Japanese Tsunami Marine Debris

Key Aquatic Invasive Species Watch

The March 11, 2011, tsunami off the coast of Japan sent an estimated five million tons of debris into the ocean, of which a significant but unknown amount is circulating and being modeled in the currents of the Pacific Ocean. Driven by currents and winds for over 5,000 miles from the tsunami-damaged fishing port of Misawa, Japan, a large 188-ton concrete dock washed onto Agate Beach, Oregon, nearly 15 months after the tsunami. The dock carried with it more than 100 living marine species of nearshore Japanese origin, including species known to be invasive on the U.S. west coast. Twenty months after the tsunami, a second dock of the same design from Misawa beached at Olympic National Park along the Washington coast, carrying with it more than 60 marine species. Tsunami-driven marine debris like these docks is expected to circulate in the ocean currents for years to come. Prior to the arrival of the tsunami-driven dock, some invasion biologists had predicted that the tsunami debris would be colonized with open-ocean (pelagic) species such as gooseneck barnacles (*Lepas* spp., below).

Lepas anatifera (pelagic gooseneck barnacle)—NOT AN INVADER!

(Large picture: Oregon Office of Emergency Management, Oregon Dept. of Fish and Wildlife; two small pictures: Jessica Miller, OSU-HMSC; newly settled *Lepas*: Sam Chan, Oregon Sea Grant)

Gooseneck barnacles (*Lepas* spp.) are open-ocean (pelagic) barnacles. They are the most common and abundant species found on marine debris. Goose-neck barnacles **are not a species of invasive concern**. Debris covered *only* by *Lepas* spp. does not have to be reported, unless the structure is large enough to pose a hazard in other ways. *Lepas anatifera (*gooseneck barnacles) are native, filter-feeding crustaceans that live attached to floating objects in the open ocean. They do not occur on rocks in the intertidal zone. They have a long, fleshy stalk that attaches to the substrate; and smooth, off-white calcareous plates that protect the body and internal organs. A feathery, filter-feeding net can often be seen extended and extracted.

- **NATIVE** (defined as naturally occurring on both sides of the Pacific Ocean)
- **Size range:** 4 to 90 cm, including stalk

Tsunami Marine Debris: A Potential Invasive Species Pathway in the Modern Era

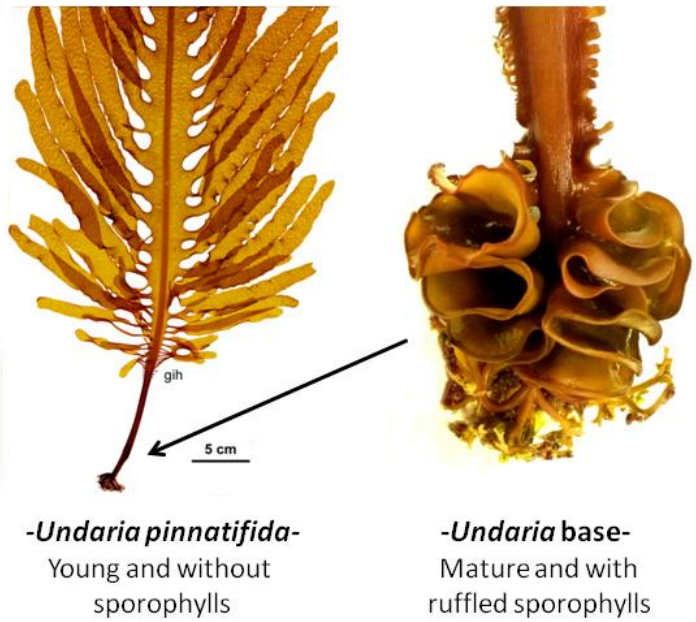
The open ocean is a low-productivity environment in which nearshore species are unlikely to survive for extended periods. The arrival of nearshore species of Japanese origin after at least 15 months in the open ocean spotlights an invasive species pathway driven by natural disasters in the modern era, including their potential risks and issues surrounding their early detection and rapid response (EDRR). The phenomenon of large, human-made debris serving as a raft for living nearshore species drifting across the Pacific is illustrated by the organisms found on tsunami marine debris. We lack documented evidence of this phenomenon occurring in the North Pacific Ocean, involving known sources of such a potentially large volume of biofouled material within such a compressed period of time. Compared to the 1800s and early 1900s, the modern era has created an extensive amount of marine infrastructure. Thus, natural disasters that move pieces of human-marine infrastructure are a new dispersal pathway to consider. These marine structures provide multiple substrates and microhabitats for a wide array of **biofouling** species (the attached and associated free-living organisms found on marine structures), which include diverse organism types, sizes, and life-history stages of the organisms.

Listed below are eight known, potentially invasive species from Japan to watch for (early detection). As of the date of this publication (June 2013), each of these has been found on large structures of marine origin (floating docks) that have washed onto North American shores from the 2011 Japanese tsunami.

Japanese Tsunami Debris Invasive Species Watch

Undaria pinnatifida (wakame kelp)

(Left: Jessica Miller, OSU; right: Gayle Hansen, OSU)



-Undaria pinnatifida-
Young and without sporophylls

***-Undaria* base-**
Mature and with ruffled sporophylls

An edible kelp species native to Japan, *U. pinnatifida* can be highly invasive and disruptive to native kelp ecosystems. In addition to its occurrence on larger tsunami debris, it may recruit in the natural environment on existing docks, pier pilings, or rock in newly disturbed areas. *Undaria* has lobes or finger-like projections from its blade margin and two highly ruffled sporophylls at its base. (Gayle Hansen, OSU)

- **INVASIVE**
- **Size range:** can grow to 3 m long

Grateloupia turuturu (red alga)

(Left: Connecticut Sea Grant; right: Cory Janiak)

This red seaweed is a large perennial with thin, flat blades that are pink to maroon in color. It grows to several meters in length, appears in both divided and undivided forms, and is most abundant in October and least abundant in May. (Conn. Sea Grant)

- **INVASIVE**
- **Size range:** can grow to 3 m long

Codium fragile subsp. *fragile* (dead man's fingers)

(Left: Connecticut Sea Grant; right: Cory Janiak)

This branching green algae with spongy, hairy fingers can reach one meter in height. It forms extensive beds in shallow bays and harbors. Adult plants are pale to dark green in color and have a very bush-like appearance, with many branches arising from a disk-shaped pad. (Dalhousie University)

This species is widespread around the world; it has been found in San Francisco Bay, Tomales Bay, and Willapa Bay on the North American west coast. It is very similar to our native species *Codium fragile* subsp. *Californicum*, but it reproduces asexually through fragmentation, making it a dangerous invader. (Gayle Hansen, OSU)

- **INVASIVE**
- **Size range:** can grow to 1 m long

Caprella cristibrachium (skeleton shrimp)

(John Chapman, OSU)

Caprellids, commonly referred to as "skeleton shrimp", are a family of amphipod crustaceans that occur in nearly all marine waters of the world. Their bodies are highly elongated and stick-like and they have relatively small heads. Caprellids are most commonly found on hard surfaces and among bryozoans and hydroids. (John Chapman, OSU)

- **POTENTIALLY INVASIVE**
- **Size range:** can grow to 4 cm long

Hemigrapsus sanguineus (Asian/Japanese shore crab)

(Left: OSU Hatfield Marine Science Center; right: Pat Kight, Oregon Sea Grant)

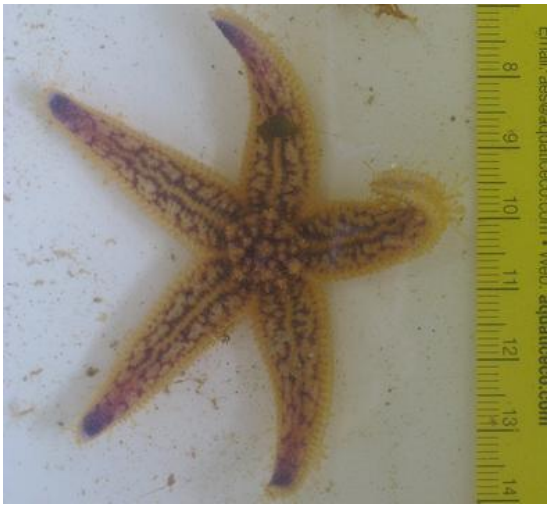
The Asian/Japanese shore crab has a square-shaped shell with three spines on each side of the carapace, ranging in colors from green to purple to orange-brown to red. It has light and dark bands along its legs and red spots on its claws. This versatile crab inhabits any shallow, hard-bottom intertidal — or sometimes subtidal — habitat. (USGS)

Oregon's native shore crabs *Hemigrapsus oregonensis* and *Hemigrapsus nudus* can look very similar to this species, so it is best not to collect specimens unless a state authority asks you to do so. When specimens are requested, it is important to follow the specimen collection protocol below.

- **INVASIVE**
- **Size range:** 35 mm (1.5 in) to 42 mm (1.65 in) in carapace width

Asterias amurensis (Northern Pacific seastar)

(Left: OSU Hatfield Marine Science Center; right: Pat Kight, Oregon Sea Grant)



This species of sea star is predominantly light purple in color, and is often seen with purple or red detail on its upper surface. There are numerous small spines with sharp edges on the upper body surface. On the underside of the body, these spines line the groove in which the tube feet lie, and join up at the mouth in a fan-like shape. The underside is a uniform yellow in color. It is normally found in shallow water but it can be found from the intertidal area through to the subtidal as deep as 200 m. (New Zealand Ministry for Primary Industries)

- **INVASIVE**
- **Size range:** can reach 40 to 50 cm in diameter

Mytilus galloprovincialis (European blue mussel, Mediterranean mussel)

(Left: Pat Kight, Oregon Sea Grant; right: Jessica Miller, OSU)

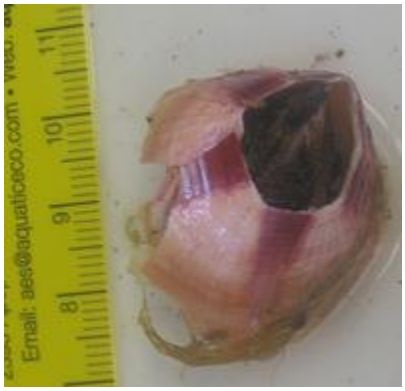
Mytilus galloprovincialis is dark blue or brown to almost black. The two shells are equal and nearly quadrangular. The outside is black-violet colored, trending to shades of brown and often with a varnished sheen; on one side the rim of the shell ends with a pointed and slightly bent umbo, while the other side is rounded, although shell shape varies by region (ISSG). This mussel cannot be easily

distinguished externally from our native mussel *Mytilus trossulus*; thus, as with *Hemigrapsus* crabs, it should not be collected unless a state authority asks you to do so.

- **INVASIVE**
- **Size range:** up to 15 cm, although typically only 5–8 cm

Megabalanus rosa **(acorn barnacle)**

(Both photos: OSU Hatfield Marine Science Center)



Megabalanus rosa has a five-plated acorn/conical-shaped smooth shell that is pinkish to red and sometimes white. The detail of the operculum can be used to identify the species. The orifice is often greater than ½ its basal diameter. This genus of barnacle grows rapidly and is larger than many other barnacles. It can be found on any hard substrate, such as wood, rock, concrete, and reef, and resides in low to subtidal waters. (Australian NIMPIS)

- **INVASIVE**
- **Size range**: up to 5 cm in height

What You Can Do if You Spot Invasive Species on Marine Debris

Marine debris containing species **in addition to** gooseneck barnacles **IS** of concern.

If you find marine debris with species other than gooseneck barnacles on them (or if you are unsure of the species):

1) Take several photos, from different distances, of the organisms found with the marine debris, and place some type of object next to each organism as a scale reference, such as a pen, pocketknife, pop can, or shoe. Send the photos to **DisasterDebris@noaa.gov** *and* to your state Fish and Wildlife department's invasive species coordinator (see table of contact information at end) along with the location, your name, the date, and a short description.*
2) If the item is small, drag it above the high-tide line (to keep it out of the ocean) or place it in a designated dumpster.
3) Under no circumstances should marine debris with substantial organisms growing on its surface (biofouling) or in cavities be towed or moved into estuarine and nearshore environments, until the species can be confirmed and treated by the proper authorities (see contact information).

*Please adhere to the following protocols if you are asked by experts to collect specimens for detailed identification in addition to photos.

Some of the species listed here can look very similar to native species, so it is best not to collect specimens unless you are requested to do so by a state authority. Take several photos, from different distances, of the organisms found with the marine debris. Place an object (a pen, pocketknife, pop can, or shoe) next to each organism as a scale reference. Send the photos, along with the location, your name, the date, and a short description, to DisasterDebris@noaa.gov and to your state Fish and Wildlife Department's invasive species coordinator (see the table of contact information at the end of this document).

Specimen Collection Protocols

For animals

1. **Temporary live collection to transport to authorities:** Place the organism in a small plastic bag with a label, and place in a cooler of ice. For short-term storage, organisms can be placed in a refrigerator for up to 24 hours or in a freezer for longer periods of time. Frozen specimens can be transferred in a cooler of ice if the drop-off time is less than 4 hours. (If transfer time is greater than 4 hours, or if the specimens are to be mailed, see **Preservation**, below).
2. **Preservation:** Place **animals** in well-sealed plastic jars in 70–95% ethanol (or gin, vodka, or rubbing alcohol if ethanol is not available). Be sure to include on the label what preservation solution was used (e.g., ethanol, gin, rubbing alcohol).

For seaweeds

1. Place **seaweeds** in between two seawater-dampened paper towels, place in a plastic bag on ice, and keep cool (for 1- to 2-day delivery to taxonomist).
2. For longer-distance seaweed transport and mailing, there are three options: (1) prepare pressed specimens (best for larger specimens), (2) preserve in 5% formalin/seawater, or (3) dry in silica gel. NOTE: seaweed specimens should be scraped off the substrata with holdfast intact and reproductive material, if possible.

Labels for both animals and seaweeds

It is critical that you place a label *inside* the container and affix a label on the outside as well. Details are provided below for **external** and **internal** label procedures.

1. A clear **EXTERNAL** label should be placed on the outside of any collecting container. The label should be written in pencil or permanent marker and include your contact information, date collected, name of collector (if different), preservative used, and exact location of collection (GPS coordinates, if known).
2. A clear **INTERNAL** label is critically important as external labels can fall off, and it is difficult to determine what specimens are and where they came from after the fact. This label should be written in pencil on paper (preferably waterproof paper, if available) and include your contact information, date collected, name of collector (if different), preservative used, and exact location of collection (including GPS coordinates, if known).

Mailing

Mail the specimen to appropriate contact**.** Be sure to follow your mailer's rules and guidelines for transporting chemicals (some carriers will not mail items in standing alcohol, in which case animals should be wrapped in paper towels damp with alcohol). Notify the intended recipient that you have mailed the specimen.

State and Provincial Contact Information

Send marine debris pictures to DisasterDebris@noaa.gov as well as to the appropriate state or provincial contact listed below.

Washington	1-855-WACOAST Invasive species coordinator: Allen Pleus, allen.pleus@dfw.wa.gov
Oregon	Beach.debris@state.or.us, call 211 Invasive species coordinator: Rick Boatner, rick.j.boatner@state.or.us
California	Invasive species coordinator: Martha Volkoff, MVOLKOFF@dfg.ca.gov
Alaska	Invasive species coordinator: Tammy Davis, tammy.davis@alaska.gov
Hawaii	dlnr.marine.debris@hawaii.gov, 808-587-0400 Invasive species coordinator: Sonia Gorgula, Sonia.Gorgula@hawaii.gov
British Columbia	Invasive species coordinator: Thomas Therriault, Thomas.Therriault@dfompo.gc.ca

References

Acorn barnacle:
http://adl.brs.gov.au/marinepests/index.cfm?fa=main.spDetailsDB&sp=6000009296#generalInfo
Asian shore crab:
http://fl.biology.usgs.gov/Nonindigenous_Species/Asian_shore_crab/asian_shore_crab.html
Dead man's fingers: http://myweb.dal.ca/rescheib/codium.html
European blue mussel: http://www.issg.org/database/species/ecology.asp?si=102
Northern Pacific seastar: http://www.biosecurity.govt.nz/pests/northern-pacific-seastar
Red alga: http://seagrant.uconn.edu/whatwedo/ais/listour.php
Response Protocols for Biofouled Debris and Invasive Species Generated by the 2011 Japan Tsunami:
http://www.anstaskforce.gov/Tsunami/FINAL%20JTMD%20Biofouling%20Response%20Protocol_19%20Oct%202012.pdf

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Partners

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