Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

Scientific Name: *Jassa marmorata*

Common Name *a tube-building amphipod*

Phylum	Arthropoda
Class	Malacostraca
Order	Amphipoda
Family	Ischyroceridae

Final Rank 57.18

Data Deficiency: 11.25

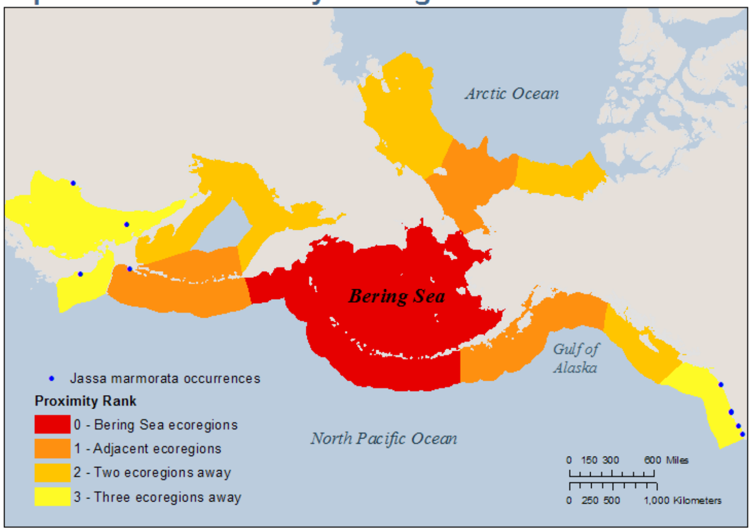

Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

Category Scores and Data Deficiencies

Category	Score	Total Possible	Data Deficient Points
Distribution and Habitat:	25	26	3.75
Anthropogenic Influence:	6.75	10	0
Biological Characteristics:	16	25	5.00
Impacts:	3	28	2.50
Totals:	50.75	88.75	11.25

General Biological Information

Tolerances and Thresholds

Minimum Temperature (°C)	-2	Minimum Salinity (ppt)	12
Maximum Temperature (°C)	27	Maximum Salinity (ppt)	38
Minimum Reproductive Temperature (°C)	NA	Minimum Reproductive Salinity (ppt)	31*
Maximum Reproductive Temperature (°C)	NA	Maximum Reproductive Salinity (ppt)	35*

Additional Notes

J. marmot is a tube-building amphipod, greyish in color with red-brown markings. Its maximum length is 10 mm and there are two distinct morphs of males with two different mating strategies. The 'major' morphs are fighter males, while the 'minor' morphs are sneaker males. This species is difficult to identify in the field, and easily confused with other Jassa species.

There is some uncertainty around its native distribution due to the difficulty of distinguishing between J. marmorata and similar species, but it is likely native to the northwest Atlantic. It was introduced to Western North America, South America, South Africa, Australia, New Zealand, China, Japan, and Russia. It is generally found in ballast water, fouling communities and intertidal areas, attached to ship hulls, rocks, algae, and buoys. It builds tubes of detritus and algae fragments and can occur in very high densities (up to 1 million individuals/m2)

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:
Found in the Gulf of Alaska, Primorsky Krai in Russia, Hirtshals, Denmark (57.6°N) and Tjärnö, Sweden (58.9°N), which are similar in latitude to the Bering Sea (Conlan 1990). Based on geographic range, can tolerate temperatures ranging from -2°C to 27°C.

Sources:
Conlan 1990 NEMESIS; Fofonoff et al. 2003

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 J. marmorata is 12ppt to 38ppt (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

1.3 Establishment requirements - Water temperature

Choice: U — Unknown/Data Deficient

Score: of

Ranking Rationale:

Background Information:
No information available in the literature.

Sources:
None listed

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: **B** Present in an ecoregion adjacent to the Bering Sea

Score: 3.75 **of** 5

Ranking Rationale:
There is one documented occurrence for J. marmorata in an ecoregion adjacent to the Bering Sea, and numerous occurrences documented in areas two and three ecoregions away (Nemesis database).

Background Information:
J. marmota has been observed in the Gulf of Alaska and the Sea of Okhotsk (Conlan 1990).

Sources:
Conlan 1990   NEMESIS; Fofonoff et al. 2003

1.6 Global ecoregional distribution

Choice: **A** In many ecoregions globally

Score: 5 **of** 5

Ranking Rationale:
Wide global distribution.

Background Information:
J. marmorata has a global distribution including cold temperate waters of the north Atlantic, where it is native, and the north Pacific Ocean (California, British Columbia, Russia, Japan) where it is considered non-native. In Europe, J. marmorata is found from Denmark to Spain. In subtropical areas in South America (Brazil, Chile), Africa (South Africa, Tanazania). Found in Australia and New Zealand (Conlan 1990; Fofonoff et al. 2003).

Sources:
Conlan 1990   NEMESIS; Fofonoff et al. 2003

1.7 Current distribution trends

Choice: **A** Recent rapid range expansion and/or long-distance dispersal (within the last ten years)

Score: 5 **of** 5

Ranking Rationale:
Continual expansion observed since arrival along the west coast of North America.

Background Information:
Can rapidly colonize artificial and natural habitats (Fofonoff et al. 2003; Franz and Mohamed 1989). Invasion history includes arrival on the west coast around the 1950's and continued expansion associated with anthropogenic structures and transportation all along the coast extending from Mexico to Alaska (reviewed in Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003   Franz and Mohamed 1989

Section Total - Scored Points:	25
Section Total - Possible Points:	26.25
Section Total -Data Deficient Points:	3.75

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:

Has been observed using ballast water and ship fouling to transport, and has the capability to disperse naturally once in a new environment.

Background Information:

Observed transporting in ballast water and on ship hulls. Once it is transported to a new area, individuals can disperse away from original substrate by drifting or floating (Havermans et al. 2007). Although dispersal capability is limited, strong water currents may increase dispersal distance (Molnar et al. 2008).

Sources:

Molnar et al. 2008   Havermans et al. 2007

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

Choice: **B**

Readily establishes in areas with anthropogenic disturbance/infrastructure; occasionally establishes in undisturbed areas

Score: 2.75 of 4

High uncertainty? ☑

Ranking Rationale:

Readily observed in association with anthropogenic infrastructure, as well as in undisturbed areas.

Background Information:

Can establish on natural substrates such as macroalgae, rocks, and oyster reefs (Conlan 1990; Carr et al. 2011; Beermann and Franke 2012). Studies suggest a preference for hard, anthropogenic substrates, including pilings, fishing traps, and ships, although this emphasis on anthropogenic substrates may be due to sampling bias.

Sources:

NEMESIS; Fofonoff et al. 2003   Beermann and Franke 2012   Carr et al. 2011   Conlan 1990

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

Choice: **B**

No

Score: 0 of 2

Ranking Rationale:

Not currently farmed or intentionally cultivated.

Background Information:

Sources:

None listed

Section Total - Scored Points:	6.75
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:
Preys on numerous taxa readily available in the Bering Sea.

Background Information:
Primarily a suspension feeder on phytoplankton and detritus, but also preys on ostracods and other small crustaceans (Dixon and Moore 1997; reviewed in Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003   Dixon and Moore 1997

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:
Tolerates wide range of water temperatures and salinities, and uses numerous habitat types.

Background Information:
J. marmorata is widely distributed in both temperate and subtropical regions, and can tolerature a wide range of temperatures and salinities (Franz 1989; Fofonoff et al. 2003). It prefers hard substrates including rocks, woody detritus, docks, ships and other organisms such as oysters (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003   Franz 1989

3.3 Desiccation tolerance

Choice: **U** Unknown

Score: of

Ranking Rationale:
The tolerance of amphipods to desiccation is suspected to be quite low, however, no information regarding desiccation tolerance of J. marmorata was available in the literature.

Background Information:
J. marmorata is an intertidal species. A study in Sicily reported that J. marmorata were dominant in the surf zone, +0.5m above water (Krapp-Schickel 1993). A report from Denmark found J. marmorata most commonly associated with the "mid-zone" 1 to 5m below water, but occurring throughout the water depths they sampled (0 to >7m) (Leonhard and Pedersen 2006). Bousfield (1973) suggests the tolerance of amphipods to desiccation is generally quite low (qtd. in Hill 2000).

Sources:
Hill 2000   Krapp-Schickel 1993   Bousfield 1973   Leonhard and Pedersen 2006

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:

Short generation time but not asexual or hermaphroditic, moderate fecundity, and high parental investment.

Background Information:

Females brood their eggs and care for their young. Brood size is dependent on adult female body size, and large females can produce 125-175 embryos (Beerman and Purz 2013). Fecundity period is short and occurs for females immediately after they moult, however, individuals can mate multiple times and reproduction can occur throughout the year (Clark and Caudill 2001). Gravid females have been observed year-round in some locations, but are most abundant in May-August (e.g. Jamaica Bay, New York; Franz 1980). A closely related species, Jassa falcata, is reported to have a generation time of <1 year, and age at maturity of 2 to 6 months (Hill 2000).

Sources:

Hill 2000 Clark and Caudill 2001 NEMESIS; Fofonoff et al. 2003 Beermann and Purz 2013

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

Score: 0.75 of 2.5

Ranking Rationale:

No larval dispersal stage. Poor swimmers, short-distance dispersal (centimeters) of juveniles searching for habitat or mates; adults live inside their self-built tubes and move around by crawling or swimming, but rarely leave the home they have built. There is potential for dispersal by currents.

Background Information:

Amphipod crustaceans lack a larval dispersal stage. Tube-building amphipods are generally poor swimmers, but short-distance dispersal (on the scale of centimeters) occur in juveniles in search of a substrate or mates (Franz and Mohamed 1989). Adults live inside their self-built tube and move around by crawling and swimming, but rarely leave the home they have built for themselves (Fact Sheet 14). There is also potential for dispersal by currents (Franz and Mohamed 1989), however, once introduced in an area, it tends to remain at the point of introduction (Fact Sheet 14).

Sources:

Franz and Mohamed 1989 Fact Sheet 14

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: **C** Low – Exhibits none of the above characteristics

Score: 0.75 of 2.5

Ranking Rationale:
Dispersal is limited at all lifestages.

Background Information:
Embryos are kept inside a maternal pouch and young are cared for by the mother. Once they are old enough, juveniles may engage in short-distance dispersal (on the scale of centimeters), but tend to stay close to their parents (Fact Sheet 14; Franz and Mohamed 1989). Adults live inside their self-built tube. They move around by crawling and swimming, but rarely leave the home they have built for themselves (Fact Sheet 14).

Sources:
Franz and Mohamed 1989 Fact Sheet 14

3.7 *Vulnerability to predators*

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

Score: 1.25 of 5

Ranking Rationale:
Consumed by numerous taxa.

Background Information:
Preyed upon by fish, crabs and shrimps (Leonhard and Pedersen 2006; Fofonoff et al. 2003)

Sources:
NEMESIS; Fofonoff et al. 2003 Leonhard and Pedersen 2006

Section Total - Scored Points:	16
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:
Limited/short-term impact on communities.

Background Information:
J. marmorata is capable of rapid colonization, and often the dominant amphipod species in an community. It may compete with native marine organisms for food and space (Molnar et al. 2008), however, over time it is typically displaced by slower-growing organisms such as sponges (Conlan 1994). More general studies have shown that amphipods may play important roles in determining the type and distribution of algal communities, particularly where predation pressure is low (Molnar et al. 2008)

Sources:
Molnar et al. 2008 Leonhard and Pedersen 2006 Conlan 1994

4.2 Impact on habitat for other species

Choice: C Limited – Has limited potential to cause changes in one or more habitats

Score: 0.75 of 2.5

Ranking Rationale:
High abundance may reduce habitat for some species.

Background Information:
Dense masses of amphipod tubes may inhibit the settlement of boring organisms and other foulers such as tunicates (e.g. Ciona spp.; Barnard 1958). These dense masses can also provide habitat for other organisms, such as polychaetes (Barnard 1958; Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003 Barnard 1958

4.3 Impact on ecosystem function and processes

Choice: D No impact

Score: 0 of 2.5

High uncertainty? ☑

Ranking Rationale:

Background Information:
No ecosystem impacts have been reported in the literature (Fofonoff et al. 2003)

Sources:
NEMESIS; Fofonoff et al. 2003

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

Choice: **D** No impact

Score: 0 of 2.5

High uncertainty? ☑

Ranking Rationale:

Background Information:
No impacts to high-value, rare or sensitive species have been reported in the literature (Fofonoff et al. 2003)

Sources:
NEMESIS; Fofonoff et al. 2003

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

High uncertainty? ☑

Ranking Rationale:

Background Information:
No disease or parasite interactions have been reported in the literature (Fofonoff et al. 2003)

Sources:
NEMESIS; Fofonoff et al. 2003

4.6 *Level of genetic impact on native species*

Can this invasive species hybridize with native species?

Choice: **U** Unknown

Score: of

Ranking Rationale:

Background Information:
The ability of J. marmorata to hybridize with native species in the Bering Sea is unknown, however, there have been no reports of hybridization with local species outside of the Bering Sea.

Sources:
NEMESIS; Fofonoff et al. 2003

4.7 *Infrastructure*

Choice: **B** Moderate – Causes or has the potential to cause degradation to infrastructure, with moderate impact and/or within only a portion of the region

Score: 1.5 of 3

Ranking Rationale:
Fouling of infrastructure may cause damage.

Background Information:
Tubes can form dense mats, which may foul infrastructure (e.g. pilings) and obstruct water flow through pipes (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

4.8 Commercial fisheries and aquaculture

Choice: **D** No impact

High uncertainty? ☑

Score: 0 of 3

Ranking Rationale:
None reported.

Background Information:
No economic impacts have been reported in the literature (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

4.9 Subsistence

Choice: **D** No impact

High uncertainty? ☑

Score: 0 of 3

Ranking Rationale:
None reported.

Background Information:
No economic impacts have been reported in the literature (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

4.101 Recreation

Choice: **D** No impact

High uncertainty? ☑

Score: 0 of 3

Ranking Rationale:
None reported.

Background Information:
No impacts to recreation have been reported in the literature (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

4.11 Human health and water quality

Choice: **D** No impact

High uncertainty? ☑

Score: 0 of 3

Ranking Rationale:
None reported.

Background Information:
No impacts to human health or water quality have been reported in the literature (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	3
Section Total - Possible Points:	27.5
Section Total -Data Deficient Points:	2.5

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:

No species-specific management, conatinment or eradication efforts have been made for Jassa marmorata; however certain measures have been taken to address the issue of invasive species in ballast water. While BWE can be highly effective at reducing the abundance of coastal organisms, efficacy varies across taxonomic groups, and residual organisms still remain in ballast tanks following exchange (Ruiz and Reid 2007). As a result, ballast water exchange is commonly viewed as a short-term or “stop-gap” option that is immediately available for use on most ships, but that will gradually be phased out as more effective, technology-based methods become available (Ruiz and Reid 2007).

BWTS are replacing BWE as a method for reducing the risk of introductions. However, a review of current BWMS concluded that no system achieves complete sterilization or removal of all living organisms (Science Advisory Board 2011). Additionally, performance standards still allow for a certain number of organisms to exist in treated ballast water, such that vessels carrying large volumes of ballast water (e.g. ≥ 100,000 tons) may still discharge a high number of organisms, with potential risk of introductions (Gollasch et al. 2007)

Background Information:

Ballast water exchange (BWE) can be highly effective at replacing coastal ballast water with mid-ocean water (88-99% replacement of original water) and reducing coastal planktonic organisms (80-95% reduction in concentration) across ship types, when conducted according to guidelines and regulations (Ruiz and Reid 2007). However, presently, there is no way to verify the extent to which BWE occurred, and whether exchange approached the 100% empty-refill or 300% flow-through as required (Ruiz and Reid 2007). Moreover, because efficacies are < 100%, coastal organisms still remain in ballast tanks following exchange. Several studies have found coastal organisms in ships that had reportedly undertaken BWE (qtd. in Ruiz and Reid 2007). Oceanic species added to tanks during exchange can pose additional invasion risk if recipient ports are saltwater (Cordell et al., 2009; Roy et al., 2012, qtd. in Bailey 2015).

Treatment of ballast water is replacing ballast water exchange as a method for preventing the spread of aquatic invasive species. In the U.S., treatment systems must be approved by the U.S. Coast Guard. As of Dec. 23rd 2016, USCG has approved 3 ballast water management system (BWMS) and 56 alternate management systems (to be replaced by a BWMS within 5 years of compliance date). These systems must meet certain water performance standards

Sources:

Ruiz and Reid 2007

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:

To comply with ballast water regulations, vessels will have to equip themselves with an onboard ballast water treatment system. These systems represent a major short-term cost for vessel owners (up to $3 million), with additional costs over time to maintain and replace equipment (e.g. chemicals, filters, UV light bulbs).

Background Information:

The costs associated with purchasing a ballast water treatment system depend on the volume of water that needs to be treated. Systems with a pump capacity of 200-250 m^3/h can cost from $175,000 to $490,000. The estimated price for larger systems with a pump capacity of around 2000 m^3/h range from $650,000 to nearly $3 million.

Sources:

Zagdan 2010

5.3 Regulatory barriers to prevent introductions and transport

Choice: **C** Regulatory oversight and/or trade restrictions

Score: of

Ranking Rationale:
No species-specific regulatory oversight or trade restrictions are currently in place for Jassa marmorata. Alaska does not have state regulations on ballast water management, but two federal regulations (USCG and EPA) require mandatory reporting and ballast water treatment or exchange.

Background Information:
State regulations: Alaska does not have a state regulations related to the management of aquatic invasive species in discharged ballast water. It relies on the U.S. Coast Guard (USCG) to enforce national standards. In Alaska, data from 2009-2012 show moderate to high compliance with USCG reporting requirements (Verna et al. 2016).

Federal regulations: In the U.S., ballast water management (treatment or exchange) and record-keeping is mandatory and regulated by the USCG, with additional permitting by the Environmental Protection Agency (EPA). Certain vessels (e.g. small vessels or those traveling within 1 Captain of the Port Zone) are exempt from USCG and EPA regulations.

Sources:
EPA 2013 Verna et al. 2016

5.4 Presence and frequency of monitoring programs

Choice: **A** No surveillance takes place

Score: of

Ranking Rationale:

Background Information:
No information regarding monitoring programs for J. marmorata exist online or in the literature.

Sources:
None listed

5.5 Current efforts for outreach and education

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

Score: of

Ranking Rationale:

Background Information:
No education or outreach materials were available online or in the literature for J. marmorata.

Sources:
None listed

Section Total - Scored Points:
Section Total - Possible Points:
Section Total -Data Deficient Points:

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