Pacific Northwest Invasive Species Profile

Orconectes rusticus: Rusty Crayfish

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Fish 423 - Aquatic Invasion Ecology

Fall 2011

Image courtesy of Jeff Gunderson

Diagnostic Information:

Order: Decapoda

Family: Cambaridae

Genus: *Orconectes*

Species: *rusticus*

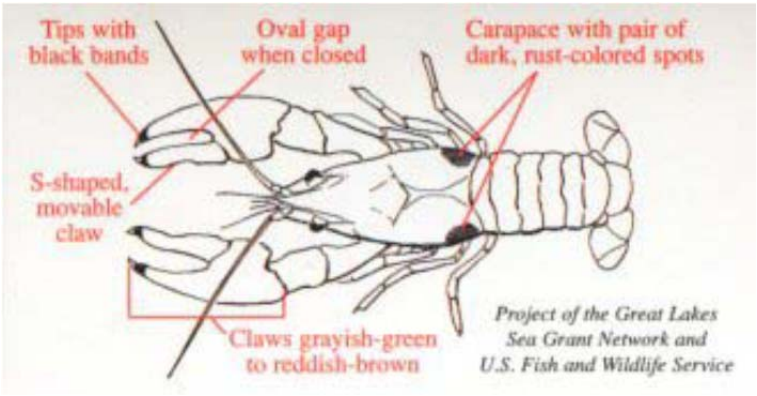

Fig. 1: Illustration featuring distinguishing features of *O. rusticus.*

Common name: rusty crayfish

Orconectes rusticus is a greenish aquamarine crayfish that a can be distinguished from other crayfish species by a distinctive "rusty" brown spot located on either side of the posterolateral margins of the carapace hence the common name, rusty crayfish. The aquamarine shading is most noticeable on the walking legs. Other visible coloration includes a rust colored, brown band running dorsally along their abdomen (Wetzel et al. 2004). Rusty crayfish also typically have larger chelae (claws) compared to other common North American crayfish species. The chelae are typically smooth and reddish-green to greyish brown in color with a dark colored band near the tip (Gunderson 2008). At maturity this crayfish can grow from 3.5cm to 10 cm in length (Gunderson 2008). If comparing individuals that are morphologically similar it can also be helpful to note that upon close inspection of the cephalic half of the incisor region of the mandible *O. rusticus* has a straight blade-like edge compared to some more crenate incisors in other species (Wetzel et al. 2004).

Life History and Basic Ecology

Mature individuals of this species can mate in late summer, early fall, or early spring. Males transfer sperm to females who store the sperm until her eggs are ready to fertilize, usually in late April or May (Gunderson 2008) when water temperatures are an optimal temperature of approximately 4°C (Momot

Fig. 2: The chelae of *O. rusticus* featuring reddish-green coloration and the distinctive dark band at the outer tip. (Image courtesy of Jeff Gunderson, SeaGrant).

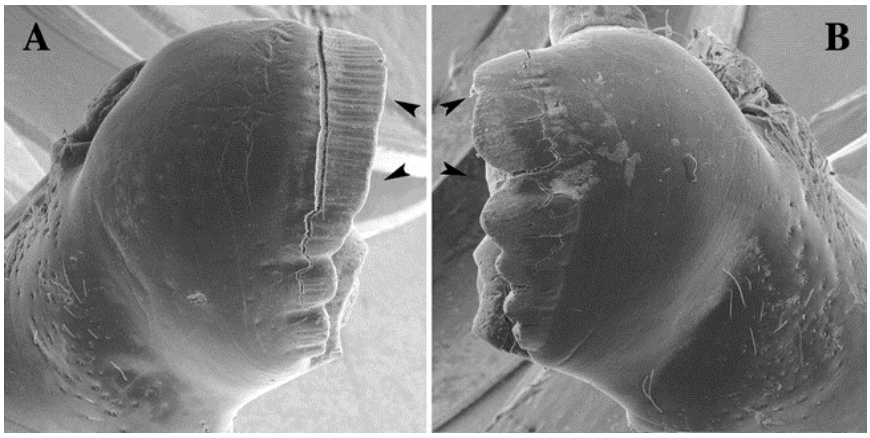

Fig. 3: The left image (A) is of the straight-edged incisor region of the mandible of *O. rusticus* compared to the more crenate incisor of *O. luteus* on the right (B).

1984). The eggs are fertilized externally and attached to the swimmerets on the underside of the female's abdomen. Eggs can number from 80 to 575 and hatch after 3-6 weeks (Gunderson, 2008) depending on water temperature. Developing young stay with the female for several molts over several weeks which reveal more intensive parental care in this species. Rusty crayfish young are released around June or July and typically mature at ten molts over the course of a little over a year (Gunderson 2008). At *this point the molting process slows and in spring males molt into a sexually inactive form II* until summer when they molt again and return to form I. A typical individual of this species will have a lifespan of 3-4 years.

O. rusticus is considered a trophic generalist (Wilson et al. 2004). This makes them a strong candidate to become an invasive species since they can readily eat a wide range of items including terrestrial leaf litter, benthic algae, macrophytes, aquatic invertebrates, fish eggs, and detritus (Wilson et al. 2004). Smaller individuals tend to be carnivorous while also being common prey items for multiple species of fish. Larger individuals tend to be more omnivorous and maintain a size and refuge behaviors that mostly prevent them from becoming popular prey items. These varying characteristics allow *O. rusticus* to integrate into food webs at multiple levels, increasing their candidacy for invasiveness (Wilson et al. 2004).

O. rusticus are found in freshwater lakes, ponds and streams. Within these bodies of water they can be found in low-flow pooling areas and areas with moderate rates of flow excluding high flow areas within lakes and rivers. Observed preference of substrate includes rocks and logs or other areas with debris but does not exclude bottom types such as clay, silt, sand or gravel (Gunderson 2008). Rusty crayfish do not burrow but exhibit behavior that allows them to clear a pocket under rocks or other debris. Because this species does not burrow they require bodies of water that will provide appropriate conditions (water quality) year-round. In addition, research suggests that success and failure of establishment in rusty crayfish populations post introduction rely on dissolved calcium levels higher than 2.5 mg/L

Fig 4: Images of a male (left) and female (right) *O. rusticus*. Note the chelae of the male are noticeably larger than the female and used to grasp the female in mating. (Image courtesy of Jeff Gunderson, SeaGrant)

and pH levels higher than 5.5 (Olden et al. 2006). These biotic factors may be key factors that assist management in predicting which waterways the rusty crayfish will be able to establish and possibly focus efforts on preventing establishment in those prime areas.

Current Geographic Distribution

O. rusticus is native to the Ohio River Basin which spreads throughout western Ohio and parts of Indiana, Kentucky and Tennessee. Over the last fifty year that range has expanded upon its historic range and has established populations in portions of Illinois, Michigan, Wisconsin, Minnesota, Iowa, Pennsylvania, New Mexico, parts of Ontario and most if not all the Laurentian Great Lakes (Olden et al. 2006 & 2009; Lodge et al. 2006).

Prior to 2008 the farthest westward that rusty crayfish had been reported was the North Platte River near Douglas, Wyoming and Conchas Lake in New Mexico (Olden et al.2009). In 2005 a survey conducted by the Xerces Society for Invertebrate Conservation and the Confederated Tribes of Warm Springs Reservation of Oregon reflected the presence of a non-native crayfish believed to be the within the same genus as the rusty crayfish in the upper main stem of the John Day River in Oregon. This established rusty crayfish population was initially identified incorrectly and upon further investigation was revealed to in fact be *O. rusticus* in 2008 making the John Day River populations the first established populations of the invasive rusty crayfish west of the Continental Divide (Olden et al. 2009). To date the John Day River populations in Oregon are the only established populations within the Pacific Northwest region which is important to note as prevention of introduction and spread are keys to the most effective invasive species management.

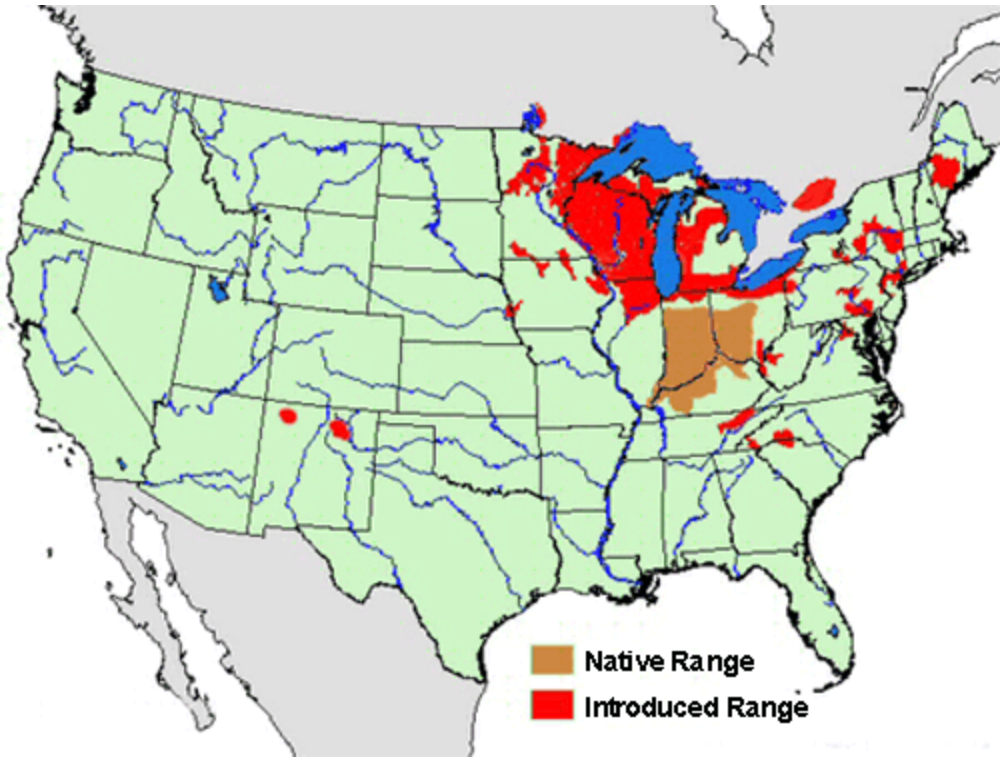

Fig. 5: The Native Range of *O. rusticus*, (highlighted brown) and the introduced range (highlighted red) as of 2007.

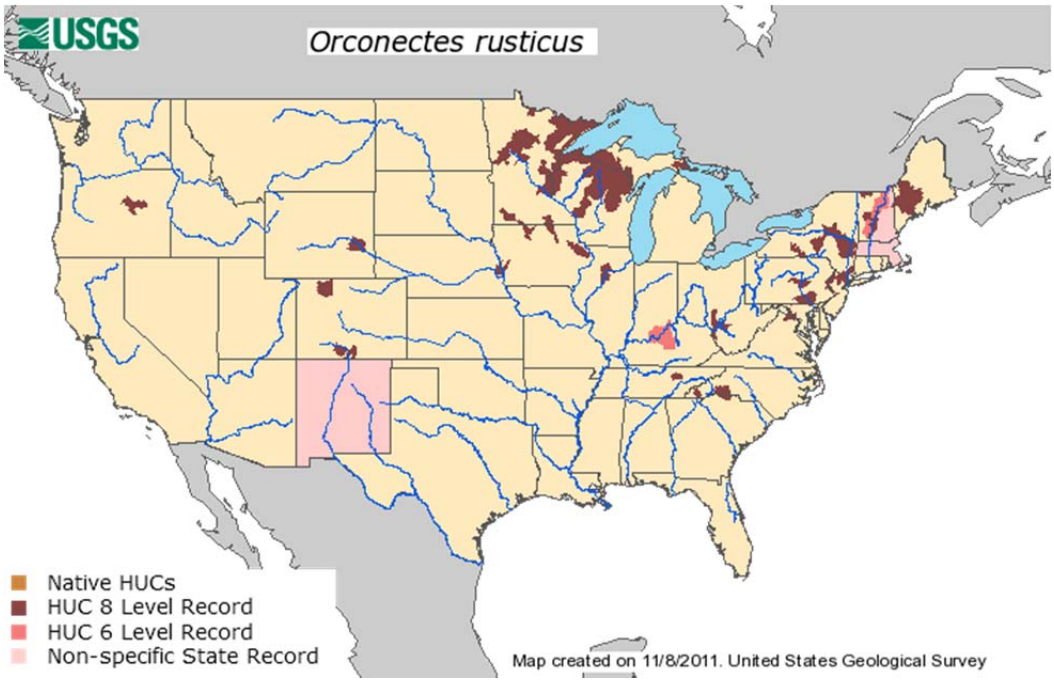

Figure 6: Map of the current range of *Orconectes rusticus* within the United States. (USGS Nonindigenous Aquatic Species Database, Gainesville, FL.

History of Invasiveness

Historically anthropogenic factors have been responsible for the spread of non-native crayfish in North America (Lodge et al. 2000). Vectors of human-assisted spread have included legal and illegal stocking of ponds, stocking crayfish species to control certain macrophyte populations, dispersals into new drainage basis as a result of man-made canals, the aquarium pond trade, the live seafood trade, and escapes from the bait trade (Lodge et al. 2000). In the past it is likely that introductions of the rusty crayfish most frequently occurred as a result of a combination of the sale of this species as bait for anglers leading to the subsequent release of un-used live bait by anglers in ponds, lakes and streams novel to rusty crayfish and the connectedness of bodies of water within drainage basins allowing the further spread of this non-native species (Olden et al. 2006). For example, in Minnesota crayfish were not necessarily a commonly used bait item but they were popular in states surrounding Minnesota and most likely brought in by anglers from outside the state as a less expensive bait item (Gunderson 2008). There was also concern that the commercial harvest of this abundant invasive species in Wisconsin incentivized illegal stocking further enhancing the likelihood of spread (Gunderson 2008).

Invasion Process

In the past, across much of the northern Midwestern United States, we have seen rusty crayfish introduction, establishment and spread as a result of anthropogenic vectors such as bait bucket release and aquatic nuisance weed control (Lodge et al. 2000). Factors that enhanced establishment after introduction and the subsequent spread of crayfish were the connectedness of drainage basins which allowed natural spread of rusty crayfish. In addition in many instances this invasive species was commonly able to outcompete local species of crayfishes for resources including nutrients and protective cover (Wilson et al. 2004).

More recently, in the Pacific Northwest, a new human-assisted vector has presented itself. The introduction and resulting establishment of rusty crayfish in the John Day River in Oregon is believed to be a result of the biological supply trade for science curricula in schools (Olden et al. 2009). Elementary and grade school teachers use crayfish as educational live laboratory organisms and the specimens are ordered from both local and national distribution centers that were found to stock this known invasive species (Olden et al. 2009). Teachers often commit to live release of organisms once the lesson is over as a “humane” alternative to euthanizing animals in the classroom (Larson et al 2008). This practice over time and spatially increases the propagule pressures and enhances the likelihood that a trophic generalist species such as the rusty

crayfish will be able to invade a pond, stream or river and outcompete native crayfish such as the signal crayfish, *Pacifastacus leniusculus.* This fact has lead researchers to hypothesize that it will only be a matter of time before populations are discovered in Washington State in addition to Oregon's John Day population (Olden et al. 2008).

Once *O. rusticus* has been introduced and is able to establish, the ecological impacts on the ecosystem can be drastic. This species commonly reduces native species by means of reproductive interference, competition, and predation although it does appear one method not applicable is the passing of a novel parasite or disease (Lodge et al. 2000) *O. rusticus* also aggressively preys on macrophytes, benthic algae and aquatic invertebrates such as snails and can alter nutrient availability within littoral-zone food webs (Olden et al. 2008) and decimating aquatic plant beds depleting ecosystems of their native aquatic flora (Wilson et al 2004). In addition to outcompeting native crayfish species for nutrients, the rusty crayfish also causes an increase in fish predation on native species by taking over hiding places and protective coverings formerly occupied by native species further reducing native populations (Gunderson 2008). There is also a strong suggestion that rusty crayfish play a role in genetic extirpation of local populations as a result of hybridization after establishment (Perry et al. 2001) which reduces the overall biodiversity of local freshwater ecosystems (Lodge et al. 2000).

In the case of the John Day River in Oregon, rusty crayfish give a more specific cause for concern. This river basin is home to a healthy Chinook salmon (*Oncorhynchus tshawytscha*) run that has been depressed in numbers when compared to historic runs (Olden et al. 2009). The worry is that even a small disturbance will hinder the salmon runs and threaten their health in the future since invasive crayfish species have been shown to prey on fish eggs and compete with developing juvenile salmon for habitat (Olden et al. 2009).

Management Strategies and Control Methods

Unfortunately many chemicals that would kill rusty crayfish are not selective and would harm other non-target native crayfish species as well (Gunderson 2008). In the past eradication methods for rusty crayfish have been costly and ineffective. In Wisconsin the development of a commercial fishery to fish down the invading biomass resulted in the incentive to illegally stock ponds, lakes and streams (Gunderson 2008). It has also been suggested that establishing and maintaining healthy stocks of small-mouth bass in lakes can effectively keep rusty crayfish populations to a size where their impacts are not as negative, although this method would not halt further spread of a species as it only takes on female carrying fertilized eggs on her abdomen to spread a future population further downstream

(Wilson et al. 2004). Currently the most effective proactive method for the prevention of introduction and spread is through education (Olden et al. 2006). This includes education of bait-dealers, anglers, teachers, the general public and even aquatic landscaping managers concerning the ecological impacts of invasive crayfish on the local region discoursing introductions in the first place as opposed to reactive control methods employed in the past (Olden et al. 2006). Educating the public and those who also educate children about the natural world is the key to preventing future introductions which is the key element to preventing future invasions and spread of existing invasions.

Current Research and Management Efforts

Current research is needed in the investigation of more human assisted vectors in which invasive crayfish, like the rusty crayfish might travel in order to spread further throughout the Pacific Northwest. A recent topic of interest was golf courses and their use of crayfish as pest management for aquatic weeds in ponds throughout the courses (Larson et al. 2008). The concern is that the non-native crayfish may appeal as a natural pest control but that they are biologically well equipped to move over land to other bodies of water within the area of the course which may in turn have wider connectedness and allow for increased likelihood of establishment and spread within a larger drainage basin (Larson et al. 2008). There is an obvious comparison to be made between unknowing grounds keepers on gold courses and unknowing teachers in elementary schools. As a part of integrated vector management, identification of a potential vector and the subsequent sealing off of that vector through outreach and education may prove an efficient form of prevention in the future (Larson et al. 2008) but further research of the impacts of current outreach and education are still in the works with results yet to be calculated. In the future analyzing shifting human behaviors and activities will become more and more important in predicting novel vectors for species invasion (Larson et al. 2008). Education the lay public how to identify native and non-native crayfish species may also become helpful in tracking and recording novel populations across the region. Citizens who are able to observe and pass the sightings along to appropriate organizations may help note novel populations before they can establish. Continual evaluation of potential pathways will have to be assessed if we are to keep the rusty crayfish from further invading the Pacific Northwest.

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Other Resources

Brief Guide to Crayfish Identification in the Pacific Northwest: http://www.fish.washington.edu/research/oldenlab/pdf/Guide%20to%20Crayfish%20Identification%20(Dec2009).pdf

Identifying and Collecting Nonnative Crayfish in Washington: http://wdfw.wa.gov/ais/html/orconectes_rusticus/IdentifyingCollectingNonnativeCrayfishWashington.pdf

Olden Research Lab @ University of Washington: http://www.fish.washington.edu/research/oldenlab/invasionalert.html

Survey of non-native crayfish records in the Pacific Northwest (University of Washington): http://www.surveymonkey.com/s/YVKNSXL (seeking outside participation in recording known occurrences of non-native crayfish in the Pacific Northwest)

Oregon Public Broadcasting's (OPB) story, "Invasive Crayfish May Be Class Pets First": http://news.opb.org/article/invasive-crayfish-may-be-class-pets-first/

Experts within the Pacific Northwest

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