Unlocking Ocean Secrets: Marine Mammal Monitoring Through eDNA

Questions from the Marine Mammal SIG webinar

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Introduction

Following the recent Marine Mammal Special Interest Group (MMSIG) webinar on environmental DNA (eDNA), hosted by Ashleigh Kitchiner at the Institute of Marine Engineering Science and Technology (IMarEST), it was clear that interest in the subject is stronger than ever. The discussion brought together researchers, practitioners, and students from across the world to learn about how eDNA is being applied in marine mammal science, from diet analysis to conservation monitoring.

While the conversation was rich and wide-ranging, time ran short and we were unable to address the many thoughtful questions submitted by participants. Below is a summary of the key themes raised, which we will continue to explore throughout this article.

Expanding the Applications of eDNA

Several questions focused on how eDNA can be integrated with other research tools and analytical approaches. Participants were particularly interested in the potential for combining stable isotope analysis with eDNA to better understand feeding ecology and energy pathways, as well as how hydrodynamic and decay models might be used to interpret eDNA in high-flow environments such as tidal channels. There was also curiosity around whether eDNA could contribute to real-time monitoring and vessel management models, opening exciting possibilities for applied marine conservation.

eDNA sequencing and quantification are useful tools for aquatic biomonitoring, but prior knowledge of a system is helpful when planning field sampling. Factors such as tides, turbidity, currents, and UV light exposure all affect the persistence of eDNA. Many questions still exist for applying eDNA across different environments, such as sinking and flow rates, and particularly how long eDNA from marine mammals persists in the environment.

Autonomous sampling technologies that can be moored in deep or offshore locations, or travel on gliders or other remote vehicles, show great promise for biomonitoring when scientists are not often present in the area. Programmable samplers that can preserve filtered samples and decontaminate in between samples can be deployed for 6 to 12 months at a time while collecting regular samples, removing the need for expensive research vessels to be on site numerous times a year. This is particularly advantageous for detecting migratory marine mammals that may show seasonal patterns in their abundance.

Sampling, Storage and Degradation

A recurring theme was the practical challenge of sampling and preserving eDNA in marine environments. Attendees asked about how long eDNA persists in water and sediment, whether

it can be stored in stasis for mass sampling, and how to minimise contamination when using tools such as Niskin bottles. Questions about the DOT eDNA sampler were also frequent, particularly regarding its sample capacity, operational indicators, and commercial availability.

Several participants were keen to understand how different preservation techniques compare, and whether eDNA might naturally persist in sediment layers as a kind of biological record. Others were curious about the single-use nature of filters, storage protocols, and the need for consistent handling standards to ensure comparability across studies.
Numerous preservation methods exist, including desiccating or freezing filters, or adding liquid preservatives, which include RNAlater, ethanol, or buffers such as Longmire buffer. Preservatives seem to be relatively comparable to one another, while other sampling parameters, such as filter pore size and water volume filtered, can lead to different results and organisms being detected.

DNA, once bound to silt particles both in the water column and in sediments, can persist for decades to even thousands of years. This allows the analysis of fish, plant, and microbial communities from the past (e.g., Sakata et al. 2020 Sedimentary eDNA provides different information on timescale and fish species composition compared with aqueous eDNA - Sakata - 2020 - Environmental DNA - Wiley Online Library)

Understanding Diet and Behaviour

The use of eDNA to study diet, particularly through fecal sampling, prompted lively interest. Attendees asked how researchers separate fecal DNA from environmental DNA in surrounding water, and how the quality of fecal samples compares to direct biological samples. Specific questions were raised about whether detected prey species truly represent diet or could reflect eDNA already present in the environment.

Metabarcoding can also be used to identify prey species directly from stomach samples, which removes the difficulty in separating prey DNA from DNA in the water. This can be lethal for sampling in fish and may be difficult in marine mammals, but is a potentially viable way for studying prey species aside from fecal samples.

Data, Reference Libraries and Genomic Gaps

Several attendees asked about the reference databases used for matching eDNA sequences. How are these repositories created, and what happens when a detected species lacks existing genomic information? This led to broader discussion about data accessibility, the completeness of reference libraries, and the implications for interpreting species presence in new areas.

Participants also asked how to verify detections of non-native or previously unrecorded species, and how to distinguish between actual presence and DNA transport through water movement. These questions highlight the growing need for standardised frameworks for eDNA interpretation in marine systems.

Reference databases for DNA barcoding, which identifies species one at a time from a small tissue sample, have been in development for decades, particularly for common "barcoding" markers such as COI. These libraries have expanded over time on a global scale, with researchers collecting specimens, sequencing their DNA, and adding the DNA to reference databases. Fish-specific reference libraries also exist, for other DNA markers such as 12S and 16S. However, there are still many species, especially very small invertebrates or those living in remote and extreme environments, who do not have reference sequences for eDNA detections. In cases like these, the computational processing of eDNA (known as 'bioinformatics') can still determine if most DNA sequences belong to a particular phylum or family of organisms, even if it can't determine the species. In addition, reference libraries are ever-expanding, and so data can be processed again at a later date as species references are added.

Community, Training and Future Research

Beyond technical questions, the session also generated enthusiasm from students and early-career researchers. One attendee asked for guidance on finding graduate programmes focused on using eDNA for marine mammal research, underscoring the importance of training and mentorship as the field expands.

There are programs in many countries that focus on or have adapted eDNA as a tool for research and monitoring biodiversity! My advice is to focus on a system of interest (e.g., polar oceans, freshwater rivers, tropical reefs) and find a researcher working in that system, and propose eDNA as a tool for detecting marine mammals or any group of interest. Training in genetics and phylogenetics is useful but not strictly necessary, as many ecological analyses can be conducted with species lists generated using eDNA.

There were also queries about whether UK-based researchers and companies are actively applying eDNA in marine settings, and how interdisciplinary collaborations can support more robust monitoring networks.

Looking Ahead

The volume and depth of questions reflect both the promise and complexity of eDNA as a tool for marine science. From improving detection methods and data interpretation to scaling up for ecosystem-wide applications, the field continues to evolve rapidly.

For those who missed the session, a recording is available here on YouTube. Thank you to everyone who attended and contributed such thoughtful questions. Your engagement shows just how much interest there is in advancing this exciting area of marine research.