Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

Scientific Name: *Batillaria attramentaria*

Common Name *Japanese false cerith*

Phylum	Mollusca
Class	Gastropoda
Order	Neotaenioglossa
Family	Batillariidae

Final Rank 46.00

Data Deficiency: 12.50

Species Occurrence by Ecoregion

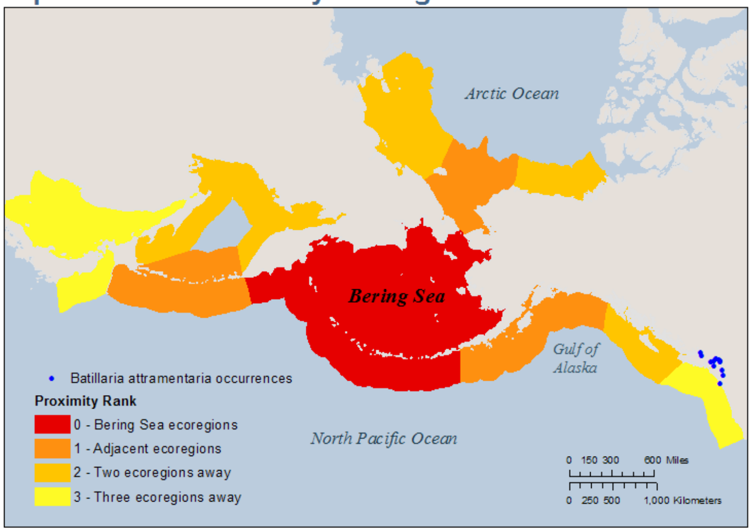

Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

Category Scores and Data Deficiencies

Category	Score	Total Possible	Data Deficient Points
Distribution and Habitat:	12.25	23	7.50
Anthropogenic Influence:	6	10	0
Biological Characteristics:	17	25	5.00
Impacts:	5	30	0
Totals:	40.25	87.50	12.50

General Biological Information

Tolerances and Thresholds

Minimum Temperature (°C)	-2	Minimum Salinity (ppt)	7
Maximum Temperature (°C)	40	Maximum Salinity (ppt)	33
Minimum Reproductive Temperature (°C)		Minimum Reproductive Salinity (ppt)	
Maximum Reproductive Temperature (°C)		Maximum Reproductive Salinity (ppt)	

Additional Notes

Size of adult shells ranges from 10 to 34 mm. The shell is usually gray-brown, often with a white band below the suture, but can range from light brown to dirty-black. Historically introduced with the Pacific oyster, Crassostrea gigas, but in recent years, it has been found in areas where oysters are not cultivated. Nevertheless, its spread has been attributed to anthropogenic vectors rather than natural dispersal.

1. Distribution and Habitat

1.1 Survival requirements - Water temperature

Choice: A Considerable overlap – A large area (>75%) of the Bering Sea has temperatures suitable for year-round survival

Score: 3.75 **of** 3.75

High uncertainty? ☑

Ranking Rationale:
Temperatures required for year-round survival occur over a large (>75%) area of the Bering Sea. Thresholds are based on geographic distribution, which may not represent physiological tolerances; we therefore ranked this question with "High uncertainty".

Background Information:
Based on its geographic distribution, B. attramentaria can tolerate temperatures from -2°C to 40°C.

Sources:
NEMESIS; Fofonoff et al. 2003

1.2 Survival requirements - Water salinity

Choice: B Moderate overlap – A moderate area (≥25%) of the Bering Sea has salinities suitable for year-round survival

Score: 2.5 **of** 3.75

High uncertainty? ☑

Ranking Rationale:
Salinities required for year-round survival occur in a moderate area (≥25%) of the Bering Sea. Thresholds are based on geographic distribution, which may not represent physiological tolerances; moreover, models disagree with respect to their estimates of suitable area. We therefore ranked this question with "High uncertainty".

Background Information:
This species' salinity tolerance ranges from 7 to 33 PSU (based on geographic distribution).

Sources:
NEMESIS; Fofonoff et al. 2003

1.3 Establishment requirements - Water temperature

Choice: U Unknown/Data Deficient

Score: **of**

Ranking Rationale:
Reproductive temperature requirements are unknown.

Background Information:
No information found.

Sources:
None listed

1.4 Establishment requirements - Water salinity

Choice: U Unknown/Data Deficient

Score: **of**

Ranking Rationale:
Reproductive salinity requirements are unknown.

Background Information:
No information found.

Sources:
None listed

1.5 Local ecoregional distribution

Choice: C Present in an ecoregion two regions away from the Bering Sea (i.e. adjacent to an adjacent ecoregion)

Score: 2.5 of 5

Ranking Rationale:
This species occurs in southern BC and in southern Russia.

Background Information:
This species is found on Vancouver Island, BC and in southern Russia.

Sources:
NEMESIS; Fofonoff et al. 2003

1.6 Global ecoregional distribution

Choice: C In few ecoregions globally

Score: 1.75 of 5

Ranking Rationale:
Currently, this species is limited to temperate waters on either coasts of the Pacific Ocean.

Background Information:
This species is native to the Northwest Pacific, including Russia, Japan, Taiwan and Hong Kong. It has been introduced to the west coast of North America. It was first found in Washington in 1924, but has since spread to other areas in Washington and to California. In its native range, it extends as far north as the southern Sakhalin and Kuril Islands in the Sea of Okhotsk. Its northern limit in its introduced range is Vancouver Island in southern BC.

Sources:
NEMESIS; Fofonoff et al. 2003

1.7 Current distribution trends

Choice: C Established outside of native range, but no evidence of rapid expansion or long-distance dispersal

Score: 1.75 of 5

Ranking Rationale:
This species spread slowly across the western coast of North America, where it was introduced. Its spread has been attributed to transport by anthropogenic vectors rather than natural dispersal.

Background Information:
This species was first reported in North America (Washington state) in 1924. By 1964, it had spread north to Comox, on BC's Vancouver Island. By 2007, it had reached Pendrell Sound, about ~100 km north of Comox. Its spread has been attributed to anthropogenic vectors (notably Pacific oyster culture), rather than natural dispersal. Large populations have been reported in San Francisco Bay, CA.

Sources:
NEMESIS; Fofonoff et al. 2003 Behrens Yamada 1982

Section Total - Scored Points:	12.25
Section Total - Possible Points:	22.5
Section Total -Data Deficient Points:	7.5

2. Anthropogenic Transportation and Establishment

2.1 Transport requirements: relies on use of shipping lanes (hull fouling, ballast water), fisheries, recreation, mariculture, etc. for transport

Choice: **B** — Has been observed using anthropogenic vectors for transport but has rarely or never been observed moving independent of anthropogenic vectors once introduced

Score: 2 of 4

Ranking Rationale:
This species can be transported by hull fouling and hitchhiking. Its spread has been attributed to transport by anthropogenic vectors rather than natural dispersal.

Background Information:
B. attramentaria was unintentionally introduced to North America with Pacific oysters (Crassostrea gigas). Although it has recently been found in areas where no oysters are being cultivated, anthropogenic vectors such as boat trailers, fishing gear, or boots – rather than natural dispersal – are thought to be responsible for its spread.

Sources:
NEMESIS; Fofonoff et al. 2003 Miura et al. 2006

2.2 Establishment requirements: relies on marine infrastructure, (e.g. harbors, ports) to establish

Choice: **A** — Readily establishes in areas with anthropogenic disturbance/infrastructure and in natural, undisturbed areas

Score: 4 of 4

Ranking Rationale:
This species can establish in natural and anthropogenic habitats following its introduction.

Background Information:
Its spread has largely been attributed to accidental introduction with Pacific oysters. Once introduced, it establishes on natural substrates in salt marshes and tidal pools in bays and estuaries (Byers 1999).

Sources:
NEMESIS; Fofonoff et al. 2003 Byers 1999

2.3 Is this species currently or potentially farmed or otherwise intentionally cultivated?

Choice: **B** — No

Score: 0 of 2

Ranking Rationale:
This species is not currently farmed.

Background Information:

Sources:
NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	6
Section Total - Possible Points:	10
Section Total -Data Deficient Points:	0

3. Biological Characteristics

3.1 Dietary specialization

Choice: **A** Generalist at all life stages and/or foods are readily available in the study area

Score: 5 of 5

Ranking Rationale:
B. attramentaria is a generalist, and prey items are readily available in the Bering Sea.

Background Information:
B. attramentaria is both a suspension and deposit feeder (Kamimura and Tsuchiya 2004). It feeds on plant and animal particles, detritus, and benthic diatoms. It feeds by crawling and grazing on sediments (Swinbanks and Murray 1981).

Sources:
NEMESIS; Fofonoff et al. 2003   Kamimura and Tsuchiya 2004   Swinbanks and Murray 1981

3.2 Habitat specialization and water tolerances

Does the species use a variety of habitats or tolerate a wide range of temperatures, salinity regimes, dissolved oxygen levels, calcium concentrations, hydrodynamics, pollution, etc?

Choice: **A** Generalist; wide range of habitat tolerances at all life stages

Score: 5 of 5

Ranking Rationale:
This species has broad environmental tolerances. Competition and low dispersal abilities may limit habitat use in its introduced range.

Background Information:
This species has wide salinity and temperature tolerances, and a high tolerance for low oxygen levels (Byers 2000). In its natural range, it occurs on sand, mud, and rocky substrates (Adachi and Wada 1999). In its introduced range, it occupies a narrower range of habitats, and appears confined to tidal marshes and mudflats.

Sources:
NEMESIS; Fofonoff et al. 2003   Byers 2000   Adachi and Wada 1999

3.3 Desiccation tolerance

Choice: **U** Unknown

Score: of

Ranking Rationale:
The desiccation tolerance of this species is unknown.

Background Information:
To avoid desiccation during low tide, B. attramentaria buries itself headfirst in the sand (Swinbanks and Murray 1981). Across a gradient of tidal zones, highest densities occurred at underwater sites, though some were found at drier sites (Swinbanks and Murray 1981).

Sources:
NEMESIS; Fofonoff et al. 2003   Swinbanks and Murray 1981

3.4 Likelihood of success for reproductive strategy

i. Asexual or hermaphroditic ii. High fecundity (e.g. >10,000 eggs/kg) iii. Low parental investment and/or external fertilization iv. Short generation time

Choice: B Moderate – Exhibits one or two of the above characteristics

Score: 3.25 of 5

Ranking Rationale:

This species is dioecious. It reproduces sexually and has low parental investment. This species has low fecundity and a relatively long generation time.

Background Information:

This species is dioecious and exhibits sexual reproduction. Eggs have direct development and hatch into crawling (non-planktonic) larvae. Byers and Goldwasser (2001) used field observations on another species to estimate a relationship between shell length and fecundity; based on this relationship and an average shell size of 18.4 mm, an individual female is expected to produce 205 eggs/year. B. attramaentaria can reproduce more than once over the course of its life (Lin 2006).
This species can live between 6 to 10 years (Behrens Yamada 1982), and reaches sexual maturity when it reaches ~1.3-2 mm in length (usually between 1 and 2 years old).

Sources:

Behrens Yamada 1982 NEMESIS; Fofonoff et al. 2003 Lin 2006 Byers and Goldwasser 2001

3.5 Likelihood of long-distance dispersal or movements

Consider dispersal by more than one method and/or numerous opportunities for long or short distance dispersal e.g. broadcast, float, swim, carried in currents; vs. sessile or sink.

Choice: C Disperses short (< 1 km) distances

High uncertainty? ☑

Score: 0.75 of 2.5

Ranking Rationale:

Although data on dispersal are lacking, preliminary movement estimates, as well as biological and ecological information suggest that this species has limited capacity for natural dispersal.

Background Information:

Dispersal ability is relatively limited because it produces non-planktonic larvae (qtd. in Byers 1999). Juvenile snails of small shell size can disperse locally by floating on the water surface, but high wave intensity likely impedes floating ability (Adachi and Wada 1999). Adults are mobile and capable of crawling. A preliminary mark-recapture experiment found that this species moved an average of 1 m/day (Dewar et al. 2008). However, given their locomotion style and patchy distribution, they likely do not disperse long distances (Behrens Yamada 1982). The distribution of B. attramentaria is largely (though not exclusively) restricted to bays in which it was introduced with C. gigas (Byers 1999).

Sources:

Adachi and Wada 1999 Behrens Yamada 1982 Dewar et al. 2008 Byers 1999 NEMESIS; Fofonoff et al. 2003

3.6 Likelihood of dispersal or movement events during multiple life stages

i. Can disperse at more than one life stage and/or highly mobile ii. Larval viability window is long (days v. hours) iii. Different modes of dispersal are achieved at different life stages (e.g. unintentional spread of eggs, migration of adults)

Choice: **B** Moderate – Exhibits one of the above characteristics

Score: 1.75 **of** 2.5

Ranking Rationale:

This species lacks a planktonic larval stage, and data suggest that it has limited mobility. All life stages can disperse by crawling. Juveniles can also disperse by floating.

Background Information:

This species undergoes direct development and eggs hatch into crawling (non-planktonic) larvae. Juvenile snails of small shell size can disperse locally by floating on the water surface (Adachi and Wada 1999). Adults are mobile and capable of crawling. A preliminary mark-recapture experiment found that this species moved an average of 1 m/day (Dewar et al. 2008).

Sources:

NEMESIS; Fofonoff et al. 2003 Byers 1999 Adachi and Wada 1999 Dewar et al. 2008

3.7 Vulnerability to predators

Choice: **D** Multiple predators present in the Bering Sea or neighboring regions

Score: 1.25 **of** 5

Ranking Rationale:

Several taxa found in the Bering Sea are likely to prey upon this species.

Background Information:

This species is predated upon by birds, crabs, and fishes.

Sources:

NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	17
Section Total - Possible Points:	25
Section Total -Data Deficient Points:	5

4. Ecological and Socioeconomic Impacts

4.1 Impact on community composition

Choice: **C** Limited – Single trophic level; may cause decline but not extirpation

Score: 0.75 of 2.5

Ranking Rationale:

Through competition, B. attramentaria may extirpate native snail populations, especially in areas where suitable habitat (e.g., marshes, mudflats) is limited. This species may also facilitate the establishment of other invasive species, or act in conjunction with other grazers to affect eelgrass. However, its impacts in natural ecological settings have so far been limited.

Background Information:

Because of competition with B. attramentaria, populations of the native snail Cerithidea californica declined an average of 27% over a 3-year period in northern California (Byers 1999). A modelling exercise by Byers and Goldwasser (2001) suggest that, while displacement is slow, it may lead to extinction of C. californica in northern California within 55 to 90 years. Southern populations do not seem to be under threat because there is more available habitat, and because Batillaria is currently not found south of Elkhorn Slough. C. californica is host to 10 native and species-specific trematode species, which could also become locally extinct if B. attramentaria were to extirpate C. californica (Torchin et al. 2005; Lin 2006).

In manipulative experiments, B. attramentaria increased the abundance of mud snail Nassarius fraterculus and % cover of eelgrass Zostera japonica (Wonham et al. 2005). Both are introduced species from the NW Pacific.

In Boundary Bay, BC, Swinbanks and Murray (1981) suggest that B. attramentaria cannot, by itself, limit the extent of the algal mat zone. However, the grazing activities of Batillaria, combined with the effects of two other species (Abarenicola sp. and Callianassa californiensis), might limit the extent of algal mats (Swinbanks and Murray 1981).

Sources:

Byers 1999 Byers and Goldwasser 2001 Wonham et al. 2005 Lin 2006 Torchin et al. 2005 Swinbanks and Murray 1981 NEMESIS; Fofonoff et al. 2003

4.2 Impact on habitat for other species

Choice: **B** Moderate – Causes or has potential to cause changes to one or more habitats

Score: 1.75 of 2.5

Ranking Rationale:

Because of its shell, B. attramentaria creates hard substrate habitat that can be used by other species. This trait may be especially important in areas where B. attramentaria occurs at high densities, and where hard substrates are limited (e.g., on mudflats).

Background Information:

In Padilla Bay, WA, the shells of B. attramentaria provided habitat for two introduced species, the slipper shell Crepidula convexa and the anemone Diadumene lineata, and two native hermit crabs Pagurus hirsutiusculus and P. granosimanus (Wonham et al. 2005). Given the high densities of B. attramentaria in this area (>1400 individuals/m2), the authors estimate that B. attramentaria provided 600 cm of available habitat per m2 (Wonham et al. 2005).

Sources:

Wonham et al. 2005

4.3 Impact on ecosystem function and processes

Choice: C Limited – Causes or potentially causes changes to food webs and/or ecosystem functions, with limited impact and/or within a very limited region

Score: 0.75 of 2.5

High uncertainty? ☑

Ranking Rationale:
Through bioturbation and deposition of pseudofeces, this species may affect nutrient and oxygen concentrations. The effects of B. attramentaria on ecosystem processes has not been directly measured, and so the magnitude of its effects is unknown. These effects are likely to be most pronounced in areas where B. attramentaria occur at high densities.

Background Information:
When resting and feeding, B. attramentaria creates shallow trails in the soft substrate habitats where it occurs (Swinbanks and Murray 1981). This species also deposits pseudofeces. These behaviors may affect nutrient and oxygen levels; Wonham et al. (2005) suggest that these ecosystem effects may explain why percent cover of the seagrass Zostera japonica was higher in experimental enclosures where B. attramentaria was present. The study by Wonham et al. (2005) occurred in an area of high snail density (>1400 individuals/m2).

Sources:
Swinbanks and Murray 1981 Wonham et al. 2005

4.4 Impact on high-value, rare, or sensitive species and/or communities

Choice: D No impact

Score: 0 of 2.5

Ranking Rationale:
Although this species grazes on eelgrass, it has not been shown to have significant negative impacts. We do not expect this species to impact high-value species or communities in the Bering Sea.

Background Information:
In Boundary Bay, BC, Swinbanks and Murray (1981) suggest that B. attramentaria cannot, by itself, limit the extent of the algal mat zone. However, the grazing activities of Batillaria, combined with the effects of two other species (Abarenicola sp. and Callianassa californiensis), might limit the extent of algal mats (Swinbanks and Murray 1981).

Sources:
Swinbanks and Murray 1981

4.5 Introduction of diseases, parasites, or travelers

What level of impact could the species' associated diseases, parasites, or travelers have on other species in the assessment area? Is it a host and/or vector for recognized pests or pathogens, particularly other nonnative organisms?)

Choice: B Moderate – Spreads or has potential to spread one or more organisms, with moderate impact and/or within only a portion of region

Score: 1.75 of 2.5

High uncertainty? ☑

Ranking Rationale:
B. attramentaria is host to several parasites, only one of which (C. batillariae) has been found in introduced populations. This parasite cannot be transmitted from one snail to another, but its effect on other intermediate and final hosts (fishes and birds) is unknown.

Background Information:
In Asian waters, B. attramentaria hosts a variety of parasites, but only one, Cercaria batillariae, has been found in North America populations (Torchin et al. 2005). B. attramentaria, and several species of fishes, are intermediate hosts of C. batillariae, while fish-eating birds are probably the final hosts (Torchin et al. 2005). C. batillariae cannot be transmitted from one snail to another, and is unlikely to affect native snail populations (Lin 2006).

Sources:
NEMESIS; Fofonoff et al. 2003 Lin 2006 Torchin et al. 2002 Torchin et al. 2005

4.6 Level of genetic impact on native species

Can this invasive species hybridize with native species?

Choice: **D** No impact

Score: 0 of 2.5

Ranking Rationale:
This species is not expected to hybridize with native species in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

4.7 Infrastructure

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
This species is not expected to impact infrastructure in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

4.8 Commercial fisheries and aquaculture

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
This species is not expected to impact commercial fishing in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

4.9 Subsistence

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
This species is not expected to affect subsistence resources in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

4.101 *Recreation*

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
This species is not expected to affect recreational opportunities in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

4.11 *Human health and water quality*

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
This species is not expected to impact human health and water quality in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	5
Section Total - Possible Points:	30
Section Total -Data Deficient Points:	0

5. Feasibility of prevention, detection and control

5.1 History of management, containment, and eradication

Choice: **C** Attempted; control methods are currently in development/being studied

Score: of

Ranking Rationale:
Control of this species has been attempted, and methods to do so are currently being studied.

Background Information:
Attempts to eradicate populations in Loch Lomond Marina (San Francisco Bay) and Bodega Harbor were unsuccessful. Control methods are currently being studied (e.g., Houle 2011).

Sources:
NEMESIS; Fofonoff et al. 2003 Houle 2011

5.2 Cost and methods of management, containment, and eradication

Choice: **B** Major short-term and/or moderate long-term investment

Score: of

Ranking Rationale:
Current methods are labor-intensive, and need to be repeated in order to be effective. They are unlikely to work in areas where B. attramentaria occurs at high densities.

Background Information:
Hand removal has been used as a control method. Hand removal is labor-intensive and is unlikely to achieve complete eradication, especially in high density areas (Houle 2011). Other physical removal methods have been tested, but have not been more successful than hand removal (Houle 2011).

Sources:
Houle 2011 GISD 2016

5.3 Regulatory barriers to prevent introductions and transport

Choice: **A** Little to no regulatory restrictions

Score: of

Ranking Rationale:
This species is transported by numerous vectors and no species-specific regulations are currently in place. No regulations exist to prevent the spread of invasive species by hitchhiking.

Background Information:

Sources:
CFR 2017

5.4 Presence and frequency of monitoring programs

Choice: **B** Surveillance takes place, but is largely conducted by non-governmental environmental organizations (e.g., citizen science programs)

Score: of

Ranking Rationale:
Surveillance takes place in parts of its introduced range, and is conducted by scientists and volunteers. We did not find information on state or federal monitoring programs for this species.

Background Information:
Researchers and volunteers were involved in monitoring and removal of B. attramentaria in Bodega Harbor.

Sources:
Houle 2011

5.5 Current efforts for outreach and education

Choice: **A** No education or outreach takes place

Score: of

Ranking Rationale:

Very little information exists on B. attramentaria, and no information was found to suggest that education or outreach is taking place.

Background Information:

Sources:

None listed

Section Total - Scored Points:

Section Total - Possible Points:

Section Total -Data Deficient Points:

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- 33 CFR § 151.2050 Additional requirements - nonindigenous species reduction practices

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