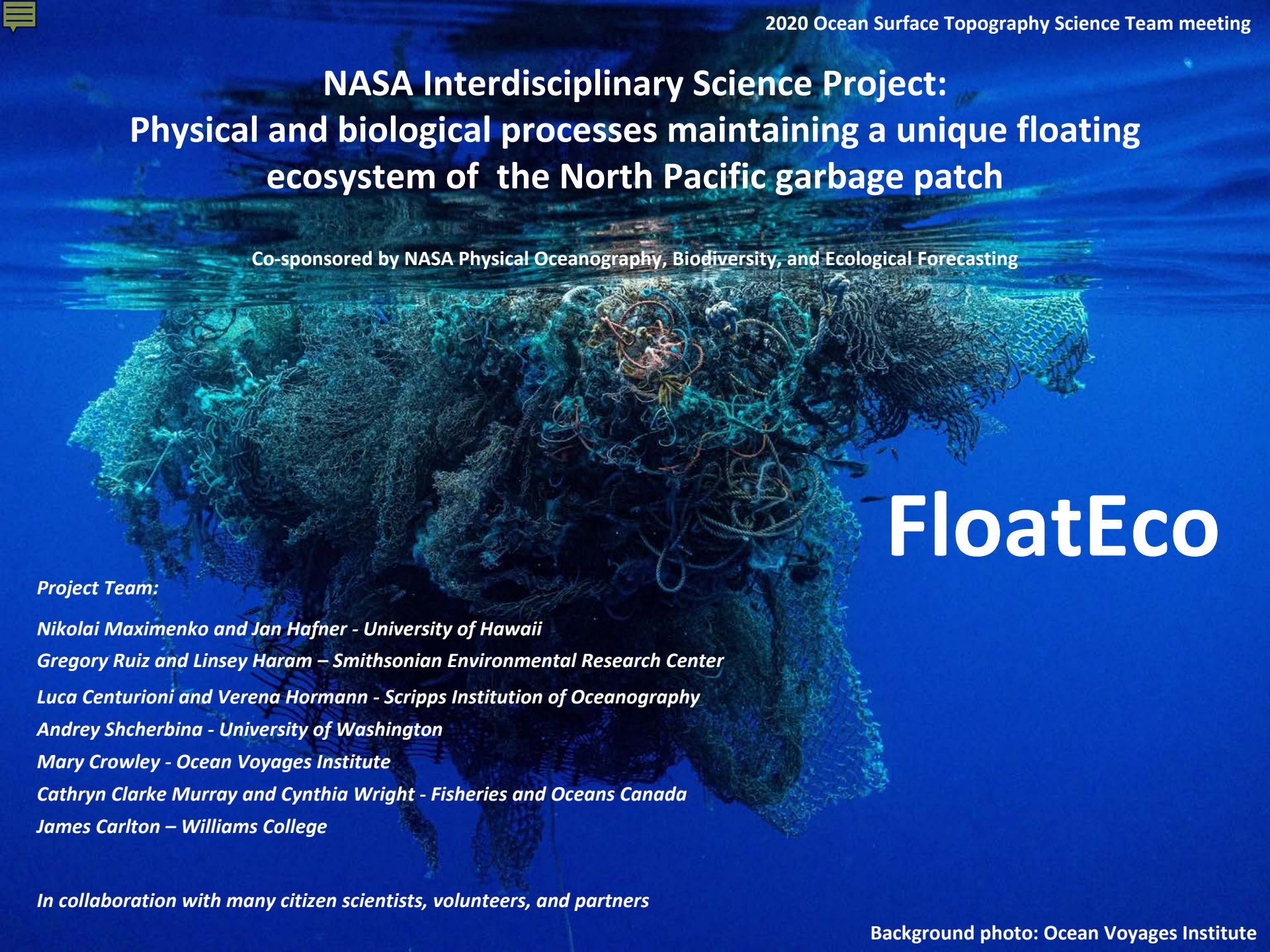
NASA Interdisciplinary Science Project: Physical and biological processes maintaining a unique floating ecosystem of the North Pacific garbage patch

Co-sponsored by NASA Physical Oceanography, Biodiversity, and Ecological Forecasting



FloatEco

Project Team:

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Gregory Ruiz and Linsey Haram – Smithsonian Environmental Research Center

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Andrey Shcherbina - University of Washington

Mary Crowley - Ocean Voyages Institute

Cathryn Clarke Murray and Cynthia Wright - Fisheries and Oceans Canada

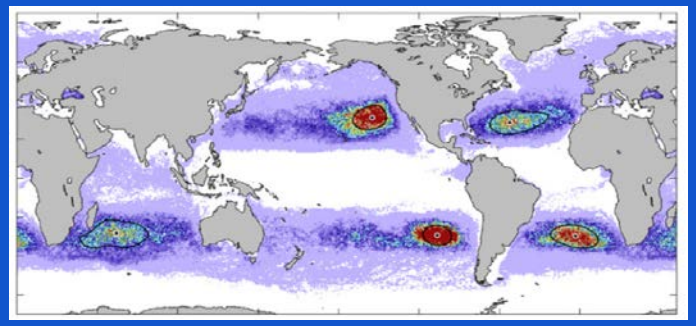
James Carlton – Williams College

In collaboration with many citizen scientists, volunteers, and partners

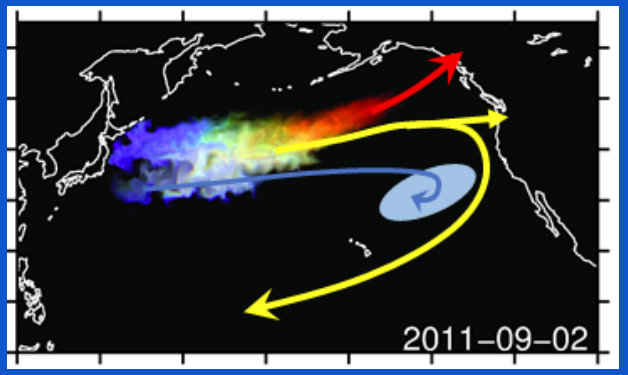
Background photo: Ocean Voyages Institute

Background

World's "garbage patches"

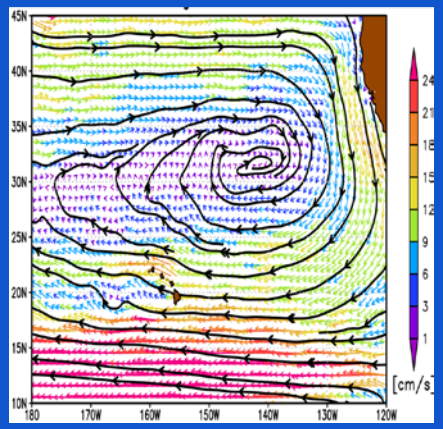


Simulated pathways of debris from the 2011 tsunami

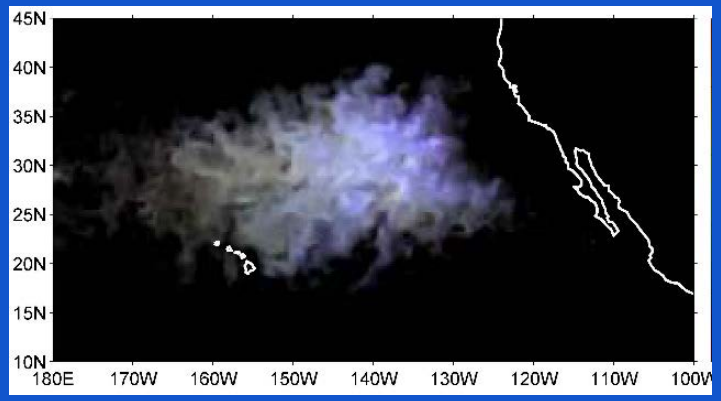


20-meter dock that traveled from Misawa (Japan) to Oregon and carried over 100 coastal species.

Mean surface currents (from GDP drifters in the eastern North Pacific)



Examples of tsunami debris items floating in the ocean and Asian biota found on debris that arrived on the US/Canada west coast



Simulated concentration of marine debris in the garbage patch

Science questions:

As a fraction of the tsunami debris was expected to end up in the “North Pacific Garbage Patch”, questions arose on

- how the ocean-atmosphere dynamics sort different types of floating objects and how they are carried and kept in the patch;
- how long coastal species can survive in the nutrient-poor pelagic ocean and if marine debris helps coastal species to establish and reproduce in the garbage patch.

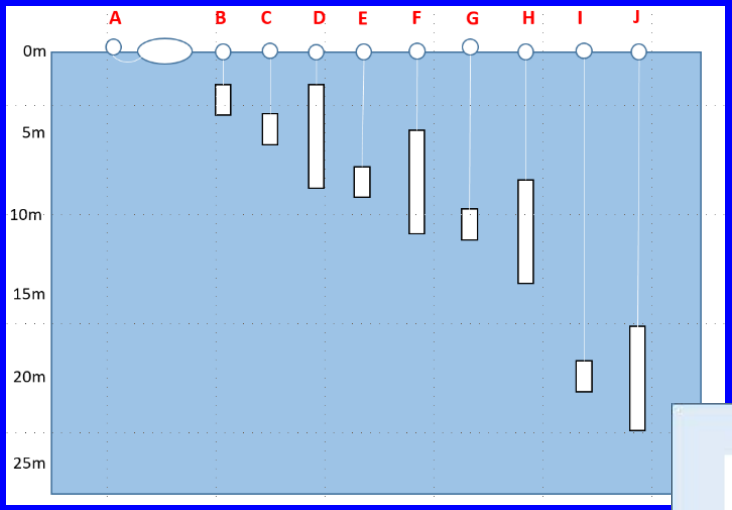
Approaches:

These questions were addressed in our “FloatEco” (Floating Ecosystem) project by

- designing and deploying drifting buoys having different geometry and different exposure to the wind;
- using a mixed-layer float (“EcoFloat”) to study effects of vertical excursions of weakly buoyant objects on horizontal transport by vertically sheared currents;
- analyzing trajectories of satellite trackers attached to large debris items;
- designing settlement panels for the open ocean and deploying them on drifters and marine debris;
- collection of biological samples from and visual/photo/video reports of macro debris; and
- at-sea collaboration with citizen scientists.

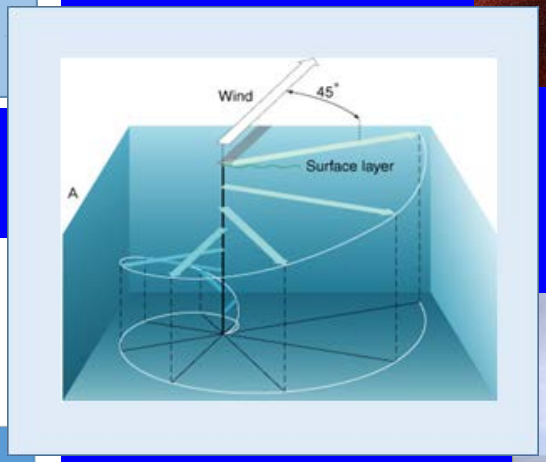
Surface drifters of various geometry

2018: 10 drifters with different depths of drogues

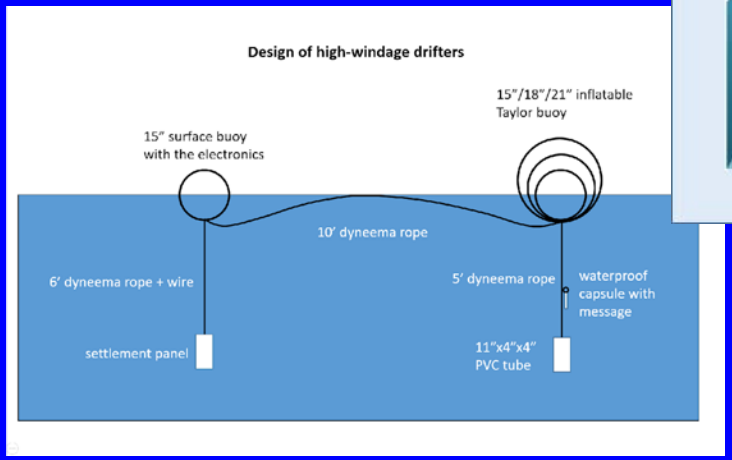


Deployed in November 2018 from Maersk "Launcher"

Schematic of Ekman spiral



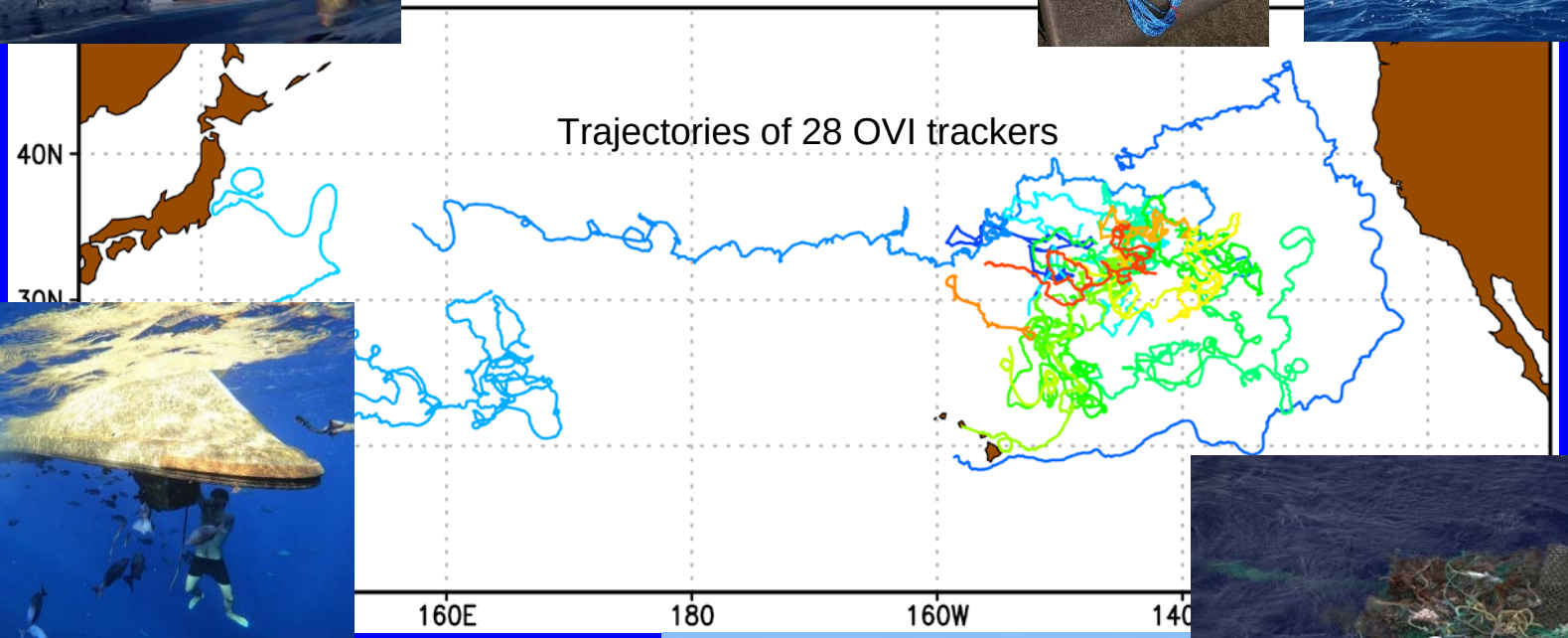
2020: 3 drifters with high-windage



Deployed in May 2020 from S/S "Kwai" during OVI cleanup expedition

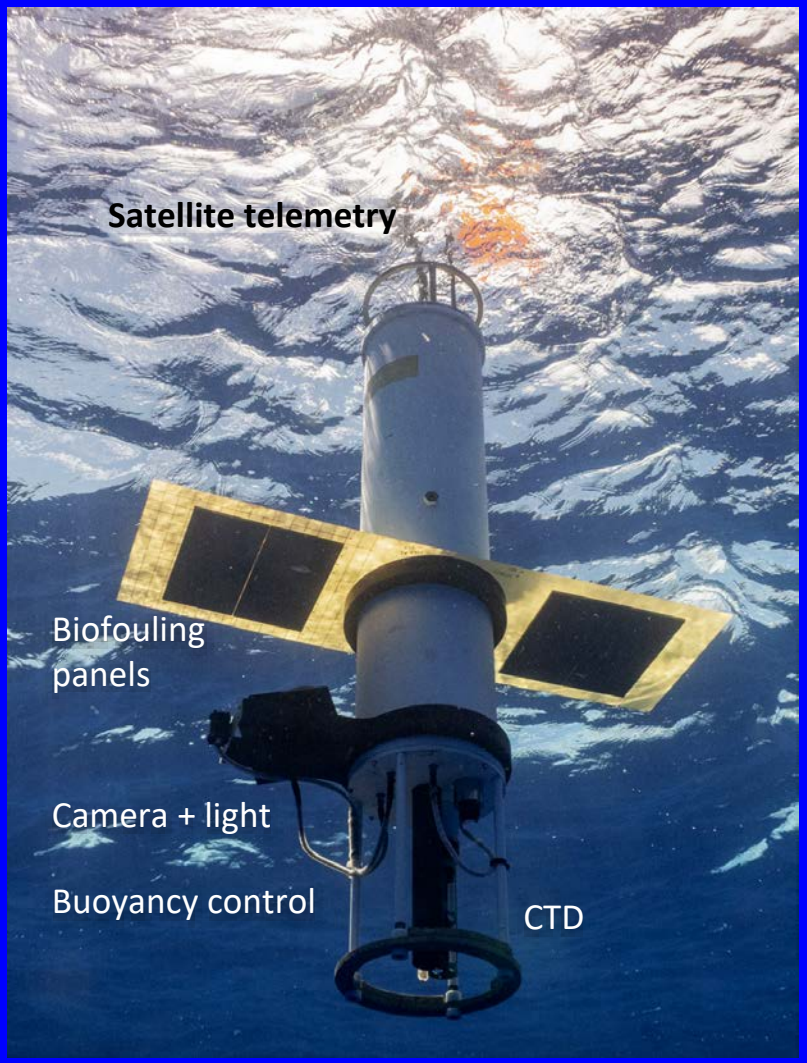
Additionally, 4 standard GDP drifters were deployed and entire GDP array was used in the analysis.

Using OVI satellite trackers to study drift of real debris items

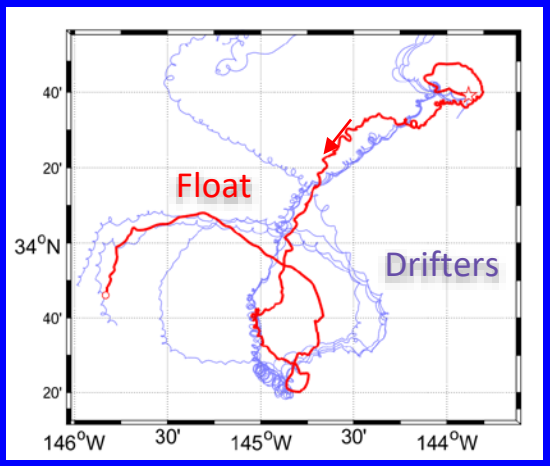


Photos:
- The Swim
- eXXpedition
- Greenpeace
- OVI

Lagrangian "Eco" Float



- Deployed/recovered by KWAI
- 68 days (May – July),
- 700 km drift
- Different modes:
  - Profiling
  - Level drifts (Ekman)
  - Turbulence-following



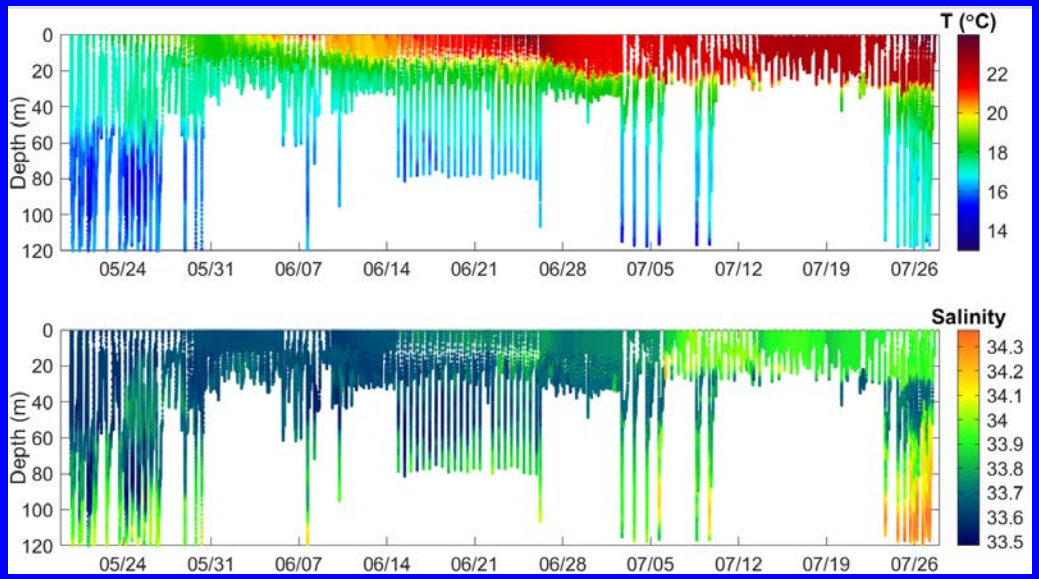
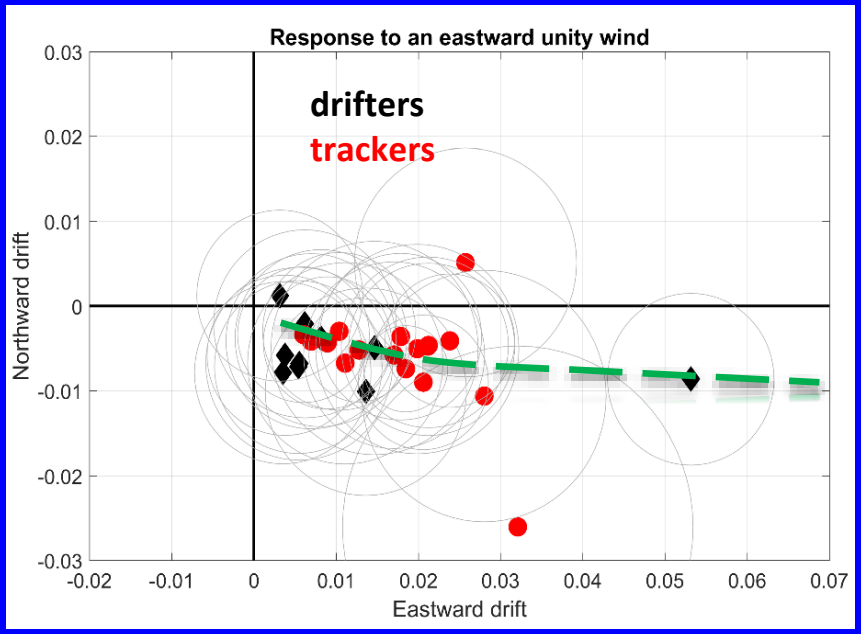
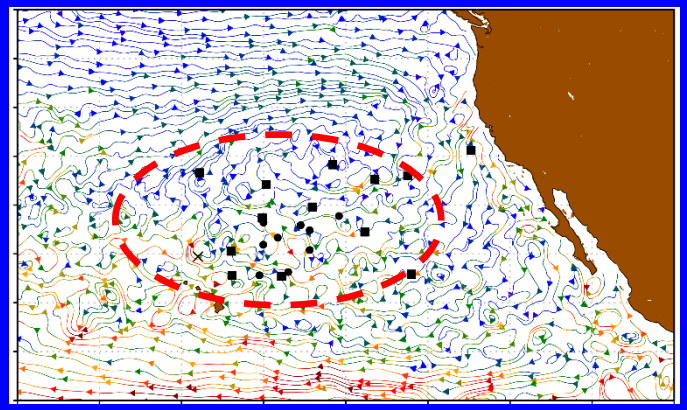


Photo courtesy of Ocean Voyages Institute

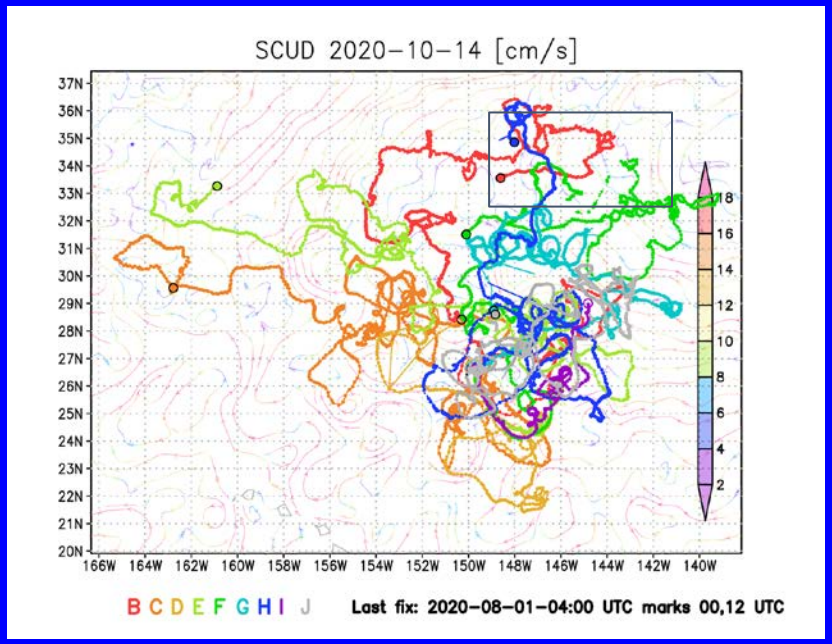
Preliminary results from drifters & trackers: roles of geometry and windage in garbage patch formation



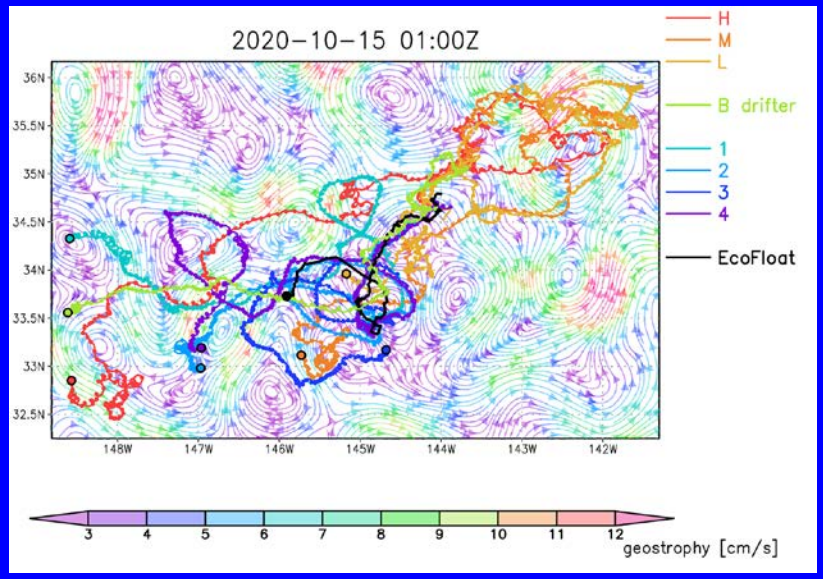
Unorganized currents and eddy mixing in the central part of the garbage patch



Trajectories of drifter array #1

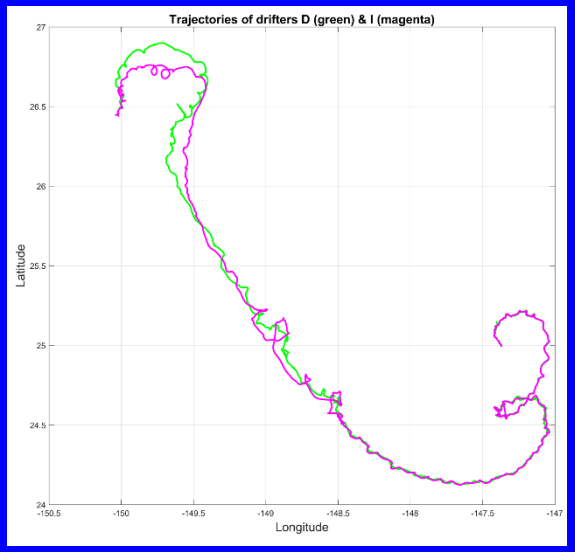


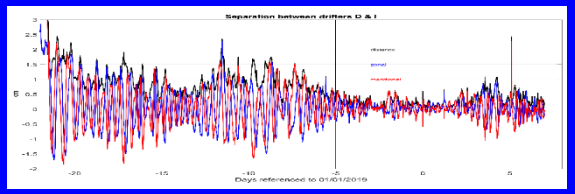
Trajectories of drifter array #2

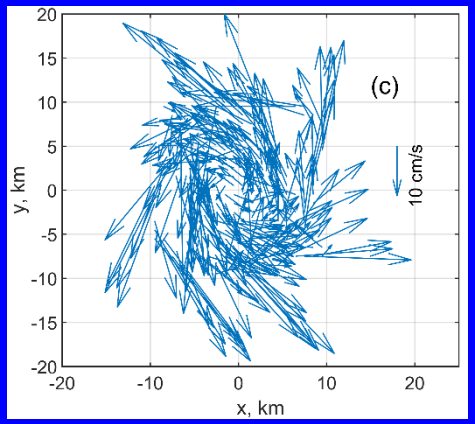


Preliminary results from drifters & trackers: close range interactions

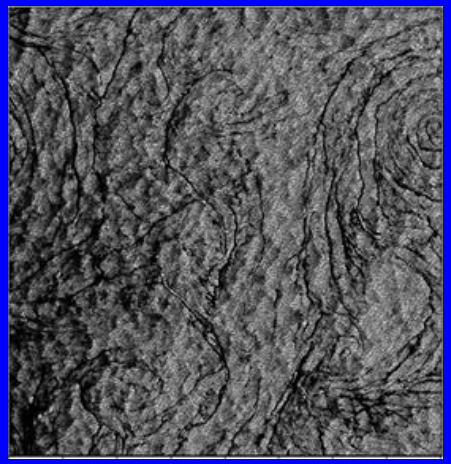
FloatEco drifters in submesoscale eddy







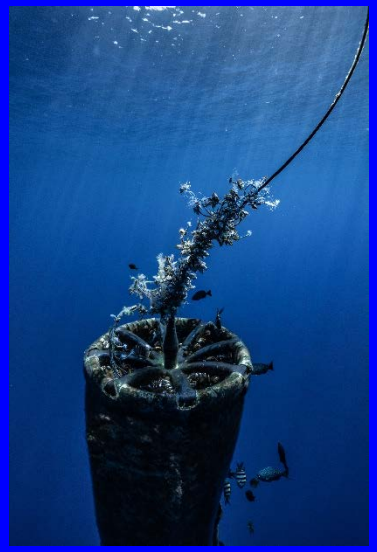
Windrows and slicks on the ocean surface



Sentinel-1 SAR image

Slick and debris accumulation

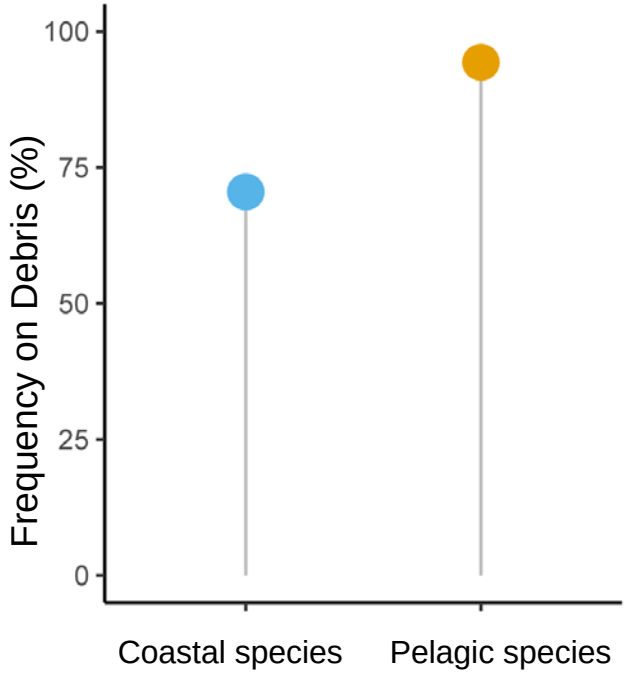
Photo courtesy of Algalite Research & Education Foundation



Fishing gear
on FloatEco drifters

Marine Debris Surveys

Photos: Smithsonian Institution



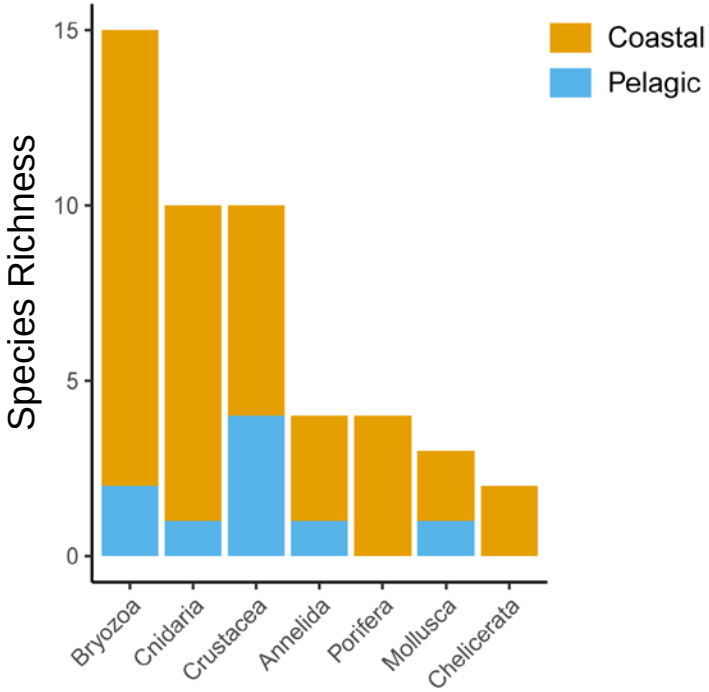



Photo: Cindy Wright

Photo: Ocean Voyages Institute

Settlement Panels


Photo: Tamara Fraser


Photo: Vortex Swim


Photo: Smithsonian Institution

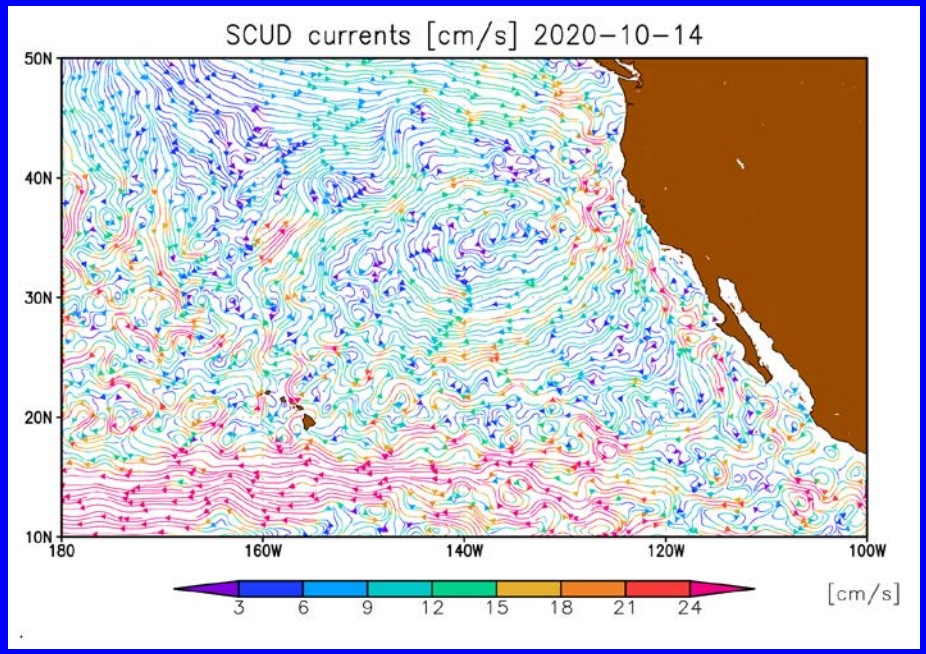
Citizen Science Contributors

Official Collaborator:
Ocean Voyages Institute (Mary Crowley)

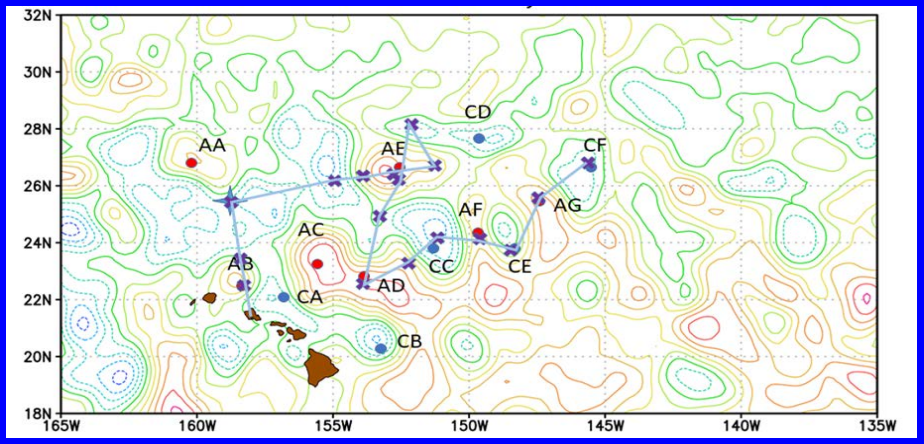
Informal partners:

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

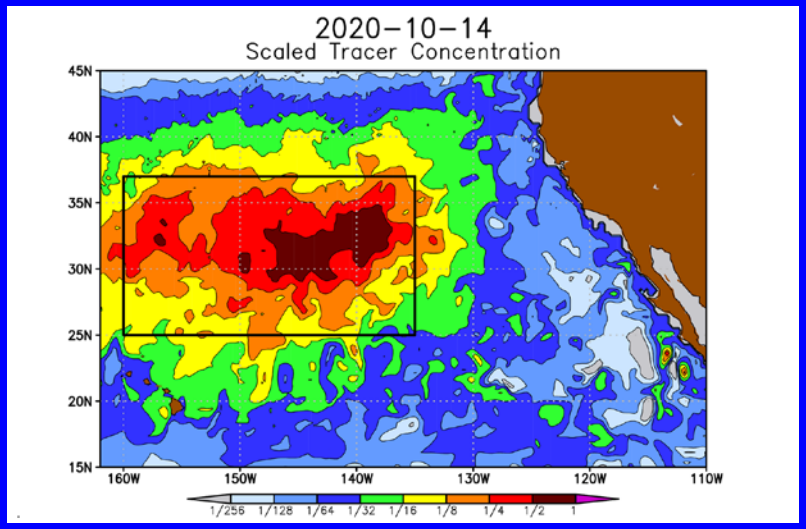
Applications



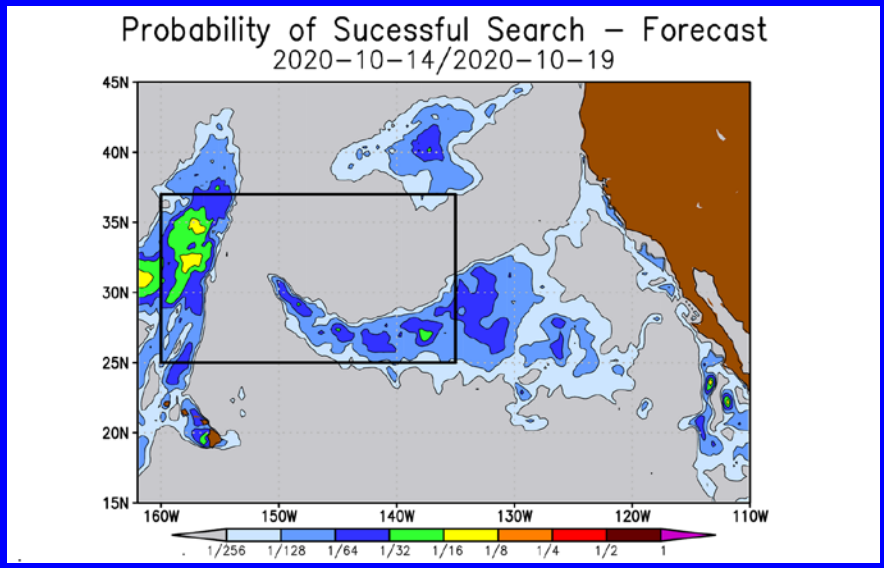
Near-real time surface currents



Optimization of expedition plans



Near-real time model marine debris concentration



Probability of success -- ocean conditions are accounted for.

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RESEARCH

Life on Floating Plastics

Plastic pollution in the ocean is a truly global issue. Each year, millions of tons of plastic enter the world's oceans, ranging from tiny microplastics, to massive, abandoned fishing nets. Yet, relatively little is known about how plastics move in the ocean and the life that forms on and around them. Floating Ocean Ecosystems (FloatEco) is a research collaborative that aims to better describe the physical and biological dynamics of floating plastics in the open ocean and their emergent properties as a new marine ecosystem.