DISCUSSION PRE-READ

Deep-Sea Biological Characterization

NOAA is advancing deep-sea biological characterization by integrating next-generation sensors with autonomous platforms and artificial intelligence (AI) to reduce scientific gaps in environments deeper than 200 meters. These efforts prioritize high-resolution data collection to understand biodiversity, habitats, and ecosystem dynamics.

Based on Executive Orders (including E.O. 14285) and the National Strategy for Mapping, Exploring, and Characterizing the U.S. Exclusive Economic Zone (NOMEC) current thematic priorities for deep-sea biological characterization include:

- **Deep-Sea Coral and Sponge Communities:** Identifying structural habitats that boost local biodiversity but are vulnerable to physical disturbance and acidification.
- **Chemosynthetic Environments:** Exploring unique species associated with cold seeps and hydrothermal vents.
- **Water Column Biology:** Characterizing pelagic ecosystems across all depths with an emphasis on benthic-pelagic coupling.

Innovative Sensor Technologies

NOAA is using a suite of advanced sampling technologies to complement traditional ship-based sampling:

- **Environmental DNA (eDNA):** eDNA is a major priority for identifying organisms from genetic material shed into the water column. Efforts are underway to develop cost-effective autosamplers, integrate in situ eDNA sampling into towed and autonomous platforms, and standardize AI-ready eDNA datasets.
- **Deployable AI and Imaging:** Advanced hardware and software allow autonomous vehicles to find and identify animals in real time. The Triton imaging system, tested in July 2025, uses AI on long-range autonomous underwater vehicles (LRAUVs) to document species for weeks at a time at depths up to 1,500 meters.
- **Advanced Acoustics:** Wideband echosounders (e.g., Simrad EK80) are being used for high-resolution 3D profiling of phytoplankton and zooplankton layers. NOAA is also testing autonomous profiling floats for soundscape characterization to extract biological data from natural sounds. There is an opportunity to expand use of active acoustics for biological characterization, towards a '4-D' map of life that leverages Seabed 2030 and fisheries data collections.
- **Hyperspectral Radiometry:** Deployed on surveys to enable automated collection of high-quality ocean color data, which serve as critical environmental co-variates for fish-habitat models.
- **High Resolution Laser Scanning:** Use of laser scanning to understand UCH environments (https://web.uri.edu/gso/news/uri-students-discover-historic-shipwrecks/) but has potential for habitat characterization

Autonomous and Low-Cost Platforms

NOAA is deploying some of the technologies above on autonomous and low-cost platforms:

- **Uncrewed Systems (UxS):** NOAA is expanding the use of long-endurance platforms like Saildrone and the Orpheus AUV, which recently collected the first direct observations of polymetallic nodules at depths exceeding 5,600 meters.
- **Low-Cost Sensors:** Through the Ocean Discovery League, NOAA is testing inexpensive systems like Maka Niu, a user-friendly, compact imaging and sensing system (GPS, depth, temperature) depth-rated to 1,500 meters to broaden the community of deep-sea explorers as well as DORIS (Deep Ocean Research and Imaging System) for cost effective access to benthic imagery.

Key Partnerships and International Cooperation

- Biological characterization efforts are heavily supported through international and public-private collaborations such as a five-year Cooperative Research and Development Agreement (CRADA) between NOAA and Fugro to design and deploy remote technologies to accelerate deep-ocean mapping and characterization.
- NOAA and the Smithsonian Institution partner actively on the 1) application of innovative omics technologies for biological characterization through biomolecular sequencing of specimens to enhance reliable reference databases and eDNA samples to characterize biological communities, and 2) cross-sector development of ocean biodiversity Key Performance Indicators (KPIs).
- NOAA also plays leadership roles in global networks such as the Marine Biodiversity Observation Network (MBON) and the Global Ocean Observing System (GOOS), advancing innovative technologies and common methods for biological observing with an emphasis on production of interoperable, open access data that is actionable for decision-making across sectors.
- NOAA geologic samples are stored at the University of Rhode Island's Marine Geological Samples Laboratory.

For awareness:

- NOAA Ocean Exploration Sampling Procedures Manual (Mar 2024)
- National Aquatic eDNA Strategy (June 2024)
- NOAA Ocean Exploration Exploration Variables (Apr 2021, see Appendix E)
- NOAA Omics Strategy (Feb 2020) & Omics Strategic Plan (Jan 2021)