



# KEY AQUATIC INVASIVE SPECIES WATCH

*Japanese Tsunami Marine Debris in the Eastern Pacific*



## THE MARCH 11, 2011, TSUNAMI OFF THE COAST OF JAPAN

sent an estimated 5 million tons of debris into the ocean, of which the government of Japan estimated 1.5 million tons (most of it likely woody construction debris) remained afloat initially. An unknown amount is still circulating in the currents of the Pacific Ocean. Driven by currents and winds for more than 5,000 miles from the tsunami-damaged fishing port of Misawa, Japan, a 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. Today, more than four years after the tsunami, marine debris

with species native to Japan continue to wash up on North American shores and are expected to circulate in ocean currents for years to come. Prior to the arrival of the tsunami-driven dock, some invasion biologists had predicted that the tsunami debris transiting across the Pacific would be colonized only with open-ocean (pelagic) species such as gooseneck barnacles (*Lepas* spp., below).



## PELAGIC GOOSENECK BARNACLE—NOT AN INVADER! (*Lepas anatifera*)

Gooseneck barnacles (*Lepas* spp.) are open-ocean (pelagic) barnacles. They are the most common and abundant species found on marine debris. Gooseneck 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

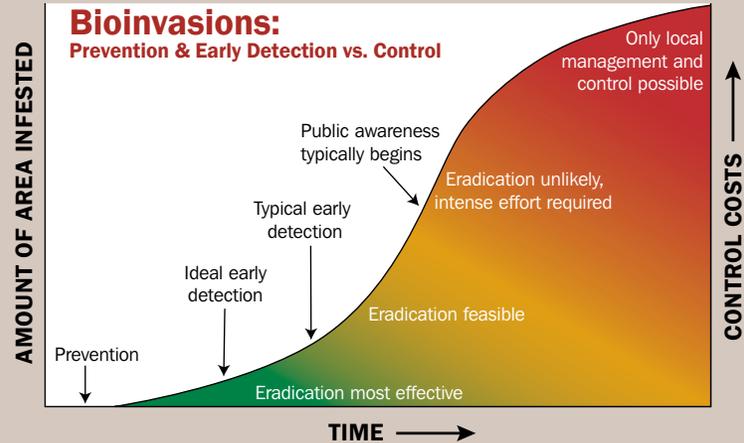


Left photo: A colony of *Lepas anatifera* with their stalks extended.  
Right photo: *Mytilus galloprovincialis* (top), *Lepas anatifera* (bottom).

## 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 on tsunami debris after at least 15 months in the open ocean spotlights an invasive species pathway driven by natural disasters in the modern era. Living nearshore species drifting across the Pacific and surviving on rafts of large, human-made and natural debris are a newly discovered phenomenon. Until the 2011 Japanese tsunami, we lacked documented evidence of this occurring in the North Pacific Ocean, involving such a large volume of biofouled material moved into the ocean within a short period of time. Compared to the 1800s and early 1900s, people in the modern era have created an extensive amount of coastal marine infrastructure that can be washed out to sea by tsunamis. These marine structures provide multiple substrates and microhabitats for a wide array of bio-fouling 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. Successful establishment of these species can harm the ecology, economy, and human health. However, it might be years after their arrival before these organisms become established and are discovered. Early detection and rapid response (EDRR) will help prevent such establishment and its harmful effects.

Listed in this guide are nine known, potentially invasive species to watch for (early detection) on marine debris, including Japanese tsunami debris. As of May 2015, each of these has been found on large structures of marine origin (e.g., docks, boats, pilings, pallets) that have washed onto North American shores from the 2011 Japanese tsunami.



## WAKAME KELP—INVADER! (*Undaria pinnatifida*)

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 on its blade margin and two highly ruffled sporophylls at its base. (Gayle Hansen, OSU)

- Size range: blades can grow to 3 m long (see image on page 9 of the long blades of *Undaria pinnatifida* attached to the dock that washed ashore at Agate Beach, Oregon, 15 months after being washed out to sea by the 2011 Japanese tsunami)



-*Undaria pinnatifida*-  
Young and without  
sporophylls

-*Undaria base*-  
Mature and with  
ruffled sporophylls

## RED ALGA—INVADER! (*Grateloupia turuturu*)

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. It can be slimy to the touch (as opposed to wet and slippery, as with other kelp), and it can feel grainy and rough when reproductive. It reproduces both vegetatively, from the edges of its blade, and via spores. (Connecticut Sea Grant)

- Size range: can grow to 3 m long

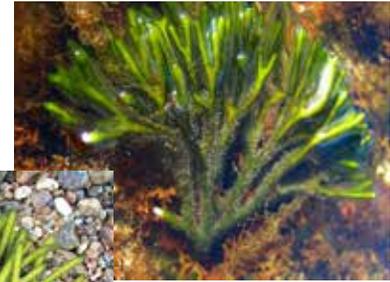


## DEAD MAN'S FINGERS—INVADER! (*Codium fragile* subsp. *fragile*)

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)

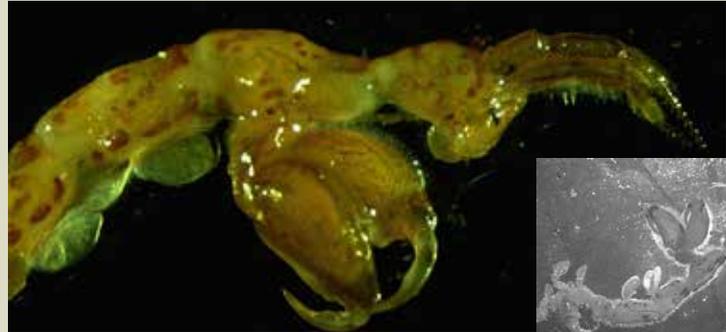
- Size range: can grow to 1 m long



## SKELETON SHRIMP—INVADER! (*Caprella cristibrachium*)

Caprellids, or “skeleton shrimp,” are a group of amphipods found worldwide in intertidal or subtidal waters. They have a highly modified body with elongated appendages and a small head. The abdomen is small, rendering the animal similar to a stick figure. Caprellids are found on upright structures and marine organisms such as bryozoans and hydroids. (John Chapman, OSU)

- Size range: can grow to 4 cm long



## STRIPED BEAKFISH—NONNATIVE

ALSO CALLED STRIPED KNIFEJAW, BARRED KNIFEJAW, ROCK BREAM, ISHIDAI

### *(Opelgnathus fasciatus)*

*Opelgnathus fasciatus*, the striped beakfish, is a species native to East Asia including Japan, Taiwan, China, and Korea. However, they have been found in locations across the Pacific Ocean, including the Hawaiian Islands and Midway Atoll, to which they likely were transported by the Kuroshio Ocean Current. More recently, a few striped beakfish have been found in the Pacific NW, several of which arrived on marine debris from the 2011 Japanese tsunami.

Juveniles have a yellowish-silver body with seven black vertical bands, which help camouflage them among kelp. As juveniles, striped beakfish are associated with drifting seaweed and marine debris, which may be a pathway of introduction. As striped beakfish age and grow, their body color turns from yellowish to grayish-white, the region around their mouth begins to darken, and their stripes disappear. Full-grown adult males develop a silvery body and a dark black mouth. Mature females develop a uniform dark body.

Striped beakfish prefer to live among rocky reefs in shallow waters, and adults can be found on the ocean bottom. Their distinguishing beak-like jaw specializes in breaking down hard-shelled organisms such as crustaceans, shellfish, and sea urchins. Striped beakfish can grow to 70 cm and live 10 to 20 years.



Juvenile striped beakfish (Sam Chan)



Adult striped beakfish (Hiroaki Matsumoto)

## SPECIMEN COLLECTION PROTOCOL

If you find a striped beakfish in Oregon, please take photos of the fish and call **1-866-INVADER** or report it online at **oregoninvasiveshotline.org**. The Oregon Dept. of Fish and Wildlife will be contacted promptly to assist you.

If you find a striped beakfish in another state, please report it to the appropriate state and provincial contacts listed on the back cover.

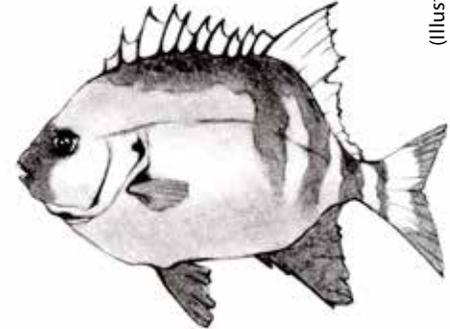


Striped beakfish found alive in a Japanese boat swept out by the 2011 Tohoku tsunami and beached on the Washington coast (WDFW-Pleus)

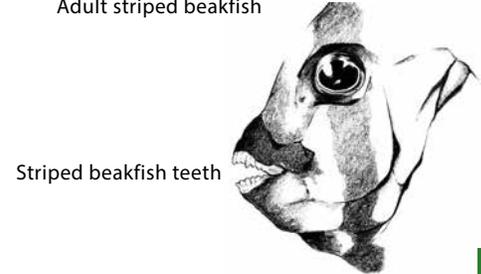
(Travis Haring)



Juvenile striped beakfish



Adult striped beakfish



Striped beakfish teeth

(Illustrations by Amanda Slade)

## ASIAN/JAPANESE SHORE CRAB—INVADER! (*Hemigrapsus sanguineus*)

The Asian/Japanese shore crab has a square-shaped shell with three spines on each side of the carapace, ranging in color 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 on page 10.

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



## NORTHERN PACIFIC SEASTAR—INVADER! (*Asterias amurensis*)

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 also be found from the intertidal area through to the subtidal as deep as 200 m. (New Zealand Ministry for Primary Industries)

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



## EUROPEAN BLUE MUSSEL, MEDITERRANEAN MUSSEL—**INVADER!** (*Mytilus galloprovincialis*)

*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.

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



## ACORN BARNACLE—**INVADER!** (*Megabalanus rosa*)

*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 half 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)

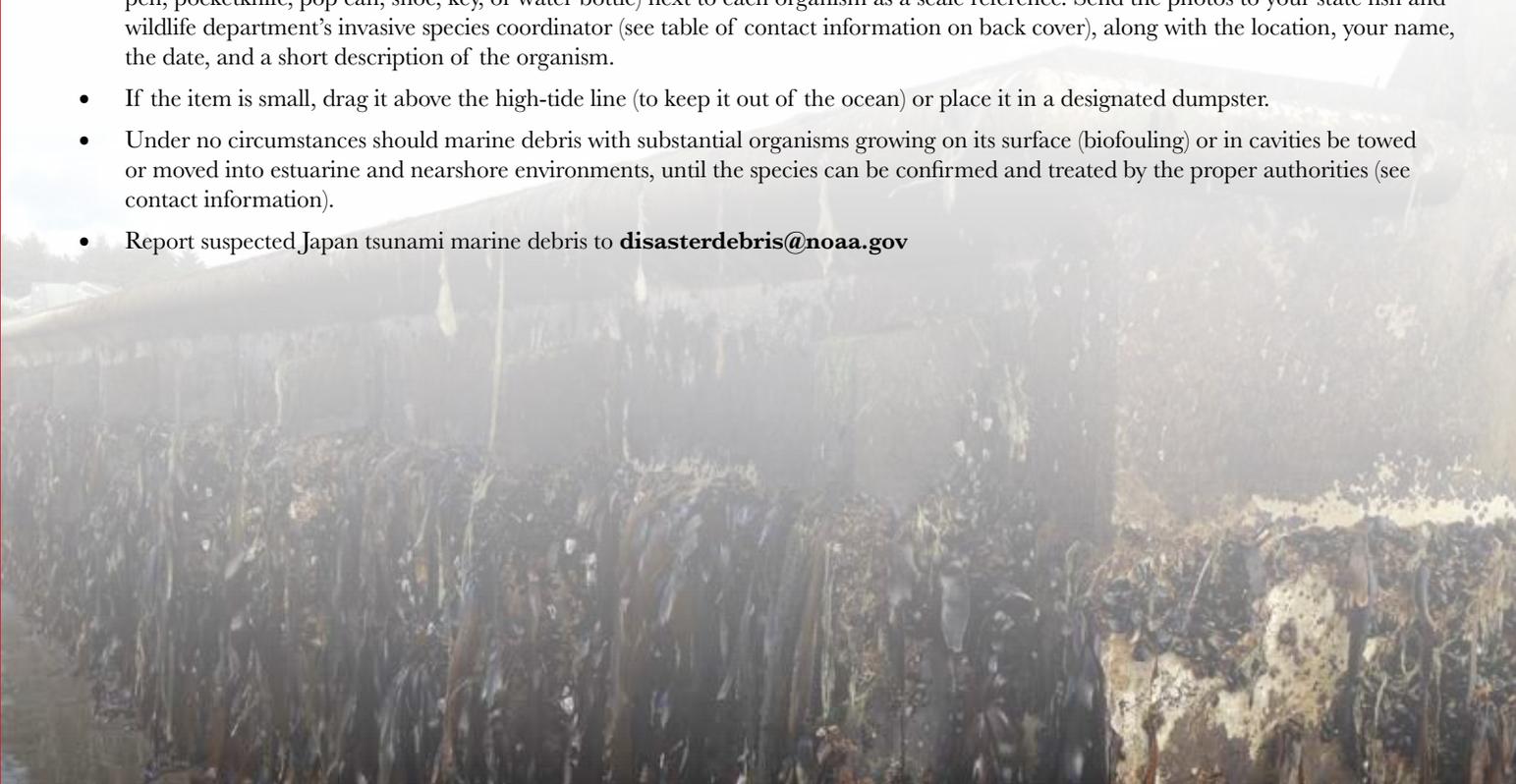
- Size range: up to 5 cm in height



## 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):

- Take several photos, from different distances, of the organisms found with the marine debris, and place some type of object (e.g., a pen, pocketknife, pop can, shoe, key, or water bottle) next to each organism as a scale reference. Send the photos to your state fish and wildlife department's invasive species coordinator (see table of contact information on back cover), along with the location, your name, the date, and a short description of the organism.
- 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.
- 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).
- Report suspected Japan tsunami marine debris to **[disasterdebris@noaa.gov](mailto:disasterdebris@noaa.gov)**



## **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, if ethanol is not available, gin, vodka, or rubbing alcohol). Be sure to include on the label what preservation solution was used (e.g., ethanol, gin, vodka, rubbing alcohol).

### **FOR SEAWEEEDS**

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 (the rootlike base of the seaweed that attaches to substrates) intact and reproductive material, if possible.

### **LABELS FOR BOTH ANIMALS AND SEAWEEEDS**

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 the appropriate state or provincial contact at right.

<b>Washington</b>	1-800-OILS-911 Invasive species coordinator: Allen Pleus, allen.pleus@dfw.wa.gov
<b>Oregon</b>	beach.debris@state.or.us; call 211; or visit oregoninvasiveshotline.org Invasive species coordinator: Rick Boatner, rick.j.boatner@state.or.us
<b>California</b>	Invasive species coordinator: Martha Volkoff, mvolkoff@dfg.ca.gov
<b>Alaska</b>	Invasive species coordinator: Tammy Davis, tammy.davis@alaska.gov
<b>Hawaii</b>	dlnr.marine.debris@hawaii.gov, 808-587-0164 Invasive species coordinator: Joshua Atwood, joshua.p.atwood@hawaii.gov
<b>British Columbia</b>	Invasive species coordinator: Thomas Therriault, Thomas.Therriault@dfompo.gc.ca

## REFERENCES

Acorn barnacle: <http://bit.ly/17aZo2Q> [last accessed 10 February 2015]

Asian shore crab: <http://on.doi.gov/16PPVNv> [last accessed 4 February 2015]

Dead man's fingers: <http://bit.ly/1zTvFEZ> [last accessed 4 February 2015]

European blue mussel: <http://bit.ly/1AU91iS> [last accessed 4 February 2015]

Northern Pacific seastar: <http://bit.ly/1y8Pvbf> [last accessed 4 February 2015]

Red alga: <http://bit.ly/1mxcw1N> [last accessed 4 February 2015]

Response Protocols for Biofouled Debris and Invasive Species Generated by the 2011 Japan Tsunami: <http://1.usa.gov/1IEOrXQ> [last accessed 4 February 2015]

Striped beakfish: <http://bit.ly/1JG324O> [last accessed 1 May 2015]

**ADDITIONAL RESOURCE:** Oregon Sea Grant video, *Responding to Risks of Marine Debris*: <http://bit.ly/1KBnQIQ> [last accessed 10 February 2015]

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