Arctic Grayling (*Thymallus arcticus*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, February 2011
Revised, November 2017
Web Version, 5/17/2018

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1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2017):

"North America: widespread in Arctic drainages from Hudson Bay, Canada to Alaska and in Arctic and Pacific drainages to central Alberta and British Columbia in Canada; upper Missouri River drainage in Montana, USA. Formerly in Great Lakes basin in Michigan, USA [Page and Burr 1991]. Arctic Ocean basin in Siberia from Ob to Yenisei drainages and in Europe in some tributaries of Pechora (Usa, Kosyu, Kozhim), Korotaikha and Kara [all named rivers are in Russia, Yenisei drainage extends into Mongolia; Kottelat and Freyhof 2007]."

Status in the United States

From Fuller et al. (2017):

"**Nonindigenous Occurrences:** Grayling have been introduced into **Alaska** (Morrow 1980); Big Lake and the Salt and Verde drainages in **Arizona** (Miller and Lowe 1967; Minckley 1973; Lee et al. 1980 et seq.; Rinne 1995); at least 26 waterbodies in 11 counties, including the lower Klamath, Sacramento (Pit), San Joaquin, and northern Mojave drainages in **California** (Shebley 1917; Dill and Cordone 1997; Moyle 2002); Zimmerman Lake in the Cache la Poudre system, the North and South Platte rivers, the San Luis Valley in the Rio Grande headwaters, the Eagle and Frying Pan rivers on the west slope, and the Arkansas drainage in **Colorado** (Bowers 1901; Beckman 1952; Everhart and Seaman 1971; Ellis 1974; Morrow 1980; Wiltzius 1985; Zuckerman and Behnke 1986; Walker 1993; Rasmussen 1998); Housatonic drainage in **Connecticut**(Whitworth 1996); the Kootenai, Spokane, Salmon, Bear, and Snake (above and below the falls) drainages, and other independent drainages in **Idaho** (Bowers 1901; Linder 1963; Simpson and Wallace 1978; Lee et al. 1980 et seq.; Idaho Fish and Game 1990, 1996, 2012); the Maquoketa and Coon-Yellow systems in **Iowa** (Bowers 1901); unspecified locations in **Maine** (Kendall 1914); Ford Lake, **Michigan** (Hubbs and Lagler 1958); Twin Lake near Isabella in the Rainey headwaters, and several lakes in the Arrowhead region of the Baptism-Brule drainage, including Musquash Lake, **Minnesota** (Bowers 1901; Eddy and Underhill 1974; Phillips et al. 1982); unspecified locations in **Missouri** (Pflieger 1971); Glacier National Park, the Belly, Red Rock, Madison, Gallatin, upper Missouri-Dearborn, Sun, Clarks Fork Yellowstone, Pend Orielle, and Rock systems in **Montana** (Bowers 1901; Lee et al. 1980 et seq.; Cross et al. 1986; Holton 1990; Tilmant 1999); several unspecified streams in **Nebraska** (Jones 1963; Morris et al. 1974; Cross et al. 1986); high elevation lakes in the northern part of the state, Desert Creek, Ruby Valley, Steele Lake in Elko County, **Nevada** (Miller and Alcorn 1946; La Rivers 1962; Deacon and Williams 1984; Sigler and Sigler 1987); Long Pond in Benton (Hoover 1936), and Sunapee Lake (Bickford 1914), **New Hampshire**; the Canjilon area in **New Mexico** (Koster 1957; Sublette et al. 1990); unspecified areas of **New York** (Bickford 1914); upper Deschutes (Lee et al. 1980 et seq.) and Umatilla (Bowers 1901) systems, **Oregon**; the Atlantic basin (Susquehanna and/or Delaware drainage), **Pennsylvania** (Bean 1892); unspecified areas of **South Dakota** (Johnson 1937); lakes and streams in Duchesne, Summitt, Cache, and Daggett counties, and in the Uintah and Wasatch mountains, streams near Salt Lake City, Blind, Navajo, Lockawaxen, Caroly, Round, Sand, and Blue lakes, and Red Creek, Big Ells and Labaron reservoirs in **Utah** (Sigler and Miller 1963; Lee et al. 1980 et seq.; Sigler and Sigler 1987, 1996); Caspian Lake (Bowers 1901) and other unspecified mountainous areas in **Vermont** (Lee et al. 1980 et seq.; Morrow 1980; Cox, personal communication); below Philpott Reservoir, **Virginia** (Jenkins and Burkhead 1994); one mountain lake in **Washington** (Wydoski and Whitney 1979; Fletcher, personal communication); the Namekagon, Wolf, Brule, and Beartrap-Nemadji systems in **Wisconsin** (Bowers 1901; Becker 1983); and Yellowstone Lake, Bighorn, Wind, and Medicine Bow rivers, Big Sandy Reservoir, Jackson Lake, Babione Creek (upper Tongue), Beartooth Lake (Clarks Fork Yellowstone), and Frye Lake (Popo Agie), **Wyoming** (Johnson 1937; Baxter and Simon 1970; Lee et al. 1980 et seq.; Cross et al. 1986; DeLorme Mapping 1992; Gorges 1994; Hubert 1994)."

"**Status:** Established in several states, including Arizona (Rinne 1995). Reported from Colorado, Montana, Nevada, Oregon, and Vermont. Failed in Connecticut, Maine, Missouri, Nebraska,

New Mexico, and Virginia. Extirpated from Pennsylvania. Although largely extirpated from its native range within the Great Lakes basin, it is found in some inland lakes in the region that were not part of its original range."

Means of Introduction into the United States

From Fuller et al. (2017):

"Authorized stocking for sportfishing. First stocked in Arizona in 1943 (Rinne 1995). First stocked in Connecticut in the 1870s (Whitworth 1996). Stocked in Nebraska in 1939 (Jones 1963)."

Remarks

From Fuller et al. (2017):

"Native populations are considered extinct in Montana (Holton 1990) except for a remnant population in the Big Hole River (Wydoski and Whitney 2003). The species has be [*sic*] re-stocked in the Red Rock, Madison, Gallatin and Sun drainages, as well as other locations. A relict population was present in the Great Lakes up until the 1930s, when it was extirpated due to competition with other introduced salmonids, habitat degradation, and fishing pressure (Hubbs and Lagler 1958). The Upper Missouri River population has been proposed to be classified as threatened or endangered under the Endangered Species Act (USFWS 2010)."

From NatureServe (2017):

"Once there were four isolated stocks in North America, considered separate species: *T. signifer*, *T. montanus*, *T. tricolor*, and *T. ontariensis*. *T. signifer* now is considered synonymous with *T. arcticus*, and others as subspecies (Lee et al. 1980). Genus includes four species: one in Europe, two in Mongolia, and probably one widespread cross Asia and North America (Nelson 1984)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2017):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Protacanthopterygii
Order Salmoniformes

Family Salmonidae
Subfamily Thymallinae
Genus Thymallus
Species *Thymallus arcticus* (Pallas, 1776)
Direct Children:
Subspecies *Thymallus arcticus arcticus* (Pallas, 1776)
Subspecies *Thymallus arcticus baicalensis* Dybowski, 1874
Subspecies *Thymallus arcticus pallasi* Valenciennes in Cuvier and Valenciennes, 1848"

"Current Standing: valid"

Size, Weight, and Age Range

From Froese and Pauly (2017):

"Max length : 76.0 cm TL male/unsexed; [Page and Burr 1991]; common length : 34.3 cm TL male/unsexed; [Hugg 1996]; max. published weight: 3.8 kg [IGFA 2001]; max. reported age: 18 years [DeCicco et al. 1997]"

From NatureServe (2017):

"Lifespan usually less than 6 years but up to 10 years (Brown 1971)."

Environment

From Froese and Pauly (2017):

"Freshwater; benthopelagic; depth range 30 - ? m [Page and Burr 1991]."

"Occurs in piedmont and montane cold streams, rivers and lakes with high oxygen concentrations [Kottelat and Freyhof 2007]."

From NatureServe (2017):

"Open water of clear, cold (47-52 F) medium to large rivers and lakes. Adults move to pools after spawning, spend winter in deep water."

Climate/Range

From Froese and Pauly (2017):

"Temperate; 71°N - 44°N"

Distribution Outside the United States

Native

From Froese and Pauly (2017):

"North America: widespread in Arctic drainages from Hudson Bay, Canada to Alaska and in Arctic and Pacific drainages to central Alberta and British Columbia in Canada; upper Missouri River drainage in Montana, USA. Formerly in Great Lakes basin in Michigan, USA [Page and Burr 1991]. Arctic Ocean basin in Siberia from Ob to Yenisei drainages and in Europe in some tributaries of Pechora (Usa, Kosyu, Kozhim), Korotaikha and Kara [all named rivers are in Russia, Yenisei drainage extends into Mongolia; Kottelat and Freyhof 2007]."

Introduced

Froese and Pauly (2017) report introductions to the Czech Republic (unknown establishment status), Slovakia (unknown establishment status), and South Korea (not established).

From Dumont et al. (1988):

"Unsuccessful attempts at introducing Arctic grayling (*Thymallus arcticus*) were made in many lakes and rivers of the Mont-Tremblant and La Vérendrye parks (north of Montréal) between 1953 and 1957 (Côté 1983)."

From Kitano (2004):

"[…] accidental stocking of arctic grayling, originally cultured for the fishing ponds, to reservoirs has been detected in central Japan (Kitano et al., 2004)."

Means of Introduction Outside the United States

From Dumont et al. (1988):

"Salmonid fish (Salmonidae) are among the most important sport and commercial species in North America. Numerous attempts to extend their range have been made over the past 100 years. In Canada, Quebec was among the first provinces to be involved in such attempts. Rainbow trout (*Salmo gairdneri*), brown trout (*S. trutta*), cutthroat trout (*S. clarki*), kokanee (*Oncorhyncus nerka*), Arctic grayling (*Thymallus arcticus*) and huchen (*Hucho hucho*) were experimentally introduced in various lakes and rivers of the southern part of the province."

From Kitano (2004):

"[…] accidental stocking of arctic grayling, originally cultured for the fishing ponds, to reservoirs […]"

Short Description

From Froese and Pauly (2017):

"Dorsal spines (total): 0; Dorsal soft rays (total): 17-25; Anal spines: 0; Anal soft rays: 11 - 15; Vertebrae: 58 - 62. Distinguished by its greatly enlarged dorsal fin and its small mouth, which has fine teeth on both jaws [Morrow 1980]. Dorsal greatly enlarged in adults (especially males), reaching adipose fin when depressed, but is shorter in females; pelvic fins rather long, reach anal fin in adult males, but not in females; lower lobe of caudal often longer than upper [Morrow 1980]. A strikingly colored fish, the dorsal surface is dark purple, or blue black to blue gray, the sides gray to dark blue with pinkish iridescence, the ventral surface gray to white [Scott and Crossman 1998]. Scattered dark spots on sides, these being more numerous on the young; a dark longitudinal stripe along lower sides between pectoral and pelvic fins; dorsal fin dark with narrow purple edge (rows of reddish to orange or purple to green spots on body of fin); pelvic fins dark with irregular diagonal orange-yellow stripes; adipose, dorsal, anal, caudal and pectorals dusky to dark [Morrow 1980]."

Biology

From Froese and Pauly (2017):

"Inhabits open water of clear, cold, medium to large rivers and lakes. Enters rocky creeks to spawn [Page and Burr 1991]. […] Forms schools in moderate numbers [Frimodt 1995]. Young feed on zooplankton with a gradual shift to immature insects; adults feed mainly on surface insects but also take in fishes, fish eggs, lemmings, and planktonic crustaceans [Scott and Crossman 1998]. Spawns in montane streams with heavy current on shallows with rock-gravel bottom [Kottelat and Freyhof 2007]."

"Spawning adults move into tributaries and males establish territories. At spawning, the male follows a female, courting her with displays of his dorsal fin. He then drifts over beside her and curves his extended dorsal fin over the female. The pair vibrates and release eggs and milt. No redd is constructed, but the vibrations of the tails during the spawning act stirs up the substrate and produce a slight depression [Laird 1928; Wojcik 1955; Kruse 1959; Reed 1964; Bishop 1971]. A female may spawn only once, or several times in different areas [Scott and Crossman 1998]. After spawning, adults establish summer territories in pools generally farther upstream from the spawning site, majority moving downstream in mid-September [Schallock 1966; Vascotto 1970]."

From NatureServe (2017):

"Spawns usually in early spring (May-June). Male establishes a territory. Normally lays 400-12,500 eggs (Moyle 1976), which hatch in 11-21 days. Sexually mature in 3-4 years."

Human Uses

From Froese and Pauly (2017):

"Fisheries: minor commercial; gamefish: yes"

"Utilized fresh and can be fried, broiled, boiled, and baked [Frimodt 1995]."

Diseases

From Bailly (2013):

"Host of
Ascarophis skrjabini (Layman, 1933) Polyanski, 1952 (parasitic: endoparasitic)
Ergasilus nerkae Roberts, 1963 (parasitic: ectoparasitic)
Salmincola thymalli (Kessler, 1868) (parasitic: ectoparasitic)"

From Ieshko et al. (2015):

"Salmonids, which are frequently farmed, carry a collection of ectoparasites of the genus *Gyrodactylus* [for instance] *G*[*yrodactylus*] *magnus* Konovalov, 1967 (host: *Thymallus arcticus*) […]"

From CABI (2017):

"Arctic grayling (*Thymallus arcticus*) fry are refractory to infection with a type 1 IHNV [infectious haematopoietic necrosis virus] isolate, and this species is not likely to be a reservoir of IHNV (Follett et al., 1997)."

From Mitro and White (2008):

"The prevalence of VHSV [viral hemorrhagic septicemia virus] in fish younger than 1 year for samples including VHSV-positive fish was as follows: 13% of rainbow trout, 20% of Arctic char, 33% of grayling, 81% of brown trout, 86% of northern pike, and 100% of coregonid species."

Infectious haematopoietic necrosis and viral hemorrhagic septicemia are OIE-reportable diseases.

Threat to Humans

From Froese and Pauly (2017):

"Harmless"

3 Impacts of Introductions

From Fuller et al. (2017):

"Impact of Introduction: Unknown."

4 Global Distribution

Figure 1. Known global distribution of *Thymallus arcticus*, reported from the U.S., Canada, Russia, and Mongolia. Map from GBIF Secretariat (2017). See caption for Figure 2 for description of U.S. points excluded from climate matching.

5 Distribution Within the United States

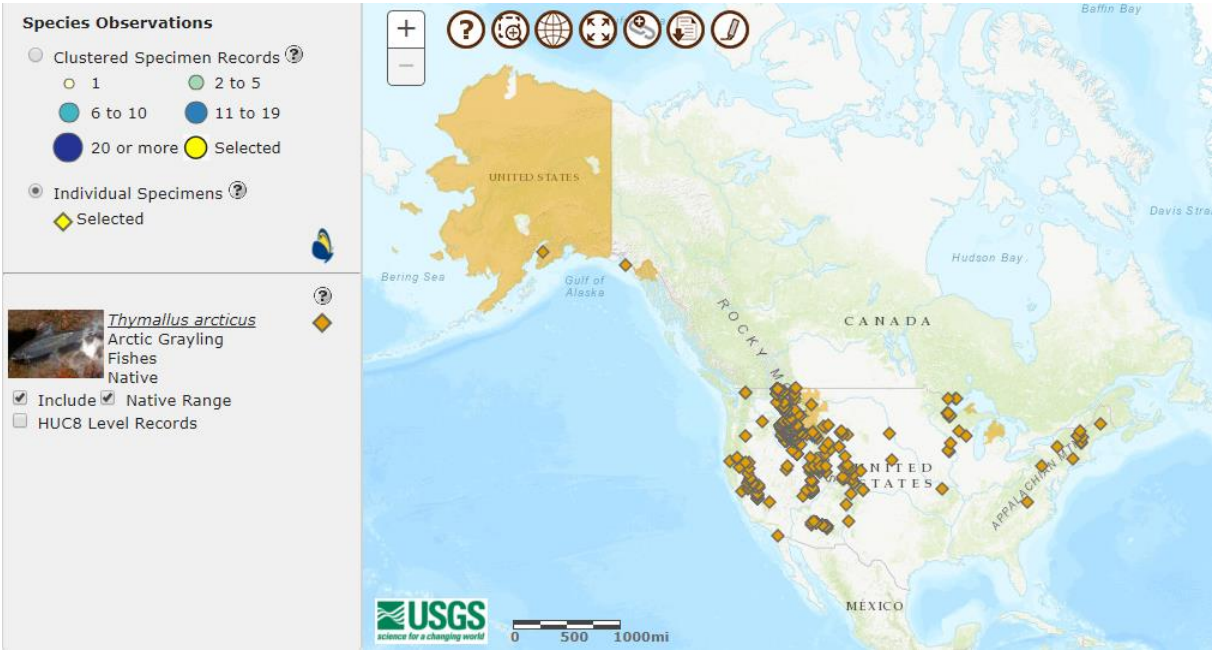

Figure 2. Known distribution of *Thymallus arcticus* in the United States. Map from Fuller et al. (2017). Shaded orange areas in Alaska, Michigan, Montana, and Wyoming represent native range. Points on the East Coast, except those in New Hampshire, were excluded from climate matching because they do not represent established populations (Fuller et al. 2017). Similarly, points in the Midwest, except in northeastern Minnesota, were excluded from climate matching because they do not represent established populations (Fuller et al. 2017). The point on the border of California and Mexico was excluded from climate matching because it does not represent an established population (Fuller et al. 2017).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was high in the West, Northeast, and Upper Midwest. The climate match was low in the Southeast. Medium matches bridged the areas between high match and low match, such as the southern Midwest and the Mid-Atlantic region. Climate6 score indicated a high climate match overall for the contiguous U.S. Scores of 0.103 and higher are classified as high match; Climate6 score for *T. arcticus* was 0.698.

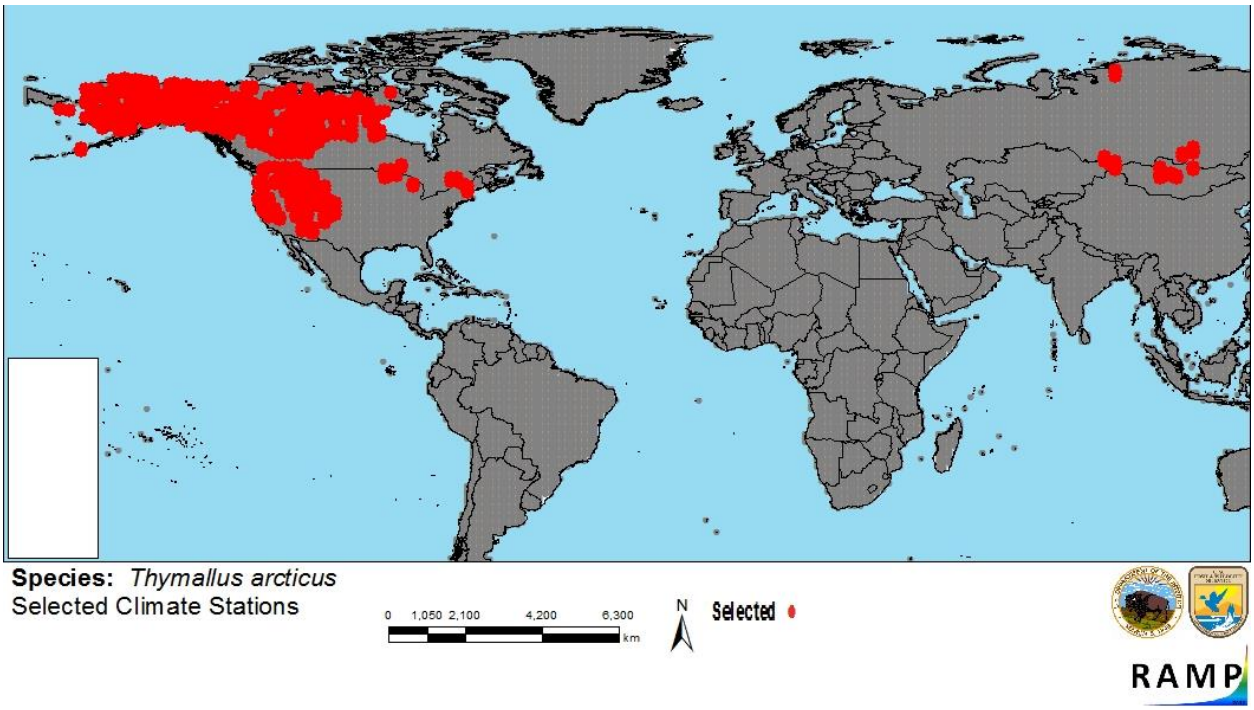

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red; Russia, Mongolia, Canada, United States) and non-source locations (gray) for *T. arcticus* climate matching. Source locations from GBIF Secretariat (2017) and Fuller et al. (2017). Only established locations were used.

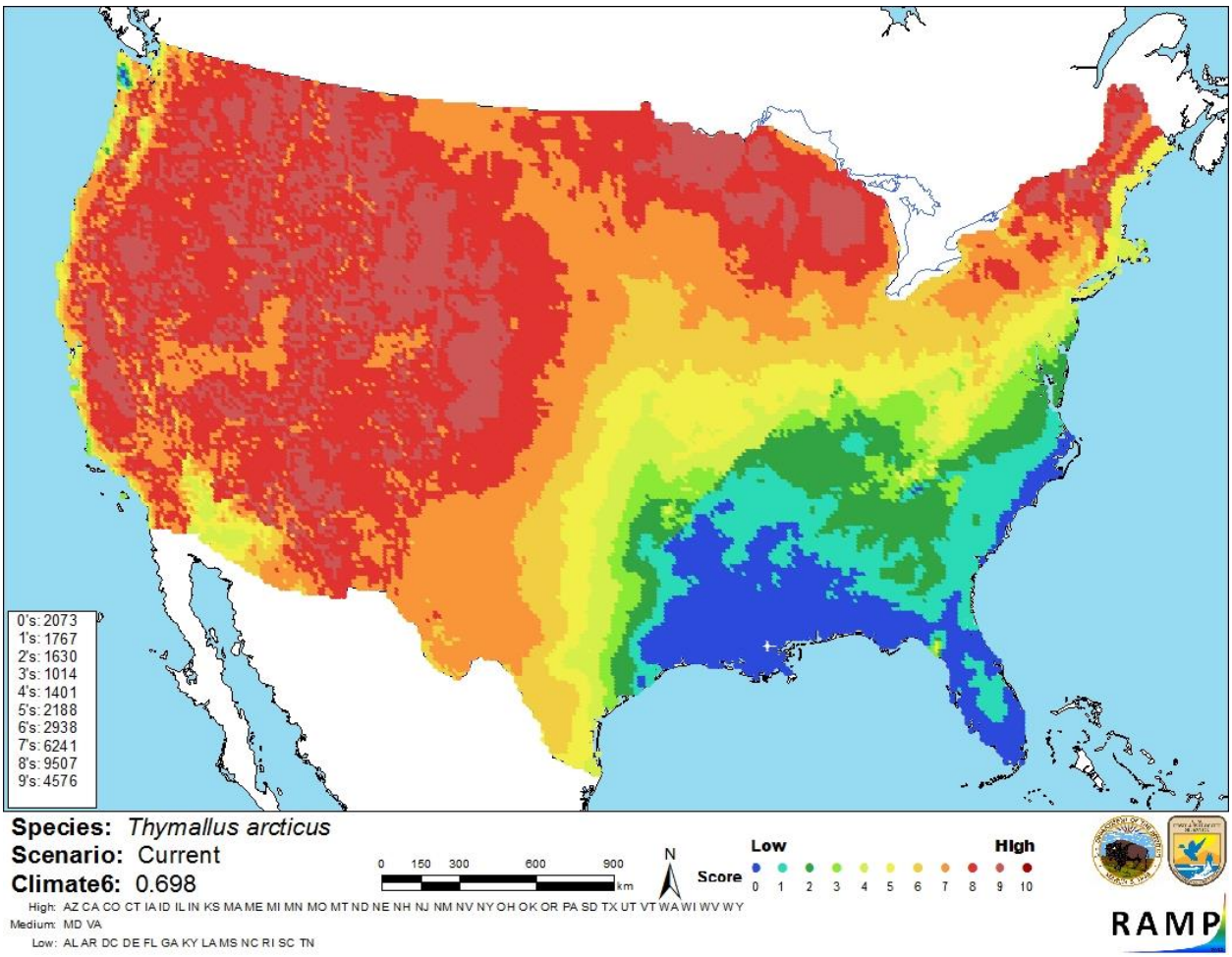

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *T. arcticus* in the contiguous United States based on source locations reported by GBIF (2017) and Fuller et al. (2017). 0=Lowest match, 10=Highest match.

The "High", "Medium", and "Low" climate match categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

7 Certainty of Assessment

Information was readily available on the biology, ecology, and distribution of *Thymallus arcticus*, but no information was available on impacts of introduction of the species. The establishment status of *T. arcticus* was unknown for several locations in which the species has been introduced. Given these information gaps, certainty of this assessment is low.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Thymallus arcticus is a salmonid native to Canada west of Hudson Bay, Alaska and parts of the contiguous U.S., and Russia. The species has been extirpated from parts of its native range in the contiguous U.S., but has now become established in several locations in the contiguous U.S. outside its native range. These established locations are due to intentional stocking programs for sport fishing. *T. arcticus* is used as a food fish. It is known to host several parasites and carry viral hemorrhagic septicemia. *T. arcticus* has a high climate match to the contiguous U.S. but somewhat specific habitat requirements, requiring cold well-oxygenated waters and appropriate spawning habitat. Currently, no impacts from introduction of *T. arcticus* have been documented. Overall risk posed by this species is uncertain.

Assessment Elements

- **History of Invasiveness: None Documented**
- **Climate Match: High**
- **Certainty of Assessment: Low**
- **Important additional information: Susceptible to viral hemorrhagic septicemia**
- **Overall Risk Assessment Category: Uncertain**

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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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