Virile crayfish (*Orconectes virilis*)
Ecological Risk Screening Summary

US Fish and Wildlife Service, February 2011
Revised, June 2015

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1 Native Range, and Status in the United States

Native Range
From Benson (2015):

"Missouri, upper Mississippi, lower Ohio, and Great Lakes drainages"

Status in the United States
From Benson (2015):

"Collected in Butte, Colusa, San Joaquin, and Yolo counties (Riegel 1959), and established in San Francisco Bay, California (Ruiz 2000).Unspecified locations in Connecticut, Maine, Massachusetts, New Hampshire, Pennsylvania, Rhode Island, Vermont, and Virginia; many creeks in Maryland, New York, and West Virginia."

Means of Introductions in the United States

From CABI (2015):

"The use of crayfish as live bait by anglers is attributed as a major factor in the spread of non-native crayfish species within the USA (Lodge et al., 2000; DiStefano et al., 2009)."

Remarks

From Benson (2015):

"Found in streams with moderate flow and turbidity, abundant cover, stable water levels. Breeding occurs in July and eggs are laid in the spring. Potential as a human food resource."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2015):

"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 (Gremicambarus)
Species Orconectes virilis (Hagen, 1870)"

"Taxonomic Status: valid"

Size, Weight, and Age Range

From ANSIS (2007):

"Adults reach a size of 45–125 mm [Momot 1967; Pflieger 1996]"

"Males usually grow larger than females [Momot 1967; Bovbjerg 1970; Pflieger 1996]"

Environment

From ANSIS (2007):

"Primarily found in streams and usually in areas with rocky bottoms [Bovbjerg 1970; Pflieger 1996]
Prefer fertile, warm, moderately turbid streams with lots of cover [Pflieger 1996]
Prefer cobble substrate and rocky crevices in streams [Bovbjerg 1970; Hill and Lodge 1994]
Often uses rocks, logs, and other organic debris as cover [Bovbjerg 1970; Pflieger 1996]
Occasionally dig pits in river banks and under rocks especially when water levels are low [Bovbjerg 1970]"

Climate/Range

From ANSIS (2007):

"Can tolerate temperatures 0° C and 32° C [Momot 1967]
Temperatures between 24° C and 25° C are preferred [Peck 1985]
Locomotion is slowed or stopped at temperatures below 10° C [Momot 1967]
Quiescence occurs in low temperatures [Bovbjerg 1970; Pflieger 1996]"

Distribution Outside the United States

Native

From ANSIS (2007):

"Native range extends from New Hampshire and Maine, across the Midwest including much of the Mississippi River and its tributaries, as far west as Colorado, south to Texas and north to Ontario, Canada [Aiken 1965]"

Introduced

From CABI (2015):

"It was deliberately introduced into France in 1897 and Sweden in 1960 but both attempts were unsuccessful. Currently in Europe, *O. virilis* is only known to be present in the Netherlands and the UK. It was introduced to both countries in 2004, and is likely to be as a result of the aquarium trade. In the Netherlands the species has only recently become widespread (Ahern et al., 2008)."

Means of Introduction Outside the United States

From CABI (2015):

"The two introduced *O. virilis* populations within Europe are thought to be linked to released aquarium specimens."

Short description

From ANSIS (2007):

"Overall reddish brown or olive brown color [Pflieger 1996]
Numerous yellow bumps on the medial (side closest to the head) sides of the pinchers [Pflieger 1996]
Pinchers often have orange or orange-red tips [Pflieger 1996]
Dark specks are often found on pinchers [Pflieger 1996]
Paired black blotches along the abdomen, especially prominent in young and individuals that have recently molted [Pflieger 1996]"

Biology

From GISD (2010):

"**Nutrition**
Orconectes virilis is omnivorous and consumes a variety of live and dead animal and plant material (ANSIS, 2007). It is known to consume macroinvertebrates such as snails and insects, as well as, small fish, fish eggs, tadpoles, and macrophytes. *O. virilis* is believed to obtain most of its nutrition by scavenging dead animals (Collicut, 1998).

Reproduction
Breeding of *Orconectes virilis* begins in the fall to early spring and extends until the adults retreat to deep water and become inactive. Breeding sometimes occurs for a brief period in the spring when the water begins warming (Collicut, 1998; ANSIS, 2007). Females store sperm for up to months and fertilize their eggs in the spring. Eggs are attached to swimmerets in a large ball resembling a raspberry. The eggs hatch one to two months after they are laid. Young hatchlings look like miniature adults and can probably grow to about 2-3cm long by the fall. (Collicut, 1998).

Lifecycle stages
The maximum lifespan of *Orconectes virilis* is 3 years. They undergo several molts in their first few months. *O. virilis* typically reaches a length of 23-56 mm in first year and a length of 58-84 mm by the second. They reach maturity during their second summer usually around 24mm.(ANSIS, 2007). *O. virilis* undergoes form alternation between the sexually mature Form I during the mating season and the sexually immature Form II outside of the mating season ([Mathews] et al, 2008)."

Human uses

From GISD (2010):

"*Orconectes virilis* is a popularly consumed food in the United States and increasingly more so in Europe (Collicut, undated). *O. virilis* a commonly used fish bait and is sold as such in bait shops. It is also sold commercially in the pet trade as pets or prey for predaceous aquarium fishes (Hunner, 1997). Beginning in approximately 1950 *O. virilis* was stocked as a biological control in the Colorado River watershed of western New Mexico and northeastern Arizona, primarily for vegetation control (Johnson, 1986)."

Diseases

From Davidson et al. (2010):

"We explored bacteria, nematodes, and a virus as potential biological control agents for *O. virilis* while avoiding harm to native species. White Spot Syndrome Virus (WSSV) from shrimp was found to be highly pathogenic and readily passed by cannibalistic behavior but not by water transmission."

From CABI (2015):

"The population of *O. virilis* from the River Lee, England was tested for crayfish plague and was found to have one of the highest infestation rates of any population of crayfish found in the UK."

Crayfish plague and white spot disease are OIE-reportable diseases.

Threat to humans

From CABI (2015):

"While there have been direct economic impacts of other introduced crayfish species such as damage to river banks, and flood defences; there are no specific examples for *O. virilis*."

3 Impacts of Introductions

From ANSIS (2007):

"Males cause a decrease in the length and growth of some macrophytes [Chambers et al. 1990]
Drastically modify the aquatic macrophyte and macroinvertebrate communities, which in turn may lead to a decline and reconfiguration of fish communities [Lodge and Lorman 1987; Chambers et al. 1990; Hanson et al. 1990]
Greatly reduce the number of snails in the community [Hanson et al. 1990; Lodge et al. 1994]
Cause a reduction in the number of small invertebrates present [Hanson et al. 1990]
May consume eggs of sunfish, bluegill, and trout leading to reduced population sizes [Horns and Magnuson 1981; Dorn and Mittelbach 2004]"

From GISD (2010):

"*O. virilis* is known to alter and reduce macrophyte biomass and diversity (Chambers et al, 1990; Davidson et al, 2010; Olden et al, 2009). It may displace native crayfish as in the case of the endangered *Pacifastacus nigrescens* in California (Light et al, 1995); *Orconectes obscurus* and *Cambarus bartonii* in North Carolina (Cooper et al, 1998); and *Orconectes limosus* and *Cambarus bartonii bartonii* in Maryland (USA) (Schwartz et al, 1963). Field and laboratoy observations indicate that is may compete with and/or cause the decline of native fish species such as juvenile desert suckers (*Catostomus clarkii*), the Sonora sucker (*Catostomus insignis*), and the federally threatened Little Colorado spinedace (*Lepidomeda vittata*) in Arizona (Davidson et al, 2010; Bryan et al, 2002); the flannelmouth sucker (*Catostomus latipinnis*) in Colorado (Carpenter, 2005); and the White Sands pupfish (*Cyprinodon tularosa*) in New Mexico

(Rogowski & Stockwell, 2006). It has been reported to contribute to the decline of the Chiricahua leopard frog (*Rana chiricahuensis*) in Arizona (Davidson et al, 2010). *O. virilis* is also known to cause the decline of native snails (ANSIS, 2007), as in the case of three forks spring snail (*Pyrgulopsis trivialis*) in Arizona (Davidson et al, 2010) and Canadian native snails *Stagnicola elodes* and *Physa gyrina* in laboratory studies (Hanson et al, 1990)."

"Additional impacts associated with *O. virilis* include the reduction of insects and other macroinvertebrates (Davidson et al, 2010; Hanson et al, 1990), the alteration of the structure and composition of littoral zones (Chambers et al, 1990), the increase in turbidity of waters (Davidson et al, 2010), and impacts to irrigation networks and levees as a result of their burrowing near head gates and weir boxes (Godfrey, 2002)."

From Martinez (2012):

"No crayfish species are native to the Colorado River Basin (CRB), including the portion of the state of Colorado west of the Continental Divide. Virile crayfish [*Orconectes virilis* (Hagen, 1870)], a recent invader in the middle Yampa River in northwestern Colorado, displayed an abrupt increase in abundance in the early 2000s, which coincided with a drought, a severe decline in the abundance of small-bodied and juvenile native fishes, and a dramatic increase in the abundance of nonnative smallmouth bass [*Micropterus dolomieu* (Lacepède, 1802)]. The annual density of virile crayfish was 6.4/m2 in 2005 and 9.3/m2 in 2006. The annual biomass density of virile crayfish was 9.0g/m2 in 2005 and 15.8 g/m2 in 2006, representing a riverwide biomass of 122 kg/ha, which equaled that of other macroinvertebrates and fish combined (120.7 kg/ha). Efforts to recover and preserve native fishes in the Upper Colorado River Basin (UCRB), particularly in the Yampa River, have been hampered by nonnative predatory fishes, but the implications of crayfish may have been overlooked and underestimated. Stream conditions during the drought apparently facilitated proliferation by virile crayfish in the middle Yampa River, likely contributing to hyperpredation on native fishes by invasive smallmouth bass."

From Carpenter (2000):

"The virile crayfish (*Orconectes virilis*), an aggressive polytrophic species, has been introduced into many Arizona streams. … In Sabino Creek, I manipulated crayfish densities in isolated pools to examine effects of crayfish on growth, mortality, and recruitment of Gila chub (*Gila intermedia*). Regardless of crayfish density, Gila chub declined slightly in weight and condition. Mortality and recruitment did not differ between densities of crayfish. I examined crayfish effects on benthic macroinvertebrates, a submerged aquatic macrophyte and associated invertebrates, and three fish species in a small stream in the White Mountains by fencing eight stream sections to prevent movement. The three fishes were speckled dace (*Rhinichthys osculus*), Sonora sucker (*Catostomus insignis*), and desert sucker (*C. clarki*). Molluscs > 10 mm and macrophytes were less abundant at sites with a high density of crayfish than at sites with low crayfish densities. Insect diversity was lower in high- vs. low-density sites. No treatment effect was observed on growth or condition of individually marked fish. Short-term laboratory experiments demonstrated predatory interactions and competition for shelter between crayfish and Gila chub, desert sucker, and speckled dace. Crayfish used shelter more than fish, displaced fish from shelter, and frequently attacked fish. Fish never attacked crayfish, and only once displaced crayfish from shelter. In predation experiments, crayfish preyed upon all species, but preyed most heavily upon desert suckers. Fish never altered use of the water column in the presence of crayfish. Density manipulation experiments in a laboratory measured food competition between crayfish and two native fishes. Growth of Gila chub was less affected by crayfish than by increased density of Gila chub. Thus crayfish are not strong competitors with Gila chub for food. However, growth of flannelmouth sucker (*Catostomus latipinnis*) was negatively impacted by presence of crayfish. These laboratory experiments provide evidence that introduced crayfish can reduce fish growth by competition for food, and that native fishes are vulnerable to crayfish predation."

4 Global Distribution

Figure 1. Global distribution of *O. virilis*. Map from GBIF (2015).

5 Distribution within the United States

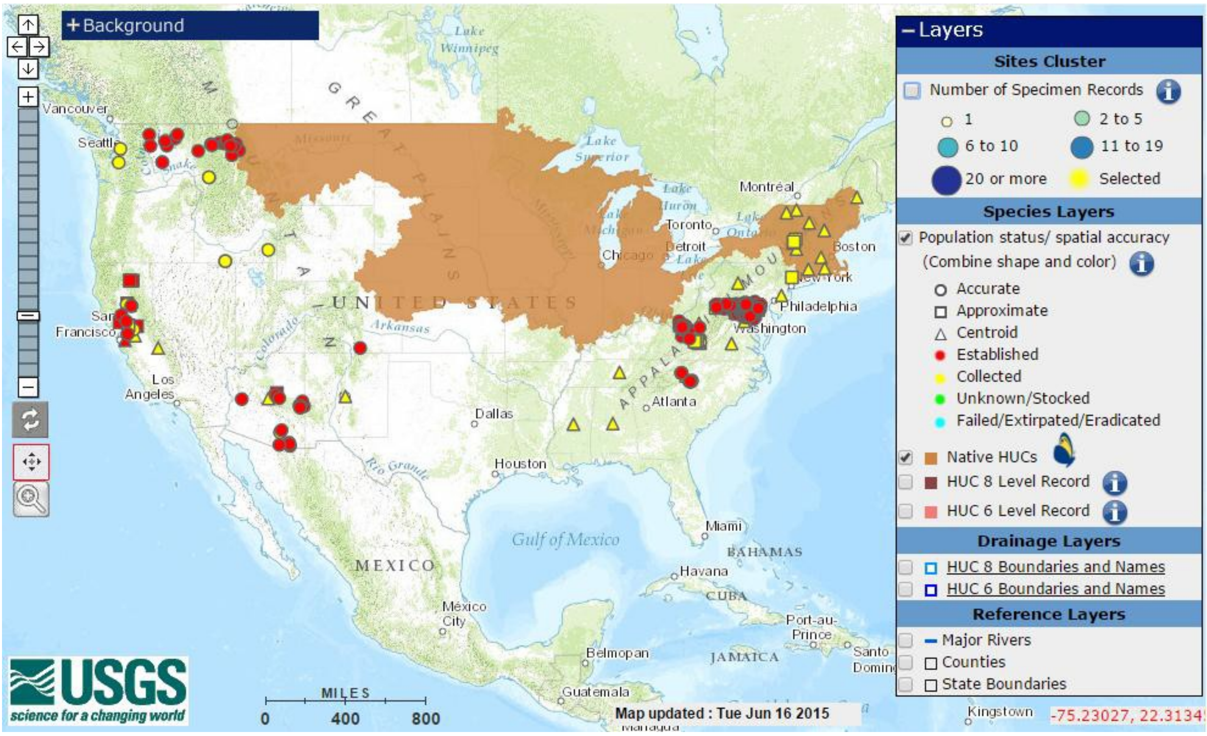

Figure 2. Distribution of *O. virilis* in the US. Map from Benson (2015).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (16 climate variables; Euclidean Distance) was high throughout the US, except for parts of the Deep South, isolated patches in the Interior West, and a narrow band along the Pacific Coast. Climate 6 match indicated that the continental US has a high climate match. The range for a high climate match is 0.103 and greater; climate match of *O. virilis* is 0.921.

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. virilis*.

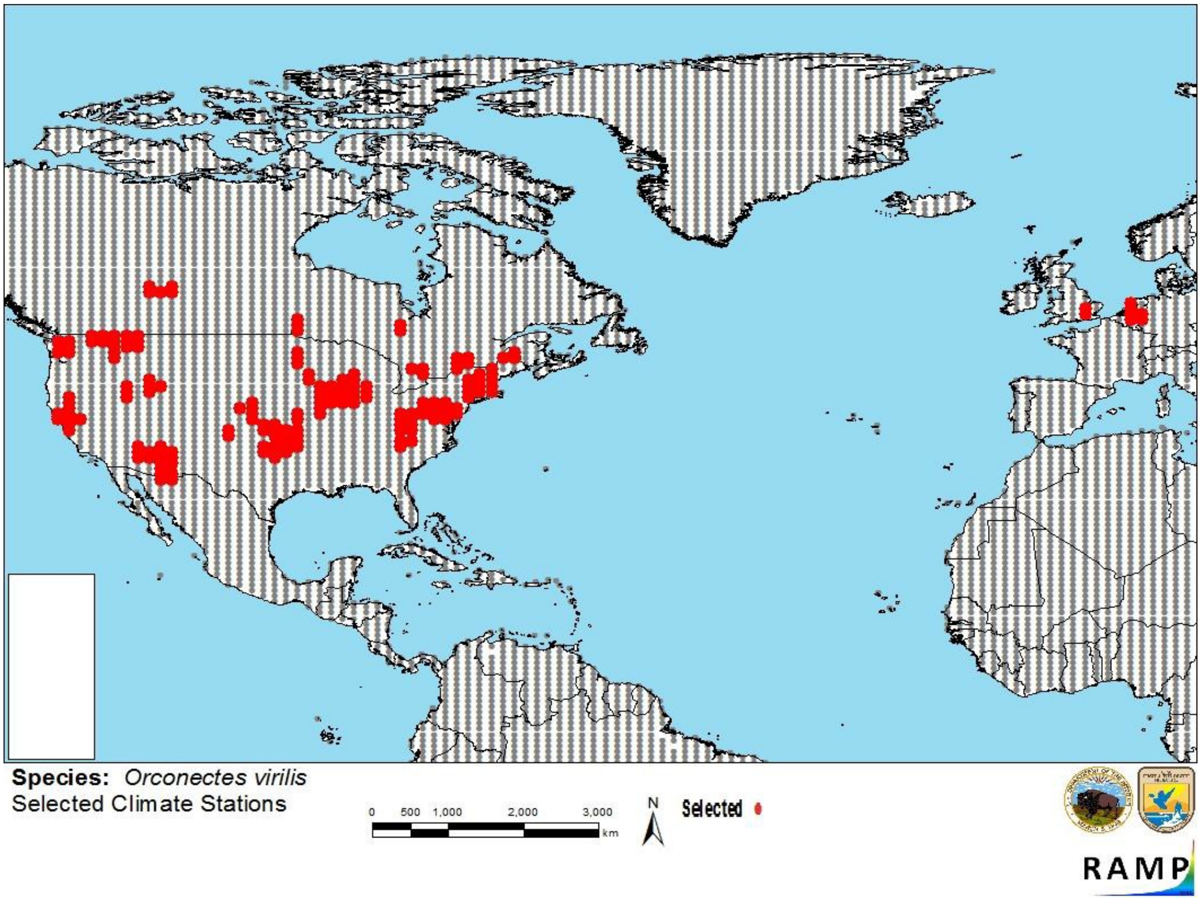

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *O. virilis* climate matching. Source locations from GBIF (2015). Only established locations were used.

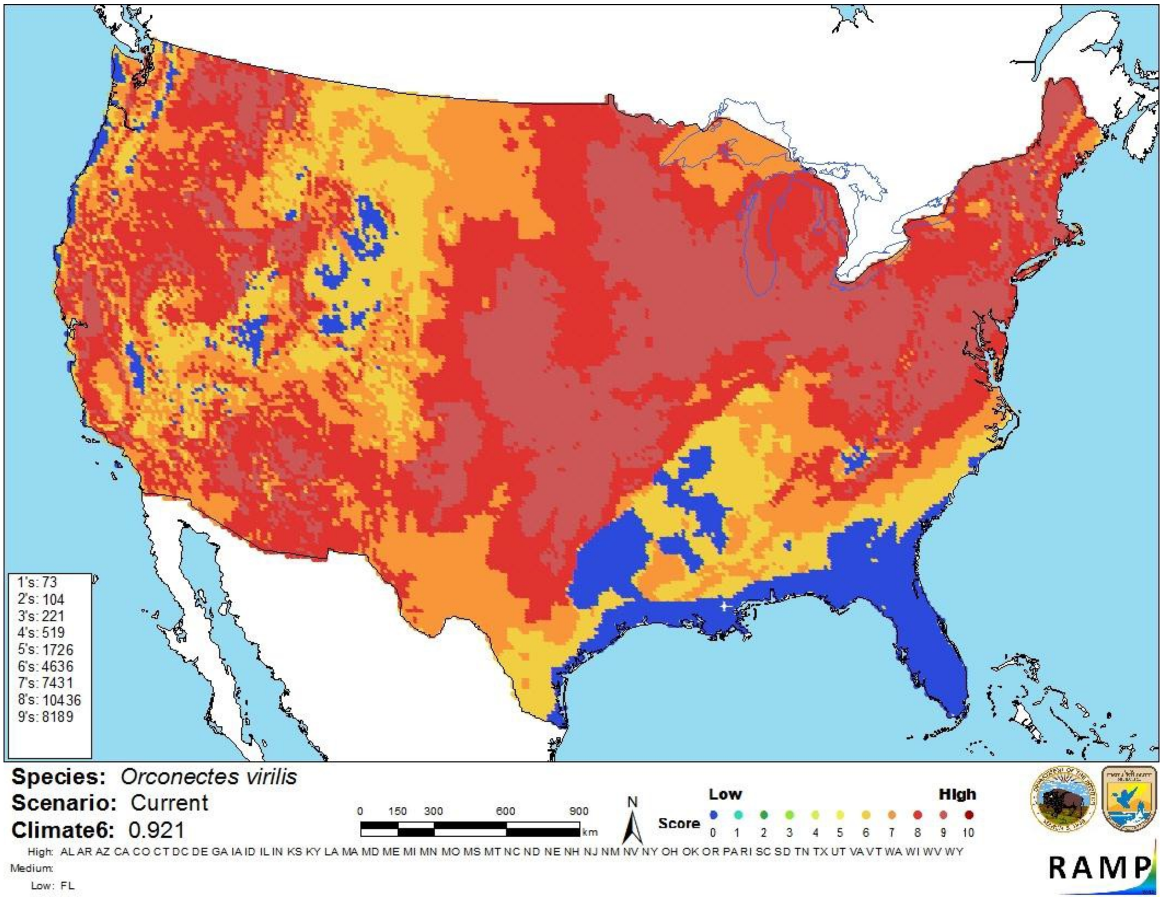

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *O. virilis* in the continental United States based on source locations reported by GBIF (2015). 0= Lowest match, 10=Highest match.

7 Certainty of Assessment

The biology and ecology of *O. virilis* 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

Orconectes virilis is a crayfish native to the northern US that has been introduced to other parts of the contiguous US, Mexico, and Europe. Its introductions have resulted in declines of native macrophytes, macroinvertebrates, and fish. The species is known to carry and/or be susceptible to two OIE-reportable diseases. High climate match and history of invasiveness argues for a high risk of spread and impact of this species. Overall risk is high.

Assessment Elements

- **History of Invasiveness:** High
- **Climate Match:** High
- **Certainty of Assessment:** High
- **Overall Risk Assessment Category: High**

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