Ruffe (*Gymnocephalus cernua*)
Ecological Risk Screening Summary

US Fish and Wildlife Service, February 2011
Revised, July 2014
Revised, June 2015


Photo: USFWS

1 Native Range, and Status in the United States

Native Range
From Fuller et al. (2014):

"Northern Europe and Asia (Berg 1949; Holcik and Hensel 1974; Wheeler 1978; Page and Burr 1991)."

Status in the United States
From Fuller et al. (2014):

"The ruffe was first identified by Wisconsin DNR in specimens collected from the St. Louis River at the border of Minnesota and Wisconsin in 1987 (Pratt 1988; Pratt et al. 1992; Czypinski et al. 1999, 2000, 2001, 2003). Following that report, reexamination of archived samples revealed misidentified larval specimens of ruffe had been collected from the same area in 1986 (Pratt 1988). The ruffe subsequently spread into Duluth Harbor in Lake Superior and several tributaries of the lake (Underhill 1989; Czypinski et al. 1999, 2000, 2004; Scheidegger, pers. comm.; J. Slade, pers. comm.). It is found in the Amnicon, Flag, Iron, Middle, Raspberry, and Bad rivers, Chequamegon Bay, and Apostle Islands National Lakeshore in Wisconsin (Czypinski et al. 1999, 2000, 2001, 2003, 2004; Tilmant 1999). In August 1994, it was found in Saxon Harbor, Wisconsin, and in the upper peninsula of Michigan at the mouths of the Black and Ontonagon rivers (K. Kindt, pers. comm.). In the lower Peninsula of Michigan along Lake Huron, the first three specimens were caught at the mouth of the Thunder Bay River in August 1995 (K. Kindt, pers. comm.). This species has also been collected in Michigan in Lake Michigan, Lake Superior, Torch Lake, Little Bay de Noc in Escanaba, Big Bay de Noc, Misery River, Ontonagon River, Thunder Bay, and Sturgeon River Sloughs (Czypinski et al. 1999, 2000,

2001, 2003, 2004; A. Bowen, pers. comm.; Pearce, pers. comm.; Zorn, pers. comm.). The ruffe has been collected in Lake Superior at Thunder Bay Harbour, Ontario, Canada (Czypinski et al. 1999, 2000, 2001, 2004, 2007)."

Means of Introductions in the United States

From Fuller et al. (2014):

"The ruffe was probably introduced via ship ballast water discharged from a vessel arriving from a Eurasian port, possibly as early as 1982-1983 (Simon and Vondruska 1991; Ruffe Task Force 1992). Within the Great Lakes, the species' spread may have been augmented by intra-lake shipping transport (Pratt et al. 1992; Stepien et al. 1998). Recent genetic research has indicated that the origin of ruffe introduced to the Great Lakes was southern Europe, not the Baltic Sea as previously believed (Stepien et al. 1998)."

Remarks

From Fuller et al. (2014):

"The ruffe has already invaded Lake Superior and GARP modeling predicts it will find suitable habitat almost everywhere in all five Great lakes. GARP models are not able to make a prediction about some of the deeper waters of Lake Superior (U.S. EPA 2008). It has been established in western portion of Lake Superior since about 1988 and expanded in an easterly direction. Ruffe has been reported from Lake Huron at Thunder Bay River, and in Thunder Bay, Lake Superior, Ontario, Canada. It has become the dominant species in the St. Louis River estuary (McLean 1993) and considered the most abundant of the 60 species found in Duluth Harbor (Ruffe Task Force 1992). Based on bottom trawl samples, ruffe makes up an estimated 80% of fish abundances in the southwestern regions of Lake Superior (Leigh 1998). The population in Duluth Harbor was estimated at two million adult fish in 1991 (Ruffe Task Force 1992). In 2006 surveys of Lake Huron, no ruffe were collected from Thunder Bay River and St. Marys River (Czypinski et al. 2007). In fact, ruffe has not been collected in the Thunder Bay region of Lake Huron since 2003 despite sampling efforts nor has it been found elsewhere in the lake (A. Bowen, pers. comm.)."

"The ruffe also has been collected in the Canadian waters of Lake Superior at Thunder Bay and in Kaministiquia River estuary, 290 kilometers northeast of Duluth. Seven fish were collected from the latter location in 1991 (Ruffe Task Force 1992). Busiahn (1993) indicated that the potential North American range of ruffe may well extend from the Great Plains to the eastern seaboard and north into Canada. However, early reports that the ruffe was established in Lake Michigan (e.g., Page and Burr 1991) are considered erroneous. In March 1997, an international symposium was held in Ann Arbor, Michigan, to exchange information on the biology and management of ruffe (Jensen 1997). Ogle et al. (1996) found that certain native species preyed on introduced ruffe; however, their study indicated that predation is unlikely to effectively prevent ruffe from colonizing new areas in the Great Lakes."

"Brazner et al. (1998) found that densely vegetated shoreline wetland habitats provide a refuge from intense competition with ruffe for indigenous fish."

“Since the last ITIS update and 2004 American Fisheries Society names list update, there has been a return to the original species epithet (cernua). Authorities such as Eschmeyer's Catalog of Fishes (30 Sept. 2011 update), the Peterson fish guide, have FishBase reflect this change. According to W. Eschmeyer (pers. comm.), "cernua" is a noun and so does not decline (i.e., not an adjective to match the masculine genus). The ITIS expert for this species also confirmed the valid species name is now *G. cernua* (W. Starnes pers. comm.), although ITIS has yet to reflect that change.”

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2015):

“Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Acanthopterygii
Order Perciformes
Suborder Percoidei
Family Percidae
Genus Gymnocephalus
Species Gymnocephalus cernuus (Linnaeus, 1758)
Taxonomic Status: valid”

Size, Weight, and Age Range

From Froese and Pauly (2015):

“Maturity: Lm 10.5 range ? - ? cm
Max length : 25.0 cm TL male/unsexed [Muus and Dahlström 1968]; common length : 12.0 cm TL male/unsexed [Muus and Dahlström 1968]; max. published weight: 400.00 g [Muus and Dahlström 1968]; max. reported age: 10 years [Kottelat and Freyhof 2007]”

Environment

From Froese and Pauly (2015):

“Freshwater; brackish; demersal; pH range: 7.0 - 7.5; dH range: 8 - 12; potamodromous [Riede 2004]; depth range 10 - ? m [Vostradovsky 1973].”

Climate/Range
From Froese and Pauly (2015):

"Temperate; 10°C - 20°C [Riehl and Baensch 1996]; 74°N - 43°N, 6°W - 169°E"

Distribution Outside the United States
Native
From CABI (2015):

"*G. cernuus* are native to most European countries. They are not native to Spain, Portugal, western France, Norway, northern Finland, Ireland, Scotland, Italy, Greece, Croatia, Serbia, or Montenegro. They are native to most of the former USSR where they inhabit rivers, lakes and brackish sea coastal waters. In the north, the range extends nearly to the coast of the arctic sea and, south, to the Aral, Caspian, and Black seas (Popova et al., 1998). They occur throughout Siberia except they are not found in the Amur River, Lake Baikal, and Transcaucasia (Berg, 1949; Holcik and Hensel, 1974; Popova et al., 1998)."

Introduced
From CABI (2015):

"In Europe they are now found in Loch Lomond, Scotland (Maitland et al.,1983), Llyn Tegid (Bala Lake), Wales (Winfield, 1992), Bathenthwaite Lake, England (Winfield, 1992), Lake Geneva, Switzerland and France, (Matthey, 1966), Lake Constance, on the borders of Austria, Germany and Switzerland (Rösch and Schmid, 1996), Lake Mildevatn, Norway (Käläs, 1995), the Camargue region, France (Ogle, 1998), and Italy (Chiara, 1986)."

Means of Introduction Outside the United States
From CABI (2015):

"The introduction of *G. cernuus* outside their native range has been accidental. The mechanism of introduction is unknown in many cases; however, introductions into England, Wales and Scotland are thought to be from their use as live bait for northern pike (*Esox lucius*) fishing (Maitland and East, 1989; Winfield, 1992)."

Short description
From Froese and Pauly (2015):

"Dorsal spines (total): 11 - 19; Dorsal soft rays (total): 11-16; Anal spines: 2; Anal soft rays: 5 - 6; Vertebrae: 35 - 36. Distinguished uniquely from its congeners by its body depth 24-27% SL. Differs further from other members of the genus by the combination of having a flank yellowish with numerous, small, irregular, dark blotches and having 11-16 dorsal spines [Kottelat and Freyhof 2007]. Caudal fin with 16 to 17 rays [Keith and Allardi 2001]. Dorsal fins are fused. Color brownish with dark spots [Muus and Dahlström 1968]."

Biology
From Froese and Pauly (2015):

"Inhabits eutrophic lakes, lowland and piedmont rivers. Most abundant in estuaries of large rivers, brackish lakes with salinities up to 10-12 ppt and reservoirs. In general, its abundance increases with increased eutrophication [Kottelat and Freyhof 2007]. Reported to prefer still or slow-flowing water with soft bottom and without vegetation [Kottelat and Freyhof 2007] and deep water with deposits of sand and gravel [Vostradovsky 1973]. Can tolerate some degradation of the environment [Billard 1997]. Can co-exist in deep lakes with *Perca fluviatilis*. Both species partly occur at different depths with *Gymnocephalus cernua* being more abundant in deeper layers [Kottelat and Freyhof 2007]. The membranous external walls of the head canals of this species provide high directional sensitivity; can feed at night in the dark using the lateral line system; feeds on zooplankton, chironomids, oligochaetes and amphipods [Collette et al. 1977]. Pelagic in coastal lakes and tidal estuaries, preying on zooplankton and fish. Spawns on a variety of substrates at depths of about 3 m or less [Kottelat and Freyhof 2007]. White to yellow eggs in sticky strands are found on rocks and weed in shallow water [Pinder 2001]. Used as bait for pike [Maitland and Campbell 1992]. Females live up to 10 year while males up to 7 years [Kottelat and Freyhof 2007]."

Human uses
From Froese and Pauly (2015):

"Fisheries: minor commercial; gamefish: yes; bait: usually"

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

Threat to humans
From Froese and Pauly (2015):

"Potential pest"

3 Impacts of Introductions

From Fuller et al. (2014):

"The ruffe has affected fish populations in other areas where introduced. In Scotland, native perch populations declined, and in Russia whitefish numbers have declined because of egg predation by ruffe (McLean 1993). Ruffe exhibits rapid growth and high reproductive output, and adapt to a wide range of habitat types (McLean 1993); therefore the species may pose a threat to native North American fish. Yellow perch *Perca flavescens*, emerald shiners *Notropis atherinoides*, and trout-perch *Percopsis omiscomaycus* have all declined since the introduction of this fish, although the association is not clear (McLean 1993). There is much concern that ruffe may have a detrimental effect on more desirable species in Lake Superior, such as yellow perch

and walleye, by feeding on the young of these species (Raloff 1992), or by competing for food (McLean 1993). Savino and Kolar (1996) conducted a laboratory study to test for competition for food between ruffe and yellow perch. They found that competition could occur between the two species but that the outcome would not always be clear. Each species exhibited competitive advantages and disadvantages. Ogle et al. (1995) studied the diet of introduced ruffe inhabiting the St. Louis estuary. Their findings indicated that the species prey heavily on benthic insects thereby suggesting that ruffe compete for food with yellow perch, trout-perch, and other native benthic-feeding fishes. Fullerton et al. (1998) also observed that similarities in dietary preferences and in feeding rates of ruffe and yellow perch suggest a strong possibility for interspecific competition. Ruffe hold an advantage over native perch in their ability to better select moving objects under relatively dim light conditions or at high turbidity. Kolar et al. (2002) found that in a laboratory setting, ruffe exhibited higher consumption rates of benthic invertebrates than yellow perch in darkness over bare cobble and complex substrates. Ruffe has a very sensitive lateral line system and night adapted vision, and is more adapted to foraging under poor light conditions that yellow perch (Hölker and Thiel 1998). In a study of ruffe predation by native pike, bass, bullhead, walleye, and perch, Mayo et al. (1998) found that though ruffe comprised 71-88% of prey species biomass, all five of the selected predators ate ruffe at lower proportions, preferentially selecting native fish species."

From GISD (2014):

"According to Sea Grant (2002), "*Gymnocephalus cernuus* compete with native fish for food and habitat. Because of this, walleye, perch, and a number of small forage fish species are seriously threatened by continued expansion of the ruffe's range. Hajjar (2002), describes *G. cernuu*s as prolific breeders and aggressive feeders. Their indiscriminate habitat requirements and selected life history traits are conducive to invasion. Their tolerance of different habitats and environmental conditions ensures successful introduction to novel locations.Their early maturation and high fecundity result in quick increases in abundance and quick establishment. *G. cernuus* have a competitive advantage over other bottom feeding fish, such as bream, *Coregonus spp*., roach, sturgeon, smelt, trout perch, Eurasian perch, and yellow perch, due to their flexible foraging abilities. They also "thrive in eutrophic conditions such as those associated with human disturbance, out-competing fish with narrower ecological requirements. They have been implicated in density declines of native fish by egg predation and competition for food in some European waters where they have been introduced. While the impact of *G. cernuus* on the Great Lakes ecosystem has not yet been considerable, the population is increasing and spreading, and has the potential to detrimentally effect highly valued commercial fishery species throughout the Great Lakes. And with the convenient mode of transportation of ballast water in ships traversing the Great Lakes, it is likely that *G. cernuus* will invade further habitats in the Great Lakes.""

From CABI (2015):

"*G. cernuus* is well-suited as an invader species; it matures quickly (sometimes within 1 year), has a high reproductive capacity, spawns multiple times over an extended period, feeds on an assortment of prey, and adapts to a wide variety of environments. They tolerate a wide range of salinities, water temperatures, dissolved oxygen concentrations, substrates, depths, lentic and lotic environments, eutrophic to oligotrophic conditions (Adams and Maitland, 1998; Hölker and

Thiel, 1998; Kovac, 1998; Lehtonen et al., 1998; Ogle, 1998; Popova et al., 1998). They have a competitive advantage over other species by being particularly adept at detecting and capturing prey in low-light or high-turbidity conditions due to an extremely sensitive cephalic lateral line system and retinal tapetum lucidum (Janssen, 1997; Hölker and Thiel, 1998; Ogle, 1998), which also helps to avoid predation in low-light conditions (Mayo et al., 1998). *G. cernuus* also have a morphological predator defence that includes well-developed dorsal and anal spines, and enlarged preopercular spines (Ogle, 1998). Their potential for rapid population growth, coupled with the threat of competition for food and space with native species, and predation on fish eggs (Adams and Tippet[t], 1991; Adams and Maitland, 1998; Hölker and Thiel, 1998; Ogle, 1998; Selgeby, 1998) pose a serious threat to fisheries in areas where they invade. *G. cernuus* has been declared invasive in the Great Lakes of the USA and Canada (Ruffe Control Committee, 1999). In a survey conducted by Winfield et al. (1998) of 31 researchers in 19 European countries, 30% of respondents perceived *G. cernuus* to be a problem. Of those that perceived them as a problem, 75% were introduced populations whereas 25% were native populations. The countries where introduced *G. cernuus* was perceived as a problem included France, Germany (southern), and the UK (Northern Ireland, north-western England, northern Wales, and south-west Scotland). Countries where native *G. cernuus* were perceived as problematic were Estonia and Russia (Yorosland)."

4 Global Distribution

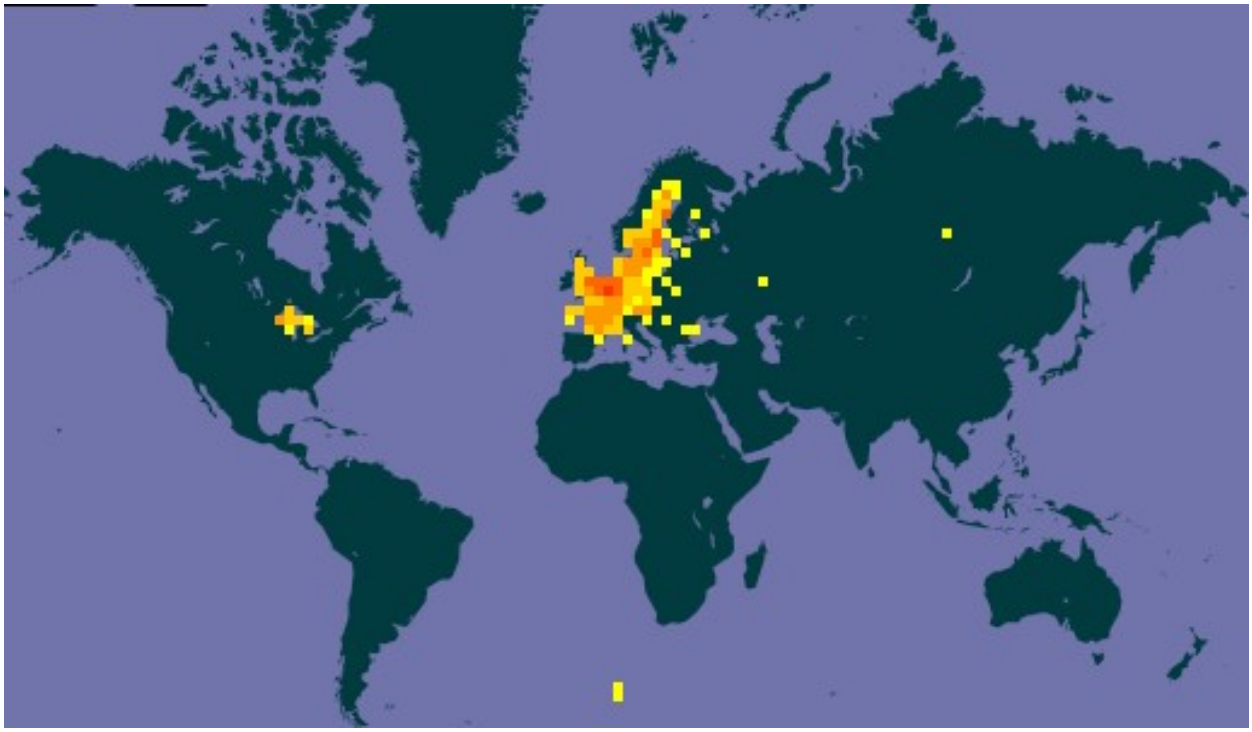

Figure 1. Global distribution of *Gymnocephalus cernua*. Map from GBIF (2015). Locations in Mongolia and the South Atlantic were not included because they were incorrectly located.

5 Distribution within the United States

Figure 2. Distribution of *Gymnocephalus cernua* in the U.S. Map from Fuller et al. (2014).

6 CLIMATCH

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) is extremely high in the Upper Midwest. A few high match areas are also seen in the Interior West. Medium climate matches are seen in the Northern Plains, Northeast, and Mid-Atlantic states, as well as small sections of the West Coast. The southern U.S. and most of the West have a low climate match. Climate 6 match indicates that the continental U.S. has a high climate match. The range for a high climate match is 0.103 and greater; climate match of *Gymnocephalus cernua* is 0.32.

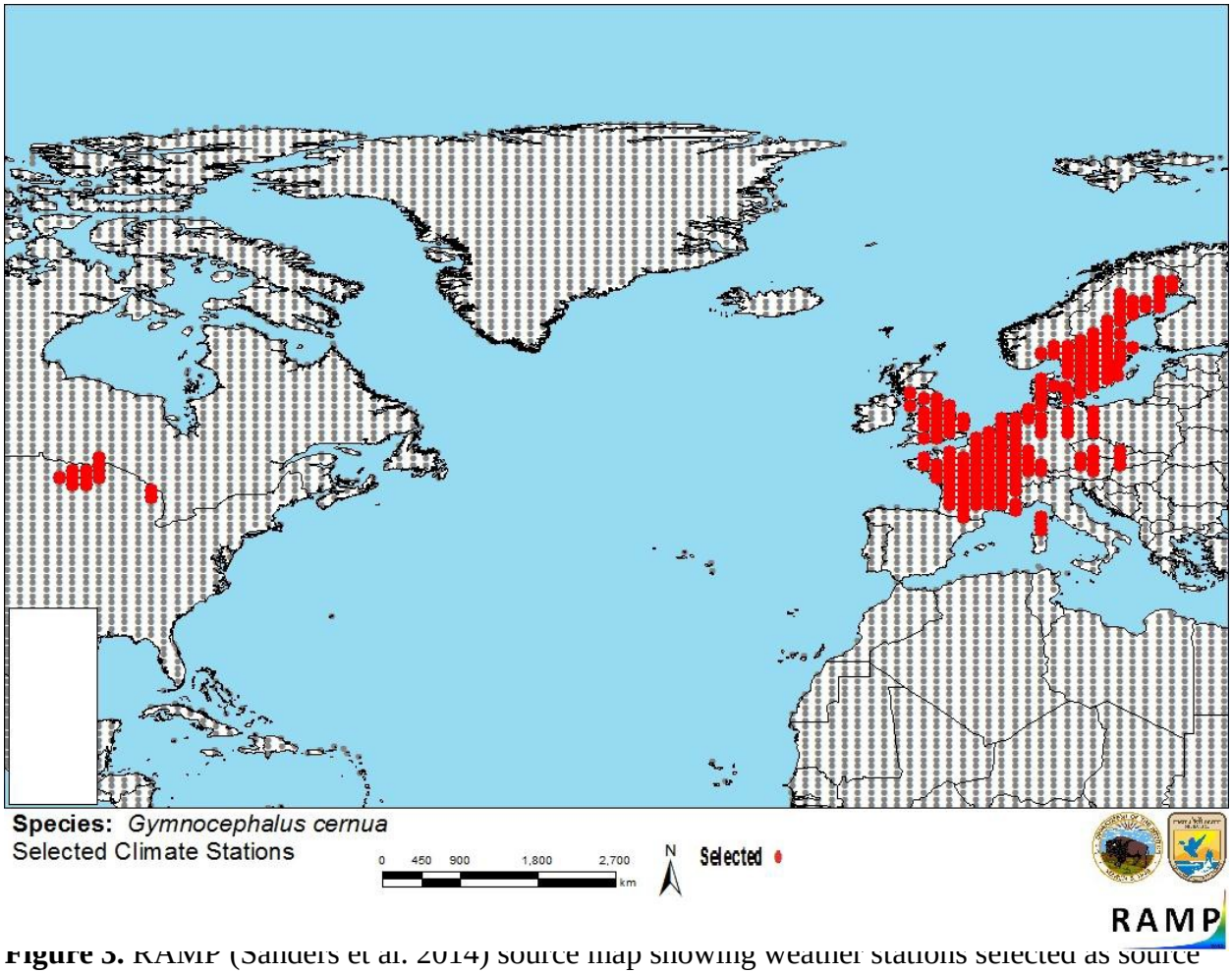

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *Gymnocephalus cernua* climate matching. Source locations from GBIF (2015).

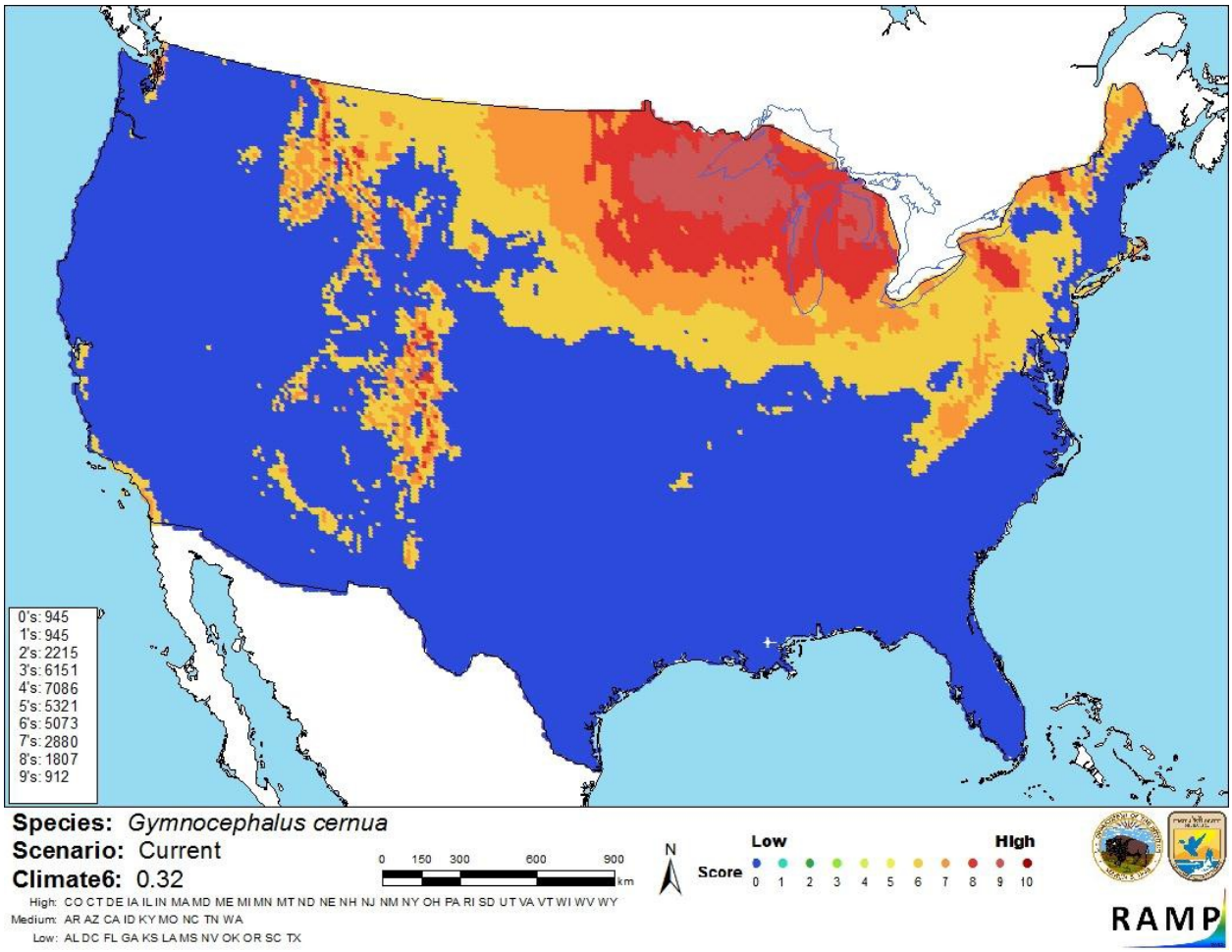

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Gymnocephalus cernua* in the continental United States based on source locations reported by GBIF (2015). 0= Lowest match, 10=Highest match. Counts of climate match scores are shown on left.

7 Certainty of Assessment

G. cernua is a well-known species. Negative impacts from introductions 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 of *G. cernua* in the Great Lakes region are occurring. There is high risk of additional introduction, establishment and impacts in other areas throughout the US by bait fish movement and fish movement through watersheds and flooding. The ruffe is very adaptable and is an extremely aggressive feeder, reducing populations of forage fish consumed by native piscivorous fishes. Consequences have been seen in fish populations in a number of

locations across the globe due to the ruffe. Climate match with the contiguous US is high. The overall risk for this species is high.

Assessment Elements

- **History of Invasiveness (Sec. 3):** High
- **Climate Match (Sec.6):** High
- **Certainty of Assessment (Sec. 7):** High
- **Remarks/Important additional information:** Potential pest
-

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

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