Arctic Char (*Salvelinus alpinus*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, November 2015
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1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2018a):

"Europe and North America: Circumpolar [Page and Burr 2011]. Iceland, Scandinavia, northern Russia (absent in rivers draining to Baltic and White Seas), Jan Mayen, Spitzberg, Kolguev, Bear and New Zemblia islands, northern Siberia, Alaska, Canada and Greenland; absent in the Alps [Kottelat and Freyhof 2007]. North America: coastal areas in Atlantic, Arctic and Pacific drainages from Newfoundland and Labrador in Canada to Alaska; south along Alantic [*sic*] Slope to Maine, USA [Page and Burr 2011]. Landlocked populations in Quebec, Canada and in Maine and New Hampshire in USA [Robins and Ray 1986]."

"[In Finland:] Occurs in northern Lappland and in Vuoksi Basin. Local stocks complemented through culture of juveniles for stock enhancement. Three original stocks endangered [Kallio-Nyberg and Koljonen 1991]. Several dwarfed stocks occur."

"[In France:] Indigenous in Lake Léman (Lake Geneva) and Bourget […]"

"[In Russia:] Present in the Mezen Bay, from which it enters the Mgla river. Enters the rivers of Kolguev I. Known from the Gulf of Ob, the Yenisei, Pyasina, Taimyr, Khatanga and Lena rivers [Berg 1962]. Known from the Lake Frolikha and mountain Lakes in the basins of the rivers Kuanda and Chara in Transbaikalia [Reshetnikov et al. 1997]. Absent in rivers draining to Baltic and White Seas [Kottelat and Freyhof 2007]."

"[In the United Kingdom:] Found in England Wales, and Scotland [Maitland and Lyle 1996]. All populations are non-anadromous [Maitland and Lyle 1996]."

"[In Alaska:] Occurs in the Aleutian Is., the Alaskan Peninula, Kodiak I. and the northern region [Morrow 1980]. It appears that all arctic charr are of the freshwater, lake-dwelling type [Morrow 1980]."

"[In Canada:] Native to many Canadian provinces; […]. Commonly farmed in eastern Canada."

From Klemetsen et al. (2003):

"On the American continent, the southernmost native populations occur in woodland lakes in Maine, US (Kircheis 1980, 1989)."

"The native distribution matches the last (Weichsel–Wisconsin) glaciation in the Holarctic closely. The species probably occurred over most of the glaciated areas in early post-glacial times but is today absent from many lakes in the southern part of these areas; probably for climatic reasons (too warm), because of eutrophication (Hartmann 1984; Ruhlé 1984; Champigneulle & Gerdeaux 1995; Maitland 1995) or from negative interactions with increasingly complex fish assemblages (Hammar 1998). About 1300 populations (Maitland 1995) migrate to full strength sea-water as anadromous fish, and the charr has found its way to remote islands such as the Faeroes (Gydemo 1983), Jan Mayen (Skreslet 1973) and Bear Island (Klemetsen et al. 1985). It can tolerate slightly brackish lakes as in Nordlaguna, Jan Mayen (Skreslet 1969) and Arresjøen, Svalbard (Svenning 1993). Some northern populations are riverine (Curry-Lindahl 1957; Power 1973), but the typical environment of the charr is oligotrophic and ultraoligotrophic lakes."

Status in the United States

From Froese and Pauly (2018a):

"[In Alaska:] Occurs in the Aleutian Is., the Alaskan Peninula, Kodiak I. and the northern region [Morrow 1980]. It appears that all arctic charr are of the freshwater, lake-dwelling type [Morrow 1980]. Important sport fish in the Wood River Lakes [Morrow 1980]."

Fuller and Neilson (2018) list *Salvelinus alpinus* as observed in Colorado from 1993 to 2008, in Connecticut in 1880, in Maine from 1992, in Michigan in 1985, in New Hampshire from 1878 to 1977, in New Jersey from 1905 to 1978, and in New York from 1888 to 1967. All the observations in Maine are from continuously stocked populations or failed introductions, except for two established populations, one in Big Reed Pond in Piscataquis County and the other in

Enchanted Pond in Somerset County. *S. alpinus* is listed as established in the following waterbodies in New Hampshire: Dan Hole Pond, Connecticut Lake, Sawyer Pond, Penacook Lake, Star Lake, and Sunapee Lake.

From Fuller and Neilson (2018):

"Extirpated in Connecticut, Michigan, New Jersey, and New York. Stocked in Colorado."

From Fuller et al. (2018):

"Sunapee trout [*Salvelinus alpinus aureolus*] were native to Sunapee Lake, New Hampshire; Averill Pond, Vermont; Big Dan Pond, New Hampshire; and Floods Pond, Maine (Behnke, personal communication). Three of the four populations have become extinct and the Sunapee exists only in Floods Pond, Maine, near Bangor (Behnke, personal communication). The Sunapee populations have suffered due to hybridization with introduced lake trout *S. namaycush* (Behnke, personal communication). The blueback trout [*Salvelinus alpinus oquassa*] is native to northwestern Maine in the headwaters of the St. John and Penobscot rivers, specifically in Black Lake, Deboullie Lake, Gardner Lake, Purshineer pond in Arrostook County; Big Reed Pond, Rainbow Lake and Wadleigh Pond in Piscataquis County; Penobscot Lake in Somerset County (erroneously reported as in Piscataquis County); and in Bald Mountain Pond, also in Somerset County (Everhart and Waters 1965). Formerly existed in the Rangeley Lakes but extirpated from there circa 1904 (Kendall 1914; Everhart and Waters 1965)."

"This species [*Salvelinus aplinus oquassa*] was introduced into several lakes at the headwaters of the Salmon River in Idaho, including Alice, Vernon, Big Redfish, and Sawtooth lakes (Linder 1963; Deacon et al. 1979; Idaho Fish and Game 1990). It was also stocked in four areas in Maine: Upper and Lower South Branch Pond in Piscataquis County, Echo Lake in Hancock County and Coffee Pond in Cumberland County (Maine Department of Inland Fisheries and Game 1974; Kircheis 1976). Each location received 5,000 fish annually from 1969 until at least 1974, except for Echo Lake which began stocking in 1974. This stocking was conducted as part of a management plan to increase the range of the Sunapee trout which has become restricted to one lake (Maine Department of Inland Fisheries and Game 1974). The Sunapee trout was introduced into unspecified area(s) of Massachusetts (Fowler 1907). The species was stocked in several lakes New Hampshire, including Tewskburry Pond in Grafton and Connor Pond in Ossippee (Scarola 1973; Kircheis 1976). Lake George (Warren County) in New York was stocked with trout from Sunapee Lake prior to 1903 (Bean 1903)."

"The Blueback trout [*Salvelinus alpinus oquassa*] was introduced into the Snake River drainage below Shoshone Falls, Idaho (Idaho Fish and Game 1990); [and also] unspecified areas of Maine shortly after the species discovery in 1874 (Kendall 1914; Kircheis 1975). Although presumed native, the population at Wadleigh Pond, Maine, might have resulted from these early introductions. An experimental translocation from Wadleigh Pond to Basin Pond in Kennebec County, Fayette Township, Maine, was carried out in 1969 (Kircheis 1975). The blueback trout was also stocked in Newfound, Squam, Connor, and Sunapee lakes, New Hampshire, in 1879, and in unknown locations the previous year (Kendall 1914; Hoover 1936; Kircheis 1975).

Stocking in Sunapee Lake took place several years before the Sunapee trout was identified (Kendall 1914)."

"Established in Idaho (in Sawtooth Lake) (Behnke, personal communication); failed in New Hampshire, New York, and Massachusetts. Early blueback stockings in Maine and New Hampshire failed (with the possible exception of Wadleigh Pond (Kircheis 1975). Experimental stockings of bluebacks in Basin Pond failed (Kircheis 1975)."

Means of Introductions in the United States

From Fuller and Neilson (2018):

"Most of these introductions took place a hundred years ago and were intended to enhance sportfishing. Stock for New Jersey (and possibly New York) came from Europe."

Remarks

According to Froese and Pauly (2018a) references to *Salvelinus alpinus* in Ireland are the result of misidentifications of other *Salvelinus* spp.

From NatureServe (2018):

"Brunner et al. (2001) examined phylogeography of the *Salvelinus alpinus* complex using mtDNA sequences. They assigned the 63 observed haplotypes to five geographic regions that may be associated with different glacial refugia. Patterns of genetic variation did not entirely reflect the magnitude of phenotypic and ecological polymorphism in the *S. alpinus* complex, and not all taxa suggested by current taxonomy could be confirmed. Major groups were observed, but additional distinct lineages were also identified. There was a clear distinction between Acadian (Maine, southern Quebec) and Arctic (arctic North America, Alaska, Kamchatka Peninsula) populations, supporting current taxonomy that recognizes them as different subspecies, *S. a. oquassa* and *S. a. erythrinus*. Subspecies *oquassa* comprises landlocked populations from southeastern Quebec, New Brunswick, and the northeastern United States. *Salvelinus a. erythrinus* comprises an arctic group and a newly identified Siberian group. *Salvelinus a. taranetzi* is included in the Arctic cluster, but it exhibits a distinct and unique haplotype, supporting Behnke's (1984) suggestion that it be recognized as a distinct taxon. The Beringean group, formed entirely by specimens assigned to *S. malma* (Dolly Varden), encompassed the area formerly assigned to *Salvelinus a. taranetzi*; the Beringean group could not be confirmed as the sister taxon to all other *Salvelinus alpinus*, and the species status of *S. malma* was regarded as questionable. Five nominal subspecies fell into the Siberian group and all were genetically undifferentiated."

From Fuller et al. (2018):

"Sunapee trout [*Salvelinus alpinus aureolus*] hybridize with introduced brook trout *S. fontinalis* in Idaho (Behnke, personal communication)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to Fricke et al. (2018), *Salvelinus alpinus* (Linnaeus 1758) is the valid name for this species. It was originally described as *Salmo alpinus*.

From ITIS (2018):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Protacanthopterygii
Order Salmoniformes
Family Salmonidae
Subfamily Salmoninae
Genus *Salvelinus*
Species *Salvelinus alpinus* (Linnaeus, 1758)"

Size, Weight, and Age Range

From Froese and Pauly (2018a):

"Maturity: L_m 60.0 […] Max length : 107 cm TL male/unsexed; [IGFA 2001]; common length : 40.0 cm TL male/unsexed; [Svetovidov 1984]; max. published weight: 15.0 kg [Svetovidov 1984]; max. reported age: 40 years [Quinn 2001]"

From Fuller and Neilson (2018):

"Size: 96 cm."

Environment

From Froese and Pauly (2018a):

"Marine; freshwater; brackish; benthopelagic; anadromous [Riede 2004]; depth range 0-70 m [Billard 1997], usually 0-1 m [Rikardsen et al. 2007]. […]; 4°C - 16°C [assumed to be recommended aquarium temperature] [Baensch and Riehl 1991]; […]"

From Klemetsen et al. (2003):

"They have been recorded down to 220 m in Loch Ness, Scotland (Shine et al. 1993; A. Shine pers. comm.). In Gander Lake, Newfoundland, they were caught in gill nets at 200 m (O'Connell & Dempson 2002), and recently as deep as 280 m (M.F. O'Connell, unpublished observation)."

"Charr survive and feed very close to 0 °C (Brännäs & Wiklund 1992). […] Larsson & Berglund (1998) found that the growth rates of 1+ charr were high in the range 13–18°[C]. Langeland & L'Abée-Lund (1996) found that charr moved to relatively warm littoral water (17°[C]) when the density of trout (and charr) had been reduced. In another study, Langeland & L'Abée-Lund (1998) found that charr avoided littoral temperatures of 16–20°[C]. There is thus somewhat conflicting information about the influence of high temperatures on the habitat choice of charr, but it appears that warm epilimnic water can be the reason why charr often move to the hypolimnion during the summer."

Climate/Range

From Froese and Pauly (2018a):

"Temperate; […]; 82°N - 41°N, 180°W - 180°E [Freyhof and Kottelat 2008]."

From Klemetsen et al. (2003):

"*S. alpinus* is the only species with a circumpolar distribution. It is also the northernmost of all *Salvelinus* species, and indeed of all freshwater and anadromous fish. To cite Johnson (1984), it has a capacity to explore the unknown waters left by the receding icecap."

"Arctic charr are found throughout the arctic, subarctic, boreal and temperate climate regions of the Holarctic. […] It is typically found in cool or cold lakes with depauperate fish communities. In alpine or northern lakes, it is often the only fish species. Extreme northern populations live in lakes where the ice does not disappear in the summer in some or most years."

Distribution Outside the United States

Native

Part of the native range of *Salvelinus alpinus* occurs within the United States. See Native Range above for a full description.

From Froese and Pauly (2018a):

"Europe and North America: Circumpolar [Page and Burr 2011]. Iceland, Scandinavia, northern Russia (absent in rivers draining to Baltic and White Seas), Jan Mayen, Spitzberg, Kolguev, Bear and New Zemblia islands, northern Siberia, Alaska, Canada and Greenland; absent in the Alps [Kottelat and Freyhof 2007]. North America: coastal areas in Atlantic, Arctic and Pacific drainages from Newfoundland and Labrador in Canada to Alaska; south along Alantic [sic] Slope to Maine, USA [Page and Burr 2011]. Landlocked populations in Quebec, Canada […] [Robins and Ray 1986]."

"[In Finland:] Occurs in northern Lappland and in Vuoksi Basin. Local stocks complemented through culture of juveniles for stock enhancement. Three original stocks endangered [Kallio-Nyberg and Koljonen 1991]. Several dwarfed stocks occur."

"[In France:] Indigenous in Lake Léman (Lake Geneva) and Bourget […]"

"[In Russia:] Present in the Mezen Bay, from which it enters the Mgla river. Enters the rivers of Kolguev I. Known from the Gulf of Ob, the Yenisei, Pyasina, Taimyr, Khatanga and Lena rivers [Berg 1962]. Known from the Lake Frolikha and mountain Lakes in the basins of the rivers Kuanda and Chara in Transbaikalia [Reshetnikov et al. 1997]. Absent in rivers draining to Baltic and White Seas [Kottelat and Freyhof 2007]."

"[In the United Kingdom:] Found in England Wales, and Scotland [Maitland and Lyle 1996]. All populations are non-anadromous [Maitland and Lyle 1996]."

"[In Canada:] Native to many Canadian provinces; […]. Commonly farmed in eastern Canada."

From Klemetsen et al. (2003):

"The native distribution matches the last (Weichsel–Wisconsin) glaciation in the Holarctic closely. The species probably occurred over most of the glaciated areas in early post-glacial times but is today absent from many lakes in the southern part of these areas; probably for climatic reasons (too warm), because of eutrophication (Hartmann 1984; Ruhlé 1984; Champigneulle & Gerdeaux 1995; Maitland 1995) or from negative interactions with increasingly complex fish assemblages (Hammar 1998). About 1300 populations (Maitland 1995) migrate to full strength sea-water as anadromous fish, and the charr has found its way to remote islands such as the Faeroes (Gydemo 1983), Jan Mayen (Skreslet 1973) and Bear Island (Klemetsen et al. 1985). It can tolerate slightly brackish lakes as in Nordlaguna, Jan Mayen (Skreslet 1969) and Arresjøen, Svalbard (Svenning 1993). Some northern populations are riverine (Curry-Lindahl 1957; Power 1973), but the typical environment of the charr is oligotrophic and ultraoligotrophic lakes."

Introduced

From Froese and Pauly (2018a):

"[In Turkey:] Introduced to Black Sea watersheds [Çiçek et al. 2015]."

"[In France:] […] and introduced in other mountain lakes. Reared for restocking and human consumption [Billard 1997]. Established in 138 lakes."

"[In Italy: Introduced and] Known from alpine lakes and rivers of north eastern Italy [Bianco 2013]."

"[In Canada:] […] introduced into Alberta [Coker et al 2001]"

"[In Czech Republic:] Unsuccessful despite additional attempts since its introduction in 1972 [Welcomme 1988]."

"[In Slovakia:] Unsuccessful despite additional attempts since its introduction in 1972."

Froese and Pauly (2018a) also list *Salvelinus alpinus* as introduced in Latvia and Serbia. They list *S. alpinus* as introduced but not established in Cyprus, Denmark, Morocco,

DAISIE (2018) lists *Salvelinus alpinus* as alien and established in Croatia and Latvia; alien and extinct in the Czech Republic; alien and not established in Denmark; alien and no status indication in Greenland and Slovenia.

FAO (2018) lists the subspecies *S. alpinus alpinus* as introduced and status unknown in Germany and Latvia. It is listed as introduced but not established in Italy, the Netherlands, Spain, Morocco, and Czechoslovakia. It is listed as introduced and probably not established in the wild in Denmark, and Ireland. It is listed as introduced and probably established in Cyprus. It is listed as introduced and established in France, an area of Former Yugoslavia, and Kerguelen Island (sub Antarctic island).

From Klemetsen et al. (2003):

"The southernmost populations in Europe are found in the Pyrenees but all are introduced by man (Machino 1995). The original post-glacial distribution in the Alps region was restricted to the Rhine and Danube catchments (Pechlaner 1987) but charr have been extensively introduced to many lakes in central Europe (Pechlaner 1984b; Brunner et al. 1998). […] All high altitude populations are probably introduced by man, some of them in mediaeval times (Pechlaner 1984)."

Means of Introduction Outside the United States

FAO (2018) lists aquaculture, fisheries, angling and sport, and to fill an ecological niche as reasons of introduction for the subspecies *Salvelinus alpinus alpinus*.

Short Description

From Froese and Pauly (2018a):

"Dorsal spines (total): 4-5; Dorsal soft rays (total): 8-16; Anal spines: 3-4; Anal soft rays: 7-15; Vertebrae: 62-68. Distinguished by the presence of 23 to 32 gill rakers, 37 to 75 pyloric caeca and, on the sides and back, pink to red spots, the largest of which are usually larger than the pupil of the eye [Morrow 1980]. Lateral line curves slightly downward from the head [Morrow 1980]. Pelvic fins with axillary process; caudal emarginate [Morrow 1980]. Color highly variable, depending on location, time of year and degree of sexual development. In general, back is dark, usually rather brown but sometimes with a green cast; the sides are lighter, belly pale; sides and back are liberally sprinkled with pink to red spots, the largest spots along the lateral line usually larger than the pupil of the eye; forward edges of pectoral, pelvic and anal fins, and sometimes the caudal, with a narrow white margin; fins pale in young, dorsal and caudal dark in adults [Morrow 1980]. Spawning adults, especially males, are brilliant orange-red to bright red on the

ventral side and on the pectoral, pelvic and anal fins. Young have about 11 dark parr marks on each side [Morrow 1980]. Caudal fin with 19 rays [Spillman 1961]."

Froese and Pauly (2018a) also list 208–215 scales on lateral line, 30–34 scale rows above lateral line, 28–34 scale rows below lateral line, 1 pectoral spine with 12–16 soft rays, and 2 pelvic spines with 7–11 soft rays.

Biology

From Froese and Pauly (2018a):

"Nerito-pelagic [Coad and Reist 2004]. Occurs in the sea along coasts, estuaries, rivers, and lakes with cold, clear water [Kottelat and Freyhof 2007]. Found in deep runs and pools of medium to large rivers [Page and Burr 1991, 2011]. Anadromous forms spend a considerable time of their lives at sea; non-migratory populations remain in lakes and rivers [Svetovidov 1984]. Anadromous populations enter rivers to breed during fall and winter [Page and Burr 2011]. Freshwater populations feed on planktonic crustaceans, amphipods, mollusks, insects and fishes [Svetovidov 1984]. Anadromous individuals feed little in freshwater and never feed during migrations. Spawning usually takes place on pebble to stone bottom in lakes. Riverine stocks spawn in rivers with slow current (02.-0.8 m/s), but there are some riverine anadromous stocks (in Norway) which spawn yearly in fast-flowing waters of riffles [Kottelat and Freyhof 2007]. Extremely sensitive to water pollution (cold water and oxygen oriented) [Allardi and Keith 1991]."

"Males are generally territorial but when females start showing spawning behavior, males pair up with females and lose interest in their territories. Spawning takes place at almost any time of the day. A female invades a males territory and finds a suitable spot for a redd. Once a spot has been selected, she starts digging. While the female is digging, the male courts her by circling around her and then gliding along her side and quivering. When the redd is completed, the pair release egg and sperm. The pair then swim forward out of the nest, often still ejecting sex products. This may be repeated up to 5 times before the female begins to cover the eggs. The female then digs at the edge of the pit, covering the eggs and beginning the next redd [Morrow 1980]. Males often mate with more than one female, taking the second mate after the first has exhausted the eggs. Sometimes, a female will mate successively with two or more males [Fabricius 1953; Fabricius and Gustafson 1954]. Several days are usually required for females to deposit all their eggs [Morrow 1980]."

From NatureServe (2018):

"Spawns in fall (peaks last 2 weeks of October in Labrador). Eggs hatch in spring. In Labrador, most females are sexually mature by 8 years, a few at 3 years (spawning migrants are 3-18 years old) (Dempson and Green 1985). Individuals spawn at 2-3-year intervals in north, yearly in south."

Human Uses

From Froese and Pauly (2018a):

"Marketed fresh, smoked, canned [Morrow 1980], and frozen. Eaten sautéed, broiled, fried, microwaved and baked [Frimodt 1995]."

"Commercially caught in Siberia [Morrow 1980]."

"Important sport fish in arctic Canada and important in the subsistence fishery of eskimos in some regions [Morrow 1980]."

"Fisheries: minor commercial; aquaculture: commercial; gamefish: yes"

From Klemetsen et al. (2003):

"It is a valuable sport and household fish, not the least for indigenous peoples of the North (Balikci 1980; Johnson 1984; Boivin et al. 1989; Power et al. 1989). Important commercial fisheries are developed in Canada (Kristofferson et al. 1984; Dempson 1995; Dempson & Shears 1998) and the species has a potential in aquaculture (Jobling et al. 1993)."

Diseases

Infectious salmon anemia virus, *Gyrodactylus salaris*, and salmonid alphavirus are OIE-reportable diseases.

From Froese and Pauly (2018a):

"Enteric Redmouth Disease, Bacterial diseases"

Crane and Hyatt (2011) report that *Salvelinus alpinus* can be infected with infectious salmon anemia virus.

Lewisch et al. (2018) report salmonid alphavirus infection in *S. alpinus*.

According to Froese and Pauly (2018b), *Salvelinus alpinus* is a host for *Abothrium crissum*, *Caligus elongatus*, *Diphyllobothrium dendriticum*, *D. ditremum*, *D. salvelini*, *Diplocotyle olrikii*, *Eubothrium salvelini*, *Gyrodactylus salvelini*, *Lepeophtheirus salmonis*, *Proteocephalus arcticus*, *P. longicollis*, *Pseudocapillaria salvelini*, *Salmincola carpionis*, *S. edwardsii*, *S. thymalli*, and *Triaenophorus crassus*.

Poelen et al. (2014) list *Salcelinus alpinus* as a host for *Abothrium* sp., *Acanthocephala* sp., *Acanthocephalus anguillae*, *Acanthocephalus clavula*, *Acanthocephalus lucii*, *Aeromonas salmonicida*, *Anisakis simplex*, *Ascarophis* sp, *Bothrimonus* sp., *Bothrimonus sturionis*, *Bothriocephalidae* sp., *Brachyphallus crenatus*, *Bunodera luciopercae*, *Capilaria* sp., *Clinostomum* sp., *Contracaecum aduncum*, *Contracaecum osculatum*, *Corynosoma strumosum*, *Crepidostomum* sp., *Crepidostomum cooperi*, *Crepidostomum fausti*, *Crepidostomum metoecus*, *Cryptocotyle lingua*, *Cyathocephalus truncatus*, *Cystidicola farionis*, *Cystidicola stigmatura*,

Cystidicoloides ephemeridarum, *Cystidicoloides tenuissima*, *Derogenes varicus*, *Diphylloborhtium* sp., *Diphyllobothrium cordiceps*, *Diphyllobothrium dendriticum*, *Diphyllobothrium ditremum*, *Diphyllobothrium latum*, *Diplocotyle olrikii*, *Diplostomum labracis*, *Diplostomum spathaceum*, *Discocotyle sagittata*, *Distomum* sp., *Echinorhynchus* sp., *Echinorhynchus bothniensis*, *Echinorhynchus gadi*, *Echinorhynchus lateralis*, *Echinorhynchus salmonis*, *Echinorhynchus truttae*, *Eubothrium* sp., *Eubothrium crassum*, *Eubothrium salvelini*, *Eustrongylides* sp., *Gyrodactylus arcuatus*, *Gyrodactylus birmani*, *Gyrodactylus derjavini*, *Gyrodactylus salaris*, *Gyrodactylus salvelini*, *Hedruris androphora*, *Hemiurus levinseni*, *Hirudinae* sp., *Hysterothylacium aduncum*, *Hysterothylacium gadi*, *Hystrichis* sp., infectious pancreatic necrosis virus, *Lecithaster gibbosus*, *Ligula intestinalis*, *Myxobolus arcticus*, *Nanophyetus salmincola*, *Neoechinorhynchus* sp., *Neoechinorhynchus rutili*, *Neoechinorhynchus salmonis*, *Nucleospora salmonis*, *Nybelinia surmenicola*, *Paramphistomum* sp., *Philometra* sp., *Philometra agubernaculum*, *Philonema oncorhynchi*, *Philonema sibirica*, *Phocanema* sp., *Phyllodistomum* sp., *Phyllodistomum conostomum*, *Phyllodistomum umbrae*, *Pomphorhynchus bosniacus*, *Pomphorhynchus laevis*, *Prosorhynchus squamatus*, *Proteocephalus* sp., *Proteocephalus arcticus*, *Proteocephalus filicollis*, *Proteocephalus longicollis*, *Proteocephalus thymalli*, *Proteocephalus torulosus*, *Pseudocapillaria salvelini*, *Pseudoterranova decipiens*, *Raphidascaris acus*, *Renibacterium salmoninarum*, *Rhabdochona denudata*, *Schistocephalus solidus*, *Scolex pleuronectis*, *Spironucleus barkhanus*, *Spironucleus salmonicida*, *Sterliadochona ephemeridarum*, *Tetracapsuloides bryosalmonae*, *Tetraonchus alaskensis*, *Triaenophorus* sp., *Triaenophorus crassus*, *Triaenophorus nodulosus*, *Triaenophorus robustus*, and *Truttaedacnitis alpinus*.

Threat to Humans

From Froese and Pauly (2018a):

"Harmless"

3 Impacts of Introductions

From Fuller and Neilson (2018):

"The impacts of this species are currently unknown, as no studies have been done to determine how it has affected ecosystems in the invaded range. The absence of data does not equate to lack of effects. It does, however, mean that research is required to evaluate effects before conclusions can be made."

From Murdoch et al. (2013):

"The significant post-[*Salvelinus alpinus*]introduction increase in lake chub $\delta^{15}N$ may also be attributable to interannual variation as values differed significantly among the three study years, and the post-introduction pattern of change was not unidirectional. However, the possibility of an introduction impact cannot be ruled out, where Arctic charr may have influenced lake chub to increase its dependency on prey with higher $\delta^{15}N$ values."

4 Global Distribution

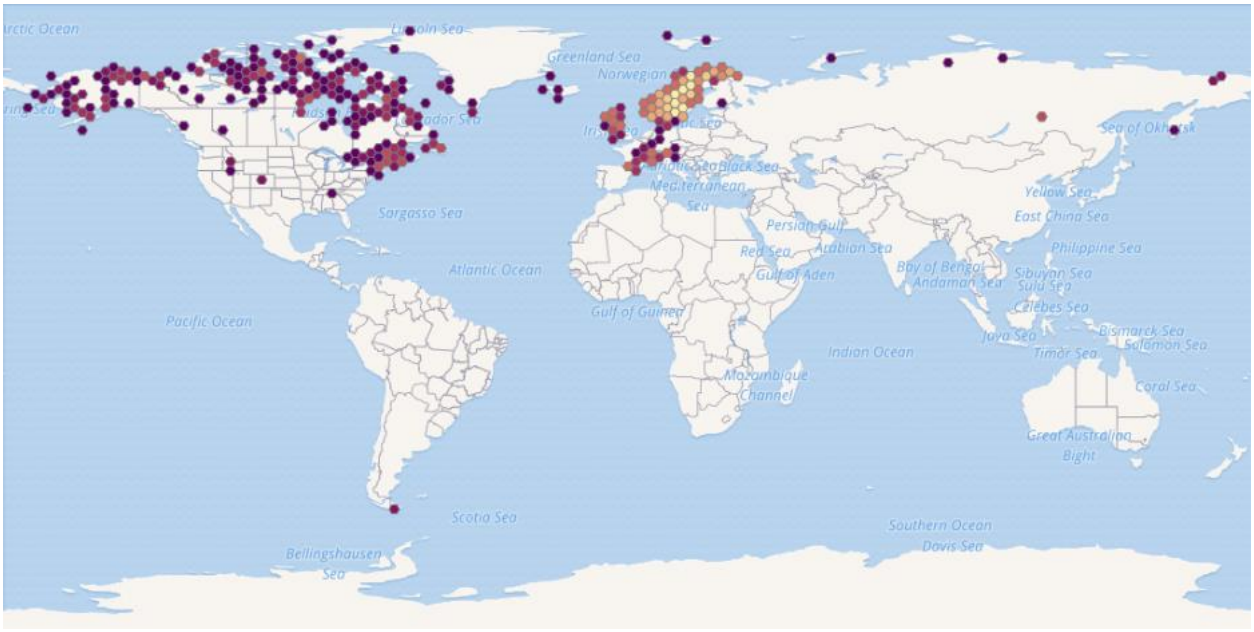

Figure 1. Known global distribution of *Salvelinus alpinus*. Locations are across the northern portions of North America, Europe, and Asia. Map from GBIF Secretariat (2018).

The location in southern Argentina (Figure 1) was not used as a source point in the climate match. No confirmation of an established population at this location was found in the literature and further there were no records of introduction found in the southern hemisphere.

The locations in Denmark (Figure 1) were used as source points in the climate match. While some sources list *Salvelinus alpinus* as not established in Denmark, the number of observations spread across the country and spanning many years as recorded by a national survey of fish species (GBIF Secretariat 2018) indicates that the species is established in Denmark.

5 Distribution Within the United States

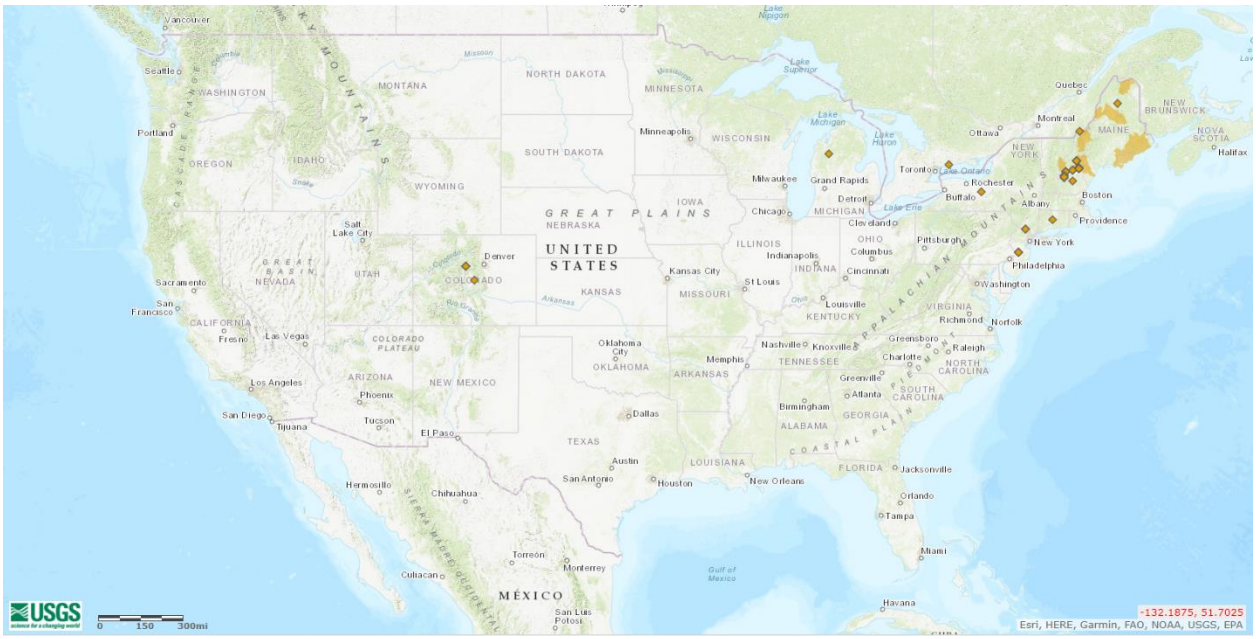

Figure 2. Known distribution of *Salvelinus alpinus* in the contiguous United States. Orange shading in northern New Egland indicates the native range of this species within the contiguous United States. Map from Fuller and Neilson (2018).

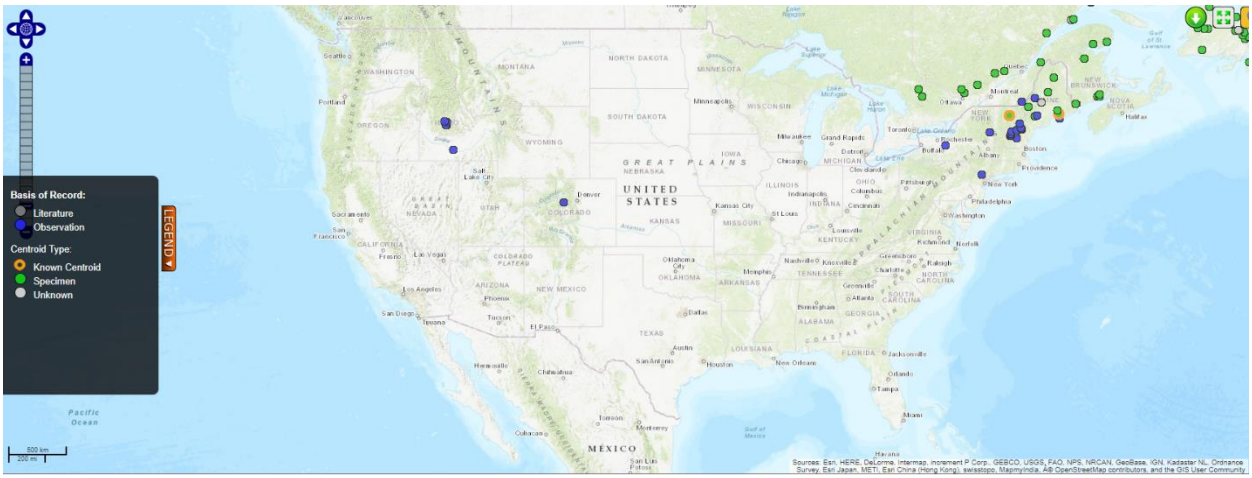

Figure 3. Additional known distribution of *Salvelinus alpinus* in the contiguous United States. Map from BISON (2018).

Locations in Colorado, Connecticut, Michigan, New Jersey, and New York (Figures 2, 3) were not used as source points for the climate match. The introductions failed, the populations are extirpated, or are sustained by continuous restocking and not natural reproduction (Fuller and Neilson 2018).

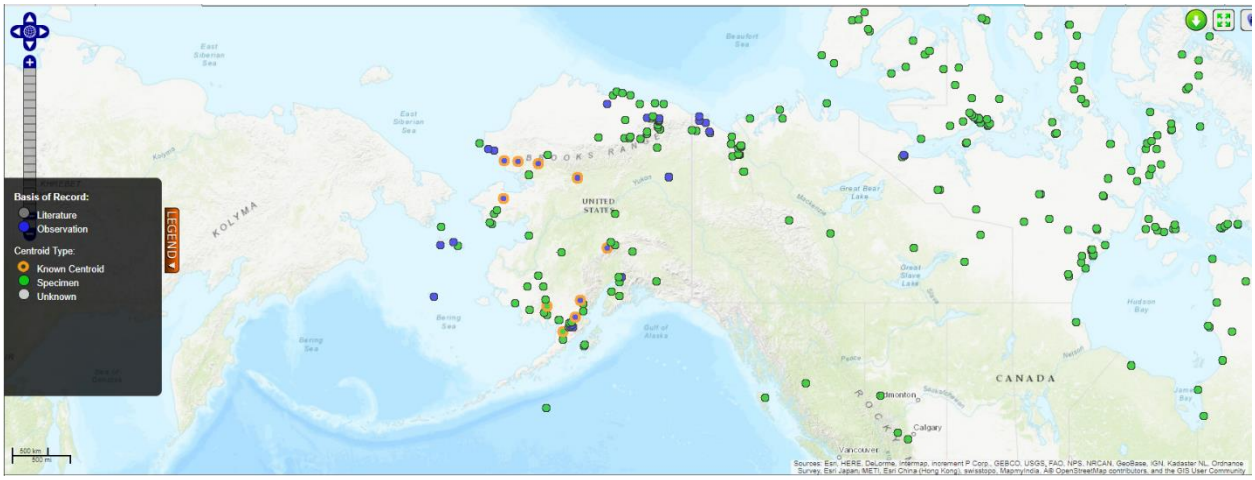

Figure 4. Distribution of *Salvelinus alpinus* in Alaska and western Canada. Map from BISON (2018).

Marine observations (Figures 1, 4) were not used as source points for the climate match. RAMP (Sanders et al. 2018) climate matches are valid for terrestrial and freshwater areas, not marine zones.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Salvelinus alpinus* was high in the Northeast and around the Great Lakes with narrow bands of high match extending south toward northeastern Texas and northern North Carolina. There were also areas of high match in the western plains, east of the Rocky Mountains. The Gulf Coast, along the Mexican border, the southwest, Midwest, and northern Pacific Coast all had low climate matches. Everywhere else had a medium match. The Climate 6 score (Sanders et al. 2018; 16 climate variables; Euclidean distance) for contiguous United States was 0.357, high. The following states had high individual climate scores: Arkansas, California, Colorado, Connecticut, Delaware, Idaho, Illinois, Indiana, Kentucky, Massachusetts, Maryland, Maine, Michigan, Minnesota, Missouri, Montana, North Carolina, New Hampshire, New Jersey, Nevada, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Utah, Virginia, Vermont, Washington, Wisconsin, West Virginia, and Wyoming.

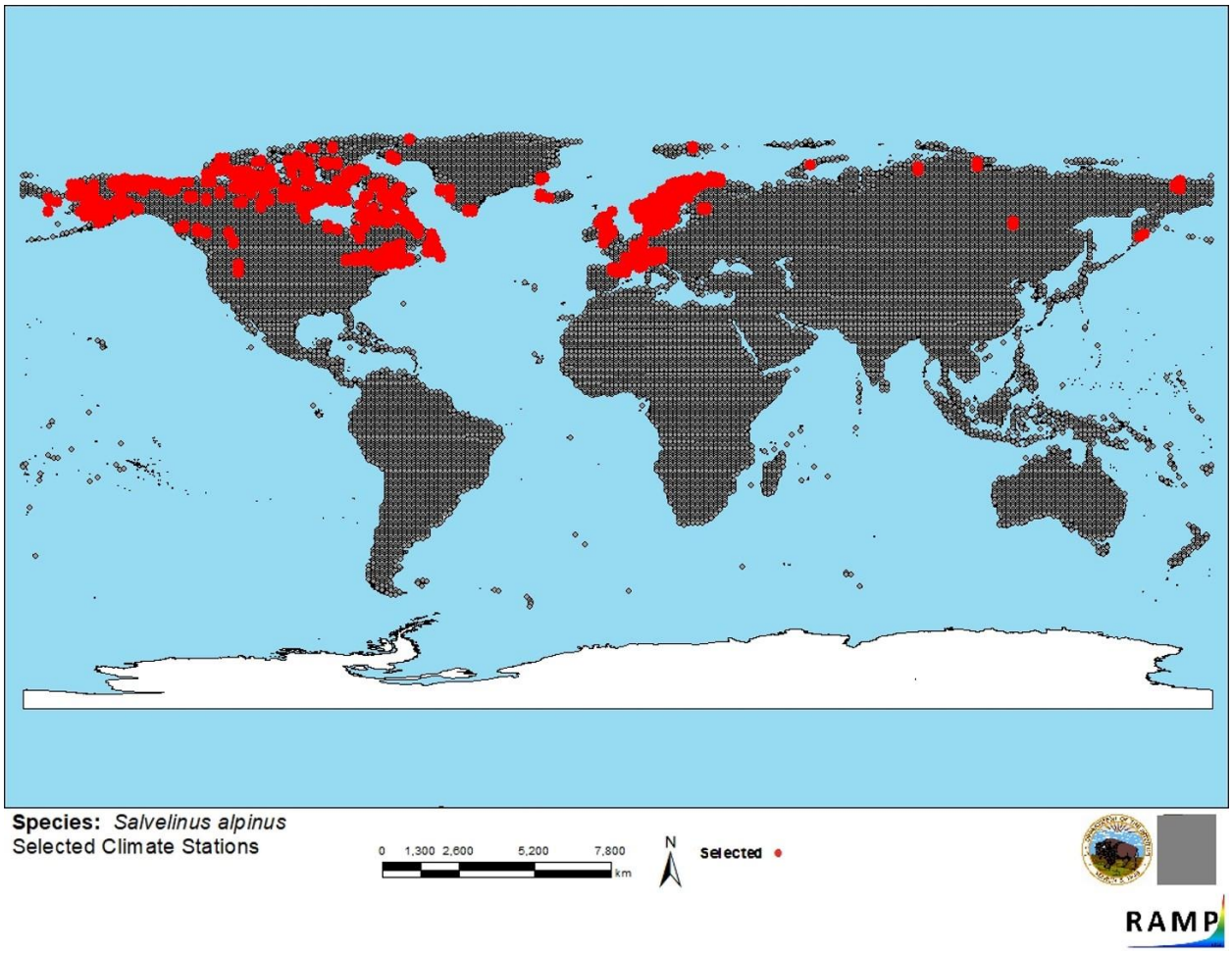

Figure 5. RAMP (Sanders et al. 2018) source map showing weather stations in the northern hemisphere selected as source locations (red) and non-source locations (gray) for *Salvelinus alpinus* climate matching. Source locations from BISON (2018), Fuller and Neilson (2018), and GBIF Secretariat (2018).

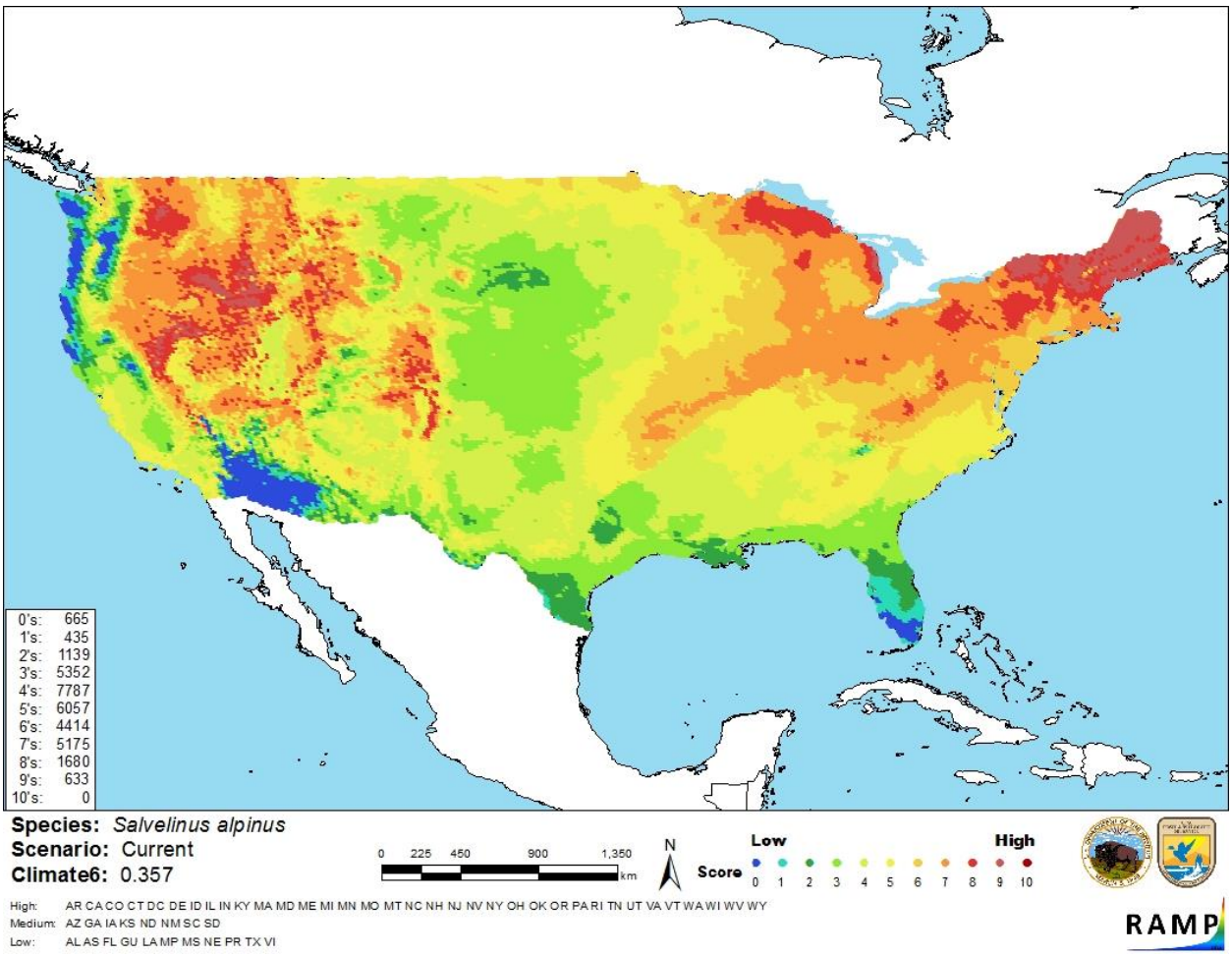

Figure 6. Map of RAMP (Sanders et al. 2018) climate matches for *Salvelinus alpinus* in the contiguous United States based on source locations reported by BISON (2018), Fuller and Neilson (2018), and GBIF Secretariat (2018). Counts of climate match scores are tabulated on the left. 0 = Lowest match, 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≤X≤0.005	Low
0.005<X<0.103	Medium
≥0.103	High

7 Certainty of Assessment

Certainty of assessment for *Salvelinus alpinus* is low. Information on the biology of this species is substantial, including considerable peer-reviewed literature. However, literature on *Salvelinus alpinus* invasion history and actual environmental impacts does not exist.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Arctic Char (*Salvelinus alpinus*) is a salmonid native throughout the northernmost arctic with both anadromous and freshwater populations, and has been widely introduced for human uses. One source stated that *S. alpinus* has probably been introduced into new locations since medieval times. The species is adapted to survive in many marine, freshwater, and brackish environments with depauperate fish communities, and is the only fish species present in some systems. *S. alpinus* can be infected with multiple OIE-reportable diseases. There are multiple recognized subspecies. The history of invasiveness is not documented. *S. alpinus* supports subsistence, commercial, and recreational fisheries. There are many records of introduction, mostly intentional, and some have resulted in established wild populations. One study suggested a possible impact from introduction on a food web but could not sufficiently rule out normal variation in the system as a cause for the observed impact. No other information on impacts of introduction was found. The climate match for the contiguous United States is high. The areas of highest match are in the Northeast, Great Lakes, and western plains, east of the Rocky Mountains. Certainty of this assessment is low due to the lack of information available on impacts of introduction. The overall risk assessment category is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): None Documented**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Low**
- **Remarks/Important additional information:** Infectious salmon anemia virus, *Gyrodactylus salaris*, and salmonid alphavirus are OIE-reportable diseases.
- **Overall Risk Assessment Category: Uncertain**

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