# Fukushima – a view from the ocean

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*http://cafethorium.whoi.edu*


CMER

Center for Marine & Environmental Radioactivity

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

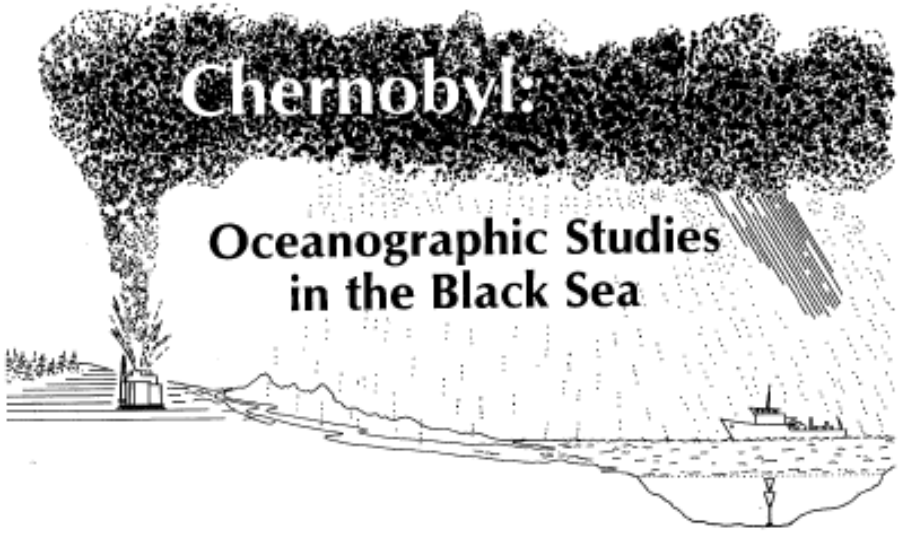
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

and the

WOODS HOLE OCEANOGRAPHIC INSTITUTION

SEPTEMBER 1986






*—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

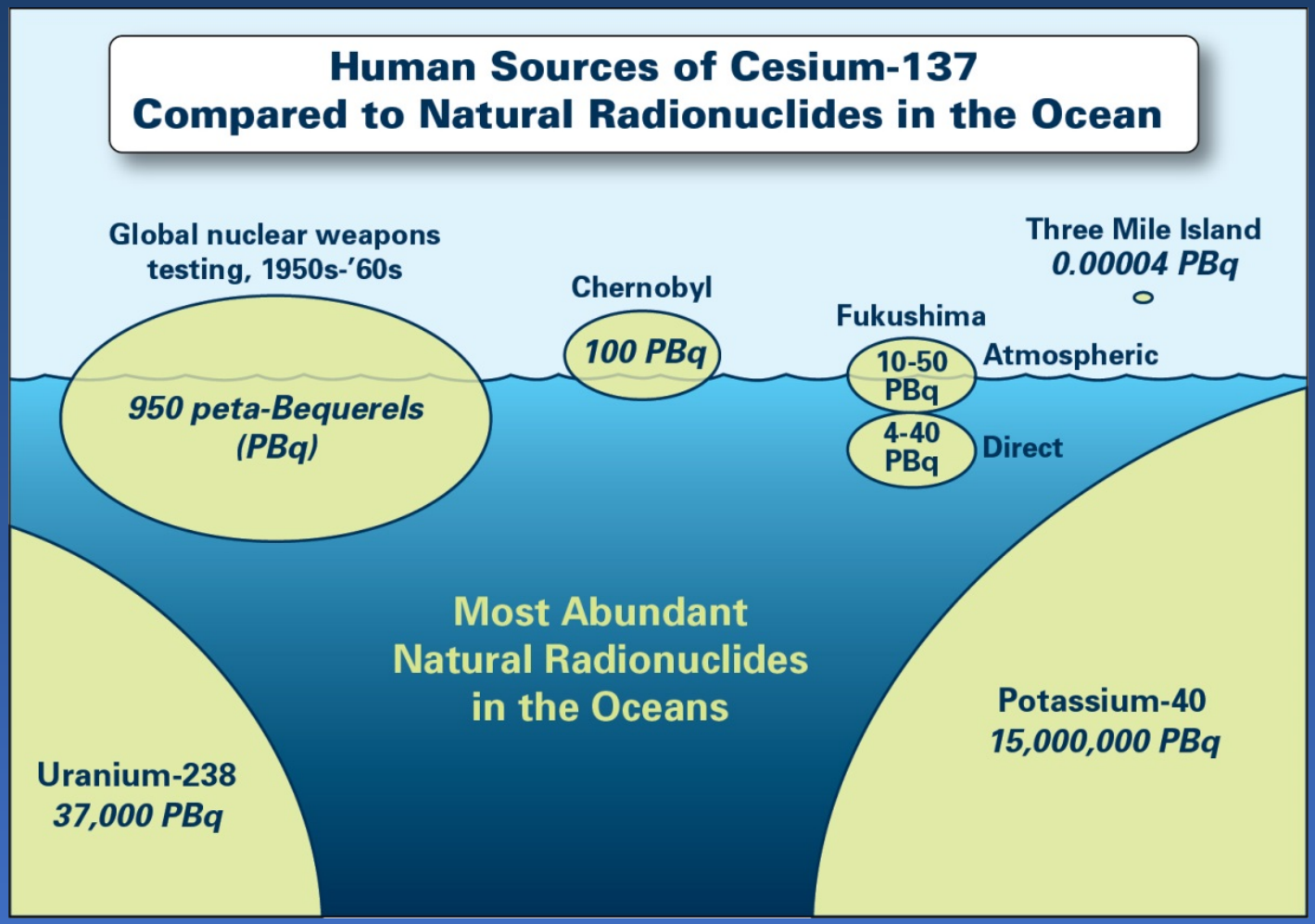
The New York Times

# Sendai coast

Before and after March 11, 2011 satellite images

The New York Times

# We live in a radioactive world (and ocean)

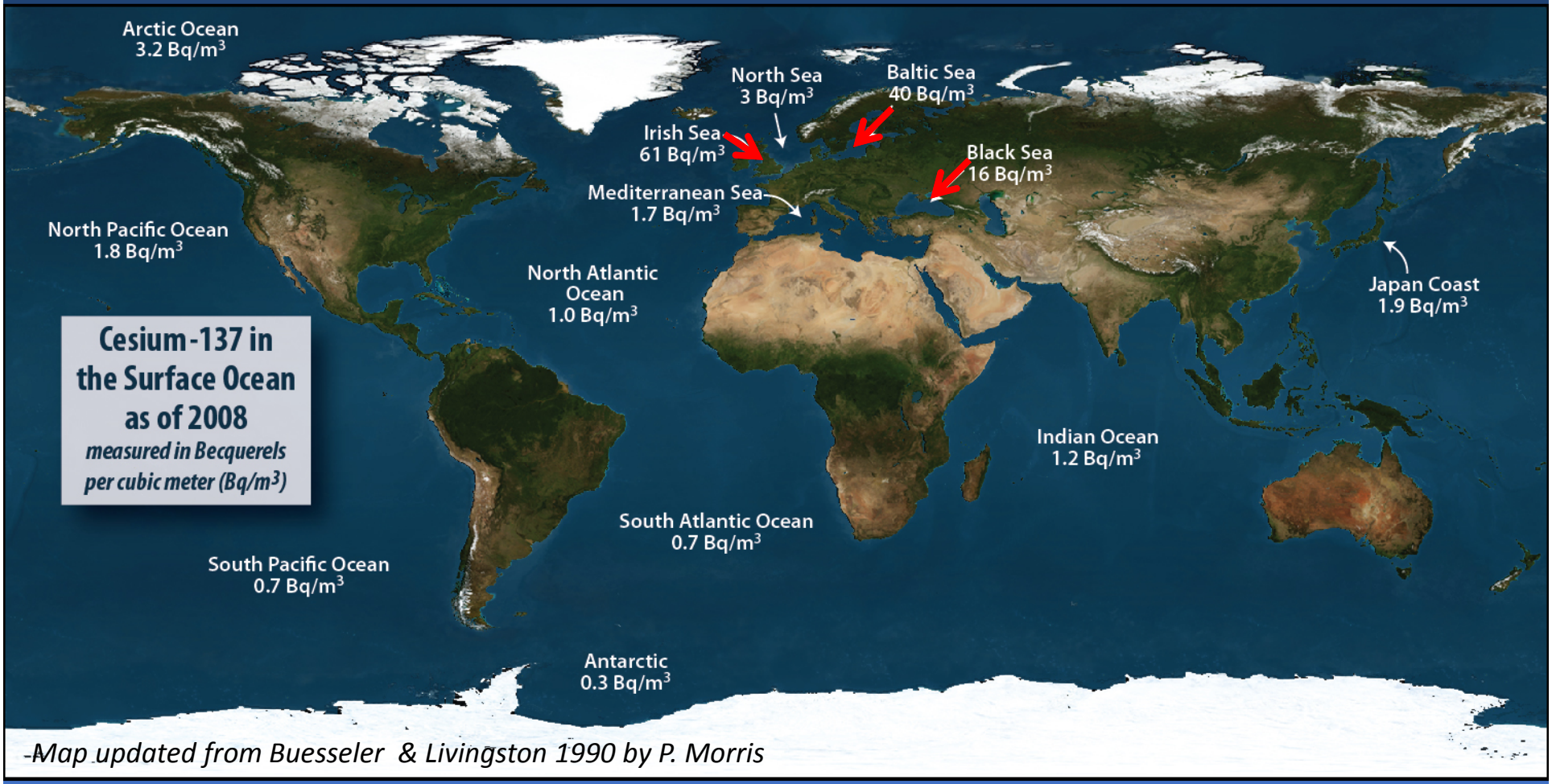



1 Bq = 1 Becquerel = one radioactive decay per second

1 PBq = peta-Becquerel = one million billion Bq

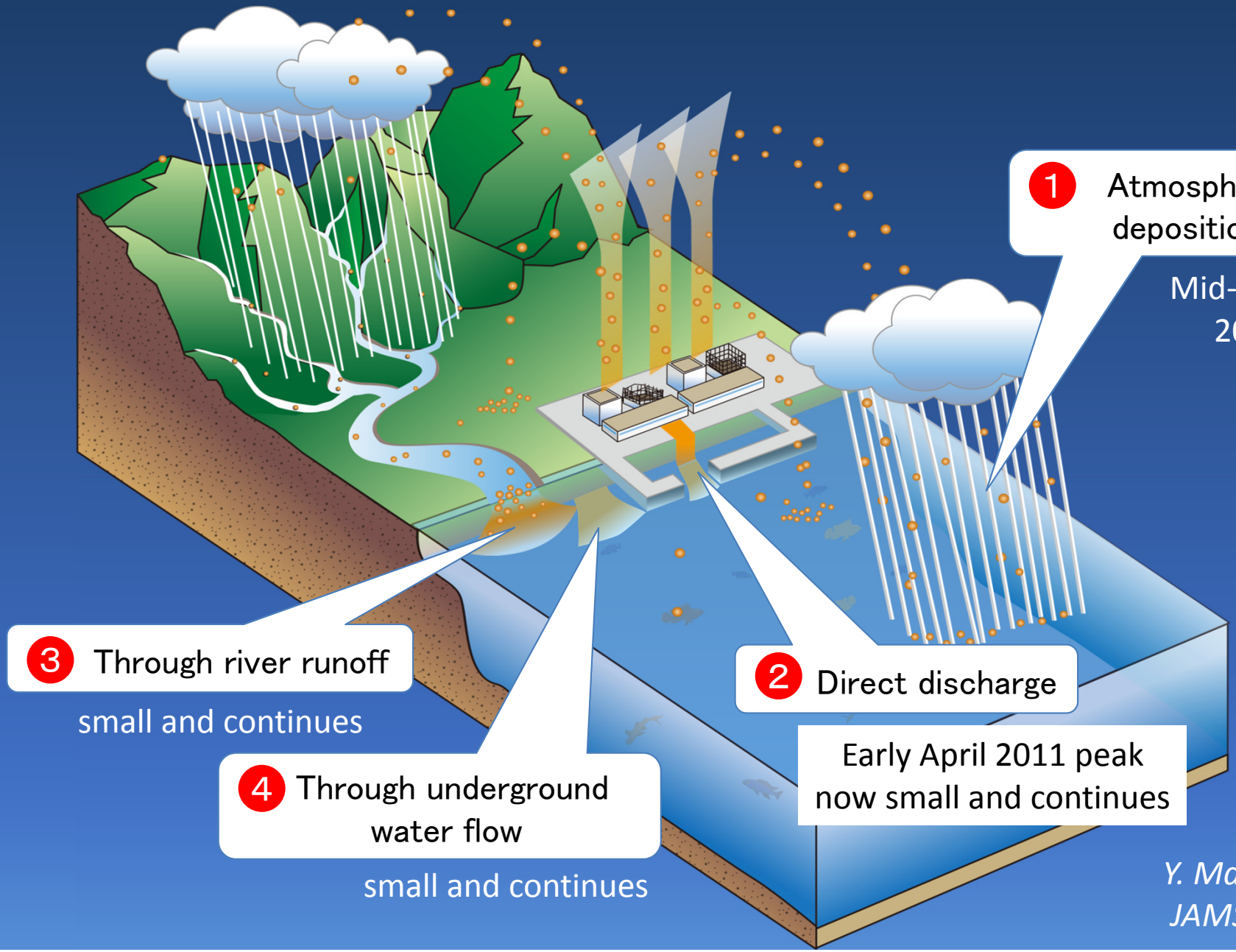
$10^{15}$ Bq = 1,000,000,000,000,000 Bq

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

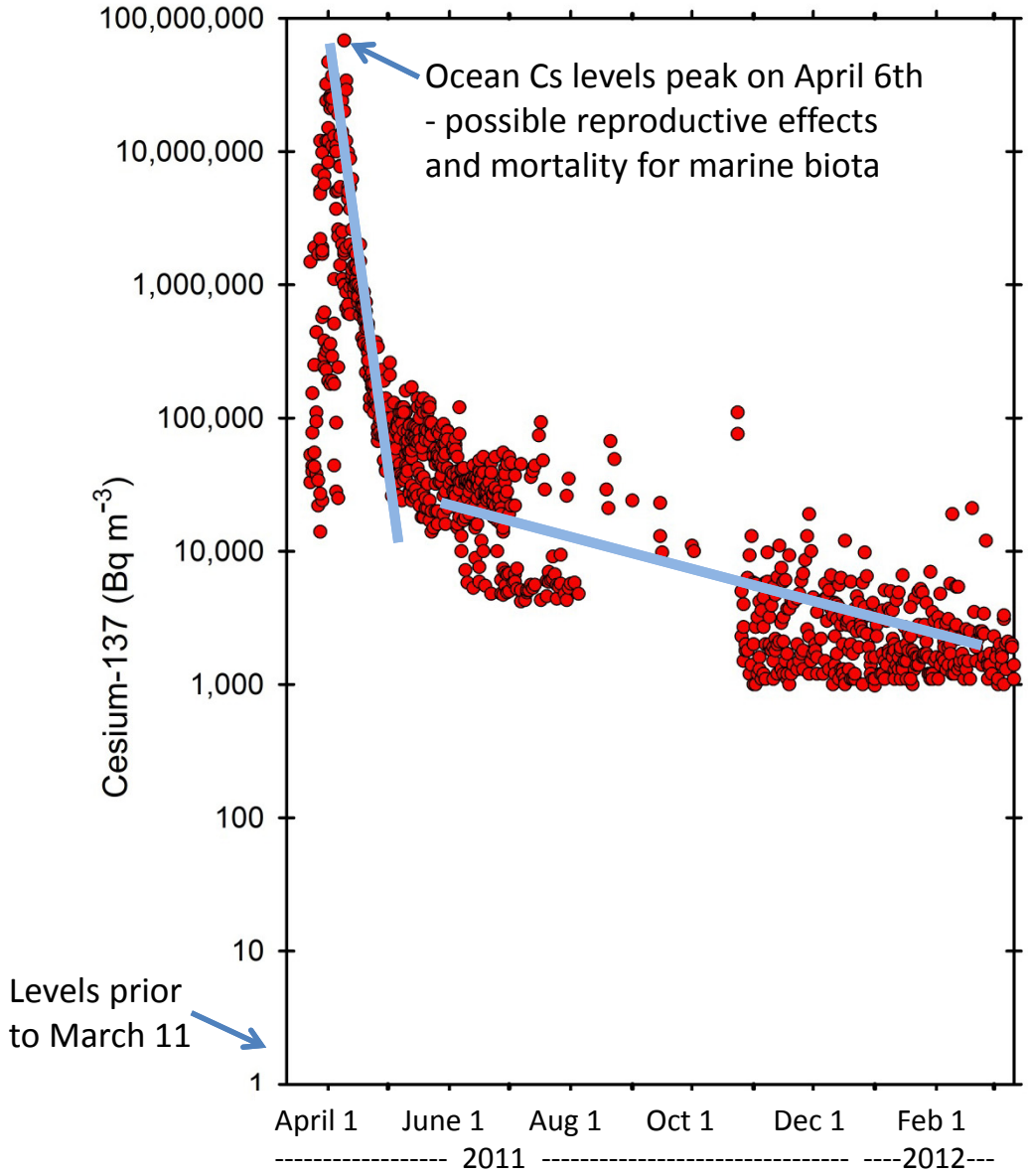



*Map updated from Buesseler & Livingston 1990 by P. Morris*

# Sources of Fukushima radionuclides to the ocean



# One year history of cesium-137 in ocean off Fukushima

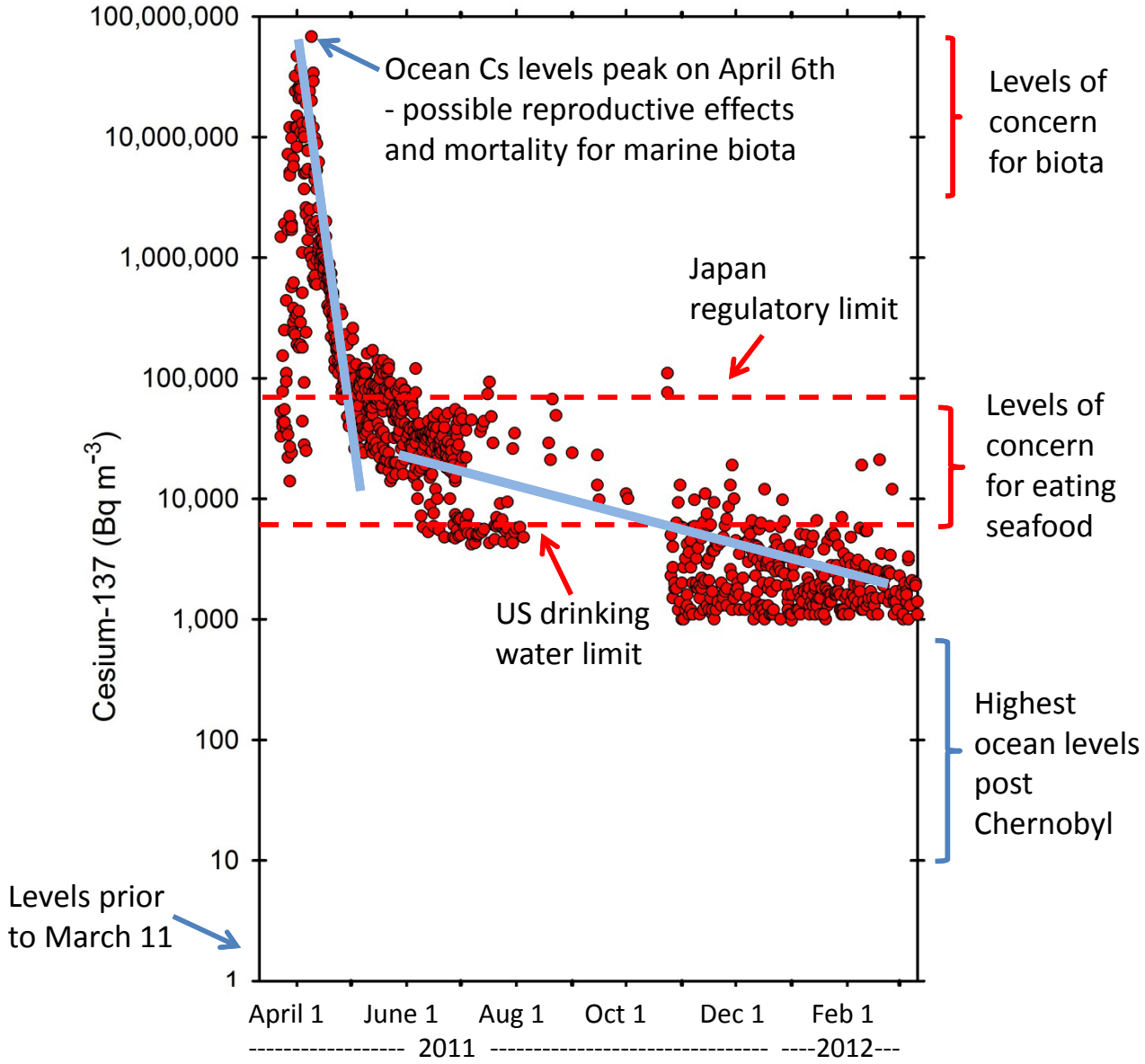




*Data from TEPCO*

*Buesseler et al., 2012*

# One year history of cesium-137 in ocean off Fukushima





*Data from TEPCO*

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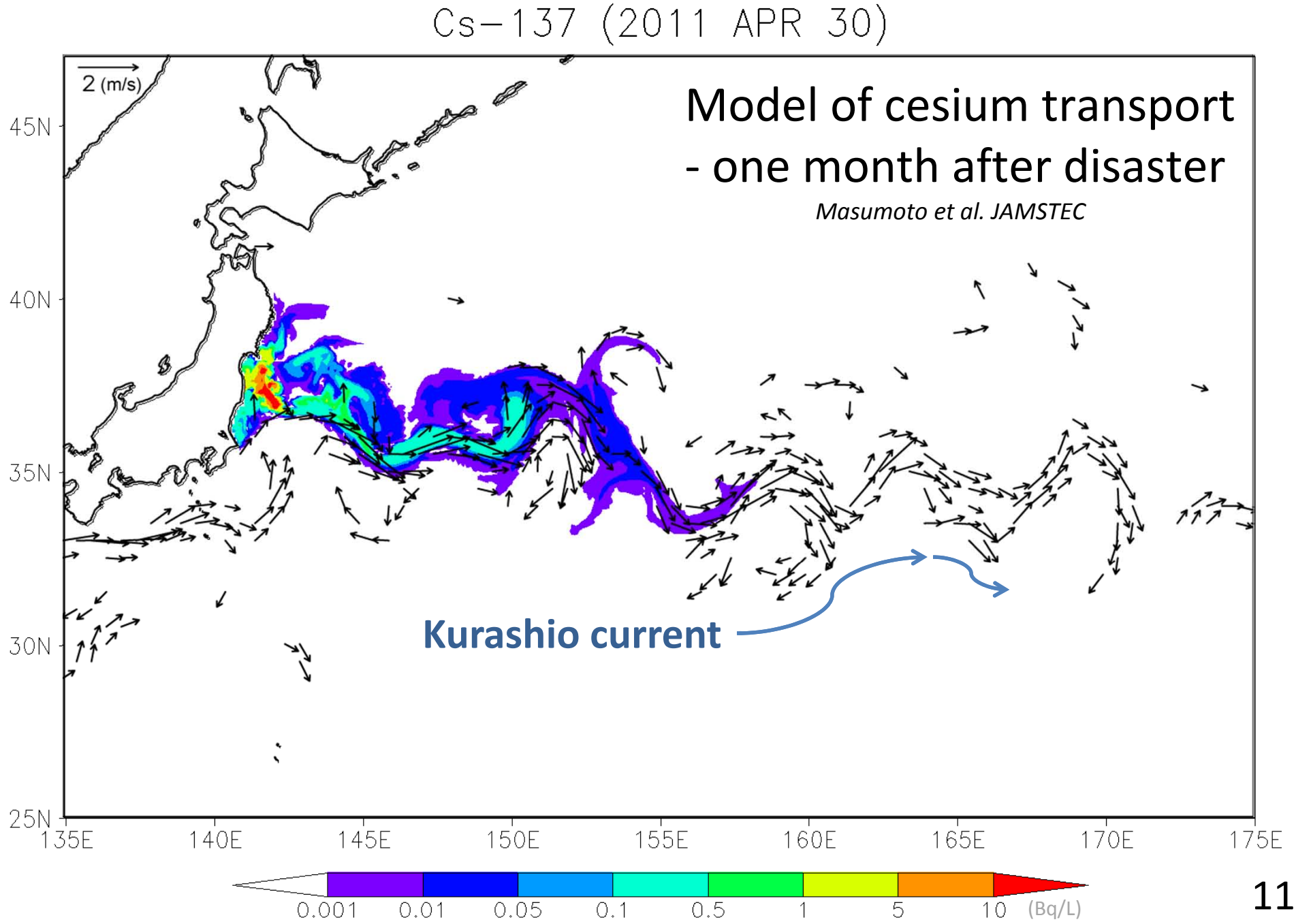
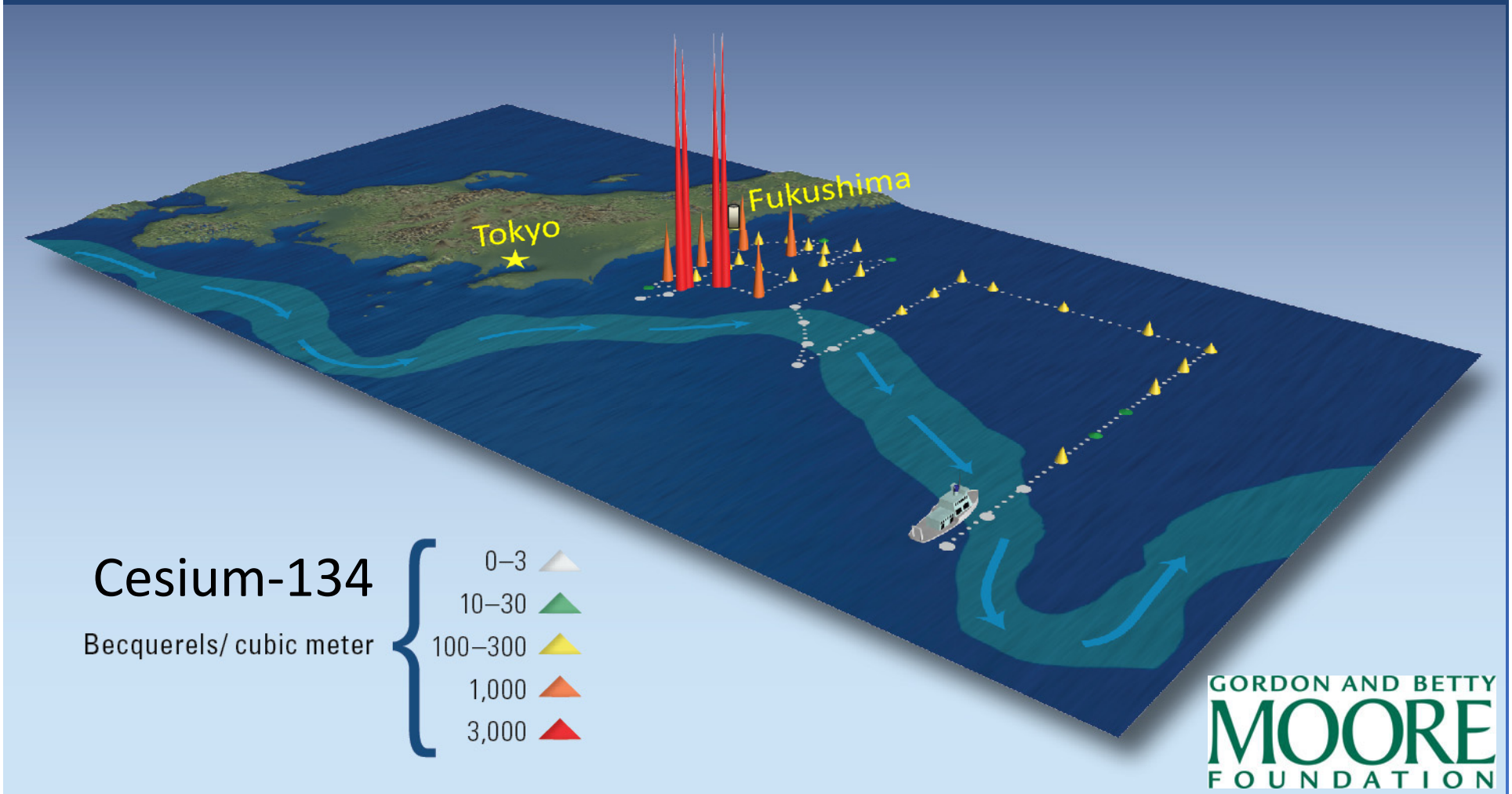
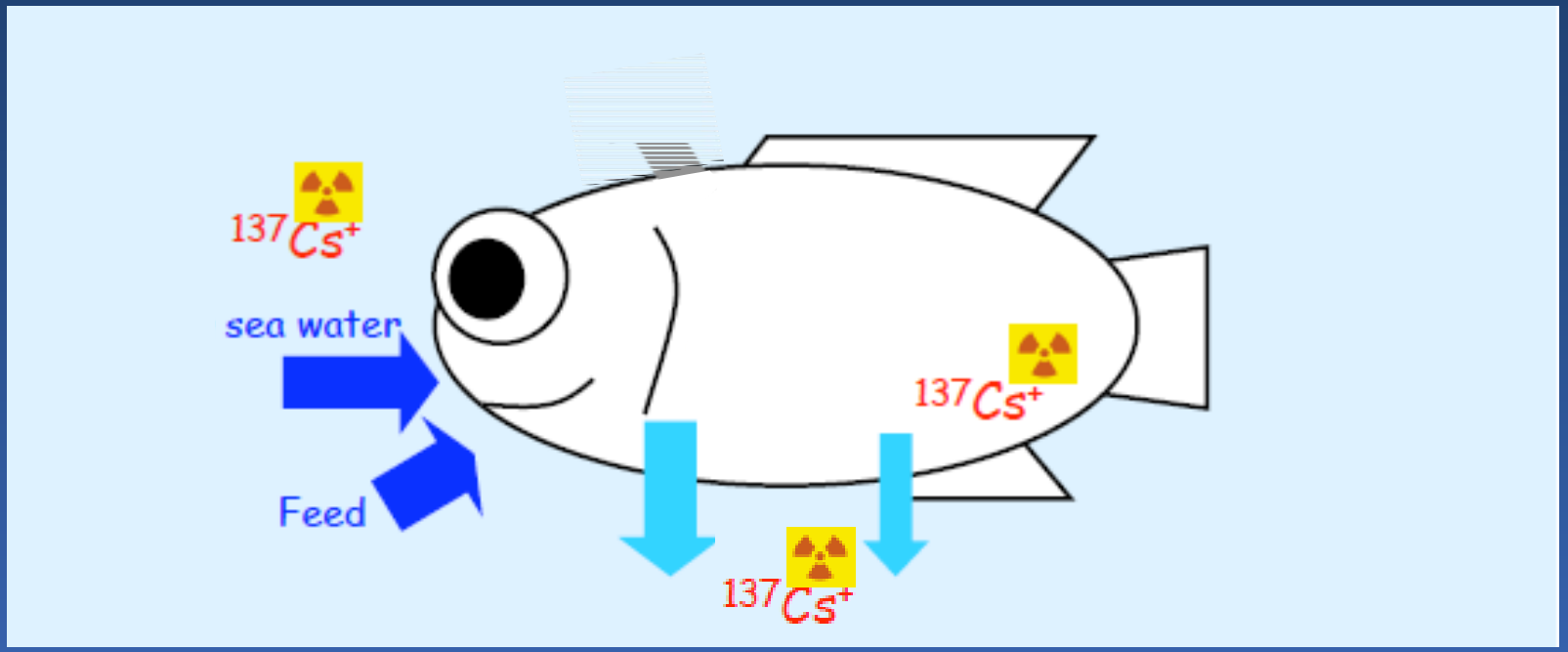

Cs−137 (2011 APR 30)
2 (m/s)
Model of cesium transport
- one month after disaster
Masumoto et al. JAMSTEC
Kurashio current
45N
40N
35N
30N
25N
135E
140E
145E
150E
155E
160E
165E
170E
175E
0.001
0.01
0.05
0.1
0.5
1
5
10
(Bq/L)

# Rapid response cruise in June 2011



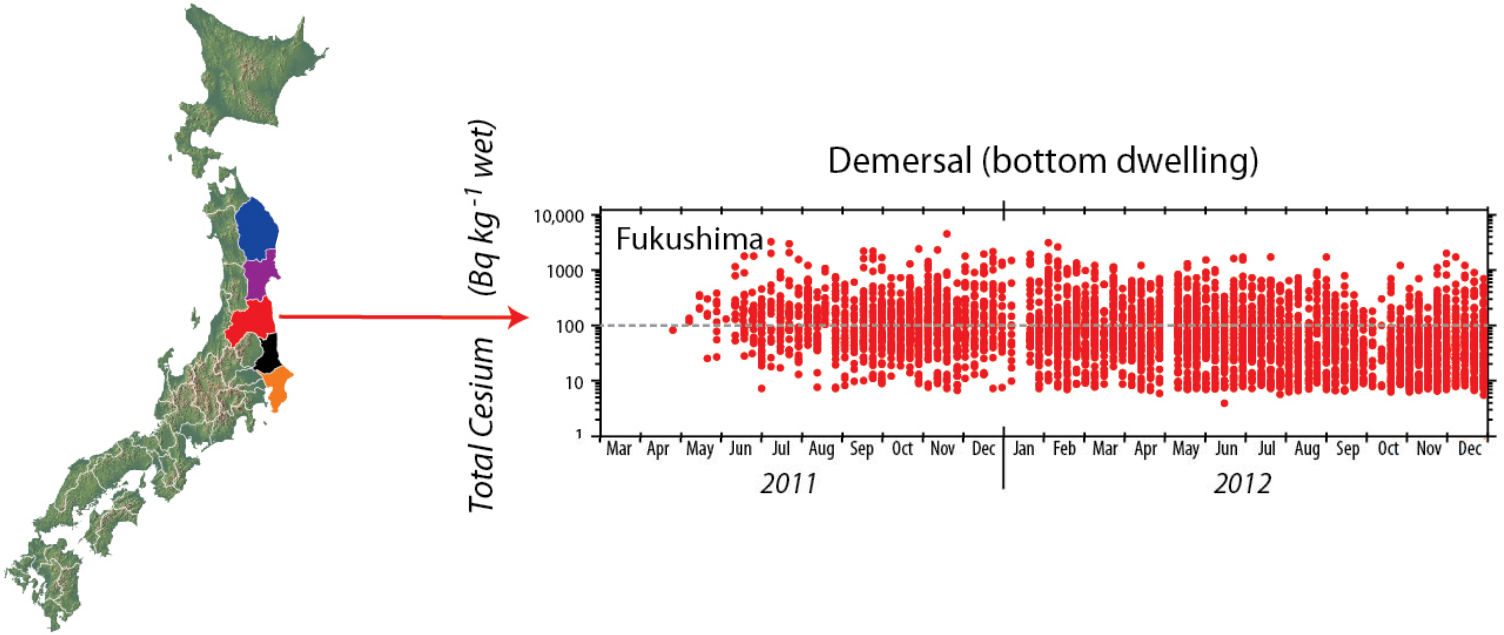

GORDON AND BETTY MOORE FOUNDATION

# What about Fish and cesium accumulation?



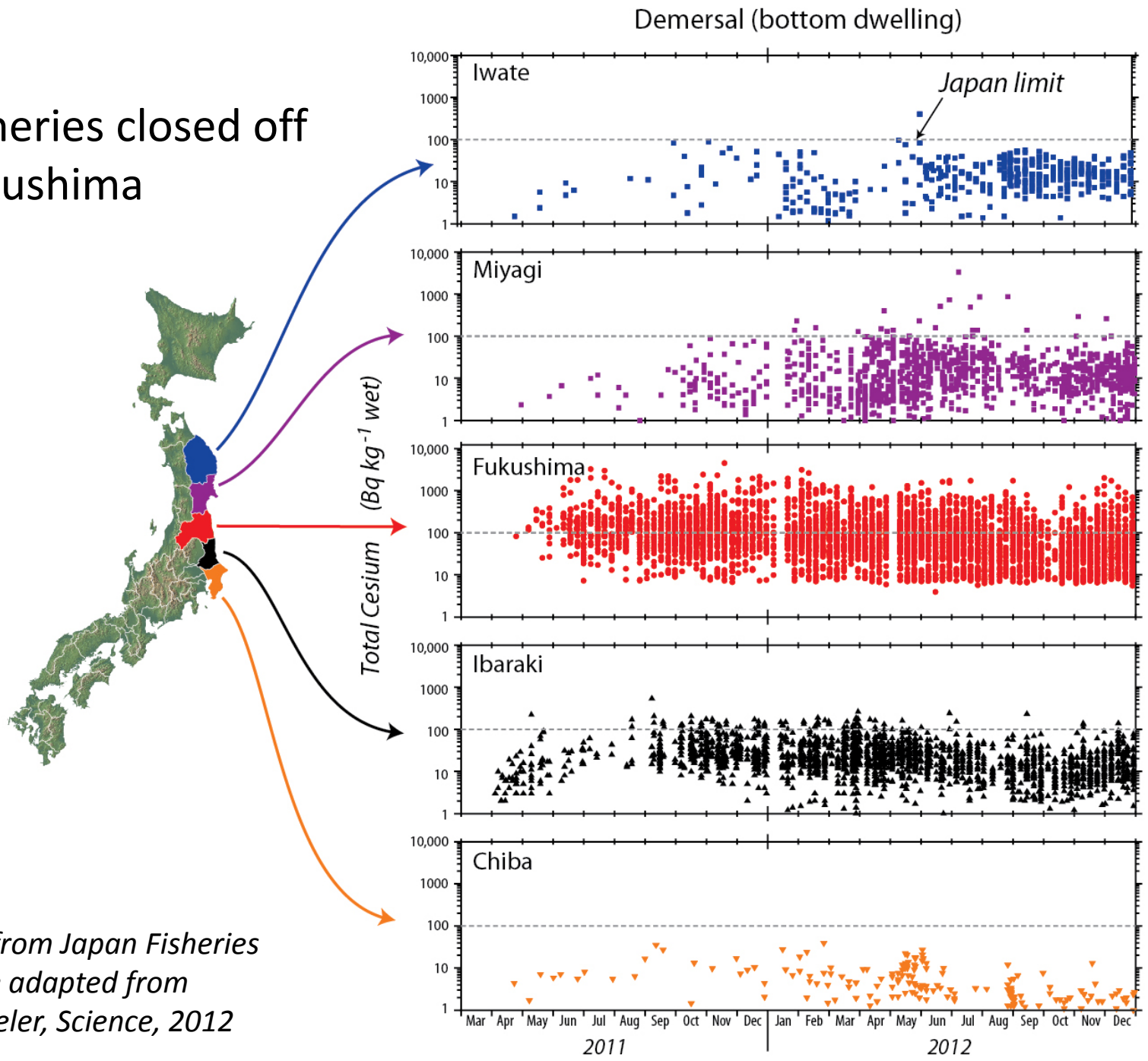

*information page from Japanese Ministry of Agriculture, Forestry and Fisheries*

# Cesium remains high in bottom dwelling fish near Fukushima



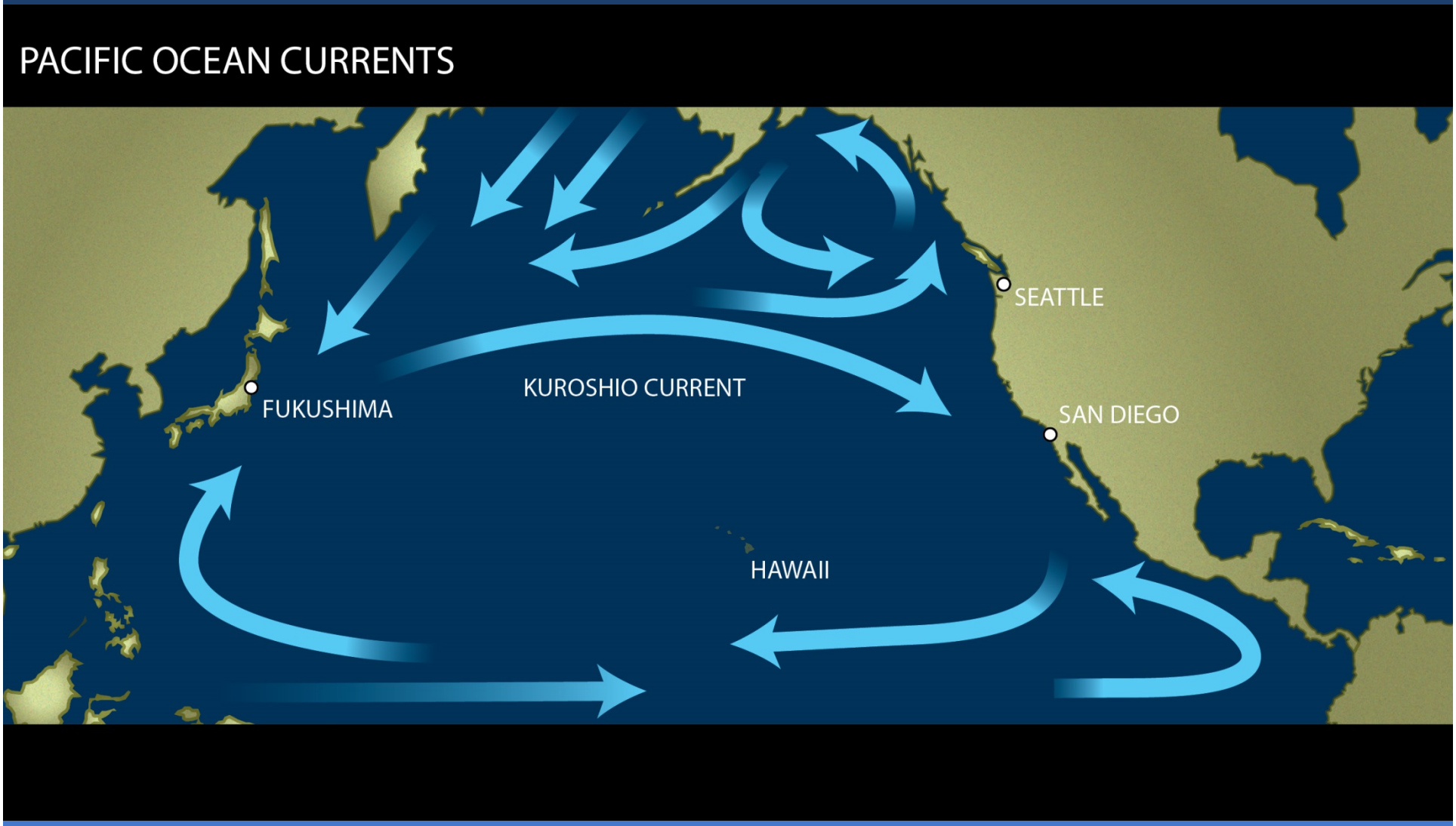

*Data from Japan Fisheries*
*Figure adapted from*
*Buesseler, Science, 2012*

# Fisheries closed off Fukushima

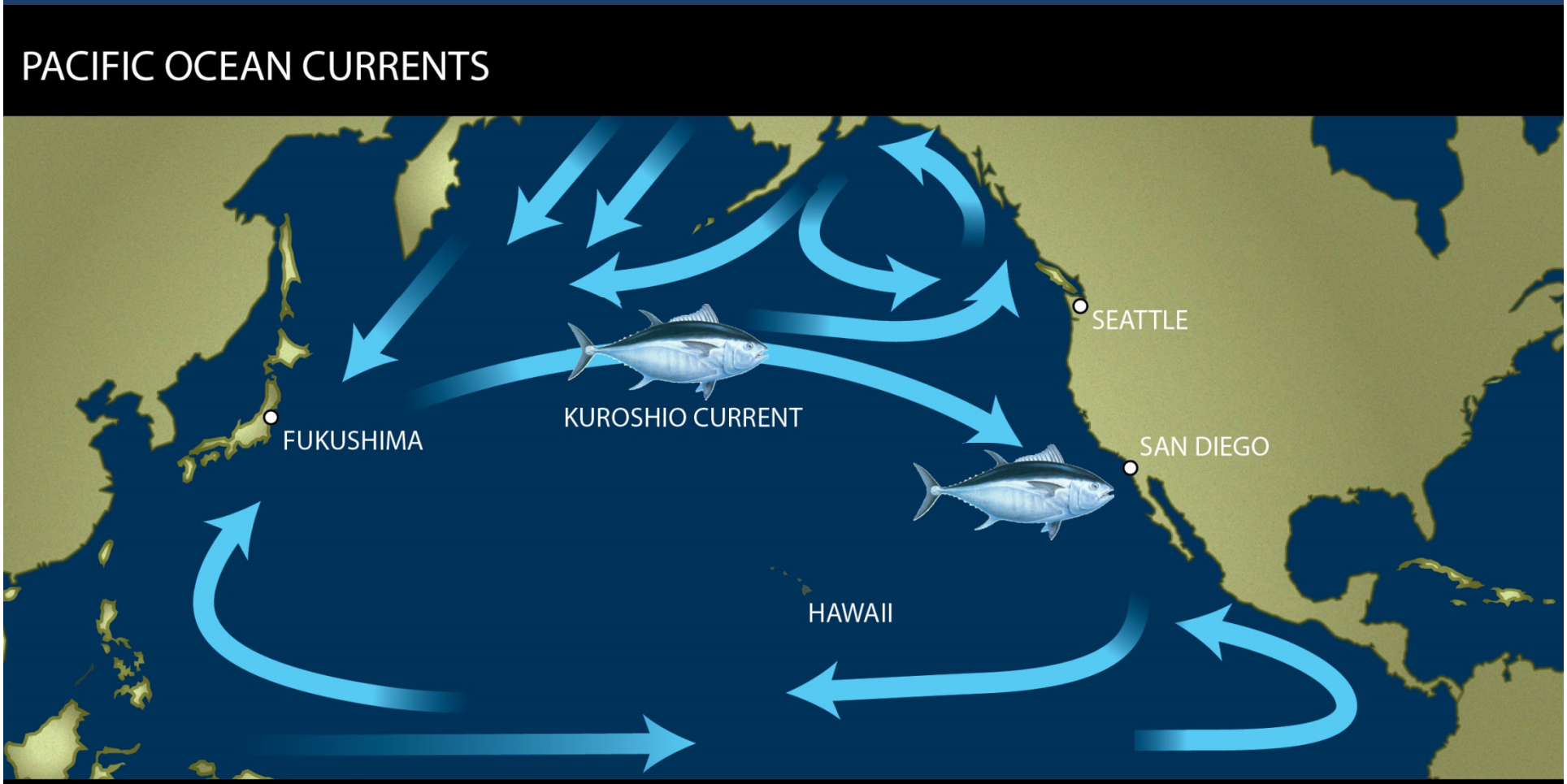



*Data from Japan Fisheries*
*Figure adapted from*
*Buesseler, Science, 2012*

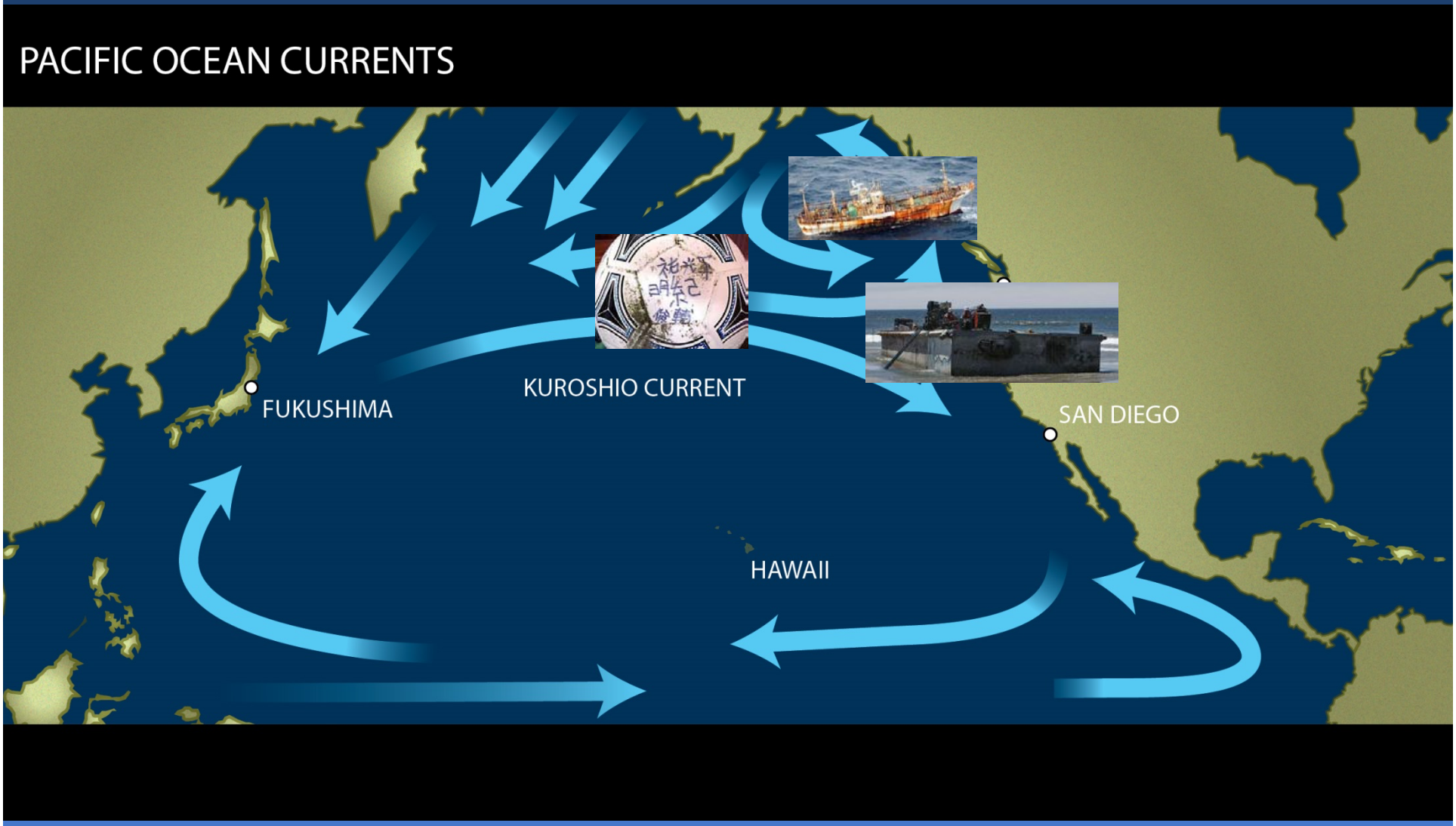
# How far and fast do Fukushima radionuclides travel?



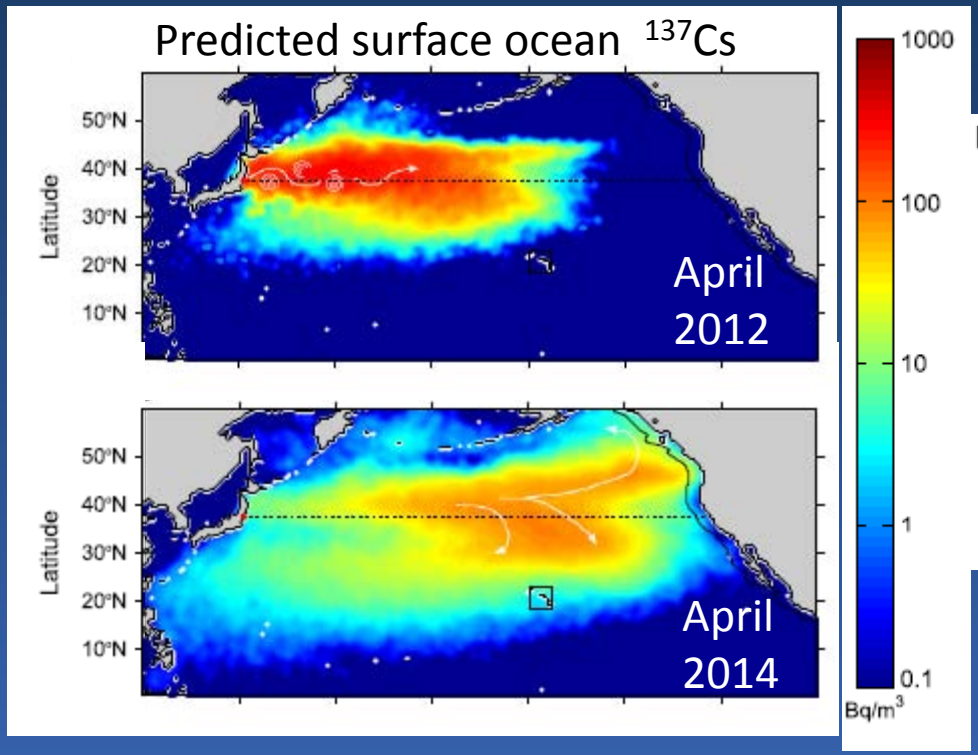
# Pacific Blue Fin Tuna migration- arrived in fall 2011

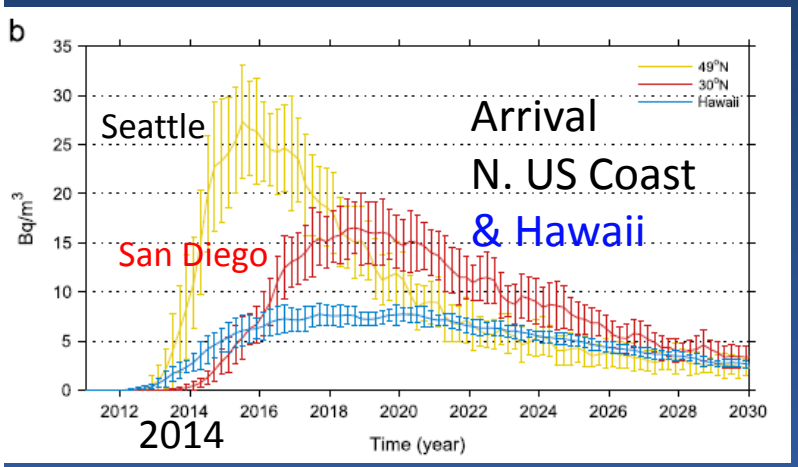


# Debris carried by currents and winds- arrived 2012



# Radionuclides carried only by ocean currents




*Rossi et al., DSRI, 2013*

- 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

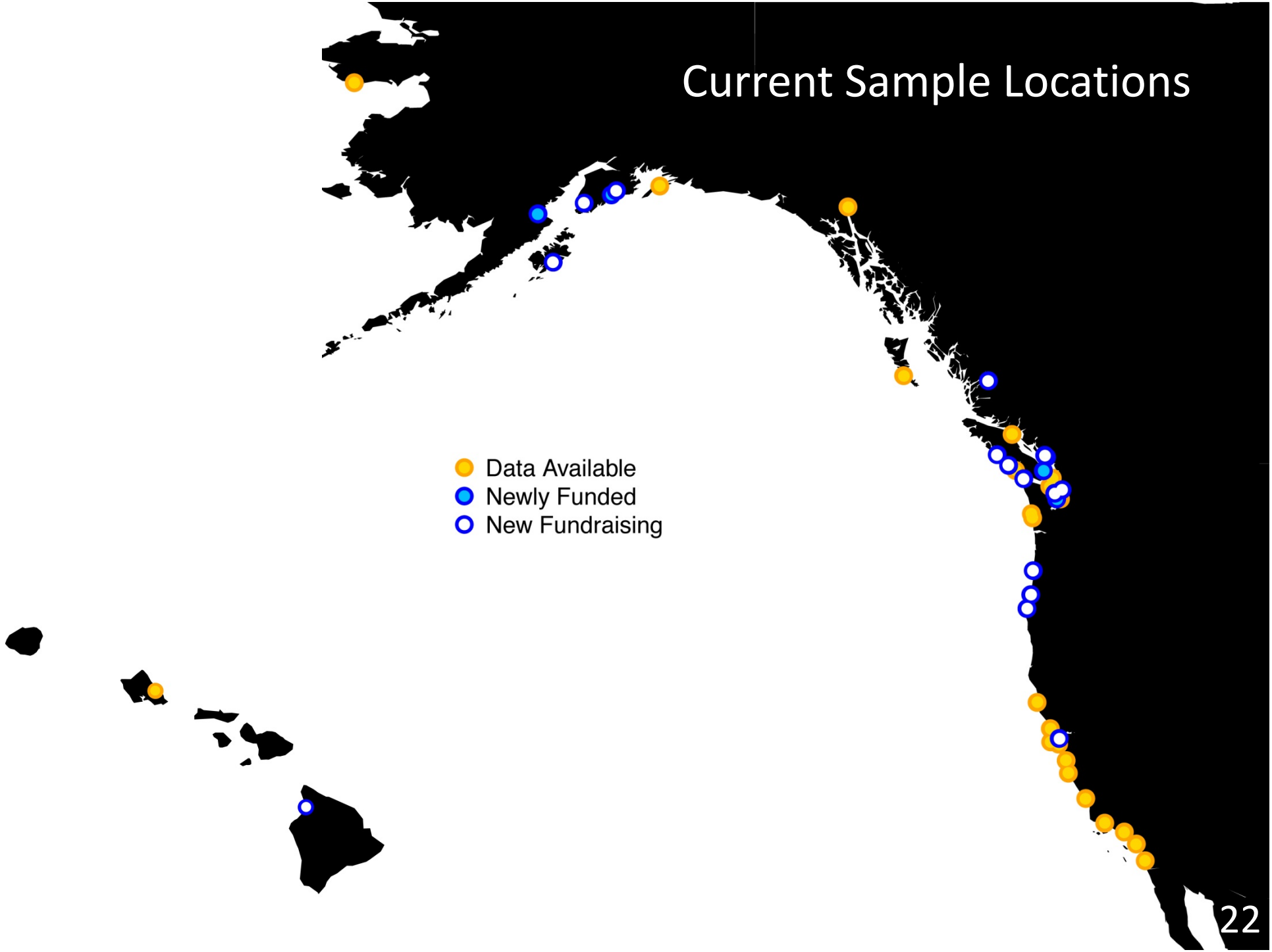
*Jan. 14, 2014*


http://ourradioactiveocean.org

# Success stories


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

# Current Sample Locations



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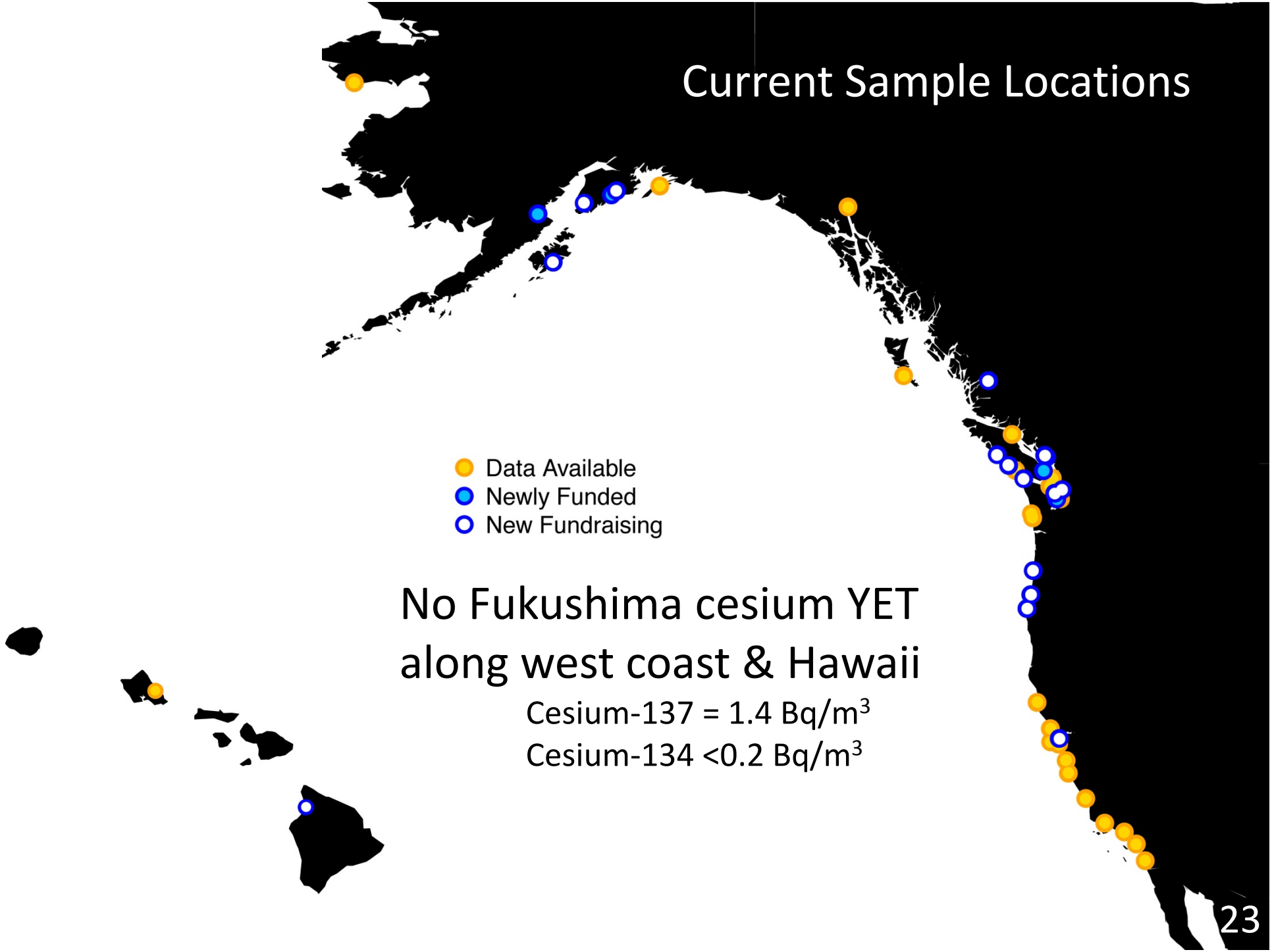


No Fukushima cesium YET along west coast & Hawaii

Cesium-137 = 1.4 Bq/$m^3$

Cesium-134 <0.2 Bq/$m^3$

Pt. Reyes CA

## Our supporters

Alaska Ocean Observing System
Alaska SeaGrant
Bamfield Marine Science Centre
Cook Inletkeeper
David Suzuki Foundation
Deerbrook Charitable Trust
Dominical Real Estate
Gordon and Betty Moore Foundation
Gwaii Haanas National Park Reserve
Humboldt State University, Marine Lab
Idaho Section of the American Nuclear Society
KUSP Santa Cruz
LUSH Cosmetics
Norton Sound Economic Development Corp.
Nuxalk Nation
Onset Computer
Pacific Blue Foundation
Picture Farm Company
and……..

Santa Cruz, CA

## Our supporters, cont.

Point Blue Conservation Science
Prince William Sound Science Center
Resurrection Bay Conservation Alliance
San Luis Obispo Mothers for Peace
Santa Barbara Channel Keeper
Say Yes! to Life Swims LLC
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The Guacamole Fund
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Gulf of Alaska, AK

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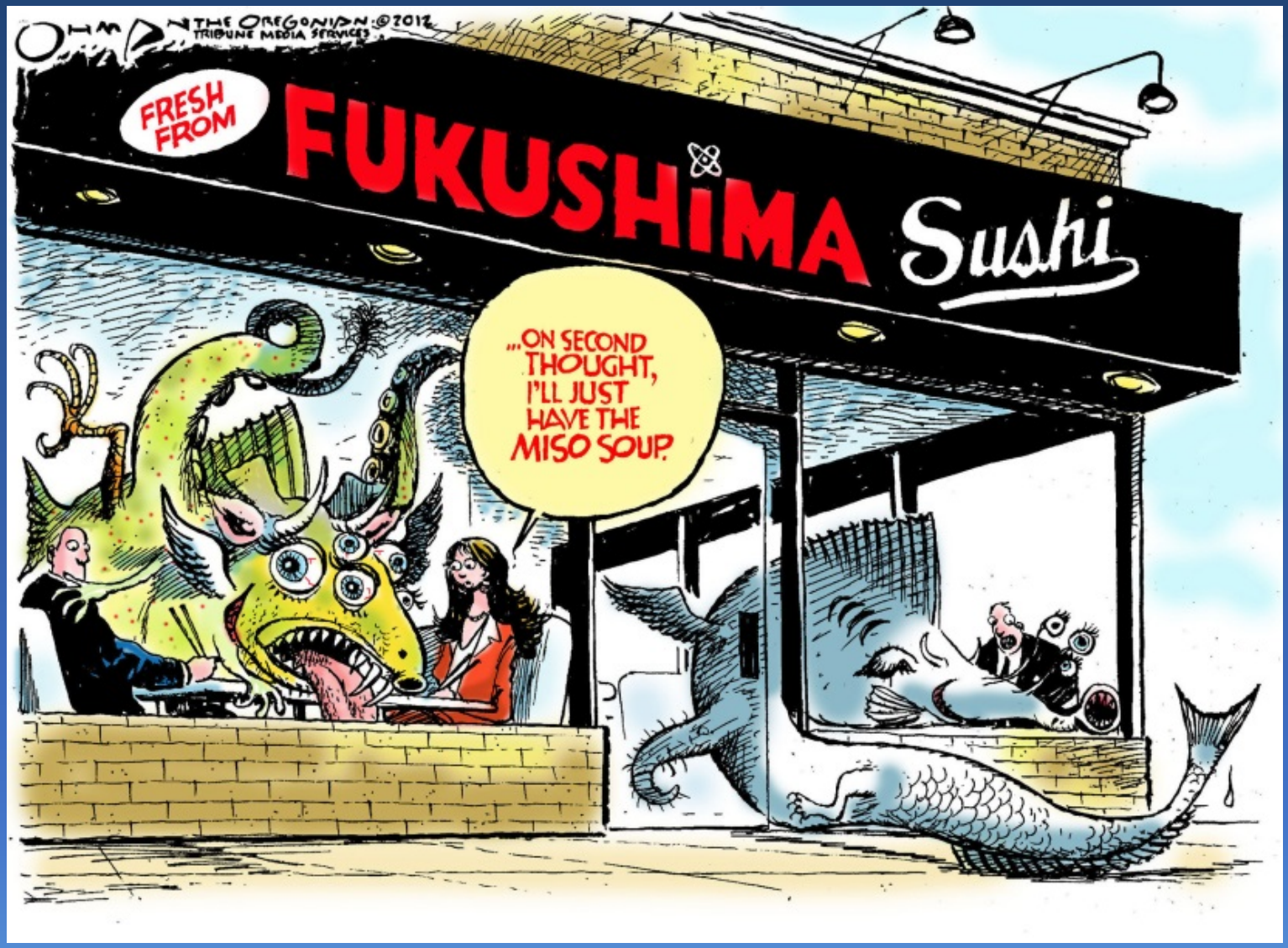
Woods Hole Oceanographic Institution

Santa Barbara, CA

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

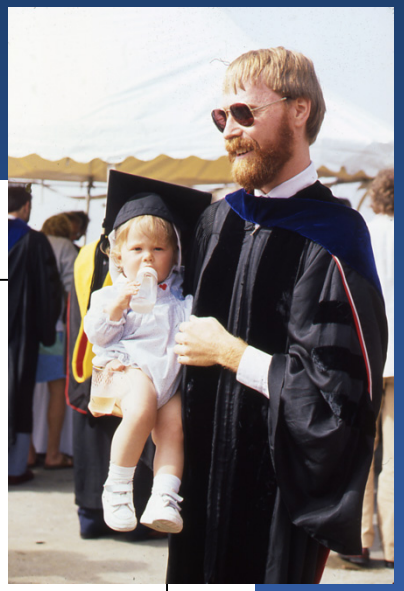
# Fukushima showed

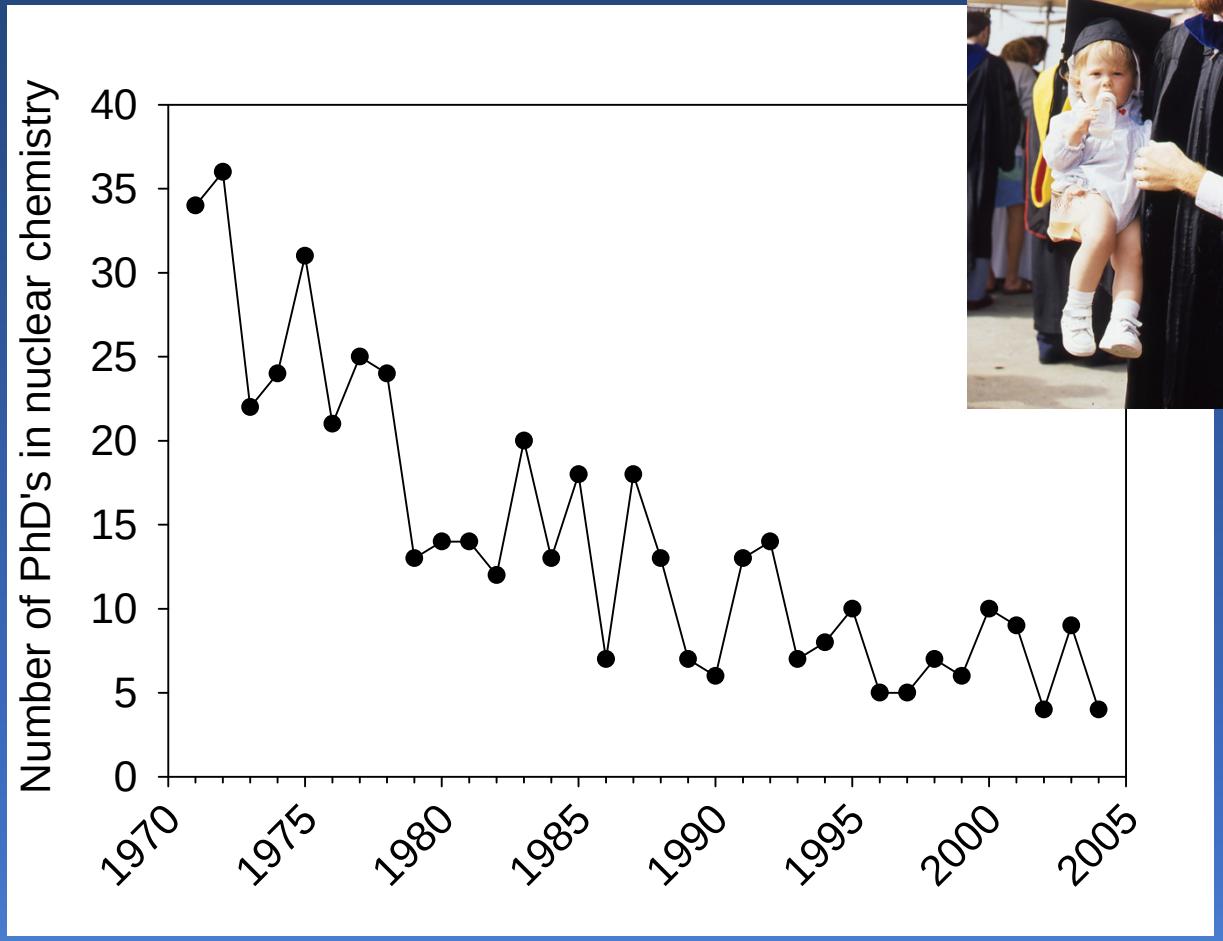
## Public concern



# Fukushima showed

## Education/training need





CMER Center for Marine and Environmental Radioactivity

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## 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

Center for Marine & Environmental Radioactivity

# Support needed for

## Citizen Scientists

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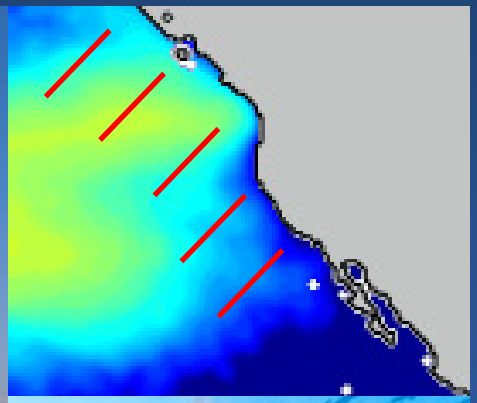
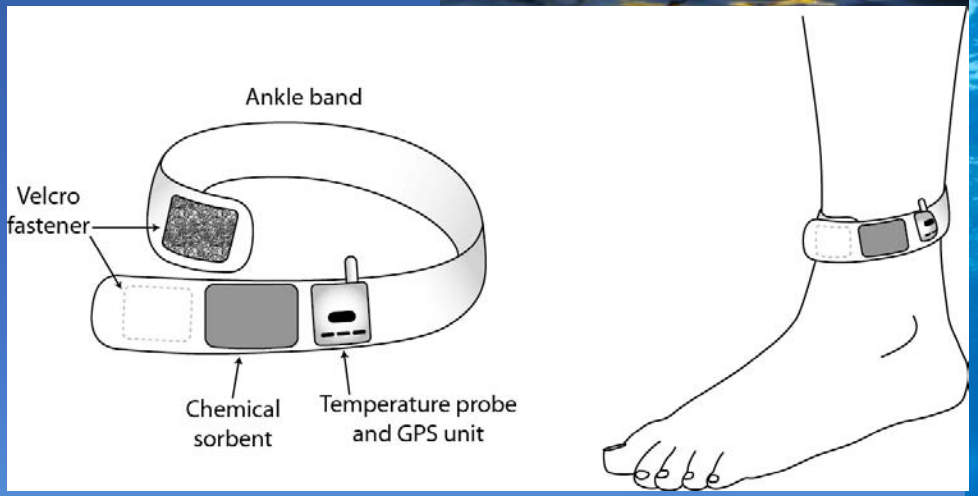
# Support needed for

New Tools

- Wave glider
- Rad-band





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# Support needed for

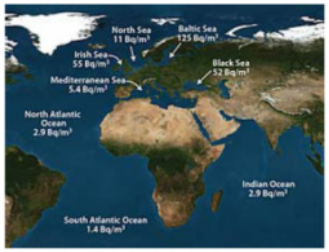
## To better understand our radioactive ocean


Woods Hole Oceanographic Institution

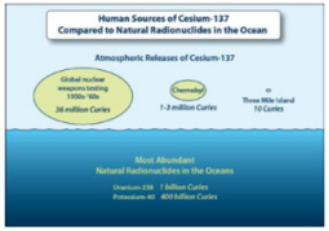
### FAQ: Radiation from Fukushima

*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*




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)

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http://ourradioactiveocean.org

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