Lake Ottawa, Michigan. Species *Potamogeton amplifolius, P. richardsonii,* and *Elodea canadensis* were among the most effected (Peters et al, 2008).

New York (United States (USA))
Competition: *Orconectes rusticus* is replacing native crayfish *O. propinquus* in the Susquehanna River watershed (Kuhlmann, 2008).

North Carolina (United States (USA))
Competition: *Orconectes rusticus* is believed to be a threat to the native crayfish including the endemic *Cambarus lenati* and *C. spictatus* (Fullerton & Watson, 2001).

Ohio (United States (USA))
Competition: *Orconectes rusticus* competes with and displaces native crayfish *O. obscurus*, *O. propinquus*, and *O. sanborni* in Ohio and is also believed to displace *O. sloanii* (Jezerinac, 1986; Mather & Stein, 1993).

Oregon (United States (USA))
Competition: Native crayfish *Pacifastacus leniusculus* were not found in nearly all locations where *Orconectes rusticus* were found to have established. This fact combined with *O. rusticus*'s

propensity for displacing native crayfish indicates that it has likely displaced *P. leniusculus* in some locations (Olden et al, 2009).

Wisconsin (United States (USA))
Competition: *Orconectes rusticus* displaces and replaces native crayfish *O. virilis* and a previous invader *O. propinquus* and in locations throughout northern Wisconsin. It outcompetes these species for resources due to their more aggresive nature and larger chela and has become the dominant crayfish in Wisconsin (Garvey & Stein, 1993; Garvey et al, 2003; DiDonato & Lodge, [1993]; Olsen et al, 1991).
Economic/Livelihoods: Researchers have calculated fisheries damages, including the reduction of sport fish, of *Onconectes rusticus* in Vilas County, Wisconsin to be about 1.5 million annually (Keller et al, 2008).
Hybridisation: *Orconectes rusticus* hybridizes with non-native crayfish, *O. prooinquus* in Wisconsin (Perry et al, 2001a; Perry et al, 2001b).
Reduction in native biodiversity: *Orconectes rusticus* reduce abundance and species richness of native snails in northern Wisconsin lakes (Lodge et al, 1998). In a long-term study of Trout Lake, Wisconsin, *O. rusticus* was found to reduced mean lake-wide abundance of Odonata, Amphipoda and Trichoptera, decrease snail densities and reduced submerged macrophyte species richness at some locations, and all but eliminated resident *O. propinquus* and *O. virilis* populations (Wilson et al, 2004)."

From Kreps (2009):

"A long-term, whole-lake survey of snail and crayfish abundance showed that the magnitude of impact by *O. rusticus* can be great, differs across habitats, and that the full extent of impact on congeners and prey may not be evident until many years after initial colonization. Analysis of snail gut contents and a set of laboratory feeding experiments demonstrate that snails do not consume macrophytes, indicating that the primary effect of *O. rusticus* predation on snails is reduced grazing efficiency on periphyton. Samples from two lakes that experienced large declines in *O. rusticus* abundance indicated little ecosystem recovery. Comparison of food webs in invaded and uninvaded lakes using stable isotopes provided evidence that *O. rusticus* decoupled littoral and pelagic food webs. The combined effect of reduced grazing efficiency and food web decoupling is likely to be reduced flow of energy to the top of the lake food web."

From Conard et al. (2015):

"The introduction of rusty crayfish to lakes and streams in the Northeast has caused significant population declines in native unionid mussel populations (Klocker and Strayer 2004)."

4 Global Distribution

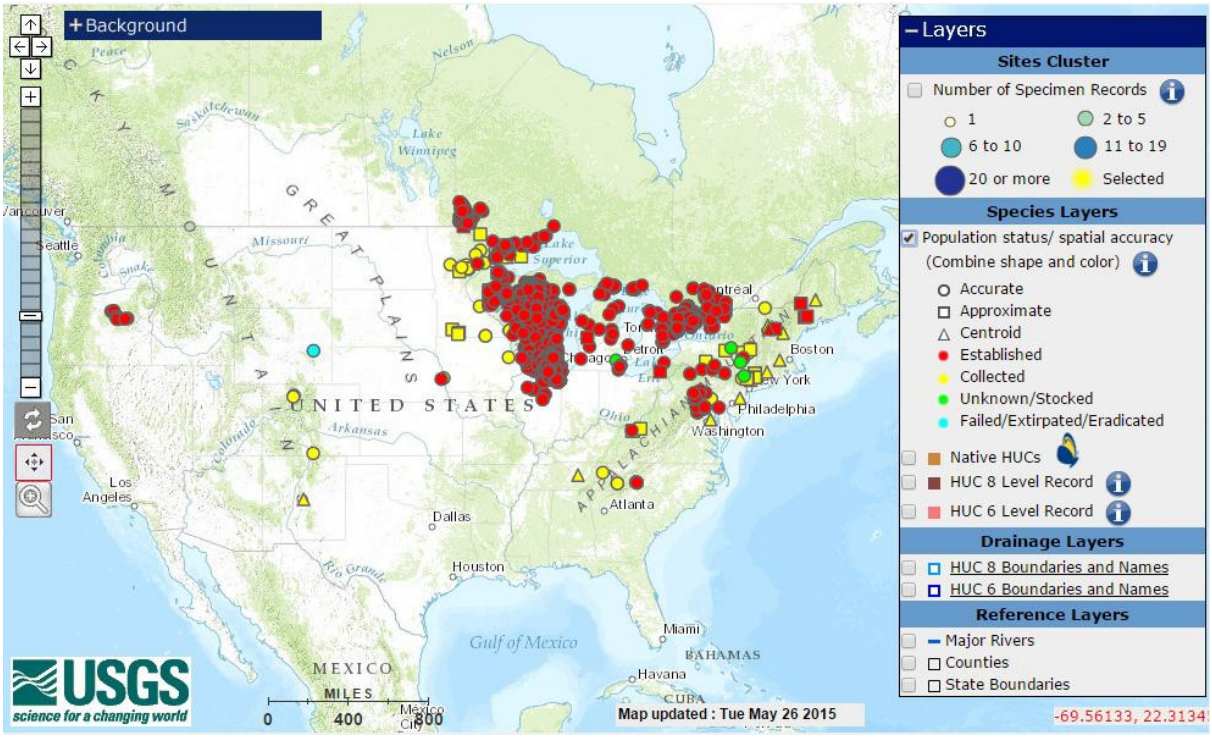

Figure 1. Distribution of *O. rusticus*. Map from Conard et al. (2015).

5 Distribution within the United States

See 4 Global Distribution

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was high for the Northeast, Mid-Atlantic, and Midwest regions, as well as for parts of the Intermountain West. The climate match was low for the West Coast, Gulf Coast, Desert Southwest, Texas, and Florida. Climate 6 proportion indicated that the contiguous U.S. has a high climate match. The range for a high climate match is >0.103; the climate match of *O. rusticus* is 0.66.

Crayfishes have been observed to establish populations in climates different from that found within their native range (M. Hoff, U.S. Fish and Wildlife Service, personal communication). The climate match shown here may be an underestimate of climate suitability for the establishment of *O. rusticus*.

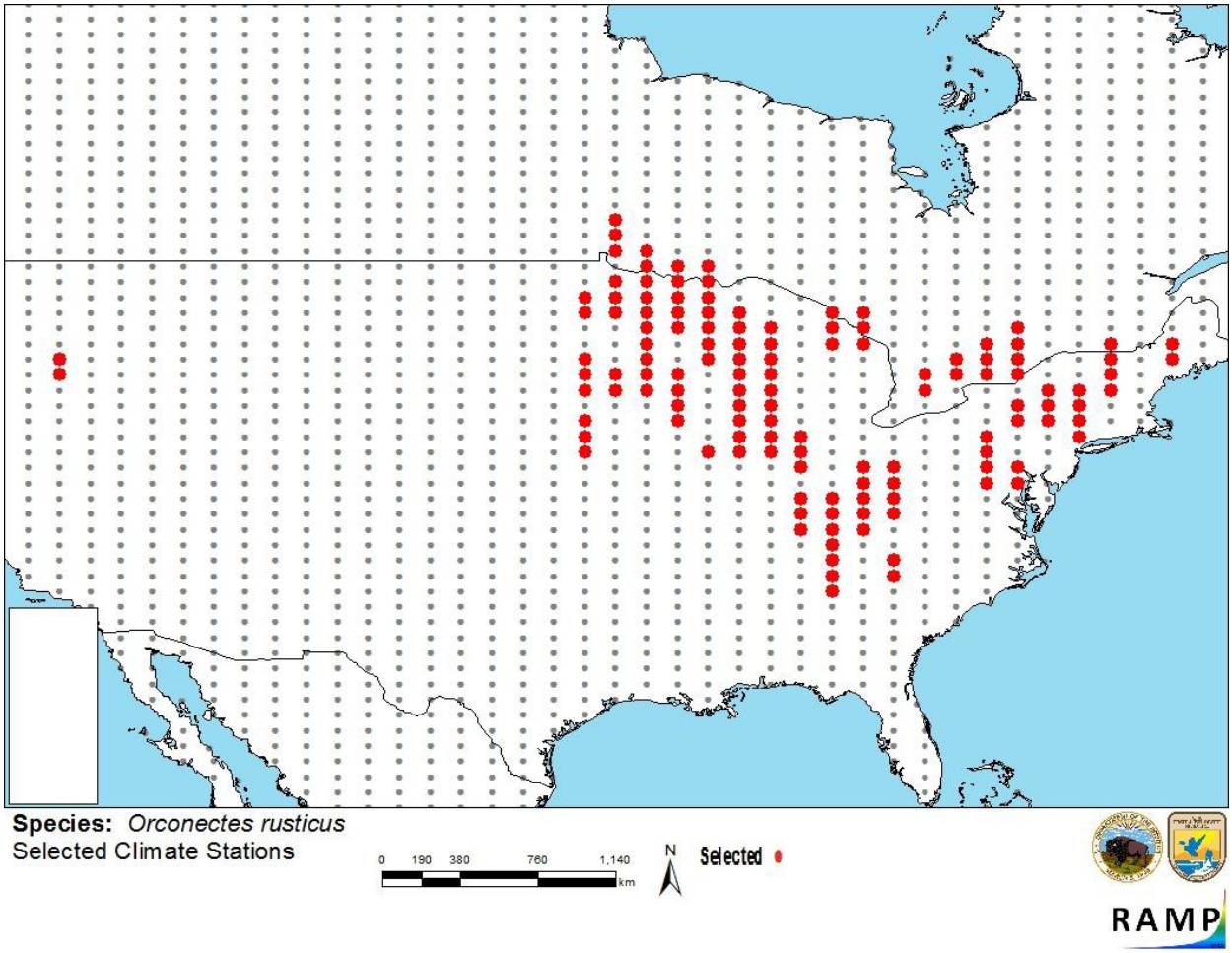

Figure 2. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Orconectes rusticus* climate matching. Source locations from GBIF (2013) and Conard et al. (2015).

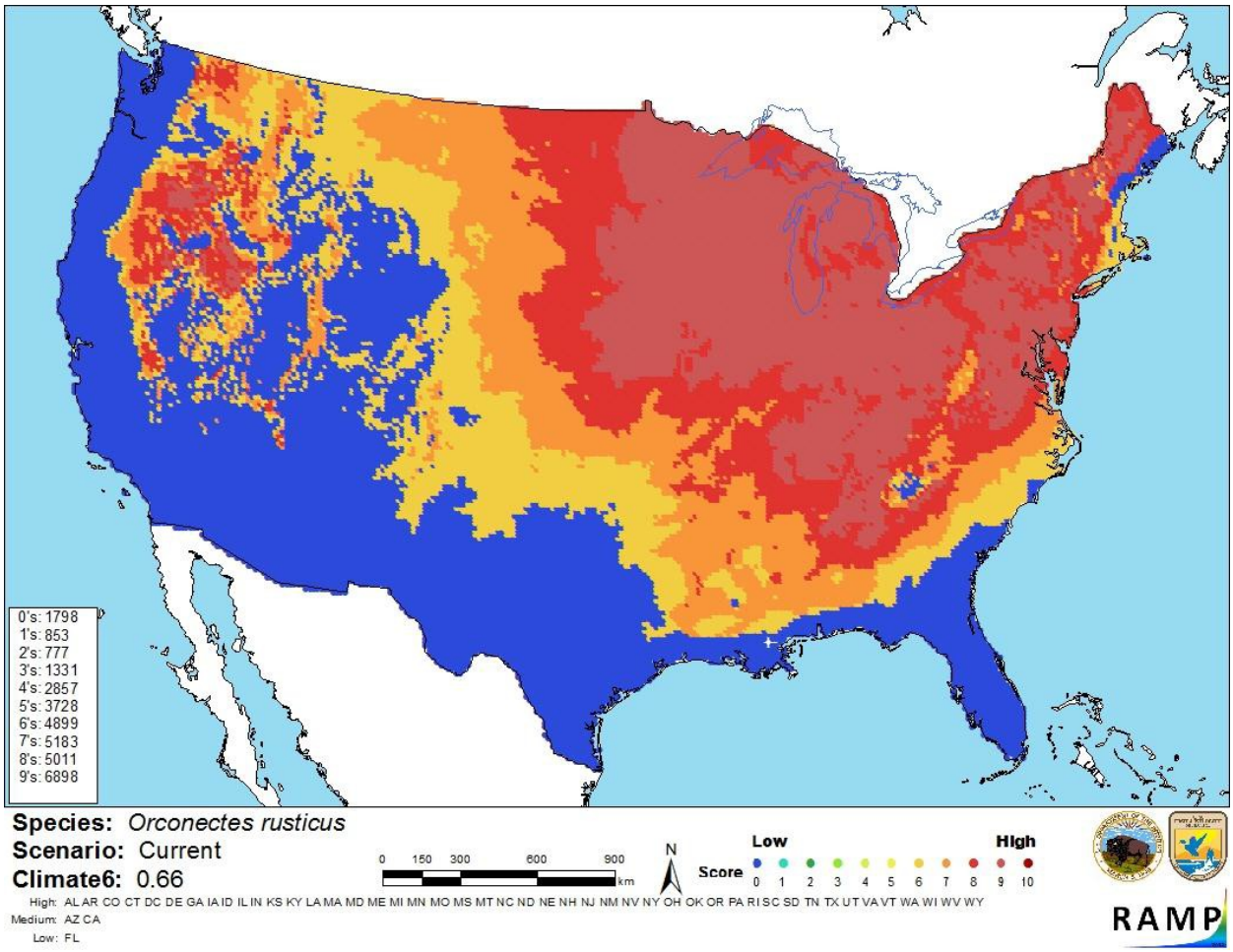

Figure 3. Map of RAMP (Sanders et al. 2014) climate matches for *Orconectes rusticus* in the continental United States based on source locations reported by GBIF (2013) and Conard et al. (2015). 0= Lowest match, 10=Highest match. Counts of climate match scores are tabulated on the left.

7 Certainty of Assessment

The biology and ecology of *O. rusticus* are well-known. Negative impacts from introductions and spread of this species are adequately documented in the scientific literature. No further information is needed to evaluate the negative impacts the species is having where introduced. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Continental United States

Establishment and impacts in the Midwest, Northeast, and few locations in Western United States are occurring. There is high risk of additional introduction, establishments and impacts in other areas throughout the United States through bait bucket introductions or range expansion. There are documented instances of *O. rusticus* displacing native crayfish species and lowering the abundance and diversity in aquatic vegetation and invertebrates in areas they invade. In at least some cases, ecosystems are unable to recover from the effects of *O. rusticus* even after its

population is reduced. The species is reported to be somewhat salinity tolerant. It could impact estuarine environments. Climate match with the United States is high. Overall assessment for this species is high.

Assessment Elements

- **History of Invasiveness (Sec. 3):** High
- **Climate Match (Sec.6):** High
- **Certainty of Assessment (Sec. 7):** High
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9 References

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