ASK AN EXPERT:

November 2025

Advancing Next-Generation Ocean Management with Environmental DNA (eDNA)

CALIFORNIA OCEAN SCIENCE TRUST

California Ocean Science Trust (OST) strengthens the bridge between scientific research and sound ocean management. Created by California state legislation, OST supports and brings world-class science and innovation together with state and federal policymakers to accelerate progress toward a healthy and resilient coast and ocean.

What is environmental DNA (eDNA) Technology?

All living organisms shed trace amounts of DNA—such as cells, tissue, mucus, and waste—into their environment. This genetic material, known as environmental DNA or eDNA, can be collected from water, soil, and air and analyzed to identify which species are present in a given area. Since each species has a unique sequence of DNA, **eDNA works like a fingerprint left behind,** allowing scientists to detect species without seeing or capturing them.

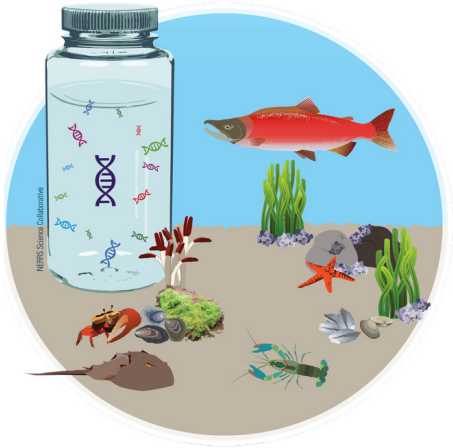

Photo Credit: NERRS Science Collaborative

Advancing Resource Management with eDNA

Environmental DNA is a proven and well-established molecular technology used in natural resource management and ocean monitoring. eDNA enables scientists to assess species distributions and track changes in community composition from a single sample. Because it relies on collecting environmental samples rather than direct observation, eDNA can avoid much of the costs, field effort, and detection challenges of conventional monitoring methods. As a result, when used in combination with these traditional methods, eDNA expands the scale and efficiency of monitoring and the quality and type of monitoring data collected.

Strengths

- Simple to sample with minimal equipment or taxonomic expertise
- Cost-effective and non-invasive to both species and habitats
- Highly sensitive for detecting rare or low-abundance species
- Effective at identifying multiple species from one sample

Current Limitations

- eDNA cannot be used to measure exact population size, but in some cases can be used to estimate changes in species abundance and/or biomass
- eDNA may travel from its original source, so detections reflect presence in a broader area rather than a specific site
- eDNA must be matched to existing DNA sequences, which are not always available

California Specific Use-Cases for eDNA

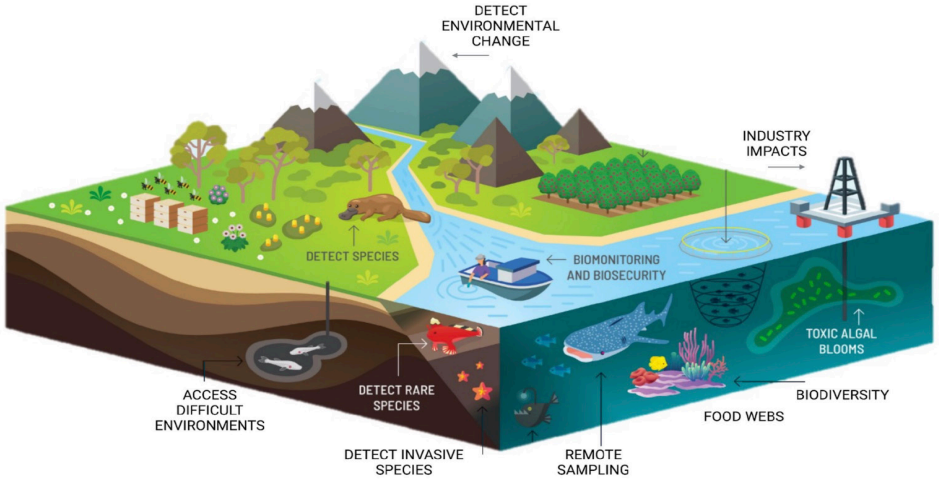

Figure 1: eDNA monitoring applications
Photo Credit: Dr. Susanna Theroux, SCCWRP. Modified from Berry et al., 2020 Environmental DNA

Fisheries Stock Assessments

eDNA improves the efficiency and scale of collecting Essential Fishery Information as required under the Marine Life Management Act. For example, NOAA has used eDNA to estimate Pacific hake abundance[1], the largest fishery on the U.S. West Coast.

Invasive Species Detection

eDNA identifies species at very low abundance, allowing early detection of invasive organisms before they spread. This approach is currently being employed in California with the monitoring of the invasive golden mussel in the Delta.[2]

Harmful Algal Bloom (HABs) Early Warning

Routine testing with eDNA can identify harmful algal species before blooms appear, giving managers more time to predict and respond before impacts occur. This approach is being used by the USGS to monitor emerging HABs events before they take place.[3]

Biodiversity Monitoring

California's 30x30 policy aims to conserve 30% of state lands and waters by 2030. Since a single eDNA sample can simultaneously detect species from microscopic plankton to fish and whales, it provides a scalable, efficient tool to monitor marine protected areas.[4]

Water Quality Testing

Testing for bacteria using eDNA allows beaches to be monitored more often and produces faster, more accurate results than conventional methods. In 2022, San Diego County and the U.S. EPA developed a new water quality test using this approach that offers same-day water quality results.[5]

Rare Species Detection

Rare or endangered species are often difficult to detect due to their low abundance or elusive behavior. eDNA improves detection and supports compliance with State and Federal environmental regulations, as demonstrated by California agencies use in monitoring the Delta smelt and Chinook Salmon.[6]

References: [1]Shelton et al., 2022 https://doi.org/10.1098/rspb.2021.2613. [2]CDFW, 2025 Golden Mussel Response Framework. [3]USGS, 2025 eDNA for Water-Quality Monitoring and Public Health Protection. [4]Gold et al., 2021 https://doi.org/10.1371/journal.pone.0238557 [5]U.S. EPA, 2022. Approval to Implement a Beach Water Quality Rapid Detection Method. [6]California Department of Water Resources, 2024. Environmental DNA Strategy