Dark Falsemussel *(Mytilopsis leucophaeata)*
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, March 2012
Revised, August 2017 and December 2017
Web Version, 1/28/2019

Image: dshelton. Licensed under CC BY-NC. Available: https://www.inaturalist.org/observations/3831381. (December 2017).

1 Native Range and Status in the United States

Native Range

From Fofonoff et al. (2017):

"[…] native to the east coast of North America from the Chesapeake Bay to Veracruz, Mexico."

Status in the United States

From NatureServe (2017):

"This species is native from Chesapeake Bay southward through the Gulf of Mexico but was introduced into the Hudson River, New York, as early as 1937 and later to the lower Charles River, Massachusetts, according to Rehder (1937), Jacobson (1953) and Carlton (1992). Benson et al. (2001) cite invasions in Alabama, Florida, Kentucky, and Tennessee."

"Introduced sites in New England include the Housatonic River in Shelton, Fairfield Co., Connecticut; the Charles River in Boston, Suffolk Co., Massachusetts; and the lower Hudson River basin, New York (Smith and Boss, 199[5]). In Alabama, it is locally abundant in upper Mobile Bay and parts of the Mobile Delta and is occasionally found far inland in the Tennessee River and Mobile Basin, presumably dispersed by barges although there is evidence that it reproduces in fresh water in Alabama (Williams et al., 2008)."

The establishment status of *Mytilopsis leucophaeata* in Tennessee and Kentucky is not adequately documented.

From Fofonoff et al. (2017):

"In 1937, two specimens were collected in the tidal Hudson River, near Haverstraw, New York (NY) (Rehder 1937). In 1952, an established population of *M. leucophaeata* was found near Haverstraw, and as far downriver as Englewood, New Jersey (Jacobson 1953). In 1992, *M. leucophaeata* was found from Tarrytown, NY (49 River Km, 5-9 PSU) to Newburgh, NY (99 River Km, 0-3 PSU) (Walton 1996). It was also found to be common in the tidal Housatonic River, upstream from Long Island Sound, at Shelton, Connecticut at 0.5-2 PSU (Smith and Boss 1995). In 1995, *M. leucophaeata* was found in the impounded section of the Charles River in Cambridge, Massachusetts, which receives brackish water through locks, at salinities of ~1 PSU (Smith and Boss 1995). This population appears to be established, with museum specimens collected in 2008 (Museum of Comparative Zoology 2012)."

"Two specimens were found in the upper Mississippi River in Illinois in the 1980s (Koch 1989, cited by Kennedy 2011a), but we know of no further records from this river system."

Means of Introductions in the United States

From Kennedy (2011a):

"Human activity undoubtedly is responsible for range extensions in North America. Nuttall (1990) wrote that the apparent lack of fossil records from the U.S. Atlantic coast suggests that the northern part of the species' range results from introductions by humans. Koch (1989) proposed that the specimens in Illinois were transported by a barge arriving from the higher-salinity Gulf of Mexico, and Smith and Boss (199[5]) attributed the northward spread of the species into Connecticut and Massachusetts to introductions by boat traffic. However, although Pathy and Mackie (1993) and Therriault et al. (2004) claimed that the presence of dark falsemussels in the Hudson River was due to transport in ship ballast water, Rehder (1937) and Jacobson (1953) had not speculated on the transport mechanism in their reports of this range extension. It is perhaps more likely that the dark falsemussel arrived in the Hudson River with eastern oysters *Crassostrea virginica* to which it attaches and which, until disease became a concern, have been moved from place to place around the world, including along the U.S. Atlantic coast (Carlton and Mann 1996). […] Ingersoll (1887) also noted that planters used the shells of oysters shucked by the food trade as cultch, thereby providing an opportunity for fouling organisms to be introduced to the Hudson River over the years."

Remarks

From Gofas and Rosenberg (2016):

"Orig. name	*Mytilus leucophaeatus* Conrad, 1831
Synonymised names	*Congeria cochleata* (Nyst, 1835) (synonym)
	Congeria leucophaeta [*sic*] (misspelling of *leucophaeatus* (Conrad, 1831))
	Mytilus americanus Récluz, 1858
	Mytilus cochleatus Nyst, 1835
	Mytilus leucophaeatus Conrad, 1831 (original combination)"

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2017):

"Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Protostomia
      Superphylum Lophozoa
        Phylum Mollusca
          Class Bivalvia
            Subclass Heterodonta
              Order Veneroida
                Superfamily Dreissenoidea
                  Family Dreissenidae
                    Genus *Mytilopsis*
                      Species *Mytilopsis leucophaeata* (Conrad, 1831) – dark falsemussel"

"Taxonomic Status:
Current Standing: valid"

Size, Weight, and Age Range

From Fofonoff et al. (2017):

"Maximum reported sizes range from 18 to 25 mm."

From GISD (2017):

"It has been found to have an average growth rate of about 3-6 mm/year (Verween, 2006[a]). Young Dark false mussels in Amsterdam Harbor were measured to an average of 4 mm by the end of May after a period of no growth over winter. Their subsequent average sizes included 8 mm(end [*sic*] of June), 11 mm (end of July), 15 mm (end of August), 17 mm (mid-September), and 19 mm (end of October). The maximum size was about 23–24 mm and no individual seemed to be older than a year and a few months (Vorstman, 1933). However, these sizes may not be typical as first year and even maximum sizes of 10-15 mm have also been reported (Kennedy, 201[1a])."

Environment

From Palomares and Pauly (2017):

"Benthic; brackish; depth range 0 - 55 m [Rosenberg 2009]"

From GISD (2017):

"*Mytilopsis leucophaeata* generally inhabits oligohaline to mesohaline estuarine environments (Kennedy, 201[1a]). It is strongly euryhaline and has been recorded from salinities of 0-25 PSU with an optimal range of 0.75-20.9 PSU (Verween et al, 2010). It is also fairly temperature tolerant and may tolerate temperatures from 6.8°C to 37°C, but its optimum range, in which reproduction occurs, is between 15°C to 27°C (Verween et al, 2010; Rajagopal et al, 2005b; NOBANIS, 2011)."

From Verween et al. (2007):

"At its place of origin, *M. leucophaeata* is restricted to warm, more temperate waters (Marelli and Gray, 1983) but in Europe, it endures much lower temperatures: the species has been found in fluctuating water temperatures ranging from of 5 °C in Finland (Laine et al., 2006) up to 30 °C in Miami (Siddall, 1980)."

Climate/Range

From Palomares and Pauly (2017):

"Temperate"

Distribution Outside the United States

Native

From Fofonoff et al. (2017):

"[…] native to the east coast of North America from the Chesapeake Bay to Veracruz, Mexico."

"Museum records from Caribbean islands (Jamaica, Cuba, Haiti, Guadeloupe, mostly as *Congeria leucophaeta*, Academy of Natural Sciences of Philadelphia 2012; Museum of

Comparative Zoology 2012; U.S. National Museum of Natural History 2012) may represent misidentifications of *Mytilopsis sallei*."

Introduced

From Fofonoff et al. (2017):

"[…] *Mytilopsis leucophaeata* was first collected in Antwerp, Belgium in 1835 (Nyst 1835, cited by Kennedy 2011a) […] Early invasions in northern Europe included the Amstel River, Amsterdam, Netherlands in 1895 (Wolff 2005); the Canal de Caen, Normandy in 1910 (Germain 1931, cited by Oliver et al. 1998), the Weser River and the Kiel Canal, Germany both in 1928 (Nehring 2002), and the Zuider Zee and Rhine Delta (Van Jutting 1936, 1943, cited by Wolff 2005). […] In 1962, it was found in the isolated Russian Baltic port of Kaliningrad (surrounded by Poland), but it is likely extinct there now (Brohmer 1962, cited by Laine et al. 200[6]). However, in the Baltic Sea, it is established in the Warnow River, Rostock, Germany (Darr and Zettler 2000, cited by Laine et al. 200[6]), the Gulf of Gdansk (in 2010, Dziubinska 2011), the Gulf of Finland (in 2003, Laine et al. 200[6]), and the Gulf of Bothnia, Sweden (in 2011, Werner in ICES Advisory Committee on the Marine Environment 2012). […] In the British Isles, *M. leucophaeata* was first found on an enclosed dock in Cardiff, Wales in 1996 (Oliver et al. 1998), and later found in the Thames estuary in 1999 (Bamber and Taylor 2002, cited by Heiler et al. 2010). […] In 1993, it was found near Seville, on the Guadalquivir River estuary, on the southern Atlantic coast of Spain (Escot et al. 2003), and in 2002, in a canal at d'Aigues-Mortes on the Mediterranean coast of France (Girardi 2003, cited by Heiler et al. 2010). In 2002, it was identified by molecular means in the Dniester lagoon on the Black Sea in Ukraine (Therriault et al. 2004). In 2009, it was found to be abundant in the southern Caspian Sea, near Bandar Anzali, Iran (Heiler et al. 2010)."

From Kennedy (2011a):

"The species has also been recorded lately from northeastern Brazil (de Souza et al. 2005; Farrapeira et al. 2007)."

Means of Introduction Outside the United States

From Fofonoff et al. (2017):

"Although *M. leucophaeata* has a preference for brackish water, it tolerates salinities of 30 PSU and above, as well as freshwater (Castagna and Chanley 1973; Siddall 198[0]), and so could be transported by hull fouling through seawater, or freshwater canals. Its planktonic larvae can also tolerate salinities as high as 32 PSU (Siddall 198[0]), facilitating transfer with ballast water (Verween et al. 2010)."

From Kennedy (2011a):

"[…] the species' introduction in northeastern Brazil has been linked to fouling on ships (Farrapeira et al. 2007)."

"[…] although ship traffic may indeed be an important transfer vehicle, other vectors may be involved. Note again that eastern oysters were commonly transported to Europe from Chesapeake Bay over time (Ingersoll 1887; Wolff and Reise 2002), allowing them to serve as a possible vector for introducing the dark falsemussel to the Continent. Now that the species is established in Europe, vectors other than ship traffic, such as transfers of associated organisms as well as transport of larvae by water circulation patterns, may contribute to future movements among sites."

From Verween et al. (2006b):

"The presence of stepping stones of estuaries all over Europe however leaves the possibility of minor dispersal by means of transportation of juveniles through attachment to the legs and feet of waterfowl and shorebirds.

Short Description

From GISD (2017):

"It has a thick, rugrose [*sic*] periostractum [*sic*] covering its shell that is dark brown in adults and cream-colored in young specimens with fine to medium rough concentric lines. It commonly has "zebra stripes" and zig-zag patterns in juveniles (Verween *et al*, 2010; NOBANIS, 2011; Laine *et al*, 2006). Its shell shape is mytiliform and incurved with the anterior side depressed, hinge margin excavated, and teeth obsolete (Verween *et al*, 2010). The interior of the shell of *M. leucophaeata* is gray and has a shelf, or myophore, plate at the anterior with an apophysis, a small triangular tooth that serves as an attachment point for anterior retractor muscles, which is absent many similar-looking mussels including the Zebra mussel *Dreissena polymorpha* (Verween *et al*, 2010; Zebra Mussel Information System, 2002)."

Biology

From Kennedy (2011a):

"In its native habitat, individuals can be found attached byssally to eastern oysters (Conrad 1831, 1857–1858), often nestled in the interstices of clumps of a byssate mytilid, the hooked mussel *Ischadium recurvum* that also attaches to oyster shell (Hinkley 1907; pers. obs.; […]). The dark falsemussel occasionally forms large clumps of individuals on solid substrates such as pier pilings, sticks, stones, or bottles (pers. obs.; see also Wolff 1969). When first reported from Europe (Nyst 1835), it was attached in 'très-grande abondance' to floating wharves in company with barnacles and 'coralliophages' (a type of boring mollusc that Nyst did not name)."

From Fofonoff et al. (2017):

"*Mytilopsis leucophaeata* is a small mussel which has separate sexes that release eggs and sperm into the water column, resulting in planktonic larvae. The first stage of larval development is a trochophore, followed by a shelled veliger. Spawning in Belgium began at 16-19ºC, and was prolonged, with individuals spawning several times from spring to fall, peaking in summer (Verween et al. 2010). The trochophore stage was reached within 8-24 h, and by 21- 48 h larvae had a D-shaped shell (Verween et al. 2010; Kennedy 2011b). Laboratory-reared larvae at 21-

26°C began to settle at about 6 to 15 days from fertilization, and 194-210 μm in length (Siddall et al. 198[0]; Kennedy 2011b). […] Field and laboratory observations suggest that spawning and settlement can be stimulated by sudden decreases in salinity, such as occurs following heavy rains (Kennedy 2011a; Kennedy 2011b)."

"Postlarvae of *M. leucophaeata* often settle on a filamentous surface, such as vegetation, after which larvae move to hard surfaces such as logs, stones, shells, and artificial structures (Verveen et al. 2010; Kennedy 2011b)."

"They are vulnerable to predation by crabs and fishes, which may account for their frequent scarcity and the 'boom and bust' nature of their occurrences in Chesapeake Bay (Kennedy 2011b)."

From Palomares and Pauly (2017):

"Commensal with amphipods [Thomas and Klebba 2007]."

From GISD (2017):

"*Mytilopsis leucophaeata* is a filter feeder that consumes phytoplankton, plant detritus, diatoms, and other organic matter (Verween *et al*, 2010; Kennedy, 201[1a])."

Human Uses

No information available.

Diseases

From Kennedy (2011a):

"Little is known about parasites and symbionts of dark falsemussels, and only for North American forms. Wardle (1980a) discovered the symbiotic rhabdocoele *Paravortex gemellipara* in the digestive tract of one dark falsemussel (15 mm long) of four examined in a sample from the north shore of Galveston Island, Texas. This turbellarian flatworm also occurs in hooked mussels, with the incidence of infestation apparently higher in denser mussel populations (Wardle 1980a), so there is opportunity for cross contamination where the two bivalve species coexist. In a second study, Wardle (1980b) found metacercariae of the fluke *Proctoeces maculatus* in 2 of 10 dark falsemussels and in 5 of 17 hooked mussels collected from Galveston Bay."

No OIE-reportable diseases have been documented in this species.

Threats to Humans

From GISD (2017):

"*Mytilopsis leucophaeata* is a biofouling species which commonly disturbs coolant water systems of industrial and power plants."

3 Impacts of Introductions

From NOBANIS (2017):

"It was only with strict regulations on the use of biocides during the 1990s that *Mytilopsis leucophaeata* became a serious fouling problem for cooling water systems along the coasts of Belgium, Netherlands and France (Verween et al., 2005). No information is available on competition or tolerance of anoxia or environmental contaminants. Hence nothing is known about its effects on native ecosystems."

From GISD (2017):

"*Mytilopsis leucophaeata* is a biofouling species which commonly disturbs coolant water systems of industrial and power plants. Its rapid reproduction in such an ideal environment may result in extremely dense populations that clog water intakes and may damage or cause failure to systems (Rajagopal *et al*, 2002[a]; Kennedy, 201[1a]; Verween *et al*, 2006[a]). Specific examples of its biofouling have been reported from Belgium, Finland, and the Netherlands with densities ranging from tens of thousands to even millions of individuals/m2 (Verween *et al*, [2007]; Laine *et al*, 2006; Rajagopal *et al*, 2002[b]). *M. leucophaeata* also fouls boats, ropes, cages, and other marine equipment (Bergstrom, 2004). Aside from biofouling, dense populations *M. leucophaeata* alter ecosystems and likely have significant ecological effects similar to that of the more widely researched dreissenid Zebra mussel, (*Dreissena polymorpha*), which demand further investigation."

From Rajagopal et al. (2002b):

"*M. leucophaeata* is a biofouling and nuisance organism, causing problems in industrial cooling water systems (Jenner *et al.* 1998). Settlement densities as high as 6.5 million/m^2 have been reported near power station intakes in the Noordzeekanaal (The Netherlands), the canal which connects the harbors of Amsterdam with the North Sea (Rajagopal *et al.* 1995). A comparison of biomass values in the literature with those obtained for *M. leucophaeata* (37 kg/m^2 dry weight) from the Noordzeekanaal shows that the biomass build-up there is probably one of the highest reported from the temperate waters."

From Fofonoff et al. (2017):

"[…] significant ecological impacts have not been observed in invaded waters, either in the Northeast US (Hudson, Housatonic, and Charles Rivers), or in invaded European waters."

From Verween et al. (2006b):

"Pathy and Mackie (1993) posed that the ecological and economical threats of *M. leucophaeata* are less severe than those of the zebra mussel. However, the fact that they inhabit brackish waters makes them far more resistant to environmental changes (Siddall, 1980), which makes them potentially an even more robust fouler than *D. polymorpha*. Therefore, *M. leucophaeata* is more resistant to anti-fouling techniques than the freshwater *D. polymorpha*, as proven by Rajagopal et al. ([1997], [2003], 2005a). A comparison of chlorine toxicity data with *M. leucophaeata*, *D. polymorpha* and *Mytilus edulis* shows that *M. leucophaeata* is the most tolerant species (Rajagopal et al., 2002[b]).”

“*M. leucophaeata* adults are smaller than those of *D. polymorpha* adults, which makes the fouling problems less severe in density. On the other hand, *M. leucophaeata* is a long-lived species in comparison to *D. polymorpha*, which means that the adult population will remain a problem in the conduits for a longer time, which can introduce more severe problems in time. Knowledge on the cyclic presence of mussel larvae provides a basis for an ecologically and economically proper use of biocides (Relini, 1984). The strict timing of *M. leucophaeata* larvae in the harbour of Antwerp is an indication that to prevent new biofouling, a pointed dosage of biocides during the period of larval presence will be as effective as a continuous dosage throughout the year. This saving can lead to the exploration on the use of ecologically less harmful, but more expensive biocides. The long lifespan on the other hand states that even though larvae may be effectively combated, the adult population in the conduits will remain a noncombatable source of larvae for a long time. In summary, *M. leucophaeata* is a slower invader in Europe (Van der Velde et al., 2010) than *D. polymorpha* in the U.S. However once invaded, it is an even more severe fouling species than *D. polymorpha*, and as such it has to be taken in account that *M. leucophaeata* has most definitely the potential of becoming the brackish water equivalent of *D. polymorpha* in Europe.”

4 Global Distribution

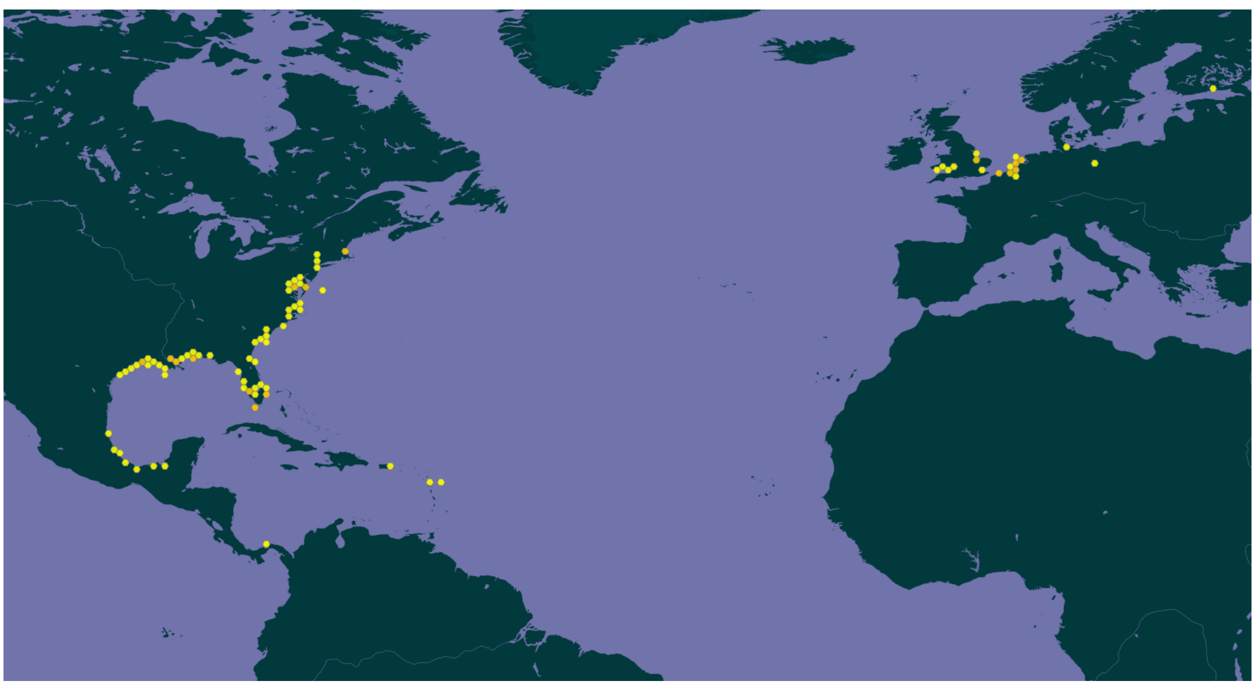

Figure 1. Known global distribution of *M. leucophaeata*. Map from GBIF Secretariat (2017). A point in central Mexico and a point in the Atlantic Ocean were excluded from this map due to invalid coordinates. Some points were not included in climate matching analysis: a point in Panama because it represents a fossil, not a contemporary specimen or observation, and points on

Caribbean islands because of uncertainty about their validity (see Distribution Outside the United States). No occurrences were reported from France, Spain, Sweden, Ukraine, and Iran, where the species is likely established given reported high abundances.

5 Distribution Within the United States

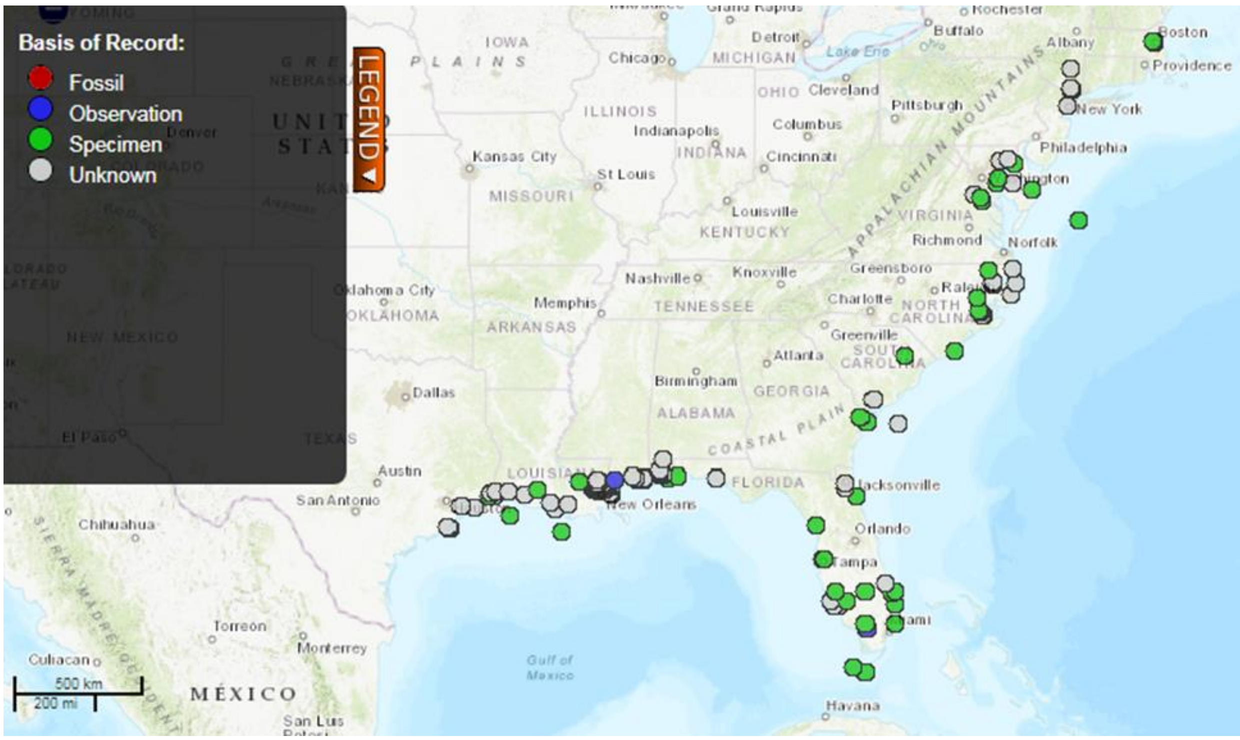

Figure 2. Known distribution of *M. leucophaeata* in the United States. Map from BISON (2017). Points in Puerto Rico were excluded from this map and climate matching analysis because of uncertainty about their validity (see Distribution Outside the United States).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was high along the length of the Atlantic Coast of the United States and along the Gulf Coast except in southern Texas. High match extended from the Atlantic Coast west across the Ohio River basin and the Great Lakes. A narrow band of medium climate match extended from Wisconsin to southern Texas. Medium match was also found in inland Maine, northwestern Washington, and the southern California coast, as well as in some areas of the Interior West. Much of the western United States showed a medium low climate match. Climate 6 score indicated that the contiguous United States has a high climate match overall. Scores of 0.103 and greater are classified as high match; Climate 6 score of *M. leucophaeata* was 0.402. Only the states of California, Kansas, North Dakota, Nebraska, Nevada, and Oregon had low climate scores; all other states had medium or high climate scores. Note that this climate matching analysis was performed for the entire contiguous United States, while *M. leucophaeata* is predominantly found in brackish water environments.

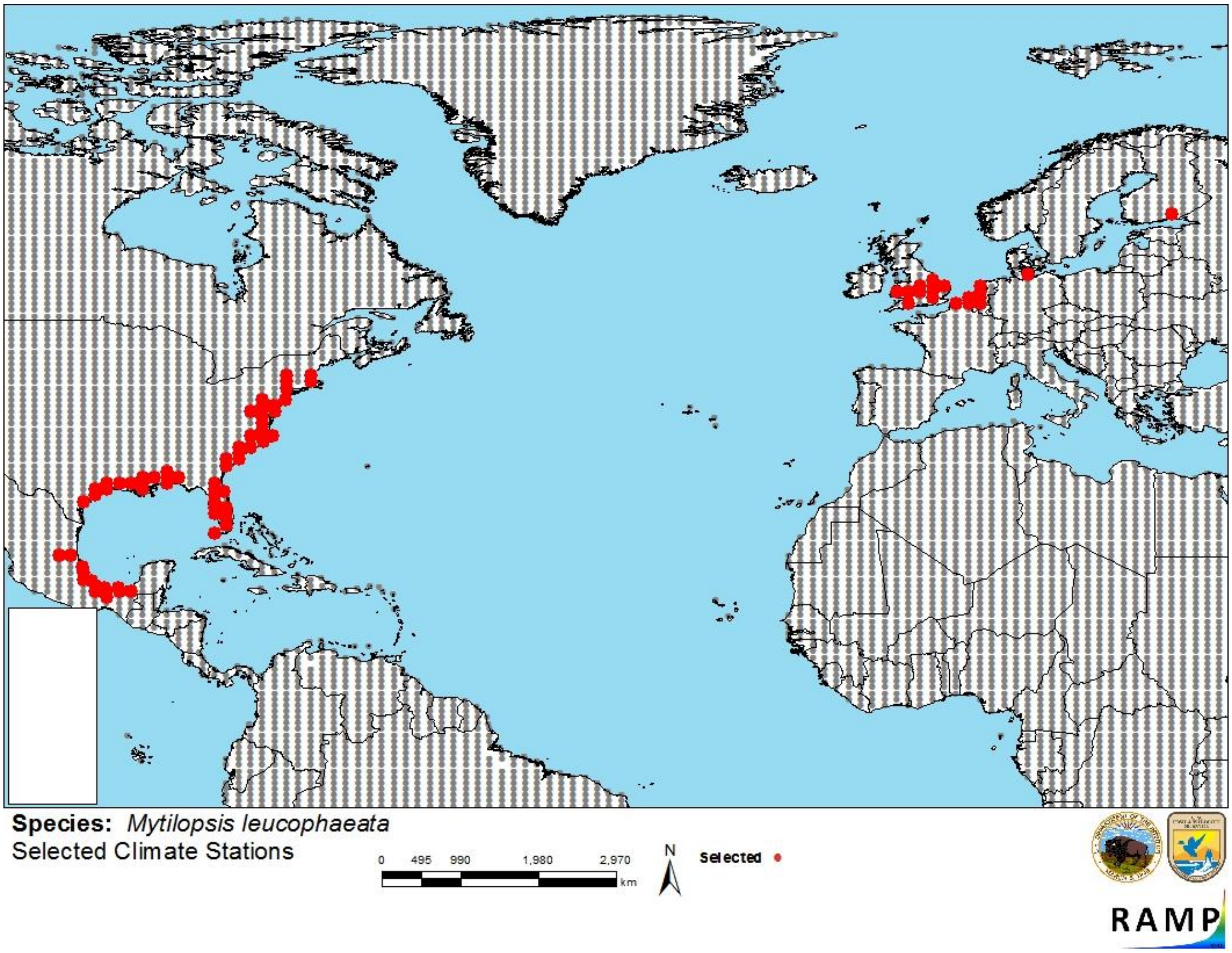

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red; United States, Mexico, United Kingdom, Belgium, Netherlands, Germany, Finland) and non-source locations (gray) for *M. leucophaeata* climate matching. Source locations from GBIF Secretariat (2017) and BISON (2017).

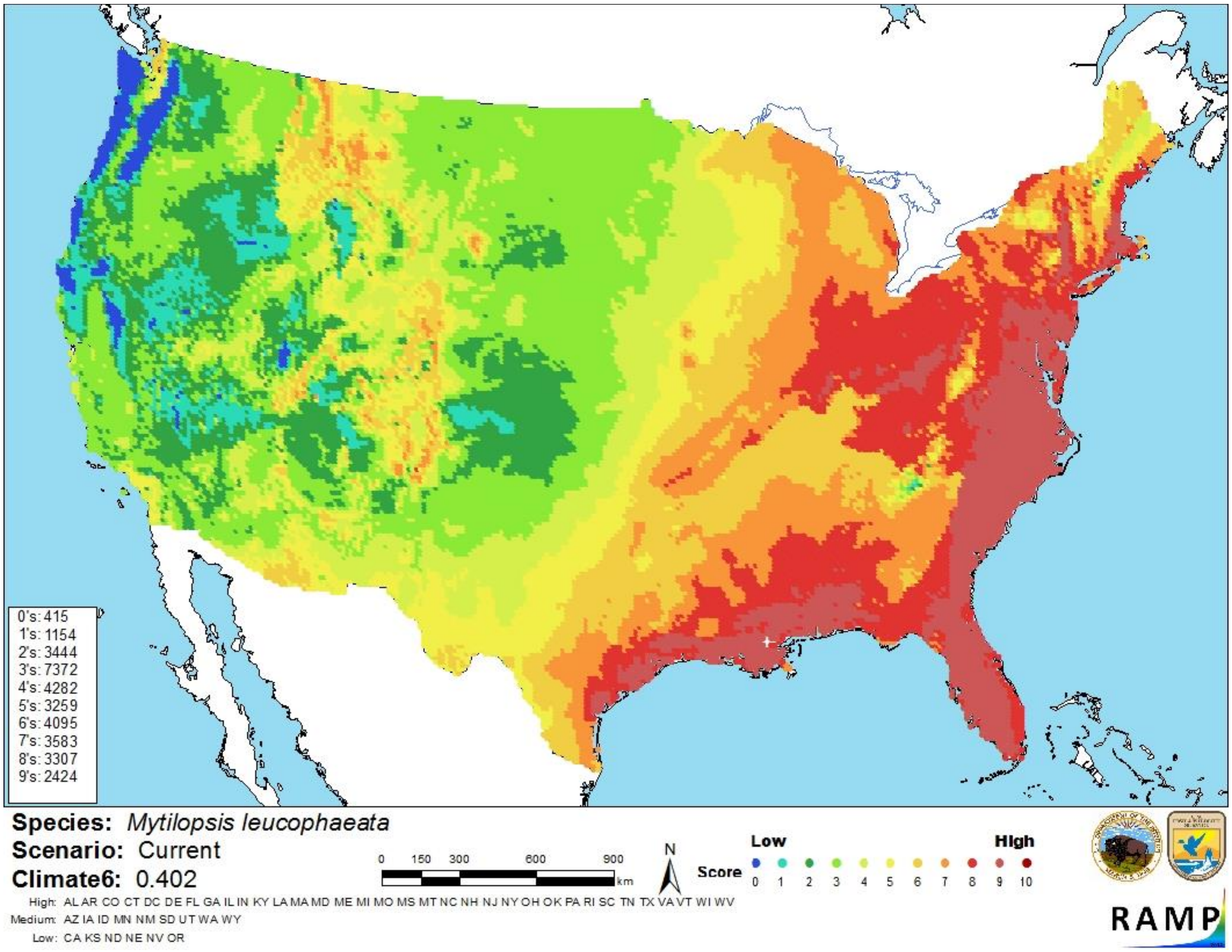

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *M. leucophaeata* in the contiguous United States based on source locations reported by GBIF Secretariat (2017) and BISON (2017). 0=Lowest match, 10=Highest match.

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

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

7 Certainty of Assessment

Information is readily available on the biology, ecology, and distribution of *M. leucophaeata*. Economic impacts of introduction have been documented by multiple authors from multiple locations, although ecological impacts are not well studied or understood. Because of the quantity of information available and thorough documentation of economic impacts, certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Mytilopsis leucophaeata, dark falsemussel, is a dreissenid mussel native to the east coast of North America from the Chesapeake Bay to Veracruz, Mexico. The species has wide temperature and salinity tolerances, but typically inhabits estuarine environments. In the eastern United States, *M. leucophaeata* has become established in a several locations outside its native range as a result of transport by boat or in shipments of eastern oysters. *M. leucophaeata* is also established in Brazil and several locations in Europe, where it has become problematic as a biofouler of industrial cooling water systems. Ecological impacts of *M. leucophaeata* have not been well studied anywhere in its introduced range. History of invasiveness and certainty of assessment are high because of documented economic impacts. Climate match to the contiguous United States is high overall, with high match extending across much of the eastern United States. It is important to note, however, that salinity differs between the predominantly estuarine occurrences used as source locations in climate matching and the many inland freshwater target locations in the contiguous United States showing a high match in the climate matching analysis. Like other habitat features, salinity may interact with climate to limit the locations where *M. leucophaeata* can establish within the contiguous United States. Overall risk assessment for *M. leucophaeata* remains high because of the demonstrated economic impacts of this species and its high climate match to the contiguous United States.

Assessment Elements

- **History of Invasiveness: High**
- **Climate Match: High**
- **Certainty of Assessment: High**
- **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 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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