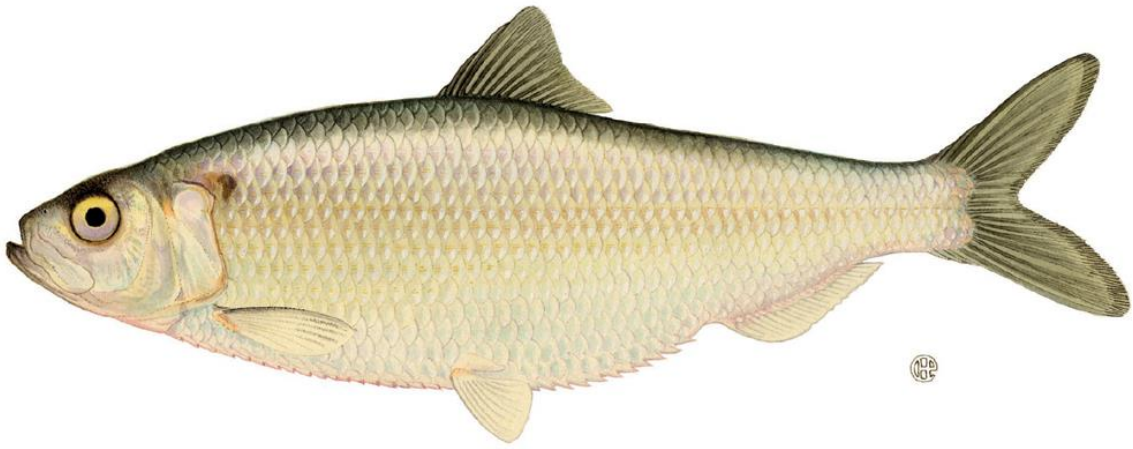
Blueback Herring (*Alosa aestivalis*)

Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, web version – 03/30/2018



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1 Native Range and Status in the United States

Native Range

From NatureServe (2013):

"Range encompasses the North American Atlantic coast from Nova Scotia to the St. Johns River, Florida."

Status in the United States

From NatureServe (2013):

"Range encompasses the North American Atlantic coast from Nova Scotia to the St. Johns River, Florida. The species has been introduced in reservoirs in several states, and in the Tennessee River system in Tennessee (Bozeman and Van Den Avyle 1989, Page and Burr 2011)."

From Fuller et al. (2016):

"Blueback Herring was first collected in Lake Ontario in 1995. It has been collected from the Tennessee River in Georgia and Tennessee (Rassmussen 1998). Currently established in Tellico and Norris Reservoirs in Tennessee (J. Negus, personal communication). Established in Oneida Lake, the Oswego River in Minetto, Lake Champlain, and the upper Mohawk River upstream of Cohoes Falls, New York (Greeley 1935; Limburg et al. 2001; D. MacNeill and R. Owens, personal communication). In North Carolina, Blueback Herring were introduced into the Savannah, Broad, and Yadkin drainages, and into nonnative areas of the Cape Fear and Roanoke drainages (Menhinick 1991; Jenkins and Burkhead 1994). It has been introduced to an unspecified location in the Chesapeake Bay basin in Pennsylvania (Christmas et al. 2000). Blueback Herring were accidently introduced into Lakes Jocassee and Keowee, South Carolina, between 1972-1974 (Prince and Barwick 1981); they have now been collected from most reservoirs in the Savannah River system and in Lake Murray (Rohde et al. 2009). Stock obtained from the Cooper River, South Carolina was released in Texas by the Texas Parks and Wildlife Department in Lake Theo, Briscoe County, in 1982 (Guest 1983; Howells 1992). This population persisted until August 1988 (Schramm et al. 1991). Blueback Herring have been collected from Lake Champlain, Vermont (S. Good, personal communication). Blueback Herring have been stocked in several inland reservoirs in Virginia, including Smith Mountain Lake, Occoquan Reservoir, Kerr Reservoir, and lakes Anna, Brittle, and Chesdin (Jenkins and Burkhead 1994)."

"Established in New York, North Carolina, South Carolina, Tennessee, Vermont, and Virginia. Extirpated in Texas."

"One of the most common fish species in the Hudson River estuary (Hurst et al. 2004). Detection of a small population of Blueback Herring in Lake Ontario would be difficult because of the size of the Lake relative to the area routinely sampled and the herring's superficial similarity with Alewife, a fish sampled in large enough numbers that only a fraction of the adults are examined closely enough to distinguish between the two species (Owens et al. 1998). Owens et al. (1998) also asserted that colonizing a lake with resident population of Alewife, a fish that would be in direct competition with Blueback Herring for space and resources, and a surfeit of piscivores, both stocked and unstocked, may prove too difficult for *A. aestivalis*."

From CABI (2016):

"In 1962, a specimen of *A. aestivalis* was collected in the Northern Gulf of Mexico, off the Florida coast. USGS NAS (2015) suggests this to be part of the species' invaded range."

Means of Introductions in the United States

From Fuller et al. (2016):

"In most areas other than New York, these fish were intentionally stocked for forage. In New York these fish are expanding their range using ship locks and canals. Blueback Herring was first recorded in the Mohawk River upstream of Cohoes Falls in 1934 (Greeley 1935). They were reported from Lake Champlain on the New York side in the late 1970s, and from the Vermont side in 1997. Juveniles were apparently present in Oneida Lake by 1981 or 1982. Adults were

first documented in 1994 by Cornell researchers based at Shackleton Point. Several thousand immature fish were also documented in 1994 at a power plant in Minetto on the Oswego River. Two immature fish were caught in Lake Ontario near Oswego in October 1995 by U.S. Geological Survey personnel conducting fish surveys (R. Owens, personal communication). Blueback Herring in Jocassee and Keowee Reservoirs, South Carolina, were accidentally included in Threadfin Shad (*Dorosoma petenense*) stockings in 1972 and 1974 (Prince and Barwick 1981); the population in Lake Murray, SC, is likely the result of a bait bucket introduction."

From CABI (2016):

"The spread of *A. aestivalis* outside of its native range does not comprise a large geographical area. Due to the fact that its introduction into new areas has mostly been a result of intentional stocking, the risk factor for further introduction is human-induced spread, via bait bucket contamination and stocking. Further spread from a point of introduction could then occur via the species' migration."

Remarks

From NatureServe (2013):

"Listed as Vulnerable in view of drastic declines in abundance that have occurred in many areas in recent decades. The degree of decline over the entire range over the past three generations (about 15 years) is uncertain but probably exceeds 30 percent. Range extent and area of occupancy have not declined very much if at all."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From Eschmeyer et al. (2017):

"***aestivalis, Clupea*** Mitchill [S. L.] 1814:21 […] [Report, in part, of Samuel L. Mitchill] New York, U.S.A. No types known. Also in Mitchill 1815:456 […], Pl. 5 (fig. 6). •Valid as *Alosa aestivalis* (Mitchill 1814) -- (Lee et al. 1980:61 […], Smith 1986:65 […], Whitehead 1985:192 […], Robins & Ray 1986:67 […], Scott & Scott 1988:102 […], McAllister 1990:51 […], Page & Burr 1991:33 […], Desfosse et al. in Jenkins & Burkhead 1994:217 […], Murdy et al. 1997:78 […], Scott & Crossman 1998:119 […], Fuller et al. 1999:42 […], Munroe in Collette & Klein-MacPhee 2002:112 […], Scharpf 2003:13 […], Munroe & Nizinski 2003:810 […], Nelson et al. 2004:66 […], Scharpf 2005:9 […], Page & Burr 2011:147 […], Schmidt & Morse 2011:229 […], Page et al. 2013:67 […]). **Current status:** Valid as *Alosa aestivalis* (Mitchill 1814). Clupeidae."

From ITIS (2016):

"Kingdom Animalia
Subkingdom Bilateria

Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Clupeomorpha
Order Clupeiformes
Suborder Clupeidae
Family Clupeidae
Subfamily Alosinae
Genus *Alosa*
Species *Alosa aestivalis* (Mitchill, 1814)"

Size, Weight, and Age Range

From Froese and Pauly (2016):

"Max length: 40.0 cm SL male/unsexed; [Robins and Ray 1986]; common length: 27.5 cm SL male/unsexed; [Whitehead 1985]; max. published weight: 200.00 g [Robins and Ray 1986]; max. reported age: 8 years [Hugg 1996]"

Environment

From NatureServe (2013):

"Adults occur in saltwater except during the breeding season; they occur up to at least 200 km offshore. Juveniles move to sea when about 1 month old."

From Fuller et al. (2016):

"Anadromous; living in marine systems and spawning in deep, swift freshwater with a hard substrate."

From Froese and Pauly (2016):

"Marine; freshwater; brackish; pelagic-neritic; anadromous [Riede 2004]; depth range 5 - 55 m [Scott and Scott 1988]."

Climate/Range

From Froese and Pauly (2016):

"Subtropical; 41°N - 25°N, 84°W - 60°W [Whitehead 1985]"

Distribution Outside the United States

Native

From NatureServe (2013):

"Range encompasses the North American Atlantic coast from Nova Scotia to the St. Johns River, Florida."

Introduced

No records of introductions of *Alosa aestivalis* outside the United States were found.

Means of Introduction Outside the United States

No records of introductions of *Alosa aestivalis* outside the United States were found.

Short Description

From Fuller et al. (2016):

"This fish is silvery in color, has a series of scutes (modified scales that are spiny and keeled) along its belly, and is characterized by deep bluish green backs. The most distinguishing characteristic of this species is the black to dusky in color of its peritoneum (the lining of the abdominal cavity). Blueback Herring and Alewife are difficult to distinguish from one another and are often regarded collectively as river herring. Alewife has larger eyes, greater body depth, and pearly to white peritoneal linings. Jenkins and Burkhead (1994); Owens et al. (1998); Page and Burr (1991); Smith (1985); Whitehead (1985)."

From Froese and Pauly (2016):

"Dorsal spines (total): 0; Dorsal soft rays (total): 15-20; Anal spines: 0; Anal soft rays: 15 - 21; Vertebrae: 47 - 53. Moderately compressed, belly with distinct keel of scutes. Upper jaw with a distinct notch; lower jaw rising steeply within mouth; minute teeth present at front of jaws (disappearing with age). Lower gill rakers 41 to 52 (fewer in fishes under 10 cm standard length), slender. Back dark blue, sometimes bluish-grey; a dark spot on shoulder [Whitehead 1985]. Peritoneum black [Robins and Ray 1986]. Branchiostegal rays 7 [Jones et al. 1978]."

Biology

From NatureServe (2013):

"Spawning occurs in fresh or brackish water, in tidally influenced portions of coastal rivers (Bozeman and Van Den Avyle 1989). According to Lee et al. 1980, spawning occurs in deep swift water over hard substrates. According to Bozeman and Van Den Avyle 1989, spawning occurs in shallow areas covered with vegetation, old rice fields, and river swamps and small tributaries above tidal influence. Eggs sink and adhere to objects on the bottom (Scott and Crossman 1973); after a few hours the eggs unstick and drift downstream (Dadswell 1980). Larvae occur in or slightly downstream from spawning areas; juveniles may exhibit net upstream movement until emigration from freshwater in summer or fall (or, in some areas, the next spring)

(Fay et al. 1983). Nursery areas in the Neuse River, North Carolina, were characterized by deep, black water draining hardwood swamps, with little salinity or current and with a mud or detritus bottom (Bozeman and Van Den Avyle 1989)."

"Habitat includes riverine, estuarine, and Atlantic coastal waters; also in certain lakes and reservoirs in the southeastern United States."

From Fuller et al. (2016):

"Migrate to spawning grounds in the spring. In Connecticut, Blueback Herring spawn in 14–27°C temperatures. Usually spawns later in the spring than Alewife, when water temperatures are slightly warmer. During spawning, many eggs are deposited over the stream bottom where they stick to gravel, stones, logs, or other objects. Juveniles spend 3–7 months in freshwater, then migrate to the ocean (Yako et al. 2002). Blueback Herring are a planktivorous forage species (Winkelman and Van Der Avyle 2002)."

"The landlocked Lake Theo, Texas population attained a smaller maximum size and had a shorter life span than anadromous native populations (Schramm et al. 1991)."

From Froese and Pauly (2016):

"Form schools and possibly wintering near the bottom and out from the coast, approaching the shore in the late spring. Feed on small fishes, copepods and small shrimps. Spawn in brackish- or freshwaters of rivers, arriving in coastal waters a month or so later than *A. pseudoharengus* (in April at Chesapeake Bay, apparently when the water is above 70° C and later further north). Eggs are essentially pelagic, demersal in still water [Jones et al. 1978]. Larvae are found in fresh and brackish rivers [Jones et al. 1978]. Juveniles leave fresh and brackish nursery grounds at about 5 cm, migrating downstream [Jones et al. 1978]."

From CABI (2016):

"*A. aestivalis* can filter feed and also feed on particulate matter. Its gill rakers are very close together, making it a more effective filter feeder than *A. pseudoharengus*, thereby giving a competitive advantage in areas of overlapping range (Owens et al., 1998). *A. aestivalis* is primarily a planktivorous fish, but fish, crustacean and insect eggs, insects and young fish also comprise an important part of its diet (Fay et al., 1983; Bozeman Jr and Van Den Avyle, 1989; Davis and Foltz, 1991; Simonin et al. 2007)."

"*A. aestivalis* larvae feed on zooplankton when they develop a large enough mouth, and eating larger prey as their mouth continues to grow (Bozeman Jr and Van Den Avyle, 1989; Fay et al., 1983). Crecco and Blake (1983) reported that *A. aestivalis* larvae feed mostly on rotifers of the genus *Keratella*. The stomach contents of young contained mostly remains of water fleas *Bosmina* sp. (Fay et al., 1983)."

"The diet of adults in the Lake Theo reservoir in Texas was composed primarily (89.4%) of cladocerans (Guest and Drenner, 1991). Domermuth and Reed (1980) reported that *A. aestivalis*

feeds mostly on cladocerans, particularly the Daphnidae and Bosminidae families. Stomach contents indicated that they primarily consume planktonic and drift organisms and do not feed on benthic invertebrates or terrestrial insects. Juvenile fish sampled in the Hudson River estuary fed primarily on chironomid larvae, copepods and the gastropod *Amnicola* sp. (Grabe, 1996)."

Human Uses

From NatureServe (2013):

"Historically valuable in commercial fisheries."

From Froese and Pauly (2016):

"Marketed mostly fresh and salted [Whitehead 1985]."

From CABI (2016):

"*A. aestivalis*' spawning run supports recreational and commercial fisheries across the eastern coast of North America (Crecco and Blake, 1983). River herring (*A. aestivalis* and *A. pseudoharengus*) is used for fish meal and fish oil to be added to fertilizer, pet food and domestic animal feed, with a smaller portion used for fishing bait and the remainder for human consumption (Fay et al., 1983)."

Diseases

No records of OIE reportable diseases were found.

From Froese and Pauly (2016):

"Parasites found are acanthocephalan and nematodes [Bigelow et al. 1963]."

From Bailly (2008):

"Host of *Clavellisa cordata* Wilson C.B., 1915 (parasitic: ectoparastitic)
Ergasilus clupeidarum Johnson S.K. & Rogers, 1972 (parasitic: ectoparastitic)
Lernaeenicus radiatus Le Sueur, 1824 (parasitic: ectoparastitic)"

Threat to Humans

From Froese and Pauly (2016):

"Harmless"

3 Impacts of Introductions

The following information details actual impacts of introductions of *Alosa aestivalis*.

From Fuller et al. (2016):

"The introduction of Blueback Herring into Theo Reservoir in Briscoe County, Texas resulted in the elimination of large-bodied zooplankton such as Leptora, Epischura, Mesocyclops, and Daphnia, while small-bodied zooplankton such as Cerio-daphnia, Tropocyclops and Bosmina increased. There appeared to be little change in lengths of the zooplankton in the reservoir after herring introduction, but the community shifted from cladoceran to copepod dominance (Guest and Dremmer 1991)"

The following information details potential impacts of introductions of *Alosa aestivalis*.

From Fuller et al. (2016):

"Unknown, very likely to find suitable habitat throughout the Great Lakes system. GARP models predict it could find the entire region as suitable habitat, except possibly the deeper waters of Lake Superior (USEPA 2008). If Blueback Herring became established in Lake Ontario, they could spread to other Great Lakes and impede recovery of depressed populations of indigenous fishes such as Cisco and Lake Trout (Owens et al. 1998). Cold water may prevent its establishment."

From CABI (2016):

"Davis and Foltz (1991) assessed the possibility of competitive effects between threadfin shad, *Dorosoma petenense*, and *A. aestivalis* in the Jocassee Reservoir in South Carolina, USA. Both fish were stocked as prey for piscivorous fish. Davis and Foltz (1991) observed low dietary overlap between the species even though they are on the same trophic level. Despite their low competitive interactions, the study concluded that *A. aestivalis* are 'voracious planktivores' as well as piscivores, increasing the likelihood that it may affect zooplankton as well as small fish populations of any system where they may be introduced. It has also been suggested that invasive *A. aestivalis* can potentially affect native populations of smelt and forage fish (Marsden and Hauser, 2009)."

From Marsden and Hauser (2009):

"Other species, such as blueback herring, have invaded too recently for effects to be seen."

Many of the above impacts are only theoretical but in Theo Reservoir, Texas, *Alosa aestivalis* was directly responsible for extirpations of groups of zooplankton.

4 Global Distribution

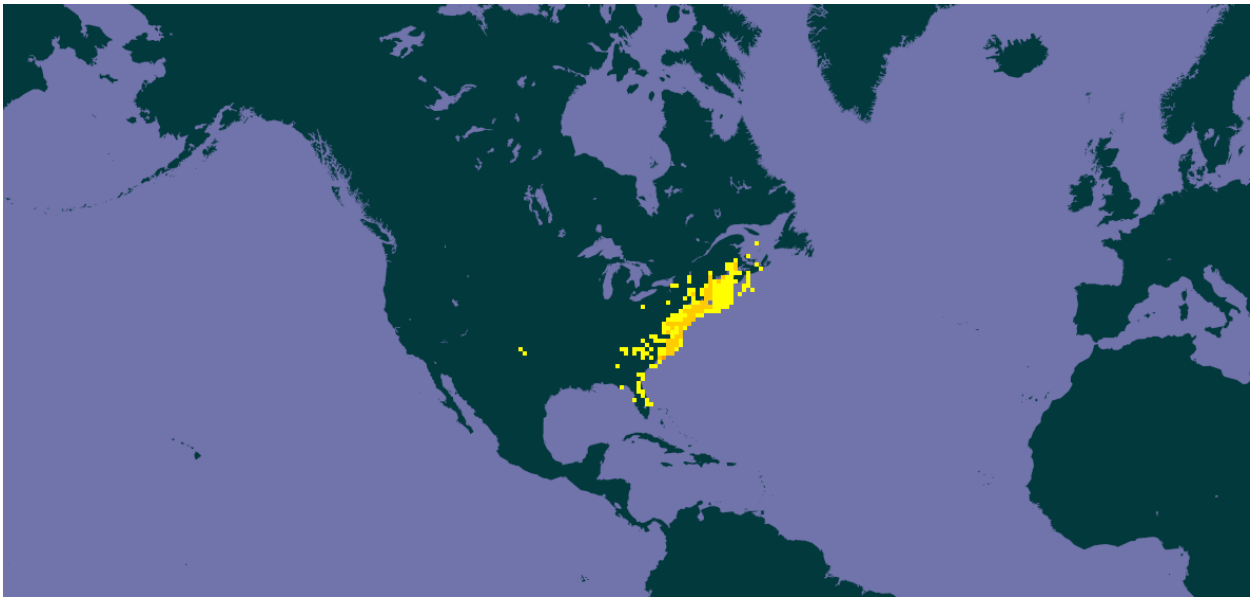

Figure 1. Known global distribution of *Alosa aestivalis*. Map from GBIF Secretariat (2016).

The locations in Texas are from an extirpated population (Fuller et al. 2016) and were not used as source locations for the climate match.

5 Distribution Within the United States

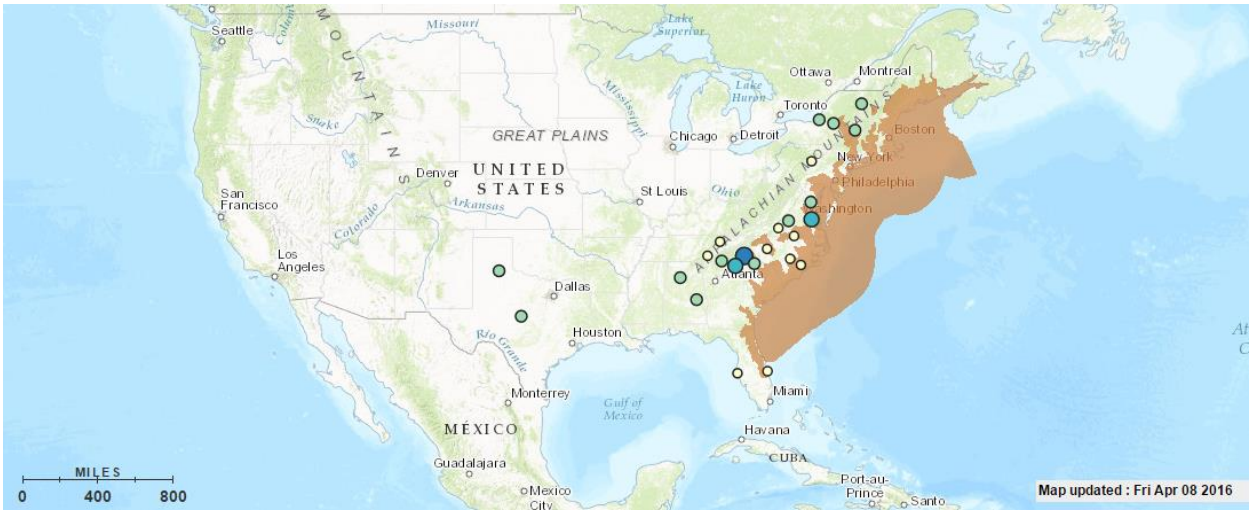

Figure 2. Known distribution of *Alosa aestivalis* in the United States. Brown shading indicated the native range of *A. aestivalis*. Map from Fuller et al. (2016).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Alosa aestivalis* was high for much of the eastern half of the United States. It was medium to low west of the Mississippi. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous U.S. was 0.389, high, and Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

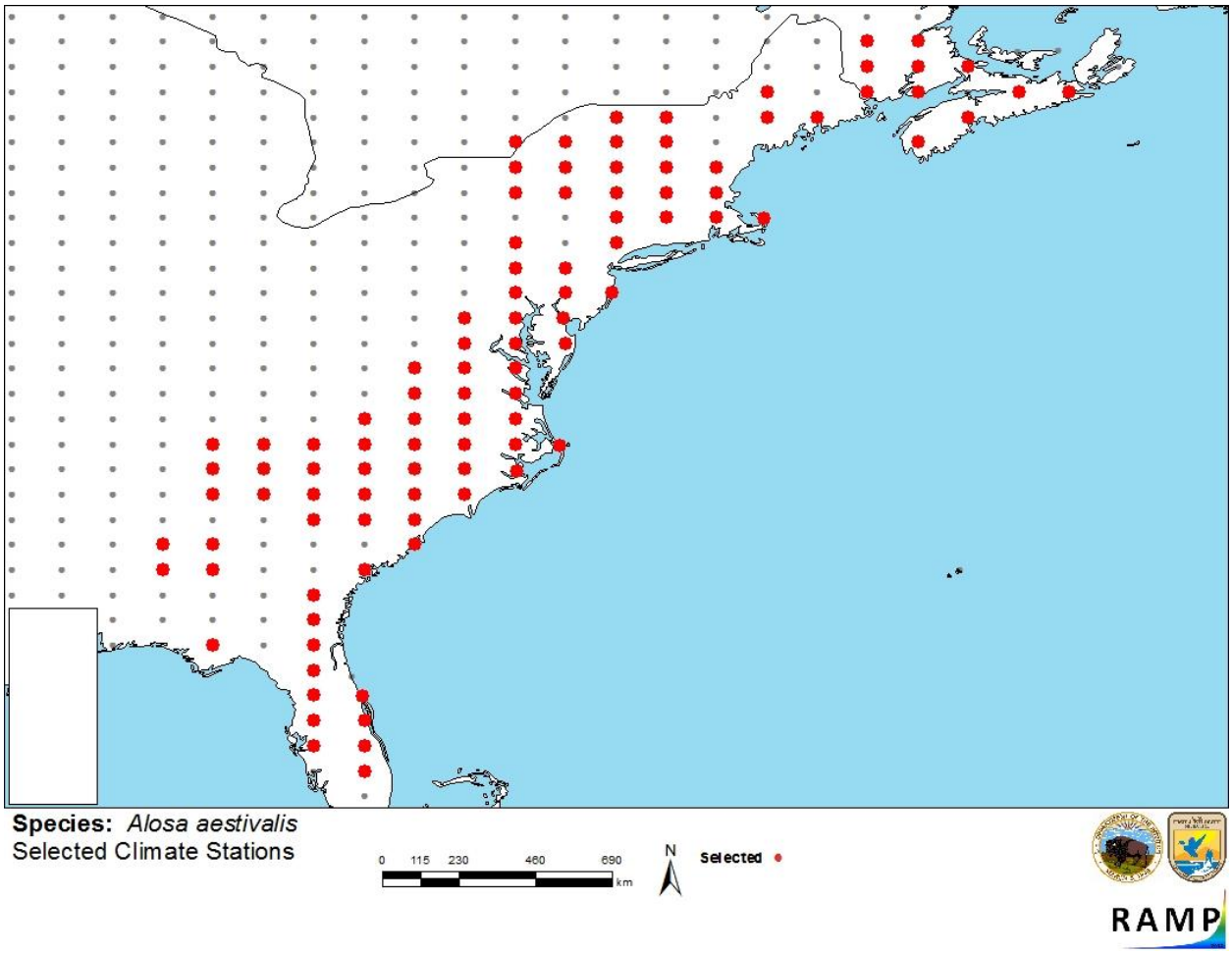

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Alosa aestivalis* climate matching. Source locations from Fuller et al. (2016), and GBIF Secretariat (2016).

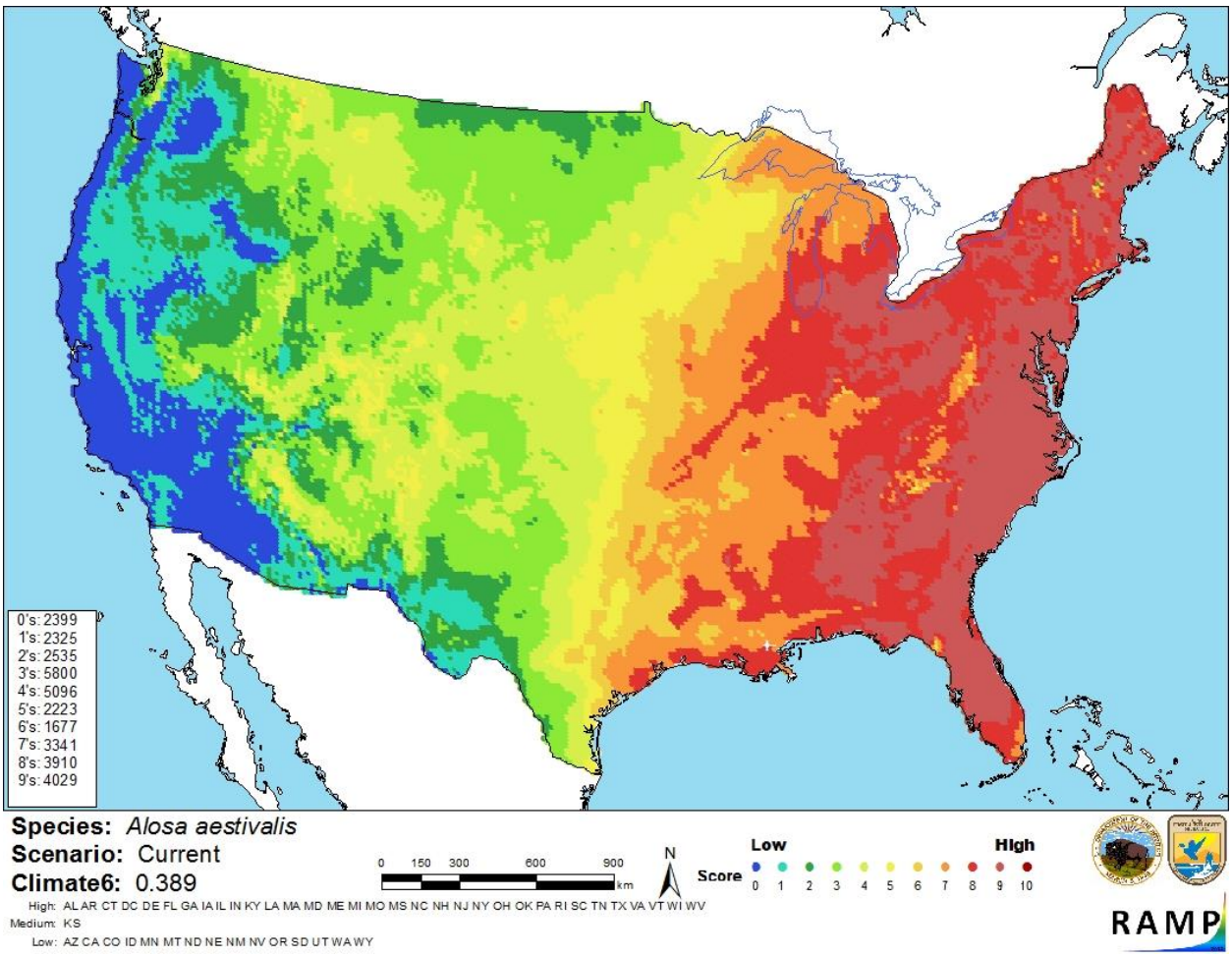

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Alosa aestivalis* in the contiguous United States based on source locations reported by Fuller et al. (2016), and GBIF Secretariat (2016). 0= Lowest match, 10=Highest match.

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

The certainty of assessment for *Alosa aestivalis* is medium. There was adequate biological and ecological information available. There were records of introduction found. There were few records of any impacts from introduction and most of the records found indicated potential and not demonstrated impacts.

8 Risk Assessment

Summary of Risk to the Contiguous United States

The history of invasiveness of *Alosa aestivalis* is high. There were records of introduction, mostly the result of deliberate stocking but some using other methods such as canals. A study on a now extirpated population in Texas indicated that the presence of this species resulted in entire groups of plankton disappearing from the community. The climate match was high. The areas of high match are centered on the species' native and already invaded range. However, there are areas of high match further inland than the already invaded areas, including most of the Great Lakes Basin, indicating there is the potential for this species to establish populations in favorable climates if it spreads. The certainty of assessment is medium. The overall risk assessment category is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): Medium**
- **Remarks/Important additional information** No additional remarks.
- **Overall Risk Assessment Category: High**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

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

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