

Update Fall 2014:

**Marine Bioinvasions
and
Japanese Tsunami Marine Debris (JTMD)**

(t + 44 months from March 11, 2011 launch)

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Aquatic Nuisance Species Task Force Meeting
USFWS, Falls Church, Virginia
November 5, 2014

2011 Tōhoku Earthquake and Tsunami

March 11, 2011

Generated millions of tons of debris ejected into the North Pacific Ocean

- Debris was from the land and coastal zone.
- Debris was largely from northeastern Honshu prefectures (Aomori, Miyagi, Iwate, and Fukushima)
- Some of the debris field did not drift away from Japan in the spring of 2011: debris remained nearshore, and some debris drifted to southern Japan

Living organisms
generally on
Oceanic Debris
(fishing gear, glass floats, pallets, etc.)

Living organisms
generally not on
Oceanic Debris

Oceanic
Biofouling:
the gooseneck barnacle
Lepas



Harbor and Coastal
Biofouling:
**Mussels, balanid
barnacles, hydroids,
tubeworms**



How does tsunami-generated marine debris differ from “natural rafting” across the Pacific Ocean?

Historic Rafting:

wood
(trees, branches,
root masses)

Modern Rafting:

adds
anthropogenic
materials

Marine debris:

largely non-biodegradable material:
*long-lasting plastic, fiberglass, and other
floating substrates* differs fundamentally
from prehistoric rafting

How does tsunami-generated marine debris differ from other vectors ?

Ballast Water

Vessel Hull Fouling

Shipping vectors differ in *quality* and *quantity*
from slow-moving rafts
of mature adult marine biotic communities

(with the subsequential potential for long
residency in the target coastal region)

On the morning of Tuesday, **June 5, 2012**
451 days (14.5 months) at sea,
“**Misawa 1**” landed
just north of Newport, central Oregon

Lost March 11, 2011
from Port of Misawa,
Aomori Prefecture



Prior to the March 2011 Tohoku Tsunami
reports of

the rafting of living species from
Japan → North America

were non-existent in the
scientific, management, or historical literature



National Science Foundation RAPID Grant:

Testing the Invasion Process: Survival, Dispersal,
Genetic Characterization, and Attenuation of
Marine Biota on the 2011 Japanese Tsunami Marine Debris Field

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Questions and Goals

- **Diversity**: What species are capable of surviving a long-distance rafting journey, presumably largely through oligotrophic ocean waters ... and for how long?
- **Invasive Species?**: Are there species of obvious invasion concern (arriving alive and in reproductive condition), which may focus field surveys for target taxa?
(→ *Early Detection / Rapid Response*)
- **Vector Linkage**: Develop a genetic picture to confirm identifications and to match JTMD populations against any possible future invasions

National Science Foundation RAPID

Specifically

- ***Biodiversity***: Assessing overall species composition; for selected taxa: population structure, viability, reproductive condition, trophic structure, growth and dispersal track history (oxygen isotopic and (for example) barium contents of shells); oyster and mussel parasites and pathogens
- ***Biotic Attrition***: Tracking diversity, abundance, and frequency over time.
- ***Genetic Characterization***: Mitochondrial COI sequencing from mussels and other taxa to confirm identity and to contrast with native and established non-native species in western North America. Mixed species samples to be analyzed by next-generation sequencing of COI.

As of October 2014, we have received, collected, or examined **256 objects** (docks, boats, floats, buoys, *et al.*) generated by the 2011 Tohoku Tsunami and with Japanese biofouling aboard (from AK, BC, WA, OR, CA, and HI)

JTMD BEARING JAPANESE BIOFOULING SPECIES

**NATIONAL SCIENCE FOUNDATION RESEARCH GRANT:
REGISTER OF BIOFOULED DEBRIS**

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Registration is in order of information received, not necessarily in chronological order

SUMMARY

Register Number	Type	Photograph	Code Name (and name of boat, if known)	State/Territory/Province	Location	Date of Interception	Origin in Japan (Prefecture)
JTMD-BF-1	dock		Misawa 1 (M1)	OR	Agate Beach	2012 June 4	Misawa (Aomori)
JTMD-BF-2	vessel		Ilwaco boat <i>Name of boat:</i> 壮洋 (Sou-you; "Vast Ocean")	WA	Ilwaco		
JTMD-BF-3	float		Thompson float	OR	off Lincoln City	2012 June	
JTMD-BF-4	float		OR offshore float	OR	off Alsea Bay	2012 June	

Each object is assigned a unique JTMD-BF-#

Diversity (phyletic range) is impressive

ALGAE seaweeds

CYANOBACTERIA

RHIZARIA

CILIOPHORA

PORIFERA

CNIDARIA

Hydrozoa

Anthozoa

NEMATODA

NEMERTEA worms

ANNELIDA: Polychaeta

MOLLUSCA

Gastropoda

Bivalvia

Polychaeta

clams, oysters

seaweeds

blue-greens

forams

ciliates

sponges

hydroids

sea anemones

nematodes

ribbon worms

worms

snails

mussels/clams

polychaetes

CRUSTACEA

Copepoda

Ostracoda

Cirripedia

Amphipoda

Tanaidacea

Isopoda

Decapoda

INSECTA

ACARINA

BRYOZOA

KAMPTOZOA

ECHINODERMATA

Asteroidea

Echinoidea

Holothuroidea

CHORDATA

Ascidiacea

Pisces

Barnacles, amphipods,
crabs, others

ostracodes

barnacles

amphipods

tanaids

isopods

crabs

marine flies

mites

moss animals

nodding heads

sea stars

sea urchins

sea cucumbers

sea squirts

fish

Long Beach, Washington: March 22, 2013



Sai-shou Maru
("Dignified Victory")

wet well

Abalone and sea urchin fishery boat



Seaside Aquarium, Oregon

Oplegnathus fasciatus
“Barred knifejaw”

(aka “Striped beakperch”
“Striped beakfish”, “False parrotfish”)





Government of Japan
Ministry of Environment (MoE)
funding through
North Pacific Marine Science Organization (PICES)

- * Continue (complete?) JTMD **biodiversity characterization**
- * Analysis of **Bivalve Parasites and Pathogens** Associated with JTMD
- * **DNA Barcoding** of JTMD Vouchers and Initial Creation of JTMD Barcode Database
- * **Early Detection of JTMD-Related Invasions**, including:
 - Initiate Surveys of Pacific Coast Mussels for Detection of Japanese Endoparasitic Hydroid *Eutima*
 - Initiate Collections of Environmental DNA (Plankton and Fouling)



ORIGIN
Misawa 1-4
March 11, 2011
Port of Misawa,
northern Honshu

Misawa 3
Found ashore
December 18, 2012
Olympic National Park, WA

Misawa 1
June 5, 2012
Agate Beach OR

Misawa 4
?

Misawa 2
September 17-19, 2012
Drifting past Maui and Moloka'i,
Hawaiian Islands

Misawa 2
*is still out
there as well*