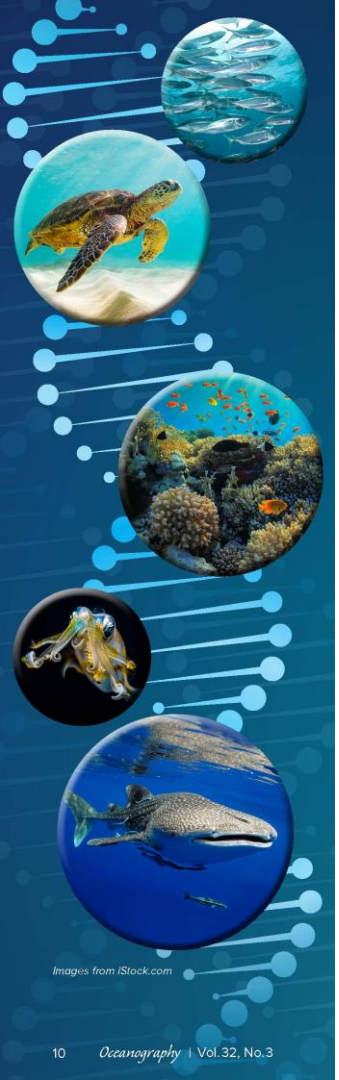
OCEAN BIOMOLECULAR OBSERVING NETWORK

Developing new and scalable technologies for observations of life in the sea

Francisco Chavez
Monterey Bay Aquarium Research Institute

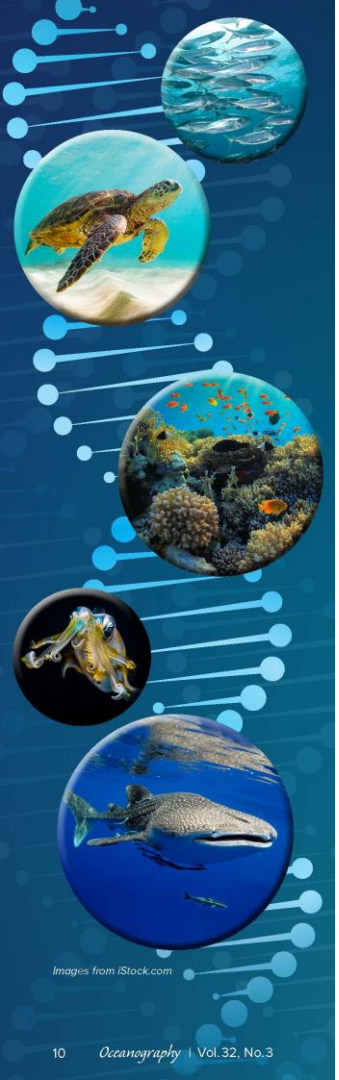
https://tos.org/oceanography/article/observing-life-in-the-sea-using-environmental-dna



OBON OBJECTIVES

1) Build a coastal-to-open ocean multi-omics biodiversity observing system; include biomolecular analysis in long term observation systems ; **develop autonomous sampling and analysis capability**
2) Enhance marine 'omics' data systems and enhance ecosystem models by adding biomolecular components
3) Partner with marine conservation and management specialists, policymakers, private sector and to address sustainable development
4) Develop and transfer capacity through training programs combined with funded equipment programs supported by development/aid agencies and philanthropy

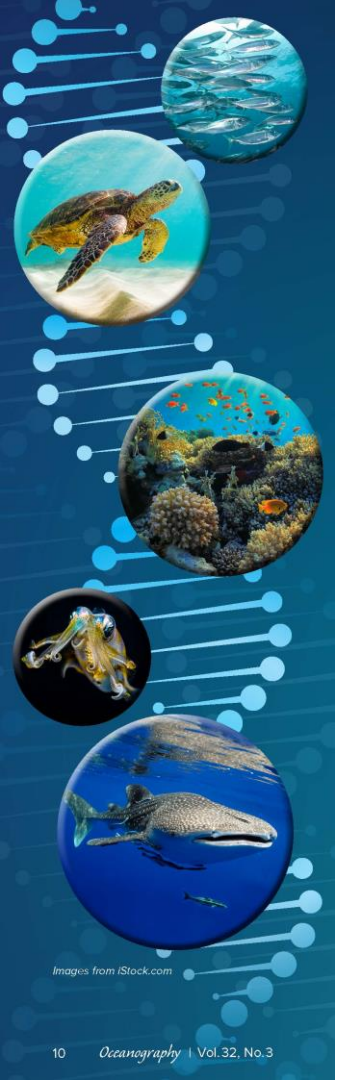
OBON
OCEAN BIOMOLECULAR OBSERVING NETWORK



Traditional Approach to Biodiversity Monitoring

- Go to sea on a ship or from shore
- Bring samples to ship and/or shore
- Process samples via laboratory analysis (species and abundance, etc.)
- Synthesize information over years

OBON
OCEAN BIOMOLECULAR OBSERVING NETWORK

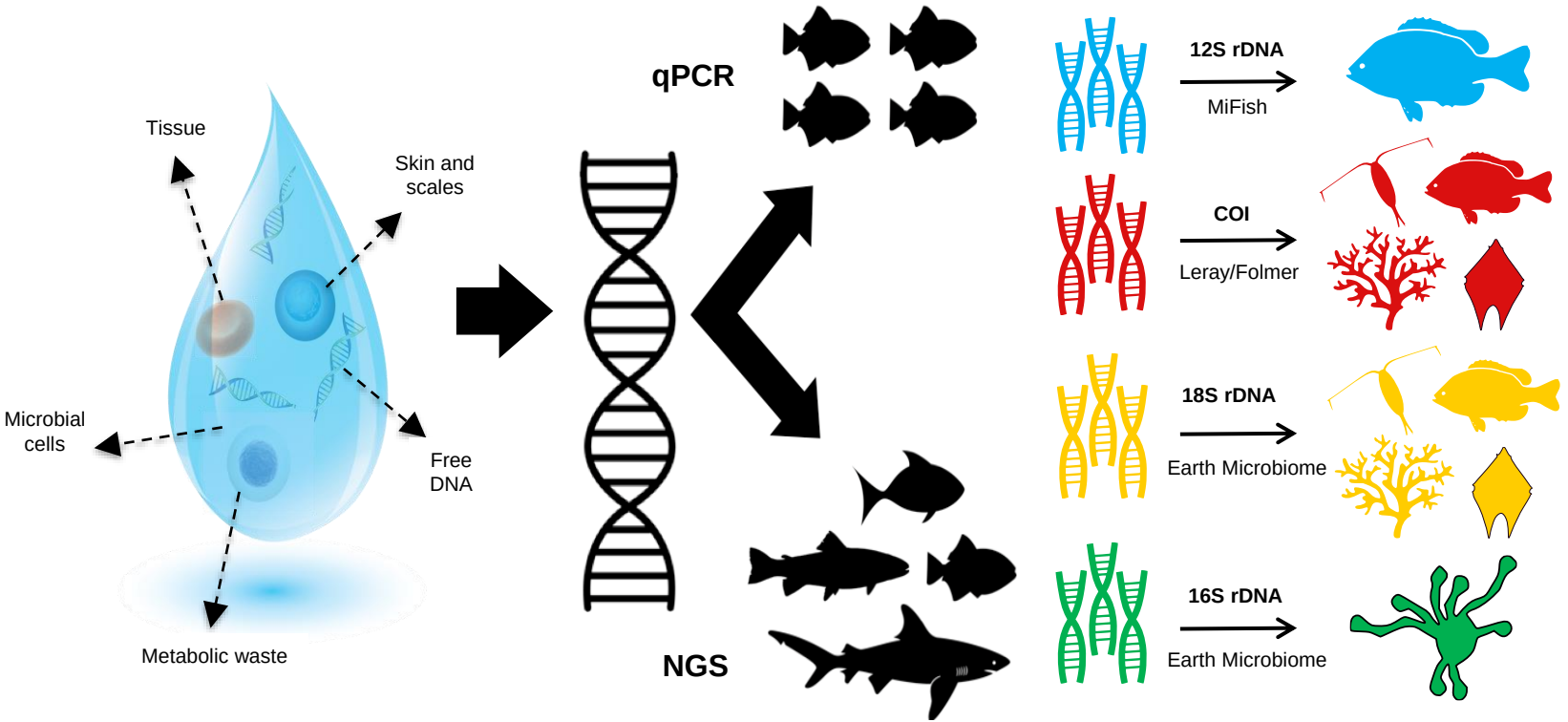


A new set of requirements

- Near real-time information (i.e. moorings on the TOGA-TAO array are used to track El Niño) requires continuous presence.
- Globally distributed information (i.e. Argo floats track the distribution of heat and salt) requires smaller and lower cost platforms
- Multidisciplinary (wind to microbes to whales) real-time and global information (i.e. how can we tell if Life in the Sea is changing and why), requires a new model
- Emerging technology: environmental DNA

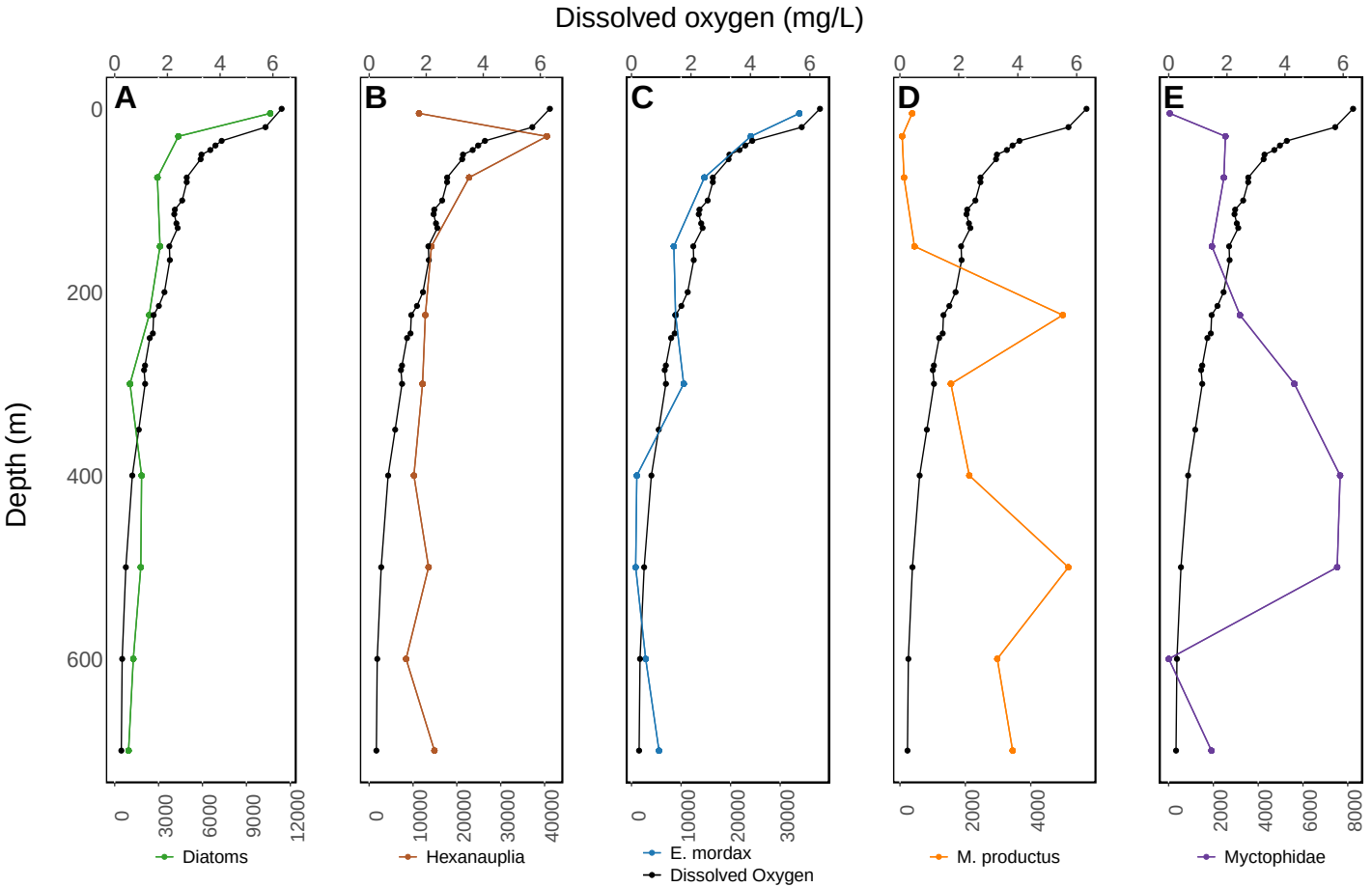
OBON
OCEAN BIOMOLECULAR OBSERVING NETWORK

Environmental DNA (eDNA) a cheaper, less invasive and scalable approach to observe life in the sea

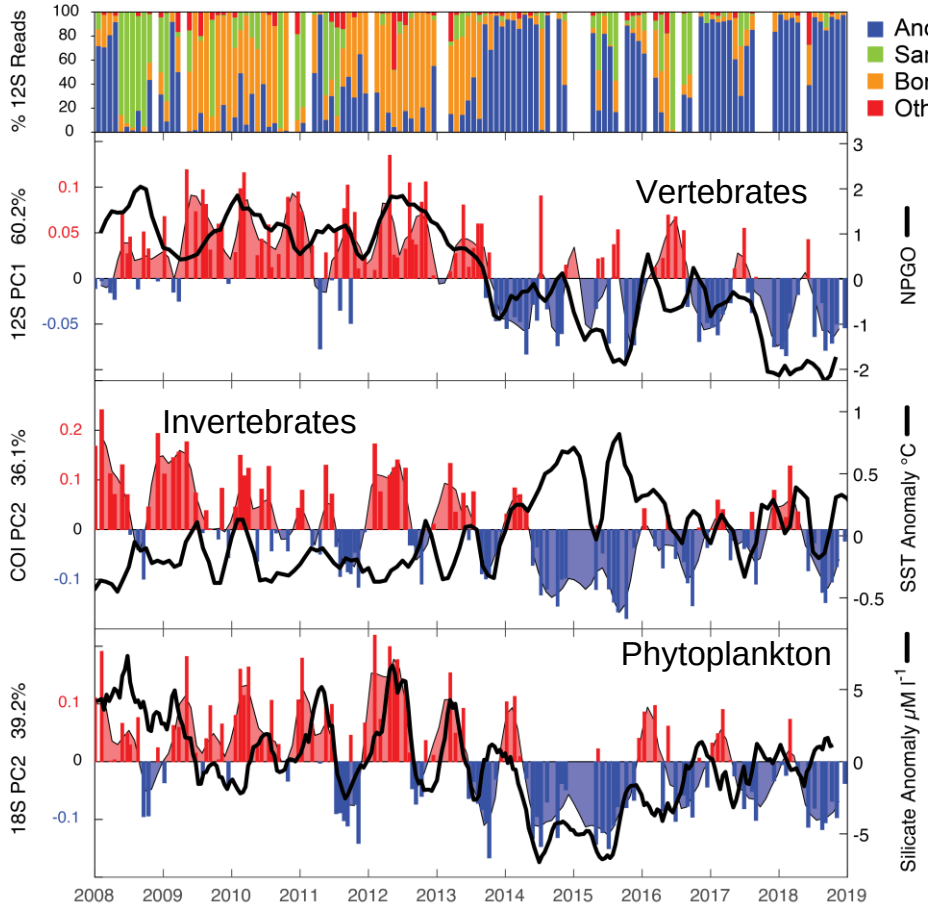


Examples to follow

Vertical distributions of life in the sea just like temperature, salinity and oxygen



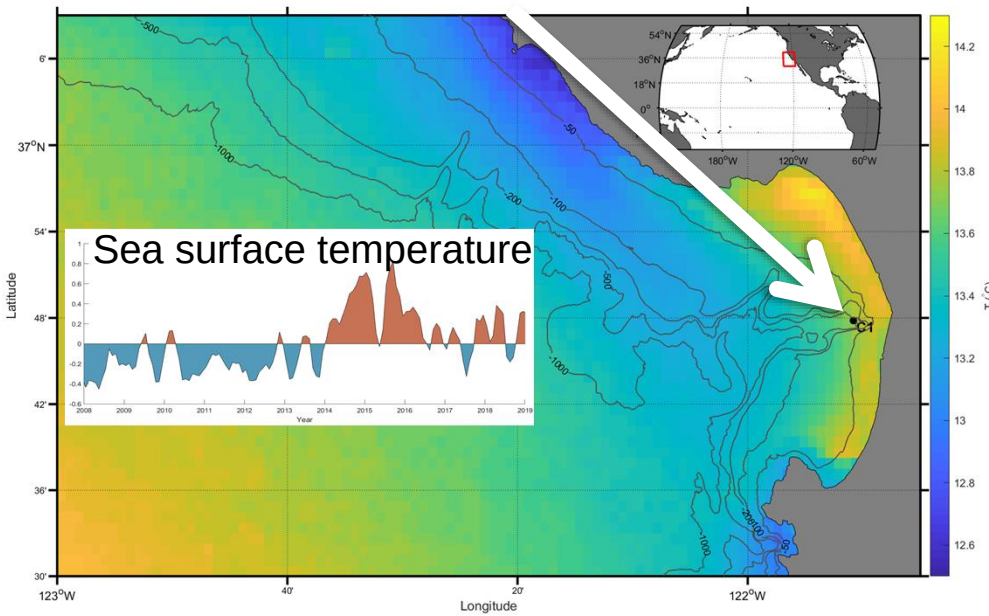
Marine regime shift



Identified using eDNA

Changes over time

Samples from

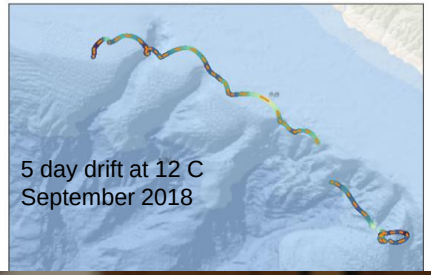


2008-2018 time series

Pitz et al. in prep

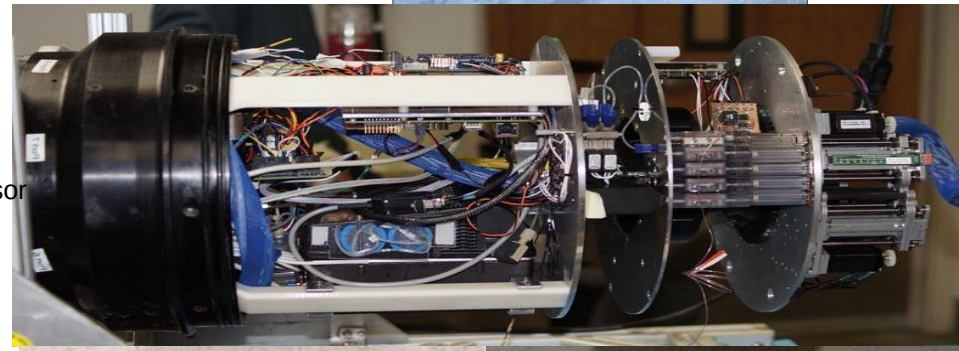
eDNA automation: Long Range AUVs and Argo floats with eDNA sensors

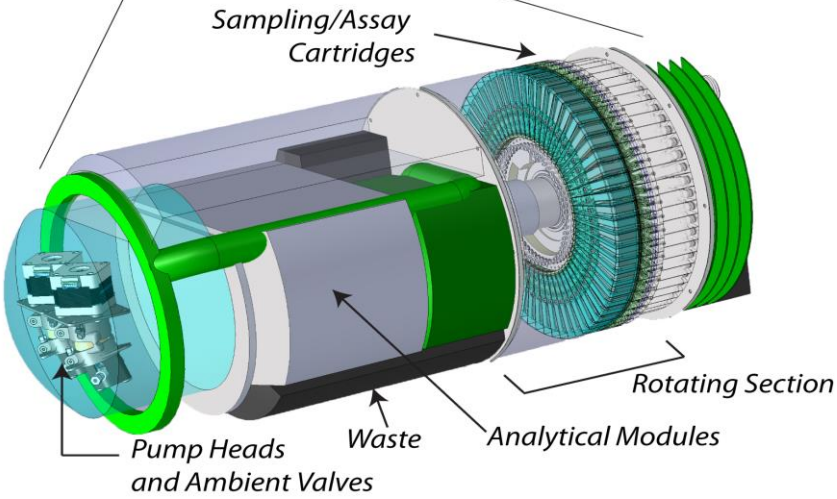
A new window for observing life in the sea



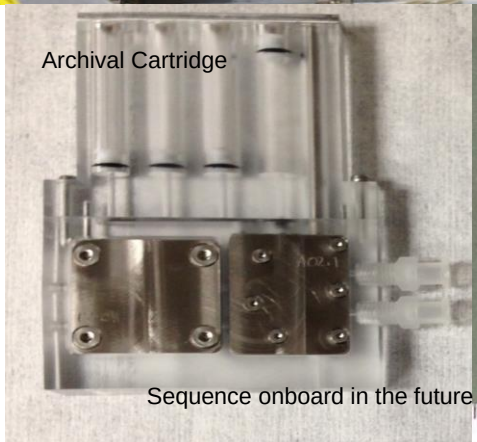
~**14 days, 945 km at full speed, 1800 km on primaries**

Environmental Sample Processor



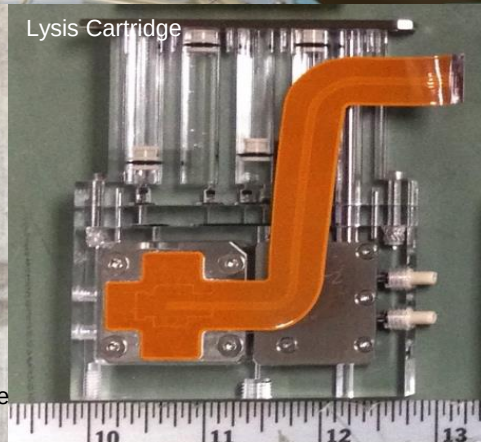


Courtesy of ESP AND LRAUV teams



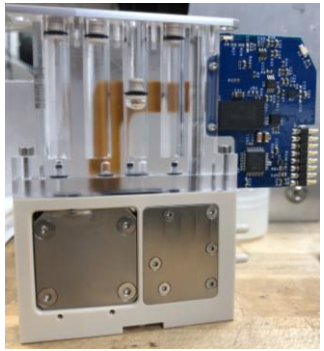
Archival Cartridge

Sequence onboard in the future

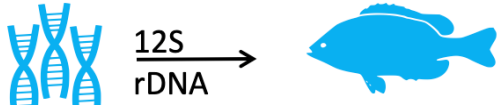


Lysis Cartridge

The future: eDNA sequencing and bioinformatics *in situ* at sea



(A) Sample collection and DNA extraction on autonomous systems



(B) PCR + library prep

(C) Use a miniature device to sequence DNA

(D) Bioinformatics at sea with species ID using GPU processing

Rockfish sp.
1,018,542 reads

California Anchovy
1,789,385 reads

Humpback Whale
372 reads

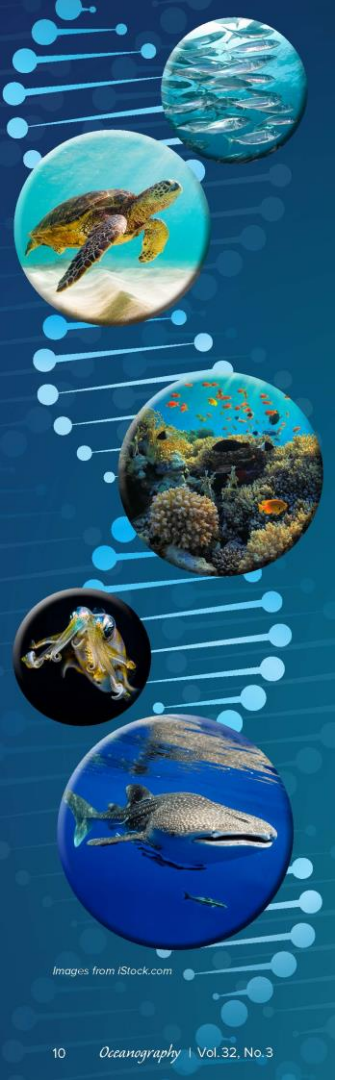
(E) Information telemetered to shore (for real time decisions)

eDNA wheel and co-design

- The system improves over time with feedback from users, as methods develop and become more efficient, libraries grow, and technology advances

The eDNA wheel

Continuously turning

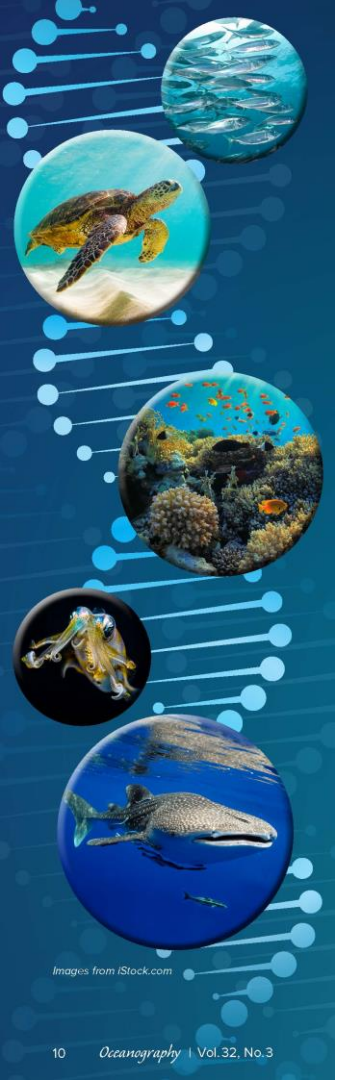


Summary

- Environmental DNA is a powerful new tool for observing life in sea
- Supports a wide variety of applications, from scientific discovery to applied management
- Challenges remain but tremendous opportunities ahead including routine global observations of marine biodiversity

Contact: chfr@mbari.org

OBON
OCEAN BIOMOLECULAR OBSERVING NETWORK



OBON PARTNERS

- 30 universities
- 48 research institutes
- 12 government agencies (US and non-US)
- 9 non-profit organizations
- 21 established research programs
- 2 corporations
- 4 other UN-endorsed UN Decade programmes – so far
- 38 nations represented

OBON
OCEAN BIOMOLECULAR OBSERVING NETWORK