



Emerging biomolecular technologies for the observation and management of marine life

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Agnes Weiner

NORCE

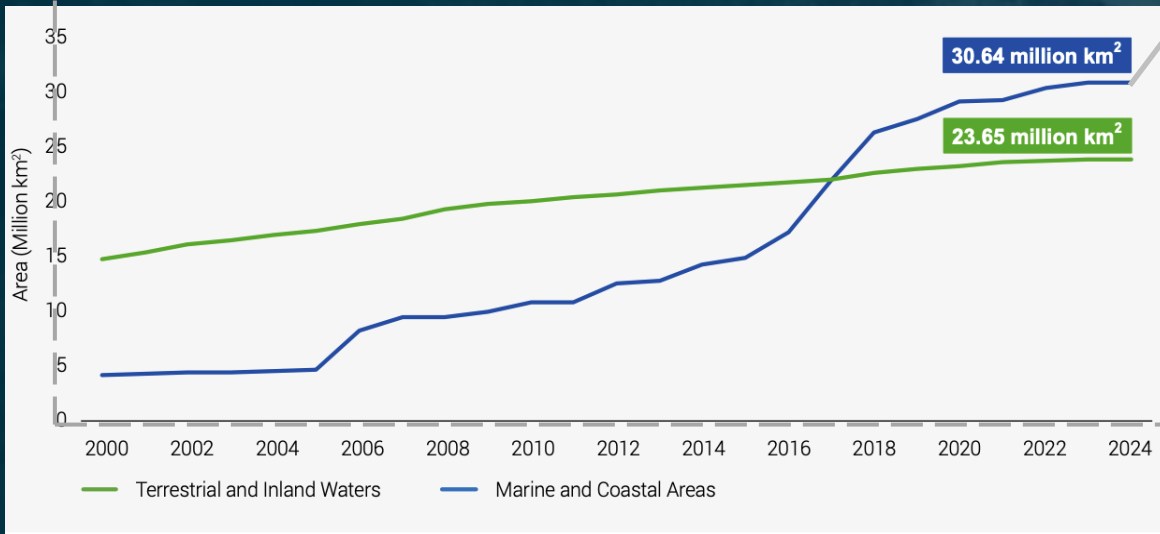
Damien Eveillard

Nantes Université

On our way to protecting 30% of the oceans by 2030

Marine Target = 61M km² (30%)

Only 2.8% are fully or highly protected MPAs



While we accelerate the designation of MPAs to meet 30 x 30 in the oceans, **how will we know they're effective?*

Themes of the BBNJ treaty

1. Marine Genetic Resources and Digital Sequence Information
2. Marine Protected Areas
3. Environmental Impact Assessments
4. Transfer of Marine Technology

2030

UNEP-WCMC and IUCN (2024). Protected Planet Report 2024. UNEP-WCMC and IUCN: Cambridge, United Kingdom; Gland, Switzerland.



DNA IS THE **MOST SCALABLE** METRIC OF MARINE BIODIVERSITY

Advantages:

- All life contains DNA
- The collection of eDNA is simple and non-invasive
- It can deliver species-specific, quantitative data over seascapes



Invasive species detection



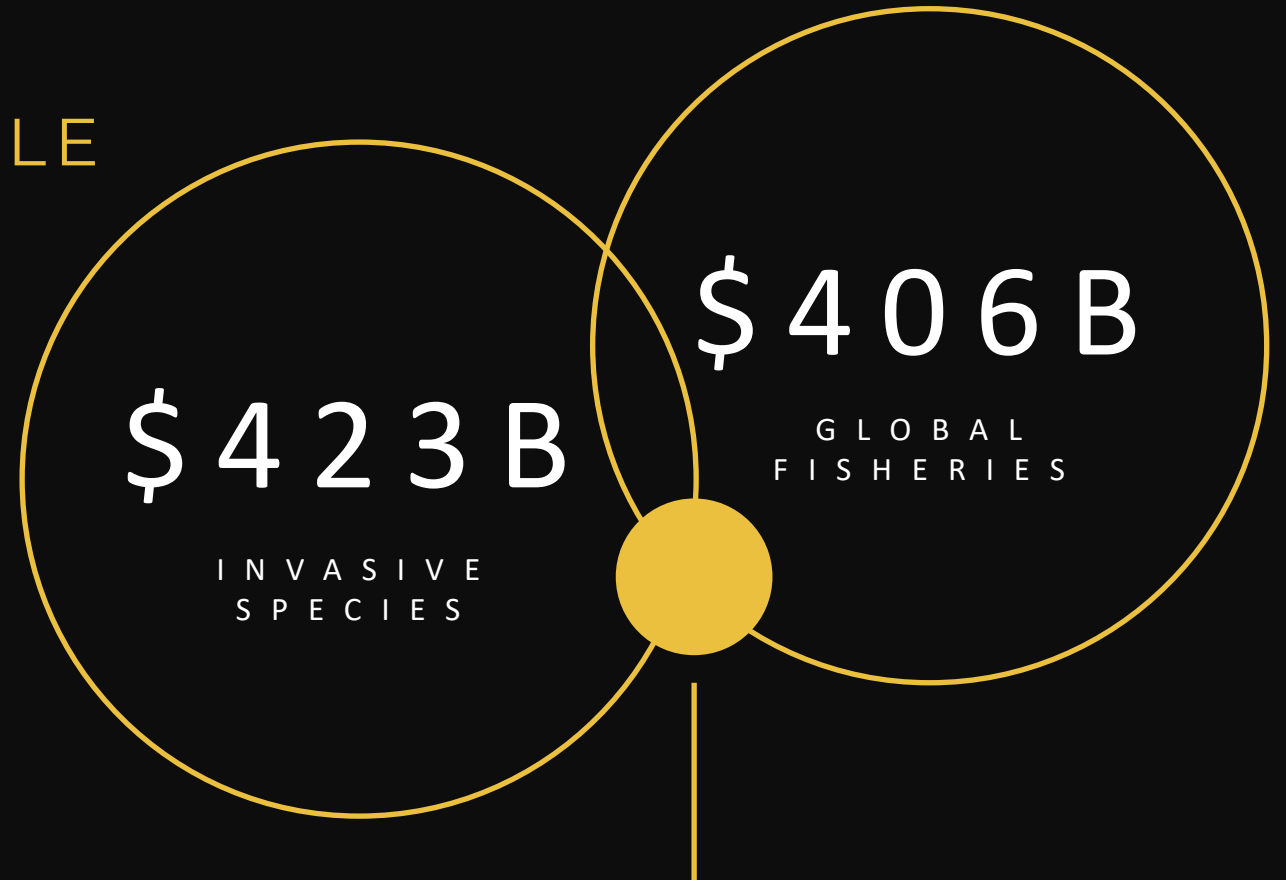
Harmful algae and pathogen monitoring



Fish stock assessments



Marine protected areas

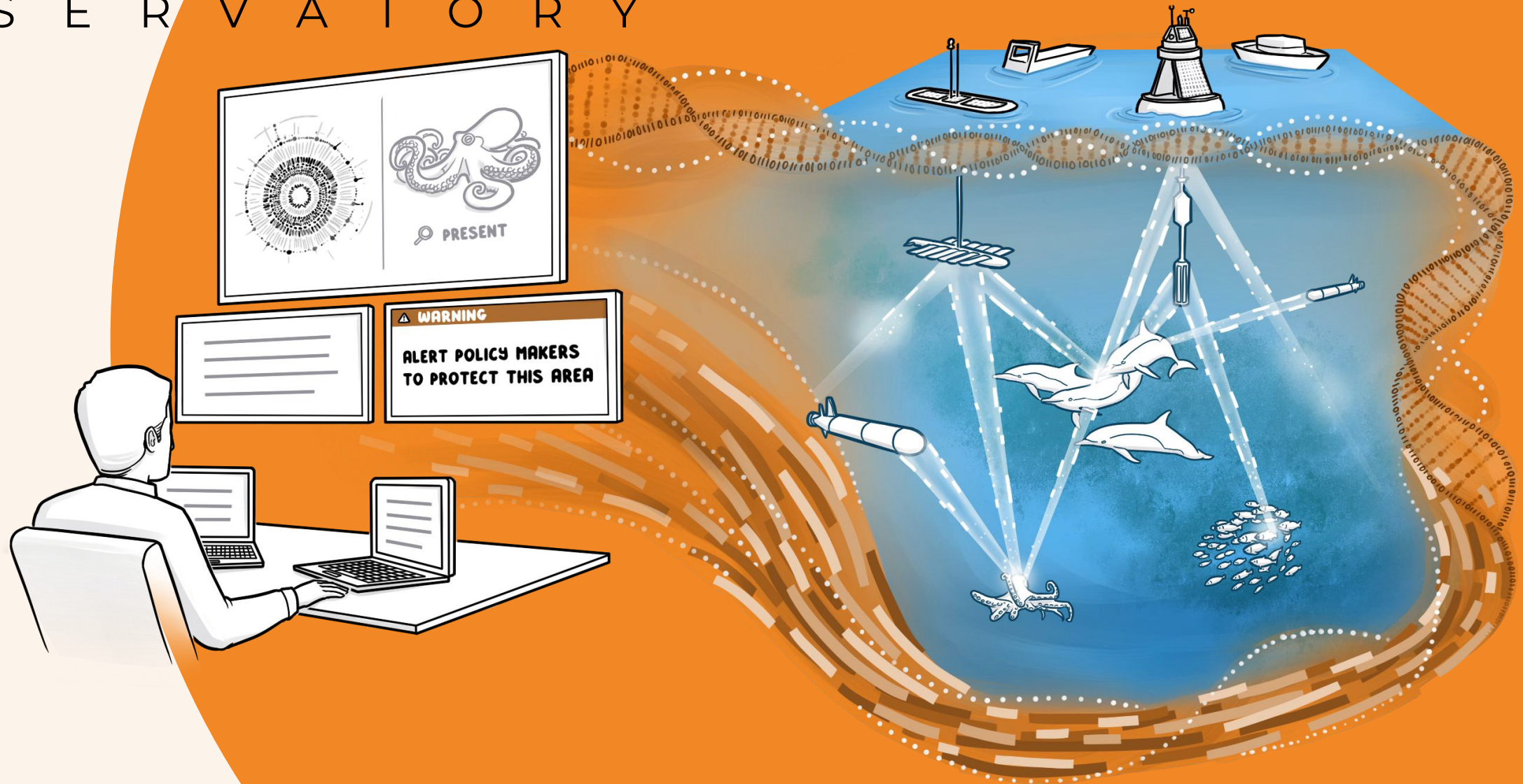


BY 2036

\$31.5 B

ENVIRONMENTAL
IMPACT
ASSESSMENTS

A GLOBAL eDNA OBSERVATORY



A G L O B A L e D N A O B S E R V A T O R Y

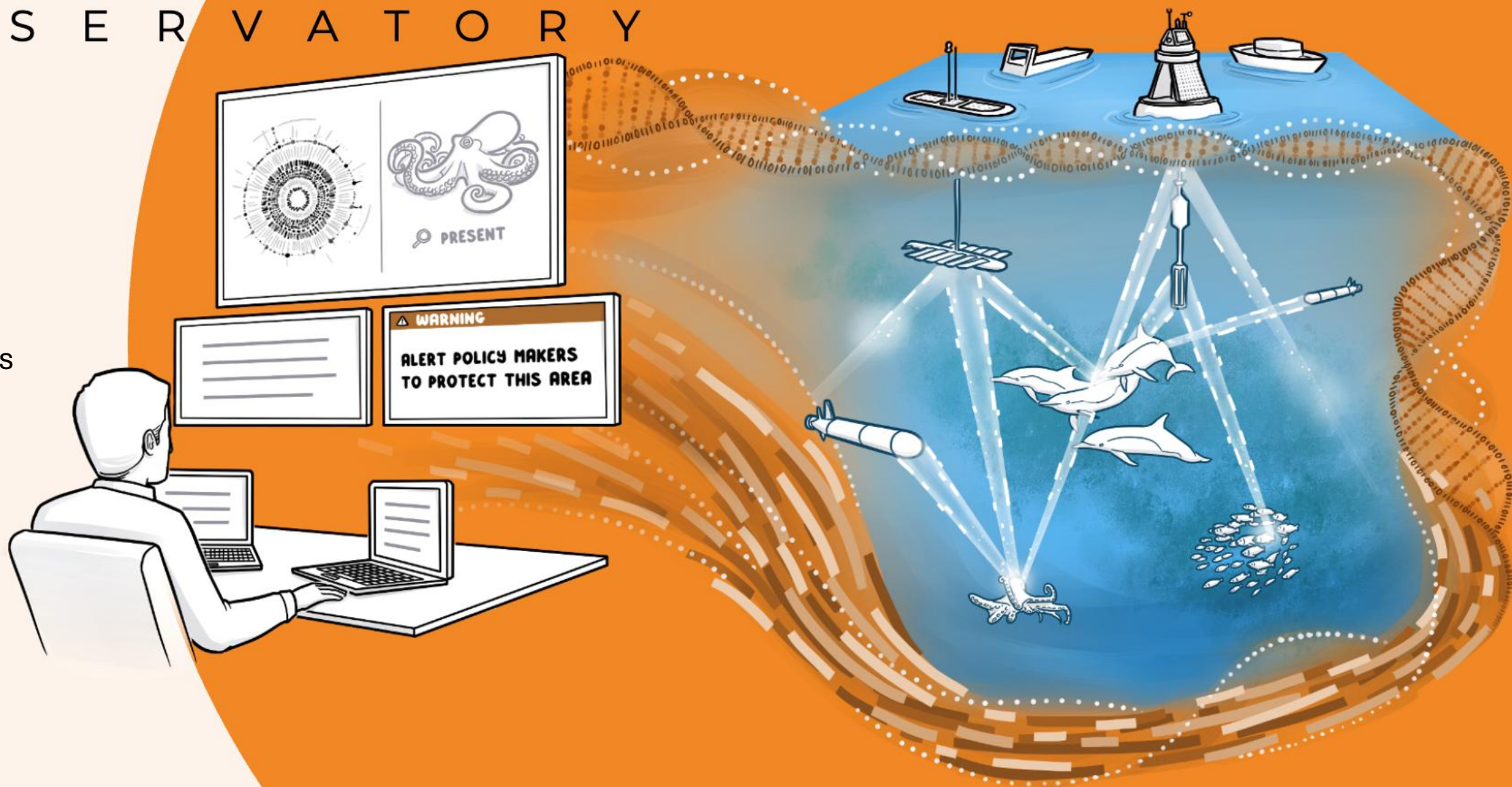
Samplers

Sensors

Policy

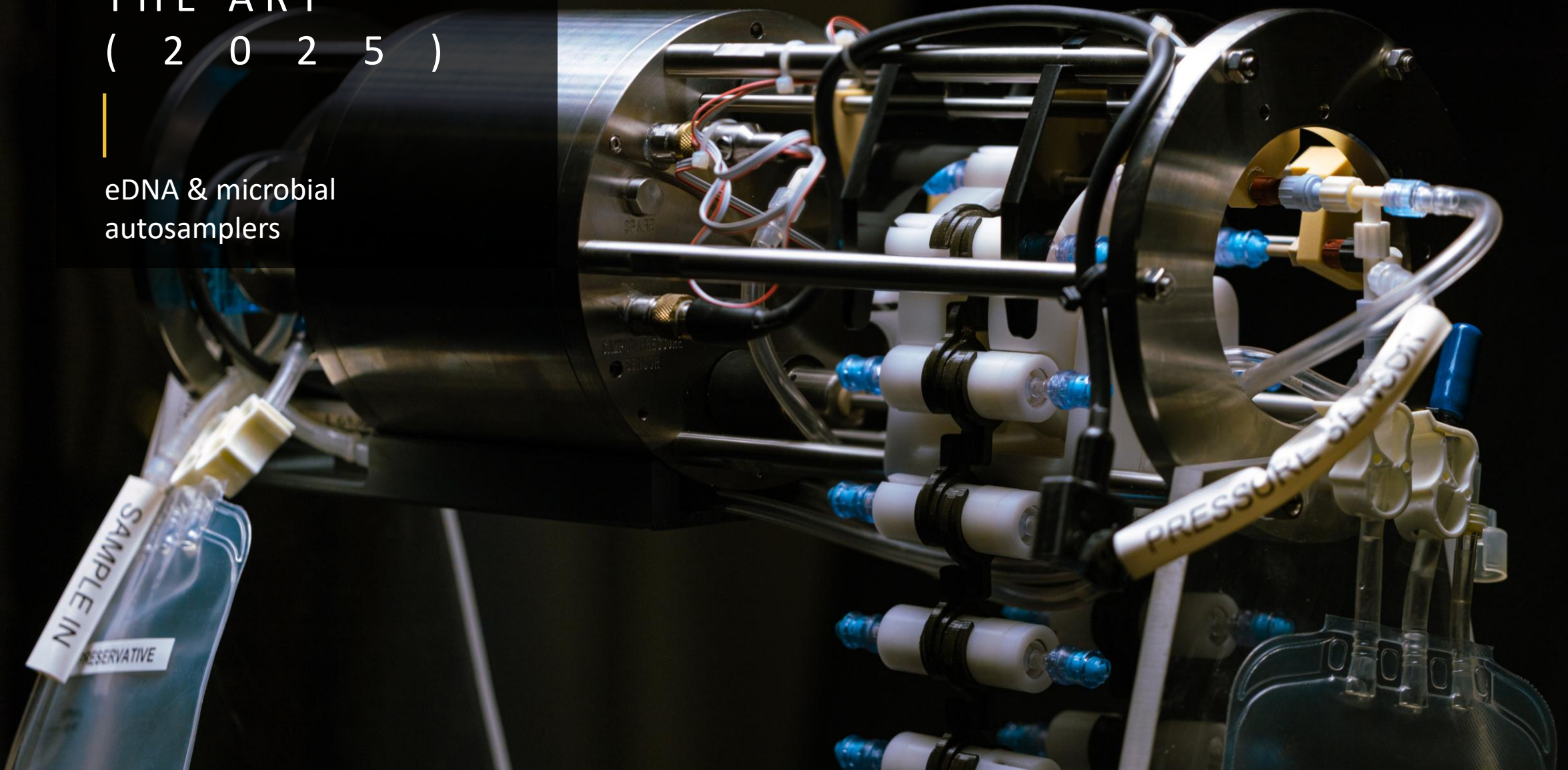
Dashboards

Models



STATE OF THE ART (2 0 2 5)

eDNA & microbial
autosamplers





Kevan Yamahara



Environmental DNA

Dedicated to the study and use of environmental DNA for basic and applied sciences

REVIEW | [Open Access](#) | [CC](#) [BY](#) [NC](#) [ND](#)

A State-Of-The-Art Review of Aquatic eDNA Sampling Technologies and Instrumentation: Advancements, Challenges, and Future Prospects

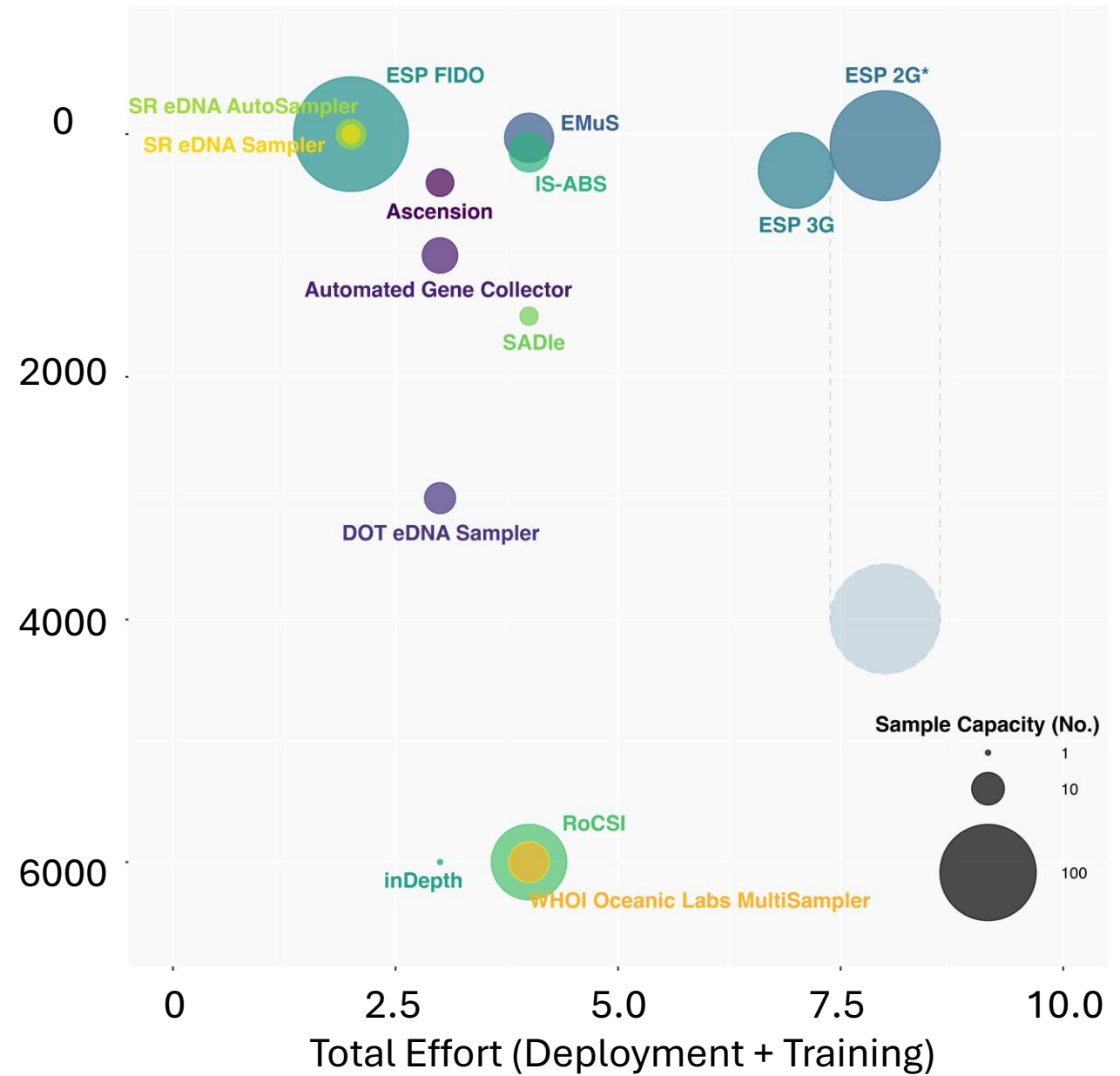
[Kevan M. Yamahara](#) [✉](#) [Elizabeth A. Allan](#), [Julie Robidart](#), [William H. Wilson](#), [James M. Birch](#), [Pascal Craw](#), [Ethan Edson](#), [Ivory B. Engstrom](#), [Tatsuhiko Fukuba](#), [Annette F. Govindarajan](#), [Alfredo M. Martins](#), [Kim M. Parsons](#), [Vincent J. Sieben](#), [Austen Thomas](#), [Ian Wilson](#), [Christopher A. Scholin](#)
... See fewer authors ^

First published: 25 August 2025 | <https://doi.org/10.1002/edn3.70170> | [VIEW METRICS](#)

Funding: This work was supported by Office of Naval Research, N00014-23-1-2521.

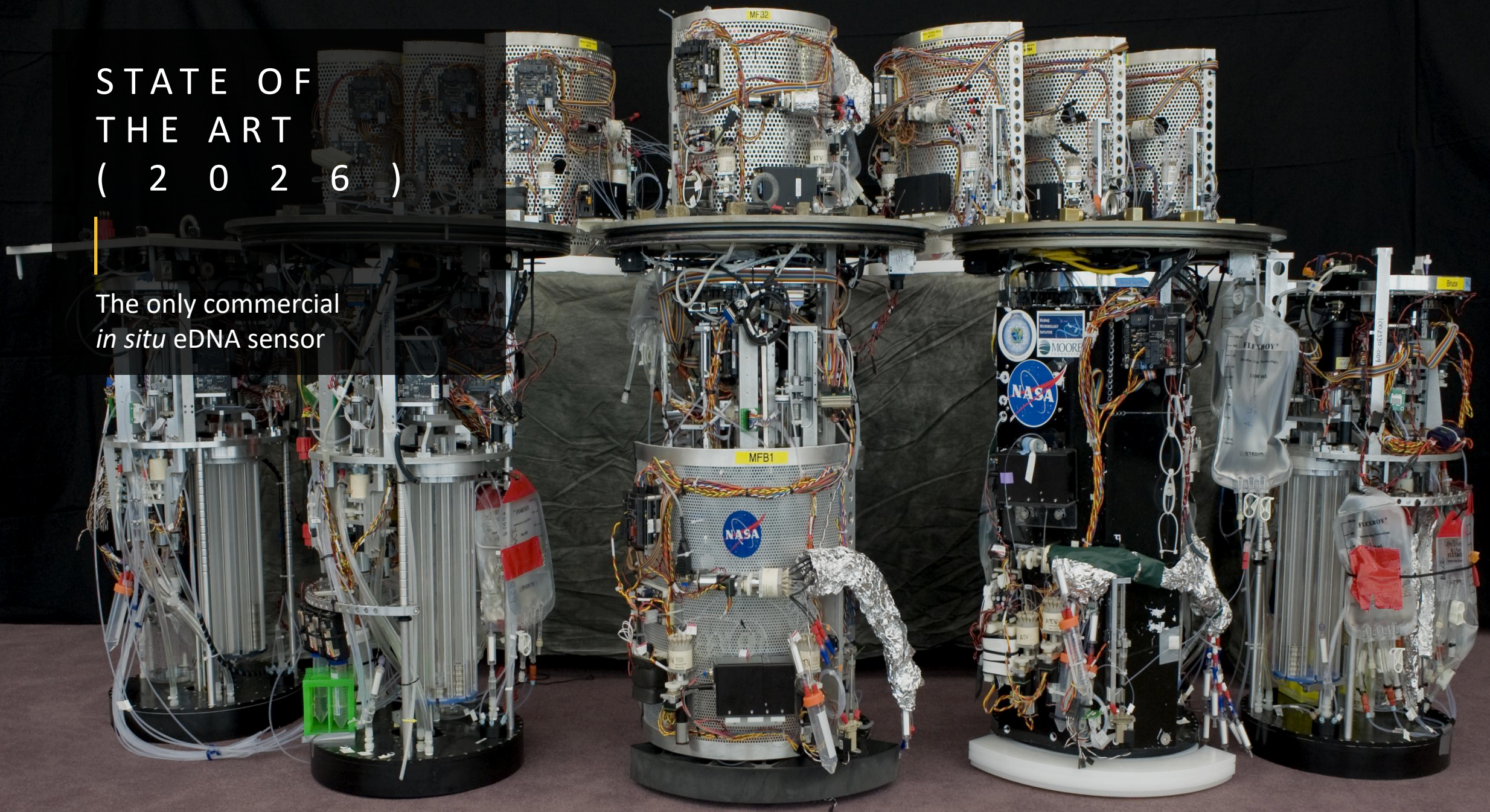


Maximum Depth (m)



STATE OF THE ART (2 0 2 6)

The only commercial
in situ eDNA sensor

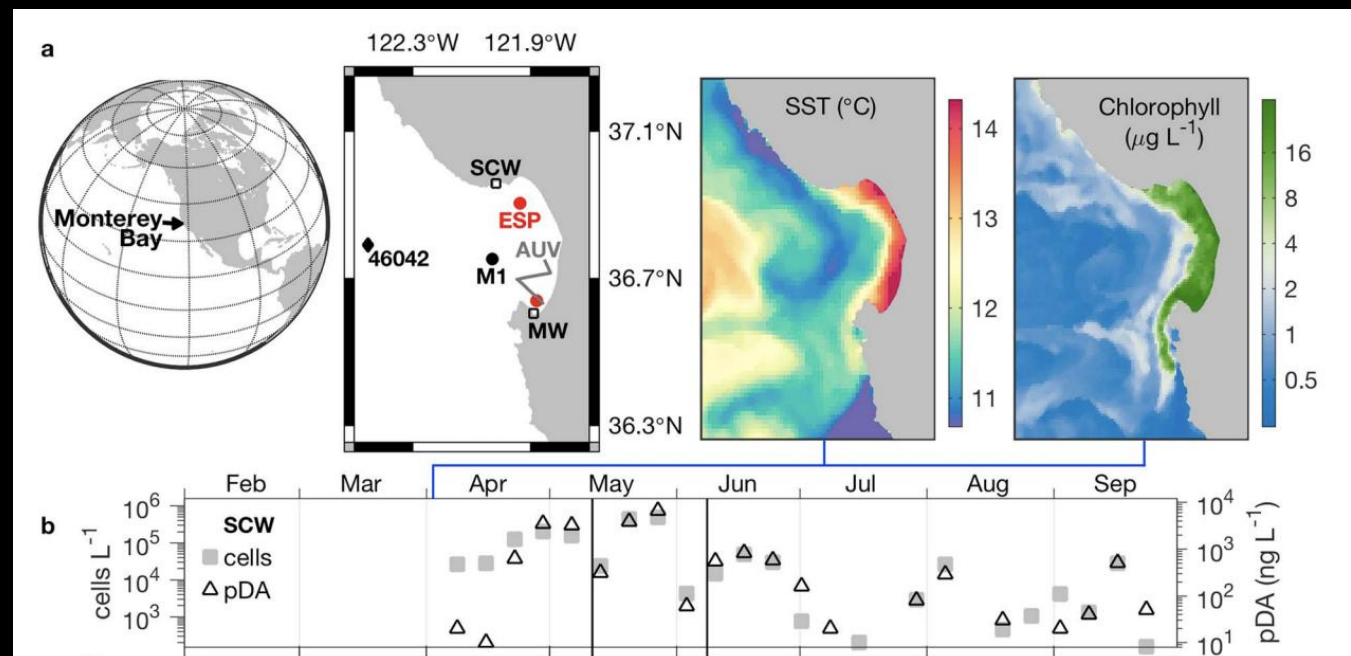
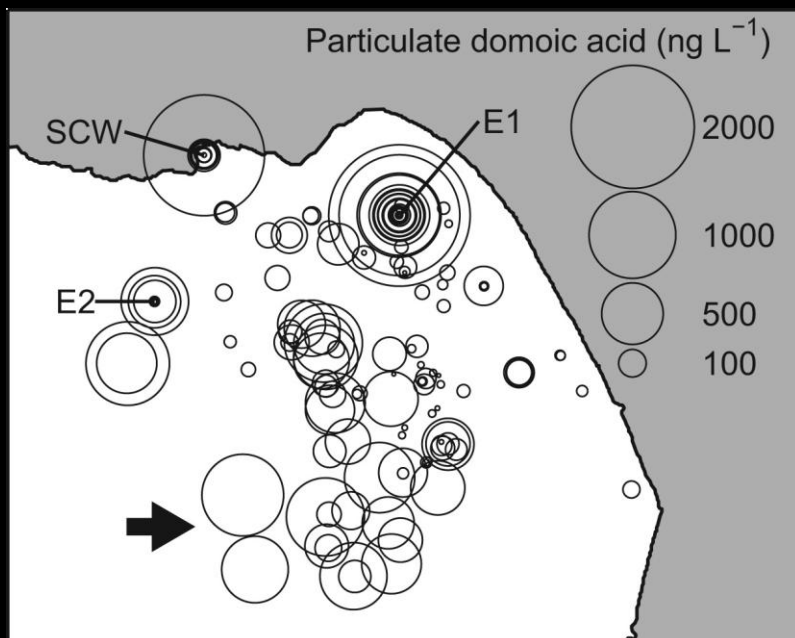
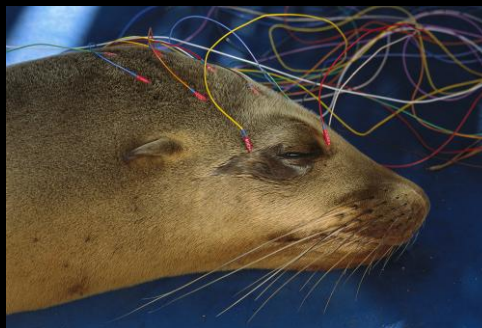


THE ENVIRONMENTAL SAMPLE PROCESSOR (ESP)

Designed for the detection of HABs

Mortality of sea lions along the central California coast linked to a toxic diatom bloom

Christopher A. Scholin*, Frances Gulland†, Gregory J. Doucette‡, Scott Benson§, Mark Busman¶, Francisco P. Chavez*, Joe Cordaro Robert DeLong†, Andrew De Vogelaere‡, James Harvey§, Martin Haulena†, Kathi Lefebvre*, Tom Lipscomb**, Susan Loscutoff††, Linda J. Lowenstine‡‡, Roman Marín III*, Peter E. Miller*, William A. McLellan§§, Peter D. R. Moeller‡, Christine L. Powell‡, Teri Rowles||, Paul Silvagni‡‡, Mary Silver*, Terry Spraker†§, Vera Trainer## & Frances M. Van Dolah‡



Pseudonitzschia and domoic acid; Ryan et al., 2014; 2017

A SHARED VISION

- Small
- User-friendly
- Submersible
- Lower-cost



ESP Generation 3

Lab-on-a-chip



A G L O B A L e D N A O B S E R V A T O R Y

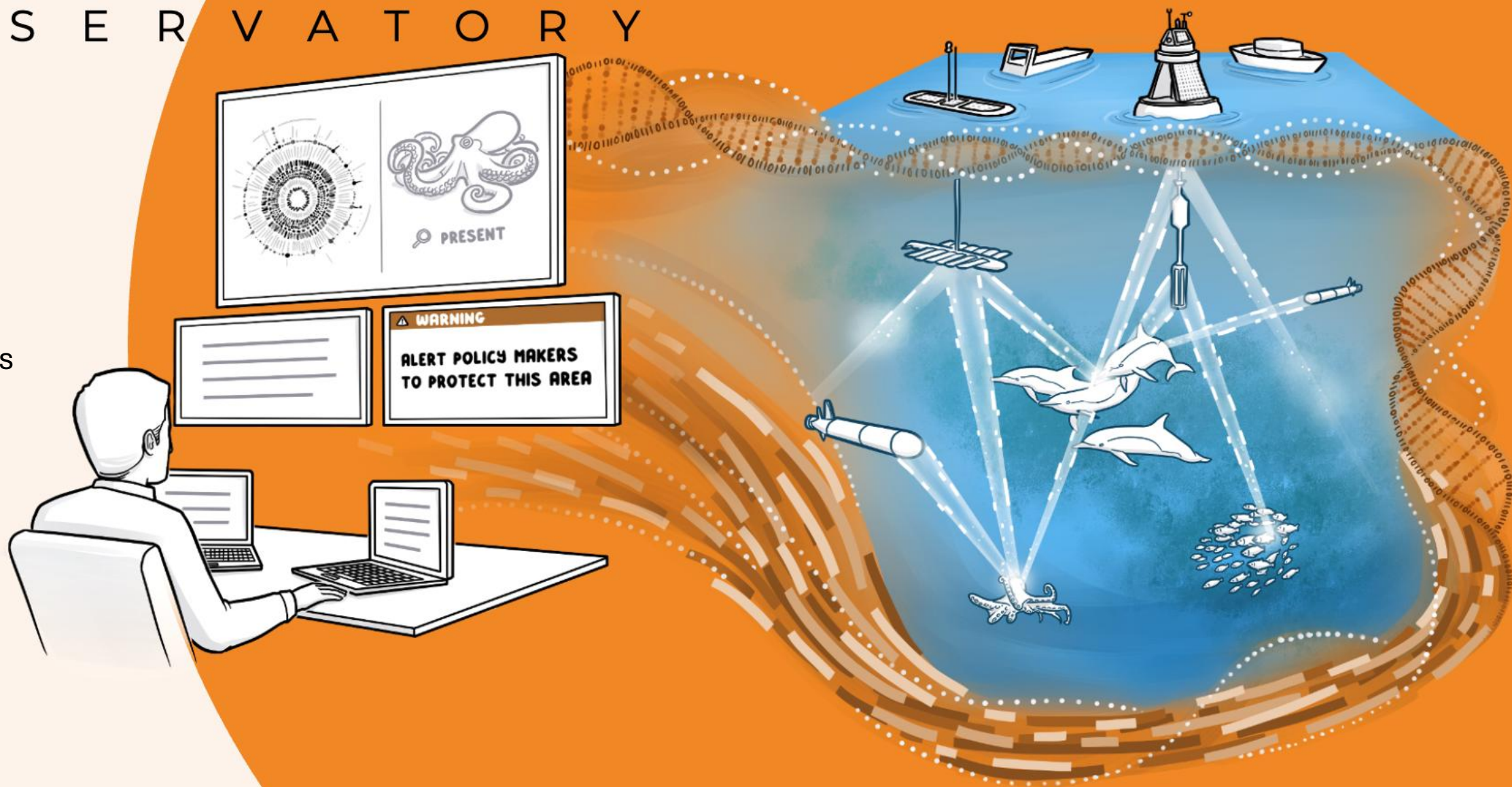
Samplers

Sensors

Policy

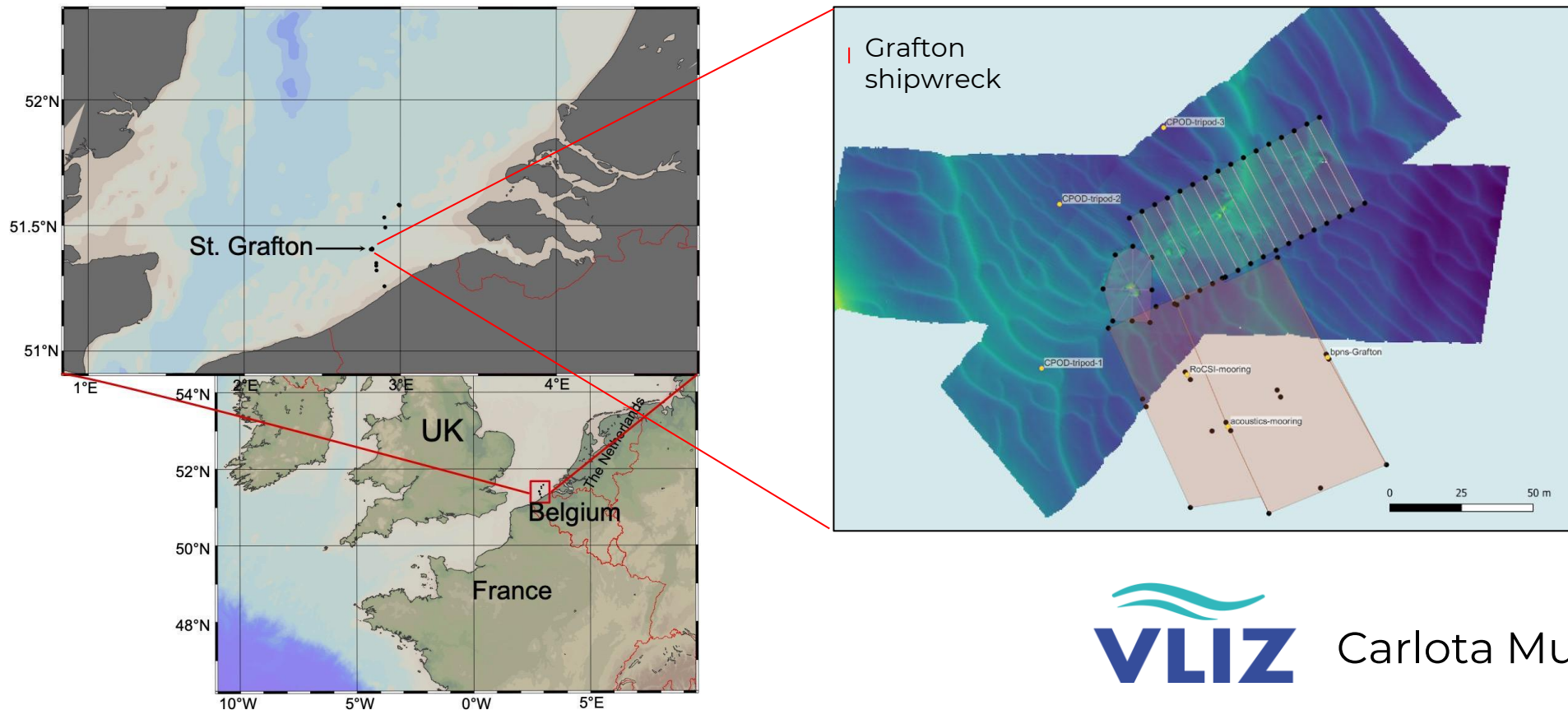
Dashboards

Models



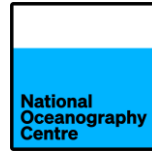
Multi-sensor biodiversity observations

Fieldwork operations: May 2025, Belgian part of the North Sea



Acoustics-Imaging-eDNA technologies

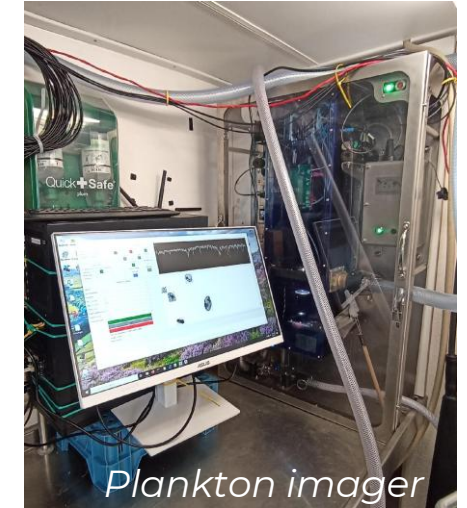
- Integration into RV Simon Stevin
 - eDNA sampler (RoCSI)
 - Plankton imager – mesozooplankton
- 2 x Moorings
 - Cetacean loggers (F-POD) – harbour porpoises
 - Echosounders - fish
 - Hydrophones – underwater sound
 - eDNA sampler (RoCSI)
- Remotely Operated Vehicle (ROV) with multi-camera system



Technical University of Denmark



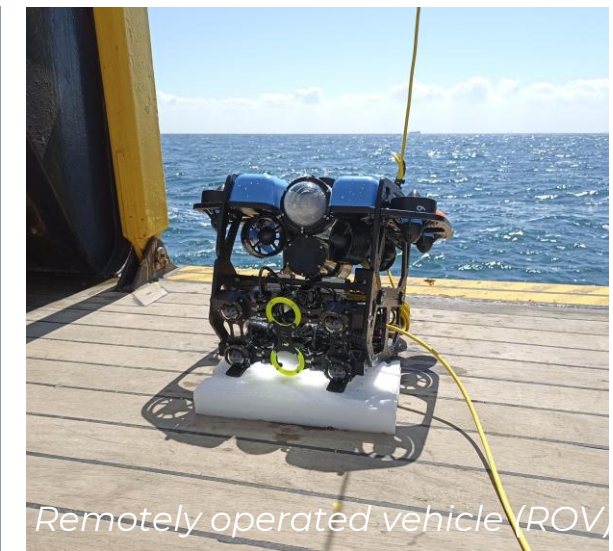
RoCSI sampler



Plankton imager



Deployment of mooring with RoCSI sampler and cetacean loggers

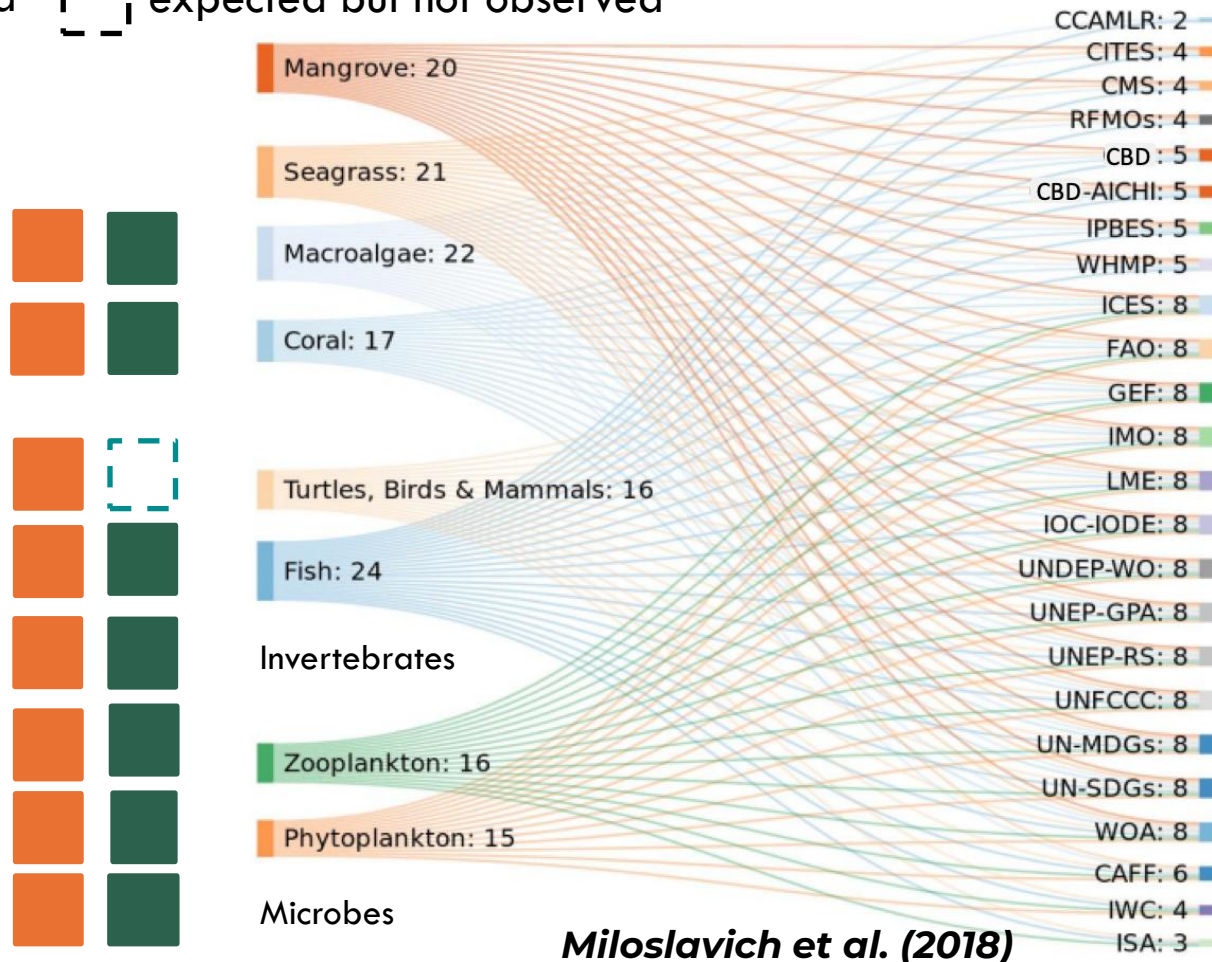


Remotely operated vehicle (ROV)

EOVs and policy relevance

KNOWN and MAPPED BY eDNA in the North Sea

achieved
 expected but not observed



Miloslavich et al. (2018)



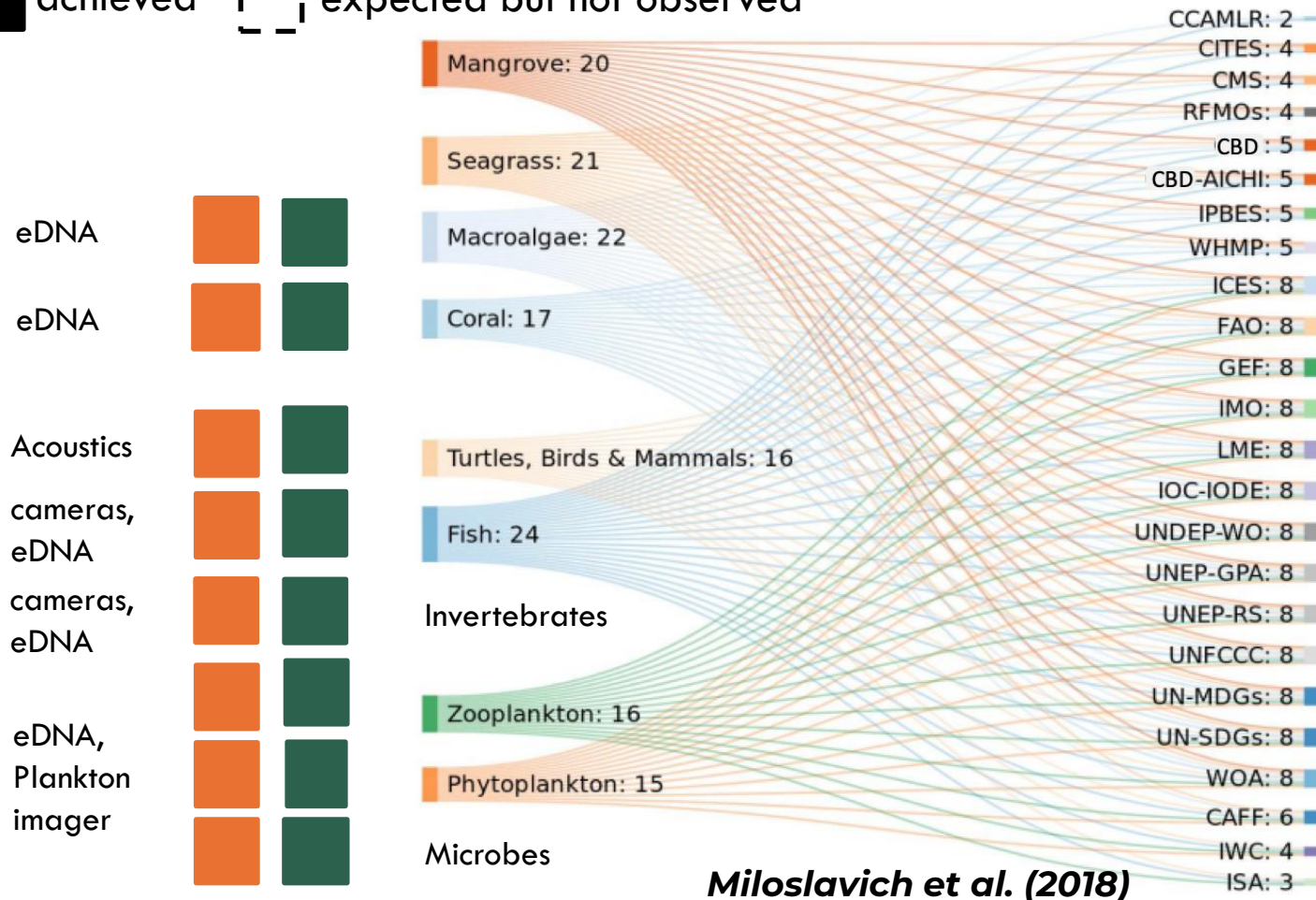
*Also identified as Essential Climate Variables (ECVs)

Pilot EOVs

EOVs and policy relevance

KNOWN and MAPPED BY SENSORS in the North Sea

achieved
 expected but not observed



Miloslavich et al. (2018)



*Also identified as Essential Climate Variables (ECVs)

Pilot EOVs

More than species detection Abundance, biovolume, behaviour

3-D image
reconstruction of the
Grafton shipwreck

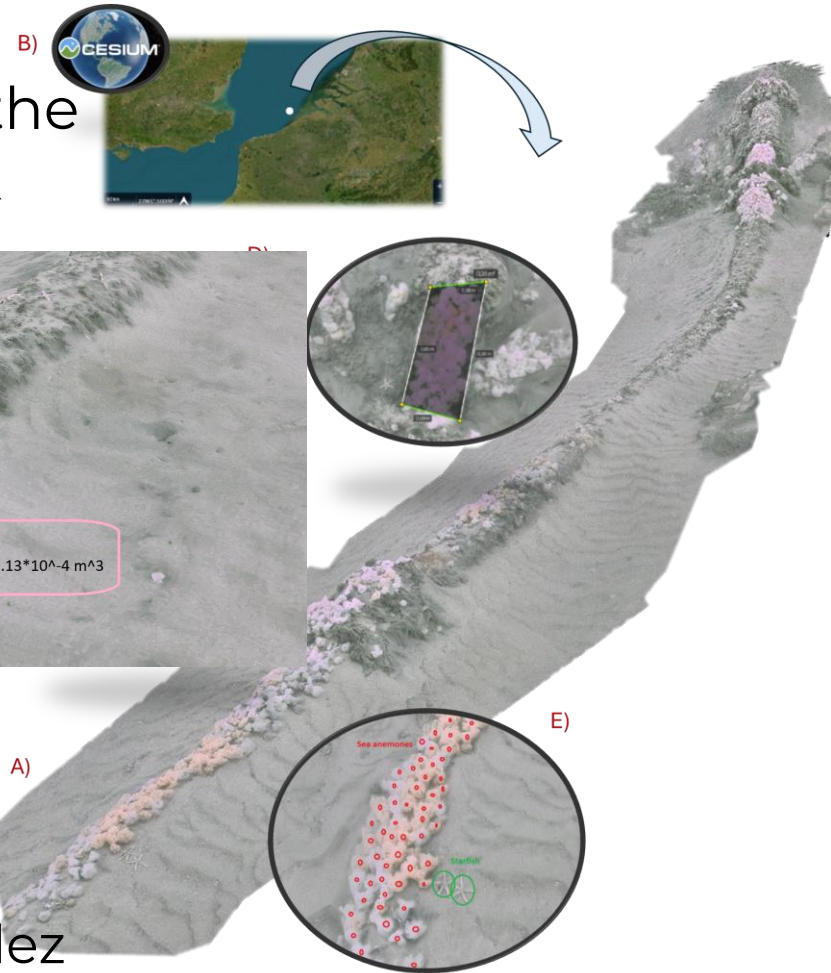
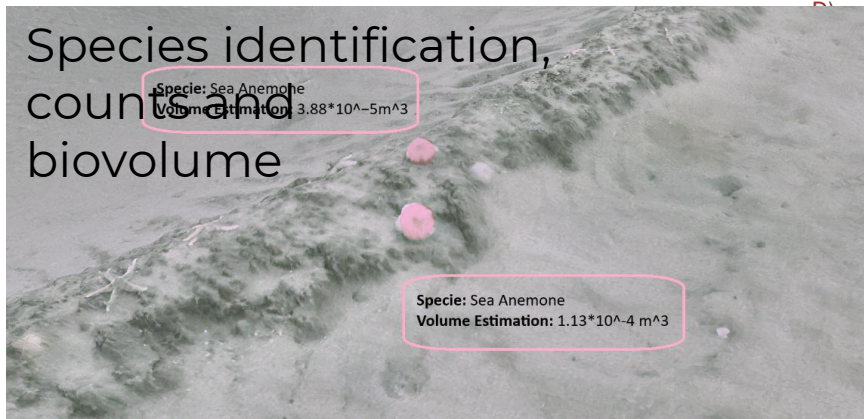


Figure 4. A) 3D model of the Grafton Shipwreck, Oostende, Belgium; generated with the proposed workflow. B) Georeferenced 3D model in Cesium. C) Vertical profile assessment of sea anemones in the 3D model. D) Sea anemones distribution calculations in the 3D model. E) Starfish and sea anemones detection in the 3D model.

Acoustics (F-POD) data:
Harbour porpoise activity
over time



Most active in early June

Arienne Calonge,
Elisabeth Desbusschere

Javier Alonso Fernandez
Fletcher Thompson
Patrizio Mariani

A GLOBAL eDNA OBSERVATORY

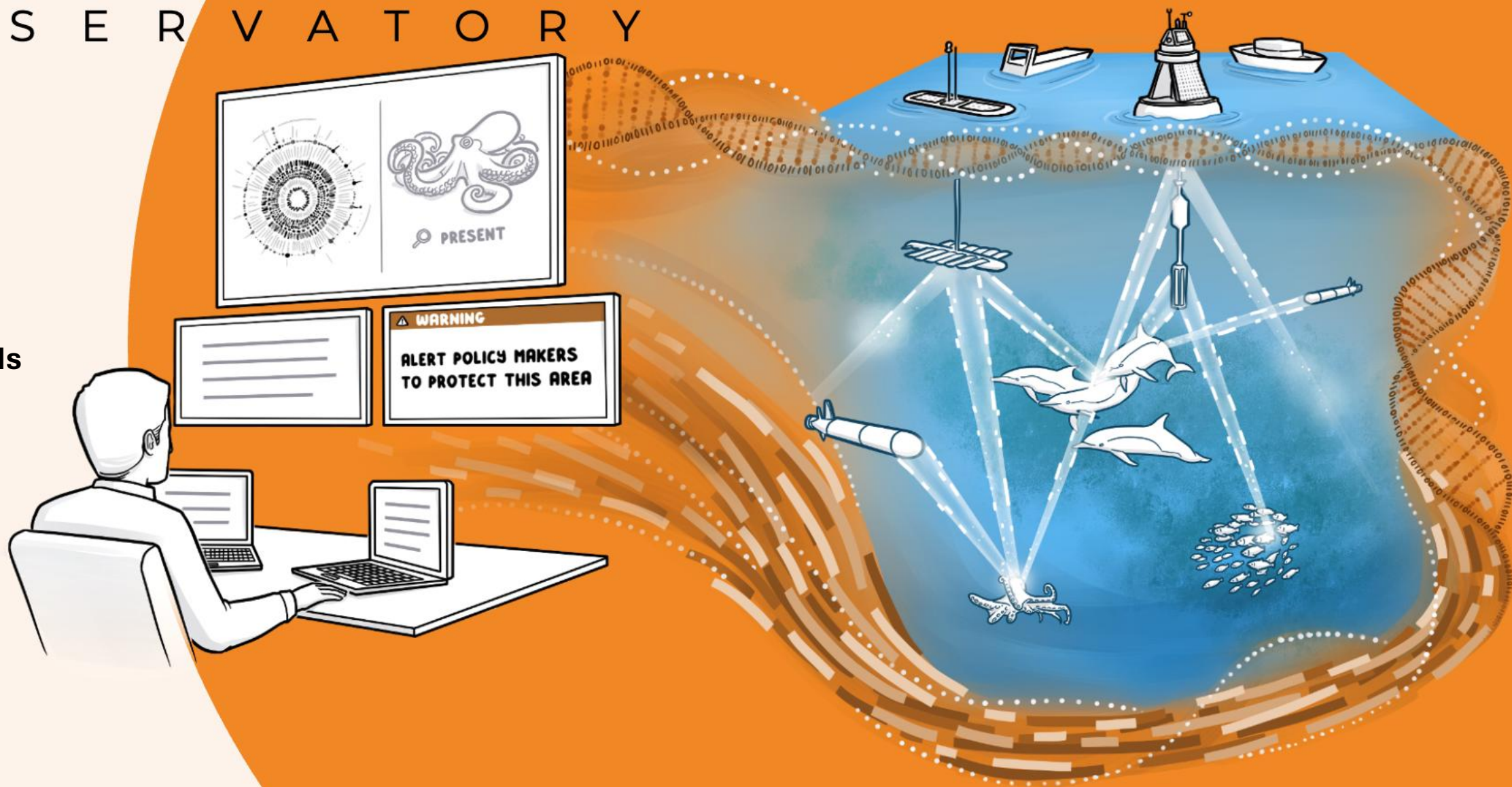
Samplers

Sensors

Policy

Dashboards

Models



MINDEROO – AUSTRALIAN MARINE PARKS DASHBOARD

Explore biodiversity across Australia's
national Marine Parks through the lens of
environmental DNA

Start exploring



Explore by area



Explore by species



Chat with the data



Explore the unknown

Ask me anything

126/200

Can you tell me all of the IUCN-listed shark species in this dataset, their conservation status, and where they were detected?

 [Show me an example](#)



Submit

Response

Question: Can you tell me all of the IUCN-listed shark species in this dataset, their conservation status, and where they were detected?

Answer:

IUCN-Listed Shark Species in Australian Marine Parks

The dataset contains **67 IUCN-listed shark and ray species** (Class Chondrichthyes) across all conservation categories. Here's a summary by threat level:

Critically Endangered (CR) - 6 species:

- *Sphyrna lewini* (Scalloped Hammerhead) - 113 detections across Indian Ocean Territories, South-west, and Temperate East
- *Mobula tarapacana* (Chilean Devil Ray) - 84 detections across multiple networks
- *Carcharias taurus* (Sand Tiger Shark) - 27 detections in South-west
- *Sphyrna mokarran* (Great Hammerhead) - 4 detections in South-west
- *Pseudobatos horkelii* (Brazilian Guitarfish) - 1 detection in South-west
- *Mobula thurstoni* (Bentfin Devil Ray) - 5 detections in Indian Ocean Territories

Endangered (EN) - 13 species:

Including *Rhincodon typus* (Whale Shark) with 113 detections, *Carcharhinus amblyrhynchos* (Grey Reef Shark) with 261 detections, and *Aetobatus narinari* (Spotted Eagle Ray) with 171 detections.

Vulnerable (VU) - 17 species:

Including *Triaenodon obesus* (Whitetip Reef Shark) with 364 detections and



Australian Government
Parks Australia

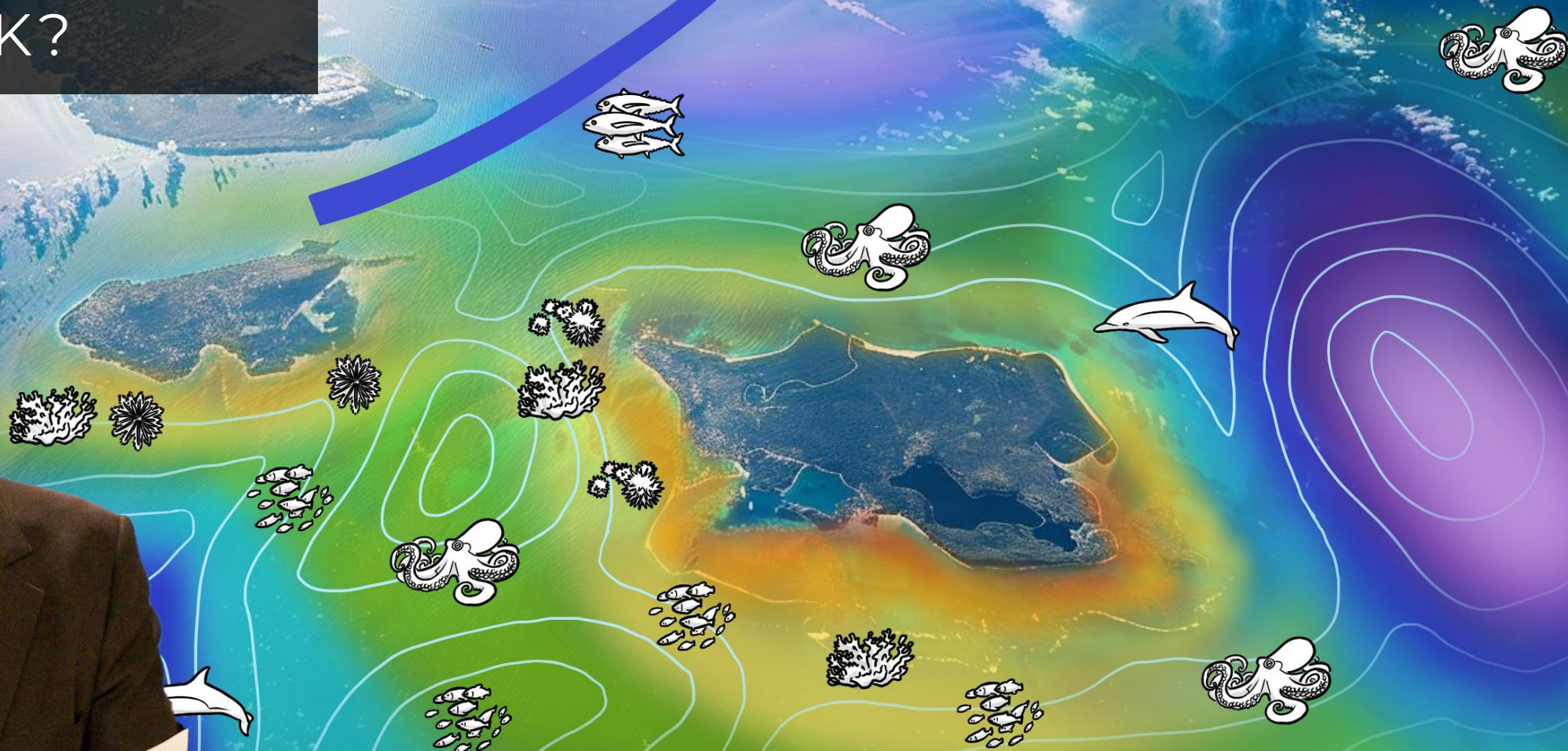
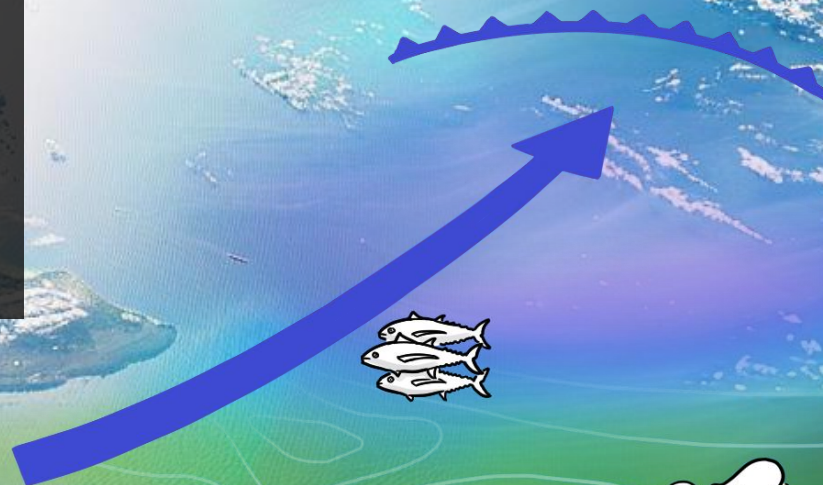


MINDEROO – AUSTRALIAN MARINE PARKS DASHBOARD

Start exploring



WHAT NEW
POSSIBILITIES
COULD THIS
UNLOCK?



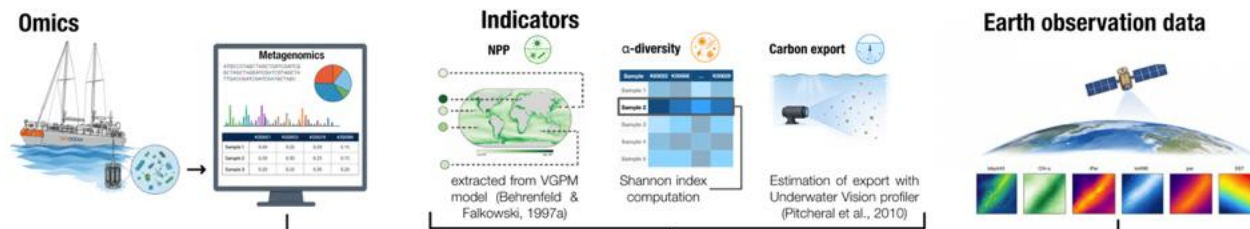
Machine Learning for mixing omics data and satellite products

Damien Eveillard



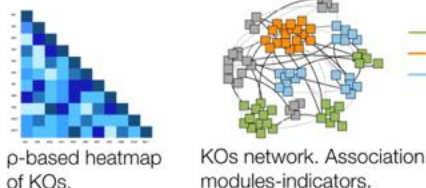
Prediction of

1. Data collection

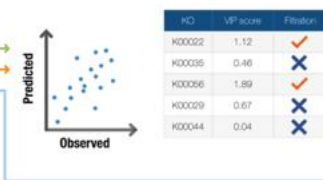


2. KOs filtration

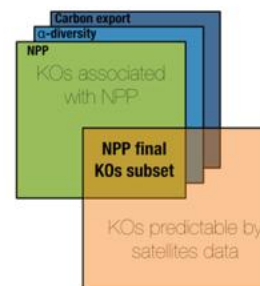
A. Weighted Gene Correlation Network Analysis using ρ proportionality metric. The KOs included in modules correlated with indicators are selected. One subset of KOs per indicator.



B. Partial Least Square KOs with a VIP score > 1 are selected.

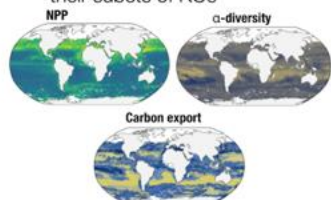


C. KOs filtration based on satellite data Estimation of KOs predictability using machine learning XGBoost multi-outputs

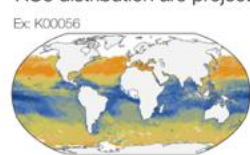


3. Predictions and projections

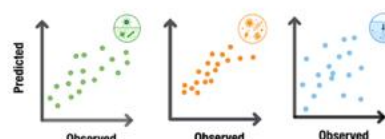
C. Indicators projections indicators are projected based on their subsets of KOs



B. KOs projections KOs distribution are projected



A. Estimating KO subsets for indicator prediction using machine learning XGBoost



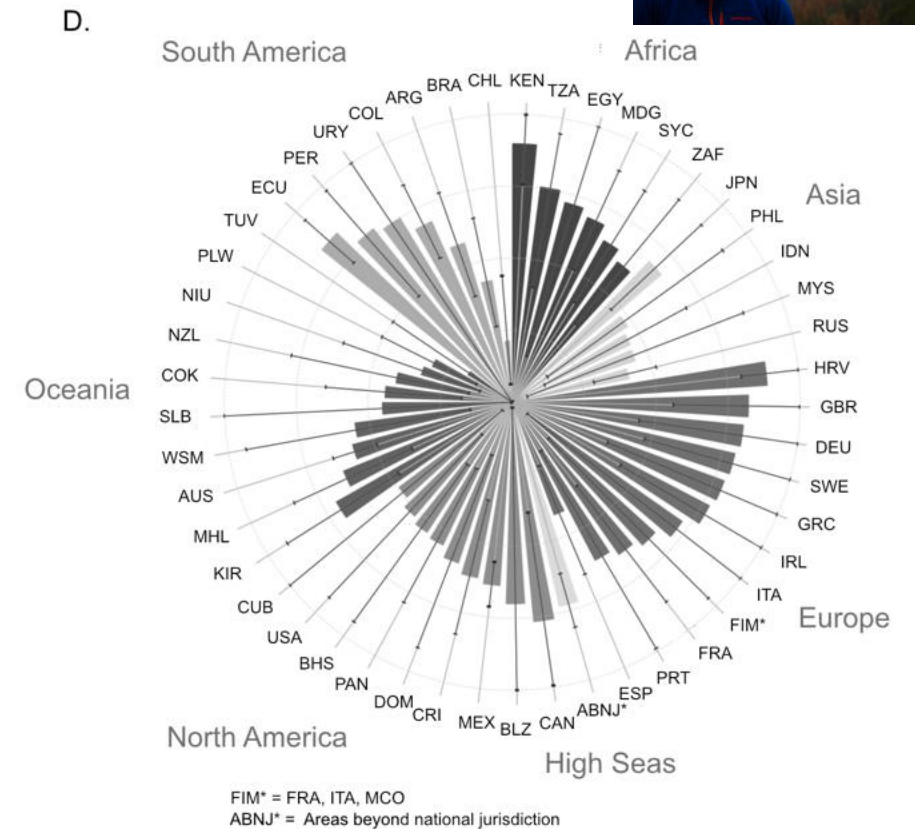
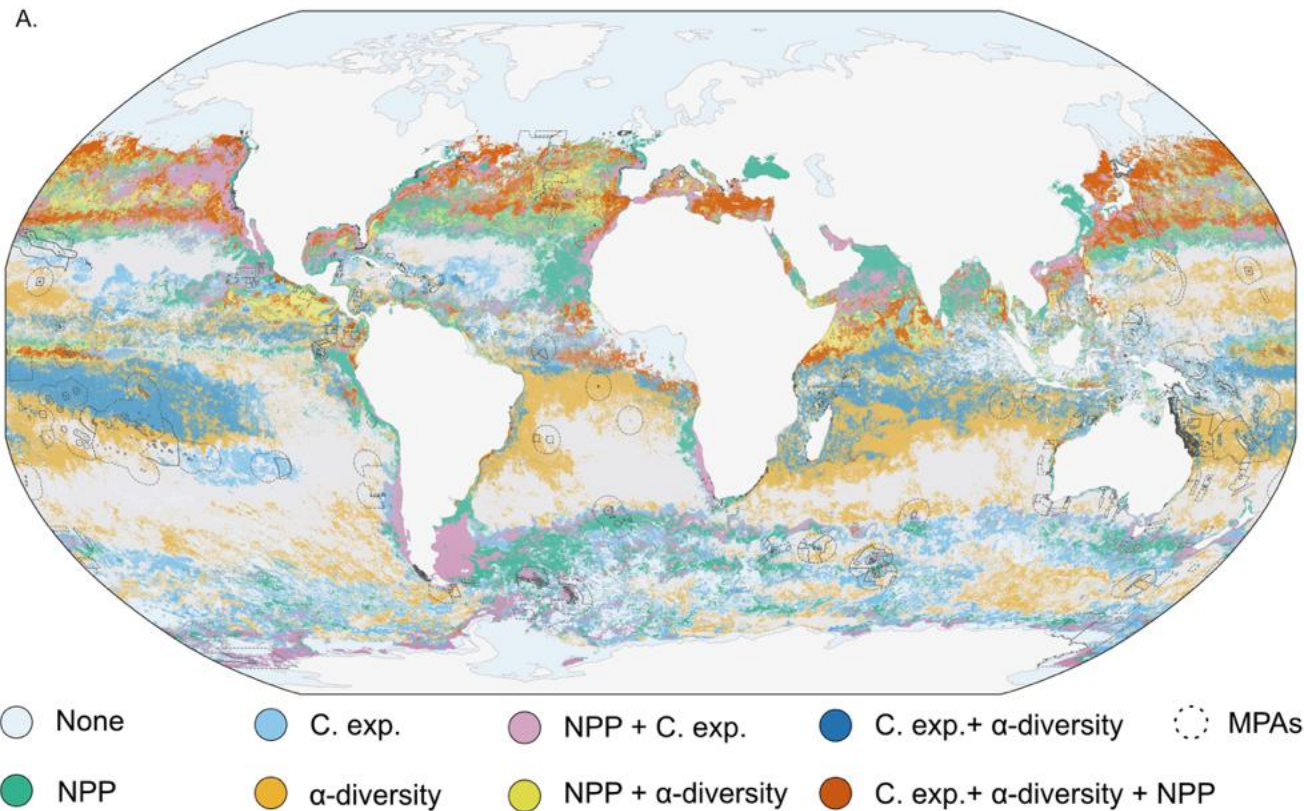
- Predicting the set of genes associated with NPP, Carbon export (at 150m), and functional diversity (i.e., diversity of KOs)
- Predicting the expression of these genes via satellite products
- Informing policymakers in near real-time

Sérandour et al. submitted

Design of Key Ocean Planktonic Areas

and assessing MPAs accuracy

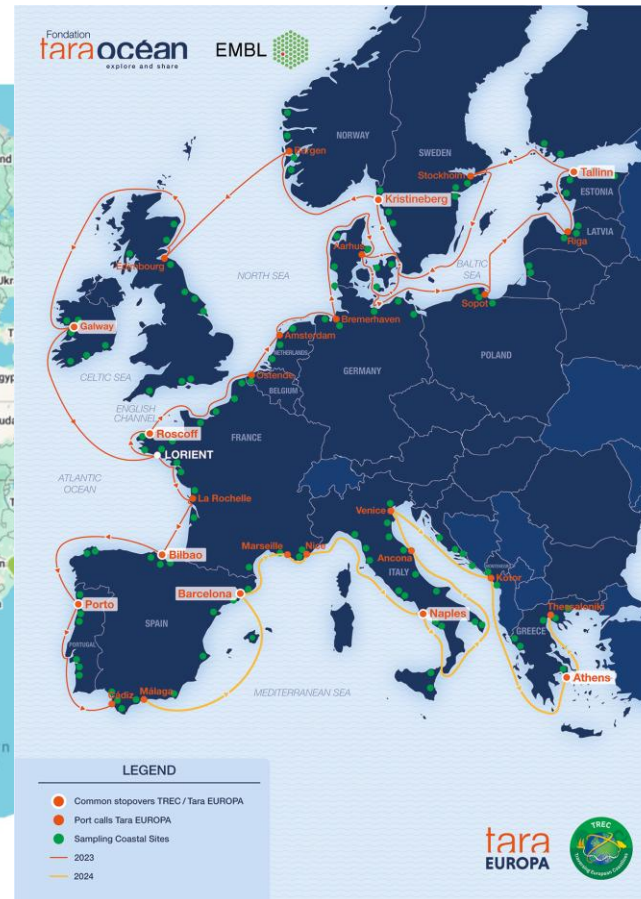
Damien Eveillard



Sérandour et al. submitted

We are the observatory, via (meta)data standards

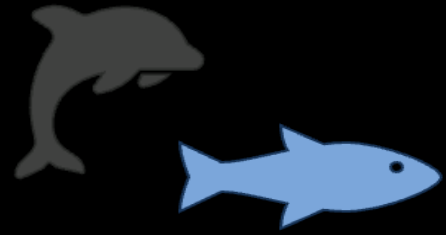
Endorsed projects



Networked observatories, demonstrating the value of biomolecular data together

A ROADMAP FOR IMPLEMENTATION

SAMPLE COLLECTION



LOWER COSTS & DEMONSTRATE VALUE



PASSIVE SAMPLERS

CITIZEN SCIENCE

OXFORD NANOPORE

IN SITU SENSING: HAZARDS

HARMFUL ALGAE

WATER QUALITY

INVASIVE SPP

FISH

→ MULTIPLEXING

ECOSYSTEM SERVICES

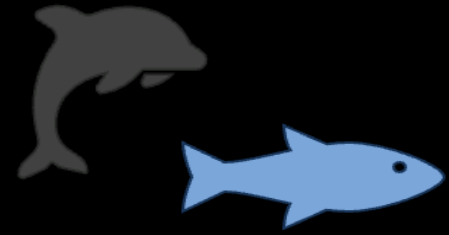
BIODIVERSITY

→ TOWARDS QUANTIFICATION AND TRENDS

SCALE VIA
COMMERCIALISATION

REFERENCE LIBRARIES
→ TAXONOMIC RESOLUTION

A ROADMAP FOR IMPLEMENTATION DATA AND MODELLING



AI IN AUTOMATING BIODISCOVERY,
BIOPROSPECTING, GENOME ANNOTATION

ML IN FINDING BIOPROVINCES,
MERGING HETEROGENEOUS DATA



OBIS & GBIF

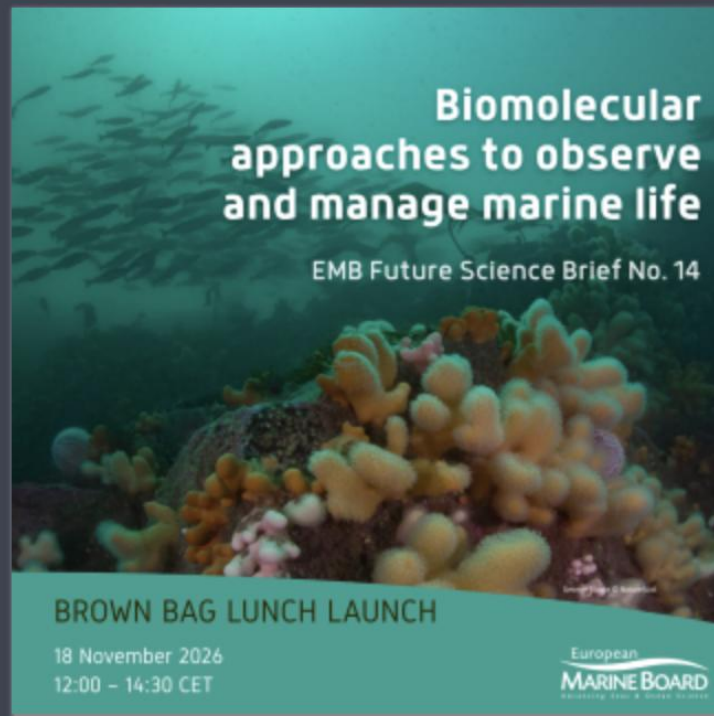
DASHBOARD – SHARED ACROSS MEMBER STATES

GENOME-SCALE METABOLIC MODELS

INTEGRATED INTO EARTH SYSTEM MODELS

OMICS-BASED VALUATION OF ECOSYSTEMS

On Wednesday 18th November 2026, EMB will host a Brown Bag Lunch on the topic of biomolecular approaches to observe and manage marine life.



This will be the launch event for the European Marine Board's Future Science Brief No. 14 on 'Biomolecular approaches for the observation and management of marine life'. The event will highlight key scientific and policy recommendations for technological developments and for scaling-up deployment of biomolecular approaches in a marine policy context. The Future Science Brief is being written by the [EMB Working Group on Biomolecular Approaches](#), consisting of 13 experts from 11 European countries. The Chair of the Working Group, Prof. Louise Allcock (Ryan Institute, University of Galway, Ireland), will present the key messages from the document, with a specific focus the state-of-the-art for biomolecular approaches, as well as their numerous policy-relevant applications. The event will end with an interactive discussion between the audience, the Chair of the Working Group and additional Working Group members.

Programme:

This Brown Bag Lunch is an in-person event, with the possibility to join the presentations remotely.

📍 Rue du Champ de Mars 21, 1050 Brussel

📅 Wednesday 18 November 2026, 12:00 - 14:30 CET



eDNA, When done right: for fish stock assessments

Received: 9 July 2020 | Revised: 20 January 2021 | Accepted: 22 January 2021

DOI: 10.1002/edn3.185

SPECIAL ISSUE ARTICLE

Environmental DNA
Dedicated to the study and use of environmental DNA for basic and applied research

WILEY

Environmental DNA (eDNA) as a tool for assessing fish biomass: A review of approaches and future considerations for resource surveys

Meaghan L. Rourke^{1,2}  | Ashley M. Fowler³  | Julian M. Hughes³  |
Matt K. Broadhurst^{4,5}  | Joseph D. DiBattista^{6,7}  | Stewart Fielder⁸  |
Jackson Wilkes Walburn¹ | Elise M Furlan⁹ 

“We reviewed 63 studies published between 2012 and 2020 and found 90% identified positive relationships between eDNA concentrations and the abundance and/or biomass of focal species.”



Contents lists available at [ScienceDirect](#)

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Environmental DNA provides quantitative estimates of a threatened salmon species

Andrew Olaf Shelton^{a,*}, Ryan P. Kelly^b, James L. O'Donnell^{b,c}, Linda Park^a, Piper Schwenke^a, Correigh Greene^d, Richard A. Henderson^e, Eric M. Reamer^e

^a Conservation Biology Division

ARTICLE

<https://doi.org/10.1038/s42003-019-0696-8>

OPEN

Environmental DNA concentrations are correlated with regional biomass of Atlantic cod in oceanic waters

Ian Salter^a ^{1*}, Mourits Joensen¹, Regin Kristiansen¹, Petur Steingrund¹ & Poul Vestergaard¹

RESEARCH ARTICLE

Aquatic environmental DNA detects seasonal fish abundance and habitat preference in an urban estuary

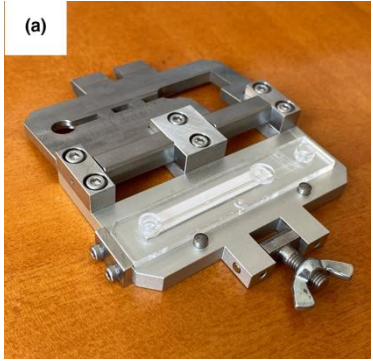
Mark Y. Stoeckle^{1*}, Lyubov Soboleva¹, Zachary Charlop-Powers²

¹ Program for the Human Environment, The Rockefeller University, New York, New York, United States of America, ² Laboratory of Genetically Encoded Small Molecules, The Rockefeller University, New York, New York, United States of America

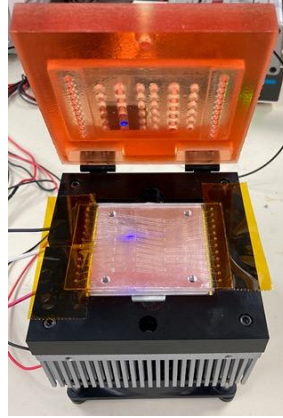
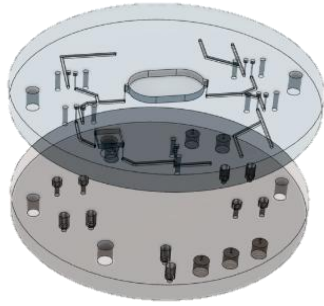
* mark.stoeckle@rockefeller.edu

....

Analytical instrumentation



Biryu Extraction Chip – GoFoton! Japan
LampTron – LAMP - NOC



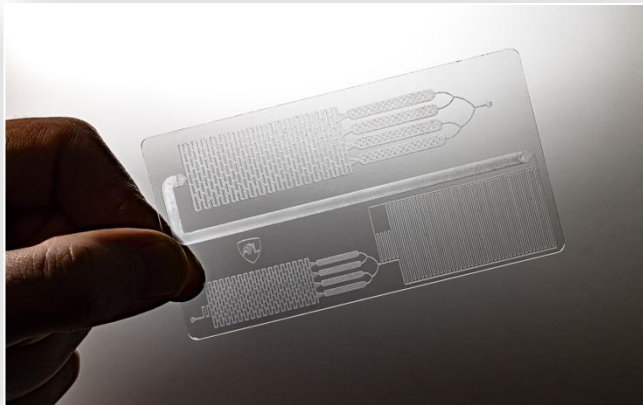
eDNA Analyzer – qPCR
-JAMSTEC



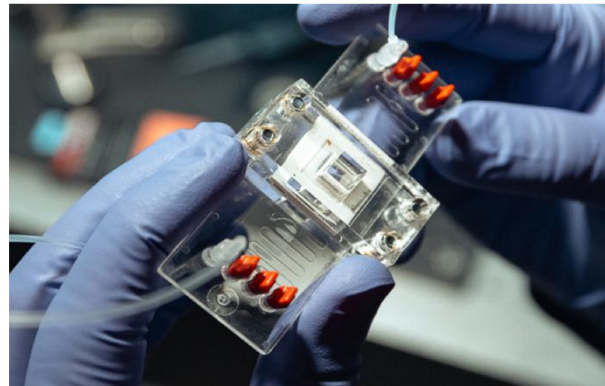
Surface Plasmon
Resonance –
Toxins - MBARI



NS2
ddPCR



Nanopore Library Prep & Minlon –
DNA Sequencing – JHU-APL



Silicon Nanophotonics - Stanford



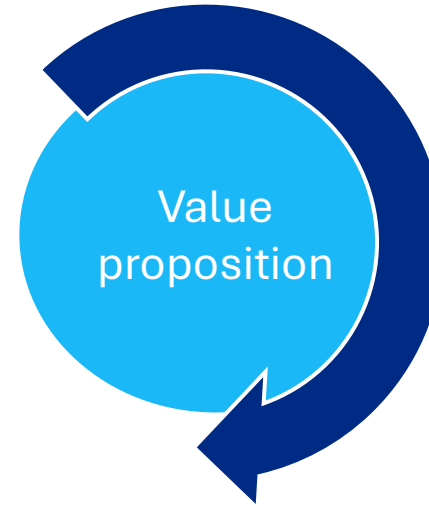
qPCR Module
Dartmouth Ocean Tech

Roadmap for marine omics AND technologies



Networked observatories demonstrating the value of eDNA together

Endorsed projects



Build trust in eDNA:

Use appropriate protocols

Participate in ring testing / interoperability work

Don't oversell and underdeliver

