INFORMATION ITEM

Lead Scientist Report

Summary

In 2020, the Delta Stewardship Council funded a symposium on environmental DNA (eDNA), fragments of genetic material from organisms found in the environment. Recent genetic technology allows scientists to collect eDNA in water samples and extract information about the presence or absence of specific species near the sampling location. The spotlighted article summarizes the state of the science for applying eDNA techniques in estuaries. In addition, it explores how these techniques could address specific management questions in the San Francisco Estuary.

Environmental DNA Methods for Ecological Monitoring and Biodiversity Assessment in Estuaries

Raman P. Nagarajan, Mallory Bedwell, Ann E. Holmes, Thiago Sanches, Shawn Acuña, Melinda Baerwald, Matthew A. Barnes, Scott Blankenship, Richard E. Connon, Kristy Deiner, Daphne Gille, Caren S. Goldberg, Margaret E. Hunter, Christopher L. Jerde, Gordon Luikart, Rachel S. Meyer, Alison Watts, and Andrea Schreier. Estuaries and Coasts (2022) https://doi.org/10.1007/s12237-022-01080-y.

DNA, found in every cell, is the genetic programming for all individuals and contains distinguishable information unique to each species. Organisms continually shed cells and the DNA they contain into the environment, in hair, scales, skin fragments, and bodily fluids. For decades, genetic technology has enabled forensic scientists to use this shed DNA to link individuals to crime scenes. More recently, environmental scientists have been able to leverage advances in genetic technology to determine which species have occupied specific locations in the environment, thereby creating the possibility for a new form of monitoring.

Two analyses are commonly performed on water samples collected for eDNA studies. qPCR is a technique that magnifies eDNA fragments that match sequences from target species, providing a “yes” or “no” answer to the question of whether specific species (e.g., endangered species, invasive species) are present in the sampled location. On the other hand, eDNA metabarcoding is a technique that broadly analyzes which species may be present from a grouping of eDNA by magnifying all eDNA present, sequencing it, and matching specific sequences to those of known species in a database. Information about a more significant number of species is available through eDNA metabarcoding compared to qPCR, but because the technique involves genetic sequencing, it takes longer and is more expensive.

Concerning monitoring applications, both techniques for analyzing eDNA present essential opportunities. qPCR may be particularly useful for detecting habitats used by rare or endangered species, mainly since it is non-invasive and does not require directly sampling individuals, which could be harmful. It may also be a valuable form of monitoring for new arrivals of certain invasive species (such as Zebra or Quagga mussels) known to be present in California but has yet to be in the San Francisco Estuary, enabling prompt action before extensive spread. Similarly, it could allow for early detection of harmful algal bloom-forming organisms. Additionally, it may complement boat-based monitoring for specific species, allowing for sampling in shallow regions challenging to access by boat, such as the vicinity of wetland restoration sites. Meanwhile, eDNA metabarcoding may be an efficient way to monitor whole communities of species, producing information about a broader range of species than currently assessed through boat-based monitoring. It, too, can be used to monitor a wide range of invasive species.

Estuaries, however, present challenges for eDNA monitoring that need to be present in lakes. Because of tidal and riverine flows, the transport of eDNA by flowing water must be considered when trying to link species detection to specific locations. In addition, the high turbidity of estuarine waters can create additional methodological challenges, such as filter clogging. For the San Francisco Estuary in particular, the procedures for detecting specific species need to be optimized, as factors that cause certain parts of eDNA to break down faster than others can vary

from place to place. The article's authors make a strong case that these scientific investments are worthwhile and cite programs in the European Union and the US Midwest that routinely use eDNA to detect invasive species and species that are overall indicators of ecosystem health. The Delta Independent Science Board's Monitoring Enterprise Review report (2022) also calls for incorporating eDNA analyses into monitoring programs, mainly because of its ability to advance the rapid detection of invasive species and rare species such as Delta smelt.

The Delta Stewardship Council has already responded to the call to invest in scientific studies of eDNA that could advance its incorporation into monitoring operations by funding two eDNA projects through the 2021 Proposal Solicitation Notice. One project, led by Raman Nagarajan, lead author of the spotlighted paper, will use eDNA to evaluate how managed fish species use restored wetlands and how fish species groupings vary across restored wetlands and over time. A second, led by Michelle Jungbluth, will use eDNA to evaluate how different types and ages of wetland restoration change the food web dynamics. However, as outlined in the spotlighted paper (see Attachment 1), more studies are needed.

Delta Science Program - National Center for Ecological Analysis and Synthesis Collaboration

As discussed at the January 2023 Council meeting, synthesis is a critical component of ecosystem-based management and informed decision-making, both of which are tools for achieving coequal goals. The need for increased capacity, dedicated time, and coordinated synthesis is widely recognized and included as an action in the Delta Science Plan, Science Action Agenda, and Interagency Ecological Program Science Strategy. One way in which the Science Program promotes synthesis is through a partnership with the National Center for Ecological Analysis and Synthesis (NCEAS) to provide training and encourage collaboration between agencies and academic scientists. For example, the 2021 NCEAS working group focused on drivers of the Delta's estuarine food supply, as detailed on the DSP-NCEAS web page. In addition, a second synthesis working group is planned for 2023 and will bring together environmental and social data to solve problems at the human-environment interface in the San Francisco Estuary. This working group will focus on expanding multi-benefit approaches to managing the Delta as a social-

ecological system and investigate the integration of human dimension data into research and management decision-making (Science Action Agenda, Management Need 3). The work may include the development of integrated frameworks, data visualization tools, and models of social-ecological systems that evaluate, for example: (1) how ecosystem restoration projects benefit and burden human communities, with an emphasis on environmental justice, (2) the costs and benefits of different strategies for managing invasive species while balancing recreational uses, and (3) the sensitivity of social metrics to different socio-political or environmental scales. The 2023 synthesis working group training events are targeted to begin in June, and the planning team is currently recruiting participants and formulating the curriculum with NCEAS.

On Your Radar

Interagency Ecological Program (IEP) 2023 Workshop

Save the Dates March 21-24, 2023, for the upcoming 2023 IEP Annual Workshop. The workshop will be held in the California Natural Resources Headquarters building at 715 "P" Street in downtown Sacramento. The workshop will be a **FREE** hybrid (in-person and virtual) event! Workshop details are available on the IEP Annual Workshop web page. Additional information is available via the IEP Annual Workshop email mailing list. Make sure to subscribe to receive updates and registration information, which will be available in late February.

The theme for this year's workshop is "Community," which reflects how the IEP relies upon multidisciplinary teams of agencies, academic and non-governmental agencies, and other scientists to accomplish its mission.

The date and time information are below.

Workshop: March 21st-23rd, 2023. 8 am- 5 pm
Training Courses: March 24th, 2023. Nine am-noon
Location: 715 P Street, Sacramento, CA 95814

Adaptive Management Forum 2023: Governance for Adaptive Management

The Adaptive Management Forum (Forum) is a biennial event that advances coordination, communication, and learning around adaptive management in the

Delta. The 2023 Forum will take place over two days in May with a thematic focus on governance for adaptive management. As noted in the Delta Plan, "To be effective, governance to support and implement adaptive management in the Delta must be flexible and can make timely changes to policies and practices in response to what is learned over time." The 2023 Forum will explore how Delta governance can effectively support adaptive management in uncertainty and dramatic social and environmental change. To support planning for the 2023 Forum, the Delta Science Program has convened a group of expert advisors representing diverse perspectives on Delta governance. Advisors include representatives of Tribal, local, state, and federal governments, representatives of environmental non-governmental organizations and community-based organizations, and academic and social scientists. The advisory group met for the first time on January 31 to discuss the goals and objectives of the Forum. The group will have two additional meetings to develop the Forum program in the upcoming months.

By the Numbers

Science Program staff will summarize current numbers related to Delta water and environmental management. The summary (Attachment 1) will inform the Council of recent counts, measurements, and monitoring figures driving water and environmental management issues.

List of Attachments

Attachment 1: By the Numbers

Attachment 2: Visual Summary of Nagarajan et al. (2022)

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