Vendace (*Coregonus albula*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, August 2012
Revised, September 2014 and July 2015

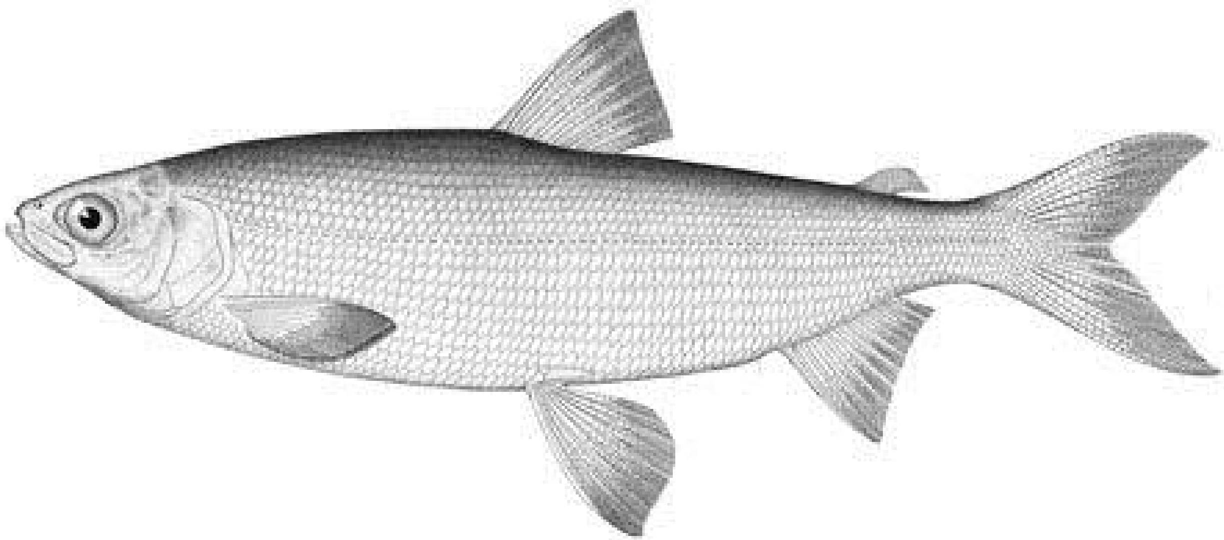

Photo: © Smithsonian Institution, National Museum of Natural History, Department of Vertebrate Zoology, Division of Fishes

1 Native Range, and Status in the United States

Native Range

From Froese and Pauly (2015):

"Europe: Baltic basin, lakes of upper Volga drainage (Seliger, Vseluga, Perejaslavskoe), some lakes of White sea basin and North Sea basin east of Elbe drainage. Anadromous in Gulf of Finland and marine in northernmost freshened part of Gulf of Bothnia; north to about 69° N in Lake Inari, northern Finland; lower Rhine (now extirpated). "

Status in the United States

From Fuller and Nico (2014):

"Thousands of young fish or fry, purported to be this species, were stocked in **Maine** in Heart Pond (Penobscot River drainage) near Bucksport, Hancock County, and Lake Hebron, Piscataquis County, during the 1880s (Smiley 1885; Baird 1889; Bean 1892; Todd 1983). … The introductions failed (Kendall 1914)."

Means of Introductions in the United States

From Fuller and Nico (2014):

"Several shipments of eggs, originally identified as coming from *Coregonus albula*, were imported from Germany by the U.S. Fish Commission in the 1880s. The Commission instructed C. G. Atkins to hatch the eggs in captivity; all or most of the surviving young were later released into the two Maine lakes (e.g., Smiley 1885). Intentionally stocked, this species was apparently seen as a potential food fish."

Remarks

From Fuller and Nico (2014):

"There is confusion over whether or not the true *Coregonus albula* was actually the one imported and stocked in this country. Todd (1983) investigated the history of the early *Coregonus* transfers and summarized much of the information. He was informed by one German contact that the fish imported to the United States from hatcheries on the Bodensee/Lake Constance (such as the 1885 shipment and possibly others) were more likely *C. wartmanni*. Kendall (1914) used the name *Leucichthys albula* for this species."

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 Protacanthopterygii
Order Salmoniformes
Family Salmonidae
Subfamily Coregoninae
Genus Coregonus
Species *Coregonus albula* (Linnaeus, 1758) – vendace"

"Taxonomic Status: valid"

Size, Weight, and Age Range

From Froese and Pauly (2015):

"Max length : 48.0 cm TL male/unsexed; [Muus and Dahlström 1968]; common length : 20.0 cm TL male/unsexed; [Muus and Dahlström 1968]; max. published weight: 1.0 kg [Muus and Dahlström 1968]; max. reported age: 10 years [Berg 1962]"

From CABI (2015):

"Vendace matures within the second to fifth years of life, at lengths 9-20 cm. In most populations, vendace rarely attain lengths >25 cm ([Sandlund 1992]; Kottelat and Freyhof, 2007; Amundsen et al., 2012), but in some lakes small and large grown forms co-exist (Reshetnikov, 2003; Gordeeva et al., 2009)."

Environment

From Froese and Pauly (2015):

"Marine; freshwater; brackish; benthopelagic; anadromous [Riede 2004]; depth range 30 - ? m."

Climate/Range

From Froese and Pauly (2015):

"Temperate; 71°N - 69°N, 2°W - 61°E"

Distribution Outside the United States

Native

From Froese and Pauly (2015):

"Europe: Baltic basin, lakes of upper Volga drainage (Seliger, Vseluga, Perejaslavskoe), some lakes of White sea basin and North Sea basin east of Elbe drainage. Anadromous in Gulf of Finland and marine in northernmost freshened part of Gulf of Bothnia; north to about 69° N in Lake Inari, northern Finland; lower Rhine (now extirpated)."

Introduced

From Froese and Pauly (2015):

"Netherlands [Bartley 2006]"
"Russian Fed. [NOBANIS 2013]"; "USSR (Holcík 1991)"
"Norway (NOBANIS 2013)"
"France [Blanc et al. 1971]"
"Ukraine [Blanc et al. 1971]"
"Belarus [Blanc et al. 1971]"
"Romania [FAO 1997]"
"Hungary [FAO 1997]"

"Czech Republic [Lusk et al. 2010]"
"Kazakhstan [Mitrofanov and Petr 1999]"

Means of Introduction Outside the United States

From CABI (2015):

"Most introductions are related to deliberate stocking and/or aquaculture for the purpose of increasing the potential for freshwater fisheries. Subsequent establishment and spread depends on the characteristics of the receiving ecosystem, and may be aided by the construction of reservoirs (e.g. Semenov, 2011)."

"Sport fishers also sometimes use vendace as bait, and in the case of transport of live bait this may present a risk of introduction to non-native water systems."

Short description

From Froese and Pauly (2015):

"Dorsal spines (total): 0; Dorsal soft rays (total): 11-13; Anal spines: 0; Anal soft rays: 13 - 17"

Biology

From Froese and Pauly (2015):

"Lacustrine and marine in open water. At sea, forages close to coast [Kottelat and Freyhof 2007]. Forms pelagic schools in deeper lakes [Svetovidov 1984]. Spawns along shores, at 3-10 m depth, rarely to 22 m depth or just below surface. Spawns deeper in clear lakes and closer to surface in lakes with humic waters [Kottelat and Freyhof 2007]. Spawns on shallow sand or gravel substrate. Anadromous in the Baltic. Feeds on planktonic crustaceans [Svetovidov 1984]."

From CABI (2015):

"Vendace is characterized as a specialized planktivore (Svärdson, 1976; [Andersson] et al., 2007), and zooplankton typically make up 75-100% of total food intake. In lakes with both small and large forms, the larger form may be partly piscivorous (Reshetnikov and Lukin, 2006) and fish can make up 20-74% of the diet. Piscivory has also been observed in small-grown vendace, but this is regarded as rather unusual (Liso et al., 2011)."

"Most vendace populations spawn in autumn on sand or gravel, usually in areas of 6-10 m depth, but winter and spring spawning populations also exist (Vuorinen et al., 1981). Vendace have high fecundity and many small eggs (80-300 egg per gram body mass). Eggs hatch around the time the lake ice disappears in spring. Due to the small egg size, the yolk sac has limited resources and vendace recruitment success may therefore be highly dependent on good timing between the hatching and the spring bloom."

"In some lacustrine populations, mature vendace make spawning migrations and spawn in rivers (Sandlund, 1992). Anadromous vendace ascend a short distance up rivers in shoals in late August to mid-October and spawn in rivers later in autumn (Svetovidov, 1984). The newly hatched larvae drift to lacustrine areas shortly after hatching (Næsje et al., 1986). Typically, length of the larvae at hatching is 7-11 mm."

"Vendace undertake shoaling and diel vertical migrations (Gjelland et al., 2009)"

Human uses

From Froese and Pauly (2015):

"Fisheries: commercial; aquaculture: experimental"

Diseases

From Meyer and Robinson (1973):

"Branchiomycosis, a gill disease caused by fungi of the genus *Branchiomyces*, is considered a major problem in European commercial fish production [Plehn 1924; Van Duijn 1956; Reichenbach-Klinke and Elkan 1965]. … Huculak [1958] reported a 100 percent loss of *Coregonus albula* when they were stocked in rearing ponds with infected carp."

Threat to humans

From Froese and Pauly (2015):

"Harmless"

3 Impacts of Introductions

From CABI (2015):

"Strong effects from the vendace planktivory have been reported as reduced zooplankton diversity, reduced individual zooplankter size, and reduced zooplankton densities. This has resulted in lowered zooplankton availability for planktivorous fish, and to a large extent displaced native planktivores from the pelagic fish communities through exploitative competition. Due to its relatively small size, vendace is an attractive prey and an important food source for pelagic piscivores. Vendace have been purposely introduced to a wide range of lakes and reservoirs."

"Studies of changes in the invading vendace population come from many different lake systems, e.g. Lake Osensjøen, southern Norway (Vuorinen et al., 1991; Sandlund, 1992), Solovetsky Islands ([Gordeeva] et al., 2009), Ural (Nesterenko, 1976), Volga drainage (Semenov, 2011), Kazakhstan (Mitrofanov and Petr, 1999), and Inari-Pasvik watercourse (Amundsen et al., 2012)."

"Being an effective zooplanktivore, vendace may heavily reduce the zooplankton stock, in turn leading to reduced algal grazing by zooplankton (trophic cascade). This may aid eutrophication of the lake. However, vendace are sensitive to eutrophication, and the potential eutrophication effect from vendace zooplankton grazing is therefore limited."

“Vendace have been observed to reduce zooplankton diversity, resulting in smaller zooplankton species and smaller sizes of individual zooplankters (Bøhn and Amundsen,1998; Amundsen et al., 2009). They have also led to large reductions in densities of native planktivorous *Coregonus lavaretus* (Bøhn and Amundsen, 2001; Gjelland et al., 2007; Bøhn et al., 2008).”

From Liso et al. (2011):

“Following the first establishment of *C. albula* in the upper part of the watercourse, native pelagic dwelling European whitefish *Coregonus lavaretus* (L.) rapidly disappeared from the pelagic zone and suffered a severe reduction in population density (Amundsen et al., 1999; Bøhn et al., 2008). The zooplankton community was heavily affected by the invader, showing a general decline in density and body size, and distinct changes in species composition (Amundsen et al., 2009). Apparently the depletion of the zooplankton resource was so severe that even the invader suffered food limitations resulting in reduced somatic growth and altered life-history variables (Bøhn et al., 2004, 2008; Gjelland et al., 2007). By 2008, the heavy predation had led to the lowest numerical density of zooplankton ever recorded in Lake Ruskebukta (69◦ 13’ N; 29◦ 14’ E; 52 m a.s.l.) in the upper part of the Pasvik watercourse, constituting only 6·8% of the density recorded in 1991, i.e. at the time when *C. albula* first arrived in the watercourse (Amundsen et al., 2009).”

“The occurrence of piscivory in the small-size *C. albula* in Pasvik hence remains highly surprising and has to be discussed in the light of the strong *C. albula* population build-up following the invasion. The efficient zooplankton feeding of the dense *C. albula* population has apparently resulted in a breakdown of the zooplankton community (Bøhn et al., 2008; P.A. Amundsen, unpubl. data), and the observed piscivory in the *C. albula* population is probably related to an extreme scarcity of the zooplankton resource. The piscivorous feeding may therefore reflect a wider food niche and a more generalist feeding strategy in response to a resource shortage. This is supported by the fact that surface insects, the main diet category observed in the present study, also represent a rather atypical prey for *C. albula* that previously has made only negligible contributions to the diet (Bøhn & Amundsen, 2001; Gjelland et al., 2007). Hence, this zooplanktivorous specialist has apparently been able to expand its dietary niche width and has made a pronounced feeding shift towards previously unused prey resources following the zooplankton depletion. This abrupt and surprising niche shift may potentially provide alternative food resources for a sustainable development of the *C. albula* population even under severe zooplankton depletion.”

From Bøhn and Amundsen (2001):

“Feeding ecology and habitat use were studied in native whitefish (*Coregonus lavaretus*) and recently invading vendace (*C. albula*) in two lake localities situated 50 km apart within the subarctic Pasvik River system, northern Norway and Russia. Whitefish originally dominated the native fish communities of both lakes. The recent invasion and successive downstream expansion of vendace allowed comparisons between two sites: one in which the influence of the new potential competitor on the native fish species was weak, and one in which the influence was strong. In the downstream lake vendace was recorded for the first time at the time of the study, and only in small numbers, whereas in the upstream lake vendace had established a high population density and was the dominant fish species in the pelagic zone. … In the downstream lake both whitefish and vendace fed exclusively on zooplankton and had almost identical diets. In the upstream lake, in contrast, whitefish fed predominantly on zoobenthos and surface insects, while vendace fed mainly on zooplankton. Thus, the strong presence of vendace as a specialized planktivore reduced the availability of zooplankton as prey for the more generalist whitefish. The food segregation between the two fish species in the upstream lake was apparently interactive and caused by a strong asymmetrical competition for zooplankton, vendace being the superior species. The ecological consequences (including reduced zooplankton size and species diversity, alteration of the pelagic food web, and eutrofication as a possible cascading effect on the primary production) of the vendace invasion in the Pasvik watercourse are considerable, even after a few years, and are likely to proceed and intensify in the future."

4 Global Distribution

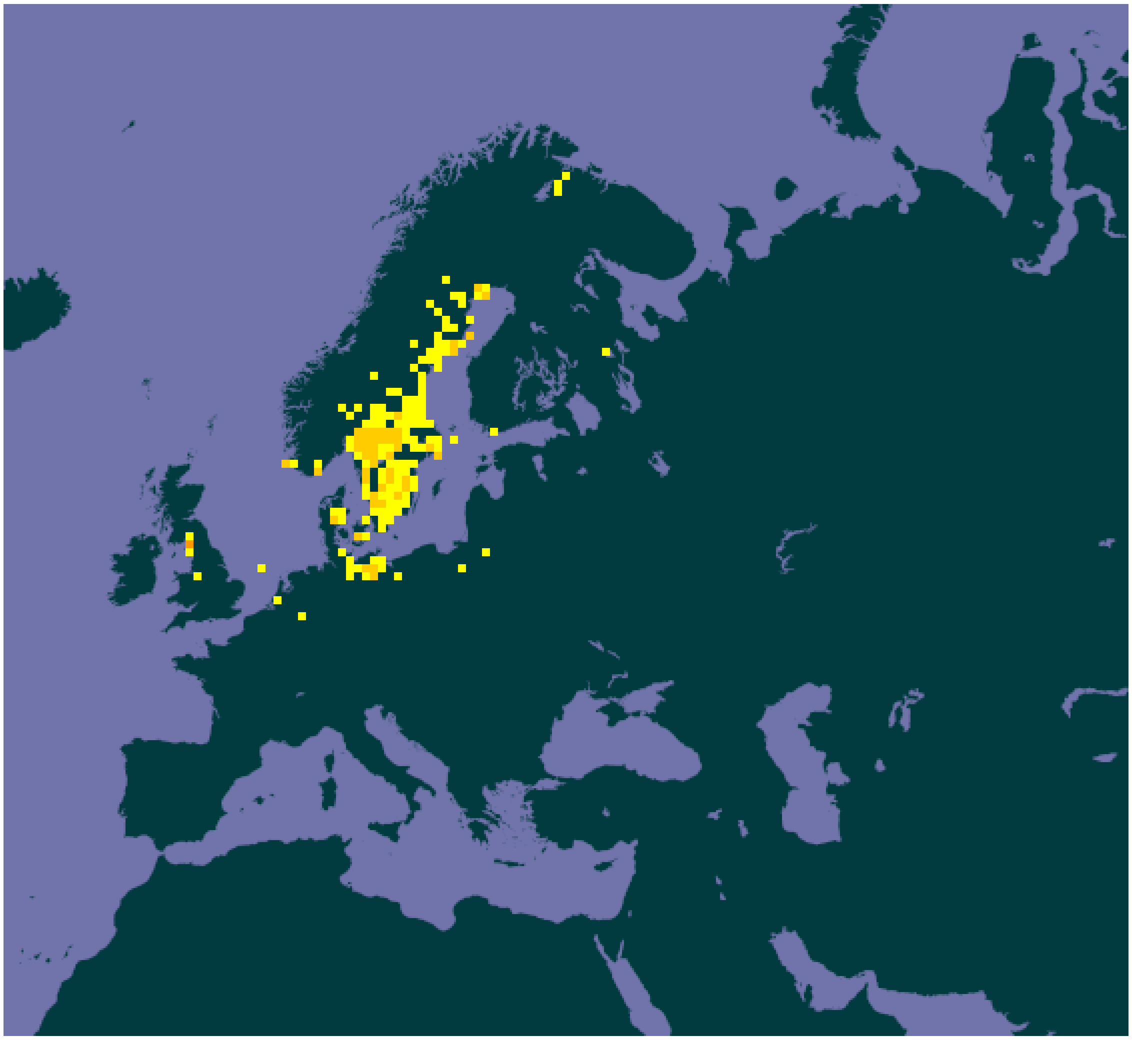

Figure 1. Map of known global distribution of *Coregonus albula*. Map from GBIF (2014).

5 Distribution within the United States

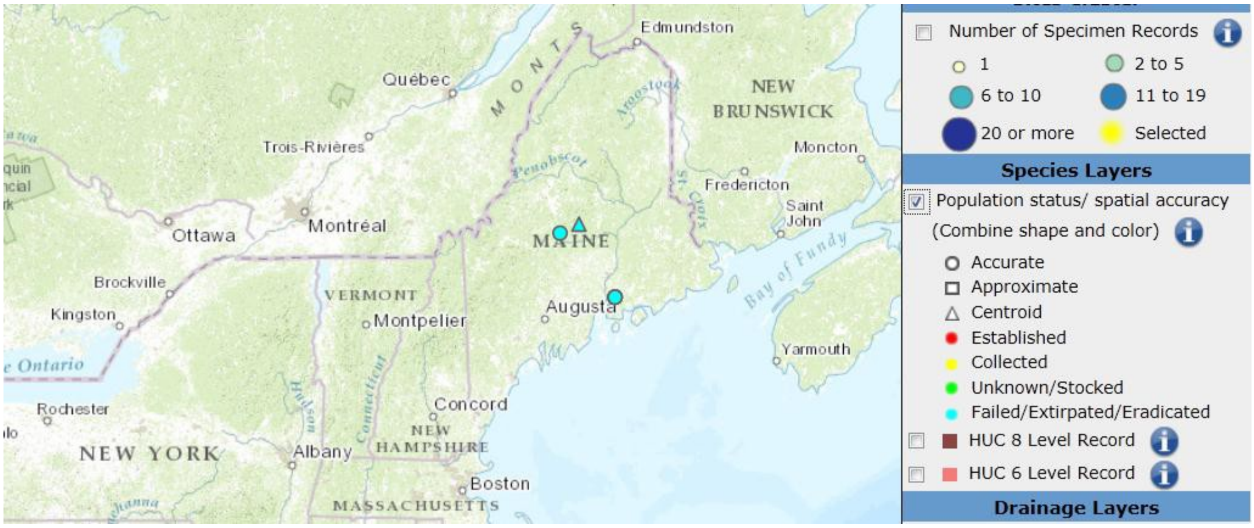

Figure 2. Distribution of *Coregonus albula* in the United States. Map from Fuller and Nico (2014).

6 CLIMATCH

Summary of Climate Matching Analysis

The climate match (Australian Bureau of Rural Sciences 2008; 16 climate variables; Euclidean Distance) was high in the western Great Lakes and isolated locations across the western United States. Medium match was found in the Northeast, eastern Great Lakes and portions of the Rocky Mountain states. Low match occurred in the Mid-Atlantic, Gulf Coast, Southwest and Pacific Coast. Highest match was in the western Great Lakes. Climate 6 match indicated that the contiguous U.S. has a medium climate match. The range for a medium climate match is 0.005 to 0.103; climate match of *Coregonus albula* is 0.067.

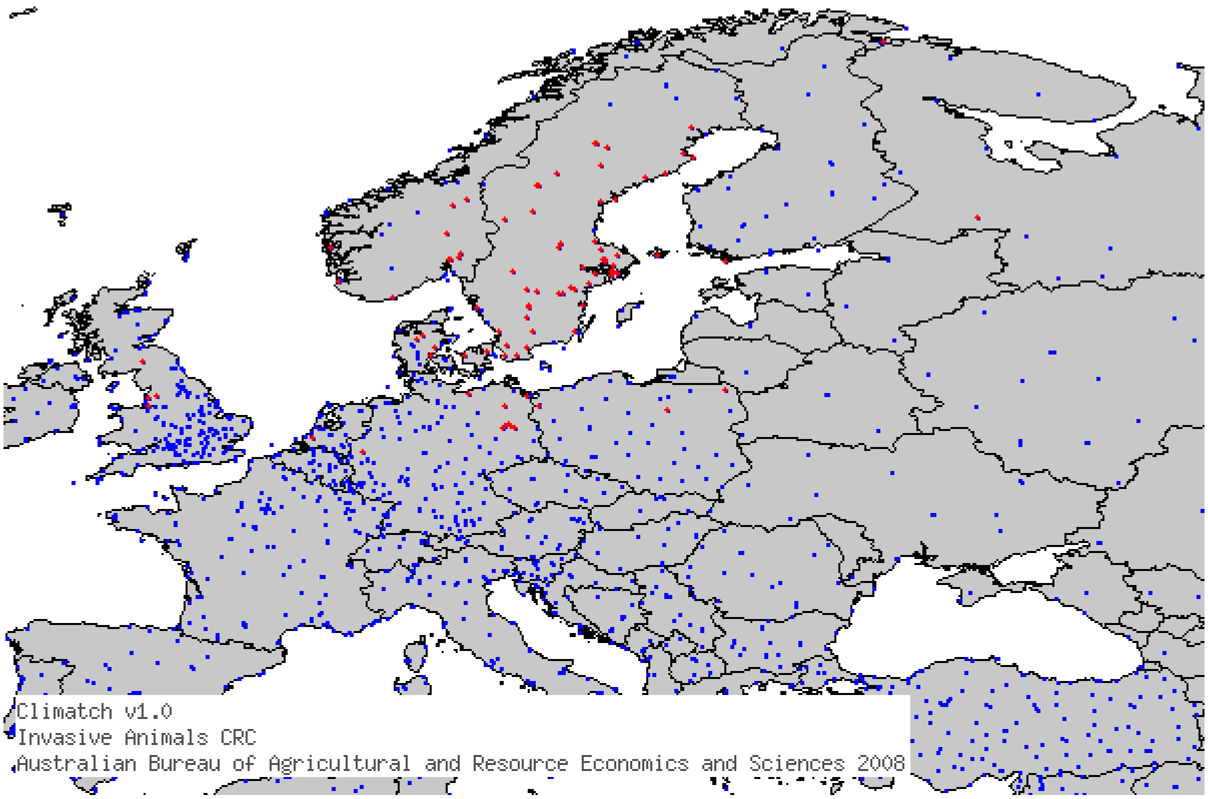

Figure 3. CLIMATCH (Australian Bureau of Rural Sciences 2008) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *Coregonus albula* climate matching. Source locations from GBIF (2014).

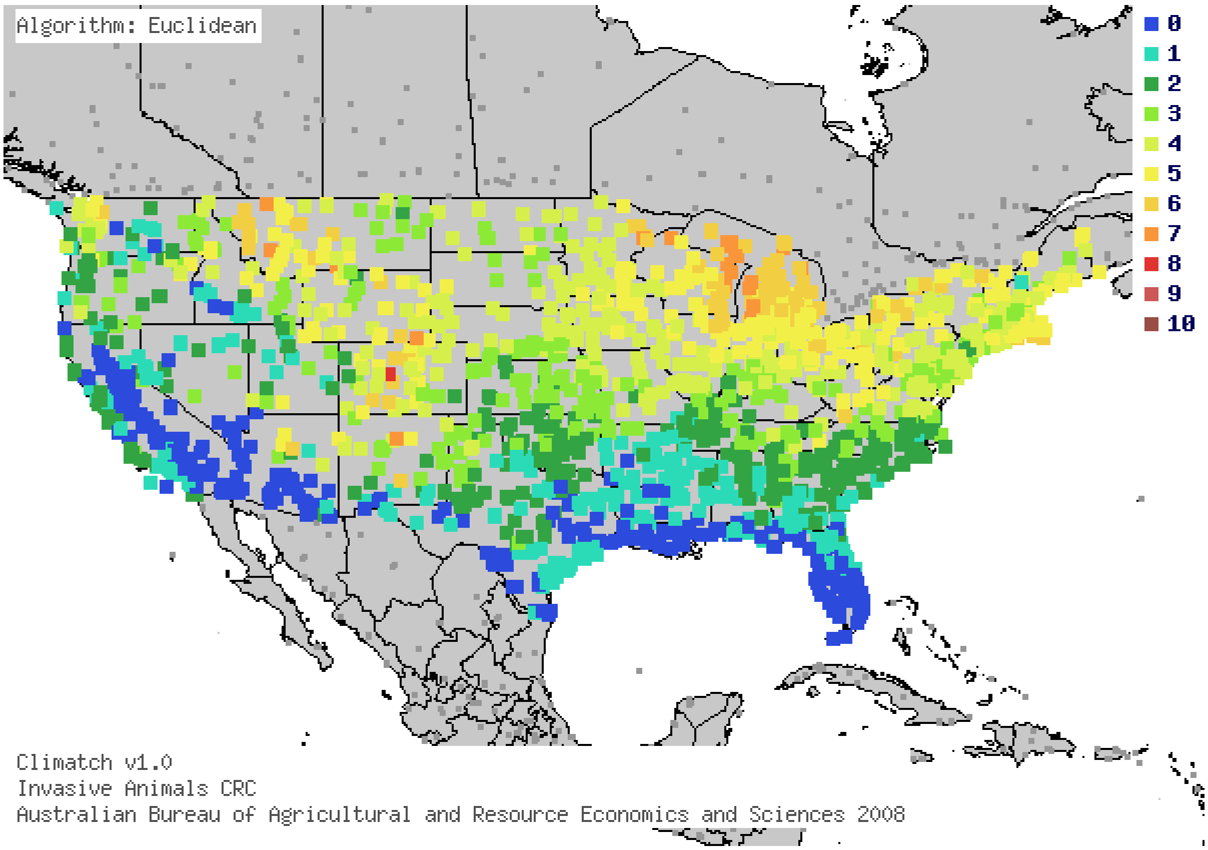

Figure 4. Map of CLIMATCH (Australian Bureau of Rural Sciences 2008) climate matches for *Coregonus albula* in the continental United States based on source locations reported by GBIF (2014). 0= Lowest match, 10=Highest match.

Table 1. CLIMATCH (Australian Bureau of Rural Sciences 2008) climate match scores.

CLIMATCH Score	0	1	2	3	4	5	6	7	8	9	10
Count	305	288	328	292	366	262	111	21	1	0	0
Climate 6 Proportion =		0.067									

7 Certainty of Assessment

The biology and ecology of *C. albula* are well-known. 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

C. albula is a fish species native to Europe. Introductions to the United States in the early 1800s failed to establish, however introductions to other countries outside its native range have had considerable negative impacts. Vendace are known to displace native species as well as alter the plankton community (reducing zooplankton diversity, individual zooplankter size, and zooplankton densities) of reservoirs and lakes where introduced. The species has also made major dietary shifts (including piscivory) to compensate for reduced zooplankton abundances following introductions. Climate match with the contiguous U.S. is medium with high match occurring in the Great Lakes. Overall risk for this species is high.

Assessment Elements

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

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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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