Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

Scientific Name: *Crassostrea gigas*

Common Name *Pacific oyster*

Phylum	Mollusca
Class	Bivalvia
Order	Ostreoida
Family	Ostreidae

Final Rank 74.25

Data Deficiency: 0.00

Species Occurrence by Ecoregion

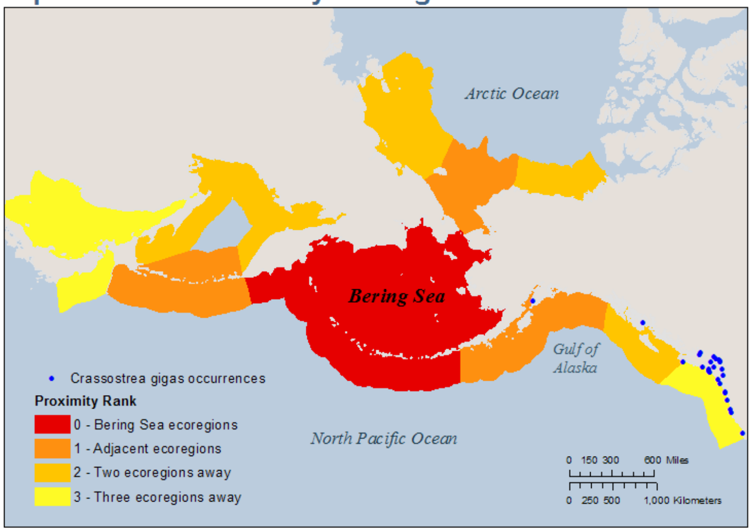

Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

Category Scores and Data Deficiencies

Category	Score	Total Possible	Data Deficient Points
Distribution and Habitat:	22.5	30	0
Anthropogenic Influence:	10	10	0
Biological Characteristics:	26.25	30	0
Impacts:	15.5	30	0
Totals:	74.25	100.00	0.00

General Biological Information

Tolerances and Thresholds

Minimum Temperature (°C)	-2	Minimum Salinity (ppt)	5
Maximum Temperature (°C)	25	Maximum Salinity (ppt)	41
Minimum Reproductive Temperature (°C)	16	Minimum Reproductive Salinity (ppt)	20
Maximum Reproductive Temperature (°C)	30	Maximum Reproductive Salinity (ppt)	30

Additional Notes

Similar in appearance to other oysters. Shells can be white to gray, and sometimes have brown or purple on the ridges. The outer surface of both valves are strongly rippled. Interior of the shell is smooth and white, with a purple muscle scar. Can grow up to 400-450 mm. The Pacific oyster is native to the Northwest Pacific, including Russia, China, and Korea. It is the most widely cultivated and harvested shellfish species in the world, and has been introduced to at least 52 countries. In introduced locations, C. gigas often starts by being confined to culture areas, but later becomes a major biomass component and ecosystem engineer. This species may pose risks to native oyster populations through competition, hybridization, and introductions of associated organisms. It also presents economic opportunities for commercial cultivation.

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: **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 geographic distribution and estimated water temperatures, Carrasco and Barón (2010) estimate a temperature range of -1.9°C to 29°C. However, an experimental study found that temperatures above 25°C inhibited feeding in adults and led to weight loss; the authors suggest 25°C as the upper limit for feeding activities (Bourlès et al. 2009).

Sources:
Bourlès et al. 2009 Carrasco and Barón

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:
Pacific oysters have a salinity range between 5 and 41 ppt (qtd. in Fofonoff et al. 2003).

Sources:
NEMESIS; Fofonoff et al. 2003

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:
Larvae were found to exhibit optimal growth at 30°C (His et al. 1989). Minimum spawning temperature is 16°C (Mann et al. 1991). Growth has been observed at low temperatures (5-15°C), but only in the presence of phytoplankton blooms, which provide an abundant food supply (Bourlès et al. 2009). No growth was observed at 8°C when phytoplankton biomass was low (Bourlès et al. 2009). Cold water temperatures may be limiting the establishment of Crassostrea gigas in Alaska (RaLonde 1993). However, climate change has recently been attributed to the establishment of Pacific oyster populations in Espevik, Norway (60°N), as well as in Denmark and Sweden (Wrange et al. 2010).

Sources:
Bourlès et al. 2009 Mann et al. 1991 His et al. 1989 RaLonde 1993 Wrange et al. 2010

1.4 Establishment requirements - Water salinity

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

Score: 1.25 of 3.75

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

Background Information:
Salinity range for growth is between 10 and 42 ppt, and between 10 to 30 ppt for spawning (Mann et al. 1991). Larvae have lower optimum salinity ranges than spat (Nell and Holliday 1988).

Sources:
Mann et al. 1991 Nell and Holliday 198

1.5 Local ecoregional distribution

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

Score: 3.75 of 5

Ranking Rationale:
This species is currently farmed in the Gulf of Alaska.

Background Information:

Sources:
RaLonde 1993

1.6 Global ecoregional distribution

Choice: A In many ecoregions globally

Score: 5 of 5

Ranking Rationale:
This species is found worldwide. It has been introduced in over 52 countries.

Background Information:
The Pacific oyster is native to the northwest Pacific (Russia, China, Korea). It has been introduced worldwide including both coasts of North America, Australia, New Zealand, Argentina, Brazil, South Africa, and in Europe from Norway to Spain, and east to Turkey.

Sources:
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:
The Pacific oyster has undergone a rapid northward expansion in the last ten years.

Background Information:
A monitoring program from 2003 to 2005 found evidence for rapid range expansion in the Wadden Sea (Brandt et al. 2008). Unusually warm water temperatures in the Wadden Sea and in Scandinavia are thought to have promoted the establishment of Pacific oyster populations in these northern regions (Diederich et al. 2005; Wrange et al. 2010). This species now occurs as far north as 60°N (Wrange et al. 2010).

Sources:
Wrange et al. 2010 Brandt et al. 2008 Diederich et al. 2005

Section Total - Scored Points:	22.5
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:

Once introduced, larvae or spat can "escape" from aquaculture sites and disperse naturally.

Background Information:

Wild oyster populations are often the result of aquaculture larvae spreading into the environment.

Sources:

RaLonde 1993

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:

Can establish in anthropogenic areas (e.g. in cultivation) and in undisturbed areas.

Background Information:

Established outside of aquaculture operations in many locations where it was introduced, including Argentina, Hawaii, Germany, and Scandinavia.

Sources:

NEMESIS; Fofonoff et al. 2003

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

Choice: **A**

Yes

Score: 2 **of** 2

Ranking Rationale:

This species has been intentionally introduced around the world for aquaculture.

Background Information:

Sources:

NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	10
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:
Food items for this species are readily available in the Bering Sea.

Background Information:
The Pacific oyster is a suspension feeder that feeds on plankton, algae, and particles in the water column.

Sources:
NEMESIS; Fofonoff et al. 2003 Padilla 2010

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 can tolerate and establish in a wide range of temperatures, salinities, and substrates.

Background Information:
The Pacific oyster tolerates a wide range of temperatures and salinities. This species is commonly found in estuaries and protected coastal areas. It prefers firm bottom substrates, but can also be found on muddy or sandy bottoms. Adults are sessile and attach themselves to rocks, reefs, woody debris, and docks. The Pacific oytser is usually found in the lower intertidal zone, to depths of 40 m.

Sources:
RaLonde 1993 NEMESIS; Fofonoff et al. 2003 Troost 2010

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:
Adults can survive exposure to air for several weeks.

Background Information:
A study testing the desiccation tolerances of five fouling species found that adult Pacific oysters were the most desiccation-tolerant taxon tested. Pacific oysters survived 16 days in natural conditions and 34 days under controlled conditions (Hopkins et al. 2016).

Sources:
Hopkins et al. 2016

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:

This species is hermaphroditic, exhibits external fertilization, and is highly fecund.

Background Information:

Pacific oysters are cyclical hermaphrodites with external fertilization. They are highly fecund, producing 50 million eggs in a single spawning (Troost 2010). C. gigas reaches sexual maturity in < 1 year (Brandt et al. 2008).

Sources:

Brandt et al. 2008   Troost 2010

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:

Although adults are sessile, larvae can disperse over several kilometers.

Background Information:

Larvae are free-swimming and can disperse between 5 and 15 km, though some may be carried even further (Troost 2010). Larvae can disperse into the environment from oyster farms and establish wild populations (Troost 2010).

Sources:

Troost 2010

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:

Larval stage is long-lived and highly mobile.

Background Information:

Larvae are free-swimming and can be dispersed by water currents. Once settled, adults may be dispersed by fouling.

Sources:

Brandt et al. 2008   NEMESIS; Fofonoff et al. 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:
This species is predated upon by several taxonomic groups that occur in the Bering Sea.

Background Information:
Predated upon by fish, birds, and invertebrates including shrimp, crabs, sea stars, and flatworms. However, in its introduced range, not all predators are able to successfully detach and open them (Troost 2010). Pacific oysters are also susceptible to disease.

Sources:
NEMESIS; Fofonoff et al. 2003 Troost 2010

Section Total - Scored Points:	26.25
Section Total - Possible Points:	30
Section Total -Data Deficient Points:	0

4. Ecological and Socioeconomic Impacts

4.1 *Impact on community composition*

Choice: **A** High – Entire community and/or may cause extirpation or extinction at the species or trophic level

Score: 2.5 of 2.5

Ranking Rationale:
Pacific oysters affect several species and communities, including native oysters, eelgrass, polychaetes, and phytoplankton.

Background Information:
Several effects have been documented, including: overgrowing and replacing blue mussels Mytilus edulis, reducing recruitment of Sabellaria polychaete, decreasing growth of eelgrass Zostera marina, and outcompeting native oysters such as the Olympia oyster and the Sydney rock oyster (reviewed in Padilla 2010). Effects seem most pronounced in soft-bottom habitats such as mudflats (Fofonoff et al. 2003). At the same time, by growing over hard substrata, Pacific oysters can overgrow native, sessile invertebrates and algae. Selective feeding can also affect phytoplankton communities (Prins et al. 1998, qtd. in Padilla 2010). Competition between native bivalves may be density-dependent and/or moderated by resource partitioning, and coexistence between Pacific oysters and other species has been recorded (Diederich 2005; Troost 2010). By creating habitat, Pacific oysters can increase biodiversity; they can also improve limpet survival (Padilla 2010).

Sources:
Troost 2010   Diederich 2005   NEMESIS; Fofonoff et al. 2003   Padilla 2010

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:
Oyster reefs can drastically change the habitat, especially in sandy or muddy sites where hard substrates are limiting.

Background Information:
Modifies habitats by constructing large, three-dimensional oyster reefs, which provide other species with protection from predation, heat, and desiccation (Padilla 2010; Troost 2010). The habitat created increases biodiversity by providing substrate for mussel and barnacle settlement, and by providing refuge for other marine organisms (Padilla 2010).

Sources:
Padilla 2010   Troost 2010

4.3 Impact on ecosystem function and processes

Choice: **A**

High – Is known to cause moderate to severe changes to food webs and/or ecosystem functions; effects have been documented in several areas

Score: **2.5** **of** **2.5**

Ranking Rationale:

The Pacific oyster has a large impact on ecosystem functions by forming oyster reefs and through its feeding, filtering, and excretory activities.

Background Information:

The Pacific oyster is often cited as an ecosystem engineer. It forms dense beds known as oyster reefs, which create habitat for other species, and affect water flow and turbulence (Padilla 2010; Troost 2010). Oysters can also alter the organic content, accumulation rate, and grain size of sediments by removing particles from the water and depositing them on the sea floor as pseudofeces (Padilla 2010). Pseudofeces can accumulate around the oyster beds, creating anoxic zones and negatively affecting vegetation such as eelgrass (Kelly et al. 2008; Troost 2010). Deposits of pseudofeces can also increase the diversity and abundance of deposit feeders (LeJart and Hily 2011, qtd. in Fofonoff et al. 2003). It can affect water clarity through feeding.

Sources:

Troost 2010   Padilla 2010   NEMESIS; Fofonoff et al. 2003   Kelly et al. 2008

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

Choice: **B**

Moderate – Causes or has potential to cause degradation of one or more species or communities, with moderate impact

Score: **1.75** **of** **2.5**

Ranking Rationale:

The Pacific oyster may affect valuable native bivalves in the Bering Sea through competition.

Background Information:

Although the Pacific oyster can compete with native oysters, Diederich (2005) found that the Pacific oyster and the blue mussel were capable of coexistence. However, the faster growth rate and larger size of C. gigas may restrict habitat use by native mussels (Diederich 2006).

Sources:

Diederich 2005   Diederich 2006

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

Score: **2.5** **of** **2.5**

Ranking Rationale:

The Pacific oyster has introduced several organisms (e.g., the Japanese oyster drill) that may affect native bivalves in the Bering Sea.

Background Information:

The introduction of Pacific oysters has been accompanied by the accidental introduction of a number of pests and parasites including the Japanese oyster drill (Ocinebrella inornata), the oyster flatworm (Pseudostylochus ostreophagus), and the copepod parasite Mytilicola orientalis, as well as three viruses and three bacterial diseases. Some of these species have had negative impacts on oysters and surrounding communities, but a study by Buhle and Ruesink (2009) found that predation by the Japanese oyster drill could not account for the high mortality rates experienced by Olympia oysters.

C. gigas may have introduced the protist Haplosporidium nelsoni to the East Coast of North America (Burreson et al. 2000). H. nelsoni infects the Pacific Oyster with minimal symptoms, but produces the symptoms of the MSX disease in the Eastern oyster (C. virginica). Outbreaks of this disease have caused high mortalities in several areas along the East Coast (Burreson et al. 2000).

Sources:

Burreson et al. 2000   Buhle and Ruesink 2009

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:

There are no native Crassostrea species in the Bering Sea. Hybridization with other bivalve genera has not been reported.

Background Information:

There have been many attempts at hybridization of Crassostrea species, but these attempts rarely lead to viable offspring (Gaffney and Allen 1993). Natural hybridization between Pacific oysters and Portuguese oysters (C. angulata) have been reported (Huvet et al. 2004; Leitão et al. 2007). Although the rates of hybridization seem low, the extent and impacts are still unknown.

Sources:

Huvet et al. 2004   Gaffney and Allen 1993   Leitão et al. 2007

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:

The Pacific oyster is a fouling organism that is known to affect anthropogenic infrastructure.

Background Information:

The Pacific oyster can foul cooling systems in coastal power stations (Rajagopal et al. 2005).

Sources:

Rajagopal et al. 2005

4.8 Commercial fisheries and aquaculture

Choice: **C** Limited – Has limited potential to cause degradation to fisheries and aquaculture, and/or is restricted to a limited region

Score: 0.75 of 3

Ranking Rationale:
Through competition, Pacific oysters may impact other commercial shellfish species, such as the blue mussel. Shellfish farming only occurs in a limited region of the Bering Sea.

Background Information:
Pacific oysters are a very important aquaculture species worldwide and in Alaska, and have many positive impacts on the economy. Shellfish farming is a small, but growing industry in Alaska, and the Pacific oyster is one of the main species farmed (Mathis et al. 2015)

Sources:
Mathis et al. 2015 NEMESIS; Fofonoff et al. 2003

4.9 Subsistence

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

Score: 0.75 of 3

Ranking Rationale:
Through competition, may affect other shellfish species that are harvested for subsistence.

Background Information:
Compared to salmon and finfish, shellfish such as oysters, clams, and mussels comprise a smaller percentage of subsistence catch in the Bering Sea (when measured by weight; Mathis et al. 2015). Although shellfish harvesting represented almost 20% catch in the Aleutians West, most municipalities in the Bering Sea recorded low percentages (< 5%) of subsistence shellfish (Mathis et al. 2015).

Sources:
Mathis et al. 2015

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:
Through competition, may affect other shellfish species that are recreationally harvested.

Background Information:

Sources:
NEMESIS; Fofonoff et al. 2003

4.11 Human health and water quality

Choice:		Score:
C	Limited – Has limited potential to pose a threat to human health, with limited impact and/or within a very limited region	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:	15.5
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:
Research to control populations is ongoing.

Background Information:
Control of small populations through hand culling has been successfully carried out in England and in Northern Ireland (Guy and Roberts 2010; McKnight and Chudleigh 2015). In New South Wales and Australia, biologists have exploited differences in desiccation tolerance between C. gigas and the native Sydney rock oyster to control C. gigas (Ruesink et al. 2005). Attempts to control C. gigas where it is established and abundant (e.g. Wadden Sea) have not been successful. Attempts to control Pacific oysters in power plants, using heat treatments were unsuccessful because this species has a very high temperature tolerance and is capable of developing resistance when exposed to sub-lethal high temperatures (Rajagopal et al. 2005).

Sources:
Guy and Roberts 2010   McKnight and Chudleigh 2015   Ruesink et al. 2005   Rajagopal et al. 2005

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:
Several methods have been developed in attempts to control or eradicate C. gigas. Most of these methods need to be repeated in order to be effective, therefore requiring moderate long-term investment.

Background Information:
In areas where oysters occur at low densities, manual removal is laborious but effective (McKnight and Chudleigh 2015). Complete eradication would likely be expensive and would have to be repeated (Kochmann 2012). Oyster dredging has been successfully applied to reduce population densities of other bivalve species (Blanchard 2009, qtd. in Kochmann 2012). Other eradication methods for controlling bivalves, e.g. species-specific pellets "BioBullets", are only useful for closed facilities. The aquaculture industry is actively researching ways to prevent the spread of larvae and disease. Triploid oysters, which do not produce larvae, have been developed, although 100% triploidy is often not achieved (Ruesink et al. 2005)

Sources:
McKnight and Chudleigh 2015   Kochmann 2012   Ruesink et al. 2005

5.3 Regulatory barriers to prevent introductions and transport

Choice: C Regulatory oversight and/or trade restrictions

Score: of

Ranking Rationale:
In Alaska, there are regulations that restrict the transport and trade of aquatic invertebrate species such as C. gigas.

Background Information:
In Alaska, oyster farms require an Aquatic Farm Operation Permit (issued by ADF&G), and only oyster seeds $\leq$ 20mm can be imported from approved providers. The transport or trade of live invertebrates is prohibited, unless a permit is obtained from ADF&G. Federal regulations are in place to prevent the spread of species by ballast water.

Sources:
AAC 2017

5.4 Presence and frequency of monitoring programs

Choice: A No surveillance takes place

Score: of

Ranking Rationale:

Pacific oysters have been intentionally introduced as an aquaculture species in Alaska. No surveillance takes place.

Background Information:

Sources:

None listed

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:

Pacific oysters were intentionally introduced in Alaska, and oyster farming is a growing industry. No education or outreach programs concerning this species' status as an invasive species are in place.

Background Information:

Educational material is available, but this material is produced in areas where Pacific oysters are considered a threat to native ecosystems. In Europe, education and outreach is directed at a small subset of the population (e.g. environmentalists, people against or concerned by the aquaculture industry). Advocacy groups such as Coastwatch Europe and SWAN provide educational material about native oysters and coastal ecosystems, and list C. gigas as a threat (Dubsky 2014). In the US, NOAA has a strong outreach program aimed at restoring oyster habitat, but unlike European publications, their monitoring handbook does not mention C. gigas as a threat to native oyster populations.

Sources:

McKnight and Chudleigh 2015 Dubsky 2014

Section Total - Scored Points:

Section Total - Possible Points:

Section Total -Data Deficient Points:

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