Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

Scientific Name: *Ilyanassa obsoleta*

Common Name *eastern mudsnail*

Phylum	Mollusca
Class	Gastropoda
Order	Neogastropoda
Family	Nassariidae

Final Rank 46.41

Data Deficiency: 2.50

Species Occurrence by Ecoregion

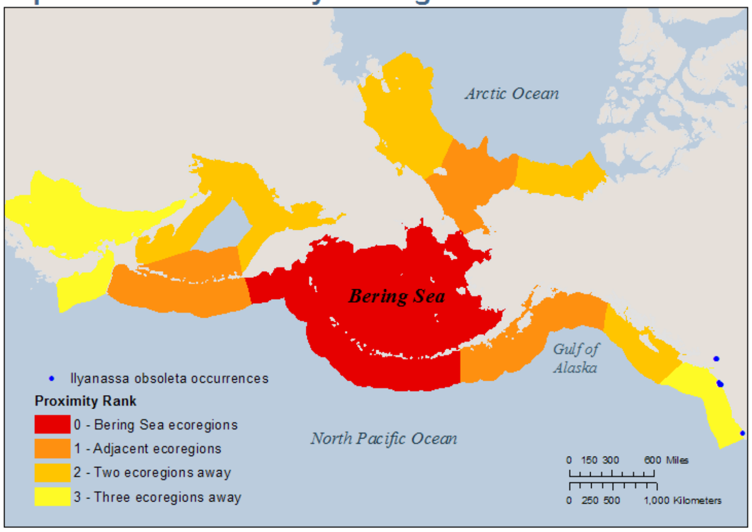

Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

Category Scores and Data Deficiencies

Category	Score	Total Possible	Data Deficient Points
Distribution and Habitat:	14.75	30	0
Anthropogenic Influence:	4.75	10	0
Biological Characteristics:	20.25	30	0
Impacts:	5.5	28	2.50
Totals:	45.25	97.50	2.50

General Biological Information

Tolerances and Thresholds

Minimum Temperature (°C)	0	Minimum Salinity (ppt)	10
Maximum Temperature (°C)	30	Maximum Salinity (ppt)	35
Minimum Reproductive Temperature (°C)	16.5	Minimum Reproductive Salinity (ppt)	21
Maximum Reproductive Temperature (°C)	28	Maximum Reproductive Salinity (ppt)	35*

Additional Notes

Ilyanassa obsoleta is a medium-sized benthic snail. Adult shells are dark brown to black and reach 25 to 30 mm in size. I. obsoleta is native to the Northwest Atlantic and the Gulf of Mexico, and was introduced to the California, Washington and British Columbia, most likely in association with the transportation of the Eastern Oyster (Fofonoff et al. 2003). Synonyms include Nassarius obsoletus and a recent genetic study proposed a name change to Tritia obsoleta (Galindo et la. 2016).

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 I. obsoleta is 0°C to 30°C (based on experimental studies). I. obsoleta has a limited tolerance for freezing (Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003   Murphy 1979

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 threshold for survival of I. obsoleta is 10 to 35 ppt (Scheltema 1965, qtd. in Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003   Scheltema 1965

1.3 Establishment requirements - Water temperature

Choice: **D** No overlap – Temperatures required for reproduction do not exist in the Bering Sea

Score: 0 of 3.75

Ranking Rationale:
Temperatures required for reproduction do not exist in the Bering Sea.

Background Information:
The temperature threshold for reproduction of I. obsoleta is 16.5°C to 28°C (based on experimental studies; Scheltema 1967).

Sources:
NEMESIS; Fofonoff et al. 2003   Scheltema 1967

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

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

Background Information:
Metamorphosis requires salinity above 20.9 ppt to complete (Scheltema 1965).

Sources:
NEMESIS; Fofonoff et al. 2003   Scheltema 1965

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:

Background Information:
Occurrences are documented for California, Washington and British Columbia (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:
Species is restricted to North America.

Background Information:
I. obsoleta is native to the eastern coast of North America, from Quebec to western Florida (Bousfield 1960 as qtd. In Fofonoff et al. 2003; Abbott 1974 as qtd. In Fofonoff et al. 2003). It was accidentally introduced on the west coast, and now populates regions of California as well as Washington (Willapa Bay) and British Columbia (Boundary Bay) (Carlton 1979; Wonham and Carlton 2005).

Sources:
NEMESIS; Fofonoff et al. 2003 Carlton 1979 Wonham and Carlton 2005

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:
Is largely restricted to Willapa and Boundary Bay in introduced range.

Background Information:
In British Columbia and Washington, remains largely restricted to the Willapa and Boundary Bay areas where it was introduced more than 50 years ago. More widespread in California, but still only occurs along a < 200 mi stretch from Bodega to Moss Landing. Has not been reported in Oregon.

Sources:
NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	14.75
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: **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:

Background Information:
Transportation of I. obsoleta is associated with the anthropogenic movements of Atlantic oysters to the Pacific coast for aquaculture. I. obsoleta lays its eggs on Atlantic oysters which facilitates its movements (Cohen 2005).

Sources:
NEMESIS; Fofonoff et al. 2003 Cohen 2005

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

Ranking Rationale:
In its introduced range, this species is largely associated with anthropogenic infrastructure.

Background Information:
Commonly associated with mudflats and other soft-sediment habitats. While it does not rely on marine infrastructure to establish, it has not been observed outside of anthropogenic areas in its introduced range.

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:
I. obsoleta is not intentially farmed or cultivated.

Sources:
None listed

Section Total - Scored Points:	4.75
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:
Consumes several taxa, many of which are available in the Bering Sea.

Background Information:
I. obsoleta is an omnivorous facultative scavenger and deposit feeder. Young snails in aquaria graze on algae and probably feed this way in the wild. Adults ingest large quantities of sediment, together with organic matter and benthic diatoms, worms, fish and crustacean remains. Also feed on decaying algae, and are strongly attracted to carrion (dead fish and mollusks). Do not attack or feed on living bivalves (Scheltema 1964).

Sources:
NEMESIS; Fofonoff et al. 2003 GISD 2016 Scheltema 1964

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:
Can live on a variety of substrates but is restricted to sheltered, soft-sediment habitats.

Background Information:
Abundant in estuaries, mudflats, and sheltered soft-sediment habitats. Can live on a wide range of substrates, from sand to anoxic muds (Levinton 1995). Also able to tolerate a range of temperatures and salinities. Experiments suggest that I. obsoleta actively avoids exposure to strong water flow, either by burrowing in the substrate or by crawling to lower velocity areas (Levinton et al. 1995).

Sources:
NEMESIS; Fofonoff et al. 2003 Levinton et al. 1995

3.3 Desiccation tolerance

Choice: B Moderately tolerant (1-7 days) during one or more stages during its life cycle

Score: 3.25 of 5

Ranking Rationale:
Can survive 3 to 20 days outside of water.

Background Information:
Adults of I. obsoleta acclimated to a warmer temperature can tolerate a greater level of cellular dehydration when exposed to air. In air with a relative humidity of 35%, the time required for 50% of 18°C acclimated snails to die was 116 hours (±9), whereas the LT50 value for the 3°C acclimated snails was 76 hours (±8).

Sources:
Murphy and McCausland 1980

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:

Sexual reproduction, low fecundity, low parental investment and a moderate generation time.

Background Information:

I. obsoleta breeds during autumn and spring via internal fertilization between males and females. Sexuality maturity and reproductive capacity is dependent on body size, with individuals maturing at approximately 12 to 14 mm with takes approximately 3 years (Scheltema 1964). Small, medium, and large females laid means of 31, 55, and 79 egg capsules, respectively (Schwab 2012). Eggs are often deposited on living substrates such as oysters and mussels. Eggs hatch into planktonic veligers (larvae), which take 10 to 22 days to develop at 17.5 to 25°C. The veligers settle and metamorphose when they reach about 650-750 µm in size (between 20-30 days, although this may be delayed until they find a suitable substrate) (Scheltema 1962; Cohen 2005). Adults live to be approximately 5 to 10 years old (Scheltema 1964; Curtis 2002), with some individuals estimated to be 30 to 40 years old (Curtis 2002).

Sources:

NEMESIS; Fofonoff et al. 2003 Curtis 2002 GISD 2016 Scheltema 1962 Scheltema 1964 Schwab 2012

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: B Disperses moderate (1-10 km) distances

Score: 1.75 **of** 2.5

Ranking Rationale:

Studies report various results ranging from meters to miles. The lack of spatial spread of introduced populations may support the former as a more reliable dispersal distance.

Background Information:

All age classes undergo short-distance, seasonal migrations between intertidal and subtidal regions, probably to avoid temperature variations (Cranford 1988). In the winter, may migrate into water as deep as five meters, and remain there for several months before returning to intertidal sites (Scheltema 1964).

In their native range, I. obsoleta were found up to 100 m from their site of release after 10 days (Curtis 2005). After initial dispersal, most snails were found ~15 m away from the release point in the first year of study, and between 30-40 m in the second year. Maximum observed distance moved in a single day was 46 m (Curtis 2005).

Egg capsules are armed with spiny flanges, and are attached to the substrate. Larvae are free swimming, but rely primarily on currents for transport. Fuchs et al. (2004) found that larvae tended to sink more frequently in turbulent than in calm waters. Larval sinking in turbulent, coastal zones could potentially affect horizontal transport of larvae over spatial scales of tens of kilometers by enhancing the retention of sinking larvae in coastal inlets (Fuchs et al. 2004). However, Gooch et al. (1972) found evidence of extensive gene flow in populations sampled along a transect from MA to NC. They propose dispersal of planktonic larvae as an explanation, and suggest that larvae can travel a maximum of 265 mi before settling (Gooch et al. 1972).

Sources:

Cranford 1988 Curtis 2005 Fuchs et al. 2004 GISD 2016 Gooch et al. 1972

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 as adults or larva, larval viability window is relatively long, and different modes of dispersal are achieved at different life stages.

Background Information:

Long planktonic larval stage: Larval viability depends on temperature, and lasts a minimum of ~10 to 22 days. If conditions are unsuitable, the veliger is followed by a pre-adult "creeping-swimming" stage, which can postpone settlement for several days. Experimentally, the total larval period may reach at least 53 days if sediment is withheld (Scheltema, pers. comm., qtd. in Gooch et al. 1972). Adults do move, and undergo seasonal migrations, though movements are likely more restricted than larvae. Eggs are attached to substrates.

Sources:

Curtis 2005 NEMESIS; Fofonoff et al. 2003 Gooch et al. 1972

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:

Preyed upon by fish, crabs and birds (Fofonoff et al. 2003).

Sources:

NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	20.25
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:
Is linked to declines in native snails and annelids.

Background Information:
Field experiments in its native range showed that high densities of I. obsoleta led to significant reductions in annelid species. Seven out of eight of the most common annelids showed decreases in average abundance in response to greater snail densities, and annelid abundance overall decreased by about 50%. In San Francisco Bay,California, it has displaced the California hornsnail (Cerithidea calofornica) through competitive interactions and predation on C. californica's eggs and larvae. This has restricted C. californica to salt pans, where the salinity is beyond I. obsoleta's tolerance (Race 1982)

Sources:
NEMESIS; Fofonoff et al. 2003 GISD 2016 Race 1982

4.2 Impact on habitat for other species

Choice: U Unknown

Score: of

Ranking Rationale:

Background Information:
The presence of I. obsoleta often leads to a decrease in populations of other annelid species, however, this is most likely due to predation on eggs and larvae, and competitive exclusion rather than habitat impacts.

Sources:
NEMESIS; Fofonoff et al. 2003

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:

Background Information:
In Washington and British Columbia, where there are dense populations and no native equivalents, it may have an impact on sediment characteristics and foodwebs, however, these impacts have not been studied.

Sources:
NEMESIS; Fofonoff et al. 2003 GISD 2016 Race 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 on high-value, rare, or sensitive species have been reported for I. obsoleta, and given its ecology, none would be expected.

Background Information:
No information available in the literature.

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: **A** High – Is known to spread multiple organisms and/or is expected to have severe impacts and/or will impact the entire region

High uncertainty? ☑

Score: 2.5 of 2.5

Ranking Rationale:
Carries numerous parasites that are transferrable to numerous host species, however, the effect on the host is unknown.

Background Information:
I. obsoleta is a host to many parasite species. Blakeslee et al. (2012) found nine species of trematodes in I. obsoleta from its native range. Four of these had birds as hosts, four had fishes, and one had a turtle. In San Francisco Bay, the introduction of I. obsoleta resulted in the transport of five trematode species, three of which reached Willapa Bay, and two reached Boundary Bay. The adult hosts of these parasites are birds and fishes, but the effects of these parasites on the hosts are unknown (Blakeslee et al. 2012). The trematode responsible for swimmers' itch, Austrobilharzia variglandis, is believed to have been introduced to the San Francisco Bay with I. obsoleta (Grodhaus and Keh 1958).

Sources:
NEMESIS; Fofonoff et al. 2003 Blakeslee et al. 2012 Grodhaus and Keh 1958

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 has been reported for I. obsoleta.

Background Information:
No information available in the literature.

Sources:
None listed

4.7 Infrastructure

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
To date, no impacts on infrastructure have been reported for I. obsoleta, and given its ecology, none would be expected.

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:
To date, no impacts on commercial fisheries or aquaculture have been reported for I. obsoleta, and given its ecology, none would be expected.

Background Information:
No information available in the literature.

Sources:
None listed

4.9 Subsistence

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
To date, no impacts on subsistence have been reported for I. obsoleta, and given its ecology, none would be expected.

Background Information:
No information available in the literature.

Sources:
None listed

4.101 Recreation

Choice: **C** Limited – Has limited potential to cause degradation to recreation opportunities, with limited impact and/or within a very limited region

Score: 0.75 of 3

Ranking Rationale:
Can impact recreational swimming in areas.

Background Information:
I. obsoleta acts as an intermediate host to the trematod Austrobilharzia variglandis, which is known to cause swimmer's itch. Outbreaks in San Francisco Bay were traced to the larvae of this blood-fluke which is thought to have been introduced with I. obsoleta (Grodhaus and Keh 1958, qtd. in Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003 Grodhaus and Keh 1958

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:

Is host to the parasite that causes swimmer's itch in humans.

Background Information:

I. obsoleta is a host to the trematode that causes swimmer's itch in humans, Austrobilharzia variglandis. In San Francisco, outbreaks of swimmer's itch were linked to this trematode and are believed to have been introduced with I. obsoleta (Grodhaus and Keh 1958). A. variglandis only causes itching and irritation in humans as it cannot complete its lifecycle in humans.

Sources:

NEMESIS; Fofonoff et al. 2003 Grodhaus and Keh 1958

Section Total - Scored Points:	5.5
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: **B** Not attempted

Score: of

Ranking Rationale:

Background Information:
No information found to suggest eradication or control has been attempted.

Sources:
None listed

5.2 Cost and methods of management, containment, and eradication

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

High uncertainty? ✔

Score: of

Ranking Rationale:
Current control methods are unstudied or labor-intensive.

Background Information:
No information found on I. obsoleta. The New Zealand mudsnail, a similar species, is an invasive freshwater gastropod. It has been proposed to use either physical or chemical methods to eradicate or control populations. Physical methods include exposing populations to freezing or desiccation in instances where draining the water body is an option. Chemical methods involve the use of biocides to kill individuals; however, these methods may be unfeasible in large and/or open (non-isolated) water bodies. Hand removal of adults (shells) may be another option for gastropod control; however, this option can be very labor and time-intensive, and may not lead to complete eradication if larvae are present in the water column (Culver and Kuris 2000).

Sources:
NZMMP 2000   Culver and Kuris 2000

5.3 Regulatory barriers to prevent introductions and transport

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

Score: of

Ranking Rationale:

Background Information:
No species-specific regulatory barriers exist.

Sources:
None listed

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:

Background Information:

The Elkhorn Slough National Estuarine Research Reserve in California trains volunteers to identify and conduct monitoring for low-priority ("least wanted") alien species. I. obsoleta is one of the 24 species on the list (Nagy 2016).

Sources:

Nagy 2016

5.5 Current efforts for outreach and education

Choice: B — Some educational materials are available and passive outreach is used (e.g. signs, information cards), or programs exist outside Bering Sea and adjacent regions

Score: of

Ranking Rationale:

Background Information:

The Elkhorn Slough National Estuarine Research Reserve in California trains volunteers to identify and conduct monitoring for low-priority ("least wanted") alien species. I. obsoleta is one of the 24 species on the list.

Sources:

Nagy 2016

Section Total - Scored Points:

Section Total - Possible Points:

Section Total -Data Deficient Points:

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