Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

Scientific Name: *Teredo navalis*

Common Name *naval shipworm*

Phylum	Mollusca
Class	Bivalvia
Order	Myoida
Family	Teredinidae

Final Rank 54.00

Data Deficiency: 0.00

Species Occurrence by Ecoregion

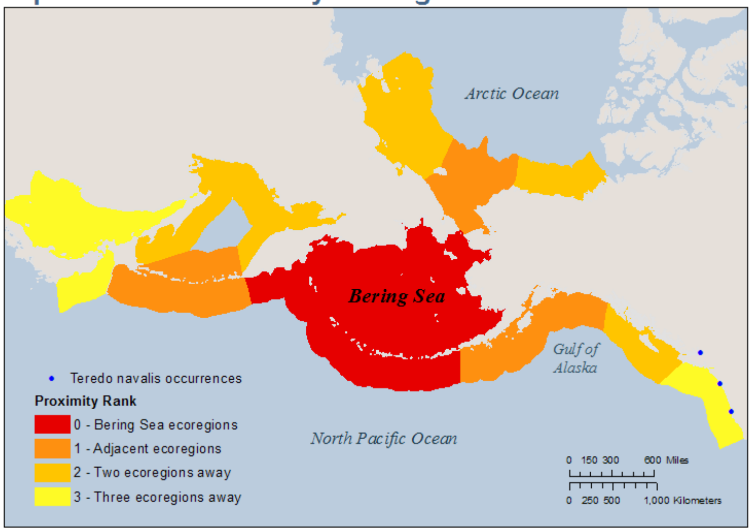

Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

Category Scores and Data Deficiencies

Category	Score	Total Possible	Data Deficient Points
Distribution and Habitat:	20.5	30	0
Anthropogenic Influence:	3.25	10	0
Biological Characteristics:	22.5	30	0
Impacts:	7.75	30	0
Totals:	54.00	100.00	0.00

General Biological Information

Tolerances and Thresholds

Minimum Temperature (°C)	0	Minimum Salinity (ppt)	5
Maximum Temperature (°C)	30	Maximum Salinity (ppt)	45
Minimum Reproductive Temperature (°C)	11	Minimum Reproductive Salinity (ppt)	9
Maximum Reproductive Temperature (°C)	30	Maximum Reproductive Salinity (ppt)	35*

Additional Notes

Teredo navalis is a highly modified bivalve adapted for boring into wood. The shell is reduced to two small, ridged valves that cover the head and are used for grinding and tearing wood. The body is naked and elongated, and ends with two siphons. It can reach up to 1000 mm in length (qtd. in Fofonoff et al. 2003). T. navalis bores into and damages boats, docks, pilings, and other wooden structures. This species has a global distribution and is one of the most widespread marine wood-borers in the world. Although its native range is unknown, it has been introduced to the East and West coasts of the United States, Brazil, Argentina, South Africa, and Australia. This species can be dispersed in wood, and in ballast water during its larval stage.

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

Review Date: 9/27/2017

1. Distribution and Habitat

1.1 Survival requirements - Water temperature

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

Score: 2.5 of 3.75

High uncertainty? ✔

Ranking Rationale:
Temperatures required for year-round survival occur in a moderate area (≥25%) of the Bering Sea. Thresholds are based on geographic distribution, which may not represent physiological tolerances; moreover, models disagree with respect to their estimates of suitable area. We therefore ranked this question with "High uncertainty".

Background Information:
T. navalis has been recorded as far north as Iceland (65°N) and the Faroe Islands (62°N). Based on geographic distribution, adults can tolerate temperatures between 0°C and 30°C. Optimal temperatures are between 15-25°C (Tuente et al 2002).

Sources:
Tuente et al. 2002   NEMESIS; Fofonoff et al. 2003   NIMPIS 2009

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 tolerance ranges from 5 to 45 ppt (based on field and experimental data).

Sources:
NEMESIS; Fofonoff et al. 2003

1.3 Establishment requirements - Water temperature

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

Score: 1.25 of 3.75

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

Background Information:
Culliney (1975) observed larvae being released at temperatures from 13° to 30°C. Appelqvist et al. (2015) report that minimum temperatures of 11°C and 12°C are needed for reproduction and larval metamorphosis, respectively. Larval swimming performance is poor below 10°C, and growth does not occur below 5°C (Fofonoff et al. 2003; Appelqvist et al. 2015).

Sources:
Appelqvist et al. 2015   Culliney 1975   NEMESIS; Fofonoff et al. 2003

1.4 Establishment requirements - Water salinity

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

Score: 3.75 **of** 3.75

High uncertainty? ☑

Ranking Rationale:
Although upper 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 up to 35 ppt. These salinities occur in a large (>75%) portion of the Bering Sea.

Background Information:
In a study by Culliney (1975), T. navalis released their offspring at salinities between 20 and 30 ppt. This species requires a minimum reproductive salinity of 9 ppt (qtd. in Fofonoff et al. 2003).

Sources:
Culliney 1975 NEMESIS; Fofonoff et al. 2003

1.5 Local ecoregional distribution

Choice: **C** Present in an ecoregion two regions away from the Bering Sea (i.e. adjacent to an adjacent ecoregion)

Score: 2.5 **of** 5

Ranking Rationale:
This species is found in southern BC and in southern Russia.

Background Information:
Found in southern British Columbia (East Redonda Island). Cryptogenic in southern Russia and in the Sea of Japan.

Sources:
NEMESIS; Fofonoff et al. 2003

1.6 Global ecoregional distribution

Choice: **A** In many ecoregions globally

Score: 5 **of** 5

Ranking Rationale:
This species has a widespread, global distribution. It has been introduced to both coasts of North America, and is widely distributed in Atlantic Europe and in Asia. It has also been reported in parts of South America and southern Africa.

Background Information:
Cryptogenic throughout Europe and Asia. In Europe, it is found from Iceland and the Norwegian Sea, south to the Mediterranean Sea and north Africa. In Asia, it occurs in India, Indonesia, the Philippines, China, Japan, southern Russia, and some Pacific islands. T. navalis has been introduced to both coasts of North America. On the West Coast, it occurs from San Diego, CA to southern British Columbia. It is considered introduced in South Africa, Australia, and the Atlantic coast of South America.

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:
This species is well-established outside of its native range, but its spread is linked to anthropogenic vectors, and no rapid expansions have been reported.

Background Information:
This species' long-distance dispersal is largely the result of anthropogenic vectors. Although sporadic, localized range expansions have been reported, they are probably due to fluctuating environmental conditions. A modelling exercise in the Baltic Sea found no evidence for climate-change related shifts in the distribution of T. navalis, and no evidence for increased risk of spread in the near-future for that region (Appelqvsit et al. 2015).

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

Section Total - Scored Points:	20.5
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: 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 requires anthropogenic vectors for transport.

Background Information:
T. navalis requires wood for habitat and food. It may occasionally be transported on drifting logs or wooden debris, but dispersal is largely the result of anthropogenic vectors.

Sources:
NEMESIS; Fofonoff et al. 2003

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

Choice: C — Uses anthropogenic disturbance/infrastructure to establish; never observed establishing in undisturbed areas

Score: 1.25 of 4

High uncertainty? ☑

Ranking Rationale:
T. navalis relies on anthropogenic substrates for establishment. Information is lacking for this species.

Background Information:
While some Teredinidae species live in natural habitats such as mangroves, T. navalis appears restricted to anthropogenic substrates, including ships, wooden docks, drifting logs and wooden debris. We did not find any sources that listed natural habitats for T. navalis, but information on this species is scarce.

Sources:
Voight 2015

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

Choice: B — No

Score: 0 of 2

Ranking Rationale:
This species is not currently farmed.

Background Information:

Sources:
NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	3.25
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:
A recent study suggests that this species is a filter feeder with a generalist diet.

Background Information:
Larvae are free-swimming and feed on plankton. Shipworms obtain most of their nutrition by filter feeding (Paalvast and van der Velde 2013), but may also eat wood.

Sources:
Paalvast and van der Velde 2013   NIMPIS 2009

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:
T. navalis requires wood to bore in.

Background Information:
Although the larval stage is planktonic, this species needs wood habitat to complete its life cycle. T. navalis exhibits wide temperature and salinity tolerances. It has a low tolerance for pollution.

Sources:
DAISIE 2016   NEMESIS; Fofonoff et al. 2003

3.3 Desiccation tolerance

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

Score: 5 of 5

Ranking Rationale:
If bored in wood, this species can withstand air exposure for several days to > 1 week.

Background Information:
T. navalis can survive up to six weeks of anoxic conditions by suspending its feeding activities, metabolizing stored energy reserves, and staying in its wood burrows (qtd. in Appelqvist et al. 2015). Preliminary experiments on thin, infested pieces of wood found that some individuals were still alive after a week’s exposure to air. Complete mortality was observed after 10 days’ exposure (Grave 1928). Survival varied from 3 days to >1 week based on thickness of wood and exposure to the sun (Grave 1928).

Sources:
Grave 1928   Appelqvist et al. 2015

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:

T. navalis is highly fecund and hermaphroditic. Fertilization is external, but eggs are brooded for 2 to 3 weeks. This species exhibits a relatively short generation time.

Background Information:

T. navalis individuals are protandrous hermaphrodites i.e., they begin life as male and later become female. Sources disagree on whether this species can self-fertilize (Hoppe 2002; Fofonoff et al. 2003). Fertilization is external, but eggs are brooded in the females' gills for 2 to 3 weeks. Eggs hatch and are released as larvae in 5 to 8 days (Culliney 1975; Hoppe 2002). Depending on water temperatures, females may have several reproductive events per season, and can release 50,000–2,000,000 eggs per event (qtd. in Appelqvist et al. 2015). Free-swimming larvae feed on plankton in the water column before settling and beginning to bore into wood. This species can live between 1 and 3 years, and reaches sexual maturity within 6 to 8 weeks.

Sources:

Appelqvist et al. 2015 Hoppe 2002 Culliney 1975 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: A Disperses long (>10 km) distances

High uncertainty? ☑

Score: 2.5 of 2.5

Ranking Rationale:

Although T. navalis larvae are poor swimmers, larvae are planktonic and the larval stage can last several weeks. Consequently, we expect this species to be capable of long-distance dispersal under favorable oceanic conditions.

Background Information:

Larval stage is planktonic and can last anywhere for 2 to 4 weeks before settlement. Under experimental conditions, larval swimming speed increased with size; the average speed for pediveliger larvae (200 μm) was estimated at 2 mm/s (Toth et al. 2015). This speed was approximately one order of magnitude less than the water velocity (Toth et al. 2015). Long-distance dispersal is therefore more likely to depend upon water currents than directional swimming. Based on current velocities, Scheltema (1971) suggested that shipworm larvae may be dispersed many hundreds of kilometers. Dispersal simulations by Appelqvist et al. (2015) predicted a predominance of localized dispersal events, with long-distance dispersal resulting in larvae dispersed to unfavorable sites; however, the resolution of the model was at a relatively coarse scale (3.7 km).

Sources:

Appelqvist et al. 2015 Toth et al. 2015 Scheltema 1971

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:
T. navalis has a long-lived, planktonic larval stage. It can disperse at more than one life stage, either by drifting in the water column (as larvae) or in wood pieces.

Background Information:
This species can disperse passively as larvae or as adults by rafting on wood (Appelqvist et al. 2015). Larvae are pelagic and long-lived, swimming in the water column anywhere from 2 to 4 before settlement.

Sources:
Appelqvist et al. 2015

3.7 Vulnerability to predators

Choice: C Few predators suspected present in the Bering Sea and neighboring regions, and/or multiple predators in native range

Score: 2.5 of 5

Ranking Rationale:
Because of its biology, this species is likely protected against predators throughout most of its life.

Background Information:
As long as their piece of wood is intact, shipworms have few predators. If the wood disintegrates, they are rapidly eaten by fishes, crabs, and other predators. They are vulnerable to protozoan parasites, such as Minchinia teredinis, which can cause extensive mortality.

Sources:
NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:	22.5
Section Total - Possible Points:	30
Section Total -Data Deficient Points:	0

4. Ecological and Socioeconomic Impacts

4.1 Impact on community composition

Choice: D No impact

Score: 0 of 2.5

Ranking Rationale:
This species is not expected to affect marine communities in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

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:
By boring into wood, this species may simultaneously destroy and create wood habitat and tunnels for other species. However, because this species is not known to bore into natural habitats (e.g., coastal forests), we expect it to have a limited impact in the Bering Sea ecoregion.

Background Information:
This species damages and destroys wood and, in so doing, may destroy habitat for other species (e.g., fouling organisms). Conversely, it can create habitat for burrowing organisms by creating holes and tunnels.

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

Ranking Rationale:
This species may accelerate decomposition and nutrient recycling, especially along woody, vegetated coastlines. However, because this species is typically associated with anthropogenic substrates and has limited dispersal abilities, we do not expect T. navalis to exert strong effects on natural ecosystems in the Bering Sea.

Background Information:
T. navalis speeds the breakdown and recycling of wood in estuaries and coastal ecosystems.

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:
This species is not expected to impact high-value species or communities in the Bering Sea.

Background Information:
No impacts have been reported.

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: **B** — Moderate – Spreads or has potential to spread one or more organisms, with moderate impact and/or within only a portion of region

Score: 1.75 **of** 2.5

High uncertainty? ☑

Ranking Rationale:
Although no specific species have been reported, the boring behavior of T. navalis may create habitat for burrowing organisms in anthropogenic substrates, which would greatly facilitate their long-distance dispersal.

Background Information:
Shipworms can facilitate the transport of other species by creating holes and tunnels in wood, providing burrowing spaces for other organisms.

Sources:
NEMESIS; Fofonoff et al. 2003

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:
This species is not expected to hybridize with native species in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

4.7 Infrastructure

Choice: **A** — High – Is known to cause degradation to infrastructure and/or is expected to have severe impacts and/or will impact the entire region

Score: 3 **of** 3

Ranking Rationale:
This species has caused several million dollars’ worth of damage to ships and wooden infrastructure, and is expected to have severe impacts in the Bering Sea.

Background Information:
T. navalis has a long history of damaging ships and structures such as piers and marinas. In the 1920s, an outbreak of T. navalis in San Francisco Bay caused an estimated $615 million dollars (in 1992 currency rates) in damage. In 1946, shipworms were reported to cause an annual $55 million ($500 million in current dollars) of damage to waterfront structures in the United States. In 1990, a floating restaurant in the US sank due to shipworm burrowing activities. In New York Harbor, where T. navalis has caused extensive damage, there are plans to spend $200 million over the next few decades to encase and preserve piers to be used as part of waterfront parks (Foderaro 2011). In the Baltic Sea, a different concern is the destruction of archaeologically important shipwrecks, which up to now were preserved from borers by low salinity (Hoppe 2002). By boring into logs, T. navalis can also be problematic for the lumber industry in coastal areas where logging occurs.

Sources:
NEMESIS; Fofonoff et al. 2003   Hoppe 2002   Foderaro 2011   NIMPIS 2009

4.8 Commercial fisheries and aquaculture

Choice: D No impact

Score: 0 of 3

Ranking Rationale:
Given its biology, this species is not expected to impact commercial fishing in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
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:
T. navalis may damage wooden equipment used for subsistence harvesting.

Background Information:
T. navalis can damage wooden traps used to catch shellfish such as lobsters and oysters. Nowadays, traps are made from wire rather than wood, but wooden traps may still be used.

Sources:
Grave 1928

4.101 Recreation

Choice: D No impact

Score: 0 of 3

Ranking Rationale:
This species is not expected to affect recreational opportunities in the Bering Sea.

Background Information:
No impacts have been reported.

Sources:
NEMESIS; Fofonoff et al. 2003

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:
There are a limited number of wooden waterfront structures in the Bering Sea ecoregion, and few large human settlements. We therefore expect T. navalis to have a limited impact on human health in this region. T. navalis has a low tolerance for pollution, and no impacts to water quality have been reported.

Background Information:
T. navalis can cause waterfront structures to collapse. This is a serious safety concern to public and private waterfront property used in recreation, entertainment, and tourism. New York City is planning to spend $200 million over the next few decades to encase and preserve piers to be used as part of waterfront parks (Foderaro 2011).

Sources:
Foderaro 2011

Section Total - Scored Points:	7.75
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:
Methods that are effective, cost-efficient, and environmentally-friendly are being researched.

Background Information:
Control methods include wrapping structures in plastic, or applying a chemical coating to them. Chemical control is probably the most effective method, but is also environmentally toxic.

Sources:
DAISIE 2009 Foderaro 2011

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:
Transitioning from wood to other materials such as metal, concrete, fiberglass, and plastic inevitably gets rid of shipworms. However, replacing or protecting existing infrastructure is very expensive.

Background Information:
New York City intends to spend $200 million over the next few decades to encase and preserve piers to be used as part of waterfront parks (Foderaro 2011).

Sources:
Foderaro 2011

5.3 Regulatory barriers to prevent introductions and transport

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

Score: of

Ranking Rationale:
Currently, there are no regulations to prevent or reduce the spread of boring organisms.

Background Information:

Sources:
CFR 2017

5.4 Presence and frequency of monitoring programs

Choice: **A** No surveillance takes place

Score: of

Ranking Rationale:
No surveillance takes place for this species.

Background Information:

Sources:
NEMESIS; Fofonoff et al. 2003

5.5 Current efforts for outreach and education

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

Ranking Rationale:

No outreach or education is taking place for this species.

Background Information:

An online search for educational materials or outreach programs did not return any results.

Sources:

NEMESIS; Fofonoff et al. 2003

Section Total - Scored Points:

Section Total - Possible Points:

Section Total -Data Deficient Points:

Literature Cited for *Teredo navalis*

- Appelqvist C., Al-Hamdani, Z. K., Jonsson, P. R., and J. N. Havenhand. 2015. Climate envelope modeling and dispersal simulations show little risk of range extension of the shipworm, Teredo navalis (L.), in the Baltic Sea. PLoS ONE 10(3): e0119217.
- NIMPIS. 2009. National Introduced Marine Pest Information System. Available from: http://www.marinepests.gov.au/nimpis
- Tuente, U., Piepenburg, D., and M. Spindler. 2002. Occurrence and settlement of the common shipworm Teredo navalis (Bivalvia: Teredinidae) in Bremerhaven harbours, northern Germany. Helgoland Marine Research 56:87-94.
- Culliney, J. L. 1975. Comparative larval development of the shipworms Bankia gouldi and Teredo navalis. Marine Biology 29(3): 245. *Access to abstract only.
- Voight, J. R. 2015. Xylotrophic bivalves: Aspects of their biology and the impacts of humans. Journal of Molluscan Studies 81:175-186.
- Paalvast, P., and G. van der Velde. 2013. What is the main food source of the shipworm (Teredo navalis)? A stable isotope approach. Journal of Sea Research 80:58-60.
- DAISIE. 2017. Delivering Alien Invasive Species Inventories for Europe, European Commission. Available from: http://www.europe-aliens.org/
- Grave, B. H. 1928. Natural history of shipworm, Teredo navalis, at Woods Hole, Massachusetts. Biological Bulletin 55(4):260-282.
- Foderaro, L. W. 2011. Cleaner harbor has a downside: Pests that plague park construction. New York Times, 23 Aug 2011. Available from: http://www.nytimes.com/2011/08/24/nyregion/cleaner-new-york-harbor-brings-pests-that-plague-park-projects.html Accessed
- Hoppe, K. N. 2002. Teredo navalis – The cryptogenic shipworm. Pages 116–119 in Leppäkoski, E., Gollasch, S., and S. Olenin, editors. Invasive aquatic species of Europe. Distribution, Impacts and Management. Springer, Dordrecht, the Netherlands.
- Scheltema, R. S. 1971. Dispersal of phytoplanktotrophic shipworm larvae (Bivalvia: Teredinidae) over long distances by ocean currents. Marine Biology 11(1):5-11. *Access to abstract only.
- Toth G. B., Larsson A. I., Jonsson P. R., and C. Appelqvist. 2015. Natural populations of shipworm larvae are attracted to wood by waterborne chemical cues. PLoS ONE 10(5): e0124950.
- 33 CFR § 151.2050 Additional requirements - nonindigenous species reduction practices
- DAISIE. 2009. Species accounts of 100 of the most invasive alien species in Europe. Pages 269-374 in DAISIE, editors. Handbook of Alien Species in Europe, Springer, Dordrecht, the Netherlands.
- Fofonoff, P. W., G. M. Ruiz, B. Steves, C. Simkanin, and J. T. Carlton. 2017. National Exotic Marine and Estuarine Species Information System. http://invasions.si.edu/nemesis/. Accessed: 15-Sep-2017.