Applications of molecular methods to advance marine species and community assessment

What we did: Molecular methods are becoming increasingly popular in environmental monitoring and bioassessment applications. Environmental DNA (eDNA) metabarcoding can be used to monitor community composition and estimate species richness. Additionally, digital PCR (dPCR) can be used for targeted species monitoring of priority taxa, such as green sea turtles. As part of two Southern California Bight Regional Monitoring Survey Elements, we collected eDNA samples from five locations in the San Diego region (Figure 1) with two primary objectives:

1. Comparison of traditional fish sampling to molecular methods for fish community composition assessments
2. Targeted species monitoring for the green sea turtle (*Chelonia mydas*)

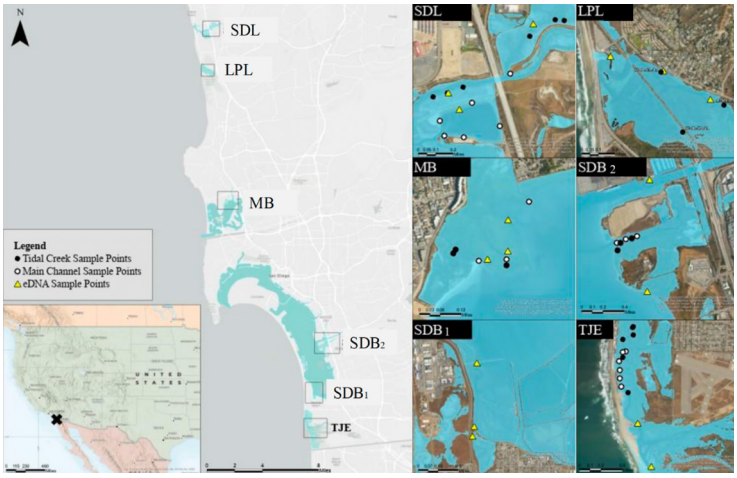

Figure 1. Study area comprising five estuaries within San Diego County: San Dieguito Lagoon (SDL), Los Peñasquitos Lagoon (LPL), Kendall-Frost Reserve in Mission Bay (MB), San Diego Bay (grouped here as SDB, with South Bay Salt Ponds shown as SDB1 and Sweetwater Marsh as SDB2), and Tijuana River Estuary (TJE). From De Wet 2025.

What we found: We demonstrated how multiple methods, including traditional block net seining and enclosure traps, community science via iNaturalist, and eDNA, can be optimized to improve our ability to detect fish species and related changes in community composition to changes in dissolved oxygen and other water quality parameters (Figure 2). The combined methods were evaluated in 2023 across five San Diego estuaries: Tijuana River Estuary, San Diego Bay (Sweetwater Marsh, South Bay Salt Ponds), Mission Bay (Kendall-Frost Marsh), Los Peñasquitos Lagoon, and San Dieguito Lagoon to illustrate improvements in fish monitoring.

Our results suggest that these methods are best used in combination. While eDNA and iNaturalist expand the breadth of species detection, traditional sampling provides critical information on fish abundance, size classes, and life stages that are not captured by the other methods.

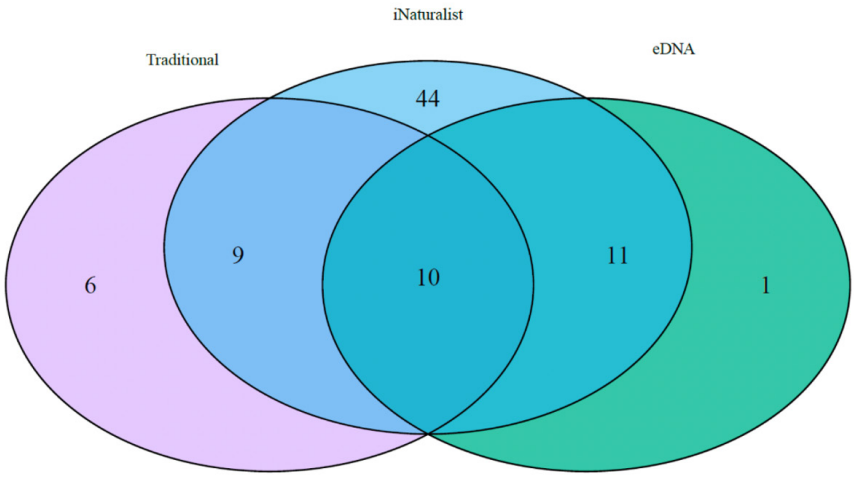

Figure 2. Venn diagram of fish species detected across all sites using traditional sampling (block net seining and enclosure traps), iNaturalist and environmental DNA (eDNA). From De Wet 2025, Master's Thesis.

The development of the green sea turtle (*C. mydas*) assay was an important step forward in the application of eDNA methods for endangered species monitoring.

We were able to demonstrate the specificity of the assay for the *C. mydas*. For field validation testing, we tested a number of samples from Chula Vista, CA with a known resident population of green sea turtles and individual green sea turtles observed during sample collection. While these samples tested positive, it confirmed that green sea turtle eDNA concentrations are very low and the rate of false negatives may be high given the low target DNA concentrations.

For green sea turtle monitoring, multiple biological replicates and high volume sampling are critical to increase probability of detection of these rare species.

How this will improve water quality:

Condition of biological communities and/or presence of sensitive biological indicators is one of the ultimate measures of whether water quality is affecting beneficial uses. This project contributes to our ability to effectively monitor the composition and condition of fish communities in estuaries that are the terminal receiving waters of several large rivers in San Diego County (Figure 3). This also advances the use of molecular methods for detection of sensitive organisms that may be affected by water quality conditions (Figure 4). The findings from this work will contribute to our ability to evaluate water quality effects and to assess the effectiveness of water quality management actions required by the regional board and/or implemented by local municipalities and communities.

Figure 3. (Left) California killifish (*Fundulus parvipinnis*) detected by all three methods. (Right) Spotted sand bass (*Paralabrax maculatofasciatus*) detected by eDNA and iNaturalist.

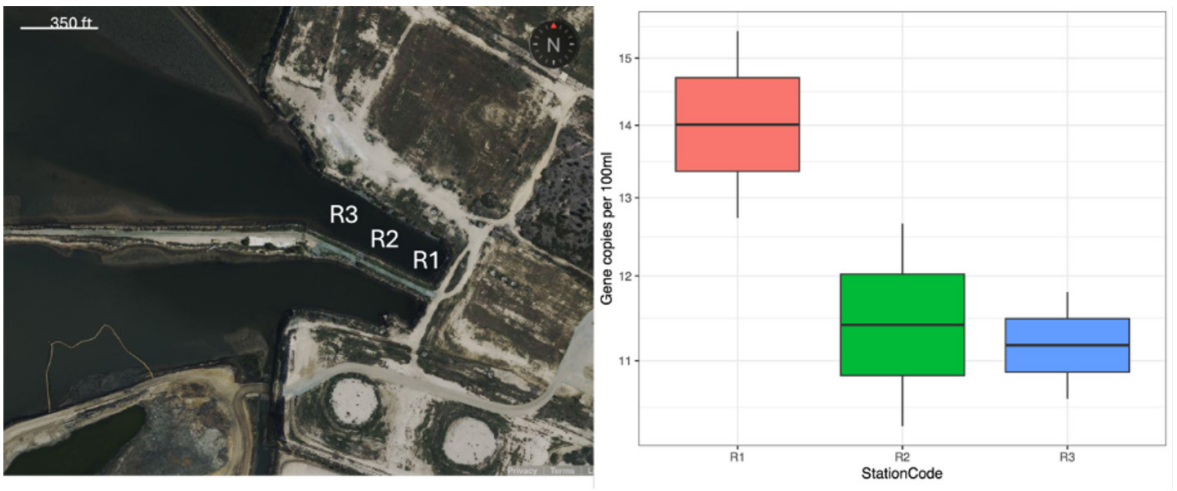

Figure 4. (Left) Map of sampling locations in Chula Vista, CA. (Right) Results from Chula Vista water eDNA samples collected and analyzed using ddPCR targeting green sea turtles.

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Data availability: Fish composition data is available via the EMPA Data Portal and Bight Data Portal. Environmental DNA data available upon request.