

Fukushima – a view from the ocean

Ken Buesseler, Senior Scientist
Woods Hole Oceanographic Institution

<http://cafethorium.whoi.edu>



HOME HELP FUND A LOCATION PROPOSE A LOCATION EDUCATE YOURSELF ABOUT THIS PROJECT

HOW RADIOACTIVE IS OUR OCEAN?

The release of radioactive contaminants from Fukushima remains an unprecedented event for the people of Japan and the Pacific Ocean. Help scientists at the Woods Hole Oceanographic Institution reveal the ongoing spread of radiation across the Pacific and its evolving impacts on the ocean.



HELP FUND A LOCATION



PROPOSE A LOCATION



VIEW CURRENT RESULTS



LEARN ABOUT RADIATION



<http://www.whoi.edu/CMER>

PLUTONIUM ISOTOPES IN THE NORTH ATLANTIC

by

KEN O. BUESSELER

B.A., University of California at San Diego, 1981

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

at the

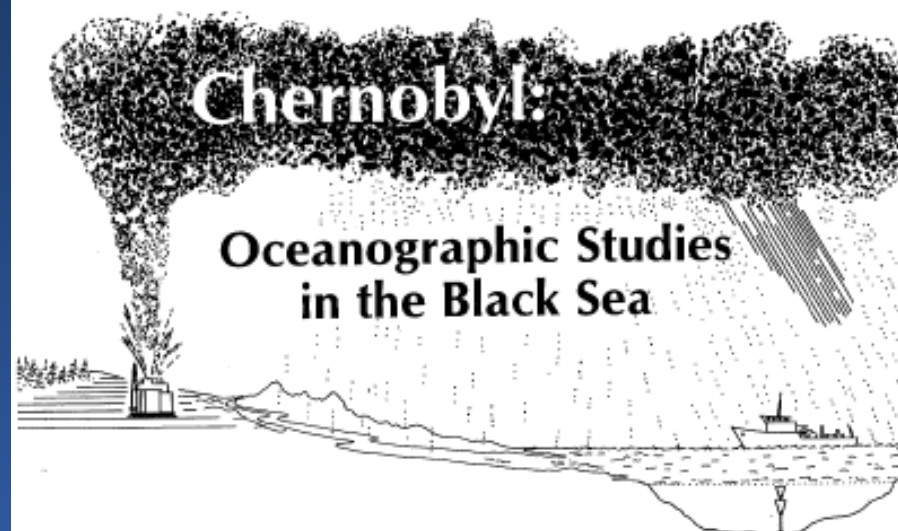
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

and the

WOODS HOLE OCEANOGRAPHIC INSTITUTION

SEPTEMBER 1986

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Oceanographic Studies in the Black Sea

—Studies on the radioactive fallout from
Chernobyl provide information about the
fates of nuclear discharges to the
environment, and about the circulation of the
nearest body of salt water—the Black Sea.

by Ken O. Buesseler

Oceanus®

Volume 30, Number 3, Fall 1987

Photos from Fukushima Dai-ichi security camera March 11

Tsunami
50 feet
tall



2



Fukushima Dai-ichi Nuclear Power Plants



Before and after March 11, 2011 satellite images

The New York Times

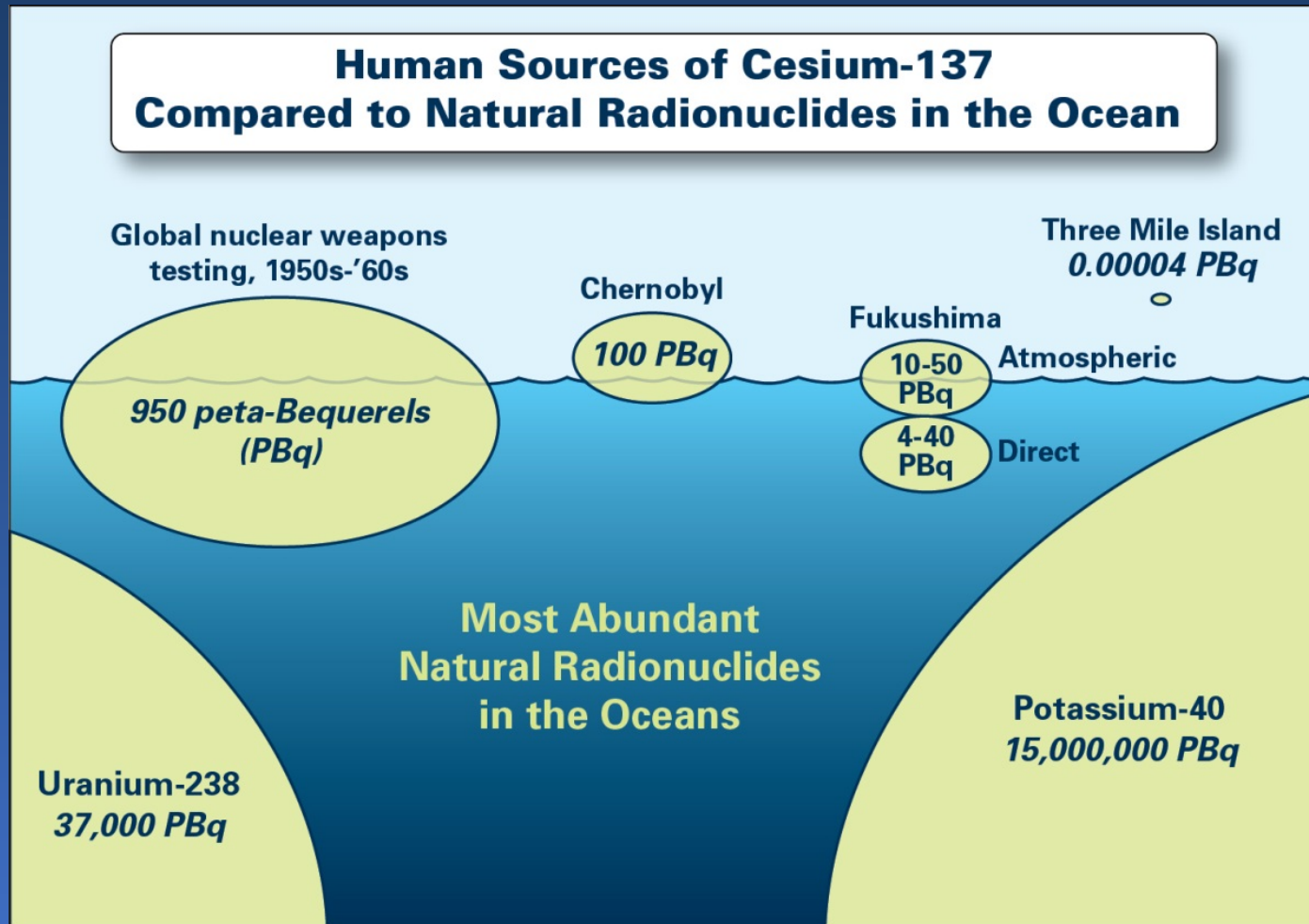
Sendai coast



Before and after March 11, 2011 satellite images

The New York Times

We live in a radioactive world (and ocean)

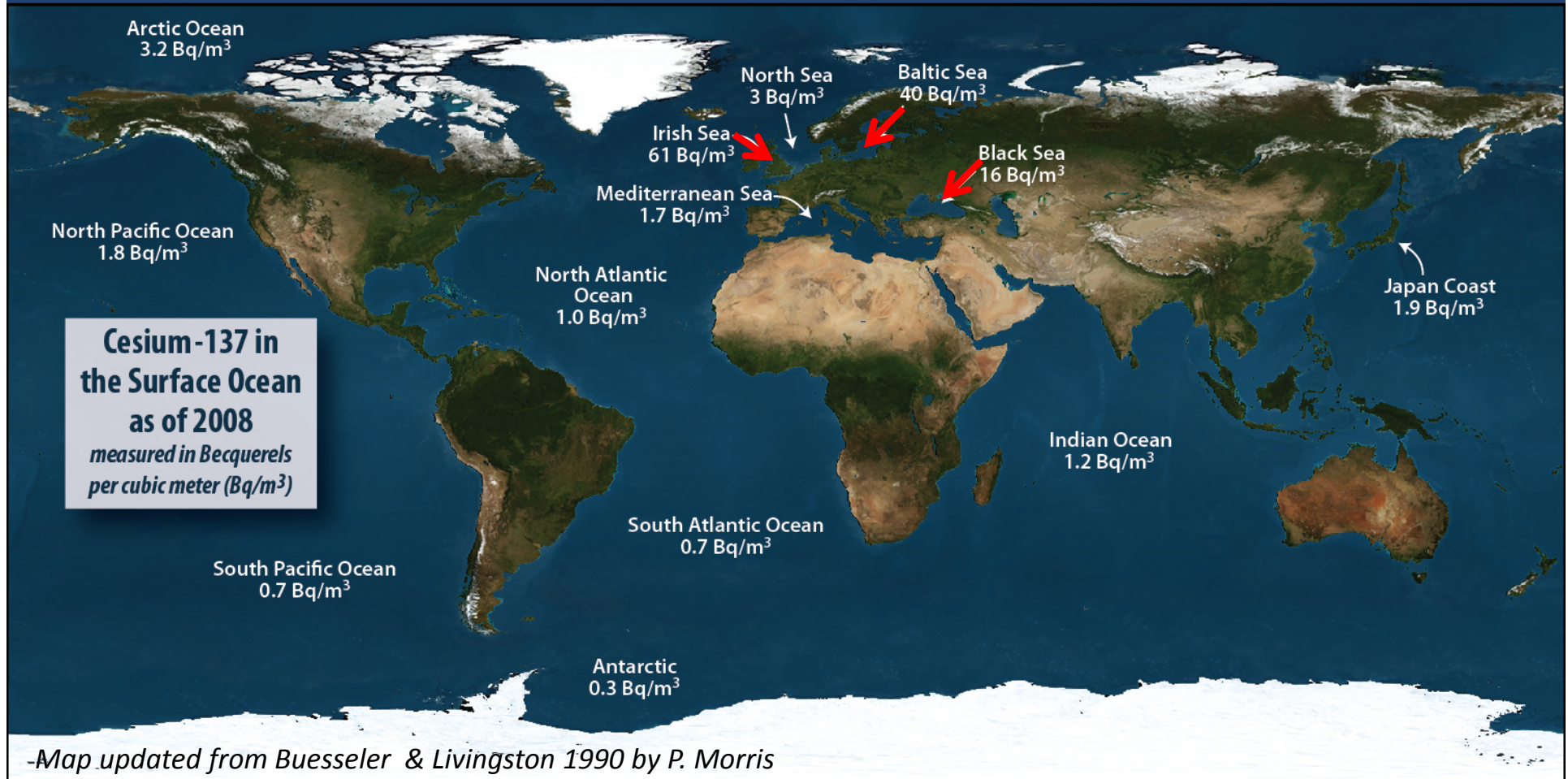


1 Bq = 1 Becquerel = one radioactive decay per second

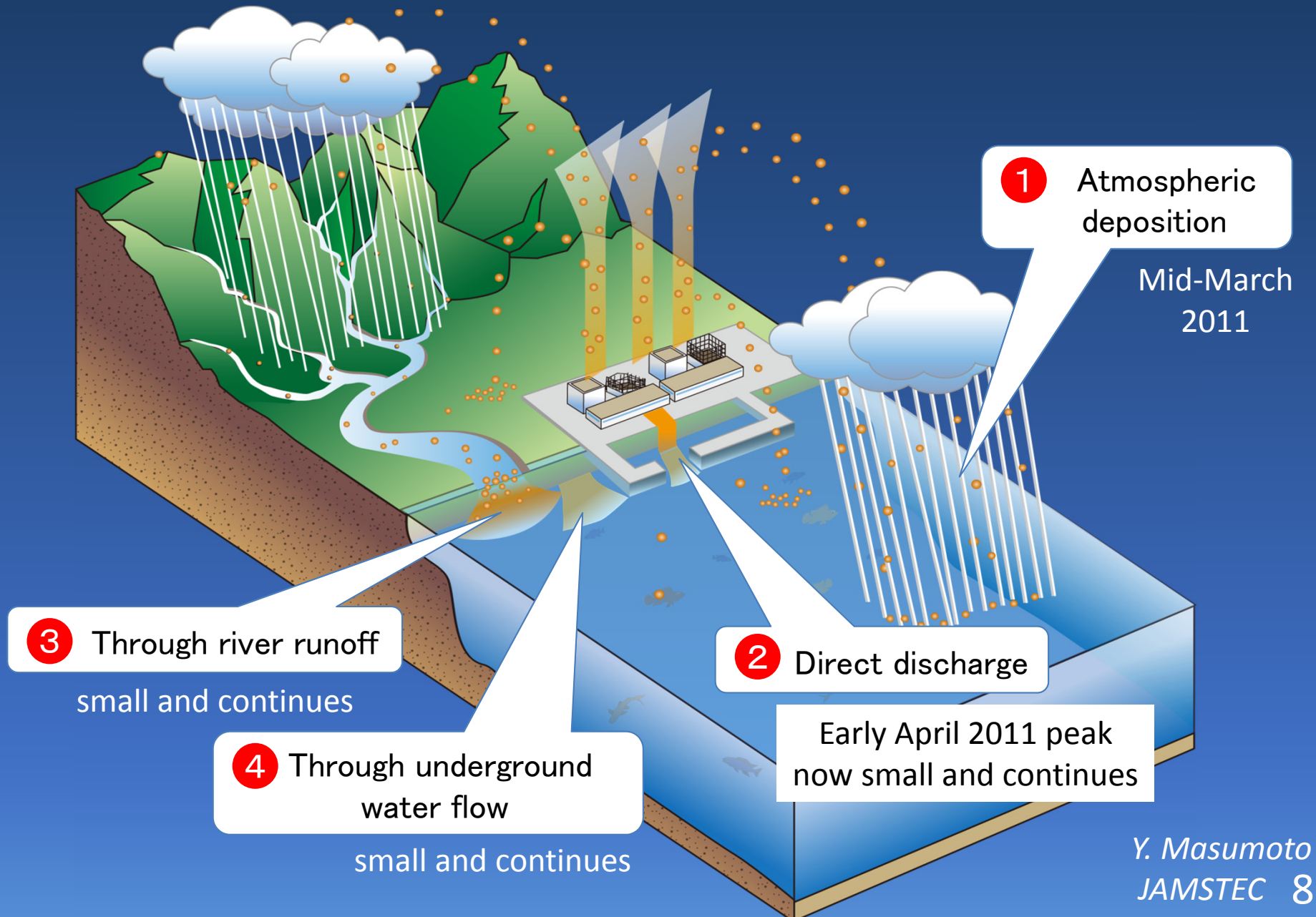
1 PBq = peta-Becquerel = one million billion Bq

10^{15} Bq = 1,000,000,000,000,000 Bq

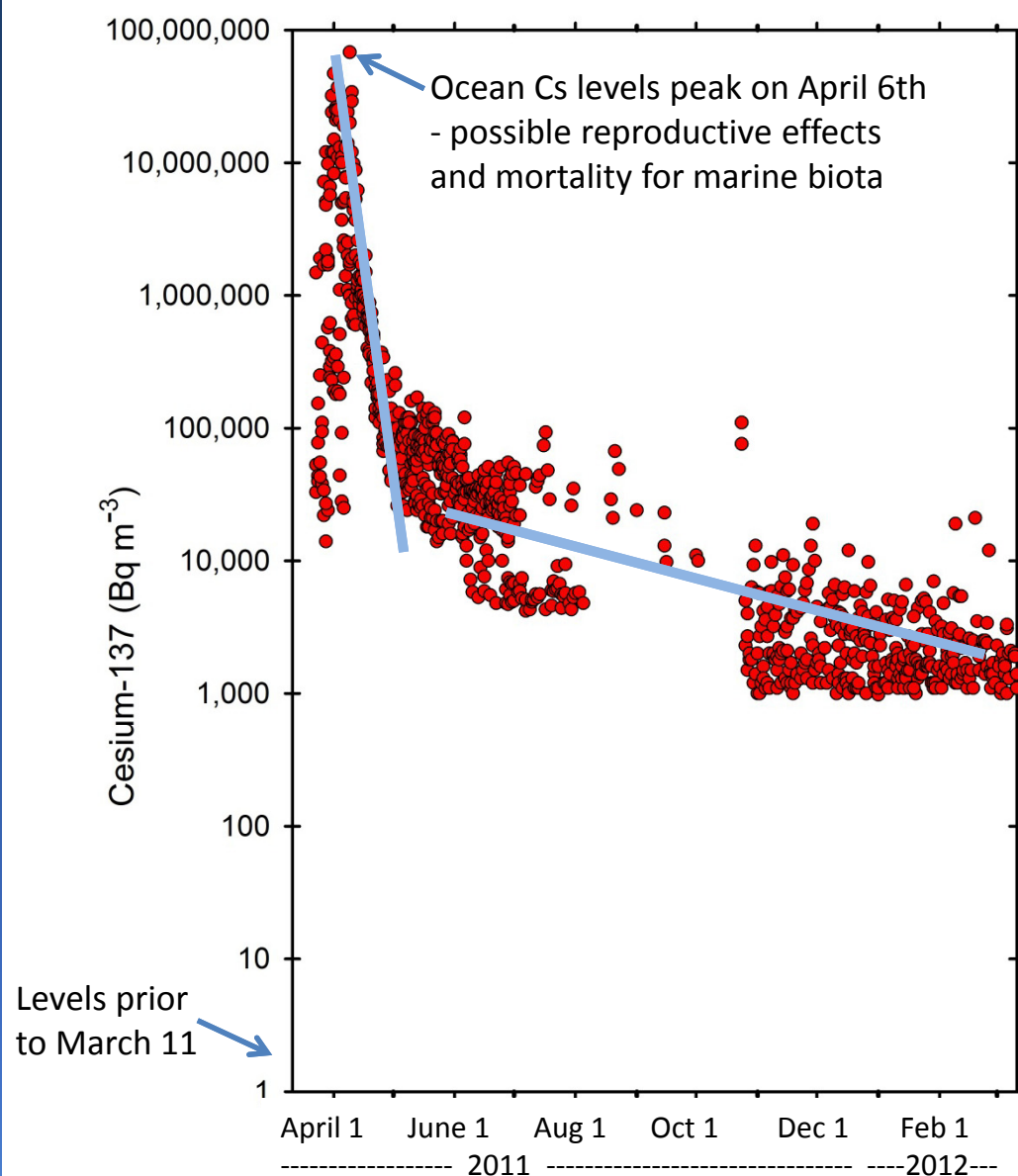
What are levels of cesium-137 in ocean prior to Fukushima?



Sources of Fukushima radionuclides to the ocean



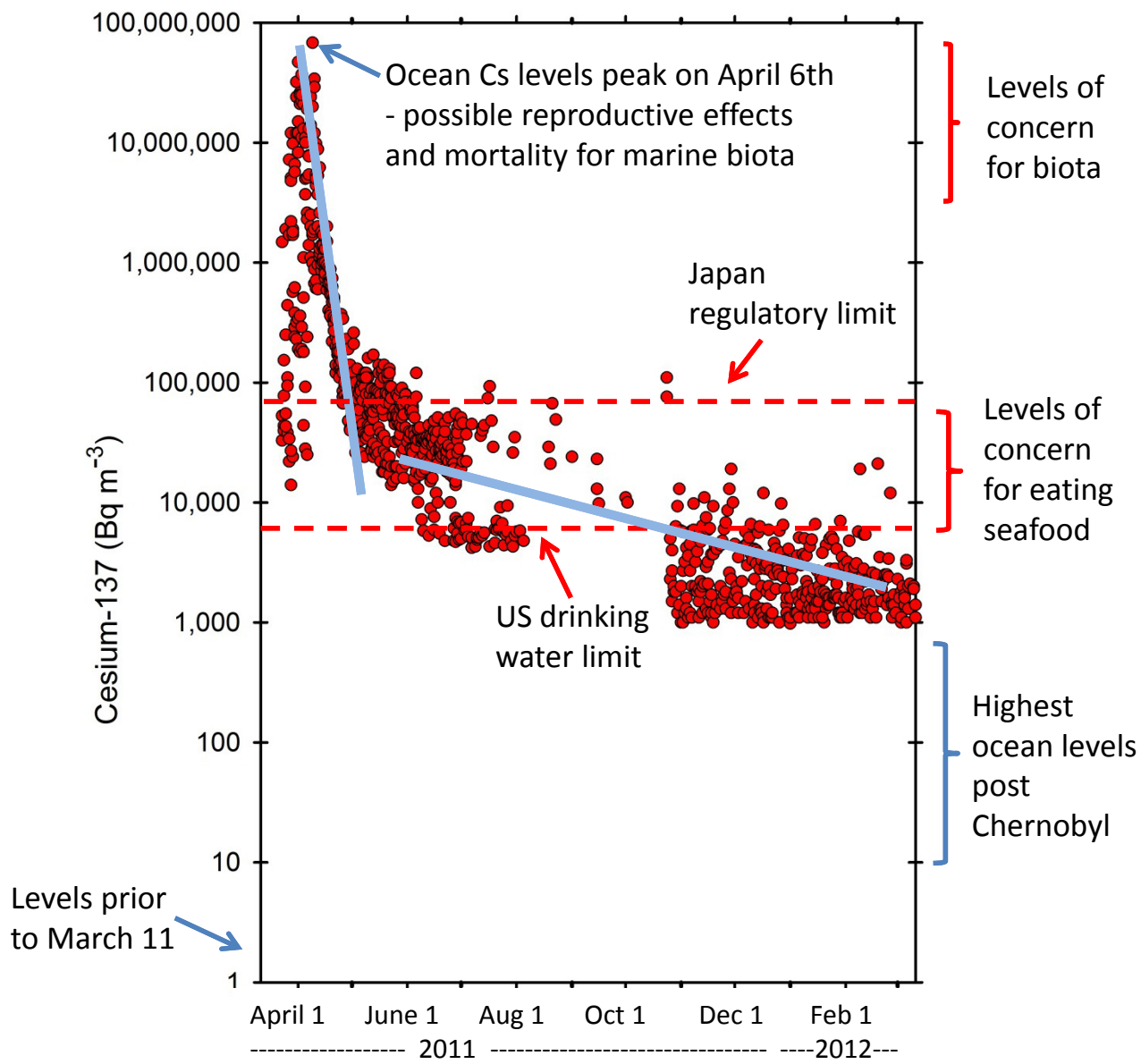
One year history of cesium-137 in ocean off Fukushima



Data from TEPCO

Buesseler et al., 2012

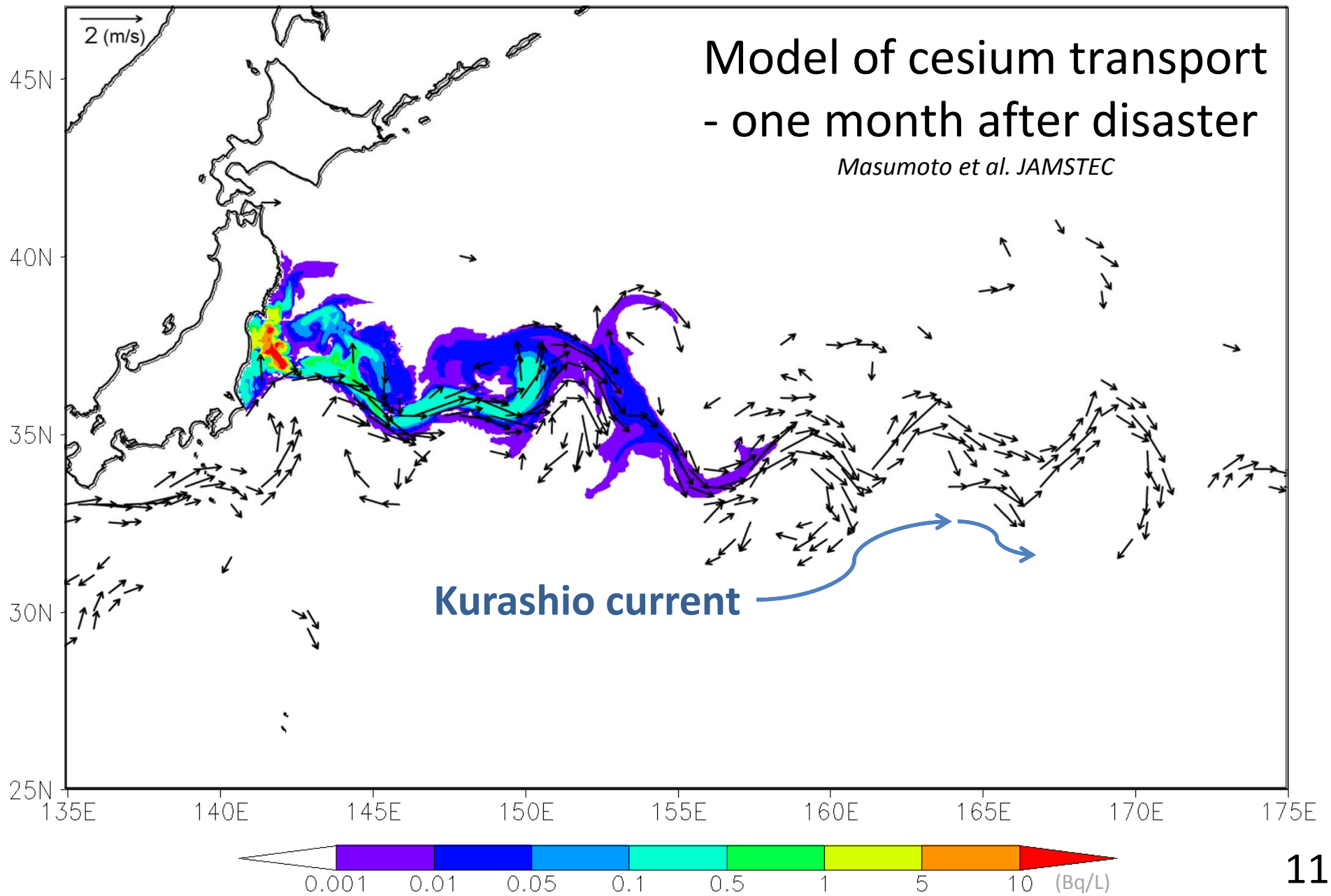
One year history of cesium-137 in ocean off Fukushima



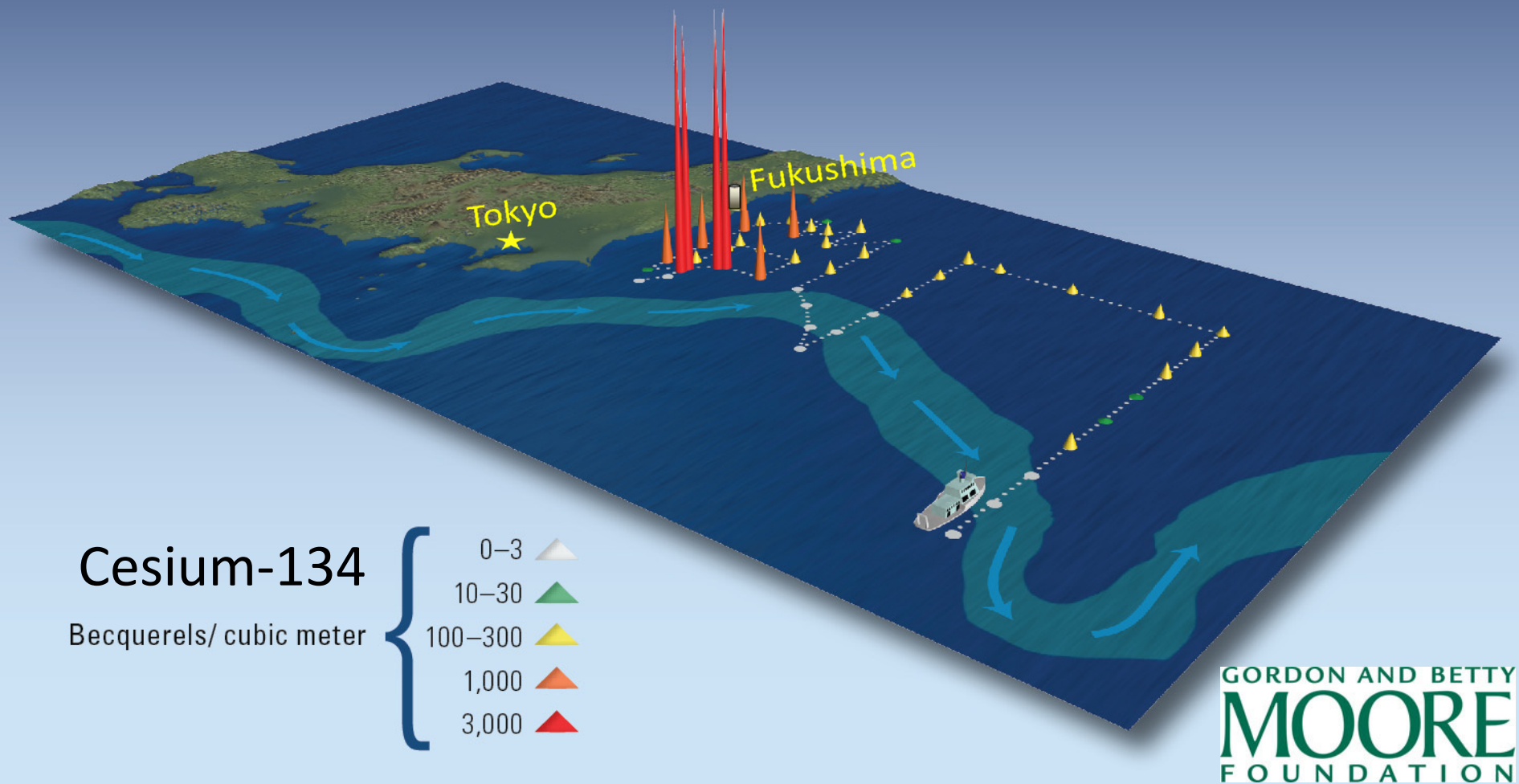
Data from TEPCO

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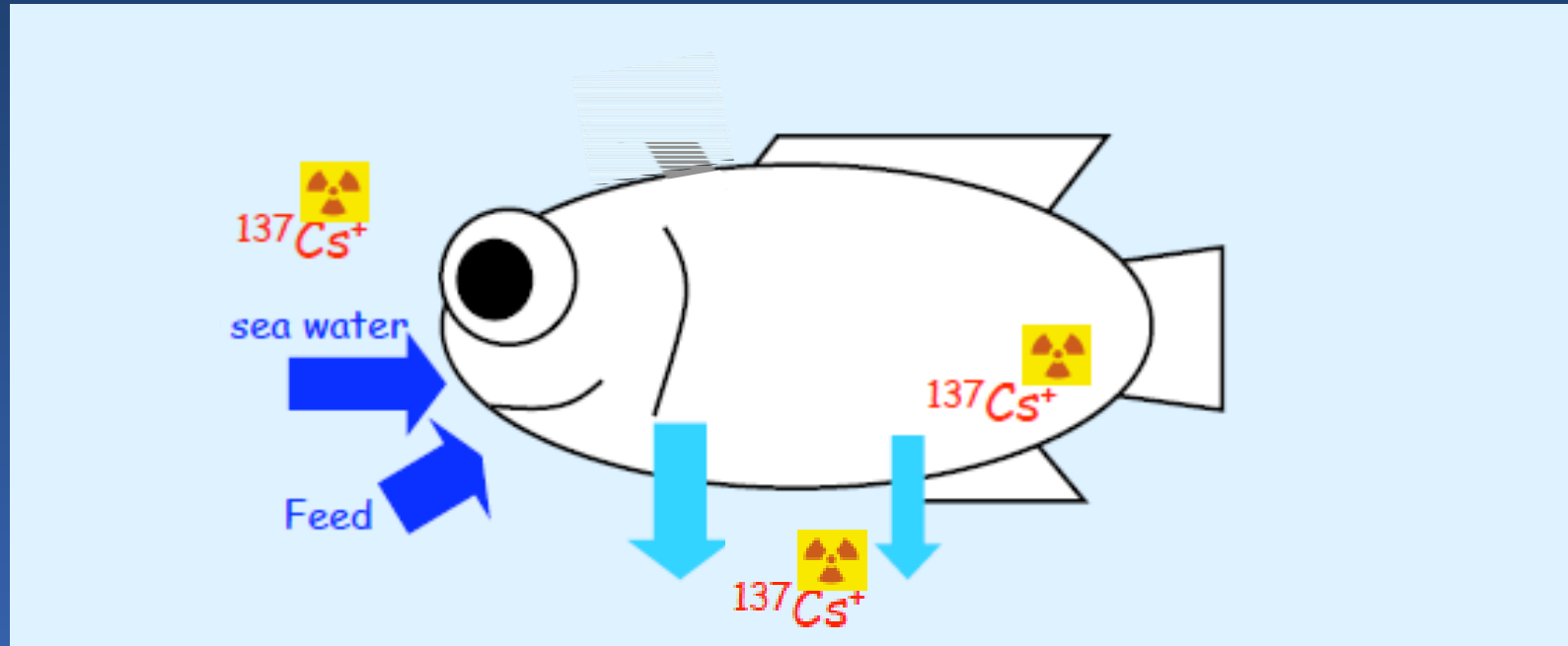
Cs-137 (2011 APR 30)



Rapid response cruise in June 2011

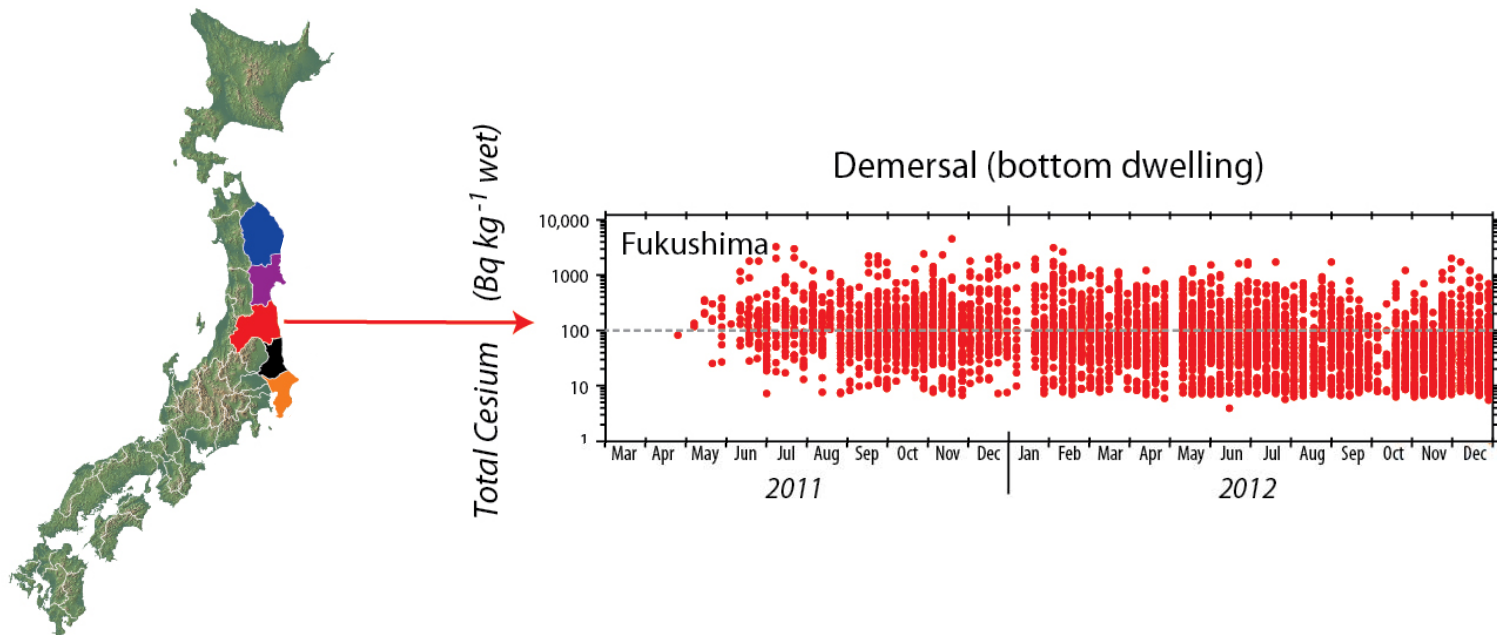


What about Fish and cesium accumulation?



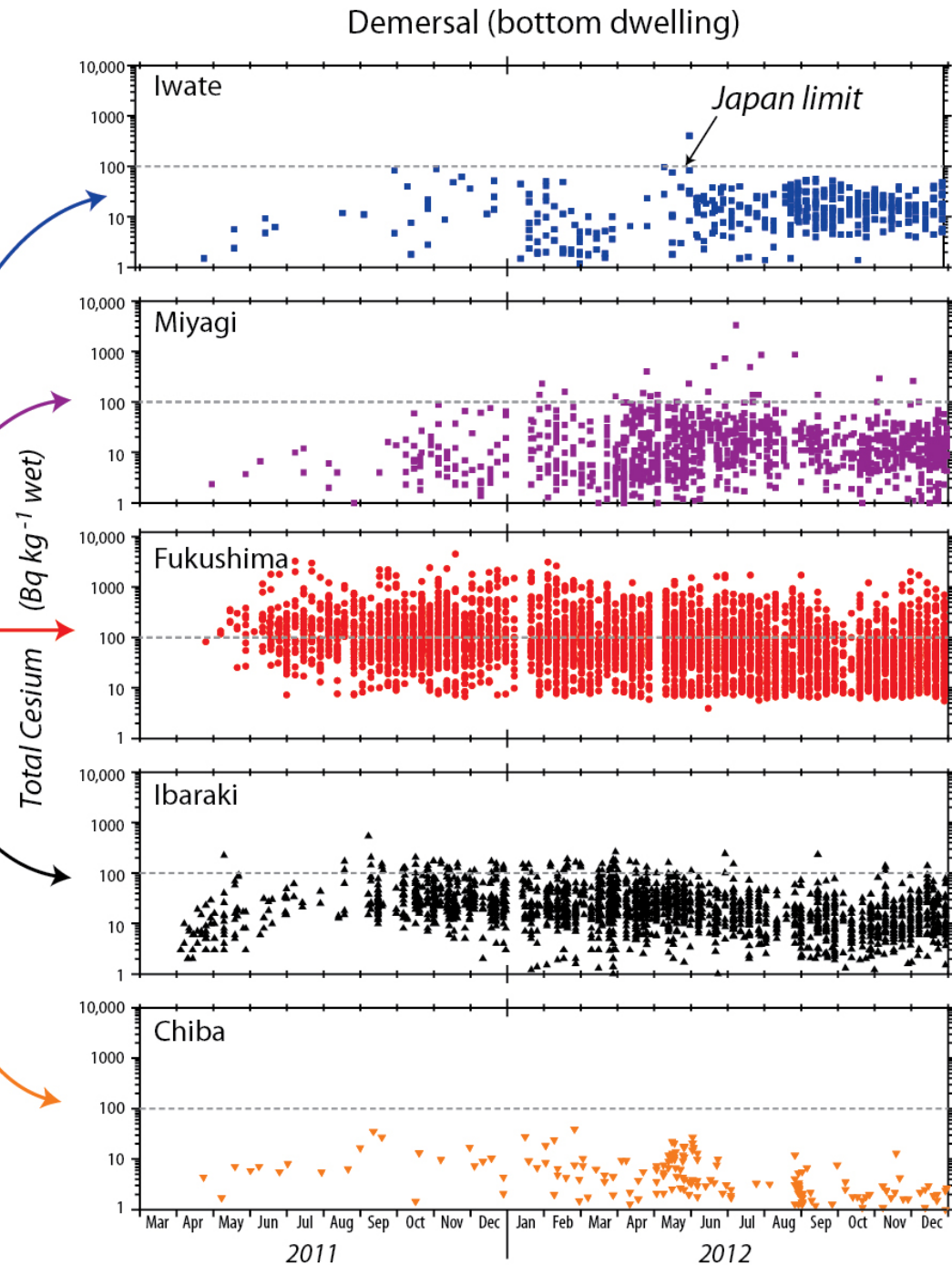
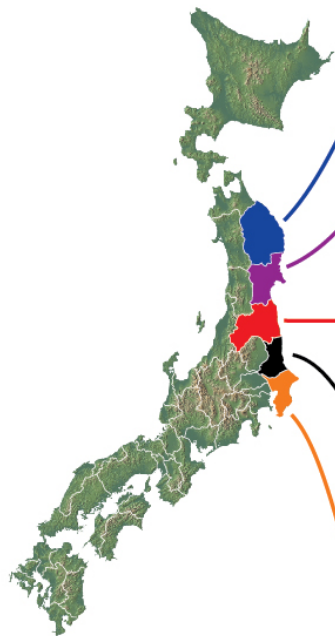
information page from Japanese Ministry of Agriculture, Forestry and Fisheries

Cesium remains high in
bottom dwelling fish
near Fukushima



*Data from Japan Fisheries
Figure adapted from
Buesseler, Science, 2012*

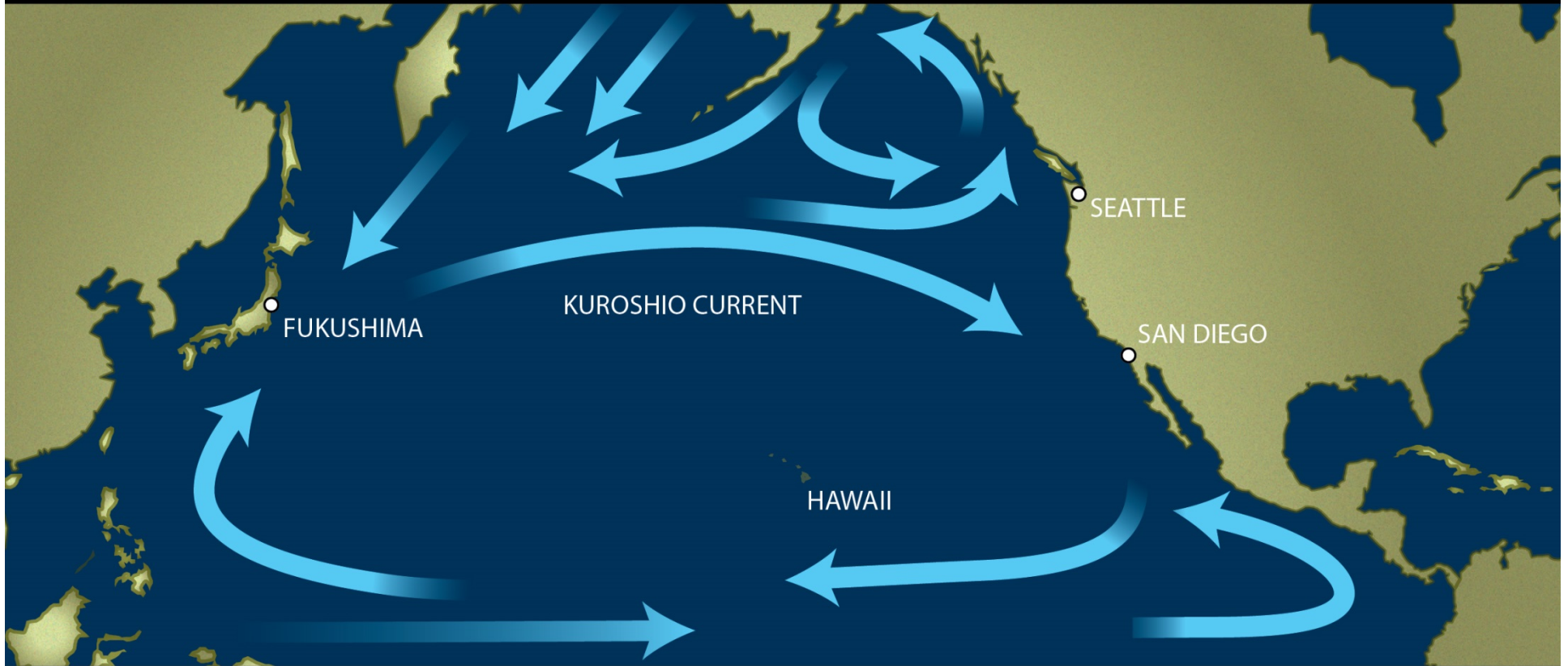
Fisheries closed off
Fukushima



Data from Japan Fisheries
Figure adapted from
Buesseler, Science, 2012

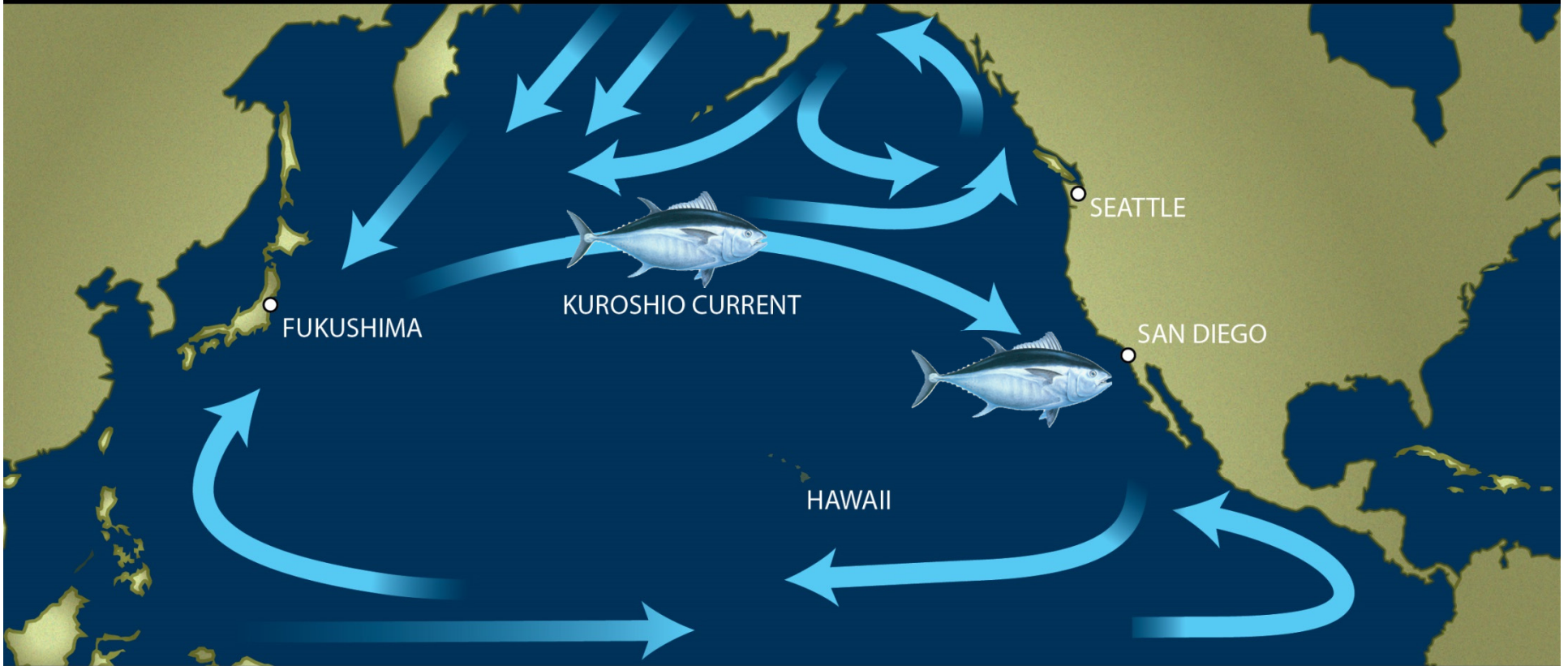
How far and fast do Fukushima radionuclides travel?

PACIFIC OCEAN CURRENTS



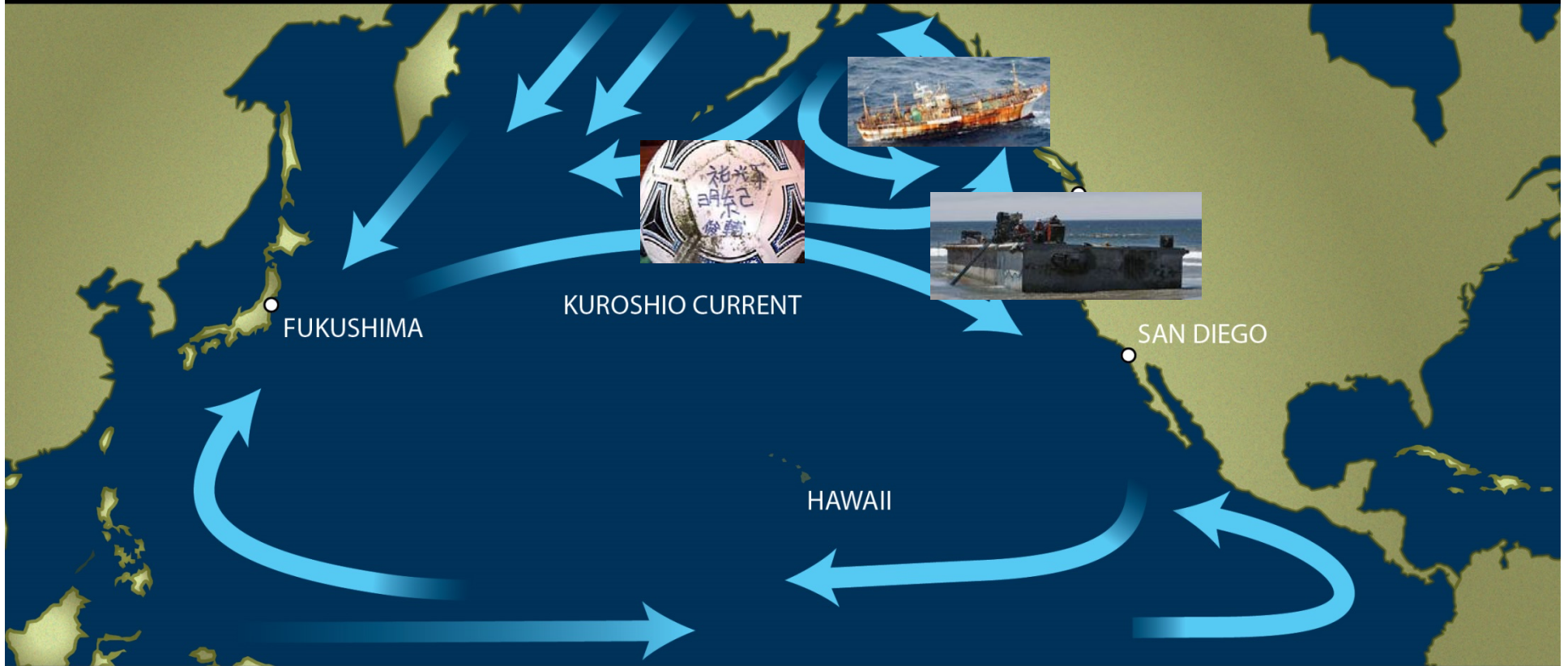
Pacific Blue Fin Tuna migration- arrived in fall 2011

PACIFIC OCEAN CURRENTS

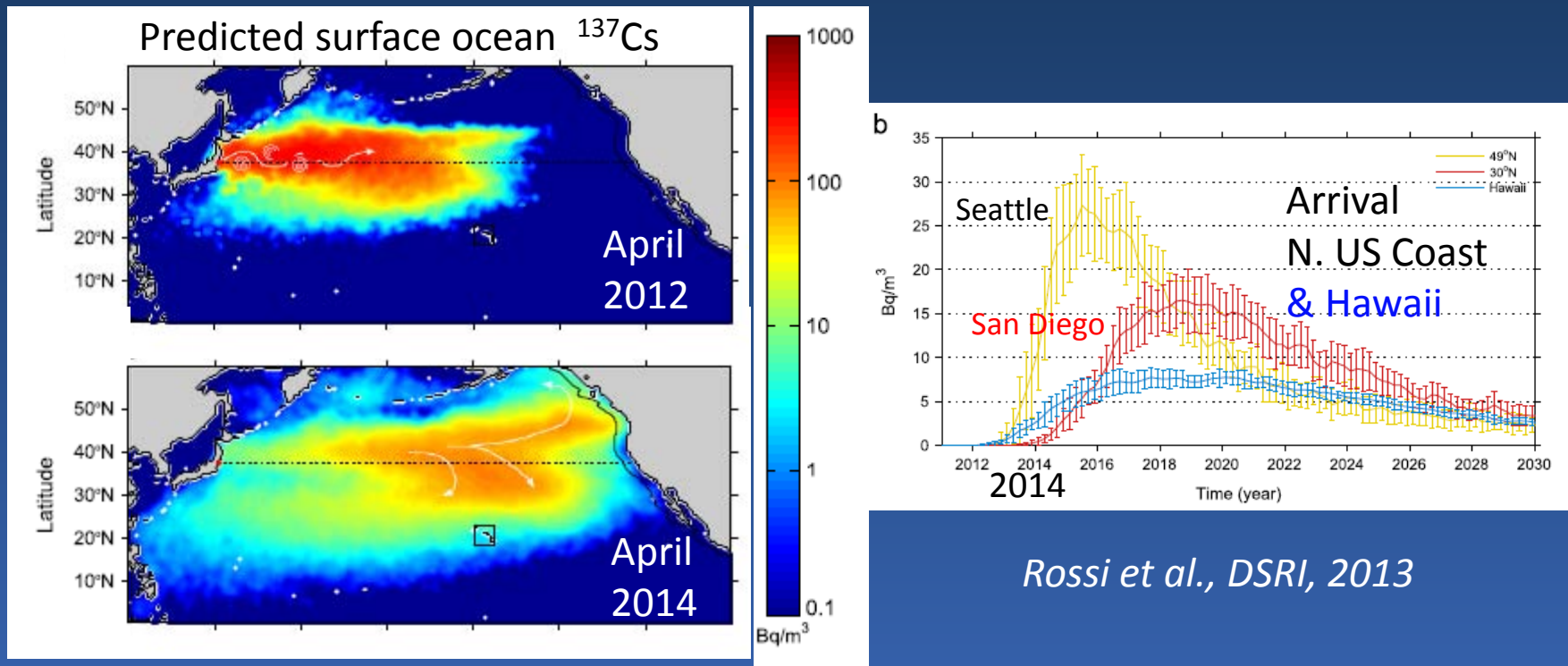


Debris carried by currents and winds- arrived 2012

PACIFIC OCEAN CURRENTS



Radionuclides carried only by ocean currents



- ❑ Predicted ^{137}Cs off US varies from 1-2 to 30 Bq m^{-3} in different models (safe for exposure & fisheries)
- ❑ Little/no vertical data to test!

In response, launched citizen scientist crowd funding site
Jan. 14, 2014



<http://ourradioactiveocean.org>

Success stories



- ❑ Public & media attention high
- ❑ >110,000 web views
- ❑ 30 sampling sites funded
- ❑ >320 donors
- ❑ >\$50K raised

Current Sample Locations

- Data Available
- Newly Funded
- New Fundraising

22

22

Current Sample Locations

- Data Available
- Newly Funded
- New Fundraising

No Fukushima cesium YET
along west coast & Hawaii

Cesium-137 = 1.4 Bq/m^3

Cesium-134 $< 0.2 \text{ Bq/m}^3$



Pt. Reyes CA

Our supporters

Alaska Ocean Observing System
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Bamfield Marine Science Centre
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Idaho Section of the American Nuclear
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and.....



Santa Cruz, CA

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Gulf of Alaska, AK

Our supporters, cont.

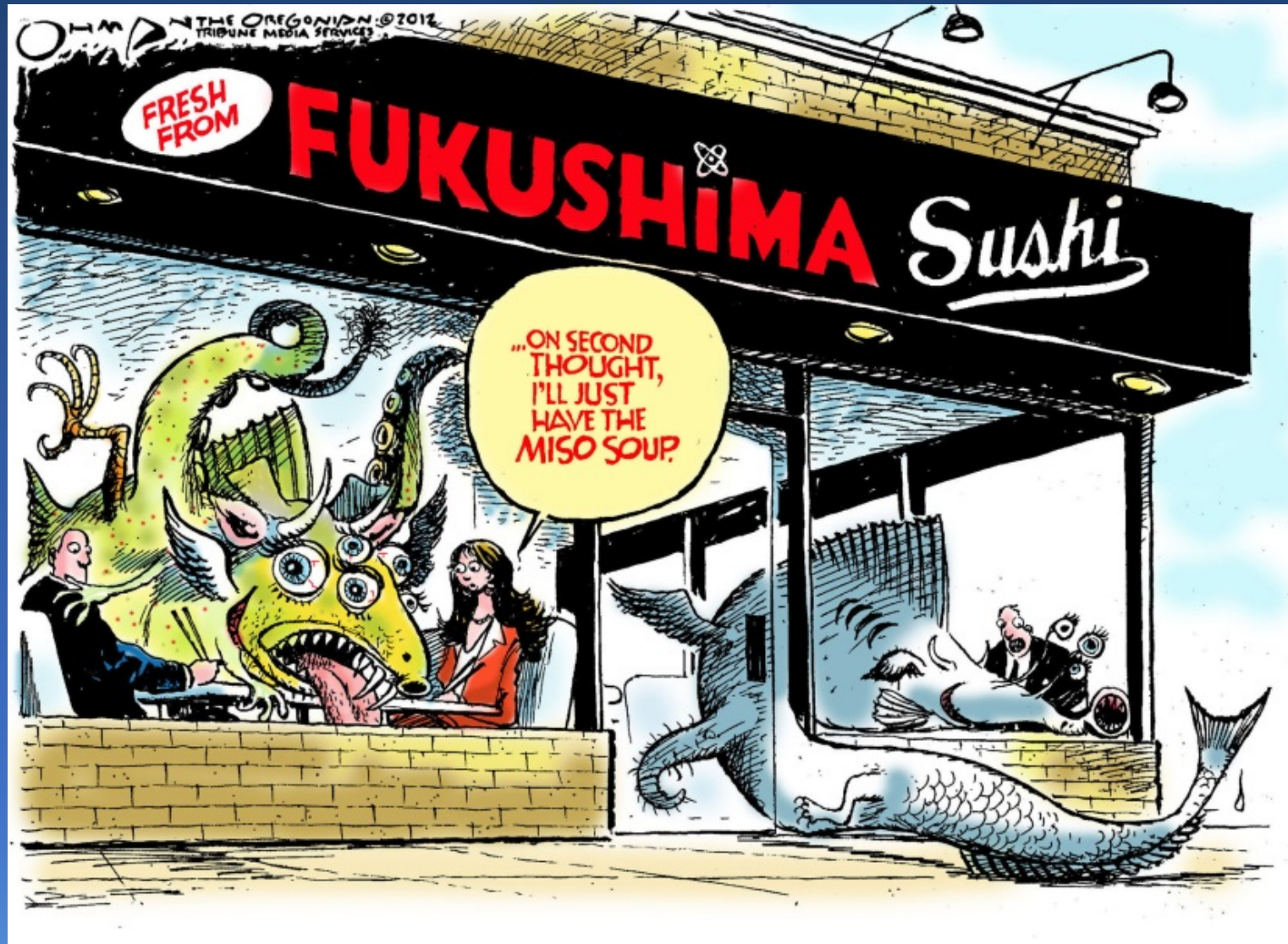
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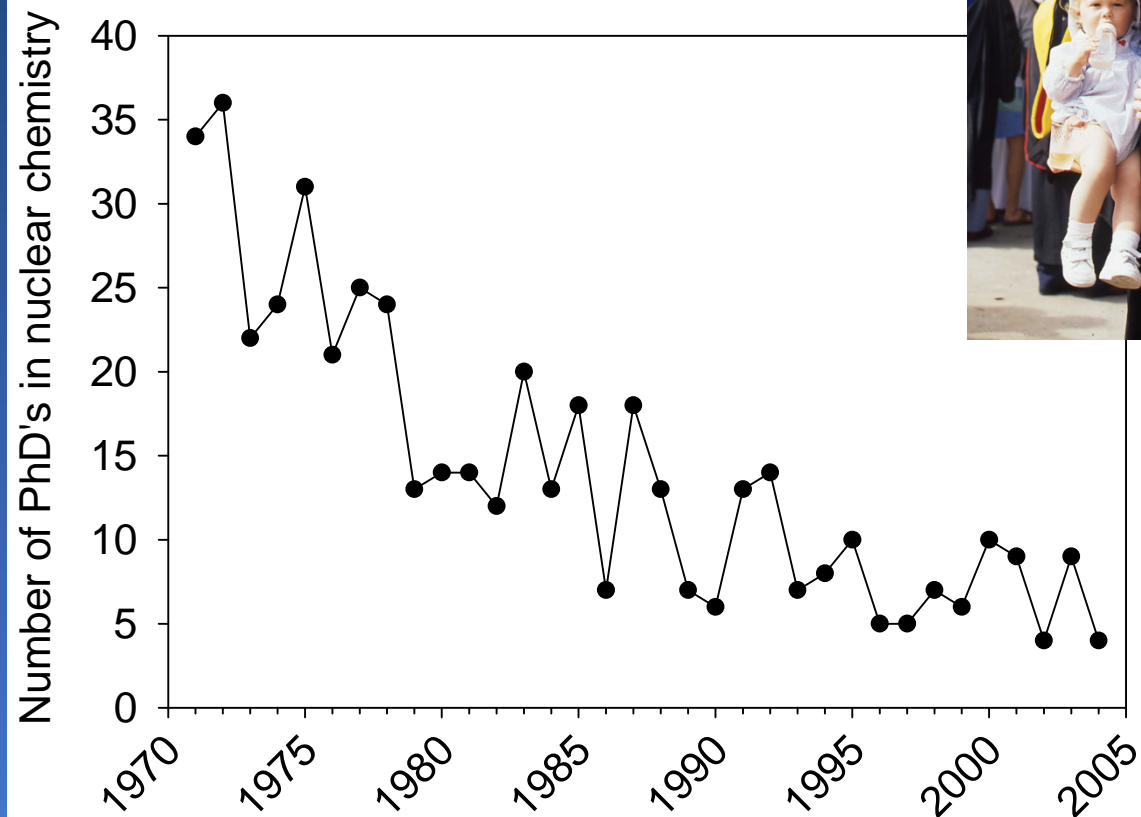
*& thanks to more than 320
concerned citizens who have
made donations!*

Fukushima showed Public concern



Fukushima showed

Education/training need



Mission

- to increase scientific and public understanding of natural and human-made radioactive elements in the oceans

Goals

- public outreach
- education and training
- promote research & engineering



Woods Hole Oceanographic Institution

Center for
Marine and
Environmental
Radioactivity

HOME ABOUT FOR RESEARCHERS STUDENT RESOURCES ABOUT RADIATION NEWS & EVENTS DONATE

FAQs about Fukushima

CMER TWITTER FEED

Tweets

CMER @whoi_cmer 7 Nov
I'm not concerned about radiation off Alaska, but lack of research is of concern
adn.com/2013/11/06/316...

CMER @whoi_cmer 26 Oct
Tweet to @whoi_cmer

Center for Marine and Environmental Radioactivity

The Center for Marine and Environmental Radioactivity (CMER) is dedicated to increasing scientific and public understanding of the sources, fate, and consequences of natural and human-made radioactive substances in the environment, in particular the oceans.

For Researchers
Information for radioecologists and radiochemists, including online resources, data, up-to-date information, and opportunities for collaboration.
National Ocean Sciences Accelerator Mass Spectrometry
» MORE

For Students
Resources for graduate, undergraduate, and high school students interested in pursuing a career in radioecology and radiochemistry.
Assuring a Future U.S.-Based Nuclear and Radiochemistry Expertise
» MORE

Radiation 101
We live in a radioactive world that includes both natural and human sources of radiation. Get the facts about radioactivity and human health.
The ABCs of Radiation (from Oceanus Magazine)
» MORE



Support needed for

Citizen Scientists

The screenshot shows the COMER website with a dark blue header containing navigation links: HOME, HELP FUND A LOCATION, PROPOSE A LOCATION, EDUCATE YOURSELF, and ABOUT THIS PROJECT. The main content area has a blue, textured background with the title "HOW RADIOACTIVE IS OUR OCEAN?" in large, bold letters. Below the title is a paragraph explaining the Fukushima event and the goal of the project. At the bottom, there are four green buttons with icons and text: "HELP FUND A LOCATION" (stack of coins), "PROPOSE A LOCATION" (location pin), "VIEW CURRENT RESULTS" (bar chart), and "LEARN ABOUT RADIATION" (lightbulb).

HOME HELP FUND A LOCATION PROPOSE A LOCATION EDUCATE YOURSELF ABOUT THIS PROJECT

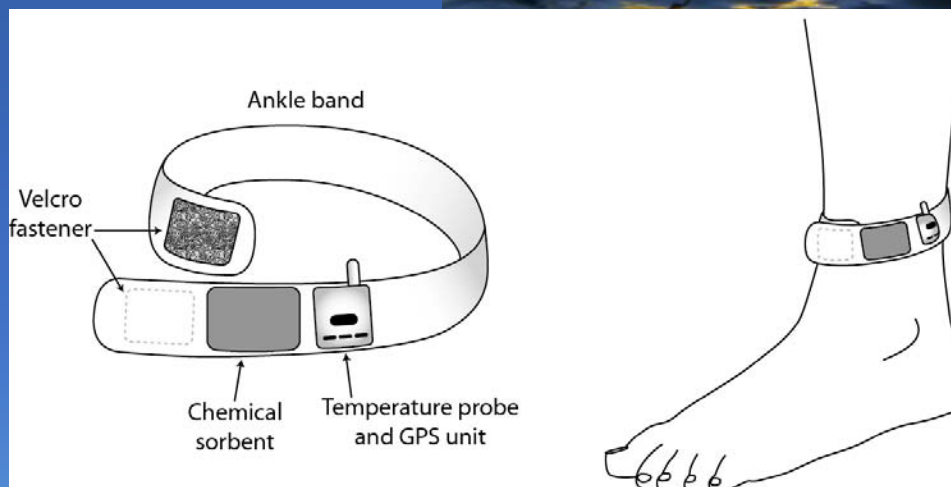
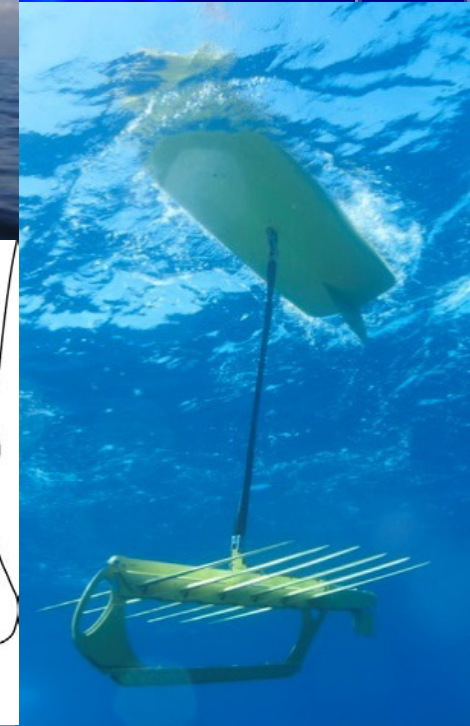
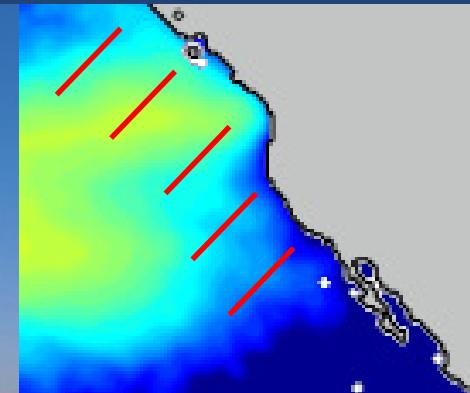
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- HELP FUND A LOCATION
- PROPOSE A LOCATION
- VIEW CURRENT RESULTS
- LEARN ABOUT RADIATION

Support needed for

New Tools
Wave glider
Rad-band



To better understand our radioactive ocean



Support needed for

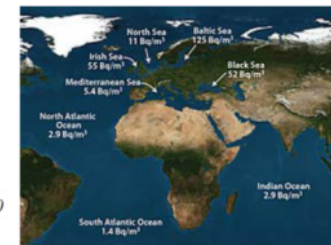
Woods Hole Oceanographic INSTITUTION

FAQ: Radiation from Fukushima

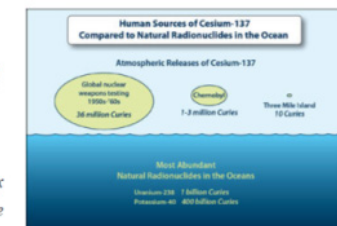


On March 11, 2011, a magnitude 9.0 earthquake—one of the largest ever recorded—occurred 80 miles off the coast of Japan. The earthquake created a series of tsunamis, the largest estimated to be over 30 feet, that swept ashore. In addition to the tragic human toll of dead, injured, and displaced, the earthquake and tsunamis badly damaged the Fukushima Daiichi nuclear power plant, eventually causing four of the six reactors there to release radiation into the atmosphere and ocean.

Since mid-2011, I have worked with Japanese colleagues and scientists around the world to understand the scope and impact of events that continue to unfold today. In June 2011, I organized the first comprehensive international meeting to study



The background level of radiation in oceans and seas varies around the globe. (Courtesy Coastal Ocean Institute, Woods Hole Oceanographic Institution)



Human sources of radiation released into the atmosphere over the past 60 years, although serious, pale in comparison to the radionuclides already naturally present in the ocean. (Illustration by Jack Cook, courtesy Coastal Ocean Institute, Woods Hole Oceanographic Institution)



