NASA Biodiversity and Ecological Forecasting Team Meeting
May 21-23, 2019, Arlington, VA

FloatEco: Study of Physical and Biological Processes Maintaining a Unique Floating Ecosystem of the North Pacific Garbage Patch

Project team

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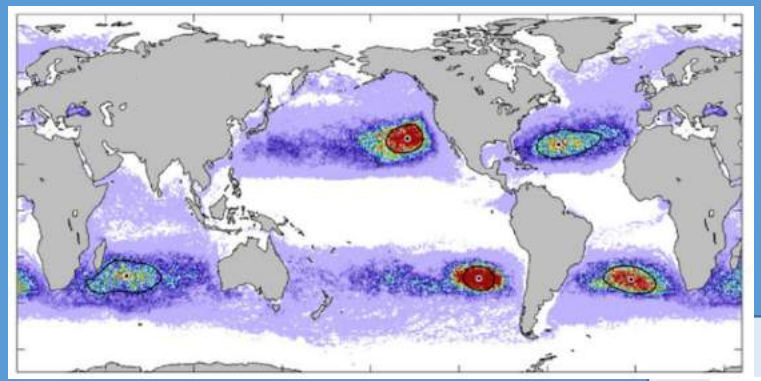
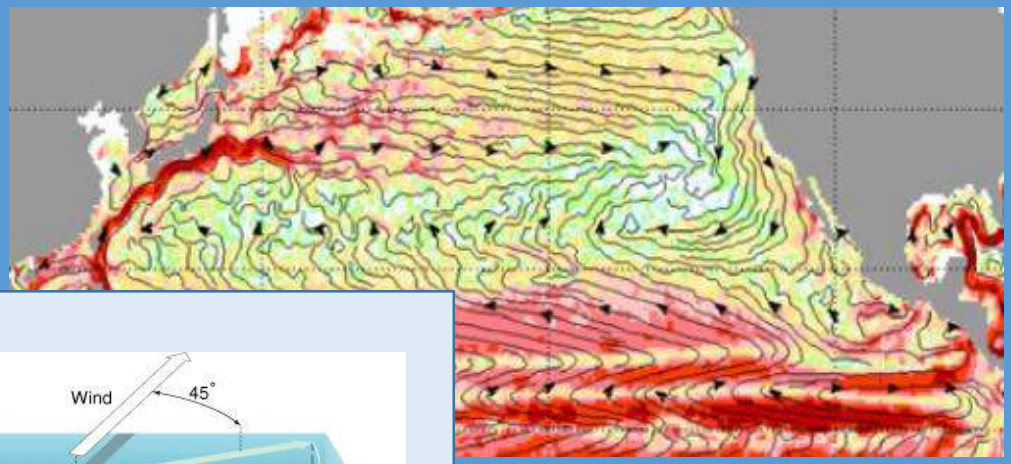
The Swim
Algalita
The Ocean Cleanup
eXXpedition
Greenpeace
Polynesian Voyaging Society
Figure 6 Voyage
Rick Pelton S/V Anais
Jim Linderman S/V Lyric
Russ Johnson
Ray McCormack S/V Firefly
N. Treneman – OSU
HI-MDAP members
and many others

Physics of "Garbage Patches"

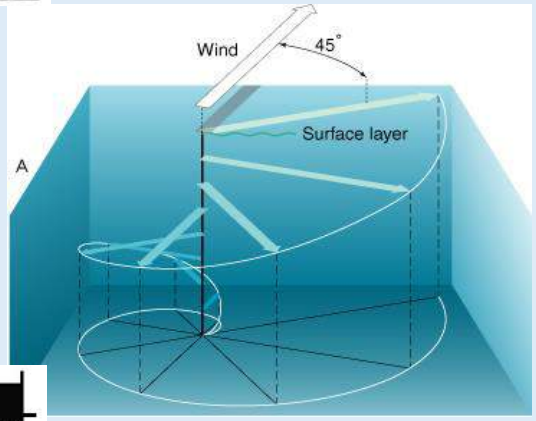
Five subtropical patches"



Multi-year mean streamlines of near-surface currents, derived from drifters, converge toward garbage patches

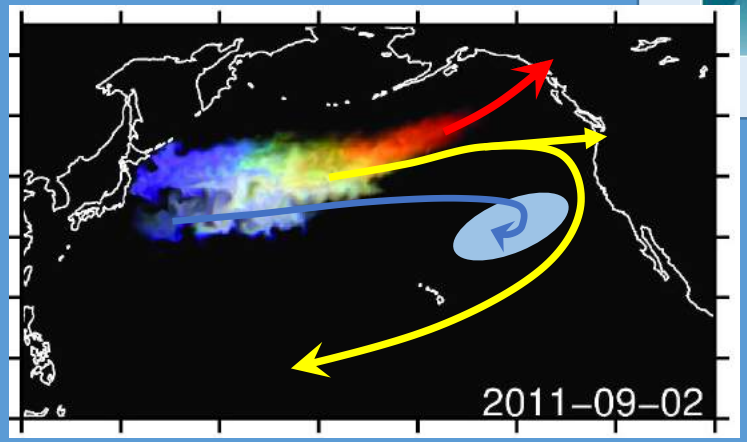


Ekman dynamics is responsible for GP formation



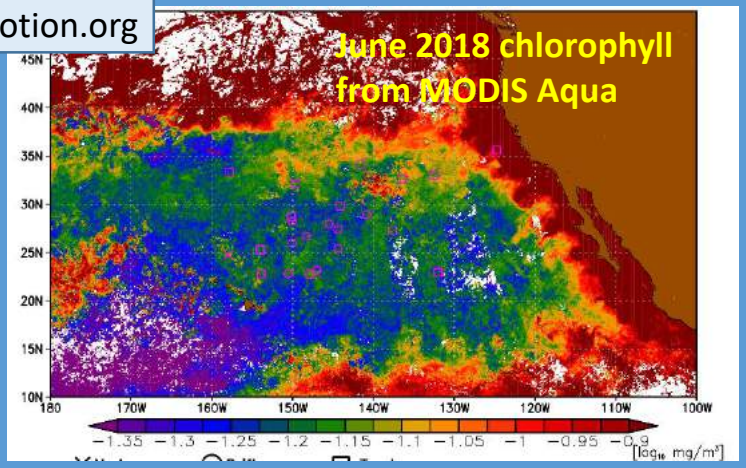
Source: oceanmotion.org

Pathways of debris depend on their windage

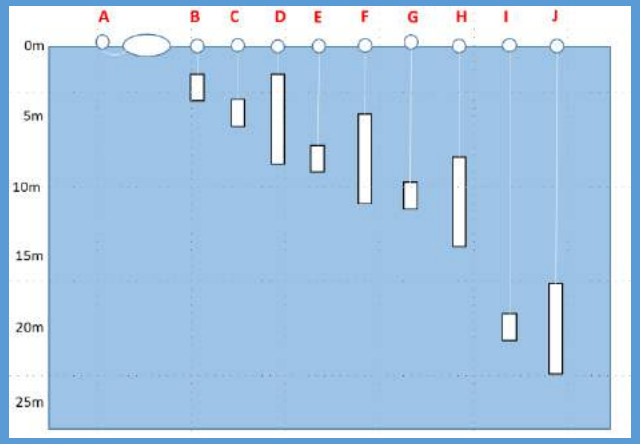


Model simulation of debris from the 2011 tsunami in Japan

Garbage patches are nutrients poor, low-chlorophyll areas



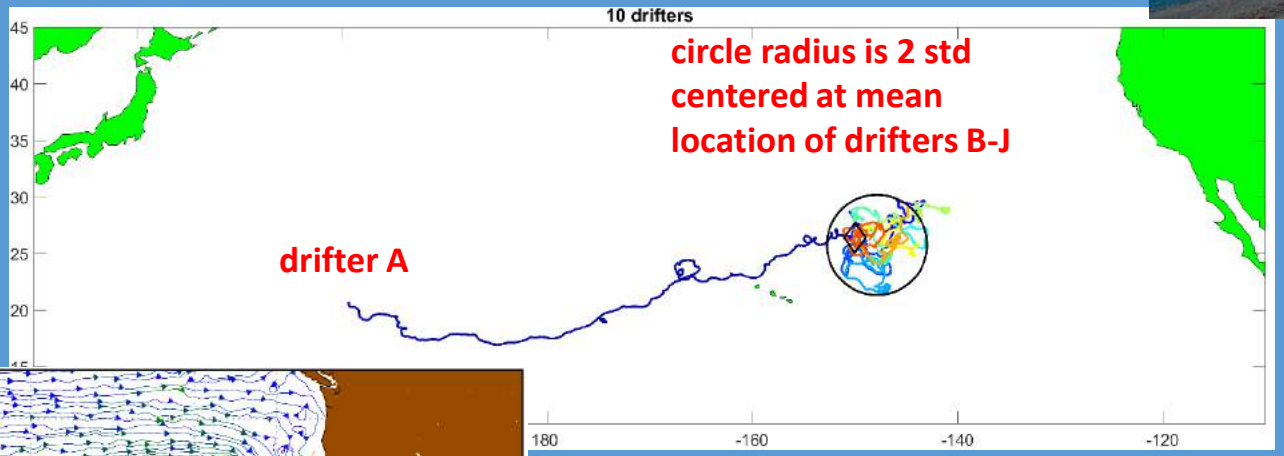
Drifter array to study debris interaction with vertically sheared currents

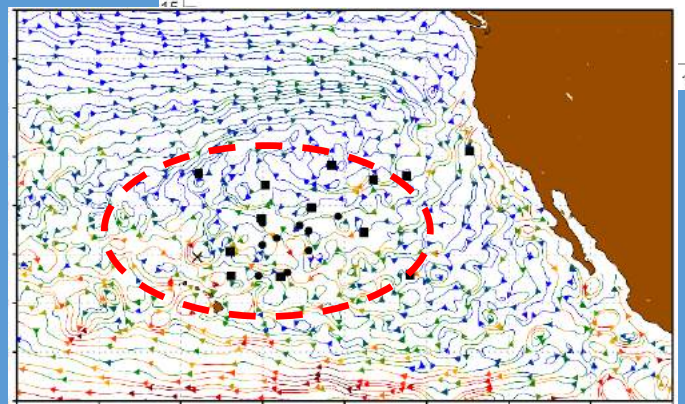


Maersk Launcher

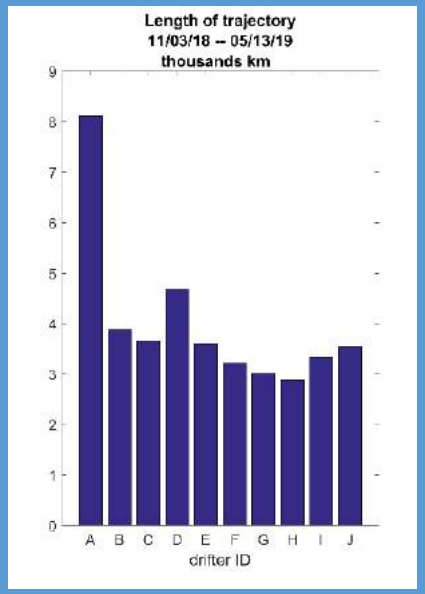
The Ocean Cleanup

Lagrangian Drifters Lab, Scripps IO



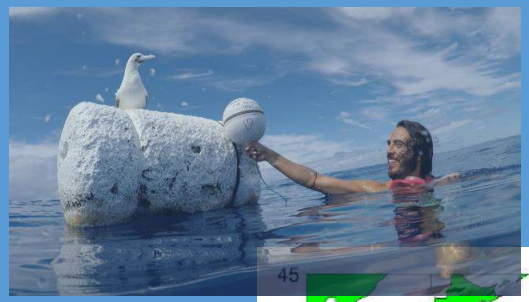


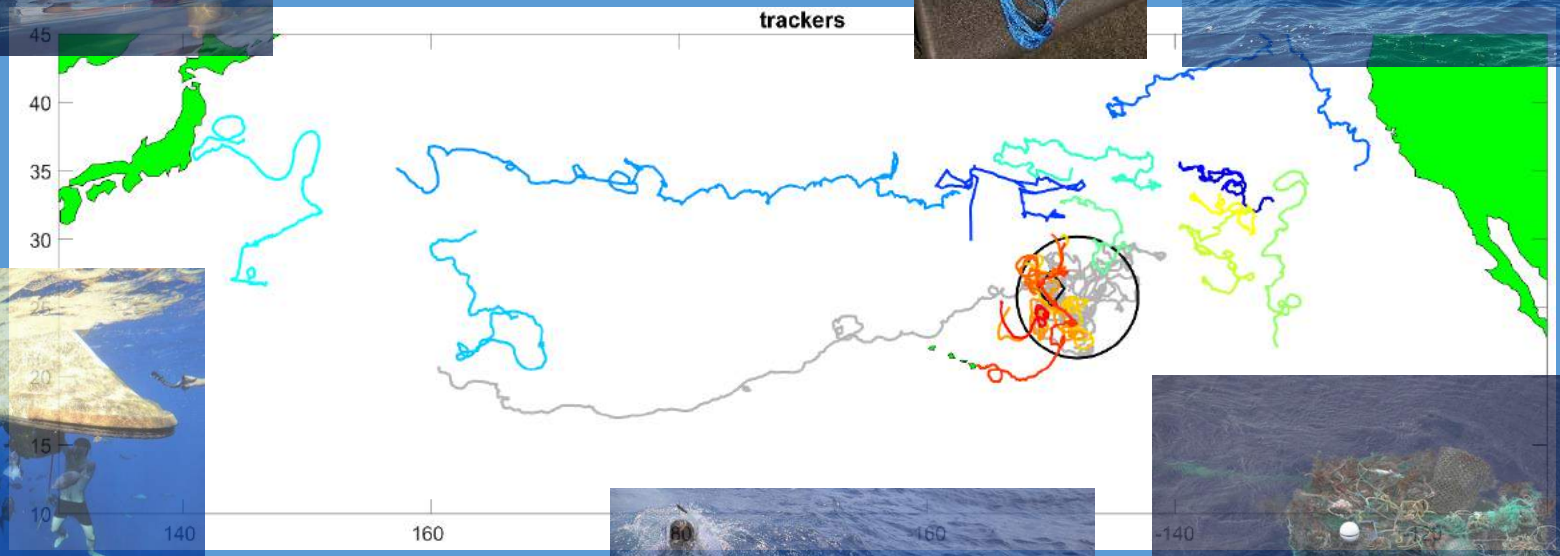
Result #1: Garbage patch area appears to be highly turbulent, with unorganized currents and low drift sensitivity to the under-water geometry of drifter.

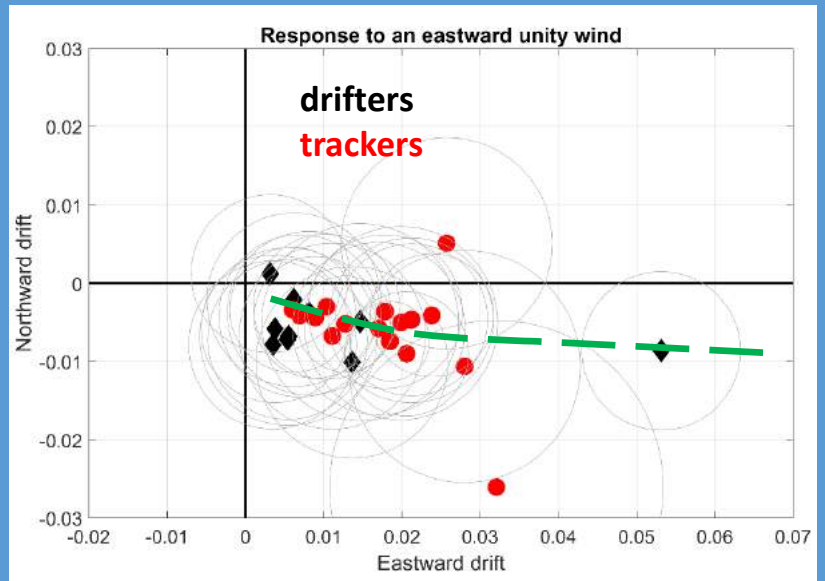


Contrary to expectation, drifters didn't travel far

Using OVI satellite trackers to study drift of actual debris



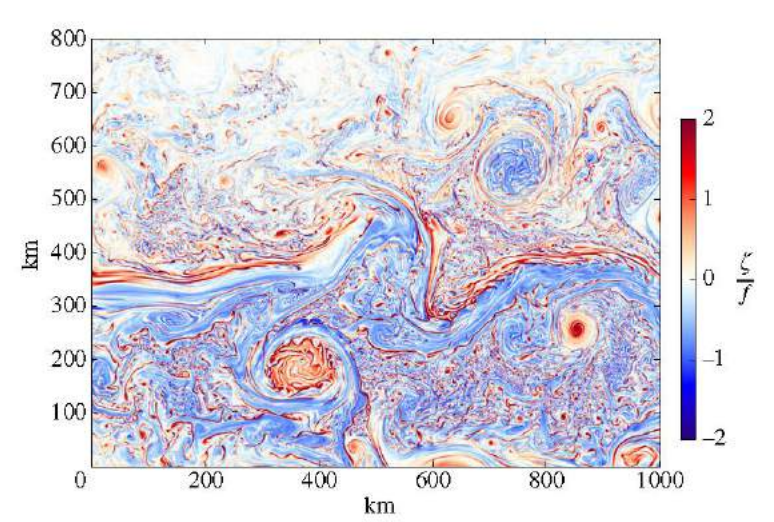




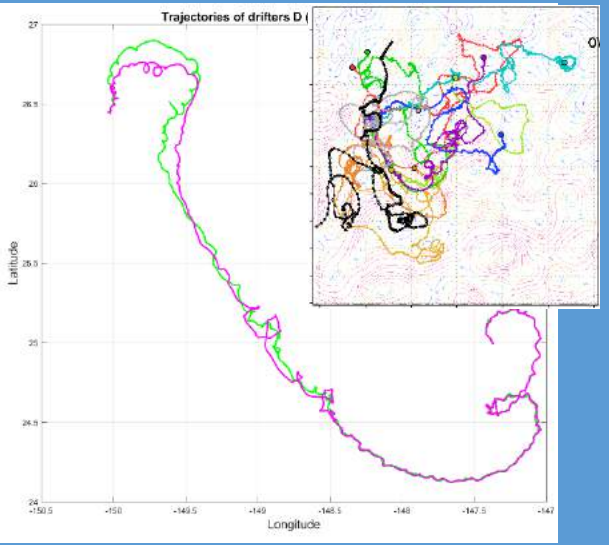
Result #2: First estimates of real debris response to the Wind (windage)

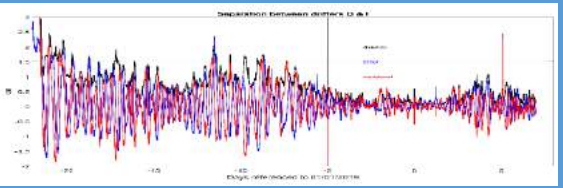
Submesoscale ocean features

In satellite images



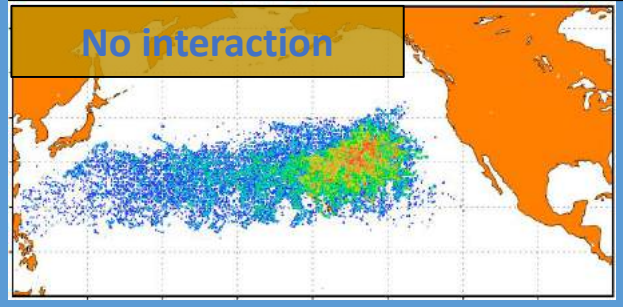
In numerical models

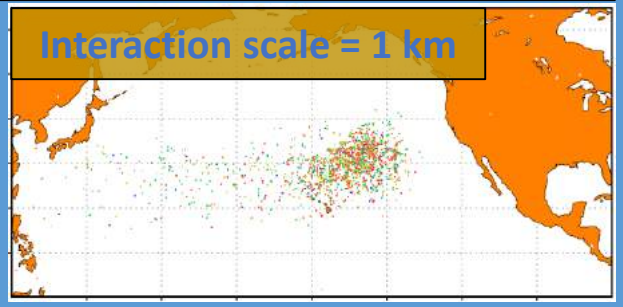


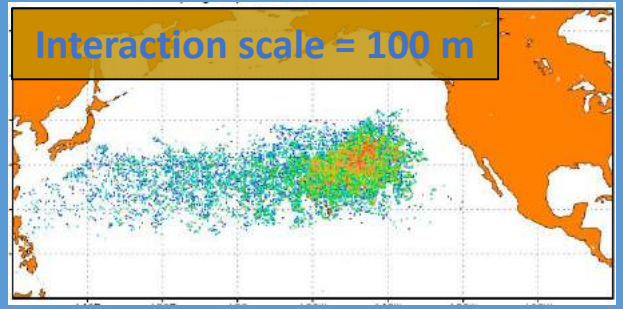


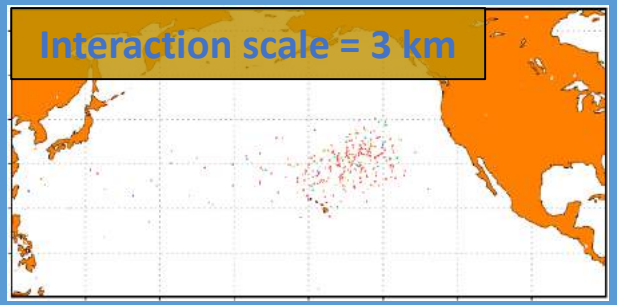
In our drifter trajectories

Distribution of interacting model particles after 20 years of integration





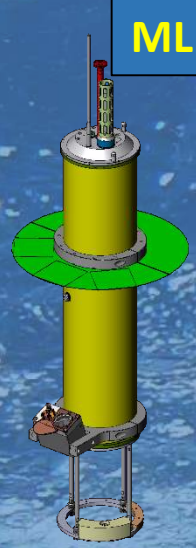


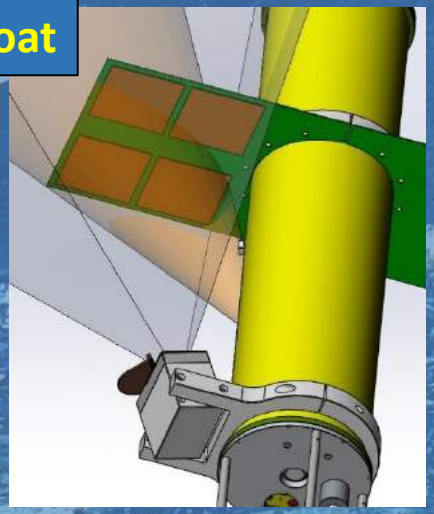


Result #3: some pairs of drifters and trackers resided in submesoscale features that seem ubiquitous in GP. E.g., drifters D (5m) and J (20m) spinned for a month is a cyclonic eddy with separation distance varying from 1.5 km to 100 m. Submesoscale interactions may be responsible for drift insensitivity to the windage. Frequent interactions between floating particles require modification of 'advection + diffusion' concept.

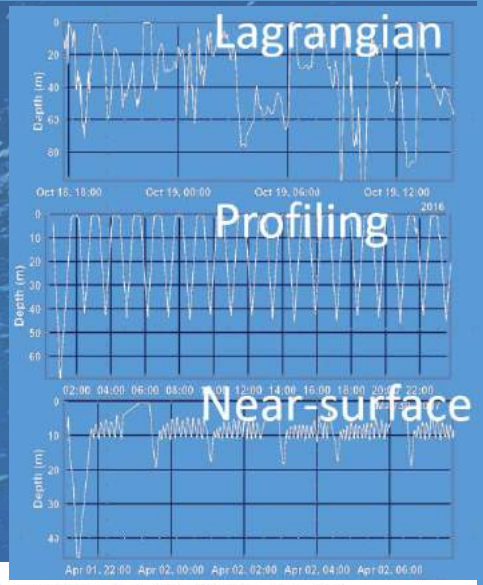
Plans for the next year

ML float



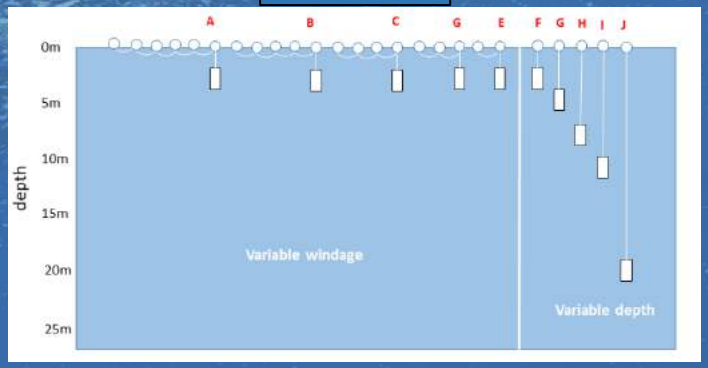


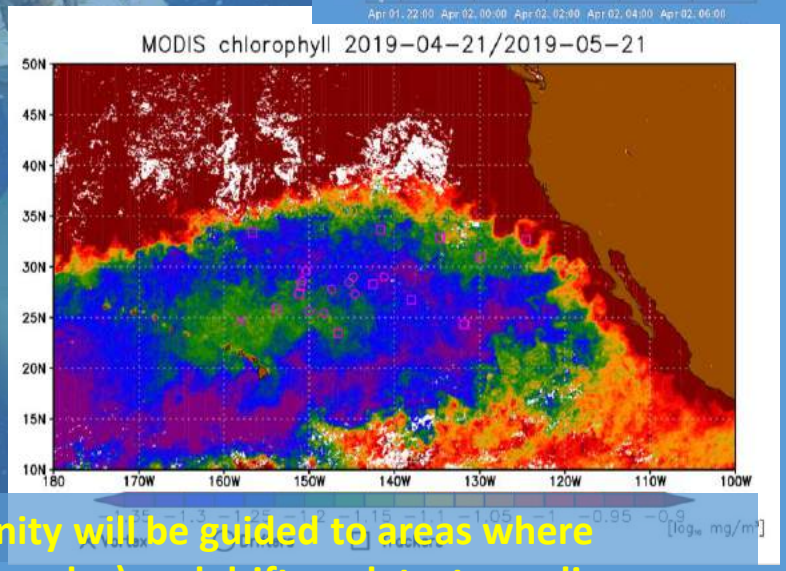
1. Mixed layer float will be deployed to simulate movement of zooplankton, microplastics and to study biofouling near the ocean surface.



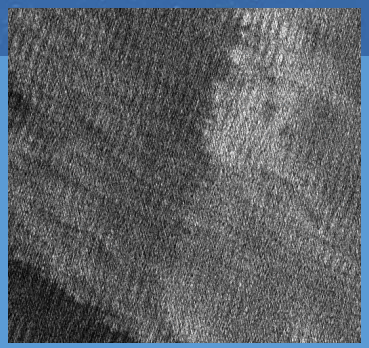
2. A set of 10 drifters will be deployed to measure effects of wind and current shear.

Drifters

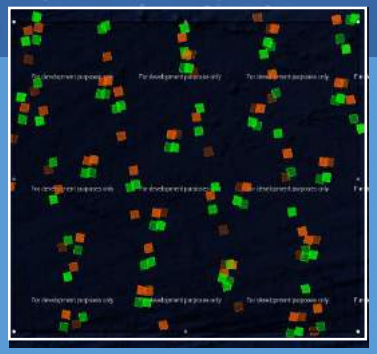




SAR: 20 km x 20km



1000 km

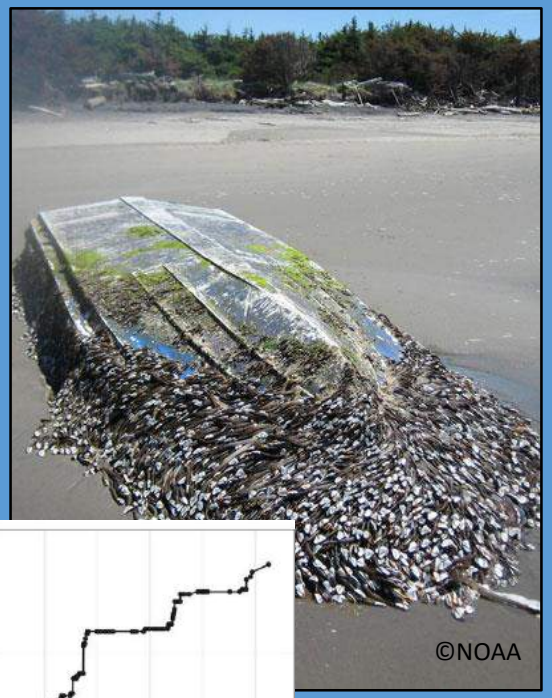


3. Boats of opportunity will be guided to areas where satellites (SST, ocean color) and drifters detect peculiar features (mesoscale eddies, fronts, chlorophyll blooms, etc.)

4. Area surveys using boats and drones, coincident with SAR (Sentinel-1) images

Biology of Floating Plastics

Plastics can transport diverse coastal species long distances

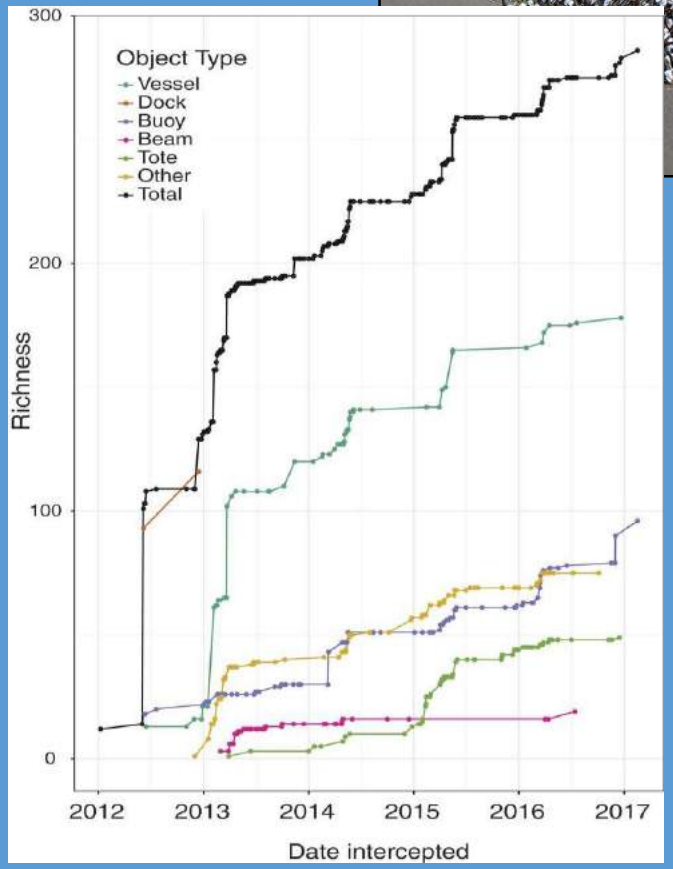


E. Japan tsunami of 2011

634 debris items from 2012-2017

>400 coastal Japanese species

Landings slowed over time, though they still occur



Carlton et al. 2017 (Science)

North America suitable for transoceanic debris species

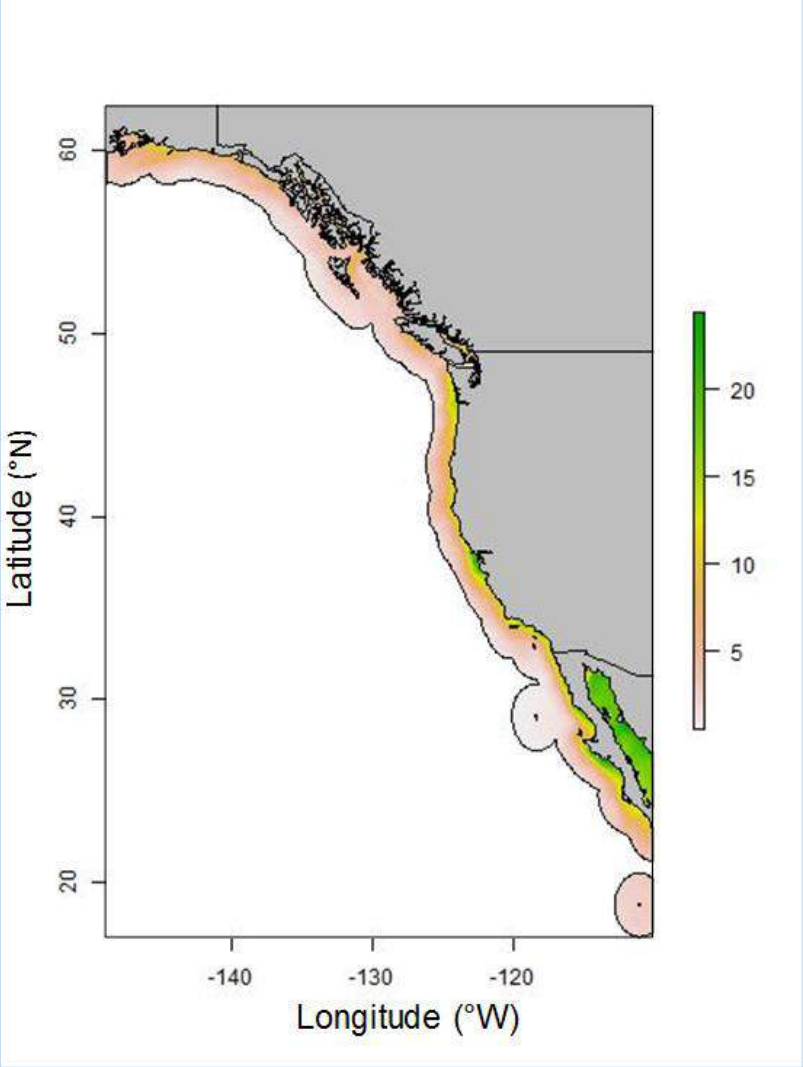
E. Japan tsunami biota

SDMs for 48 Japanese species arriving to North America

Environment suitable for 31%

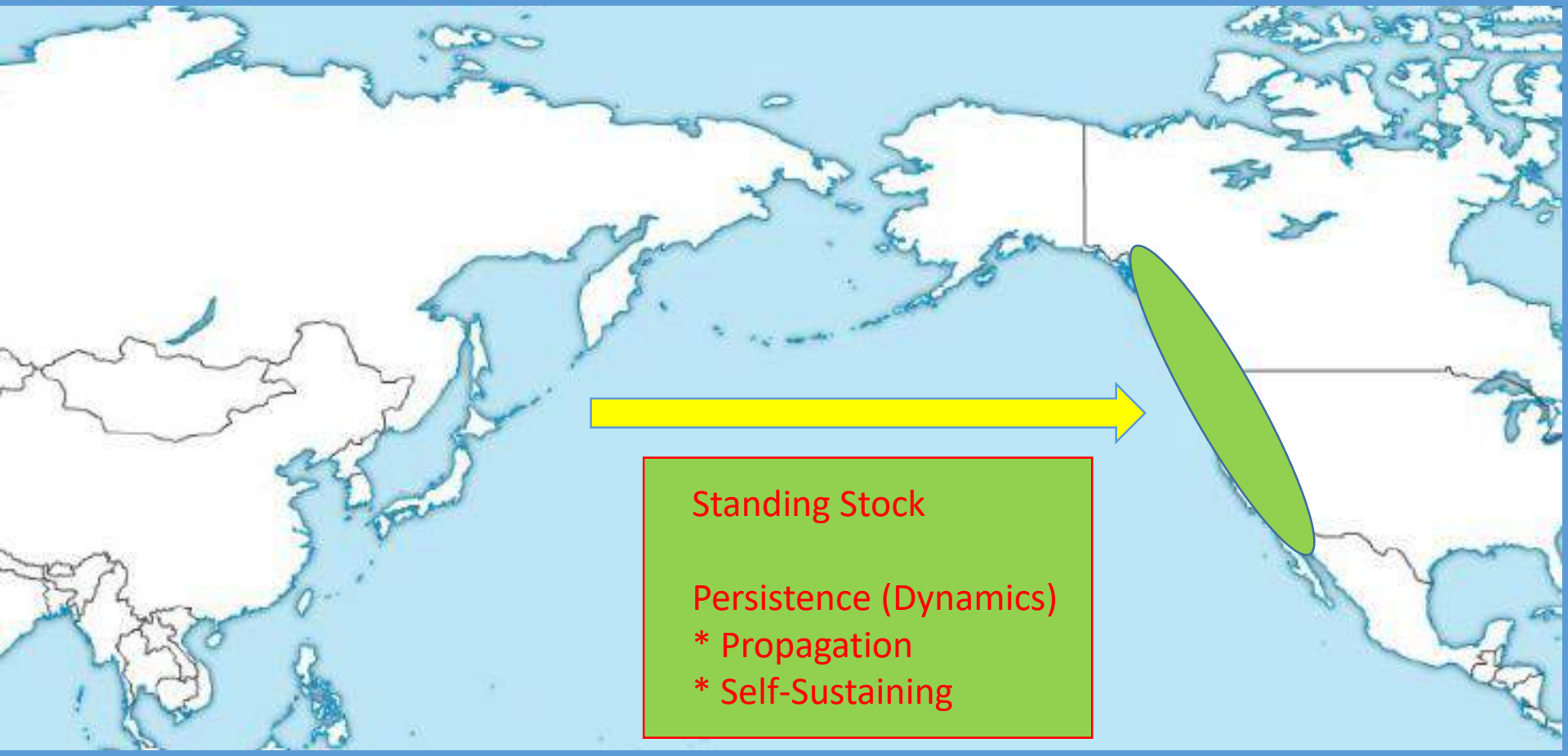
Appropriate habitat type(s) & food available

Consistent with past invasions



Simkanin et al. 2019 (Global Ecology & Biogeography)

Biology of Floating Plastics



What is the community composition on floating plastics? How similar is it to that of Japanese tsunami debris?

Composition: Diversity and Frequency of Coastal Species

Persistence: Physiological Responses

- Survival
- Reproduction
- Performance

Plastic Debris Surveys

Item Categories	# Collected
Hard Fragments	10
Rope	15
Bottle	10
Eeltrap Cone	10
Crate	9
Net	9
Buoy/Float	13
Jug/Bucket	10
Misc. Household Items	12
Wildcard	12
Total	110

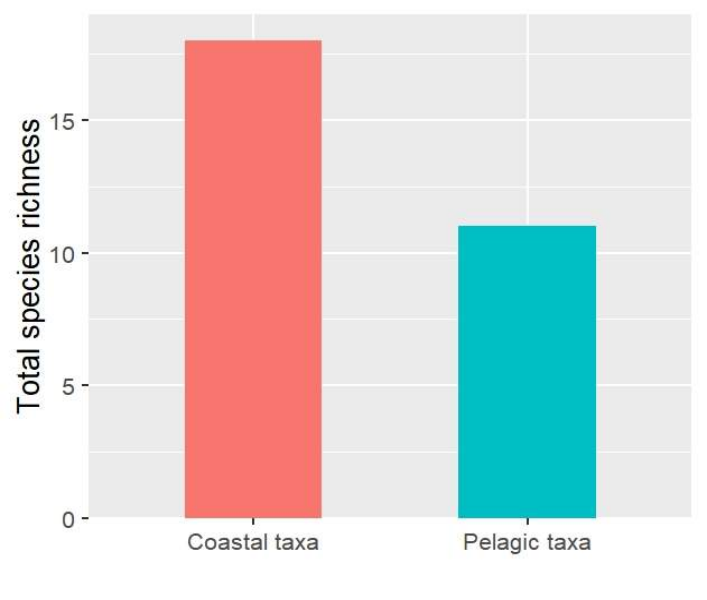
Plastic Debris Surveys

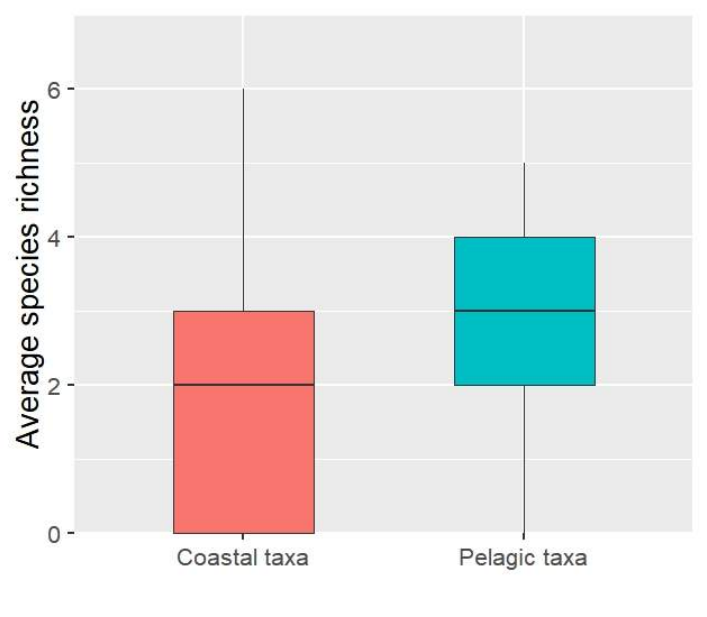
Coastal taxa

73%
of debris

Pelagic taxa

95%
of debris





Physiological Responses in Open Ocean

<u>Reproduction</u>

Are coastal species reproducing and settling on new debris in the open ocean?

Settlement panels deployed:

- Drifters
- GPS tagged debris
- Mixed layer float
- *Vessels*
- *Gliders*
- *Permanent or drifting offshore structures*

Settlement with Distance to Shore

Determine effect of distance from shore on community composition

©Tamara Fraser, DFO

IOOS
Integrated Ocean Observing System

Fisheries and Oceans Canada

Next Steps

Citizen Science Project

- Marine debris surveys by private sailors
- Website and active recruiting

Physiological Experiments

- Available platforms (ships, gliders, drifters)
- Laboratory mesocosm experiments

Bridging Oceanography and Biology

- High accumulation and convergence zones
- Predicting community structure of floating ecosystems

Scaling Up: Modeling of Open Ocean Populations

- Satellite and other data layers
- Habitat distribution models

THANK YOU

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