Bering Sea Marine Invasive Species Assessment

Alaska Center for Conservation Science

Scientific Name: *Sinelobus cf. stanfordi*

Common Name *a tube-building crustacean*

Phylum	Arthropoda
Class	Malacostraca
Order	Tanaidacea
Family	Tanaididae

Final Rank 50.42

Data Deficiency: 11.25

Species Occurrence by Ecoregion

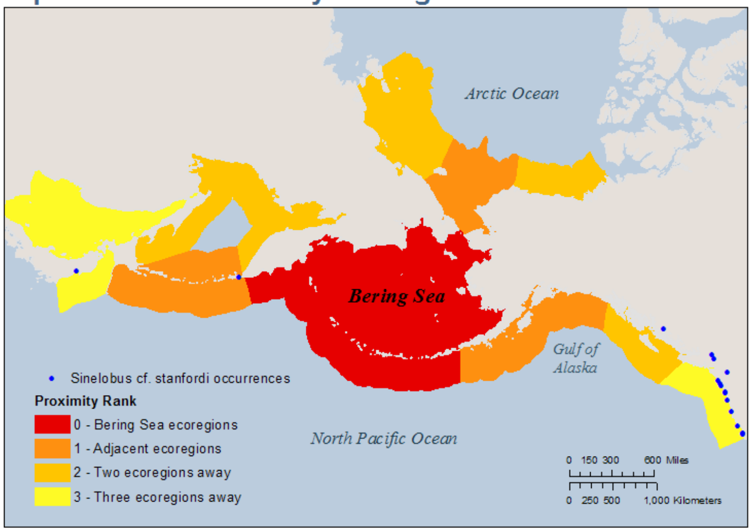

Figure 1. Occurrence records for non-native species, and their geographic proximity to the Bering Sea. Ecoregions are based on the classification system by Spalding et al. (2007). Occurrence record data source(s): NEMESIS and NAS databases.

Category Scores and Data Deficiencies

Category	Score	Total Possible	Data Deficient Points
Distribution and Habitat:	23.25	26	3.75
Anthropogenic Influence:	4.75	10	0
Biological Characteristics:	16	25	5.00
Impacts:	0.75	28	2.50
Totals:	44.75	88.75	11.25

General Biological Information

Tolerances and Thresholds

Minimum Temperature (°C)	-2	Minimum Salinity (ppt)	0
Maximum Temperature (°C)	27	Maximum Salinity (ppt)	52
Minimum Reproductive Temperature (°C)	NA	Minimum Reproductive Salinity (ppt)	31*
Maximum Reproductive Temperature (°C)	NA	Maximum Reproductive Salinity (ppt)	35*

Additional Notes

S. stanfordi is tanaid crustacean with a cylindrical body comprised of three sections: a cephalothorax, a thorax and an abdomen. Native range is unknown and is considered cyptogenic throughout its range except on the North American West Coast where it is considered an invader. It is a tube-building species that prefers soft substrates and can be found around the world due to a wide range of temperature and salinity tolerances.

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

Ranking Rationale:
Temperatures required for year-round survival occur over a large (>75%) area of the Bering Sea.

Background Information:
The temperature range for survival of S. stanfordi is -2°C to 27°C (Levings and Rafi 1978; Cohen et al. 2002).

Sources:
NEMESIS; Fofonoff et al. 2003 Levings and Rafi 1978 Cohen et al. 2002

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:
According to field measurements, the salinity range for survival is 3.7 ppt to 36.5 ppt (Levings and Rafi 1978; Cohen et al. 2002). While 3.7 ppt is the lowest reported value for Sinelobus cf. stanfordi, other Sinelobus spp. have established in freshwater.

Sources:
NEMESIS; Fofonoff et al. 2003 Levings and Rafi 1978 Cohen et al. 2002

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

High uncertainty? ☑

Score: 3.75 **of** 3.75

Ranking Rationale:
Although salinity thresholds are unknown, this species is a marine organism that does not require freshwater to reproduce. We therefore assume that this species can reproduce in saltwater (31 to 35 ppt). These salinities occur in a large (>75%) portion of the Bering Sea.

Background Information:
No information available in the literature.

Sources:
None listed

1.5 Local ecoregional distribution

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

Score: 3.75 of 5

Ranking Rationale:

Background Information:
Reported in the Sea of Okhotsk. Also found on the North American west coast from California to British Columbia.

Sources:
NEMESIS; Fofonoff et al. 2003

1.6 Global ecoregional distribution

Choice: **A** — In many ecoregions globally

Score: 5 of 5

Ranking Rationale:
Wide global distribution.

Background Information:
Native distribution is unknown, but first described from a species collected in southern Mexico. Occurs along the Pacific and Atlantic coasts of central and southern America. In North America, is considered an invader in a few East and West coast states and provinces, including British Columbia, California, Oregon, Washington, and South Carolina. It has also been collected in New Zealand, in the South China Sea, in Japan, and the Sea of Okhotsk. In Europe, occurs in the Netherlands, Belgium, and Germany (van Haaren and Soors 2009; Bamber 2014).

Sources:
NEMESIS; Fofonoff et al. 2003 van Haaren and Soors 2009 Bamber 2014

1.7 Current distribution trends

Choice: **B** — History of rapid expansion or long-distance dispersal (prior to the last ten years)

Score: 3.25 of 5

Ranking Rationale:
Rapid expansion along the west coast between 1943 and 2001. No recent information on expansion or dispersal.

Background Information:
S. stanfordi has likely been transported around the world for hundreds of years due to solid ballast, hull fouling, ballast water, and aquaculture transplants (Sytsma et al. 2004).

Sources:
van Haaren and Soors 2009 Sytsma et al. 2004

Section Total - Scored Points:	23.25
Section Total - Possible Points:	26.25
Section Total -Data Deficient Points:	3.75

2. Anthropogenic Transportation and Establishment

2.1 Transport requirements: relies on use of shipping lanes (hull fouling, ballast water), fisheries, recreation, mariculture, etc. for transport

Choice: 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:
Is readily transported through ballast water and hull fouling, however, S. stanfordi has poor natural dispersal abilities.

Background Information:
Dispersal vectors include ballast water and hull fouling (van Haaren and Soors 2009). Natural dispersal ability low as it has no larval form of dispersal, no pelagic stage, and limited swimming capacity (Larsen et al. 2014).

Sources:
van Haaren and Soors 2009   Larsen et al. 2014

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

Choice: B — Readily establishes in areas with anthropogenic disturbance/infrastructure; occasionally establishes in undisturbed areas

Score: 2.75 of 4

High uncertainty? ☑

Ranking Rationale:
Given the poor dispersal ability of individuals, populations likely stay close to their point of introduction.

Background Information:
S. stanfordi has been observed primarily in harbors, estuaries and ports where they have been brought in via anthropogenic vectors. Individuals have also been collected from bivalves, plants (e.g. algae, rushes), rocks, and within the canals of sponges (Gardiner 1975).

Sources:
NEMESIS; Fofonoff et al. 2003   Gardiner 1975

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:	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 readily available in the Bering Sea.

Background Information:
S. stanfordi is a deposit feeder that feeds on detritus and benthic microalgae (Barnes 1983 as qtd. In Fofonoff et al. 2003; Heiman et al. 2008). It has also been reported feeding on hydroids (Toniollo and Masunari 2007).

Sources:
NEMESIS; Fofonoff et al. 2003   Heiman et al. 2008   Toniollo and Masunari 2007

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:
Tolerant of a wide range of temperatures and salinities and recorded in several different habitats.

Background Information:
S. stanfordi is able to withstand a wide range of temperatures and salinities, living in a habitat that fluctuated daily from 3.6 to 32.5 PSU (van Haaren and Soors 2009). As a tube-building species it prefers silt and fine sediments but can also be found on mangroves, coral rock, aquatic vegetation, canals, and freshwater lakes and streams (Gardiner 1975; Quinn and Hickey 1990; García-Madrigal et al. 2004; Hendrickx and Ibarra 2008; van Haaren and Soors 2009).

Is sensitive to anthropogenic pollution. In Argentina abundance of S. stanfordi was significantly lower in sites with high levels of nutrient or oxygen demands (Ambrosio et al. 2014). Turbidity and conductivity did not appear to limit distribution (Ambrosio et al. 2014).

Sources:
NEMESIS; Fofonoff et al. 2003   van Haaren and Soors 2009   Gardiner 1975   Quinn and Hickey 1990   García-Madrigal et al. 2004   Hendrickx and Ibarra 2008

3.3 Desiccation tolerance

Choice: **U** — Unknown

Score: **of**

Ranking Rationale:

Background Information:
No information available in the literature.

Sources:
None listed

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, moderate parental investment, internal fertilization, short generation time.

Background Information:
Reproduces sexually. Brood is kept in maternal pouch. Laboratory experiments suggest that females can breed at least twice during their 35-day lifespan (Toniollo and Masunari 2007).

Sources:
Toniollo and Masunari 2007

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:

Background Information:
Tanaids have a poor dispersal ability as they have direct development, no pelagic stage, and a limited swimming capacity (Larsen et al. 2014).

Sources:
Larsen et al. 2014

3.6 Likelihood of dispersal or movement events during multiple life stages

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

Choice: C Low – Exhibits none of the above characteristics

Score: 0.75 of 2.5

Ranking Rationale:
Direct development from egg (borne in maternal pouch) to juvenile/adult life stage. Low dispersal potential at all life stages.

Background Information:
S. stanfordi have no larval dispersal, no pelagic stage, and only limited swimming ability (Larsen et al. 2014).

Sources:
Larsen et al. 2014

3.7 Vulnerability to predators

Choice:		Score:
D	Multiple predators present in the Bering Sea or neighboring regions	**1.25** of **5**

Ranking Rationale:

Numerous predators, many of which exist in the Bering Sea.

Background Information:

Important prey item for fishes and shorebirds such as the Mississippi Silverside (50% of diet), Yellowfin Goby (25% of diet), and Western Sandpiper (Howe and Simenstad 2007; Cohen and Bollens 2008; Sewell 1996).

Sources:

NEMESIS; Fofonoff et al. 2003 Howe and Simenstad 2007 Cohen and Bollens 2008 Sewell 1996

Section Total - Scored Points:	16
Section Total - Possible Points:	25
Section Total -Data Deficient Points:	5

4. Ecological and Socioeconomic Impacts

4.1 Impact on community composition

Choice: D No impact

Score: 0 of 2.5

Ranking Rationale:
To date, no ecological impacts have been reported (Fofonoff et al. 2003).

Background Information:
Given abundance, are likely a very important food item for predators. Can occur in very high densities, and collection samples on natural substrates often include over 1000 individuals (and sometimes over 10 000; van Haaren and Soors 2009). On silt, clay or sandy bottoms their numbers are lower. In The Netherlands, Belgium, Japan, and Canada (BC), S. stanfordi was observed co-occurring with one or more Corophiidae amphipods. In the Gamo lagoon, Japan, the tubes of Corophium uenoi were built on a different substrate (filamentous algae) than the tubes of S. stanfordi (concrete embankment). van Haaren and Soors (2009) write that competition between corophiid species and S. stanfordi should not be excluded, as they both build their silty tubes on hard substrates and probably feed on the same food.

Sources:
NEMESIS; Fofonoff et al. 2003   van Haaren and Soors 2009

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:
At high densities, there is the potential for S. stanfordi to degrade habitat for other species.

Background Information:
In West Coast estuaries, can reach high densities up 68,000 m3. could also be a potential prey item for fishes and shorebirds (Levings and Rafi 1978).

Sources:
NEMESIS; Fofonoff et al. 2003   Levings and Rafi 1978

4.3 Impact on ecosystem function and processes

Choice: D No impact

Score: 0 of 2.5

Ranking Rationale:
No ecological or economic impacts have been reported (Fofonoff et al. 2003).

Background Information:

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:
No ecological or economic impacts have been reported (Fofonoff et al. 2003).

Background Information:

Sources:
NEMESIS; Fofonoff et al. 2003

4.5 Introduction of diseases, parasites, or travelers

What level of impact could the species' associated diseases, parasites, or travelers have on other species in the assessment area? Is it a host and/or vector for recognized pests or pathogens, particularly other nonnative organisms?)

Choice: D No impact

Score: 0 of 2.5

Ranking Rationale:
No impacts due to diseases, parasites or travelers have been reported for S. stanfordi.

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: U Unknown

Score: of

Ranking Rationale:

Background Information:
No information available in the literature.

Sources:
"Needs Reference"

4.7 Infrastructure

Choice: D No impact

Score: 0 of 3

Ranking Rationale:
No ecological or economic impacts have been reported (Fofonoff et al. 2003).

Background Information:

Sources:
NEMESIS; Fofonoff et al. 2003

4.8 Commercial fisheries and aquaculture

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
No ecological or economic impacts have been reported (Fofonoff et al. 2003).

Background Information:

Sources:
NEMESIS; Fofonoff et al. 2003

4.9 Subsistence

Choice: **D** No impact

Score: 0 of 3

Ranking Rationale:
No ecological or economic impacts have been reported (Fofonoff et al. 2003).

Background Information:

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 S. standfordi, 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

High uncertainty? ✔

Score: 0 of 3

Ranking Rationale:
To date, no impacts to health and/or water quality have been reported for S. standfordi, and given its ecology, none would be expected.

Background Information:
No information available in the literature.

Sources:
None listed

Section Total - Scored Points:	0.75
Section Total - Possible Points:	27.5
Section Total -Data Deficient Points:	2.5

5. Feasibility of prevention, detection and control

5.1 History of management, containment, and eradication

Choice: **C**

Attempted; control methods are currently in development/being studied

Score: of

Ranking Rationale:

No species-specific management efforts are in place for S. stanfordi, however, this species is likely transported in ballast water and on ships' hulls as part of the fouling community. Hull fouling technologies that treat and/or safely dispose of marine organisms are currently being studied.

While BWE can be highly effective at reducing the abundance of coastal organisms, efficacy varies across taxonomic groups, and residual organisms still remain in ballast tanks following exchange (Ruiz and Reid 2007). As a result, ballast water exchange is commonly viewed as a short-term or "stop-gap" option that is immediately available for use on most ships, but that will gradually be phased out as more effective, technology-based methods become available (Ruiz and Reid 2007).

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

Background Information:

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

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

Hull fouling has historically been addressed by applying anti-fouling paints and coatings. However, the chemicals used in these paints can leach environmentally harmful toxins into the water. The use of tributyl tin (TBT) paints have been banned globally for this reason. While different types of paints and coatings have been developed, ships also need to engage in regular cleaning to fully address the invasive species issues (Hagan et al. 2014). In large vessels, hull cleaning is currently conducted to improve vessel functioning and fuel efficiency. Reducing the spread of invasive species is therefore not the primary objective. Current methods such as hull cleaning during dry-docking does not address all the areas in which fouling organisms may establish (e.g. sea chests, water pipes; Hagan et al. 2014). Hull cleaning conducted in-water would allow for a more frequent cleaning schedule. Currently, underwater cleaning is performed by divers or machines using brushes, scrapers, or pressure washers. While these methods may improve a ship's performance, they do not treat or collect the waste. Consequently, these methods may actually exacerbate, rather than reduce, the spread of invasive species (Hagan et al. 2014). Technologies that collect the debris, and/or that kill the fouling organisms, are currently being studied (Hagan et al. 2014).

Sources:

Ruiz and Reid 2007 Hagan et al. 2014

5.2 Cost and methods of management, containment, and eradication

Choice: **B** Major short-term and/or moderate long-term investment

Score: of

Ranking Rationale:

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

Current hull fouling technologies that address invasive species require purchasing of specialized equipment and regular cleaning.

Background Information:

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

According to Franmarine Underwater Services (2013), a company that supplies an in-water hull cleaning system, the cost of dry docking (including cleaning and "loss of business" costs) varies from AUD $62 200 to more than $1.3 million, depending on vessel size. The Franmarine cleaning system, which collects, treats, and disposes of biological waste (e.g., organisms) has a purchasing cost between AUD ~ $500 000 to $750 000, depending on vessel size. In-water cleaning costs range from AUD $18 800 to $255 000+ (for offshore cleaning of large vessels), with cleaning times estimated between 16 to 48 hours. Hagan et al. (2014) proposed similar estimates for the cost and time of in-water cleaning.

Sources:

Franmarine 2013 Hagan et al. 2014 Zagdan 2010

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 voluntary.

Background Information:

Compliance with fouling regulations are voluntary. Alaska does not have state regulations on ballast water management, but two federal regulations (USCG and EPA) require mandatory reporting and management. International regulations by the International Maritime Organization (IMO) are expected to come into effect in 2017. While most vessels only conduct ballast water exchange, new regulations are requiring vessels to use ballast water management systems. Treated water must meet US Coast Guard/IMO performance standards. However, all management methods that are currently available reduce, but do not eliminate, the risk of introducing new species (Bailey 2005; Gollasch et al. 2007). In Alaska, data from 2009-2012 show moderate to high compliance with USCG reporting requirements (qtd. in Verna et al. 2016). There are currently no data available to evaluate compliance with water performance standards.

Sources:

Verna et al. 2016

5.4 Presence and frequency of monitoring programs

Choice: **A**

No surveillance takes place

Score: of

Ranking Rationale:

Background Information:

No species-specific monitoring for S. stanfordi 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:

Background Information:

No educational or outreach materials exist.

Sources:

None listed

Section Total - Scored Points:

Section Total - Possible Points:

Section Total -Data Deficient Points:

Literature Cited for *Sinelobus cf. stanfordi*

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