U.S. Fish & Wildlife Service

Zander (*Sander lucioperca*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, November 2023
Revised, January 2024
Web Version, 8/5/2024

Organism Type: Fish
Overall Risk Assessment Category: High

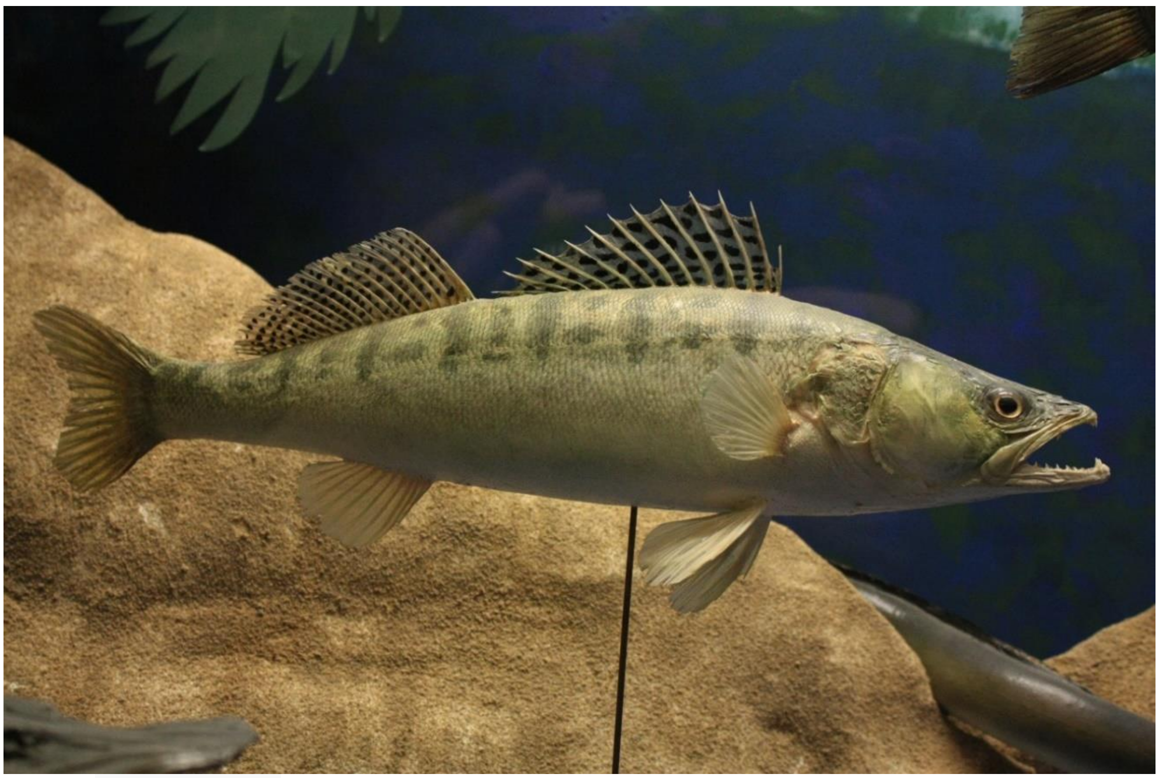
Photo: Tylwyth Eldar. Licensed under Creative Commons. Available: https://commons.wikimedia.org/wiki/File:Sandre_%28Sander_lucioperca%29.jpg (November 2023).

1 Native Range and Status in the United States

Native Range

From Larsen and Berg (2014):

"*S. lucioperca* occurs naturally in lakes and rivers of Middle and Eastern Europe from Elbe, Vistula, north from Danube up to the Aral Sea and the northernmost observations of native populations were recorded in Finland up to 64° N. *S. lucioperca* naturally inhabits Onega and Ladoga lakes, brackish bays and lagoons of the Baltic sea [sic]. The distribution range in the Baltic area is supposed to be equivalent to the range of the post-glacial Ancylus Lake, which during the period 9200-9000 BP had a water level 100-150 m above the present sealevel [sic] of the Baltic Sea (Salminen et al. 2011). The most southern populations are known from regions near the Caucasus, inhabiting brackish and saline waters of Caspian, Azov and Black Seas (Bukelskis et al., 1998). Historic evidence from 1700 and 1800 (two sources) suggests the existence of one natural population in Denmark, in Lake Haderslev Dam and the neighbouring brackish Haderslev Fiord on the east coast of the Jutland peninsula (Berg 2012)."

From Froese and Pauly (2023):

"Europe and Asia: Caspian, Baltic, Black and Aral Sea basins; Elbe (North Sea basin) and Maritza (Aegean basin) drainages. North to about 65° N in Finland."

Godard and Copp (2011) report *S. lucioperca* as native to western Asia (Afghanistan, Armenia, Azerbaijan, Georgia, Iran, Kazakhstan, Uzbekistan) and central, eastern, and northern Europe (Albania, Austria, Czechia, Estonia, Finland, Germany, Greece, Hungary, Latvia, Lithuania, Moldova, Norway, Poland, Romania, Russia, Serbia, Slovakia, Sweden, and Ukraine).

Status in the United States

From Fuller and Neilson (2023):

"Although it was thought that zander stocked into a North Dakota lake did not survive (e.g., Anderson 1992), the capture of a fish in August 1999, and another 2+ year old fish in 2000 shows that at least some survived and reproduced. Five young-of-the-year fish were collected in 2005. As of 2009, the state reports that they are established in Spiritwood Lake. The North Dakota Game and Fish Department (NDGFD) reports capture of yearlings and 2-year olds, although they same [sic] the population is very small. Genetic sampling of fish has found that all are pure zander, there has been no hybridization. Spiritwood Lake is normally a closed basin, however it was connected to the James River due to flooding in 1998–2001. Sampling by NDGFD did not find any evidence that zander escaped the lake during the flood (L. Schlueter, personal communication)."

"Courtenay et al. (1986) listed this species from New York, but the record was based on an unconfirmed report."

Regulations

Sander lucioperca was listed as injurious, effective October 2016, under the Lacey Act (18.U.S.C.42(a)(1)) by the U.S. Fish and Wildlife Service (USFWS 2016). The importation of *S. lucioperca* into the United States, any territory of the United States, the District of Columbia, the Commonwealth of Puerto Rico, or any possession of the United States, or any shipment between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any possession of the United States is prohibited.

Sander lucioperca is also regulated by the States of Alabama (ADCNR 2022), Colorado (CPW 2023), Illinois (Illinois DNR 2015), Kansas (KDWP 2023), Montana (Montana FWP 2023), New York (New York DEC 2022), Ohio (ODNR 2022), Oregon (ODFW 2022), and Wisconsin (Wisconsin DNR 2022).

While effort was made to find all applicable regulations, this list may not be comprehensive.

Means of Introductions within the United States

From Fuller and Neilson (2023):

"Stocked for sport fishing."

"Apparently the North Dakota Game and Fish Department had been interested in zander as a sport fish for many years and that agency chose Spiritwood Lake as the site of an experimental release because the water body was completely enclosed (Anderson 1992). In 1987, prior to the lake introduction, the state had hatched eggs imported from Holland, but the resulting fry were destroyed for fear that they carried pike fry rhobdo [sic] virus (Anonymous 1987a; Lohman 1989). Those wanting to introduce zander thought that it would be a boon to the fisheries of North America (e.g., Anderson 1992), whereas others expressed strong reservations (e.g., Wright 1992). Some fisheries personnel in states surrounding North Dakota and nearby Canadian provinces expressed doubts concerning the species' introduction, particularly because its effect on native species was unknown and because of its potential to spread (e.g., Wingate 1992)."

Remarks

This ERSS was previously published in August 2019. Revisions were completed to incorporate new information and conform to updated standards.

Sander lucioperca has been intentionally stocked outside its native range within the United States by State fishery managers to achieve fishery management objectives. State fish and wildlife management agencies are responsible for balancing multiple fish and wildlife management objectives. The potential for a species to become invasive is now one important consideration when balancing multiple management objectives and advancing sound, science-based management of fish and wildlife and their habitat in the public interest.

From Godard and Copp (2011):

"[…] this species is known to hybridize with Volga pikeperch *Sander volgensis* (Specziar et al., 2009; Müller et al., 2010) and also a single incident of hybridization with Eurasian perch *Perca fluviatilis* has been reported (Kahilainen et al., 2011)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2023):

Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Deuterostomia
      Phylum Chordata
        Subphylum Vertebrata
          Infraphylum Gnathostomata
            Superclass Actinopterygii
              Class Teleostei
                Superorder Acanthopterygii
                  Order Perciformes
                    Suborder Percoidei
                      Family Percidae
                        Genus *Sander*
                          Species *Sander lucioperca* (Linnaeus, 1758)

According to Fricke et al. (2023), *Sander lucioperca* is the current valid name for this species.

Size, Weight, and Age Range

From Larsen and Berg (2014):

"*S. lucioperca* obtains a maximum length of 100-130 cm which corresponds to a weight of about 15-20 kg. Maximum age is inversely correlated to growth rate. Slow-growing *S. lucioperca* in the northern part of the distribution area reach 20-24 years of age, while faster-growing *S. lucioperca* in the southern part only reach about 8-9 years (Sonesten 1991)."

From Froese and Pauly (2023):

"Maturity: L_m 37.2, range 28 - 46 cm
Max length : 100.0 cm SL [standard length] male/unsexed; [Freyhof and Kottelat 2007]; common length : 50.0 cm TL [total length] male/unsexed; [Muus and Dahlström 1968]; max. published weight: 20.0 kg [Keith and Allardi 2001]; max. reported age: 17 years [Baensch and Riehl 1991]"

Environment

From Freyhof and Kottelat (2008):

"Habitat: Large, turbid rivers and eutrophic lakes; brackish coastal lakes and estuaries."

From Larsen and Berg (2014):

"*S. lucioperca* is found in lakes, moderately running waters and brackish coastal waters with salinities up to ca. 12 ‰. It thrives in turbid, moderately eutrophic waters with high oxygen content. *S. lucioperca* is also found in clear waters if the depth is sufficient to enable it to seek refuge during daytime (Sonesten 1991)."

From Froese and Pauly (2023):

"Freshwater; brackish; pelagic; potamodromous [Riede 2004]; depth range 2 - 30 m [Billard 1997], usually 2 - 3 m [Gerstmeier and Romig 1998]. Temperate; 6°C - 22°C [assumed to refer to aquarium temperature range; Baensch and Riehl 1991]"

From Godard and Copp (2011):

"Salinity levels of up to 20 psu are tolerated, with preferred levels of <5 ppt (Winkler et al. 1988; Saisa et al., 2010). Spawning is restricted to salinity levels below 5 ppt (Lappalainen [et al.,] 2003)."

Climate

From Froese and Pauly (2023):

"[…] 67°N - 36°N, 1°W - 75°E"

Distribution Outside the United States

Native

From Larsen and Berg (2014):

"*S. lucioperca* occurs naturally in lakes and rivers of Middle and Eastern Europe from Elbe, Vistula, north from Danube up to the Aral Sea and the northernmost observations of native populations were recorded in Finland up to 64° N. *S. lucioperca* naturally inhabits Onega and Ladoga lakes, brackish bays and lagoons of the Baltic sea [sic]. The distribution range in the Baltic area is supposed to be equivalent to the range of the post-glacial Ancylus Lake, which during the period 9200-9000 BP had a water level 100-150 m above the present sealevel [sic] of the Baltic Sea (Salminen et al. 2011). The most southern populations are known from regions near the Caucasus, inhabiting brackish and saline waters of Caspian, Azov and Black Seas (Bukelskis et al., 1998). Historic evidence from 1700 and 1800 (two sources) suggests the existence of one natural population in Denmark, in Lake Haderslev Dam and the neighbouring brackish Haderslev Fiord on the east coast of the Jutland peninsula (Berg 2012)."

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Godard and Copp (2011) report *S. lucioperca* as native to western Asia (Afghanistan, Armenia, Azerbaijan, Georgia, Iran, Kazakhstan, Uzbekistan) and central, eastern, and northern Europe (Albania, Austria, Czechia, Estonia, Finland, Germany, Greece, Hungary, Latvia, Lithuania, Moldova, Norway, Poland, Romania, Russia, Serbia, Slovakia, Sweden, and Ukraine).

Introduced

From Larsen and Berg (2014):

"*S. lucioperca* has been introduced into several European countries, among others the Netherlands and Turkey (Welcomme 1988), France (Daszkiewich 1999, Keith & Allardi 2001) Italy (Gandolfi et al. 1991) and Spain (Elvira 1995). It was first introduced into the UK in 1878 by the Ninth Duke of Bedford (Cacutt 1979). He stocked 23 *S. lucioperca* into two lakes at Bedfordshire from a lake in Schleswig-Holstein in Germany. In 1910 the first reproducing population was established."

"In 1898, 200 *S. lucioperca* were successfully stocked into Lake Søgård in southern Jutland. Today more than 70 Danish lakes and rivers contain self-reproducing stocks of *S. lucioperca* (Otterstrøm 1912, Dahl 1982)."

"In the other three Nordic countries, Sweden, Norway and Finland, *S. lucioperca* is, even though it is native to these countries, the most commonly introduced none-salmonid [sic] fish species in new lakes. This has increased the present range of the originally southernly distributed *S. lucioperca* northwards in these countries. Ca. 2500 lakes > 4 ha have an introduced population of *S. lucioperca* (Rask et al. 2000, Tammi et al. 2003). In Sweden alone, more than 92 lakes and rivers contain *S. lucioperca* populations as a result of stocking (Filipsson 1994)."

"The only known natural distribution areas of the species in Lithuania is in the Curonian Lagoon and the lower River Nemunas (Bukelskis et al., 1998; Virbickas 2000). From there this species was introduced into Lake Dysnai before 1940. Numerous successful introductions into many water bodies followed. Currently large populations of pike-perch [*S. lucioperca*] inhabit the Curonian Lagoon, Kauno, Antalieptes reservoirs, Sartai, Dysnai, Dviragis Lakes, the River Nemunas, etc. (Bukelskis et al., 1998)."

"*S. lucioperca* has been stocked in at least 94 (12 %) lakes in Latvia, some artificial reservoirs on the Daugava, and the southern part of the Gulf of Riga from 1904 to 1996 (Nature of Latvia)."

"In 1881-1882, *S. lucioperca* was first stocked in western Germany, especially in Lake Constance and in the Rhine (Lehmann 1931). In later years *S. lucioperca* has also been introduced into other areas of Germany."

"Since the end of the 19th century *S. lucioperca* has been successfully introduced into more than 30 moraine lakes in south-eastern and southern Estonia (Ojaveer et al. 2003)."

From Pavličević et al. (2016):

"[*S. lucioperca*] was illegally/unintentionally introduced in Ramski Reservoir [Bosnia and Herzegovina] in the upper river [Neretva River] part in 1986, while establishment of its abundant populations was reported during the 1990s in two connected artificial reservoirs."

Godard and Copp (2011) list *S. lucioperca* as introduced to Algeria (not established), Morocco (established), and Tunisia (established) in Africa. In Asia, it was introduced to and has become established in China, Kyrgystan, and Turkey. In addition to the areas in Europe mentioned above, Godard and Copp (2011) list *S. lucioperca* as introduced to Azores (Portugal; established), Belgium (status not reported), Bulgaria (status not reported), Croatia (established), Cyperus (established), Portugal (established), Slovenia (established), and Switzerland (established).

Means of Introduction Outside the United States

From Larsen and Berg (2014):

"*S. lucioperca* has been introduced for both commercial and recreational fishing – the fish is very tasty and has high market and angling value. Furthermore, the species has been used for biomanipulation in order to reduce the number of unwanted fish, usually cyprinids (Lappalainen et al. 2003)."

"Most introductions of *S. lucioperca* have been done in lakes. From the lakes the fish have migrated into larger rivers (e.g. River Gudenaa in Denmark; Koed 2001), and in some cases have, through migration, established themselves in neighbouring lakes to the lakes where they were first introduced. In Finland, the extinction of many northern native *S. lucioperca* populations in 1960´s, has been followed by successful re-introductions in 1980´s (Colby & Lehtonen 1994). In Sweden *S. lucioperca* is still stocked to support fisheries, both within and outside the area of its natural range."

Short Description

From Larsen and Berg (2014):

"*S. lucioperca* has a long slender body. There are no spines on the gill cover. The mouth has many small teeth and a few larger teeth for catching prey. The species has two dorsal fins – the first with 13 to 18 spines and the second one with 1-2 spines and 21 to 22 soft rays. The caudal fin has 17 soft rays and the anal fin has 2-3 spines and 10-14 soft rays […]."

Biology

From Freyhof and Kottelat (2008):

"Lives up to 17 years. Spawns for the first time at 3-10 years, usually at four. Spawns in April-May, exceptional from late February until July, depending on latitude and altitude, when temperatures reach 10-14°C in spawning grounds (lowest temperature for egg incubation 11.5°C). May undertake short spawning migrations. Individuals foraging in brackish water migrate to freshwater habitats (migrations of up to 250 km have been recorded). Homing well developed, even nearby populations may be relatively isolated. Males are territorial and excavate shallow depressions about 50 cm in diameter and 5-10 cm deep in sand or gravel, or among exposed plant roots on which eggs are deposited, usually in turbid water and at 1-3 m depth. Spawns in pairs, at dawn or night. Female remains over the nest while male circles rapidly around, at about 1 metre from nest. Then male takes a vertical orientation and both swim around swiftly, and eggs and sperm are released. After all the eggs are released female leaves the nest site. Male defends the nest and fans the eggs with his pectorals. Females spawn once a year. Feeding larvae are positively phototactic and feed on pelagic organisms after they leave the nest for open water. Piscivorous, feeding mostly on gregarious, pelagic fishes."

Human Uses

From Godard and Copp (2011):

"[…] an angling target and for aquaculture, and has occasionally been used as a biomanipulation tool to remove unwanted cyrpinids (Lappalainen et al., 2003; Larsen and Berg, 2006)."

From Froese and Pauly (2023):

"Fisheries: commercial; aquaculture: commercial; gamefish: yes; aquarium: public aquariums."

"Popularly fished by sport fishers. Its flesh is succulent [Billard 1997]. Utilized fresh or frozen and eaten steamed, broiled and microwaved [Frimodt 1995]."

"It is the subject of extensive pond breeding [in France], partly for restocking purposes [Billard 1997]."

From Larsen and Berg (2014):

"*S. lucioperca* is a valuable fish – it has a high market value and is a target species in angling. After its introduction to Danish lakes, it soon became an economically very important species in commercial fisheries. […] In the Turkish Lake Egredir, the value of commercial fisheries increased several fold after the introduction of *S. lucioperca* […]."

Diseases

***Sander lucioperca* has been documented as susceptible to *Gyrodactylus* sp. Gyrodactylosis (infection with *G. salaris*) is a disease listed by the World Organisation for Animal Health (2023). *S. lucioperca* has also been documented as susceptible to epizootic hematopoietic necrosis virus, another disease listed by the World Organisation for Animal Health (2023).**

Poelen et al. (2014) list *Sander lucioperca* as a host to Perch perhabdovirus and *Parvovirinae* spp.

Poelen et al. (2014) list *Sander lucioperca* as a host to the following parasites: *Acanthocephalus anguillae, A. clavula, A. lucii, Acanthostomum imbutiformis, Ancryocephalus paradoxus, A. cruciatus, A. paradoxus, A. percae,* eel swimbladder nematode (*Anguillicola crassus*), *Anisakis schupakovi*, herring worm (*A. simplex*), *Apatemon annuligerum, Apophallus donicus, A. muehlingi, Ascaris velocissima, Ascocotyle calceostoma, A. coleostoma, Aspidogaster limacoides, Azygia lucii, Bothriocephalus acheilognathi, Brachyphallus crenatus, Bucephalus markewitschi, B. polymorphus, Bunocotyle cingulate, Bunodera luciopercae, Camallanus lacustris, Caryophyllaeides fennica, Clinostomum complanatum, Contracaecum squalii, Corynosoma semerme, C. strumosum, Cosmocephalus obvelatus, Cyathocephalus truncates, Dactylogyrus anchoratus, Desmidocercella numidica, Diclybothrium armatum*, Fish tapeworm (*Diphyllobothrium latum*), *Diplostomum baeri, D. chromatophorum, D. clavatum, D. commutatum, D. helveticum, D. mergi, D. paracaudum, D. spathaceum, D. volvens, Diplozoon paradoxum, Echinorhynchus cinctulus,* proboscis worm (*E. gadi*), *E. salmonis, Eubothrium crassum, Eustrongylides excisus, Gnathostoma hispidum, Gyrodactylus cernuae, G. longiradix, G. lucii, G. luciopercae, Hemiurus luehei, Ichthyocotylurus erraticus, I. pileatus, I. platycephalus, I. variegatus, Lecithaster tauricus, Ligula intestinalis, Metagonimus yokogawai, Metorchis xanthostomus, Neoechinorhynchus rutili, Nicolla skrjabini, Paracoenogonimus ovatus, Paracuaria tridentata, Paratenuisentis ambiguus, Philometra obturans, Phyllodistomum angulatum, P. pseudofolium, Pomphorhynchus laevis, Porrocaecum reticulatum, Proteocephalus cernuae, P. percae,* sealworm (*Pseudoterranova decipiens*), *Pulvinifer macrostomum, Pygidiopsis genata, Raphidascaris acus, Rhipidocotyle campanula, R. illense, Sanguinicola volgensis, Schulmanela petruschewskii, Streptocara crassicauda, Triaenophorus crassus, T. nodulosus,* and *Tylodelphys clavata.*

From Godard and Copp (2011):

"Eslami et al. (2011) reported *Anisakis* from the gastro-intestinal tract. […] Mokhayer (1976) records the acanthocephalan *Corynosoma caspicum*. Jalali and Molnár (1990) record the monogenean *Ancyrocephalus paradoxus*. Masoumian et al. (2005) recorded the protozoan parasite *Trichodina perforata*. Pazooki et al. (2007) recorded various parasites, including *Diplostomum spathaceum* and *Argulus foliaceus*. Barzegar et al. (2008) recorded the digenean eye parasite *Diplostomum spathaceum* from this fish. Barzegar and Jalali (2009) reviewed crustacean parasites in Iran and found *Achtheres percarum* on this species. Azadikhah et al. (2009) found 6 parasite species including two *Trichodina* spp. from the gills and *Vorticella* sp. on the skin; other parasites included *Gyrodactylus* sp. and *Argulus foliaceus* from the gills, and *Diplostomum spathaceum* from the lens of the eyes. Rolbiecki (1993) noted the parasitic metazoa of pikeperch in Poland to include *Achteres percarum, Ancyrocephalus paradoxus, Argulus foliaceus, Azygia lucii, Bothriocephalus sp., pleroceroid, Brachyphallus crenatus, Bucephalus polymorphus, Bunodera luciopercae, Camallanus lacustris, Camallanus truncates, Corynosoma semerme, Diplostomum spathaceum, Ichthyocotylurus playcephalus, Neoechinorhynchus rutile, Piscicola geometra, Pomphorhynchus laevis* and Tylodelphys clavata."

From Singh et al. (2014):

"[…] *Sander lucioperca* [is] susceptible to EHNV [epizootic hematopoietic necrosis virus] infection [Jensen et al. 2011]."

From Fuller and Neilson (2019):

"[…] resulting fry were destroyed for fear that they carried pike fry rhobdo virus (Anonymous 1987a; Lohman 1989)."

From Bovo (2010):

"During summer 2009 VER [viral encephalopathy and retinopathy] was diagnosed in a farm rearing pike-perch (*Sander lucioperca*) […]."

Saleh et al. (2012) list *Sander lucioperca* as a host for zander rhabdovirus.

Cinkova et al. (2010) list *Sander lucioperca* as a host for pike-perch iridovirus.

Pękala et al. (2015) isolated *Shewanella putrefaciens* from *Sander lucioperca*.

Froese and Pauly (2023) list *Sander lucioperca* as a host for the following additional pathogens: *Achtheres sandrae*, *Aponurus laguncula, Aponurus tschugunovi, Ascaris truncatula, Asymphylodora kubanicum, Bolbophorus confusus, Caligus lacustris, C. minimus, Camallanus truncates, Diplostomum paraspathaceum, Distomum volgense, Ergasilus sieboldi, Glugea dogieli*, *Hysteromorpha triloba*, *Lucionema balatonense, Neoergasilus japonicus, Posthodiplostomum brevicaudatum,* and *P. cuticola.*

Threat to Humans

From Godard and Copp (2011):

"Eslami et al. (2011) reported *Anisakis* from the gastro-intestinal tract. This parasite can infest man if fish is eaten smoked, salted or fried at temperatures below 50°C."

From Froese and Pauly (2023):

"Potential pest [Innal and Erk'akan 2006]."

3 Impacts of Introductions

From Larsen and Berg (2014):

"In the springtime *S. lucioperca* also predate on smolts of sea-trout (*Salmo trutta*) and salmon (*Salmo salar*) when they migrate to the sea. Studies from River Gudenaa, Denmark has shown that predation on smolts in the lower part of the river has an adverse effect on the population of sea-trout (Jepsen et al. 2000, Koed 2001, Koed et al. 2002)."

"Schulze et al. (2006) found that the perch (*Perca fluviatilis*) population in a shallow, mesotrophic lake with natural occurrence of perch and pike (*Esox lucius*) were negatively affected by *S. lucioperca* introduction. In an experiment they showed that perch was forced away from its preferred habitat, the pelagic zone, by *S. lucioperca*. As the littoral zone was already occupied by pike, the perch population was "sandwiched" between pike and the introduced *S. lucioperca*. As perch has been found to be the most important predator to control the density of zooplanktivorous 0+ cyprinids in Danish lakes, the introduction of *S. lucioperca* must be considered as negative and indeed has been observed to result in reduced environmental conditions compared to the expected in eutrophic Danish lakes (Jerl Jensen, pers. comm.)."

"Several authors have reported reduced population densities of cyprinids as a result of *S. lucioperca* introduction. Jeppesen et al. (2001) found evidence of this in a paleolimnologic study in the Danish Lake Skanderborg, where *S. lucioperca* was introduced in 1903-04. After this a permanent reduction in cyprinid densities was found. […] Cowx (1997) found that introducing *S. lucioperca* to English rivers created a crash in the cyprinid fish community."

"Brabrand and Faafeng (1993) showed how young roach shifted from pelagic to littoral habitats as a result of *S. lucioperca* introduction in a Norwegian lake. An indirect effect of the changed behaviour of roach was increased infection rate of roach with the ectoparasite *Ichthyophthirius multifiliis*, as roach was more often exposed to the free swimming state of *Ichthyophthirius multifiliis* when living in shallow water near the substrate compared to their previously more pelagic lifestyle (Brabrand et al. 1994)."

From Pavličević et al. (2016):

"The most important impact of pikeperch [*Sander lucioperca*], 28 years after its invasion in the Neretva River watershed [Bosnia-Herzegovina], is the extinction of native endemic Neretvan bleak [*Alburnus neretvae*], in the artificial reservoirs. The bleak was abundant, even in the artificial reservoirs, before the pikeperch introduction. Bleak was the major prey during the first period of pikeperch invasion."

From Schulze et al. (2006):

"The lake-wide piscivore biomass increased 1.42–1.64 times as a result of pikeperch [*S. lucioperca*] stocking and the accompanying increase in northern pike abundance. The biomass of piscivorous fish in the pelagic area almost doubled as a result of pikeperch stocking in comparison with the period before stocking when large perch was the sole pelagic predator. Therefore, a severe density-mediated perturbation could be expected. Beyond the density-mediated effects on the prey fish population (consumption rates of predators), changes in a behavioral trait (reduced diel horizontal migration of small roach) were also observed. Furthermore, among the residential predators, the introduced pikeperch induced both density-mediated effects (cannibalism and intraguild predation) and changes in habitat use and prey selectivity."

"Pikeperch stocking affected habitat use and diet composition of piscivorous perch. […] However, there was a strong tendency for perch to increasingly respond to the pelagic presence of pikeperch by shifting their daytime habitat towards a stronger use of the littoral area as a higher proportion of perch was caught in nearshore areas in 2002 as compared with 2001, and the differences were even more pronounced in comparison with the situation before pikeperch stocking (Haertel et al. 2002)."

“Northern pike may have even benefited from stocking with pikeperch. In direct comparison between the pikeperch-free and the pikeperch periods, northern pike abundance was significantly higher in 2002 than the years before pikeperch stocking, and biomass almost doubled after the pikeperch introduction.”

From Anseeuw et al. (2007):

“The introduction of this predatory fish in Western Europe created a crash in some cyprinid fish communities. Populations of native piscivorous fish species (*Esox lucius*, *Perca fluviatilis*) were locally depleted due to interspecific competition. The pike-perch is also a vector of the *Bucephalus polymorphus* parasite, that can affect native cyprinid fish species; however, a massive outbreak of this parasite has never been reported from Belgium.”

From Innal and Erk'akan (2006):

“Çildir (2001) reported that in 1955 approximately 10,000 young *Sander lucioperca* (= Zander) of 10–15 cm length imported from Austria were translocated into Lake Eğirdir [Turkey] by the Hydro Biological Research Institute (University of Istanbul). The apparent aim was to improve the fisheries of the lake. The fishery was widely practiced in central Europe at the time before transplantation and ten fish species were reported to exist in the lake: *Cyprinus carpio, Vimba vimba, Capoeta pestai, Acanthorutilus handlirschi, Thylognathus klatti, Aphanius chantrei, Cobitis taenia, Orthrias angorae, Schizothorax propyhlax* and *Pararhodeus niger*. Of these S*. prophylax* and *P. niger* were apparently misidentified since these fish are not among the fauna of Turkey. However they are presumed to represent *Phoxinellus zeregi* and *P. anatolicus*, respectively. Twenty three years [after the 1955 introduction] later in 1978 the only significant population left in the lake (apart from Zander) was carp (*Cyprinus carpio*), *Vimba vimba* and *Varicorhinus pestai* (= *Capoeta pestai*). Zander is the only species with a large stock, while carp and *Vimba vimba* catches have declined sharply. Most recent data evaluations indicate while *P. anatolicus, O. angorae, Seminoemacheilus lendli* and *Hemmigramocapoeta kemali* are still surviving in some numbers, *Phoxinellus egridiri, P. handlirschi, P. zeregi* are suspected to have gone extinct. After introduction of Zander to Beysehir Lake, the number of fish species have been decreasing drastically. The three species presumed extinct were endemic to Turkey.”

From Godard and Copp (2011):

“[…] this species is known to hybridize with Volga pikeperch *Sander volgensis* (Specziar et al., 2009; Müller et al., 2010) and also a single incident of hybridization with Eurasian perch *Perca fluviatilis* has been reported (Kahilainen et al., 2011).”

“*S. lucioperca* was introduced to the Turkish Lake Egirdir in 1955 and from 1961 became an important commercial species there. However, the introduction is associated with the disappearance of several indigenous fish species including two in the genus *Phoxinellus* which are now considered extinct (Crivelli, 1995). In this case it also led to an increase in the native Turkish crayfish *Astacus leptodactylus* which was rare due to predation on eggs and larvae by the now extinct fish, resulting in an increase in foreign trade for the Turkish economy. It has also been claimed that introductions have resulted in a significant reduction of cyprinid fishes in the UK, but a comprehensive review found no convincing evidence of this (Smith et al., 1998).”

“*S. lucioperca* is a vector of the trematode *Bucephalus polymorphus* which caused a decrease in native cyprinid populations in some French basins in the 1960s and 1970s (Lambert, 1997) and recently in water systems newly colonized by zebra mussel (*Dreissena polymorpha*) the primary host of this parasite.”

The importation, possession, or trade of *Sander lucioperca* is regulated by the following U.S. States: Alabama (ADCNR 2022), Colorado (CPW 2023), Illinois (Illinois DNR 2015), Kansas (KDWP 2023), Montana (Montana FWP 2023), New York (New York DEC 2022), Ohio (ODNR 2022), Oregon (ODFW 2022), and Wisconsin (Wisconsin DNR 2022).

Sander lucioperca is listed as an Injurious species by the U.S. Fish and Wildlife Service (USFWS 2016).

4 History of Invasiveness

The History of Invasiveness for *Sander lucioperca* is classified as High. There has been a long history of introductions outside of its native range as a recreational and commercial fish and as a biological control tool. The impacts of introductions of *S. lucioperca* are well documented and include hybridization with, competition with, and extirpation of, native species, decreases in biodiversity, and disease/pest transmission. There were a few reports where introduction of *S. lucioperca* had a beneficial impact on native species, primarily through negative impacts on other native species that had been exerting a competitive or predatory force on the benefited species.

5 Global Distribution

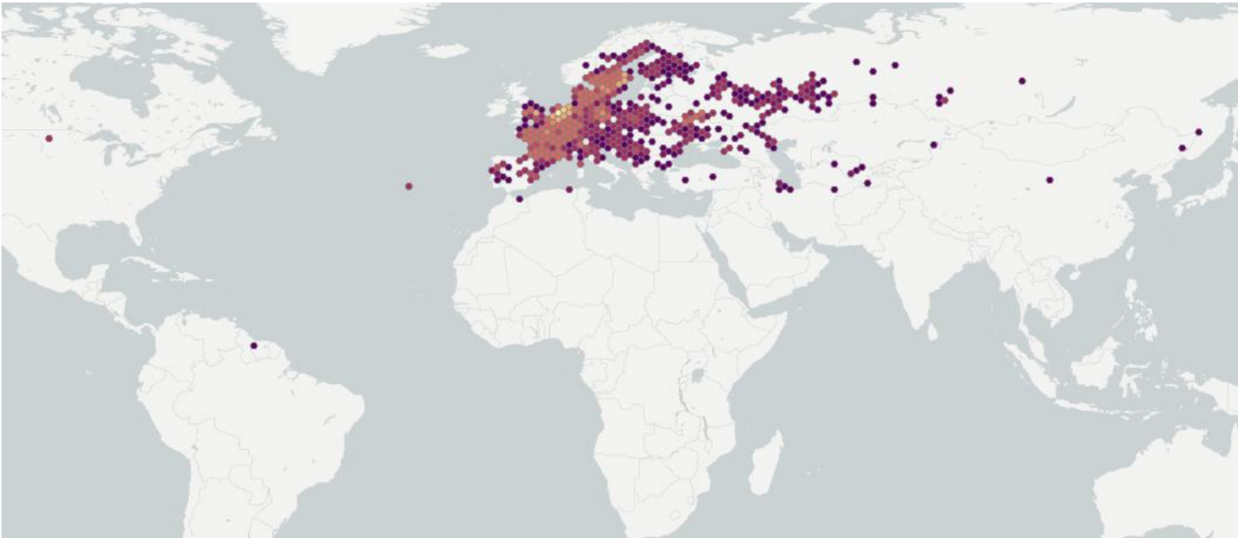

Figure 1. Reported global distribution of *Sander lucioperca*. Map from GBIF Secretariat (2023). Observations are reported from Europe, Asia, North America, and South America. The occurrence in Suriname (South America) does not represent an established population and was not used to select source points for climate matching.

6 Distribution Within the United States

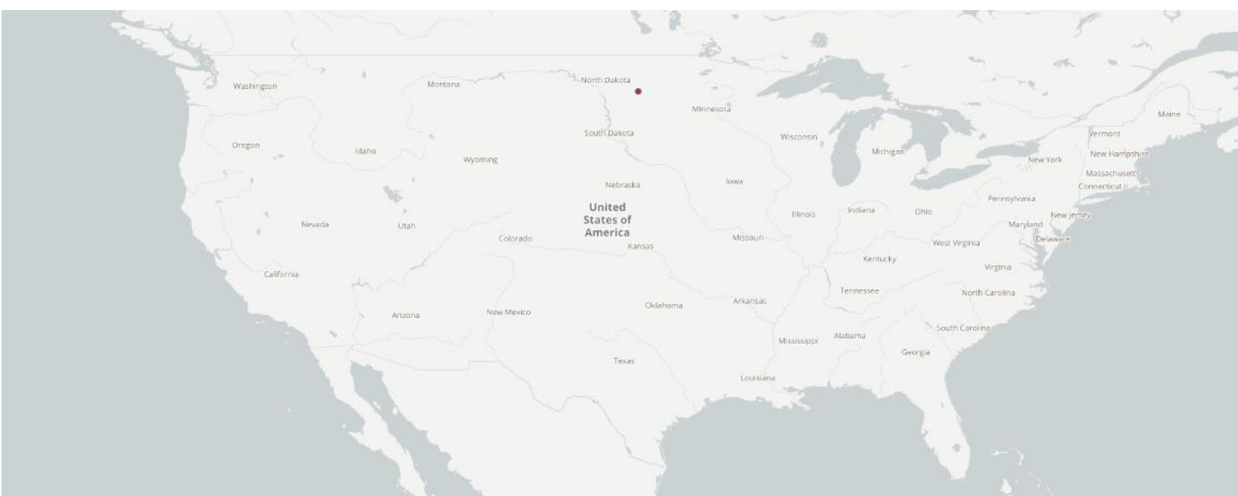

Figure 2. Reported distribution of *Sander lucioperca* in the United States. Map from GBIF Secretariat (2023). Observations are reported from North Dakota.

7 Climate Matching

Summary of Climate Matching Analysis

A medium-high climate match occurs throughout most of the contiguous United States. Areas of high match were found along the Canadian border from eastern Montana to northern Maine, including the Great Lakes Basin, and in the Ohio and Upper Mississippi River basins. Medium matches occurred along the eastern edge of the Sierra Nevada Mountain range and throughout the Great Plains and central lowland regions of the United States. Low climate matches occurred in the southeastern United States, predominantly around the Gulf of Mexico. The overall Climate 6 score (Sanders et al. 2023; 16 climate variables; Euclidean distance) for the contiguous United States was 0.926, indicating that Yes, there is establishment concern for this species. The Climate 6 score is calculated as: (count of target points with scores ≥ 6)/(count of all target points). Establishment concern is warranted for Climate 6 scores greater than or equal to 0.002 based on an analysis of the establishment success of 356 nonnative aquatic species introduced to the United States (USFWS 2024).

Projected climate matches in the contiguous United States under future climate scenarios are available for *Sander lucioperca* (see Appendix). These projected climate matches are provided as additional context for the reader; future climate scenarios are not factored into the Overall Risk Assessment Category.

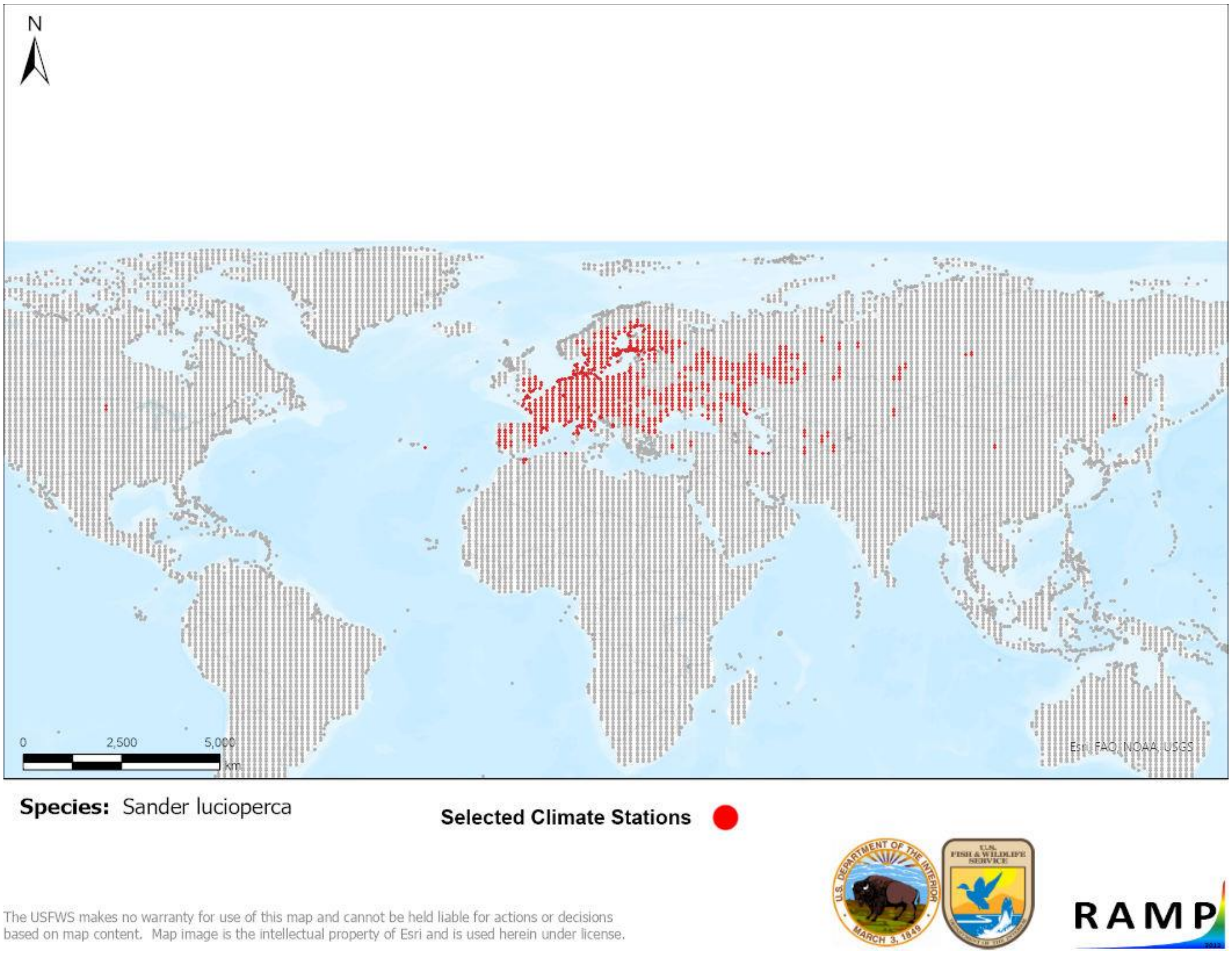

Figure 3. RAMP (Sanders et al. 2023) source map showing global weather stations selected as source locations (red; Algeria, Austria, Azerbaijan, China, Croatia, Czechia, Denmark, Estonia, Finland, Aland Islands, France, Germany, Greece, Hungary, Iran, Italy, Kazakhstan, Latvia, Lithuania, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye, Turkmenistan, Ukraine, United Kingdom, United States, and Uzbekistan) and non-source locations (gray) for *Sander lucioperca* climate matching. Source locations from GBIF Secretariat (2023). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

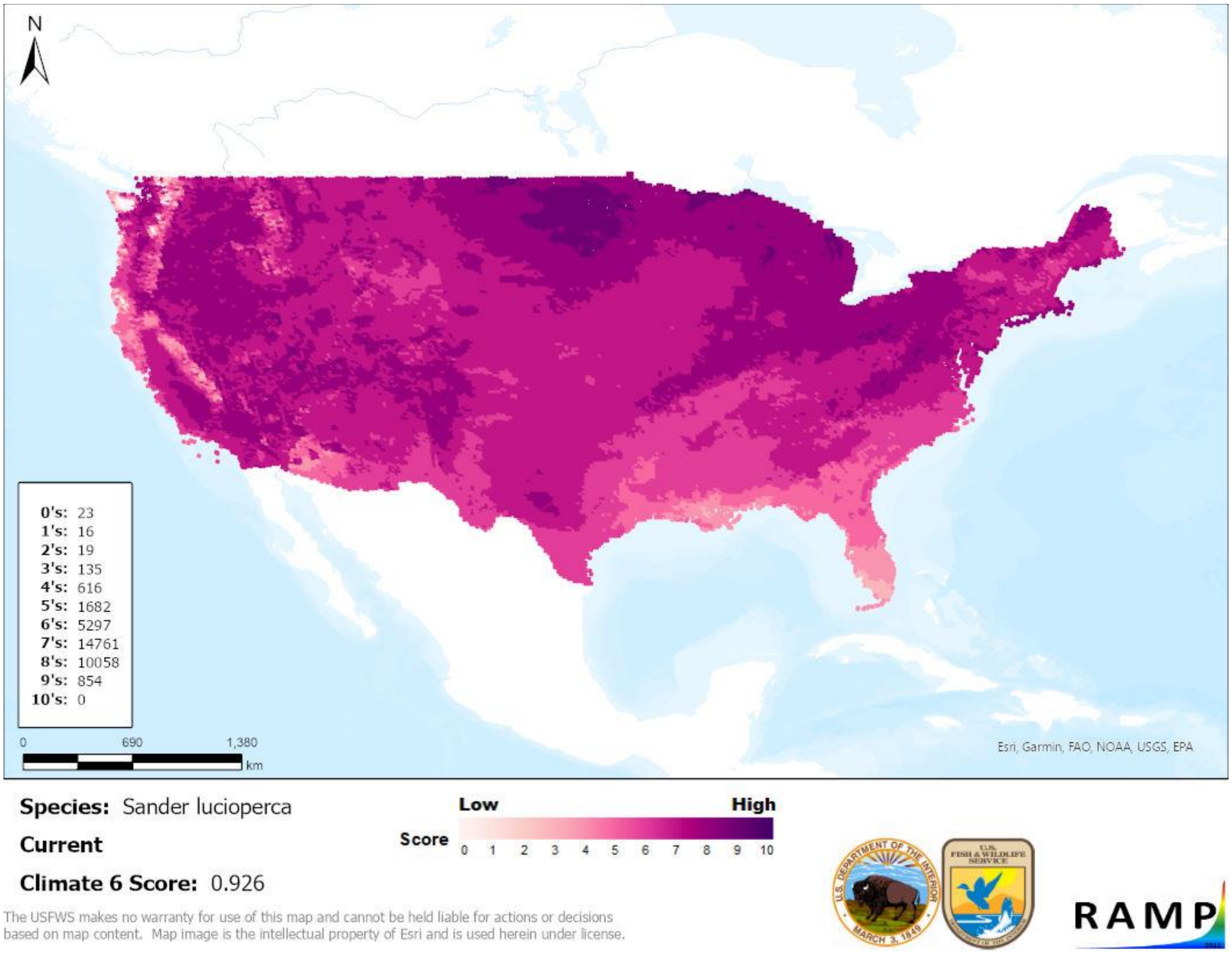

Figure 4. Map of RAMP (Sanders et al. 2023) climate matches for *Sander lucioperca* in the contiguous United States based on source locations reported by GBIF Secretariat (2023). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

8 Certainty of Assessment

The Certainty of Assessment for *Sander lucioperca* is classified as High. Information on the biology, ecology, distribution, history of introductions, and impacts of this species is readily available from peer-reviewed literature. There is a history of introductions resulting in established populations. Information on negative impacts to multiple species is available from peer-reviewed, scientifically defensible sources.

9 Risk Assessment

Summary of Risk to the Contiguous United States

Sander lucioperca, Zander, is a fish native to eastern Europe and western Asia. *S. lucioperca* is a popular food source and recreational and commercial fishing target and has been utilized as a top-down ecosystem engineer. The History of Invasiveness for *Sander lucioperca* is classified as High due to a long history of well-documented introductions leading to nonnative established populations. Many introductions, including the one in the United States, were intentional to meet fishery management goals. Impacts from these introductions include altered fish assemblages due to competition with, and consumption, of native species, extirpation of endemic species, hybridization with native species, and disease/pest transmission. *S. lucioperca* is known to be a carrier or host of two World Organisation for Animal Health listed diseases: infection with *Gyrodactylus* spp and epizootic hematopoietic necrosis virus. In 2016, *S. lucioperca* was listed as an injurious wildlife species under the Lacey Act by the U.S. Fish and Wildlife Service. Additionally, it is regulated at the State level in nine U.S. States. The climate matching analysis for the contiguous United States indicates establishment concern for this species. Most of the northern half of the contiguous United States had medium-high matches, particularly in the northern Plains. Areas of low match were concentrated along the southern border and the Gulf region. The Certainty of Assessment for this ERSS is classified as High. The Overall Risk Assessment Category for *Sander lucioperca* in the contiguous United States is High.

Assessment Elements

- **History of Invasiveness (see Section 4): High**
- **Establishment Concern (see Section 7): Yes**
- **Certainty of Assessment (see Section 8): High**
- **Remarks, Important additional information:** *Sander lucioperca* has been documented as susceptible to *Gyrodactylus* spp. and epizootic hematopoietic necrosis virus, diseases listed by the World Organisation for Animal Health (2023). *S. lucioperca* is listed as an injurious wildlife species by the U.S. Fish and Wildlife Service.
- **Overall Risk Assessment Category: 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 11.

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Appendix

Summary of Future Climate Matching Analysis

Future climate projections represent two Shared Socioeconomic Pathways (SSP) developed by the Intergovernmental Panel on Climate Change (IPCC 2021): SSP5, in which emissions triple by the end of the century; and SSP3, in which emissions double by the end of the century. Future climate matches were based on source locations reported by GBIF Secretariat (2023).

Under the future climate scenarios (figure A1), on average, high climate match for *Sander lucioperca* was projected to occur in the Colorado Plateau, Great Basin, and Great Lakes regions of the contiguous United States. Areas of low climate match were projected to occur in the Southern Florida region. Areas of low match expanded under the 2085 time step under both SSP scenarios. The Climate 6 scores for the individual future scenario models (figure A2) ranged from a low of 0.339 (model: UKESM1-0-LL, SSP5, 2085) to a high of 0.875 (model: MPI-ESM1-2-HR, SSP3, 2055). All future scenario Climate 6 scores were above the Establishment Concern threshold, indicating that Yes, there is establishment concern for this species under future climate scenarios. The Climate 6 score for the current climate match (0.926, figure 4) falls above the range of scores for future projections. The time step and climate scenario with the most change relative to current conditions was SSP5, 2085, the most extreme climate change scenario (figure A3). Under the 2055 time step for both climate scenarios, areas within the Southwest saw a moderate increase in the climate match relative to current conditions. No large increases were observed regardless of time step and climate scenarios. Under one or more time step and climate scenarios, areas within the Appalachian Range, Gulf Coast, Mid-Atlantic, Northern Plains, and Southeast saw a large decrease in the climate match relative to current conditions. Additionally, in the 2085 time step for both climate scenarios, areas within California, the Colorado Plateau, Great Basin, Great Lakes, Northeast, Northern Pacific Coast, Southern Atlantic Coast, Southern Florida, Southern Plains, Southwest, and Western Mountains saw a moderate decrease in the climate match relative to current conditions.

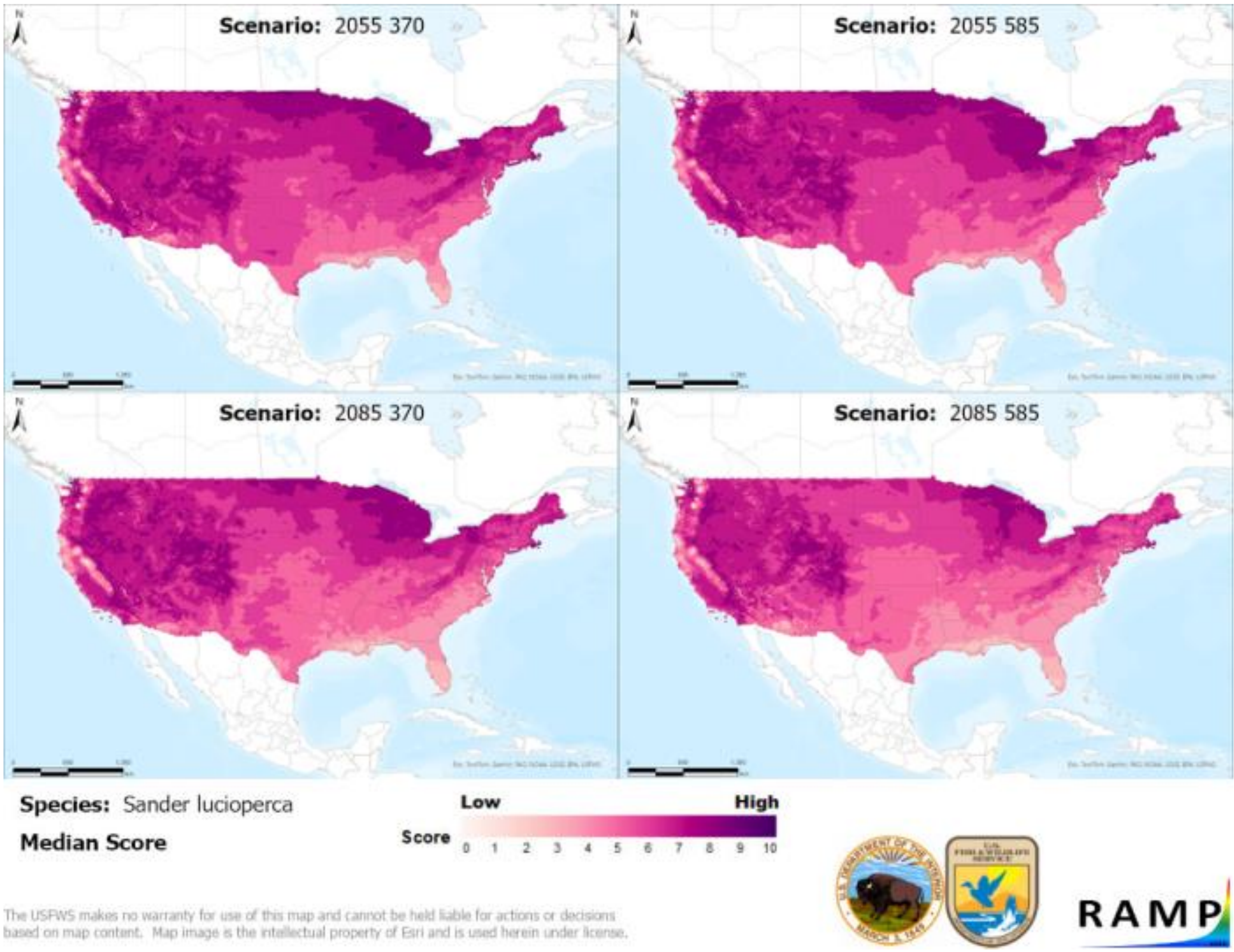

Figure A1. Maps of median RAMP (Sanders et al. 2023) climate matches projected under potential future climate conditions using five global climate models for *Sander lucioperca* in the contiguous United States. Climate matching is based on source locations reported by GBIF Secretariat (2023). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

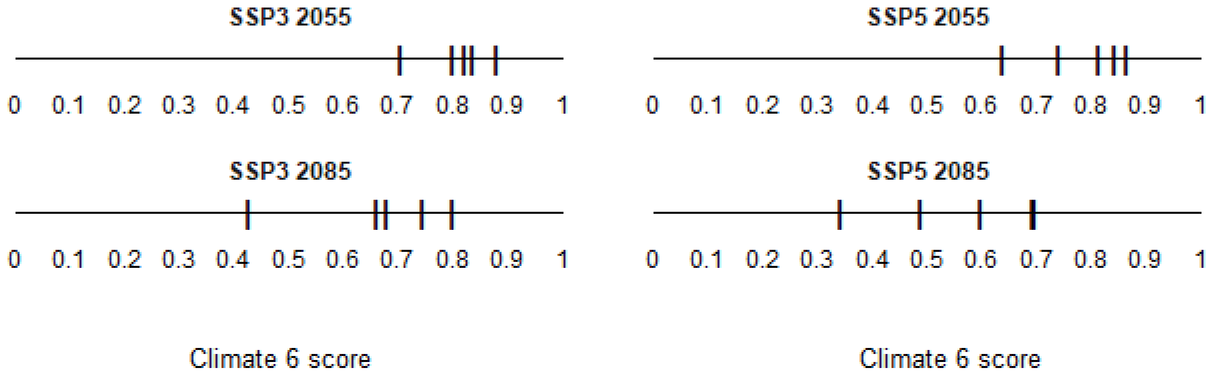

Figure A2. Comparison of projected future Climate 6 scores for *Sander lucioperca* in the contiguous United States for each of five global climate models under four combinations of Shared Socioeconomic Pathway (SSP) and time step. SSPs used (from left to right): SSP3, SSP5 (Karger et al. 2017, 2018; IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global climate models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0.

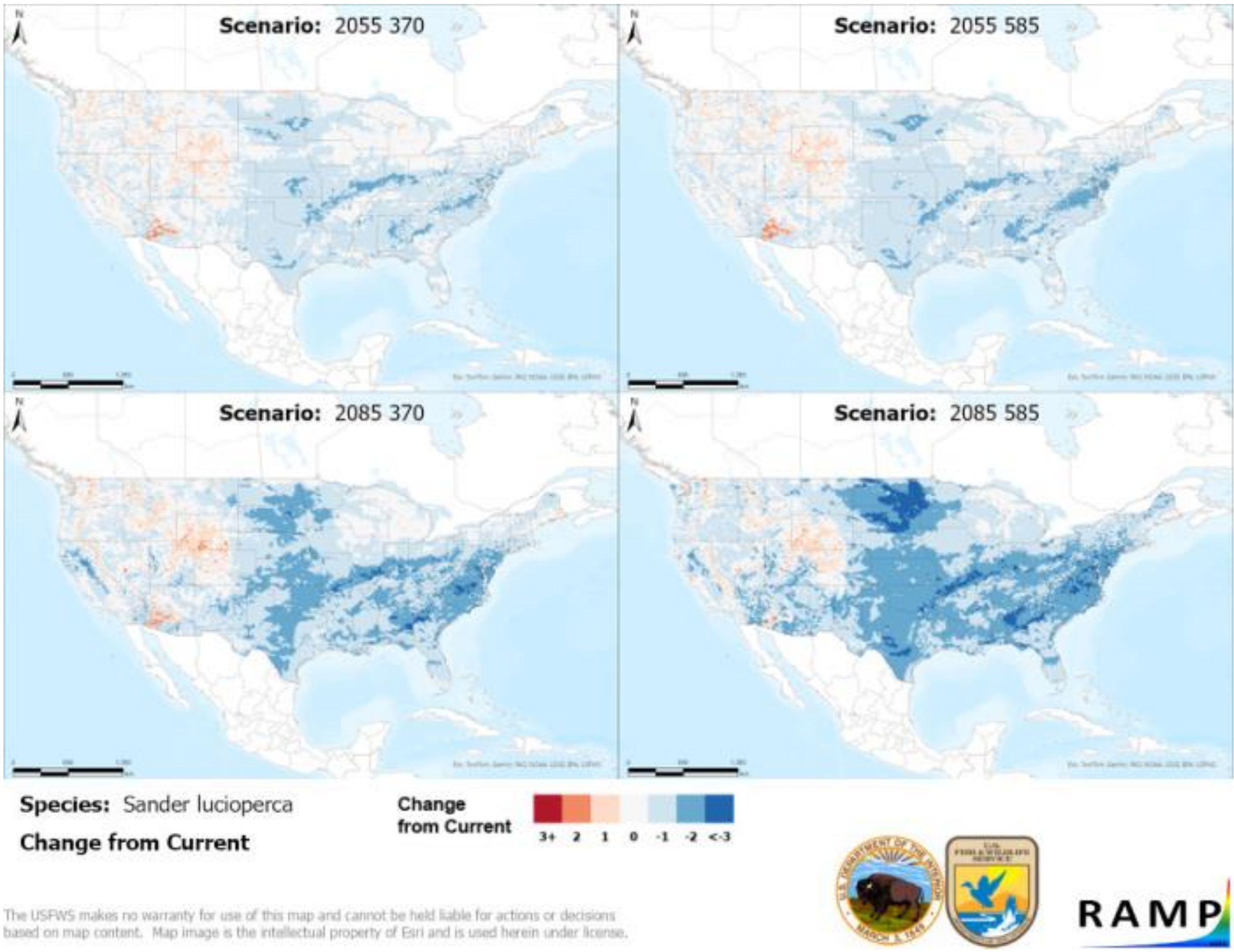

Figure A3. RAMP (Sanders et al. 2023) maps of the contiguous United States showing the difference between the current climate match target point score (figure 4) and the median target point score for future climate scenarios (figure A1) for *Sander lucioperca* based on source locations reported by GBIF Secretariat (2023). Shared Socioeconomic Pathways (SSPs) used (from left to right): SSP3, SSP5 (IPCC 2021). Time steps: 2055 (top row) and 2085 (bottom row). Climate source data from CHELSA (Karger et al. 2017, 2018); global models used: GFDL-ESM4, UKESM1-0-LL, MPI-ESM1-2-HR, IPSL-CM6A-LR, and MRI-ESM2-0. Shades of blue indicate a lower target point score under future scenarios than under current conditions. Shades of red indicate a higher target point score under future scenarios than under current conditions. Darker shades indicate greater change.

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