NOAA Omics Strategy Report, FY24 Q2

provided to the NOAA Science Council *by* the NOAA Omics Working Group

Administrative and Agency Priorities

- **High Demand for 'Omics Internship Opportunities.** The Explorer in Training Program (EiT) received a record-breaking 155 applicants for one opportunity to work with the NOAA Fisheries National Systematics Laboratory at the Smithsonian National Museum of Natural History to process environmental DNA (eDNA) samples routinely collected during NOAA Ocean Exploration expeditions on NOAA Ship *Okeanos Explorer* (**Figure 1**). This EiT opportunity reflects Objective 5.2.1 of the NOAA Omics Strategic Plan, which commits to training a diverse and inclusive cadre of ocean scientists and ocean explorers on eDNA sampling protocols.

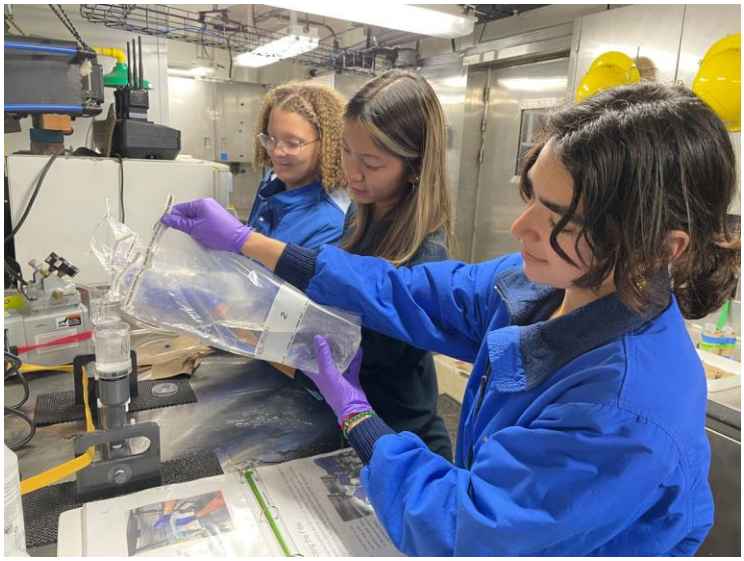

Figure 1. Explorers-in-Training Rebecca Ruiz, Rose Leeger, and Ranna Zahabi filter water samples for environmental DNA collection during the Seascape Alaska 2: Aleutians Deepwater Mapping expedition. *Credit: NOAA Ocean Exploration, Seascape Alaska.*

- **Technology Transition: Execution of Umbrella Transition Plan for Autonomous 'Omics**. An umbrella transition plan "One-NOAA: Autonomous Samplers for Improved Sampling of Marine Waters for eDNA and 'Omics Applications" has been signed and fully executed. The plan outlines the costs and benefits associated with transitioning the collection of eDNA samples and the deployment of autonomous and semi-autonomous instrumentation to NOAA ship operations to support the growing needs of marine eDNA sampling efforts across NOAA science centers more effectively and efficiently. The plan is a living document and will be updated with increasing detail as projects mature and will expand to include individual components for specific eDNA sampling instruments. The signing of a transition plan provides situational awareness of the work and an acknowledgement to move forward as we collectively seek to secure the necessary resources to advance our capabilities for marine eDNA sampling. Copies of the transition plan can be requested through ORTA's online form.
- **'Omics Featured in the 2026 Strategic Research Guidance Memorandum (SRGM).** The SRGM, an annual document produced by the NOAA Chief Scientist has been released for

FY26. The document outlines how assessments of biodiversity at the genetic level can be used to establish ecosystem baselines and metrics. For example, eDNA data could be used to evaluate the success of marine resource management strategies related to marine protected areas, aquaculture, marine carbon dioxide removal (mCDR), or alternative energy development.

Synergies Across S&T Focus Areas

- **Omics & Data Synergy.**
  - NOAA 'Omics and NOAA Data are working together to make a series of data management tools available for use across the agency, including the NOAA 'Omics Data Management Guide, a Data Management Plan template, and a bioinformatic script to convert data into the format needed for upload to the Ocean Biodiversity Information System (OBIS) (**Figure 2**). The guide has been shared across the NOAA 'Omics community of practice and was presented to the Data Governance Committee on Feb. 7, 2024 (slides here). In addition, the software edna2obis was embedded to provide help users submit their metadata. The new tool was used to publish the first NOAA 'Omics dataset (GOMECC-4 16S and 18S amplicon data) on GBIF and OBIS (and on NCBI).

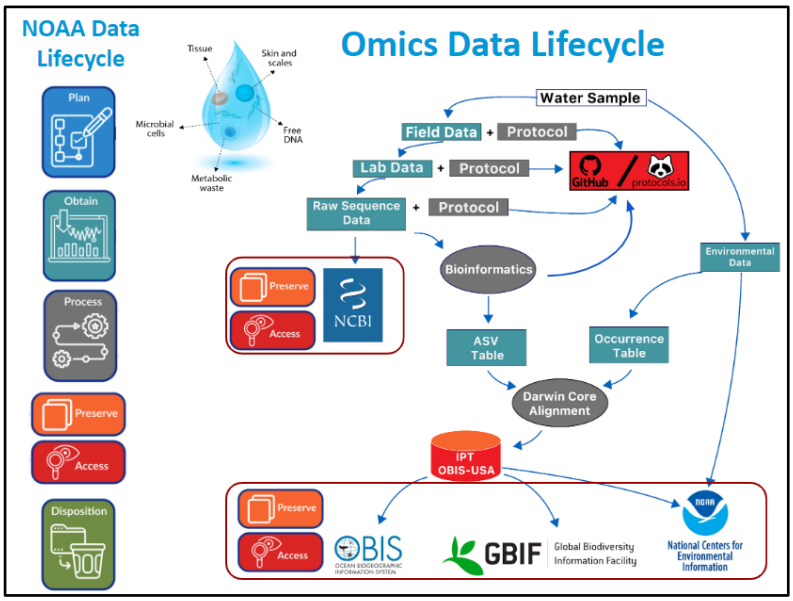

Figure 2. The DGC Data Management Handbook and NOAA Data Lifecycle was used to inform the NOAA 'Omics Data Management Guide workflow. *Credit: NOAA AOML/Katherine Siliman.*

  - Coordinated efforts between the Atlantic Oceanographic & Meteorological Laboratory (AOML) and the Pacific Marine Environmental Laboratory (PMEL) have focussed on developing metabarcoding best practices including the development of a "One NOAA" standardized bioinformatics pipeline across Tourmaline, REVAMP, and Anacapa and the creation of version-controlled, curated, comprehensive reference sequence barcode databases through rCRUX. Together, these standardization and synthesis efforts will strengthen NOAA 'Omics capabilities to generate, interpret, and apply biomolecular assays needed to 1) understand the interplay of water quality and climate driven warming, ocean acidification, hypoxia impacts on biological communities, 2) allow for the identification and forecasting of HABs, 3) better inform fisheries management through the identification of trophic

and oceanographic drivers of assemblage dynamics, and 4) map spatio-temporal distributions of protected and invasive species.

- **Omics & UxS:** The 3rd NOAA 'Omics In Situ & Autonomous Sampler Technology Virtual Workshop was held on February 15, 2024 to highlight recent advances in eDNA sampling technologies. The workshop included presentations from NOAA speakers from NMFS, OMAO and ORTA in addition to external collaborators and industry representatives. Presentations covered topics ranging from autonomous samplers to NOAA transition plans and NOAA's UxS operations. Every iteration of this workshop has shown significant growth, with this year's event increasing to over eighty participants. This amount of participation underscores the cross line office need and interest in incorporating autonomous eDNA samplers into NOAA's research programs. The organizers are grateful to the NOAA community for their contributions and participation throughout the day!

Infrastructure

- **Bioinformatics Resource and Cyberinfrastructure Launched to serve the Great Lakes.** The Great Lakes Atlas for Multi-omics Research (GLAMR) website was launched with support from NOAA 'Omics, enabling discovery and exploration of 'omics and associated environmental data specific to the Great Lakes. GLAMR was developed by the Geomicrobiology lab at the University of Michigan in partnership with the Great Lakes Environmental Research Laboratory (GLERL) and the Cooperative Institute for Great Lakes Research (CIGLR). Data are processed with standardized bioinformatics pipelines to enable comparison across studies and GLAMR makes use of existing community standards wherever possible to enable interoperability with other services. To date, 1,954 amplicon samples, 359 metagenomes, and 210 metatranscriptomes sourced largely from public repositories such as NCBI's Sequence Read Archive (SRA) and accompanying manuscripts are currently available via the GLAMR website. An introductory GLAMR workshop for Great Lakes Scientists was held in January 2024 and an additional workshop is being planned for a more diverse audience of stakeholders.

Projects

- **'Omics Showcased in the 2023 NOAA Science Report.** The 2023 NOAA Science Report released in March 2024 highlights several 'omics research accomplishments. The report features eDNA applications to serve ocean observation, environmental characterization, and ecological monitoring and helps document progress in implementing the NOAA 'Omics Strategy.
- **Mentoring Future ' Omics Scientists: Undergraduate Led study Enhances eDNA for Foundational and Understudied Zooplankton Communities.** A summer intern led publication describes the mitochondrial genome of the copepod *Cyphocaris challengeri*, a globally distributed, highly abundant zooplankton species that plays an important role in the pelagic food web. Dedicated barcoding efforts like this are needed to enhance eDNA approaches for foundational and understudied zooplankton communities.
- **Genomic Tools Detect the Novel Presence of the Japanese Sardine in the California Current Ecosystem.** During an 'omics-based investigation of population structure of the

Pacific sardine in the California Current Ecosystem, NOAA researchers from the Southwest Fisheries Science Center (SWFSC) and the AFSC detected the presence of the Japanese sardine, a distinct species that is unable to be visually distinguished from its east Pacific neighbor. How and when these west Pacific sardine arrived in the eastern Pacific is unclear, but may be related to changing ocean conditions. Researchers continue to evaluate this notable finding as it may influence overall sardine biomass estimates that are currently assumed to only comprise Pacific sardine.

- **Salmon Pen Study Addresses Knowledge Gap about the Detection Range of Fish eDNA**. A media release from the AFSC explains how an eDNA paper will be useful for understanding how eDNA disperses. The findings will help provide context for eDNA detections in future fisheries surveys (**Figure 2**).

Figure 2. Salmon net pens containing >4.6 million juvenile chum salmon in Amalga Harbor, Southeast Alaska. *Credit: NOAA Fisheries/Patrick Barry.*

- **Genomics Study Sheds Light on the Fitness of Hatchery-Raised Salmon.** A media release from the Alaska Fisheries Science Center (AFSC) highlights a recent study in Chinook salmon that shows genetic differences between hatchery and wild salmon populations in only a few generations. Information on the genetic effects of hatcheries can be integrated into future management.

Partnerships

- **NOAA 'Omics Partners with USGS in Search for Agent of Coral Disease.** AOML has been partnering with the United States Geological Survey (USGS) to search for a causative agent of Stony Coral Tissue Loss Disease (SCTLD). The SCTLD outbreak has continued largely unabated since its first observation in 2014, and represents the most lethal coral disease affecting Caribbean coral reef ecosystems ever recorded. The partnership with USGS can help researchers to understand the pathogen(s) or the environmental conditions conducive to disease spread to inform management and mitigation efforts.
- **Collection of Best Practices for Marine Microbiomes Available for Download.** The Special Issue in Frontiers in Microbiology "Marine Microbiomes: Towards Standard Methods and Best Practices | Frontiers Research Topic", a product of the Atlantic Ocean Research Alliance Marine Microbiome Working Group, is now available in e-book format. Learn more at https://marinemicrobiome.org/.

People

- **Enhanced Workforce: Implementing the NOAA 'Omics Strategic Plan.**
  - PMEL added two additional 'omics staff members to complement two new federal employees gained over the past 14 months. Additional staffing and lab equipment

investment increased sample processing throughput, recently supporting almost 4,000 individual PCR reactions from > 300 eDNA samples. Sequencing targeted microbes, phytoplankton, zooplankton, fishes, and marine mammals. PMEL standardized operating procedures, protocols, and workflows were developed and implemented through ongoing coordination with NOAA and key ocean biomolecular partners across the NE Pacific. This incoming data from West Coast Ocean Acidification 2021 cruise, autonomous eDNA samplers from Olympic Coast National Marine Sanctuary, and the Alaskan Arctic will provide critical information on how marine ecosystems are responding to changing ocean conditions.

- NWFSC added one new molecular geneticist through the Cooperative Institute for Climate, Ocean & Ecosystem Studies (CICOES) to support ongoing protected resources research, including a specific focus on the endangered Southern Resident killer whales.
- GLERL hired a Bioinformatics Specialist through CIGLR. The position focuses on the implementation of microbiological and bioinformatic methods, such as metagenomics, amplicon sequencing, and qPCR, to investigate microbial life present in the Great Lakes.