Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

Scientific Name: *Macoma petalum*

Common Name *Atlantic macoma*

Phylum	Mollusca
Class	Bivalvia
Order	Veneroida
Family	Tellinidae

Final Rank 46.75

Data Deficiency: 0.00

Species Occurrence by Ecoregion

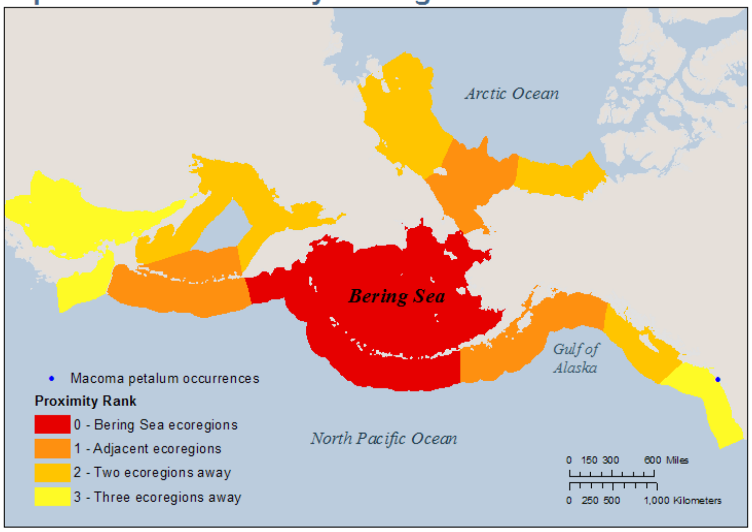

Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

Category Scores and Data Deficiencies

Category	Score	Total Possible	Data Deficient Points
Distribution and Habitat:	16	30	0
Anthropogenic Influence:	4	10	0
Biological Characteristics:	24.5	30	0
Impacts:	2.25	30	0
Totals:	46.75	100.00	0.00

General Biological Information

Tolerances and Thresholds

Minimum Temperature (°C)	0	Minimum Salinity (ppt)	2.5
Maximum Temperature (°C)	33	Maximum Salinity (ppt)	35
Minimum Reproductive Temperature (°C)	10	Minimum Reproductive Salinity (ppt)	31*
Maximum Reproductive Temperature (°C)	14	Maximum Reproductive Salinity (ppt)	35*

Additional Notes

Macoma petalum is an oval shaped, laterally compressed clam. The shell is an off-white color with a chalky texture and sometimes has a rosy hue. Adults range in size from 1 to 30 mm. M. petalum was formerly considered a synonym of M. balthica (the Baltic clam) but is now recognized as a genetically distinct species. Distinguishing the two requires molecular methods.

Reviewed by Nora R. Foster, NRF Taxonomic Services, Fairbanks AK

Review Date: 9/27/2017

1. Distribution and Habitat

1.1 Survival requirements - Water temperature

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

Score: 2.5 of 3.75

High uncertainty? ✔

Ranking Rationale:
Temperatures required for year-round survival occur in a moderate area (≥25%) of the Bering Sea. We ranked this question with "High Uncertainty" to indicate disagreements in model estimates.

Background Information:
The temperature threshold for survival of M. petalum is 0 to 33ºC (Abbott 1974 as qtd. In Fofonoff et al. 2003; Kennedy and Mihursky 1971).

Sources:
NEMESIS; Fofonoff et al. 2003   Kennedy and Mihursky 1971

1.2 Survival requirements - Water salinity

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

Score: 3.75 of 3.75

Ranking Rationale:
Salinities required for year-round survival occur over a large (>75%) area of the Bering Sea.

Background Information:
The salinity range for survival of M. petalum is between 2.5 and 35 ppt (Castagna and Chanley 1973; Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003   Castagna and Chanley 1973

1.3 Establishment requirements - Water temperature

Choice: **C** Little overlap – A small area (<25%) of the Bering Sea has temperatures suitable for reproduction

Score: 1.25 of 3.75

Ranking Rationale:
Temperatures required for reproduction occur in a limited area (<25%) of the Bering Sea.

Background Information:
The temperature threshold for reproduction of M. petalum 10 to 14ºC (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

1.4 Establishment requirements - Water salinity

Choice: **A** Considerable overlap – A large area (>75%) of the Bering Sea has salinities suitable for reproduction

Score: 3.75 of 3.75

High uncertainty? ✔

Ranking Rationale:
Although salinity thresholds are unknown, this species is a marine organism that does not require freshwater to reproduce. We therefore assume that this species can reproduce in saltwater (31 to 35 ppt). These salinities occur in a large (>75%) portion of the Bering Sea.

Background Information:
No information available in the literature.

Sources:
None listed

1.5 Local ecoregional distribution

Choice: D Present in an ecoregion greater than two regions away from the Bering Sea

Score: 1.25 of 5

Ranking Rationale:
Found as far north as Washington state.

Background Information:
Introduced populations have been recorded from California (San Francisco Bay) to Washington (Grays Harbor) (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

1.6 Global ecoregional distribution

Choice: C In few ecoregions globally

Score: 1.75 of 5

Ranking Rationale:

Background Information:
Native to the eastern coast of North America, from North Carolina to New Brunswick, Canada. Introduced in Washington and California (Fofonoff et al. 2003).

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:

Background Information:
No information found to suggest rapid colonization or range expansion.

Sources:
None listed

Section Total - Scored Points:	16
Section Total - Possible Points:	30
Section Total -Data Deficient Points:	0

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: **A**

Has been observed using anthropogenic vectors for transport and transports independent of any anthropogenic vector once introduced

Score: 4 of 4

Ranking Rationale:

Can be transported in ballast water and as accidental introductions. Larvae can disperse naturally over long distances.

Background Information:

Introductions to the west coast of North America are likely due to accidental transport with the Eastern oyster for cultivation (Cohen and Carlton 1995). Introduction through ballast water is also suspected (Fofonoff et al. 2003). Adults have limited mobility and spend most of their time buried in the substrate, but larvae can be dispersed passively by water currents.

Sources:

NEMESIS; Fofonoff et al. 2003 Cohen and Carlton 1995

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

Choice: **D**

Does not use anthropogenic disturbance/infrastructure to establish

Score: 0 of 4

Ranking Rationale:

Does not use anthropogenic disturbance or infrastructure for establishment.

Background Information:

Typical habitat includes shallow, muddy, subtidal to upper intertidal zones (Gosner 1978 as qtd. In Fofonoff et al. 2003).

Sources:

NEMESIS; Fofonoff et al. 2003

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

Choice: **B**

No

Score: 0 of 2

Ranking Rationale:

Background Information:

M. petalum is not currently farmed or intentionally cultivated.

Sources:

None listed

Section Total - Scored Points:	4
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:
Consumes taxa that are readily available in the Bering Sea.

Background Information:
M. petalum is both a deposit-feeder and a suspension-feeder. It mostly consumes microalgae (Thompson and Nichols 1988; Poulton et al. 2004).

Sources:
NEMESIS; Fofonoff et al. 2003   Thompson and Nichols 1988   Poulton et al. 2004

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: **B** Requires specialized habitat for some life stages (e.g., reproduction)

Score: 3.25 of 5

Ranking Rationale:
Limited to shallow subtidal or upper intertidal zones.

Background Information:
Typically found in shallow subtidal to upper intertidal zones, often in muddy or silty brackish waters (Gosner 1978 as qtd. in Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

3.3 Desiccation tolerance

Choice: **A** Highly tolerant (>7 days) of desiccation at one or more stages during its life cycle

Score: 5 of 5

Ranking Rationale:

Background Information:
In an experiment, average survival time out of water was about 22 days (de Zwaan and Babarro 2001).

Sources:
de Zwaan and Babarro 2001

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: A High – Exhibits three or four of the above characteristics

Score: 5 **of** 5

Ranking Rationale:

Sexual reproduction, high fecundity, external fertilization, short generation time.

Background Information:

In San Francisco Bay, spawns from January to March (Poulton et al. 2004). Can have reproductive failure during years when water temperature stays relatively warm or when salinity is low (Poulton et al. 2004). Macoma clams (not species-specific) release eggs and sperm into the water column (Chesapeake Bay Program 2016). After being fertilized, eggs develop into larvae with two tiny, transparent shells and a small foot. Larvae float in the currents for a few weeks before eventually settling to the bottom (Chesapeake Bay Program 2016).

The closely related species, M. balthica, can produce several thousands to tens of thousands of eggs (Honkoop and van der Meer 1997). The lowest average recorded for one site was 4744, though all others were above 30 000. The maximum average was 57,780 (Honkoop and van der Meer 1997). Sexual maturity is dependent on shell size rather than age, but usually occurs between 10 and 22 months (~4 mm; Tyler 2016). Lifespan is, on average, 5 to 10 years.

Sources:

Chesapeake Bay Program Honkoop and van der Meer 1997 Poulton et al. 2004 Tyler 2016

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: A Disperses long (>10 km) distances

Score: 2.5 **of** 2.5

Ranking Rationale:

Can disperse greater than 10 km.

Background Information:

Larvae are free-swimming and planktotrophic (Bos et al. 2007). A closely related species, M. balthica,disperses during its 2–5 week pelagic larval phase (Drent 2002), and during its first winter when it may drift with the use of a mucoid (byssus) thread (Beukema 1993; Hiddink et al. 2002; qtd. in Luttikhuizen et al. 2003). Experiments in the field revealed that individuals up to a size of 9 mm can be transported in this fashion over distances up to 24 km, although the density of M. bathica decreases with increasing distance from the source, suggesting that active migration – especially of adults > 1 year old – is possible, but uncommon (Beukema and de Vlas 1989). Tyler (2016) lists adult dispersal distance as short (between 100 to 1000 m) and larval dispersal potential as > 10 km, but does not provide references to support this claim.

Sources:

Tyler 2016 Drent 2002 Luttikhuizen et al. 2003 Bos et al. 2007 Beukema and de Vlas 1989

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: A High – Exhibits two or three of the above characteristics

Score: 2.5 of 2.5

Ranking Rationale:

Can disperse at more than one life stage, long larval viability window, different modes of dispersal for different life stages.

Background Information:

Although the larval stage is the most common stage of dispersal, adults of up to 9 mm can undergo active migration using byssus threads. The larval stage is long-lived and free-swimming. M. balthica is a broadcast spawner, and spawning has been observed multiple times in one season (Drent and Luttikhuizen 2003). In general, adults are not highly mobile, and remain buried underneath the substrate.

Sources:

Drent and Luttikhuizen 2003

3.7 Vulnerability to predators

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

Score: 1.25 of 5

Ranking Rationale:

Numerous predators, many of which exist in the Bering Sea.

Background Information:

Numerous predators including crabs, fishes and birds (Cohen and Carlton 1995).

Sources:

NEMESIS; Fofonoff et al. 2003 Cohen and Carlton 1995

Section Total - Scored Points:	24.5
Section Total - Possible Points:	30
Section Total -Data Deficient Points:	0

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:
Occurs at relatively low abundances. Has been negatively correlated the amethyst gem clam.

Background Information:
M. petalum appears to be negatively correlated with the amethyst gem clam, Gemma gemma (Thompson 1982). This is possibly due to feeding competition or alteration of sediment due to M. petalum production of pseudofeces (Thompson 1982). M. balthica, a closeley related species, caused a decline in harpacticoid copepods with little effect on other meiofaunal species (Ólafsson et al. 1993). Webb (1993) conducted a microcosm experiment to examine the influence of M. balthica on chlorophyll a concentrations, and found that M. balthica had no persistent effect on sedimentary chlorophyll a levels at natural bivalve field densities.

Sources:
NEMESIS; Fofonoff et al. 2003 Ólafsson et al. 1993 Webb 1993 Thompson 1982

4.2 *Impact on habitat for other species*

Choice: **D** — No impact

Score: 0 of 2.5

Ranking Rationale:

Background Information:
No impacts to habitat have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003 Thompson 1982

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

Ranking Rationale:
To date, no impacts on ecosystem function or processes have been reported for M. petalum. May impact sediment composition through production of pseudofeces.

Background Information:
May alter sediment composition through production of pseudofeces (Thompson 1982), but no specific impacts have been reported.

Sources:
Thompson 1982

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

Choice: **D** No impact

Score: 0 of 2.5

Ranking Rationale:
To date, no impacts have been reported.

Background Information:
No information available in the literature.

Sources:
None listed

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: **D** No impact

Score: 0 of 2.5

Ranking Rationale:
To date, no diseases, parasites, or travelers have been reported for M. petalum.

Background Information:
No information available in the literature.

Sources:
None listed

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:
To date, no hybridization with native species has been reported for M. petalum.

Background Information:
No information available in the literature.

Sources:
None listed

4.7 Infrastructure

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
No impacts on infrastructure have been reported to date.

Background Information:
No information available in the literature.

Sources:
None listed

4.8 *Commercial fisheries and aquaculture*

Choice: D No impact

Score: 0 of 3

Ranking Rationale:
No impacts on commercial fisheries or aquaculture have been reported to date.

Background Information:
No information available in the literature.

Sources:
NEMESIS; Fofonoff et al. 2003

4.9 *Subsistence*

Choice: D No impact

Score: 0 of 3

Ranking Rationale:
No impacts on subsistence activities have been reported to date.

Background Information:
No information available in the literature.

Sources:
None listed

4.101 *Recreation*

Choice: D No impact

Score: 0 of 3

Ranking Rationale:
No impacts on recreation have been reported to date.

Background Information:
No information available in the literature.

Sources:
None listed

4.11 *Human health and water quality*

Choice: C Limited – Has limited potential to pose a threat to human health, with limited impact and/or within a very limited region

Score: 0.75 of 3

Ranking Rationale:
Cases of PSP and other shellfish syndromes are rare in Alaska. Current regulations and safety procedures greatly reduce the risk of bacterial transmission, especially in cultivated mussels. Recreational harvesting of shellfish in the Bering Sea is limited.

Background Information:
All bivalves can bioaccumulate toxins in their tissues as a result of consuming toxic dinoflagellates. Consuming raw or cooked bivalves can lead to Paralytic Shellfish Poisoning (PSP), which can cause health issues and even death (NIMPIS 2009). The state of Alaska discourages harvesting on untested beaches (ADEC 2013).

Sources:
NIMPIS 2009 ADEC 2013

Section Total - Scored Points:	2.25
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:
Controlling the spread of invasive species that use anthropogenic vectors for transport is an active area of research (e.g. Ruiz and Reid 2007, Hagan et al. 2014).

Background Information:
No information found to suggest management has been attempted for this species in particular. M. petalum can be introduced to new areas via transport in ballast water or by hitchhiking.

Sources:
Ruiz and Reid 2007   Hagan et al. 2014

5.2 Cost and methods of management, containment, and eradication

Choice: **A** Major long-term investment, or is not feasible at this time

Score: of

Ranking Rationale:
Methods to control the spread of marine invasive species transported via ballast water are being studied, and currently necessitate major long-term investments (Zagdan 2010).

Background Information:
No information available for M. petalum in particular.

Sources:
Zagdan 2010

5.3 Regulatory barriers to prevent introductions and transport

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

Score: of

Ranking Rationale:
This species can be introduced by ballast water or by hitchhiking. There are no regulatory restrictions in place to address hitchhikers.

Background Information:
In the U.S., ballast water management is mandatory and regulated by the U.S. Coast Guard (CFR 33 § 151.2). However, there are no regulations for species that are accidentally transported as hitchhikers, as is the case with M. petalum.

Sources:
CFR 2017

5.4 Presence and frequency of monitoring programs

Choice: **A** No surveillance takes place

Score: of

Ranking Rationale:
To our knowledge, this species is not currently monitored.

Background Information:
No information found.

Sources:
None listed

5.5 Current efforts for outreach and education

Choice:		Score:
A	No education or outreach takes place	of

Ranking Rationale:

Background Information:

No education or outreach materials were found during our literature search.

Sources:

None listed

Section Total - Scored Points:

Section Total - Possible Points:

Section Total -Data Deficient Points:

Literature Cited for *Macoma petalum*

- NIMPIS. 2009. National Introduced Marine Pest Information System. Available from: http://www.marinepests.gov.au/nimpis
- ADEC. 2013. Paralytic Shellfish Poisoning Fact Sheet. Alaska Department of Environmental Conservation. Available from: http://dec.alaska.gov/eh/fss/Food/Docs/fact_PST_6-4-2013_final%20(2).pdf. Accessed 02-Jan-2017.
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