# Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

**Scientific Name:** *Nematostella vectensis*

**Common Name** *starlet sea anemone*

| | |
|---|---|
| **Phylum** | Cnidaria |
| **Class** | Anthozoa |
| **Order** | Actiniaria |
| **Family** | Edwardsiidae |

**Species Occurrence by Ecoregion**

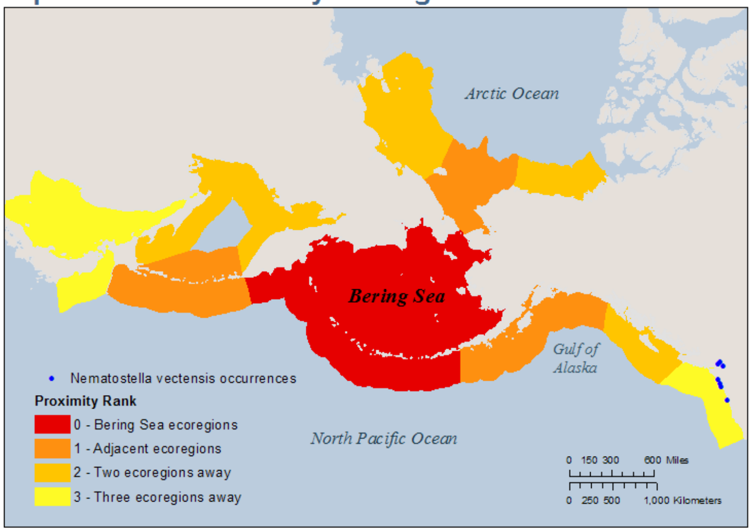


Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

**Final Rank** 43.47

**Data Deficiency:** 17.75

**Category Scores and Data Deficiencies**

| Category | Score | Total Possible | Data Deficient Points |
|---|---|---|---|
| Distribution and Habitat: | 14.75 | 26 | 3.75 |
| Anthropogenic Influence: | 2 | 6 | 4.00 |
| Biological Characteristics: | 17.5 | 25 | 5.00 |
| Impacts: | 1.5 | 25 | 5.00 |
| **Totals:** | 35.75 | 82.25 | 17.75 |

## General Biological Information

### Tolerances and Thresholds

| | | | |
|---|---|---|---|
| Minimum Temperature (°C) | -1.5 | Minimum Salinity (ppt) | 7 |
| Maximum Temperature (°C) | 32.5 | Maximum Salinity (ppt) | 52 |
| Minimum Reproductive Temperature (°C) | NA | Minimum Reproductive Salinity (ppt) | 12 |
| Maximum Reproductive Temperature (°C) | NA | Maximum Reproductive Salinity (ppt) | 34 |

### Additional Notes

Nematostella vectensis is a small (typically <1 cm) burrowing anemone. It has an elongate, wormlike body, which is usually buried with only the oral disk and mouth protruding. It typically has 16 tentacles, but may range from 12 to 18. The body is translucent and nematosomes (small ciliated spheres, unique to this genus) may be seen circulating in the gut. The typical size is 10-19 mm, but it may grow larger in culture. The crown of tentacles may reach 8 mm in diameter when extended. The anemone uses adhesive rugae on its column to anchor and move in the sediment (Sheader et al. 1997). Although common in North America, is listed as vulnerable by the IUCN Red List because of its restricted distribution in England.

## 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. Thresholds are based on geographic distribution, which may not represent physiological tolerances; we therefore ranked this question with "High uncertainty".

**Background Information:**
Found in waters that with temperatures ranging from -1.5 to 32.5 C (Fofonoff et al. 2003).

**Sources:**
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:**
Salinity range for the survival is between 7 and 52 ppt (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

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

**Background Information:**
Sexual reproduction in the laboratory occurred at 12-34 PSU (Hand and Uhlinger 1992).

**Sources:**
Hand and Uhlinger 1992

### 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:**
Present in an ecoregion three regions away from the Bering Sea.

**Background Information:**
Occurrence records in the NEMESIS database indicate presence in California, Oregon and Washington (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:**
Mainly restricted to its native range on the east coast of North America and the Gulf of Mexico. Introductions include the west coast of North America, England and Brazil.

**Background Information:**
Native to the east coast of North America, from Nova Scotia (Canada) to Georgia on the Atlantic coast, and from Florida to Louisiana in the Gulf of Mexico. N. vectensis has been introduced to the west coast of North America (from WA to CA) and England, and in 2004, seven specimens were reported from Brazil's Port of Recife.

**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:**
Low natural capacity for dispersal.

**Background Information:**
Genetic and experimental studies suggest that N. vectensis have very low dispersal capacity (Stocks and Grassle 2001; Darling et al. 2004).

**Sources:**
Stocks and Grassle 2001 Darling et al. 2004

| | |
|---|---|
| **Section Total - Scored Points:** | 14.75 |
| **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: B**

Has been observed using anthropogenic vectors for transport but has rarely or never been observed moving independent of anthropogenic vectors once introduced

**Score:** 2 of 4

**Ranking Rationale:**

This species uses ballast water and ship fouling for long distance transport.

**Background Information:**

Possibly introduced to England with Eastern oysters (Crassostrea virginica) (Sheader et al. 1997). Larval stage may also have been transported in ballast water. Darling et al. (2009) refutes the proposal of ballast water as a possible means of dispersal, and suggests that individuals are transported via ship fouling instead: Adult anemones are generally infaunal, and are typically found in habitats where their entrainment in ballast water tanks would be improbable. Dispersal propagules are much more likely to travel as components of fouling communities, on recreational watercraft or other equipment (e.g. waders, fishing gear). N. vectensis polyps have an impressive adhesive quality (J. Darling & A. Reitzel, pers. obs.) and are capable of passively attaching to most surfaces.

**Sources:**

Sheader et al. 1997   Darling et al. 2009

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

**Choice: U**

Unknown

**Score:** of

**Ranking Rationale:**

**Background Information:**

No information available in the literature.

**Sources:**

None listed

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

**Choice: B**

No

**Score:** 0 of 2

**Ranking Rationale:**

**Background Information:**

This species is not currently farmed or intentionally cultivated.

**Sources:**

None listed

| | |
|---|---|
| **Section Total - Scored Points:** | 2 |
| **Section Total - Possible Points:** | 6 |
| **Section Total -Data Deficient Points:** | 4 |

## 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:**
Feeds on a wide range of small invertebrates, including hydrobiid snails, copepods, ostracods, polychaetes, insect larvae, and bivalve larvae (Posey and Hines 1991; Hand and Uhlinger 1994).

**Sources:**
Posey and Hines 1991 Hand and Uhlinger 1994 NEMESIS; Fofonoff et al. 2003

### *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:** **C** Specialist; dependent on a narrow range of habitats for all life stages

**Score:** 1.75 of 5

**Ranking Rationale:**
Broad range of temperature and salinity, but limited to slow-moving or still water and requires sheltered conditions.

**Background Information:**
Broad temperature and salinity ranges. Associated with slow-moving or still water; sheltered conditions are required as it allows a layer of fine mud to build up, in which the animal can burrow (Williams 1983 as qtd. In Marshall and Jackson 2007). In the UK, Nematostella vectensis was absent from areas where water flow exceeded 0.18 cm/s (Sheader et al., 1997).

Sensitive to hypoxic or anoxic conditions, although it can crawl up on algal mats to avoid unfavorable conditions.

**Sources:**
Marshall and Jackson 2007 Sheader et al. 1997 NEMESIS; Fofonoff et al. 2003 Mossman 2000

### *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:**
Adults are moderately tolerant of dessication. No information for larvae.

**Background Information:**
Adults can survive up to 4 days without water in an experimental setting (Williams 1976). This is likely shorter in a natural environment where sunlight and wind can enhance dessication.

**Sources:**
Williams 1976

### *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:**

Capable of asexual reproduction with low parental investment, external fertilization and a short generation time.

**Background Information:**

Appears to primarily reproduce through asexual reproduction, as some populations consist of primarily one sex. Fission can be achieved in as little as 3 days when an organism is as young as 7 weeks. Sexual reproduction does occur but requires specialized conditions that only occur during the warmer parts of the year (Hand and Uhlinger 1994; Sheader et al. 1997).

**Sources:**

Hand and Uhlinger 1994 Sheader et al. 1997 Marshall and Jackson 2007 NEMESIS; Fofonoff et al. 2003

### *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:**

Only capable of short distance dispersal at only one life stage.

**Background Information:**

Larval stage is the only stage that is planktonic and free-swimming, and can last up to 14 days under laboratory conditions. Adults are effectively sessile, asexual propagules are incapable of dispersal, and egg mass has the tendency to sink rather than float (Darling et al. 2004; Reitzel et al. 2008). Genetic and experimental studies suggest that N. vectensis has a very low dispersal capacity (Stocks and Grassle 2001; Darling et al. 2004).

In at least certain parts of its range, N. vectensis undergoes dramatic seasonal fluctuations in population density. Demographic studies in England populations have revealed that densities can vary over three orders of magnitude, from under 100/m2 to over 2500/m2 and back again in the course of a single calendar year (Sheader et al. 1997)

**Sources:**

Darling et al. 2004 Reitzel et al. 2008 Stocks and Grassle 2001 Sheader et al. 1997 Darling et al. 2009

### *3.6 Likelihood of dispersal or movement events during multiple life stages*

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

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

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

**Ranking Rationale:**

Dispersal is limited ot the larval stage only, however, the larval viability window is relatively long (up to 14 days).

**Background Information:**

Larval stage is the only stage that is planktonic and free-swimming, and can last up to 14 days under laboratory conditions. Adults are effectively sessile, asexual propagules that are incapable of dispersal, and egg mass has the tendency to sink rather than float (Darling et al. 2004; Reitzel et al. 2008).

In at least certain parts of its range, N. vectensis undergoes dramatic seasonal fluctuations in population density. Demographic studies in England populations have revealed that densities can vary over three orders of magnitude, from under 100/m2 to over 2500/m2 and back again in the course of a single calendar year (Sheader et al. 1997).

**Sources:**

Darling et al. 2004 Reitzel et al. 2008 Sheader et al. 1997

### *3.7 Vulnerability to predators*

**Choice:** **U** Unknown

**Score:** **of**

**Ranking Rationale:**

**Background Information:**

Posey and Hines (1991) suggest that in the Rhode River, MD, distribution outside lagoons may be limited through predation by shrimps. No other predators have been listed.

**Sources:**

Posey and Hines 1991

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|---|---|
| **Section Total - Scored Points:** | 17.5 |
| **Section Total - Possible Points:** | 25 |
| **Section Total -Data Deficient Points:** | 5 |

## 4. Ecological and Socioeconomic Impacts

### *4.1 Impact on community composition*

**Choice:** **D** No impact

**Score:** 0 of 2.5

**Ranking Rationale:**
N. vectensis' small size and the fact that it is also predated upon result in a negligible impact on community composition.

**Background Information:**
As a benthic predator, N. vectensis can have direct effects on survival and recruitment of prey species. In experiments, N. vectensis decreased survivorship of Macoma mitchelli larvae, and decreased recruitment of Streblospio benedicti, relative to controls. However, in its natural range, the population of N. vectensis is itself subject to important predation by the grass shrimp Palaemonetes pugio. Given these balancing forces, net community effects will vary with seasonally fluctuating predator abundance and prey recruitment (Posey and Hines 1991).

N. vectensis can achieve high densities throughout the year, but it is individually very small with a dry weight of 0.5 mg. Even the highest reported density of 2,500 individuals/m2 would result in 1.25 g/m2 of biomass. Due to this, N. vectensis' impact is likely to be negligible (Reitzel et al. 2008).

**Sources:**
Posey and Hines 1991   Reitzel et al. 2008

### *4.2 Impact on habitat for other species*

**Choice:** **U** Unknown

**Score:** of

**Ranking Rationale:**

**Background Information:**
No information available in the literature.

**Sources:**
None listed

### *4.3 Impact on ecosystem function and processes*

**Choice:** **D** No impact

**Score:** 0 of 2.5

**Ranking Rationale:**

**Background Information:**
No ecological or economic impacts have been reported (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

**Ranking Rationale:**

**Background Information:**
No ecological or economic impacts have been reported (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:** **U** Unknown

**Score:** of

**Ranking Rationale:**

**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

**High uncertainty?** ☑

**Score:** 0 of 2.5

**Ranking Rationale:**
To date, hybridization of N. vectensis with similar species has not been reported.

**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 N. vectensis, and given its ecology, none would be expected.

**Background Information:**
No information available in the literature.

**Sources:**
NEMESIS; Fofonoff et al. 2003

### 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

**High uncertainty?** ✔

**Ranking Rationale:**
May be a predator for oyster larvae.

**Background Information:**
Hand and Uhlinger (1994) suggested that it could be a significant predator of oyster larvae in estuaries such as Chesapeake Bay, because of its dense populations in marshes and mudflats. However, its apparent scarcity and sporadic appearance (Posey and Hines 1991) argues against a role in recruitment of oysters and other commercially important shellfish in the upper Chesapeake Bay. Its importance as a predator has not yet been studied in other estuaries.

**Sources:**
Hand and Uhlinger 1994   Posey and Hines 1991   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

**High uncertainty?** ✔

**Ranking Rationale:**
May be a predator for oyster larvae.

**Background Information:**
No information found. Impact on oyster larvae (if any) would affect subsistence harvesting as well.

**Sources:**
NEMESIS; Fofonoff et al. 2003

### 4.101 Recreation

**Choice: D** No impact

**Score:** 0 of 3

**Ranking Rationale:**
To date, no impacts on recreation have been reported for N. vectensis, and given its ecology, none would be expected.

**Background Information:**
No information available in the literature.

**Sources:**
None listed

### 4.11 Human health and water quality

**Choice: D** No impact

**Score:** 0 of 3

**Ranking Rationale:**
To date, no impacts on human health or water quality have been reported for N. vectensis, and given its ecology, none would be expected.

**Background Information:**
No information available in the literature.

**Sources:**
NEMESIS; Fofonoff et al. 2003

| | |
|---|---|
| **Section Total - Scored Points:** | 1.5 |
| **Section Total - Possible Points:** | 25 |
| **Section Total -Data Deficient Points:** | 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 species-specific management, containtment or eradication exists for N. vectensis.

**Sources:**
None listed

### *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:**

**Background Information:**
No species-specific management, containment or eradication methods exist. Current hull fouling technologies that address invasive species require purchasing of specialized equipment and regular cleaning.

**Sources:**
Hagan et al. 2014

### *5.3 Regulatory barriers to prevent introductions and transport*

**Choice:** **B** Regulatory oversight, but compliance is voluntary

**Score:** of

**Ranking Rationale:**
Compliance with fouling regulations are voluntary.

**Background Information:**
In Brazil, where this species was recorded in 2004, introduced species such as N. vectensis may easily be overlooked (Silva et al. 2010). The scarcity of studies on cnidarians in soft sediments may explain the absence of earlier reports of the species. Most of the sampling that does take place is done by ecologists studying community dynamics, after which specimens are sent to taxonomists for identification (this is what led to the discovery of N. vectensis in Brazil). The authors recommend establishing a monitoring program for this species in the Port of Recife, where the anemone was found (Silva et al. 2010).
In the U.S., Coast Guard regulations require masters and ship owners to clean vessels and related infrastructure on a “regular” basis (CFR 33 § 151.2050). Failure to remove fouling organisms is punishable with a fine (up to $27 500). However, because the word “regular” is not defined, regulations are hard to enforce and compliance remains largely voluntary (Hagan et al. 2014). Cleaning of recreational vessels is also voluntary, although state and federal programs are in place to encourage owners to clean their boats. Boat inspection is mandatory on some lakes (e.g. Lake Tahoe in CA/NV, Lake George in NY). In summer 2016, state and federal agencies conducted voluntary inspections for aquatic invasive species on trailered boats entering the state of Alaska (Davis 2016).

**Sources:**
Silva et al. 2010   CFR 2017   Hagan et al. 2014   Davis 2016

### *5.4 Presence and frequency of monitoring programs*

**Choice:** **A** No surveillance takes place

**Score:** of

**Ranking Rationale:**

**Background Information:**
No species-specific monitoring for N. vectensis occurs, and no regular monitoring effort currently exists for hull fouling.

**Sources:**
None listed

### *5.5 Current efforts for outreach and education*

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

**Score:** of

**Ranking Rationale:**
Education and outreach occurs in its native region, but no information or outreach exists for N. vectensis as a non-native species.

**Background Information:**
Interestingly, in England, where its distribution is restricted, N. vectensis is listed as rare and is protected under the Wildlife and Countryside Act since 1988. Factsheets exist to inform the public on actions being taken to increase its habitat and population size. No educational or outreach material informing the public about the status of N. vectensis as an introduced (or invasive) species was found in the literature. The conservation of introduced N. vectensis populations in England appears to be motivated by its misidentification as a native species and a desire to protect vulnerable coastal habitats (Reitzel et al. 2008).

**Sources:**
Bamber 2013 Reitzel et al. 2008

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

## Literature Cited for *Nematostella vectensis*


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- Hand, C., and K. R. Uhlinger. 1994. The unique, widely distributed, estuarine sea anemone, Nematostella vectensis Stephenson: A review, new facts and questions. Estuaries 17(2):501-508.