

ENVIRONMENTAL DNA Ocean Monitoring for the 21st Century

Biological monitoring is difficult and expensive. For many species and ecosystems—especially in freshwater and marine environments—practical monitoring methods are often inefficient, destructive or costly. Yet surveys of biodiversity and species abundance are essential, and in some cases, legally required, for assessing ecosystem health. Overcoming these challenges requires new ways of measuring the living world, generating more, better, faster and cheaper biological data.

The Center for Ocean Solutions, in partnership with management agencies, engineers and scientists, is developing novel genetic techniques to more efficiently track biodiversity and species abundance in the ocean.

Environmental DNA (eDNA) is cast off from organisms in the form of metabolic waste or sloughed cells. By screening a small volume of seawater and using specific molecular markers, eDNA can determine what species are present without having to capture or observe the organisms themselves. eDNA may also offer quantitative information that is of particular importance to resource managers, such as estimates of species relative abundance in the monitored area. eDNA investigations of vertebrates have primarily focused on freshwater systems, thus the Center is uniquely positioned to pioneer this approach in the oceans.

The eDNA team aims to:

- Design and field test molecular markers that target species of interest in the California Current Ecosystem
- Survey the spatial and temporal variability of marine vertebrate eDNA
- Ground-truth eDNA to conventional monitoring methods
- Determine whether eDNA sequence data can provide quantitative estimates of species abundance
- Assess and engage potential end-users and markets for technology transfer
- Integrate eDNA into the national marine biodiversity observing network (MBON)

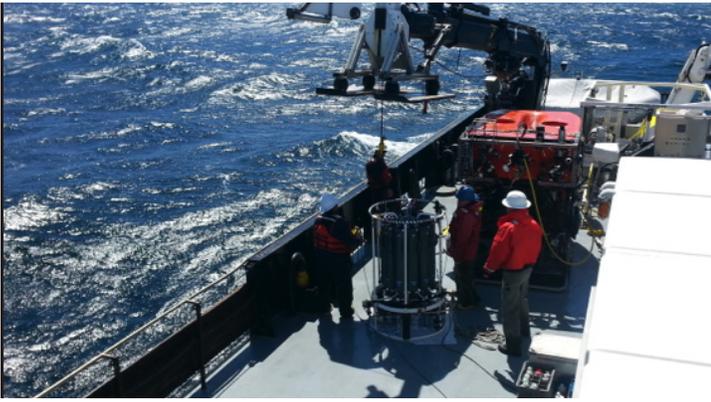
WHO WE ARE

The Center for Ocean Solutions is a collaboration among the Stanford Woods Institute for the Environment and Hopkins Marine Station, the Monterey Bay Aquarium, and the Monterey Bay Aquarium Research Institute.

The Center's mission is to work towards solving the major problems facing the ocean and prepare leaders to take on these challenges.

WHAT WE DO

We bridge the gap between research and decisionmakers and identify pathways to solutions within science, technology and policy for solving major ocean challenges.



The Center team collecting eDNA water samples in Monterey Bay. (Jesse Port)

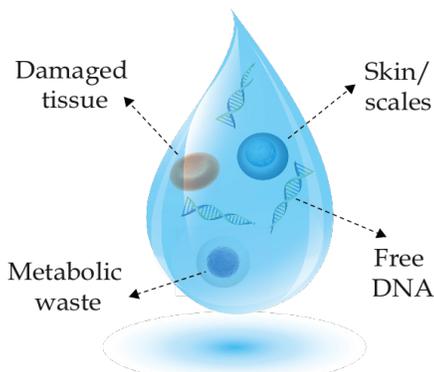


Early career science fellow Jesse Port collects water from Monterey Bay Aquarium's open sea tank to test eDNA. (Jesse Port)

HOW WE DEVELOP SOLUTIONS: *Environmental DNA*

Validating eDNA in controlled environments

In partnership with the Monterey Bay Aquarium, we demonstrated that the majority of fishes present in the Aquarium's 1.2 million gallon Open Sea Exhibit can be detected in a 1-liter water sample.



Sources of eDNA in a drop of seawater.

Validating eDNA in the field

Experiments in the kelp forest ecosystem off of Hopkins Marine Station indicate that eDNA has low error rates of detection when compared to traditional visual dive surveys as well as a fine-scale spatial resolution that distinguishes vertebrate communities.

We also have a time series at an offshore mooring in Monterey Bay assessing variability of vertebrate eDNA over seasons and with depth.

Assessing eDNA shedding rates and persistence

Through funding by the Stanford Environmental Ventures Project, we are quantifying how much DNA vertebrates shed into their environment and how long the DNA persists. Experiments are currently underway at Hopkins Marine Station in collaboration with Dr. Barbara Block and the Tuna Research Conservation Center.

Integrating eDNA into a national Marine Biodiversity Observation Network (MBON)

As part of a 5-year federal grant in collaboration with the National Oceanic and Atmospheric Administration, the Monterey Bay Aquarium Research Institute and the University of South Florida, the Center for Ocean Solutions' eDNA team is working to incorporate eDNA monitoring into a demonstration Marine Biodiversity Observation Network in the Monterey Bay, Florida Keys and Flower Garden Banks National Marine Sanctuaries.

KEY ACCOMPLISHMENTS Grants

The eDNA team was awarded a 5-year federal grant from NASA/NOAA to incorporate eDNA into a national Marine Biodiversity Observatory Network (MBON).

The eDNA project is also supported by an Environmental Venture Project grant through the Seaver Institute.

Publications

- Harnessing DNA to improve environmental management. *Science*. Vol. 344 no. 6191 pp. 1455-1456. 2014.
- Using Environmental DNA to Census Marine Fishes in a Large Mesocosm. *PLOS ONE*. DOI: 10.1371/journal.pone.0086175. 2014.
- Assessing vertebrate biodiversity in a kelp forest ecosystem using environmental DNA. *Molecular Ecology*, 25: 527-541. doi:10.1111/mec.13481

COLLABORATORS

University of Washington, Monterey Bay Aquarium, Monterey Bay Aquarium Research Institute, Hopkins Marine Station, National Oceanic and Atmospheric Administration, Monterey Bay National Marine Sanctuary, University of South Florida

For more information:

Larry Crowder
Science Director
larry.crowder@stanford.edu

Visit our website:
www.centerforoceansolutions.org



Follow us on Facebook and Twitter