Key Takeaways from Community Ocean Observing Exchanges

This document synthesizes discussions during **eight virtual ocean exchanges that have engaged over 200 members of the broad ocean science and observing communities,** hosted by the OOIFB and facilitated by a multidisciplinary suite of scientists and other stakeholders. These conversations have highlighted the importance of a broad community response to the NSF's current Dear Colleague Letter. Discussions have been shaped by the questions posed by the NSF, but many of the discussions and key takeaways highlighted below are cross-cutting.

All members of the community, across all types of expertise, positions, and career stages, are encouraged to submit a response. You are welcome and encouraged to build on the key takeaway points synthesized below, but please do not copy/paste and instead express your views in your own words**. You do not need to respond to all questions**, and can shape your comments to address the questions most relevant to the perspectives you want to share.

Key takeaways:

1) **NSF-supported ocean observing is a critical component of the overall landscape of US ocean observing**, complementing those of other operational agencies (e.g. NOAA and USGS). **NSF-supported ocean observing provides the discovery and innovation that feeds future operational observing; sustained observations provide the context necessary for continued scientific discovery.** NSF's role is particularly important in: hypothesis-driven and discovery-driven (frontier) science, interdisciplinary research, technology development (including emerging tech and AI), and training the next generation of scientists and engineers. Rather than treating observing activities as separate efforts, significant coordination should be prioritized across agencies to support a continuum from discovery to sustained observing and operational applications.

2) **At a broader level, coordination—across agencies, disciplines, and sectors—is essential.** This includes international coordination across networks, research programs, and datasets. **U.S. ocean observing is embedded within a global observing enterprise**. Sustained investment in infrastructure, expertise, and international partnerships is necessary both to contribute to global scientific objectives and to maintain U.S. leadership in ocean observing and technology development.
    - **Fragmentation reduces the value of investments.** Greater coordination among observing programs, federal agencies, international partners, industry, and other stakeholders is essential to **maximize the scientific and societal return on ocean-observing investments**.
    - **Coordination and/or co-design before deployment is key.** It should be determined whether multiple stakeholders could use the same infrastructure or sensor before an observing system is designed and deployed.

3) **Sustained, long-term observations are foundational to ocean science**, **and key to innovation and discovery.** Long-term, sustained, time-series observations are not simply "monitoring"; they are the foundation to new science, technology, and data analysis methods. They provide the baseline against which new observations, technologies, models, and AI approaches ("the next generation of predictive and analytical tools") can be interpreted and validated. Some scientific objectives —such as understanding of geophysical hazards, or detection of long-term changes from baseline variability —require decades of observation. Losing an observing system can mean losing scientific capacity (technology and human based) that cannot easily be rebuilt.
   - **Flexibility is necessary alongside continuity.** A successful ocean observing system needs both stable, permanent observations and flexible, PI-driven capabilities.
   - **Continuity and innovation are not competing priorities.** Existing infrastructure should be treated as platforms for innovation that can serve as critical test beds for developing, validating, and integrating new and emerging technologies (e.g DAS/fiber sensing, chemical sensors, imaging, eDNA, autonomous robotics, resident AUVs, acoustics, AI/ML approaches).

4) **Data management, calibration, quality control, and metadata, are essential components of ocean observing infrastructure, not an afterthought.** To be successful, an ocean observing system must produce accessible, calibrated, quality-controlled, and science-ready data. This becomes even more critical when considering **AI-ready data**. Investments in observing systems must also include the sustained human capacity needed to transform observations into accessible, reliable, science-ready data, and increasingly, AI-ready data. **AI increases—not decreases—the need for high-quality long-term observations.**

5) **Human infrastructure is just as important as technological infrastructure. Discontinuing ocean observing systems will not only eliminate instruments, it will reduce the expertise (and effective U.S. capacity) required to design, operate, maintain, interpret, and innovate around ocean observing systems.**
   - Skilled scientists, engineers, technicians, and data specialists are essential to operating existing systems, developing new technologies, and maintaining U.S. leadership in ocean science.
   - Ocean observing data is used to build data literacy in K-12, undergraduate, and graduate education (including community colleges, a NSF-stated priority). Working with data sets in this way helps to build a student's "science identity", and engages them early in the workforce development pipeline for key STEM careers. These education efforts also instill transferable, data-related skills.

6) **A coordinated NSF portfolio of fixed, mobile, autonomous, and cabled assets can provide capabilities that no individual observing system can achieve alone**. The greatest value comes from integrated ocean observing systems of complementary observations across spatial and temporal scales, not necessarily individual platforms.

Data combining multiple platforms and types produces robust observing systems that are greater than the sum of their parts and can be used by many different stakeholders.

7) **The future of NSF ocean observing should not be framed as a choice between maintaining existing infrastructure and investing in new science and technology.** A successful U.S. ocean-observing strategy must do both—preserve long-term observations, infrastructure, (human) expertise, and data systems that provide essential scientific context while using those capabilities as platforms for integration, innovation, and new discovery. The value of ocean observing lies not in individual instruments or programs, but in connected systems created by linking platforms, disciplines, agencies, nations, technologies, datasets, and people across spatial and temporal scales.

8) **Ocean observing has broad societal and national value.** These benefits often emerge from observations originally collected for fundamental science. Sustained investments can therefore generate benefits well beyond their original scientific objectives. Applications include:
    - Fisheries and aquaculture
    - Maritime safety/maritime domain awareness
    - Shipping
    - Transporation
    - Natural hazard forecasting and mitigation (earthquakes, tsunamis, hurricanes)
    - Critical infrastructure resilience (including telecommunications)
    - National security
    - Critical minerals
    - Marine energy