

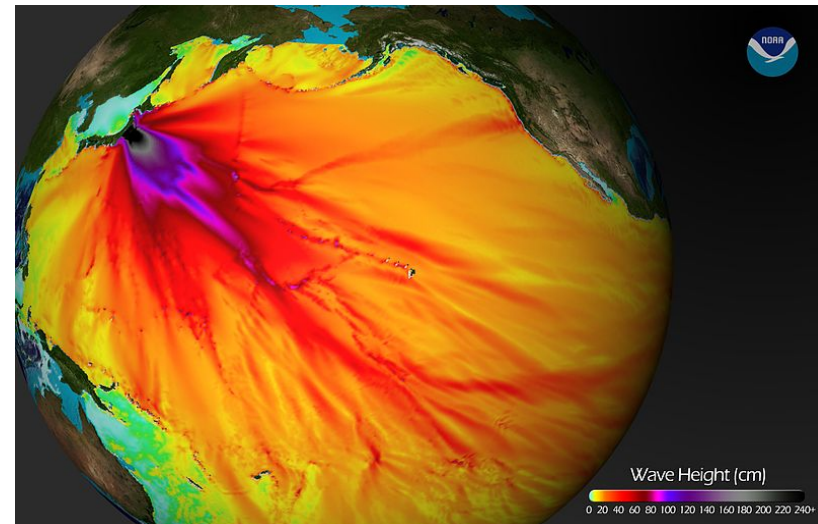


Ē Komo Mai

Story of Marine Debris from the 2011 Tsunami in Japan in Model Simulations and Observational Reports

Jan Hafner, Nikolai Maximenko
International Pacific Research Center
University of Hawaii
23-28 February 2014 / Hawaii Convention Center
Honolulu, Hawaii USA

11th MARCH 2011 Tsunami in Japan



Deposited on land

Sunk down to the ocean bottom

Floating in the ocean



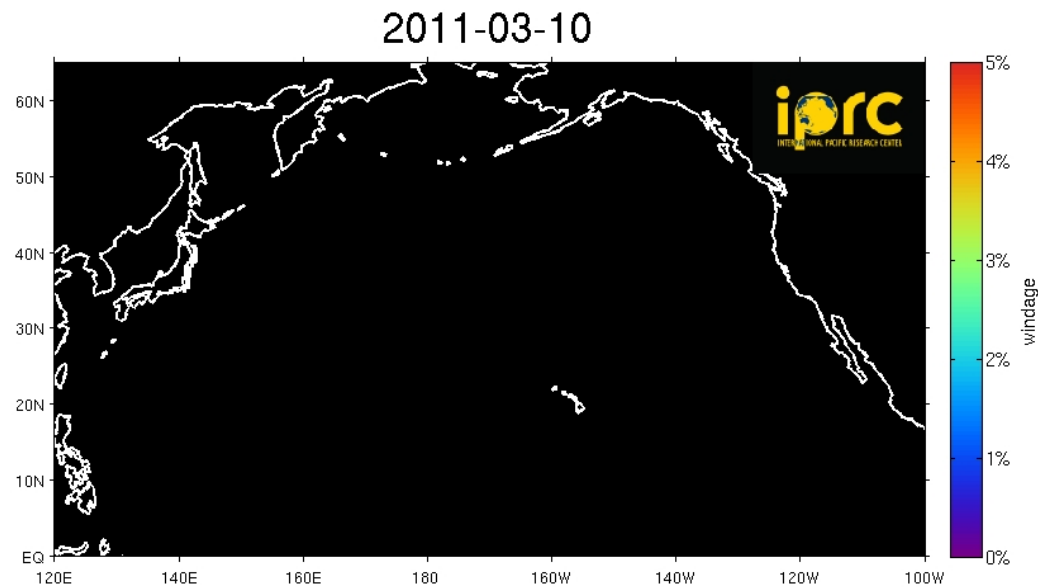
Courtesy of US Navy

IPRC Drift Model tracking tsunami debris

Apply our IPRC Drift Model which is based on our diagnostic model of ocean surface currents “SCUD “.

Debris is carried by surface ocean currents and moved by surface winds.

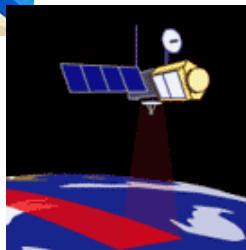
In computer model virtual tracer is placed along the coastline of east Japan and then advected by SCUD currents and QSCAT winds.



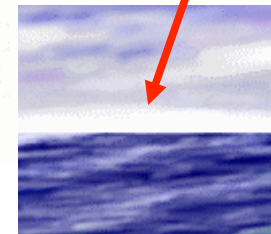
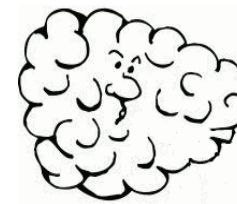
Source: Maximenko & Hafner, IPRC/SOEST, Univ. of Hawaii

SCUD - Surface CUrrents from Diagnostic model

AVISO sea level



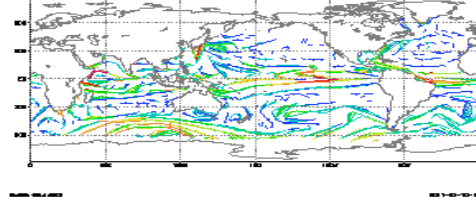
QSCAT/ASCAT ocean surface wind



SCUD



Ocean surface currents



Daily maps of ocean surface currents on 1/4 deg. lon/lat grid

Starting 01 AUG 1999
ending 18 NOV 2009
extended into real time

Formulation of the diagnostic model SCUD

$$U_{SCUD}(x,y,t) = U_0 + u_{hx} \cdot \nabla_x h(x,y,t) + u_{hy} \cdot \nabla_y h(x,y,t) + u_{wx} \cdot wx(x,y,t) + u_{wy} \cdot wy(x,y,t)$$

And similarly

$$V_{SCUD}(x,y,t) = V_0 + v_{hx} \cdot \nabla_x h(x,y,t) + v_{hy} \cdot \nabla_y h(x,y,t) + v_{wx} \cdot wx(x,y,t) + v_{wy} \cdot wy(x,y,t)$$

Where: U_{SCUD} , V_{SCUD} - modeled ocean current components

U_0 , V_0 - constant coefficient (mean)

h - sea level anomaly

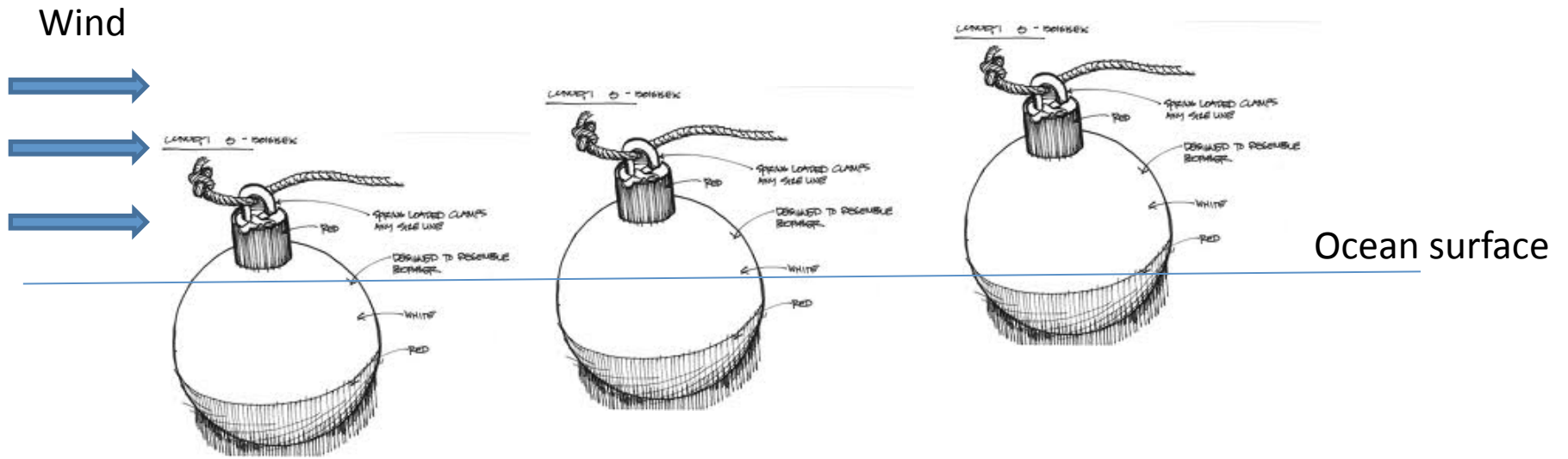
w_x , w_y U and V component of surface wind (QSCAT)

u_{hx} , u_{hy} , u_{wx} , u_{wy} - U component coefficients corresponding to sea level gradient and surface wind (function of x and y

only)

v_{hx} , v_{hy} , v_{wx} , v_{wy} - similarly corresponding V component coefficients

Windage



**Low windage,
object sitting deep in water**



Photo: Charles Moore

**Medium windage,
object sitting half in water**



Photo: Randal Reeves

**High windage,
object sitting high on water**

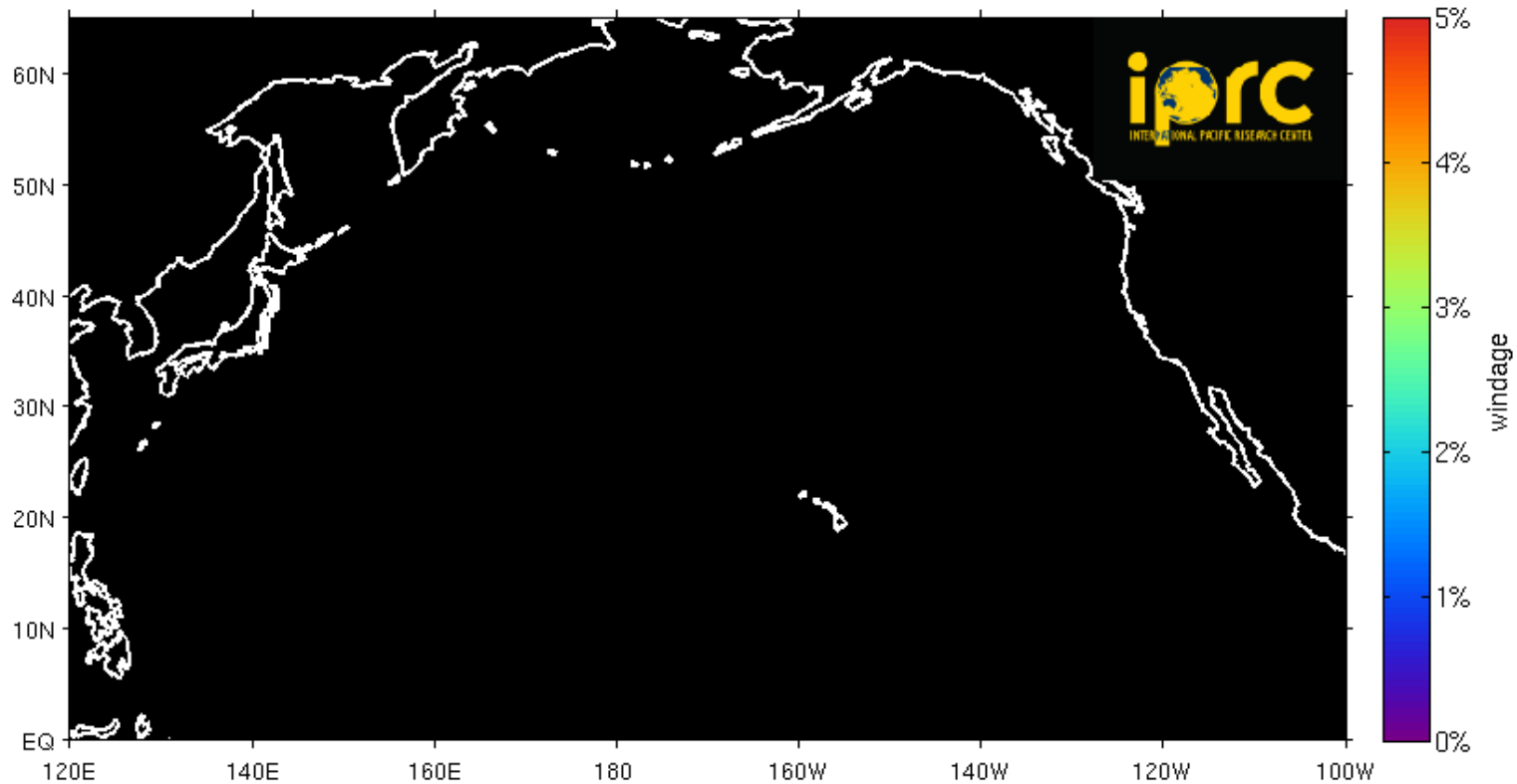


Photo: S/V "Tregoning"

For example 5% windage means an object is moving with the current + 5% wind speed

IPRC Drift Model: transport of tsunami debris

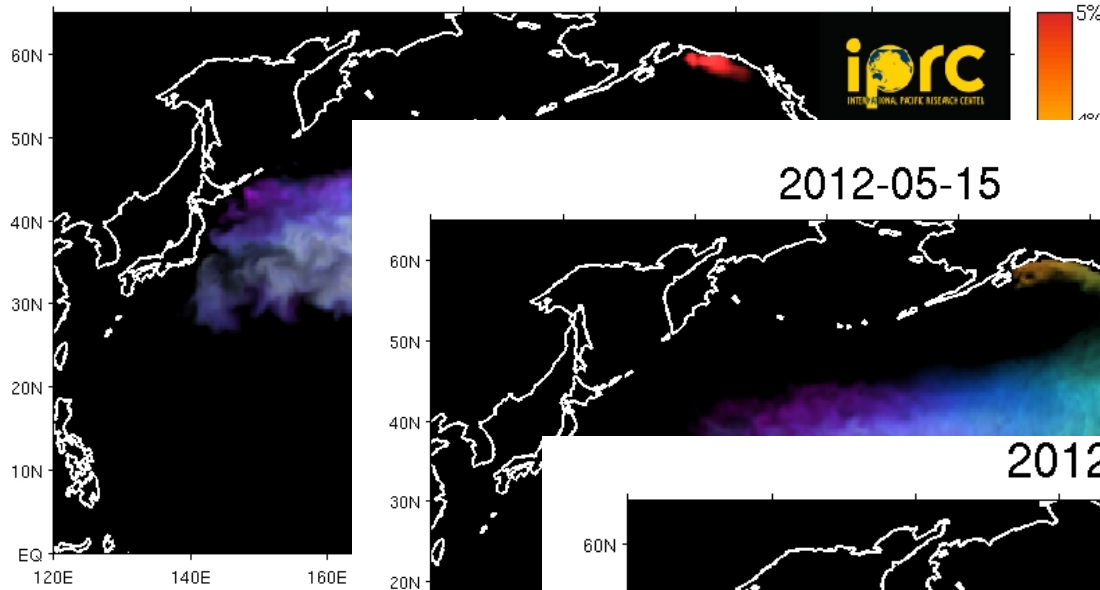
2011-03-10



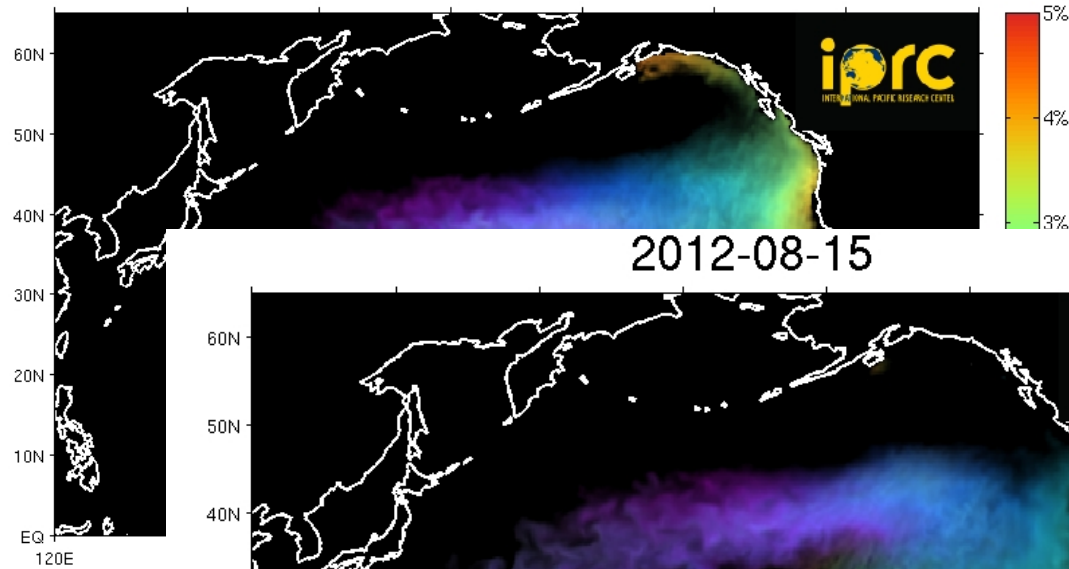
Source: Maximenko & Hafner, IPRC/SOEST, Univ. of Hawaii

Modeling the dispersion of tsunami debris

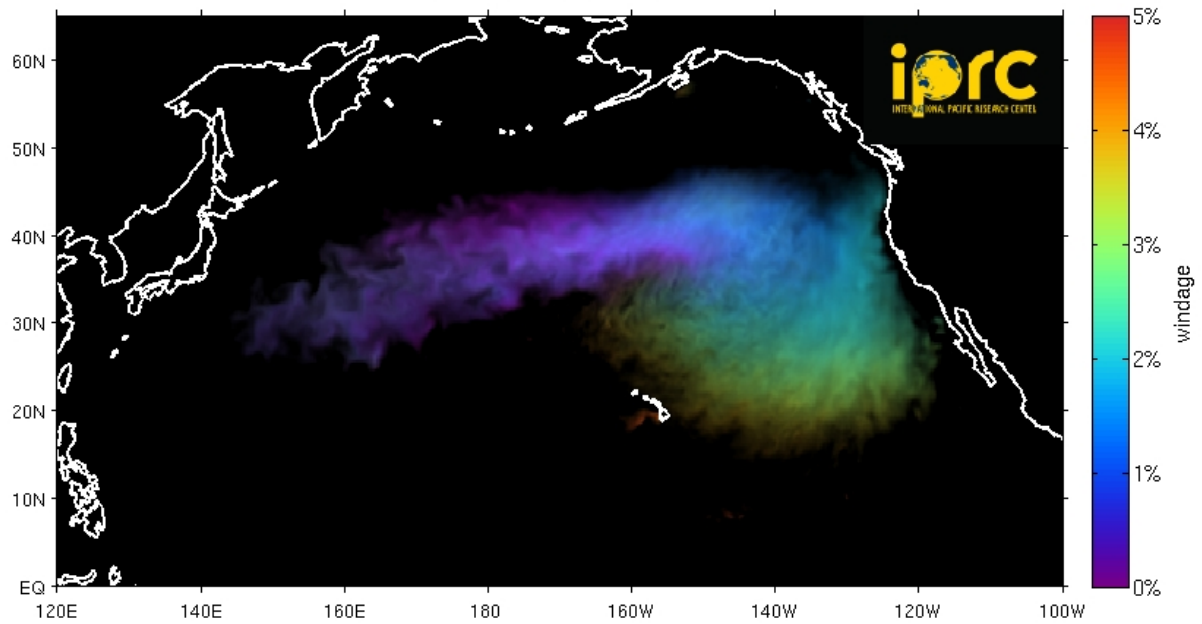
2011-11-15



2012-05-15



2012-08-15



Source: Maximenko & Hafner, IPRC/SOEST, Univ. of Hawaii

Actual Observations !

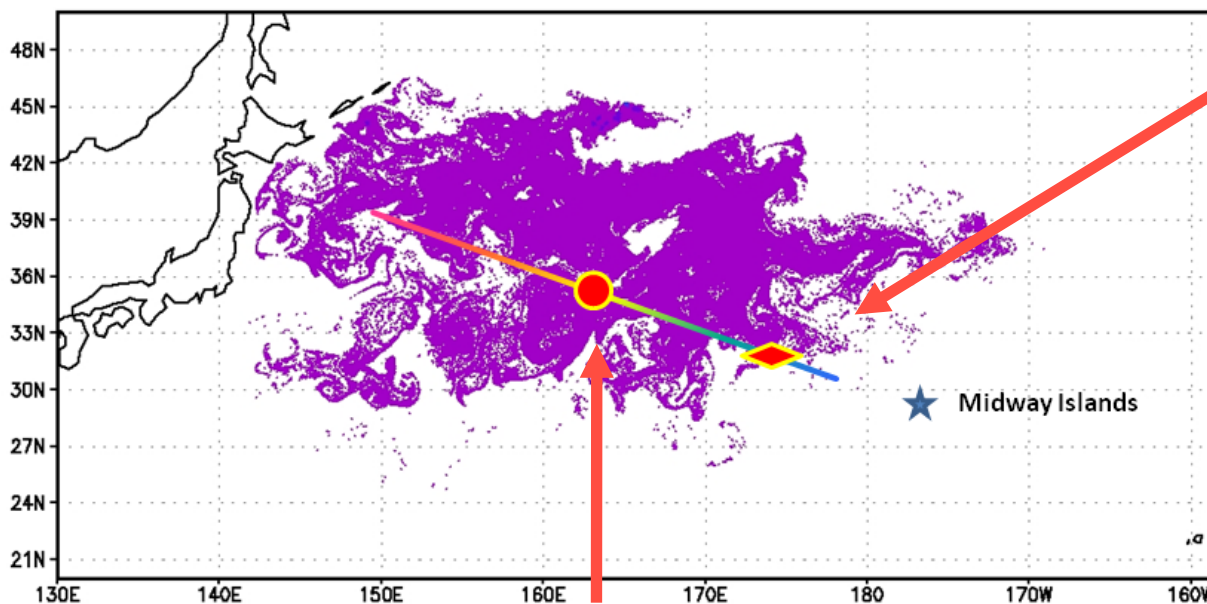
“Pallada” found tsunami debris where SCUD predicted

Small fishing boat, registered in Fukushima Prefecture



iporc
INTERNATIONAL PACIFIC RESEARCH CENTER

00Z25SEP2011



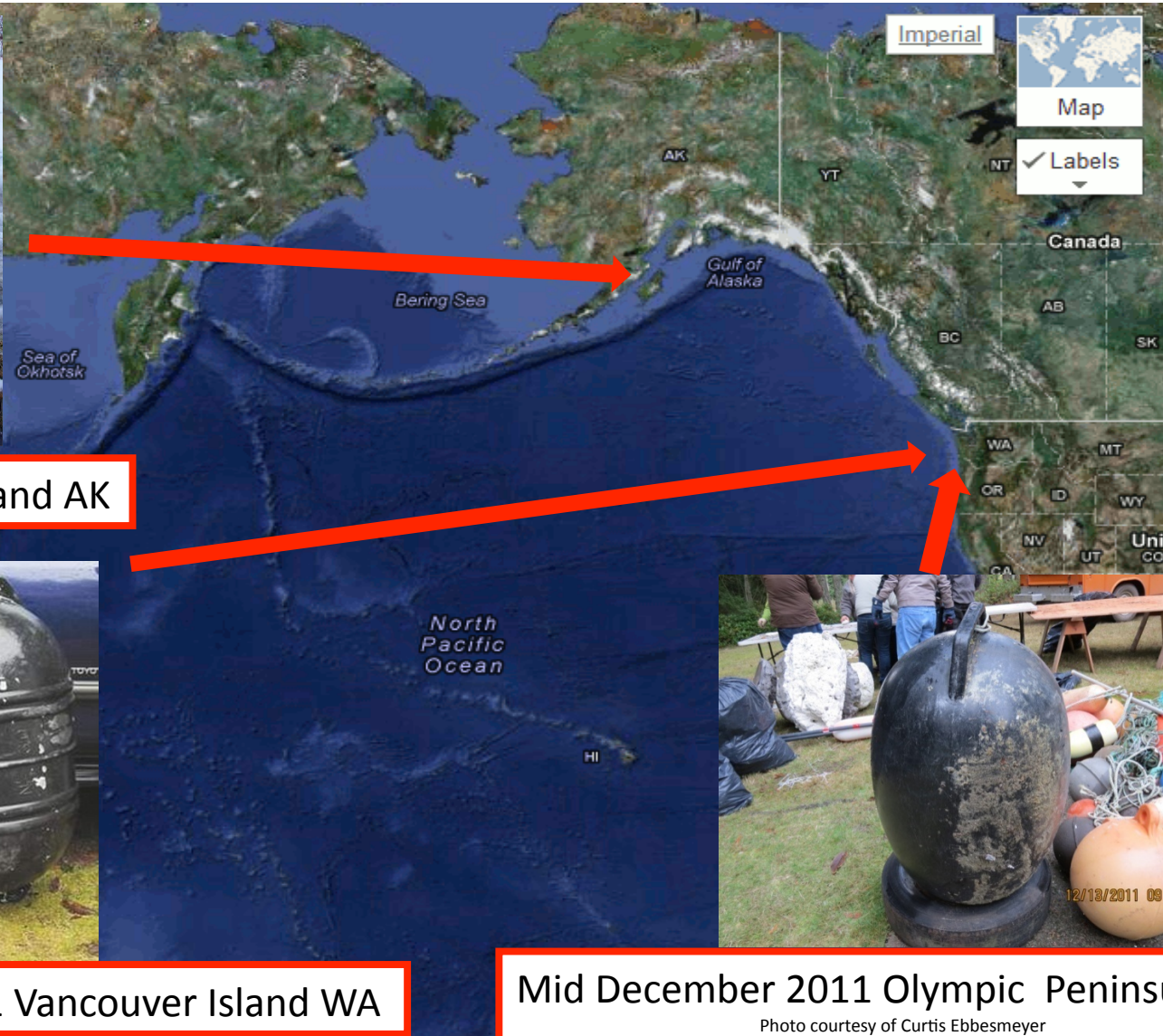
Observed maximum density of debris



Actual Observations West Coast of N. America



20 Dec 2011 Whale Island AK



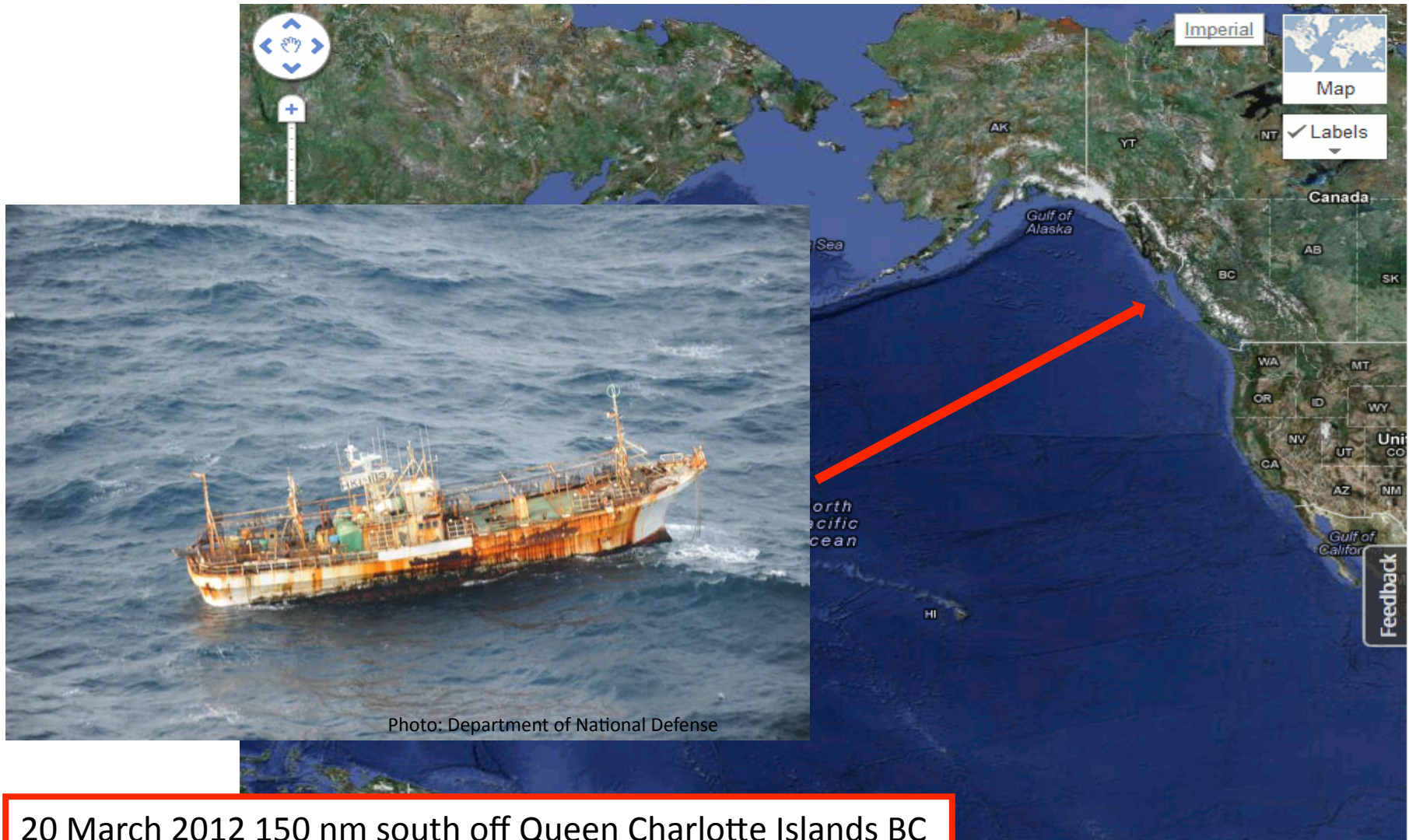
Early December 2011 Vancouver Island WA



Mid December 2011 Olympic Peninsula WA

Photo courtesy of Curtis Ebbesmeyer

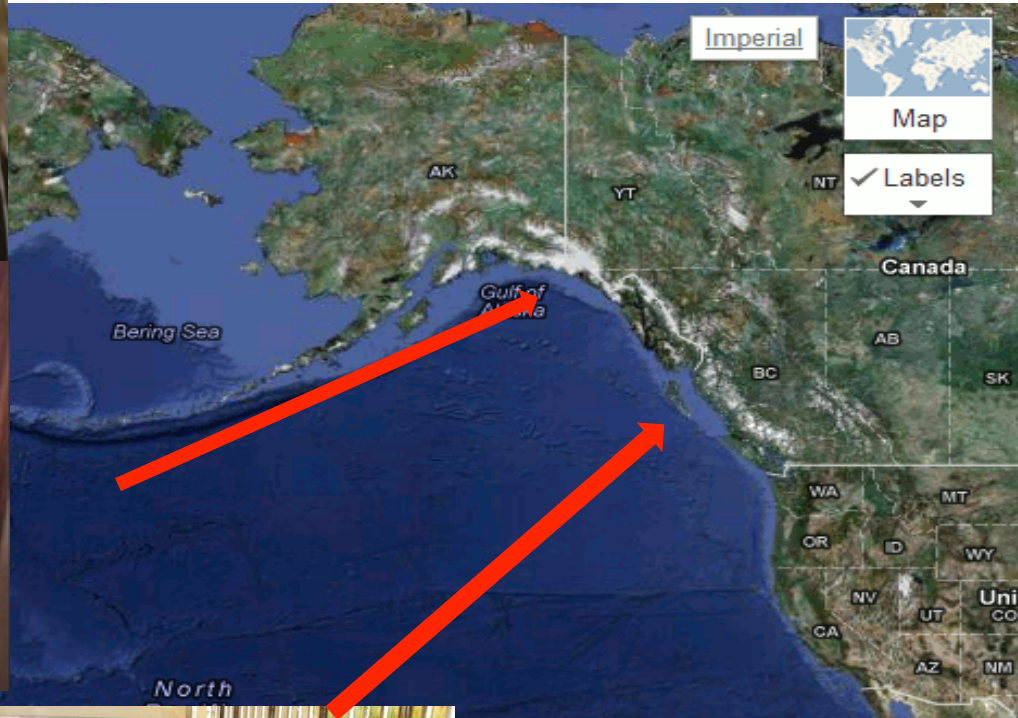
Actual Observations West Coast of N. America



Actual Observations North Pacific Ocean



Middleton Island April 2011



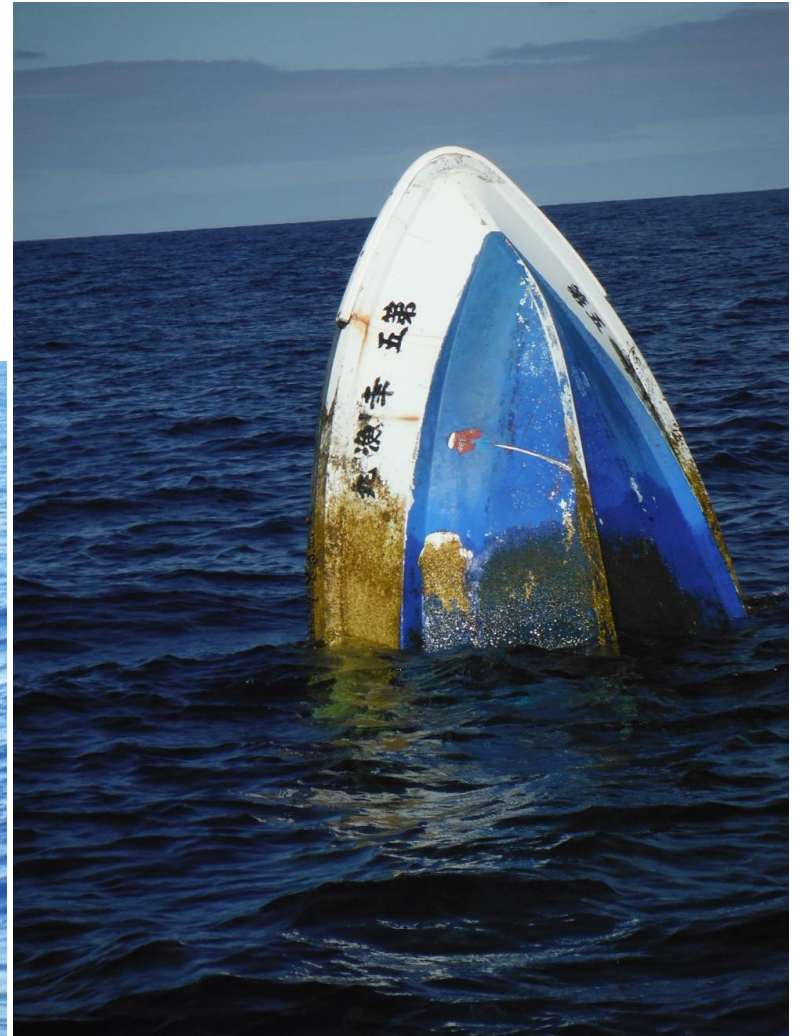
Graham Island April 2011



Actual Observations North Pacific Ocean



Actual Observations North Pacific Ocean



Actual Observations

Hawaii shores



Hilo, Big Island of Hawaii , June 2012



June 2012 –report of s/v
“Tregoning” north of Oahu



**August 19, 2012 –oyster
buoy reported by Carl
Berg
off Kilauea Point, Kauai**

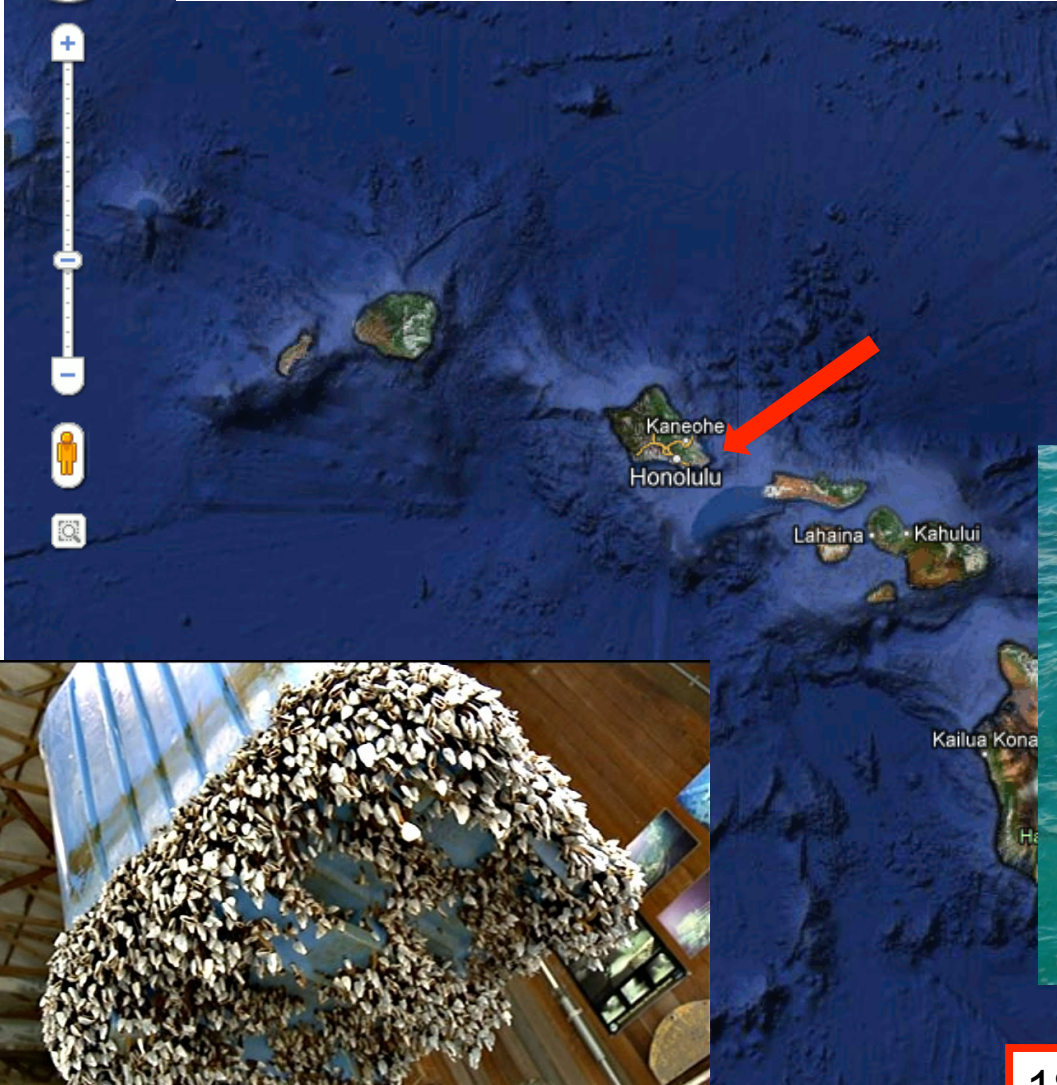
**September 3, 2012 –oyster
buoy reported by
Cynthia Vanderlipin Turtle
Bay, Oahu**

Kamilo, Big Island of Hawaii
Reported by Megan Lamson
July 14, 2012



Kure Atoll Northwest Hawaiian
Islands Reported by Scott Godwin
August 2012

Actual Observations Hawaii shores



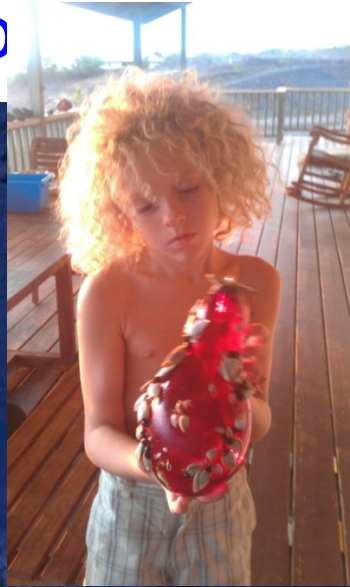
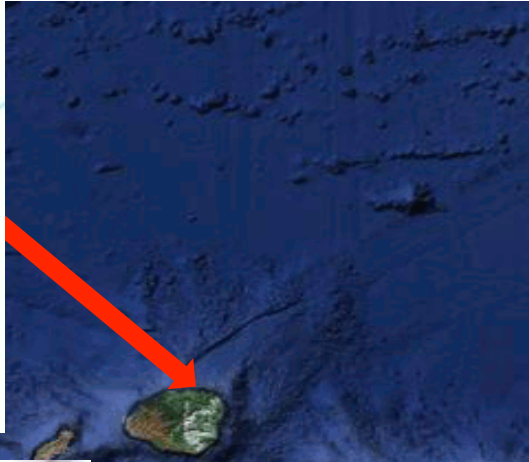
18 Sept. 2012 ,Y.K Suisan Co., Ltd

Actual Observations Hawaii shores



24-28 Sept. 2012 gasoline tanks Molokai

Actual Observations Hawaii sho



24-26 Sept. 2012 Japanese light bulbs Hanalei, Kawaihae Ha

Feedback

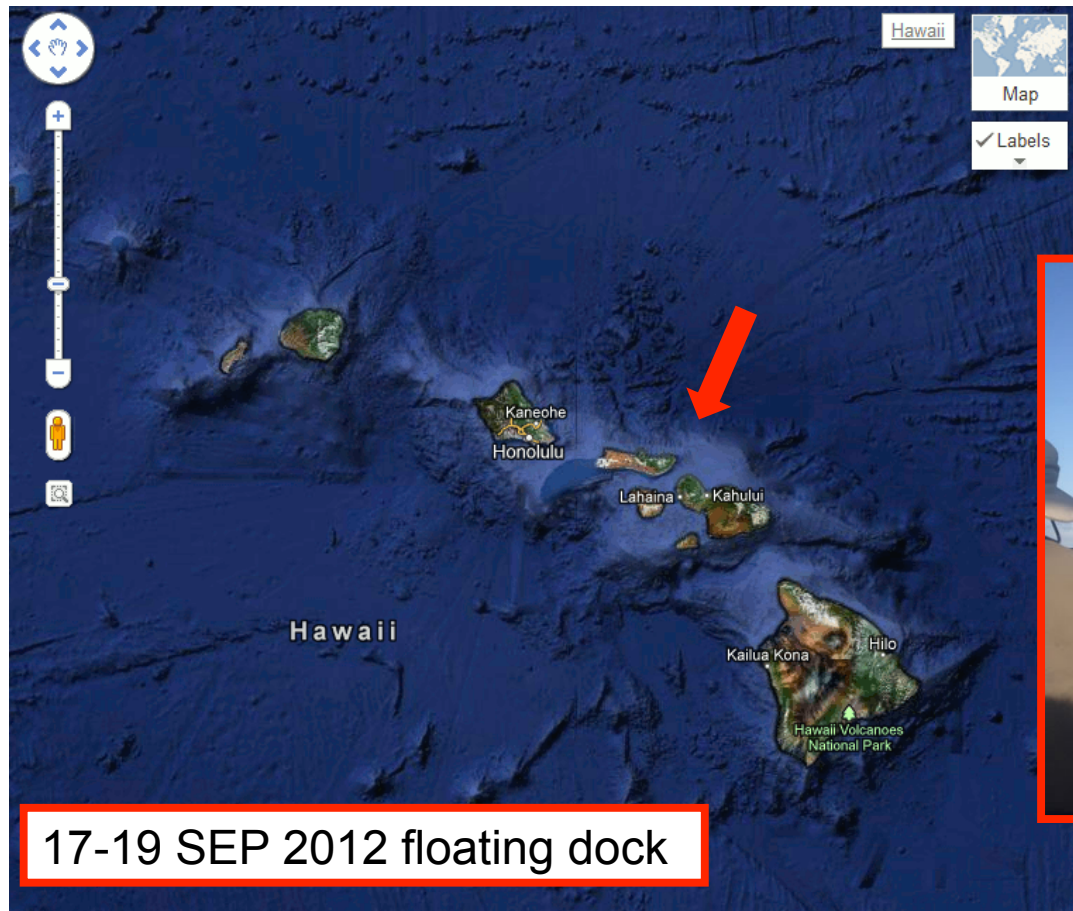
Actual Observations

Hawaii shores



03 Oct. 2012 yellow tank East of Big Island

Actual Observations Hawaii shores



Actual Observations Hawaii shores

The image features a satellite map of the Hawaiian Islands. A red arrow points to the island of Oahu. Four inset photographs show marine debris: a white styrofoam container, a yellow and blue boat, a rusted metal barrel, and a boat hull. Each photo is accompanied by a text box indicating the date and location. The map includes labels for Kaneohe, Honolulu, Lahaina, Kahului, and Kailua. UI elements like 'Hawaii', 'Map', 'Labels', and 'Feedback' are also visible.

Nov. 2012 Kahuku Golf Club coast, Oahu

Jan 2013 Hanauma Bay, Oahu

Nov. 2012 Kahana Bay, Oahu

Dec. 2012 Punaluu, Oahu

Jan 2013 Waialua, North Shore, Oahu

Hawaii

Map

Labels

Feedback

Kaneohe
Honolulu
Lahaina
Kahului
Kailua

Actual Observations Hawaii shores



Feb. 2013 Makapuu, Oahu



Jul 2013 Malaekahana, Oahu



Feb. 2013 Kahuku, Oahu



Aug 2013 Turtle Bay, Oahu



Mar. 2013 Kahuku, Oahu



Sep 2013 Lanikai, Oahu

Hawaii

Kaneohe
Honolulu
Lahaina

Hawaii Volcanoes National Park

awaii

Map

Labels

Feedback

Actual Observations Hawaii shores

Dec. 2012 Waipake Beach, Kauai

Mar. 2013 Waipake Beach, Kauai

Feb. 2013 Kapaa, Kauai

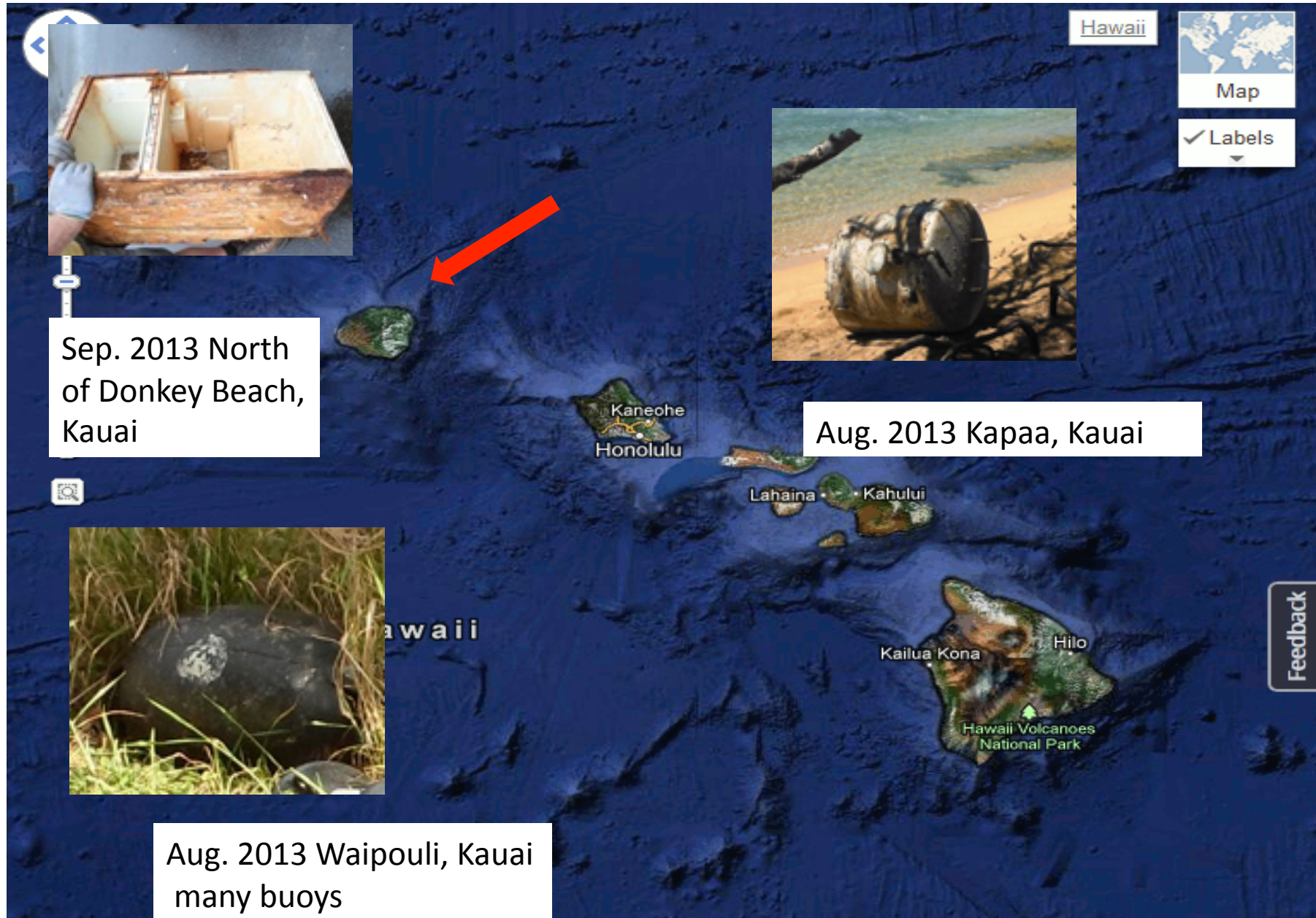
Jul. 2013 Kealia Beach, Kauai

Feb. 2013 Waipake Beach, Kauai

Feedback

The image is a satellite map of the Hawaiian Islands. A red arrow points to a small island in the upper left quadrant. Several inset photographs are overlaid on the map, each with a caption. The top-left inset shows a white container with a blue sensor. The top-right inset shows a white container with a blue sensor. The middle-left inset shows a white container with a blue sensor. The middle-right inset shows a white container with a blue sensor. The bottom-left inset shows a white container with a blue sensor. The bottom-right inset shows a white container with a blue sensor. The map includes navigation icons in the top-left corner and a 'Feedback' button in the bottom-right corner. Labels for 'Hawaii', 'Kauai', 'Honolulu', 'Kapaa', and 'Kealia' are visible on the map.

Actual Observations Hawaii shores



Actual Observations Hawaii shores wood



Actual Observations Hawaii shores wood

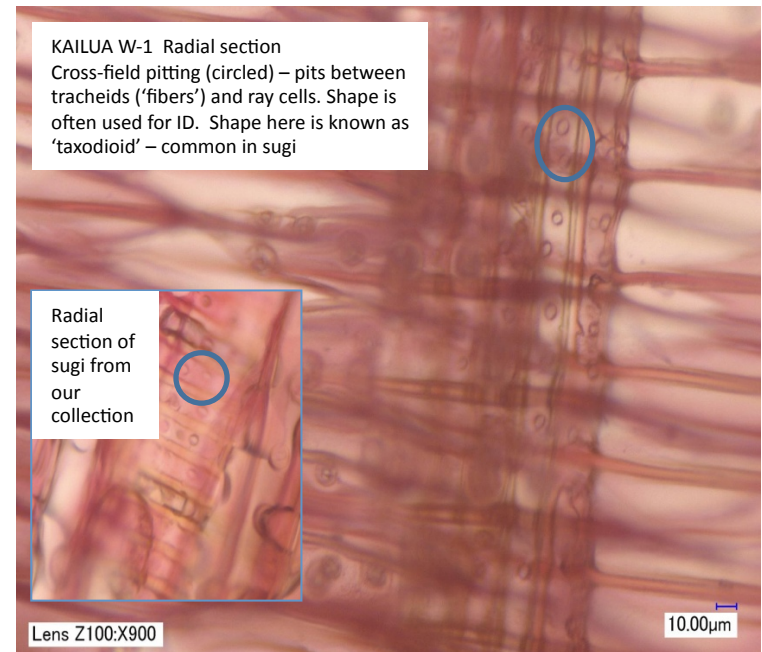
Origin: most likely Japan

tenon and mortise construction

many pieces of timber of Japanese cedar “sugi”

Also timing and large number of driftwood indicate origin from 2011 tsunami in Japan.

DNA analysis is pending



Scott Leavengood (Oregon State Univ.)
David Stallcop (Vanport International Inc.)

Changing composition in time

Observations



Buoys, bulbs,
canisters,
container

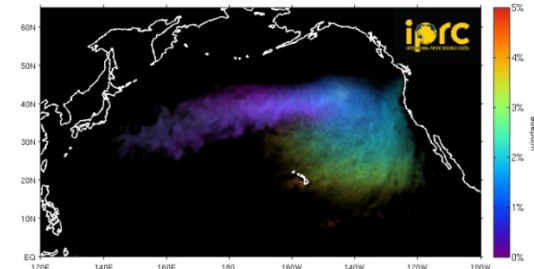


AUG-SEP 2012

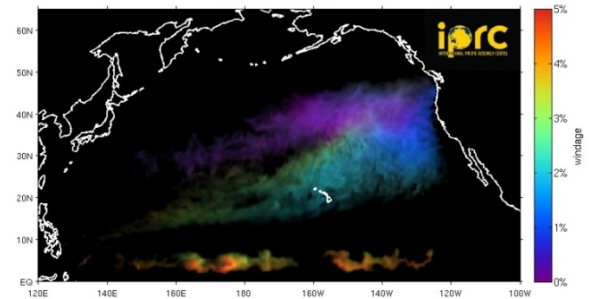
time

Model

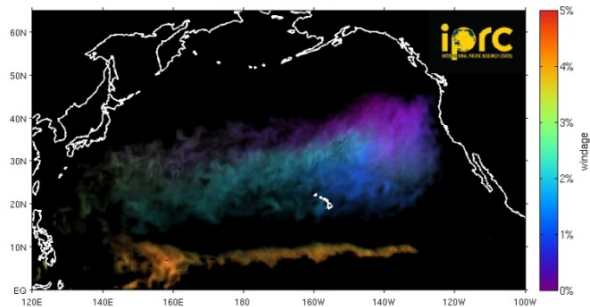
2012-09-01



2013-04-01

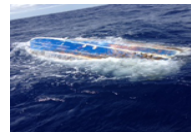


2013-11-01



MAR-APR 2013

Buoys, pallet,
fridge, boat



OCT-DEC 2013

Buoy, gas cylinder,
Timber beams,
Processed wood,
Wood poles
Tree trunks
Total number 24



The story

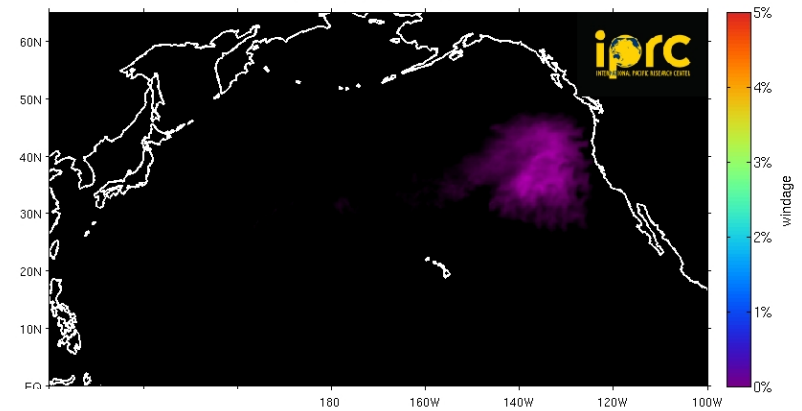
Debris sorted out by the effect of the wind

Low windage type : slow motion, destined to North Pacific Garbage Patch

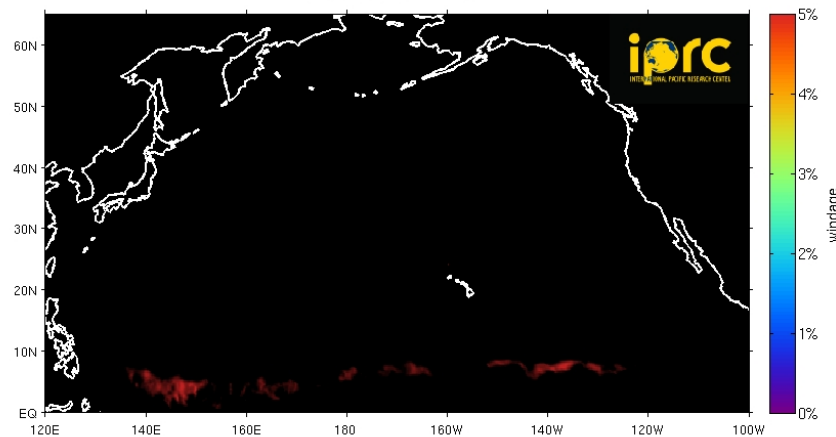
High windage type: fast moving,
destined to reach coastline

Model results consistent with
observed debris in composition
and arrival time onshore

2014-02-19

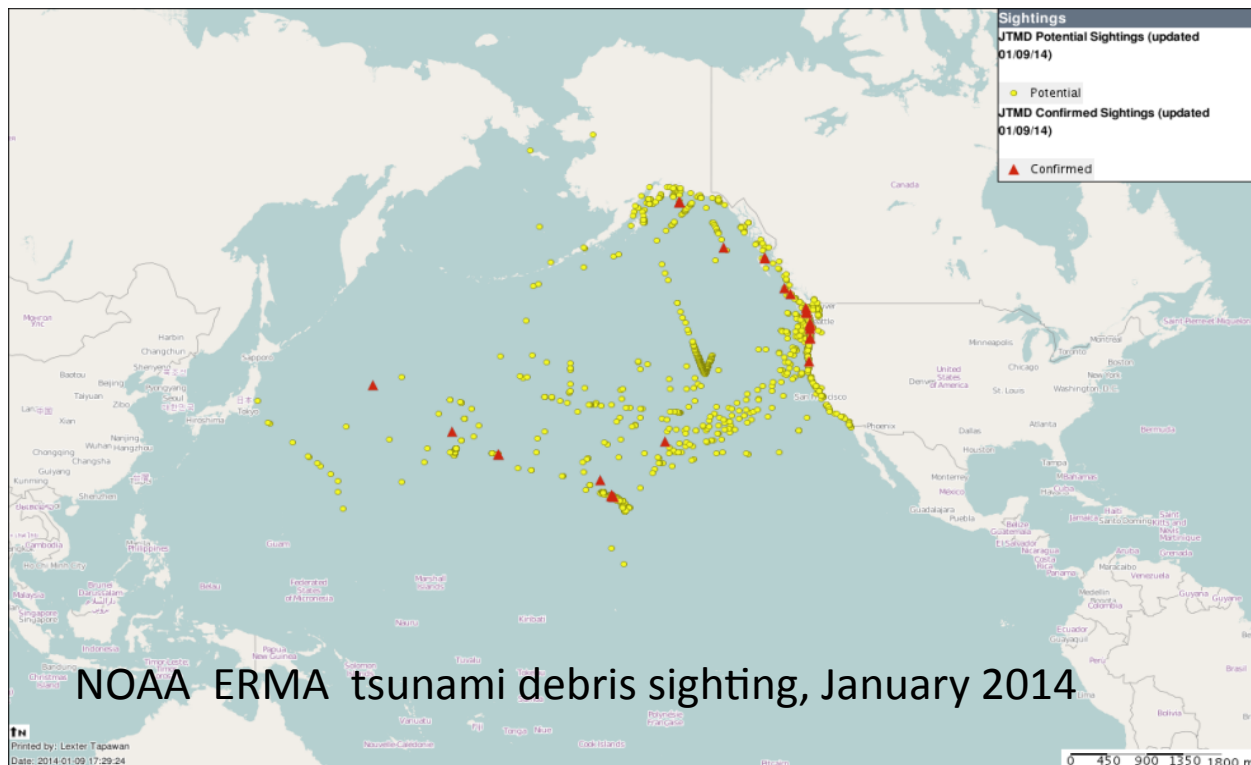


2014-02-19



The summary

- Observations are critical, but sparse especially in the ocean



The summary

- Volunteer observers: inconsistent reporting, only accidental sightings
- Needed: marine debris observing system
- Updates: IPRC Marine Debris Webpage

http://iprc.soest.hawaii.edu/news/marine_and_tsunami_debris/debris_news.php

Thank you !

