Develop a Coherent National Backbone for Living Coastal Resources

The Integrated Ocean Observing System (IOOS) is a distributed system that brings together federal, academic, commercial, and NGO and other partners to provide an integrated national ocean observing capability for the US coastal zone. While this core partnership is the unique strength of IOOS, it has yet to achieve its full potential as a truly integrated observing system. This could be accomplished by collecting, in a uniform comparable manner, a common set of environmental observations and developing a national backbone for core biological measurements.

Implementing such a sampling scheme should adhere to the guidelines developed by the Global Ocean Observing System (GOOS) Biology and Ecosystems panel (BioEco Panel) as much as possible. While biological monitoring is inherently complex, the GOOS BioEco Panel, with significant community engagement, has identified a set of Essential Ocean Variables (EOV) for biology and ecosystems. Each EOV has a specification sheet developed by the GOOS BioEco Panel that documents the background and justification for the measurements, along with a description of the derived products, supporting variables, and, in some cases, the societal drivers and pressures the EOV addresses. Example EOVs include but are not limited to Ocean Color, Phytoplankton Biomass and Diversity, Marine Turtles, Birds and Mammals Abundance and Distribution, Fish Abundance and Distribution, Macroalgal Canopy and Cover and Harmful Algal Blooms. While many EOVs are still under development, they can serve as a starting point for defining the IOOS backbone for biological monitoring. Adopting a common set of standards and protocols will be critical for validating and calibrating remotely sensed ocean color and for consistent documentation of the ocean Phytoplankton concentrations. This will enable the connection of local or regional measurements to the GLOBAL observing systems. Climate signals require that we measure physics and chemistry in a standard manner with robust quality control and assurance to extract the potential changes. For example, most of the current ocean acidification technologies vary in the precision of their measurements by orders of magnitude. What is most concerning is that although a few instruments are employed within coastal zones to monitor the pH of coastal waters, many of the devices deployed have error ranges that exceed the change in pH predicted over the next 100 years.

While many potential biological observations can be made, not all are operational. GOOS differentiates EOVs in the concept, pilot, and mature phases. Mature EOVs are those that can deliver routine measurements in an operational context. BioEco EOVs considered mature include animal-tracking upper trophic levels and passive and active acoustics. The Animal Tracking Network (ATN) is an excellent example of a national IOOS operational system, which enables researchers from any Regional Association (RA) to access data. Passive acoustics is another system currently operating nationally within the National Oceanic and Atmospheric Administration (NOAA), including the Sanctuary Soundscape Monitoring Program. These existing efforts within NOAA and the National Estuarine Research Reserve System (NERRS) should be integrated into or at least accessible through IOOS. Finally, some of the EOVs are relevant across disciplines. For example, the ocean acoustics EOV and the Animal Borne Ocean Sensors Network apply to GOOS Physics, Chemistry, and BioEco panels.

As many promising emerging technologies are on the horizon, now is the time to establish standard practices and procedures. The RAs can serve as a test bed to develop and test these new observation tools but with an emphasis on implementing these new techniques as part of an integrated national system. These pilot observational tools include measurements of eDNA, which show much promise but remain in the early phases of development and interpretation.

Recommendations for enhancing and building new capabilities focused on marine living resources include:

1. ***Develop a national inventory of biological measurements routinely made across IOOS regions.*** IOOS should develop a National Assessment of what type of biological data are being collected, who is collecting it, and where it is being stored. This inventory should include basic information such as the measure's specific measurement, latency, precision, sensitivity of the measurements taken, methods, and post-processing techniques. These data could be augmented with the extensive bathymetric and habitat data collected by private entities associated with offshore energy development, marine protected areas, and fishing.

2. ***Identify core biological measurements and standards across the IOOS enterprise. Develop the capacity to ensure the development of a specific biological capability across the IOOS enterprise. IOOS should incorporate the GOOS framework for marine life observations to the extent possible.*** One of the goals of IOOS is to detect a change in marine ecosystems due to a shifting climate. To this end, IOOS should implement consistent measurements across the RAs of the base of the food chain, including phyto and zooplankton. This should be done using equivalent methodologies and standards, such as cytobots. Measurements of upper trophic levels can be collected using passive acoustics (i.e., soundscapes) and the ATN. National Marine Sanctuaries and the NOAA Soundscapes program currently carry out such measurements. Soundscapes provide baseline measurements of noise-producing marine animals, weather, and anthropogenic activities.

3. ***IOOS should fully implement the ATN (ARGOS and acoustic tracking systems) and ensure that key sentinel species are measured routinely. Implementation would include tracking data collected by all federal agencies.*** Biological patterns are mobile (advective transport, fish migration, etc.) and require integrated measurements over regional scales. Therefore, providing standardized measurements across the regions is critical to delivering data streams to meet the needs of potential stakeholders (management, conservation, research, commercial). This will be critical to collect relevant information from climate impacts to effective management and conservation.