Rudd (*Scardinius erythrophthalmus*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, February 2011
Revised, June 2015

Photo: USGS

1 Native Range, and Status in the United States

Native Range

From Nico et al. (2015):

"Western Europe to the Caspian and Aral sea basins (Berg 1949; Robins et al. 1991b)."

Status in the United States

From Nico et al. (2015):

"This species has been recorded as introduced to 20 states. In a numbers of other states it has been used as a bait fish, but there is as yet no record of it being found in open waters. Available data indicate established populations still survive in Maine and New York, and, more recently, evidence indicates it is established in Massachusetts, Nebraska, and South Dakota. The species had breeding populations in New Jersey, Wisconsin, and Kansas, but it is apparently no longer extant in these states. It has been established in Lake Cobboseecontee, Maine, since 1973 (Courtenay et al. 1984; Burkhead and Williams 1991; Kircheis 1994). It has been established in

the Roeliff-Jansen Kill drainage, New York, since the first half of the 1900s (Smith 1985). Probably in reference to that region, Schmidt (1986) listed rudd as present in the Hudson River drainage in the northern Appalachian region. Other New York populations are considered extirpated (Courtenay et al. 1984; Smith 1985); however, Mills et al. (1993) stated that an established population was discovered in Oneida Lake, New York, in the Lake Ontario drainage, in 1990. It may also be established in the St. Lawrence River and Lake Ontario, but that conclusion awaits confirmation. Hartel et al. (1996) stated that the presence of both young and adults over several years indicated that it is reproducing in the lower Charles River in Massachusetts. According to Zadina (personal communication), rudd is considered to be established in one or more lakes in Nebraska as of 1998. Presumably this includes Lake Ogallala. There also is evidence of rudd reproduction in parts of western South Dakota; during the summer of 1997 several year classes were discovered in Pactola Reservoir, Sheraton Lake, and Newall Lake (Unkenholz, personal communication). The species was established and later became extirpated in New Jersey and Wisconsin (Becker 1983; Courtenay et al. 1984; Courtenay and Williams 1992). There has been at least one established population in Kansas. In Spring 1996, a large breeding population was discovered in a 0.6-acre farm pond in the Deep Creek-Kansas River drainage near Manhattan, Riley County. However, that population was exterminated by Kansas Department of Wildlife and Parks personnel in Summer of 1996; as of early 1998, there has been no record of rudd in sites downstream of the pond (Bever, personal communication). Although they mapped its distribution in Kansas, Cross and Collins (1995) did not provide information on reproductive status. In general, the past literature on rudd distribution and status is fragmentary and somewhat contradictory. Courtenay et al. (1986, 1991), Courtenay and Stauffer (1990), and Courtenay and Williams (1992) considered it established in Maine and New York. Similarly, Page and Burr (1991) stated that it was established in Maine and in the lower Hudson River drainage in New York. In a relatively recent work, Courtenay (1993) indicated that the rudd was established in Maine, New York, Kansas, and presumably Nebraska (postal abbreviation given as NB). Jenkins and Burkhead (1994), citing unpublished information, stated that rudd had become established in Indiana, New York, and Maine. However, we have found no evidence that the rudd was ever introduced to Indiana waters. It is likely that inclusion of Indiana was an error (Burkhead, personal communication). Muoneke (1990) incorrectly cited unpublished information in stating that rudd apparently had become established in Alabama. In many states it has been recorded but not known to be reproducing. For instance, Jenkins and Burkhead (1994) stated that it is unknown whether escapees have established a population in Virginia. Although it has been reported from several reservoirs in Missouri, Pflieger (1997) stated there is no evidence yet that rudd is established in the state. Although we have a relatively recent report of this species from Connecticut (Jones, personal communication; Whitworth (1996) stated that the species has not been found in that state. Biologists in Arkansas say it is not established in that state (N. Stone and S. Barkley, pers. comm. 2007)."

Means of Introductions in the United States

From Nico et al. (2015):

"Bait bucket release seems to be the primary mechanism by which rudd have gained access into open waters. However, the history of its introduction is complex and only partly known. The species apparently entered the United States during two widely separated periods of introduction. It was initially brought to this country either in the late 1800s or early 1900s. A second period of

introduction presumably began in the late 1960s or early 1970s. According to Courtenay and Williams (1992) and Gilbert (1998), rudd first appeared in the United States during the late 1800s. Main support for their conclusion is based on a footnote of Hubbs (1921). In his footnote, reference is made to a brief description by Bean (1897) of a variety of golden shiner *Notemigonus crysoleucas* from Central Park Lake, New York City, which Hubbs concluded to be, in reality, introduced *Scardinius erythrophthalmus*. Hubbs' opinion was based on the "permanent vermilion color of the pectorals, ventrals and anal" described by Bean for specimens apparently held in the New York Aquarium. Later, Bean (1903), repeating the same description as in the 1897 paper, elevated the race to a subspecies (i.e., *Abramis chrysoleucas roseus*). The principal character on which the new form was based was the blood red pigmentation of the fins (hence the name *roseus*). In his investigation on the history of rudd in the United States, Burkhead (personal communication) was unable to locate types for the subspecies, but he did find a single *N. crysoleucas*, dated 1894, from Central Park Lake which he examined and concluded as typical in every respect. According to Burkhead, the available information does not support or refute Hubbs' comments. Furthermore, since Hubbs' remarks presumably are based solely on Bean's color description, Burkhead concluded that it seems prudent to discard Hubbs' inference. The first verifiable U.S. record dates to 1916. In that year, some 300 specimens obtained from the New York aquarium by B. O. Webster, the Wisconsin superintendent of fisheries, were transplanted to Lake Oconomowoc, Wisconsin (Cahn 1927; Greene 1935). Myers (1925) reported on a population in Central Park Lake in New York City. The Central Park population, now extirpated, may have originated from Copake Lake, Roeliff-Jansen Kill system, which also supported a population in 1916 and possibly earlier (M. N. Feinberg, personal communication to Burkhead). The origin of the very first New York fish is not known; however, because rudd is popular in Europe as a food and game species, it may have been introduced for both purposes. The Central Park population also may have been the source for the transplant to a New Jersey park just across the Hudson (Myers 1925; Greeley 1937). The early 1950s capture of rudd by C. R. Robins in Cascadilla Creek, Tompkins County, New York, appears to be the only and last known record from the creek (Courtenay et al. 1984; Smith 1985). The origin of this population is not documented, but the relatively close Roeliff-Jansen Kill population is a logical possibility. The earliest of the more recent records is a 1973 capture of rudd from Cobboseecontee Lake in Maine. Neither year nor origin of the Maine introduction is known. At about the same time, a bait dealer in Suffolk, Virginia, began rearing rudd for bait. The source of the Suffolk, Virginia fish farmer's stock is uncertain. The interest in bait culture of rudd dramatically intensified in the early 1980s. The central Arkansas region of Lonoke and Prairie counties, an area known for its active fish farming industry, apparently became the largest producer of rudd in the United States. It appears that the greatest dispersal of rudd has been through interstate traffic rather than direct European import. In fact, much of its recent culture and spread can be attributed to its popularity as a bait among striped bass *Morone saxatilis* anglers. As a result, rudd have been widely introduced through a combination of bait bucket releases, escapes from aquaculture facilities and farm ponds, and, presumably, by dispersal from various points of introduction (e.g., Burkhead and Williams 1991). Although many rudd introductions are considered accidental, it is likely that rudd also have been intentionally released into public waters during the past few decades.”

Remarks

From Nico et al. (2015):

"Courtenay et al. (1986) described the distribution of rudd in the eastern United States. They listed it among the species with declining populations. However, Courtenay et al. (1991) and Burkhead and Williams (1991) reviewed rudd introductions and documented the more recent and rapid spread of the species as a result of its wide use as a bait fish for white bass. Many states now outlaw the use of rudd as a live bait. As a result, its rapid spread appears to have slowed."

"Although there is no evidence that rudd have been introduced to California, Dill and Cordone (1997) expressed concern that rudd may find its way into the state as a contaminant in golden shiner shipments imported as bait from Arkansas. This species has been cultured in Arkansas and Virginia (and possibly elsewhere) as baitfish and distributed to bait stores in at least 16 states (Courtenay and Williams 1992). Two specimens were taken from the Canadian side of Lake Erie at Crystal Beach (near Port Abino) in June 1997 (A. Dextrase, personal communication). That record is the first report of rudd from Lake Erie."

"Guinan et al. (2015) reported a similar summer trophic position to introduced Common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*), and suggested that seasonal trophic flexibility as a potential driver to facilitate both introduction success and the creation of novel nutrient transfer pathways among habitat types."

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 Ostariophysi
Order Cypriniformes
Superfamily Cyprinoidea
Family Cyprinidae
Genus Scardinius
Species Scardinius erythrophthalmus (Linnaeus, 1758)"

"Taxonomic Status: valid"

Size, Weight, and Age Range

From Froese and Pauly (2015):

"Max length : 51.0 cm TL male/unsexed [Billard 1997]; common length : 20.0 cm TL male/unsexed [Muus and Dahlström 1968]; max. published weight: 2.1 kg [Maitland and Campbell 1992]; max. reported age: 19 years [Gerstmeier and Romig 1998]"

Environment

From Froese and Pauly (2015):

"Freshwater; brackish; benthopelagic; pH range: 7.0 - 7.5; dH range: 10 - 15; potamodromous [Riede 2004]; depth range 0 - ? m."

Climate/Range

From Froese and Pauly (2015):

"Temperate; 2°C - 22°C [Gerstmeier and Romig 1998]; 62°N - 36°N, 10°W - 70°E"

Distribution Outside the United States

Native

From Froese and Pauly (2015):

"Eurasia: Most European rivers north of Pyrenees and Alps, eastward to Ural and Eya drainages, Aral and White Sea basins; Black Sea basin in Europe and northern Asia Minor. Naturally absent from Iberian Peninsula, Adriatic basin, Italy, Greece south of Pinios drainage, Great Britain north of 54 N, Ireland and Scandinavia north of 62° N [Kottelat and Freyhof 1997]. Definitely absent in Siberia. Reports from this area arose from the confusion between the rudd and the roach [Berg 1949]."

Introduced

From CABI (2015):

"Canada … Ireland … Madagascar … Morocco … New Zealand … Spain … Tunisia … USA"

Means of Introduction Outside the United States

From CABI (2015):

"Bait bucket release is believed to be the primary mechanism by which *S. erythrophthalmus* has gained access to open waters (Nico et al., 2008)."

From GISD (2010):

"Natural dispersal: Rudd are able to disperse within connected water bodies.
Smuggling: Rudd have been introduced illegally by anglers in some countries.

Stocking: Angling organisations may realease rudd as a sport fish."

Short description

From Froese and Pauly (2015):

"Dorsal spines (total): 3; Dorsal soft rays (total): 8 - 9; Anal spines: 3; Anal soft rays: 8 - 12; Vertebrae: 36 - 39. Distinguished from its congeners in Europe by the following combination of characters: 39-42 scales along lateral line; anal fin with 10-13½ branched rays; 9-12 gill rakers; dorsal head profile straight or slightly convex, snout pointing forward, tip at or slightly above level of middle of eye; back not humped behind nape; eye bit close to dorsal head profile when viewed laterally; articulation of lower jaw in front of anterior margin of eye; head and body compressed, head width 13-14% SL; head length 24-28% SL; caudal peduncle depth 1.5-2.0 times in its length, 11-12% SL; and all fins with reddish hue, pelvic fin deep red [Kottelat and Freyhof 2007]. Caudal fin with 18-19 rays [Spillman 1961]"

Biology

From GISD (2010):

"**Nutrition**
Largely carnivorous. When small rudd feed on aquatic crustaceans, snails and insects. As they grow larger they include small fish, worms, detritus, aquatic plants and terrestrial insects in their diet (McDowall, 2000).
Reproduction
Reproduction is by external fertilisation, with large numbers of small eggs (1 - 1.4mm in diameter) deposited amongst aquatic vegetation. Spawning occurs once per year over spring/summer, when water temperatures rise above about 18°C (McDowall, 1990)
Lifecycle stages
Males mature at the age of one, females at one to two. Lifespan exceeds four years (McDowall, 2000).
Newly hatched fish attach themselves to aquatic plants using adhesive organs. They stay attached for several days while the sustenance contained within the yolk sac is used up(McDowall, 1990)."

Human uses

From Froese and Pauly (2015):

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

Diseases

From Froese and Pauly (2015):

"Black Spot Disease 1, Parasitic infestations (protozoa, worms, etc.)"

From Bergmann et al. (2010):

“Carp pox virus not only infects different fish, e.g. carp or koi, *Cyprinus carpio* L., goldfish, *Carassius auratus* (L.), and golden ide, *Leuciscus idus* (L.), but also crucian carp, *Carassius carassius* (L.), barbel, *Barbus barbus* (L.), bream, *Abramis brama* (L.), pike-perch, *Stizostedion lucioperca* (L.), rudd, *Scardinius erythrophthalmus* (L.), smelt, *Osmerus eperlanus* (L.), tench, *Tinca tinca* (L.), carp × goldfish hybrid and various ornamental aquarium fish (McAllister, Lidgerding, Herman, Hoyer & Hankins 1985; Stoskopf 1992), CyHV-2 has only been detected in goldfish (Jung & Miyazaki 1995; Goodwin, Khoo, LaPatra, Bonar, Key, Garner & Hanson 2006), but investigations at CEFAS in Weymouth (Dr Keith Way, personal communication) found GHV in a crucian carp population. The third cyprinid herpesvirus, KHV, causes infection and induces disease in *C. carpio*. Other species, such as goldfish (El-Matbouli, Saleh & Soliman 2007; Sadler et al. 2007), crucian carp, grass carp, *Ctenopharyngodon idella* Valenciennes, or tench (Kempter & Bergmann 2007; Meyer 2008), are susceptible to infection and act as carriers.”

From Fabian et al. (2013):

“Tissue samples taken from bream, *Abramis brama* (L.), brown bullhead, *Ictalurus nebulosus* (L.), gudgeon, *Gobio gobio* (L.), common dace, *Leuciscus leuciscus* (L.), roach, *Rutilus rutilus* (L.), rudd, *Scardinius erythrophthalmus* (L.), European perch, *Perca fluviatilis* L., Northern pike, *Esox lucius* L., tench, *Tinca tinca* L., and three-spined stickleback, *Gasterosteus aculeatus* L., were found to be positive for KHV with a large variation in prevalence and a concentration range of 1–180 copies per 1250 ng DNA”

Koi herpesvirus disease is an OIE-reportable disease.

Threat to humans

From Froese and Pauly (2015):

“Potential pest.”

3 Impacts of Introductions

From Nico et al. (2015):

“Impact of Introduction: Largely unknown. In a laboratory setting, Burkhead and Williams (1991) demonstrated that rudd readily hybridize with native golden shiner, *Notemigonus crysoleucas*, a primary forage species of many native game fishes. As such, the probability exists that rudd introduced to open waters will hybridize with golden shiner, with unknown consequences to wild populations of the native species. First generation hybrids offspring should show heterosis (or hybrid vigor), but the "genetic pollution" in subsequent generations could prove detrimental due to a variety of factors, for instance spawning behavior and recruitment success, and general loss of fitness (Burkhead and Williams 1991; Courtenay and Williams 1992). Nevertheless, the interactions of the two species in nature are not known (Burkhead, personal communication).”

From Lake et al. (2002):

"Frequently, rudd have been associated with macrophyte collapse and a switch from clear to turbid water. Not only do rudd find *Nitella* spp. and *Potamogeton ochreatus*, two key species in unmodified lake ecosystems, particularly palatable, but the ecological problems are likely to be compounded by the feeding habit of rudd. Typically rudd concentrate their grazing effort on the growing apices of *Egeria densa* (Lake, 1998), which are the meristems on which plant growth is dependent (Crawley, 1983)."

"Though rudd have relatively low consumption rates of submerged aquatic macrophytes compared to grass carp, they may attain high densities without an efficient predator such as pike (*Esox lucius* L.). Rudd may prove to be a significant additive factor causing macrophyte decline in New Zealand once macrophytes become stressed through perturbations such as decreased water clarity caused by suspended sediment or algal blooms. Also, our study shows that rudd have the capacity to modify plant communities by selectively removing palatable charophytes such as *Nitella* spp."

"Selective feeding by rudd may also be significant in lakes that have been invaded by exotic oxygen weeds in New Zealand (e.g. *Egeria densa*, *Elodea canadensis*, and *Lagarosiphon major*) by facilitating their monospecific habit through suppression or exclusion of more desirable species. Van Donk & Otte (1996) observed a shift in macrophyte species composition in the Netherlands from *Elodea nuttallii* Planch. and *Potamogeton berchtholdii* (Fieb.) to *Ceratophyllum demersum*, which they attributed to the selective grazing of both rudd and coots (*Fulica atra* L.)"

From Schallenberg and Sorrell (2009):

"We reviewed lakes in New Zealand reported to have undergone regime shifts between macrophyte-dominated clear water states and devegetated, turbid states. … Regime shifts were positively related to the percentage of the catchment in pasture and negatively related to the percentage of the catchment in forest. The occurrences of the introduced macrophyte *Egeria densa* and the introduced fish, *Ameiurus nebulosus* (catfish), *Carassius auratus* (goldfish), *Scardinius erythrophthalmus* (rudd), *Cyprinus carpio* (koi carp), and *Tinca tinca* (tench), were significantly correlated to regime shifts in lakes."

From Kapuscinski et al. (2014):

"We tested feeding selectivity by rudd using five species of aquatic macrophytes: *Ceratophyllum demersum*, *Elodea canadensis*, *Najas flexilis*, *Stuckenia pectinata* and *Vallisneria americana*. … Rudd fed selectively, with consumption declining in the order *N. flexilis* > *E. canadensis* > *S. pectinata* > *V. americana* > *C. demersum*. … Selective feeding by rudd (which can be very numerous in North American fresh waters) could evidently alter macrophyte assemblages and hinder attempts to restore plant communities."

4 Global Distribution

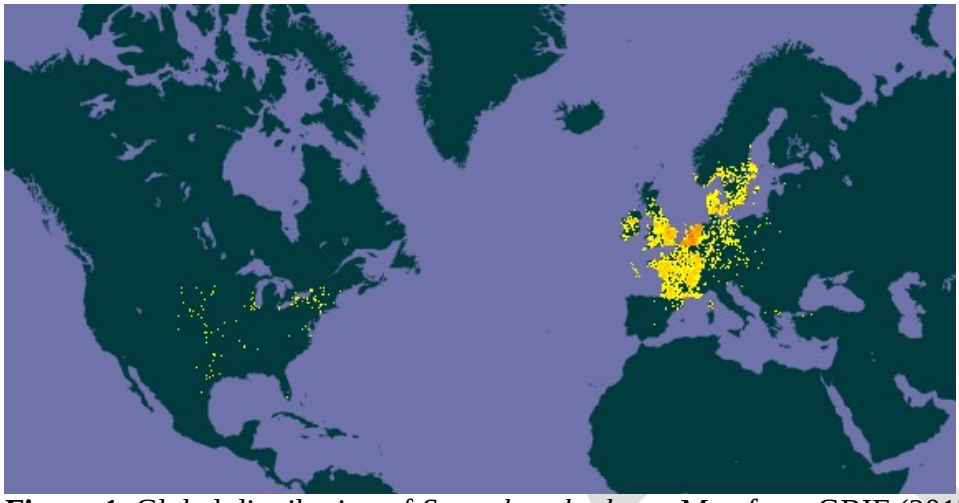

Figure 1. Global distribution of *S. erythrophtalmus*. Map from GBIF (2013).

5 Distribution within the United States

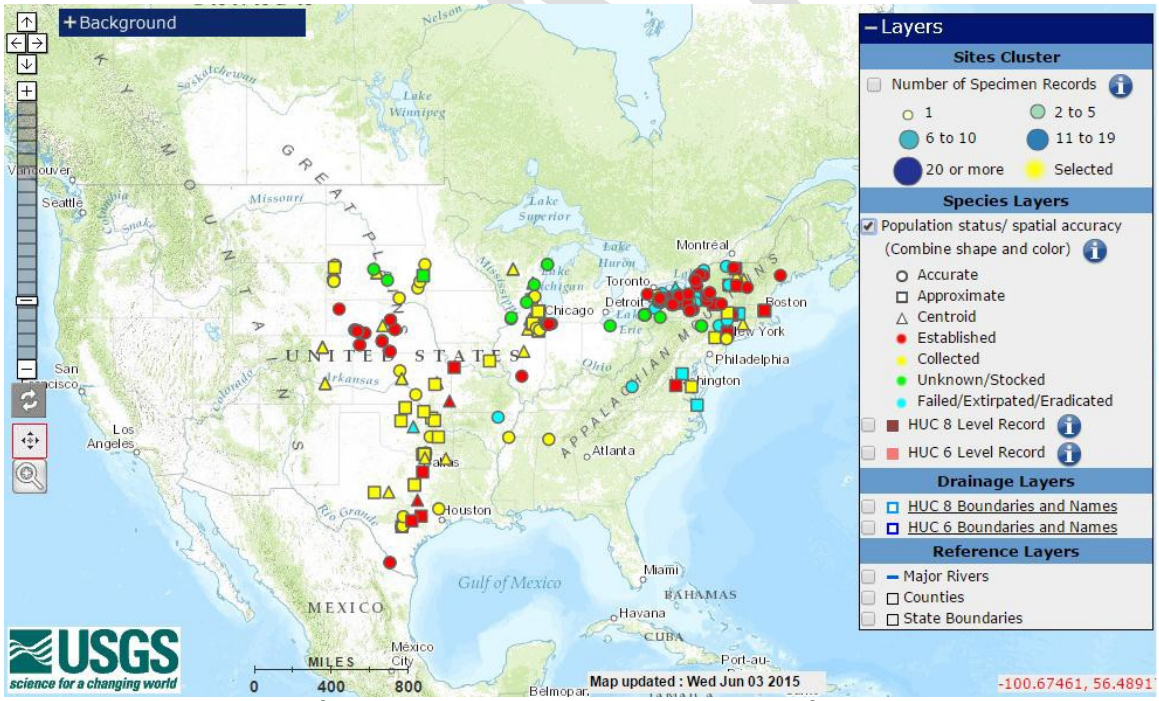

Figure 2. Distribution of *S. erythrophthalmus* in the US. Map from Nico et al. (2015).

6 Climate Match

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was high to very high for much of the central and eastern portions of the United States. Climate matching

was low in the Southeast, apart from the Atlantic coast. Isolated pockets of medium to high climate match were found on the West Coast, but most of the West had a low match. Climate 6 proportion indicated that the US has a high climate match for *S. erythrophthalmus*. The range for a high climate match is 0.103 and greater; climate match of *S. erythrophthalmus* is 0.636.

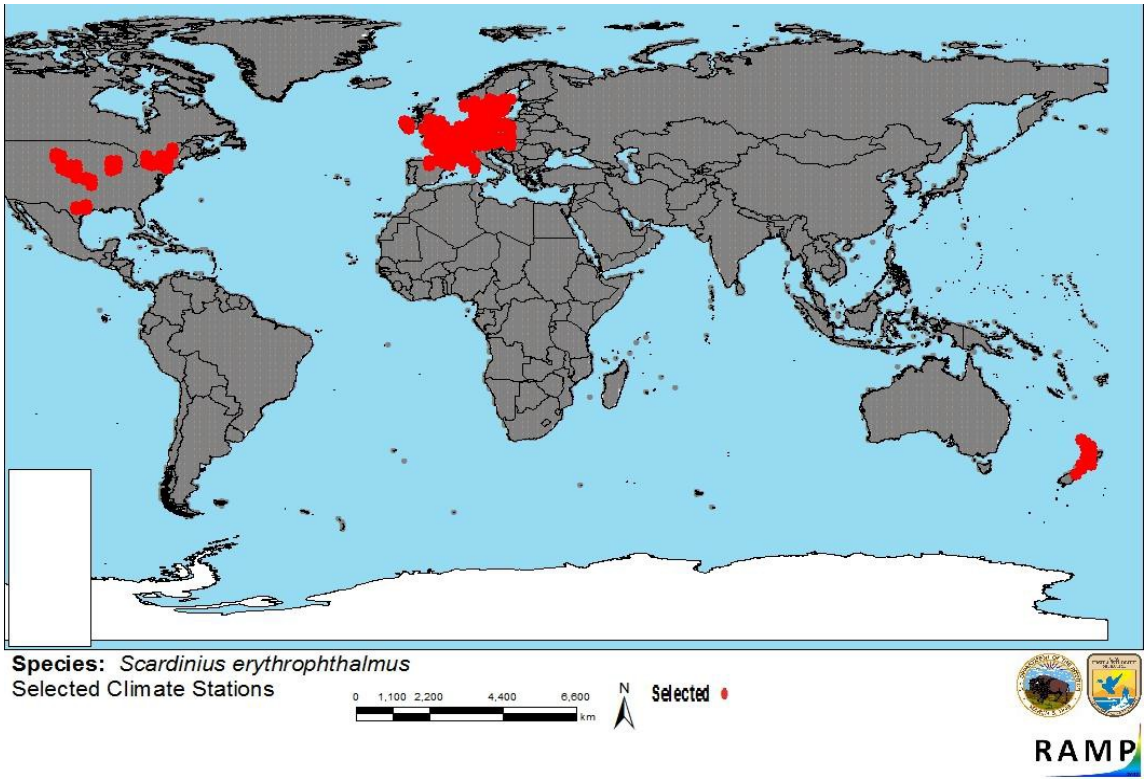

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *S. erythrophthalmus* climate matching. Source locations from GBIF (2013) and NIWA (2013).

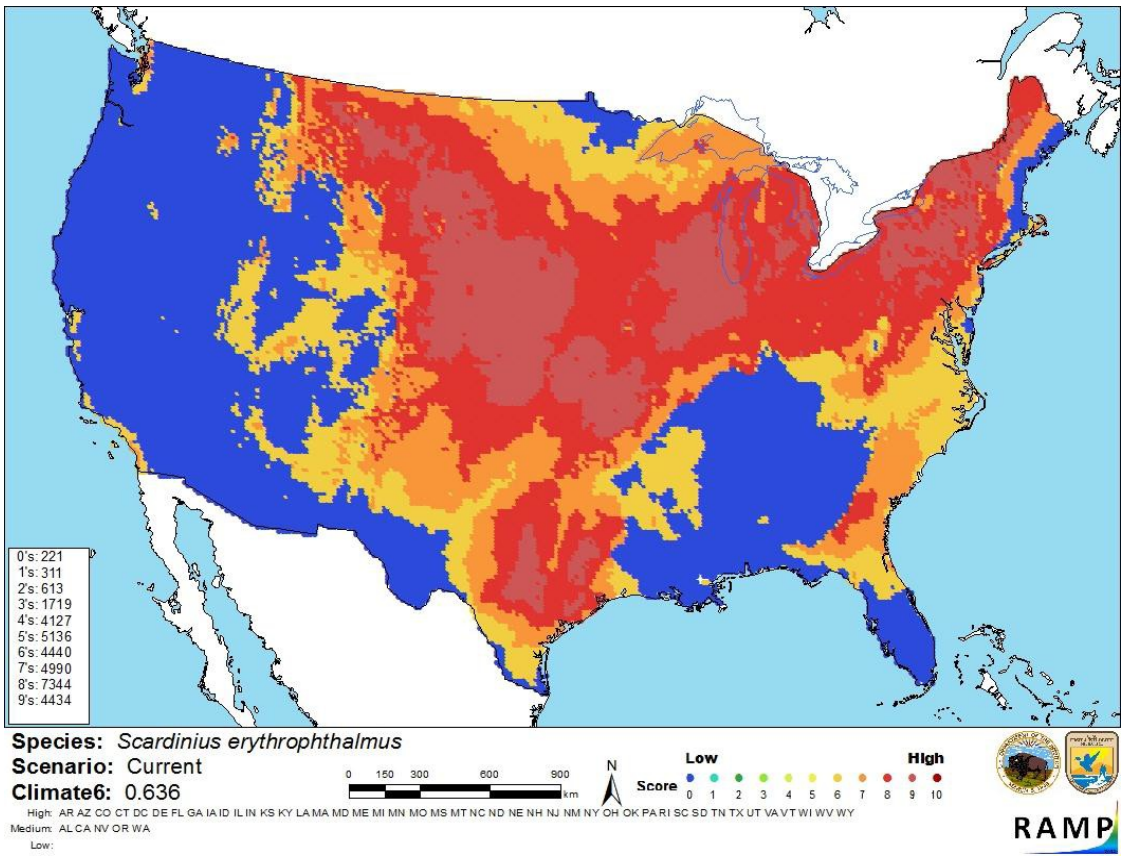

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *S. erythrophthalmus* in the continental United States based on source locations reported by GBIF (2013) and NIWA (2013). 0= Lowest match, 10=Highest match.

7 Certainty of Assessment

Some information is lacking on the distribution and establishment of *S. erythrophthalmus*. There are documented impacts of the species in a few of the areas where it has been introduced, but confusion over the impacts still exists. For these reasons, this assessment is made with medium certainty.

8 Risk Assessment

Summary of Risk to the Continental United States

Establishment of *S. erythrophthalmus* is occurring in the United States, Canada, and Eurasia. Climate match is high, so there is a high likelihood that *S. erythrophthalmus* will establish itself in new waterways, if allowed to invade them. The species is known to change macrophyte communities through selective grazing, which has sometimes contributed to regime shifts in the lakes it has invaded. 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):** Medium

☐ **Overall Risk Assessment Category: High**

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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Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

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