Monitoring our oceans - Needs and Solutions

Thomas Klein

The Swedish Agency for Marine and Water Management, SwAM

Funded by the European Union under Grant Agreement ID 101093845. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Environmental monitoring needs and opportunities for a sustainable blue economy

Swedish Agency
for Marine and
Water Management

Thomas Klein, Department of Environmental Analysis

Protect, restore and ensure sustainable use of freshwater resources and seas including fisheries management

Swedish Agency for Marine and Water Management

- **Political goals, policies and processes**
  - Swedish Environmental Objectives
  - EU policies, directives and regulations
  - Regional and international conventions
  - Agenda 2030 Sustainable Development Goals

Data and information needs are increasing – Need for a strategic approach to aquatic monitoring

Swedish Agency for Marine and Water Management

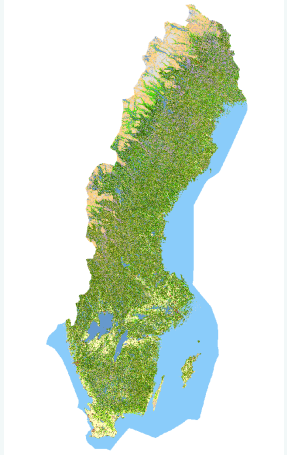
Identify and prioritize information needs

Mapping of stakeholders and responsibility

Coordinated, adaptive and risk-based monitoring

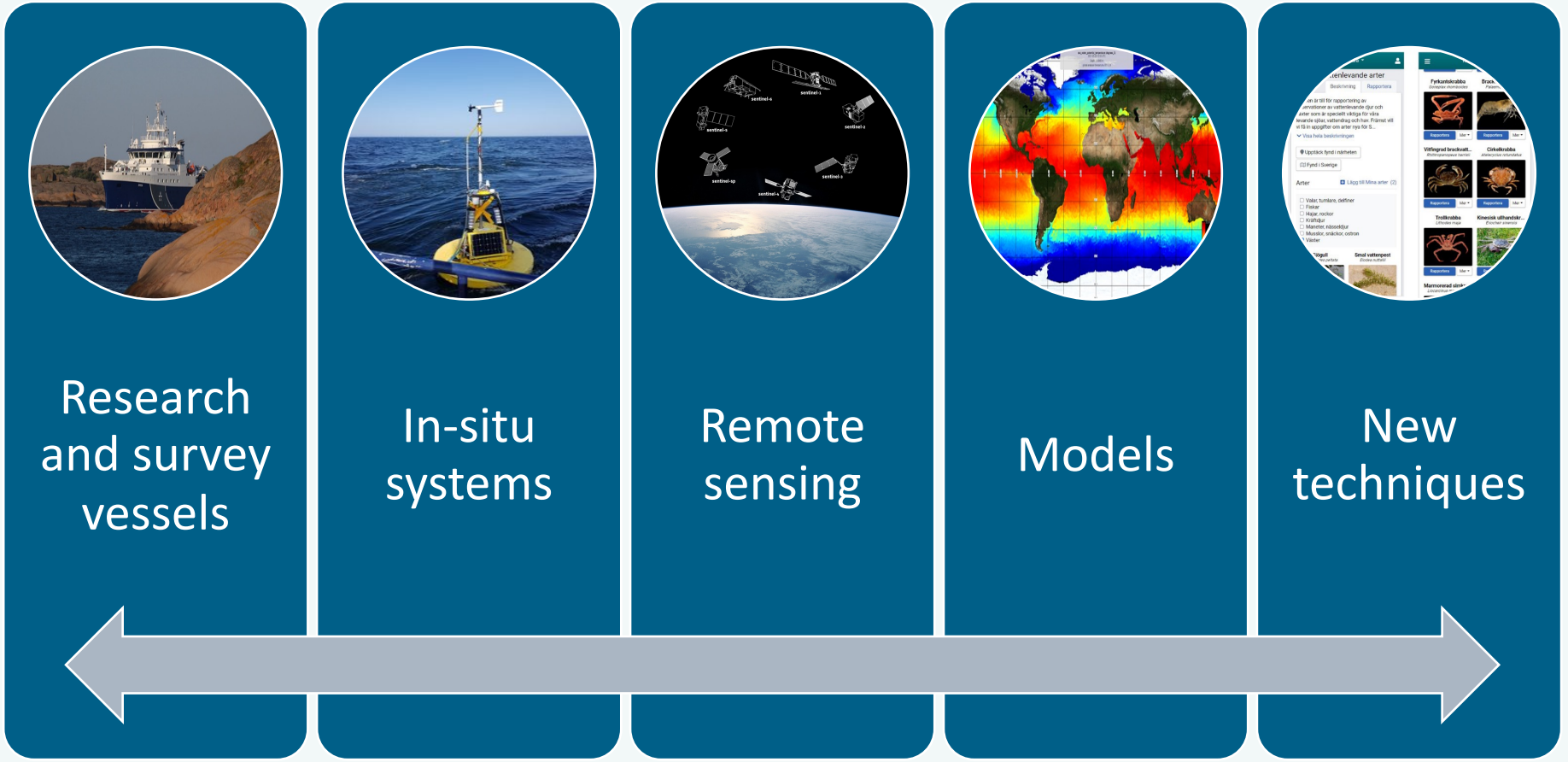
Innovative methods and cost-efficiency

Collect, manage and share information



Need to improve the joint use of environmental monitoring capabilities

Swedish Agency for Marine and Water Management



MEMFIS 2023 conference

FORMAS

Swedish Agency for Marine and Water Management

- MEMFIS = **M**arine **E**nvironmental **M**onitoring for **F**uture **I**nnovation and **S**ustainability
- 130+ experts from 10 countries convened in Stockholm, 9-10 November 2023
- A contribution to the UN Decade of Ocean Science
- Focus on Baltic Sea and North Sea
- 40+ action pledges aimed at increased cooperation

What we need to do

Contribute to digital twins of the environment

Educate society

Combine member states' off-shore monitoring programmes

Exchange of experience

Standardize methods

Develop autonomous methods

Encourage science – policy collaboration

Define the narrative and objectives

Encourage citizen participation

Share our expertise

Communicate new knowledge

Manage end-of-life for monitoring-equipments

Achieve collaboration at a policy level

Cooperate over national boundaries

Cease managing in silos

Co-design observing systems

Facilitate networking

Develop new low-cost technologies

Engage citizen science appropriately

Make data more available

Real-time forecasting

Create a "barter market" för R/Vs

Apply a holistic approach

Make new and historical data compatible

Provide infrastructure for sharing data

Develop ambidextrous organizations

Combine monitoring platforms efficiently and effectively

Key insights from MEMFIS 2023

FORMAS

Havs och Vatten myndigheten

- Together, we have the knowledge and infrastructure to deliver the environmental monitoring we need, for the ocean we want – we need to collaborate even more and balance the use of our assets
- There are inspiring examples of collaboration, coordination and sharing of knowledge, data and infrastructure – we need to learn from and scale up what already works
- There is a will to cooperation and a joint commitment to move forward with concrete actions
- There is a need to boost the adoption of new techniques in marine management
- Delivering the right environmental monitoring requires a clear picture of objectives and priorities

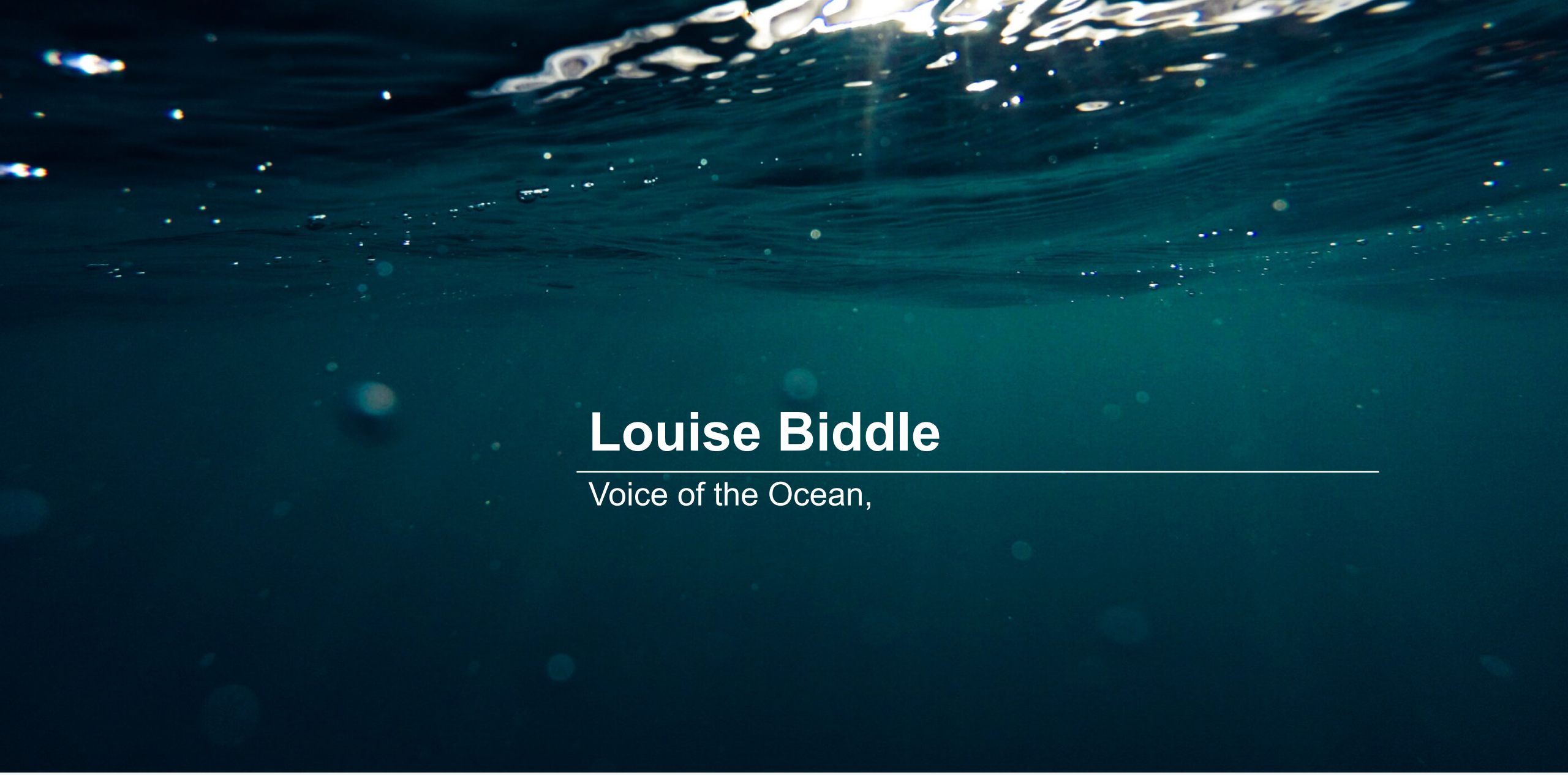
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Our Action pledge

FORMAS

Swedish Agency for Marine and Water Management

- What:
  - Compile and prioritize environmental monitoring requirements (currently +900)
  - Map the requirements with modern toolbox for monitoring
  - Identify and act on:
    - Where new more efficient techniques can be implemented directly
    - Gaps in knowledge, research needs, need for method development, standardization, scale-up (using existing national research programmes)
    - With specific regard to needs arising from the new EU nature restoration law
    - Sharing this in our regional networks and EU to identify common ground
- When:
  - 2024
- Who:
  - SWAM and Formas



Louise Biddle

Voice of the Ocean,

Data & knowledge collection for a shared ocean

Louise Biddle, Director (Ocean Knowledge), Voice of the Ocean

Mission Arena by Blue Mission BANOS

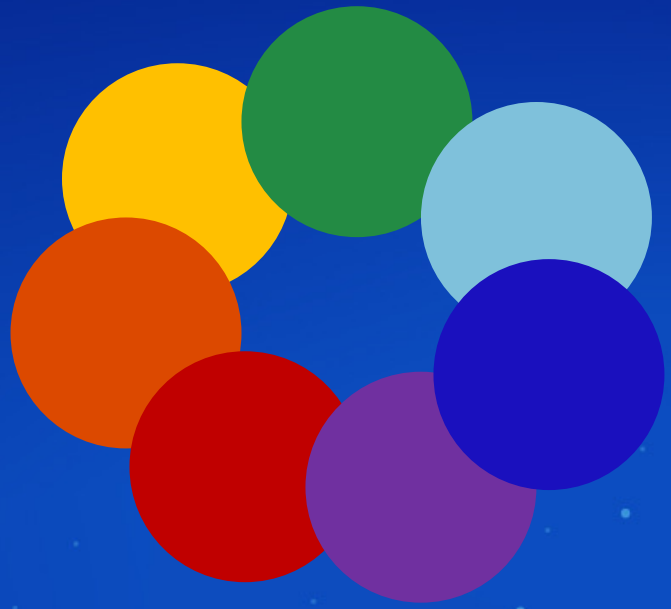
Monitoring our oceans; needs and solutions

Data Collection

Monitoring cruises
Research/universities
Industry
NGO
Citizen Science

How do we transfer knowledge?

End Users



Scientists & researchers
Blue Economy
Governments/policymakers
Next generation

Data Collection

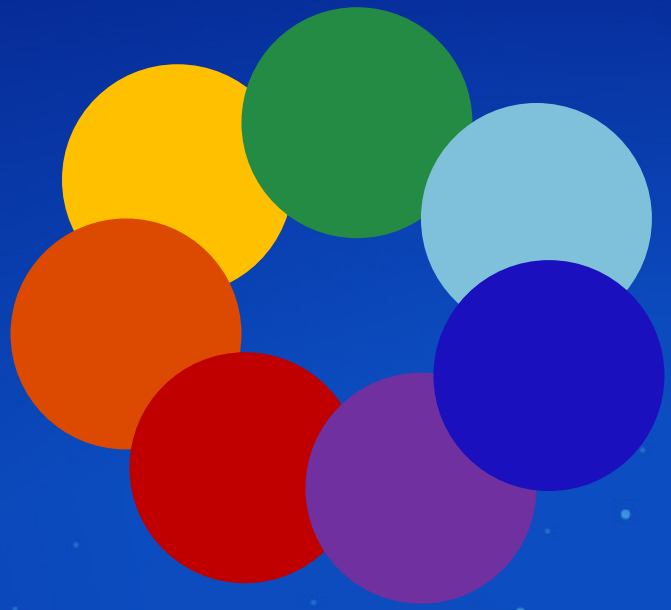
Make ”old” data more accessible

Embrace new technologies

How do we transfer knowledge?

F.A.I.R. data principles

End Users



Describe the why/what

Engage with data collectors

Voice of the Ocean Foundation

Making the oceans accessible to everyone

Ocean Knowledge

SCIENCE

Humans & the Sea

CULTURE

Education

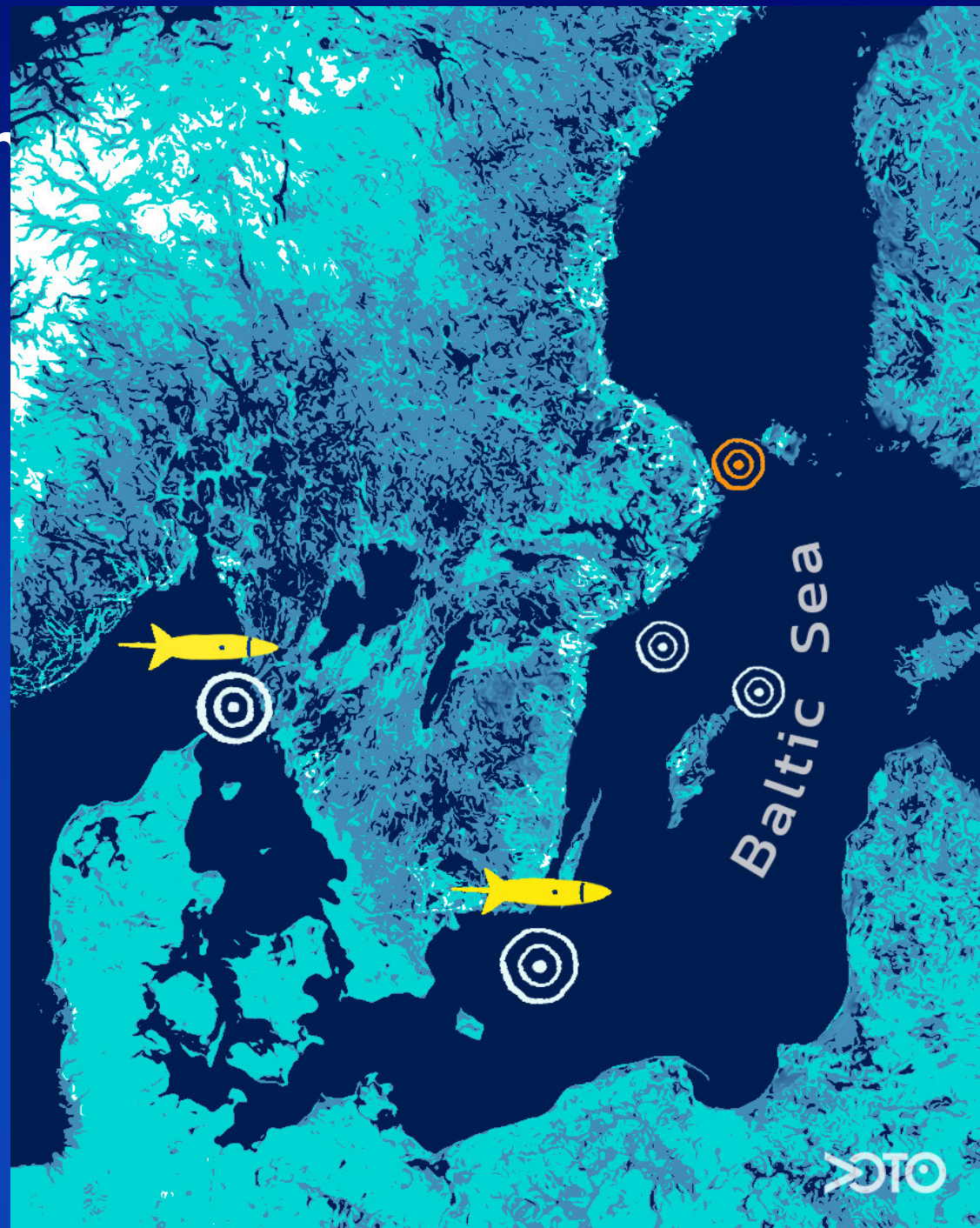
ENGAGEMENT

Voice of the Ocean Foundation

Persistence, Resolution, Accessibility

Ocean Knowledge acts as a hub

1. We run ocean observatories
2. We provide research infrastructure
3. We work with the wider scientific community (knowledge exchange)
4. We interact and work closely with sensor & platform developers



Our infrastructure

- 13 SeaExplorer gliders
- 4 Sailbuoys
- 1 mini AUV (Seaber YUCO)
- Bottom-moored ADCP
- 2x equipped vessels (MidOcean)

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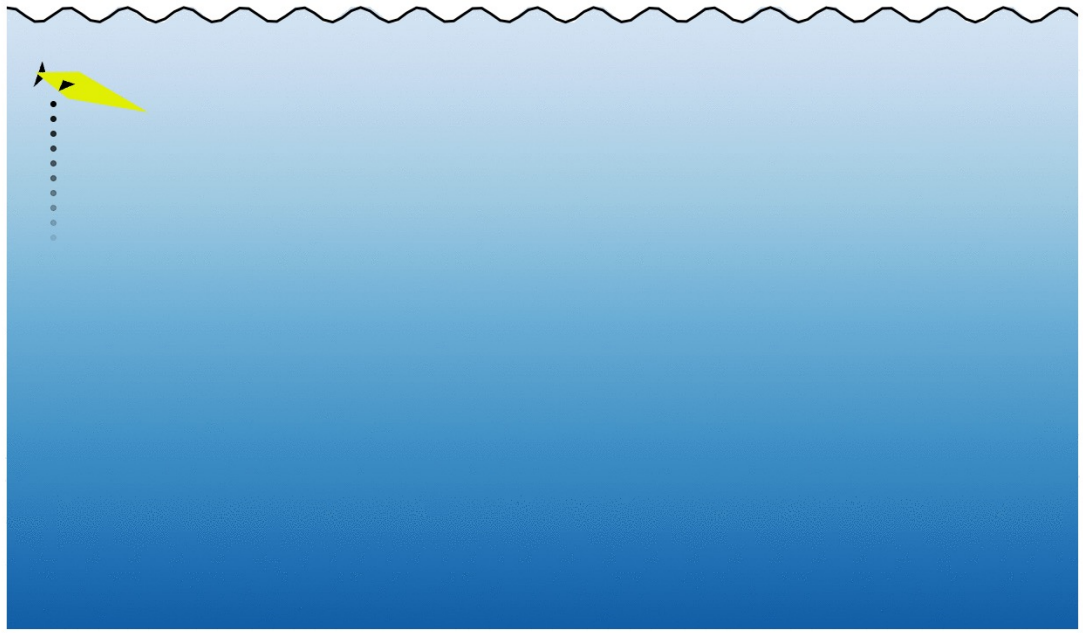
Gliders as observing tools



Standard sensors:

- temperature
- salinity
- dissolved oxygen
- chl-a / phycocyanin /CDOM
- ADCP (ocean currents)

"Special sensors”:

- Lab on a Chip – nitrate
- TriOS (chl-a, phycocyanin, CDOM)

Gliders as observing tools

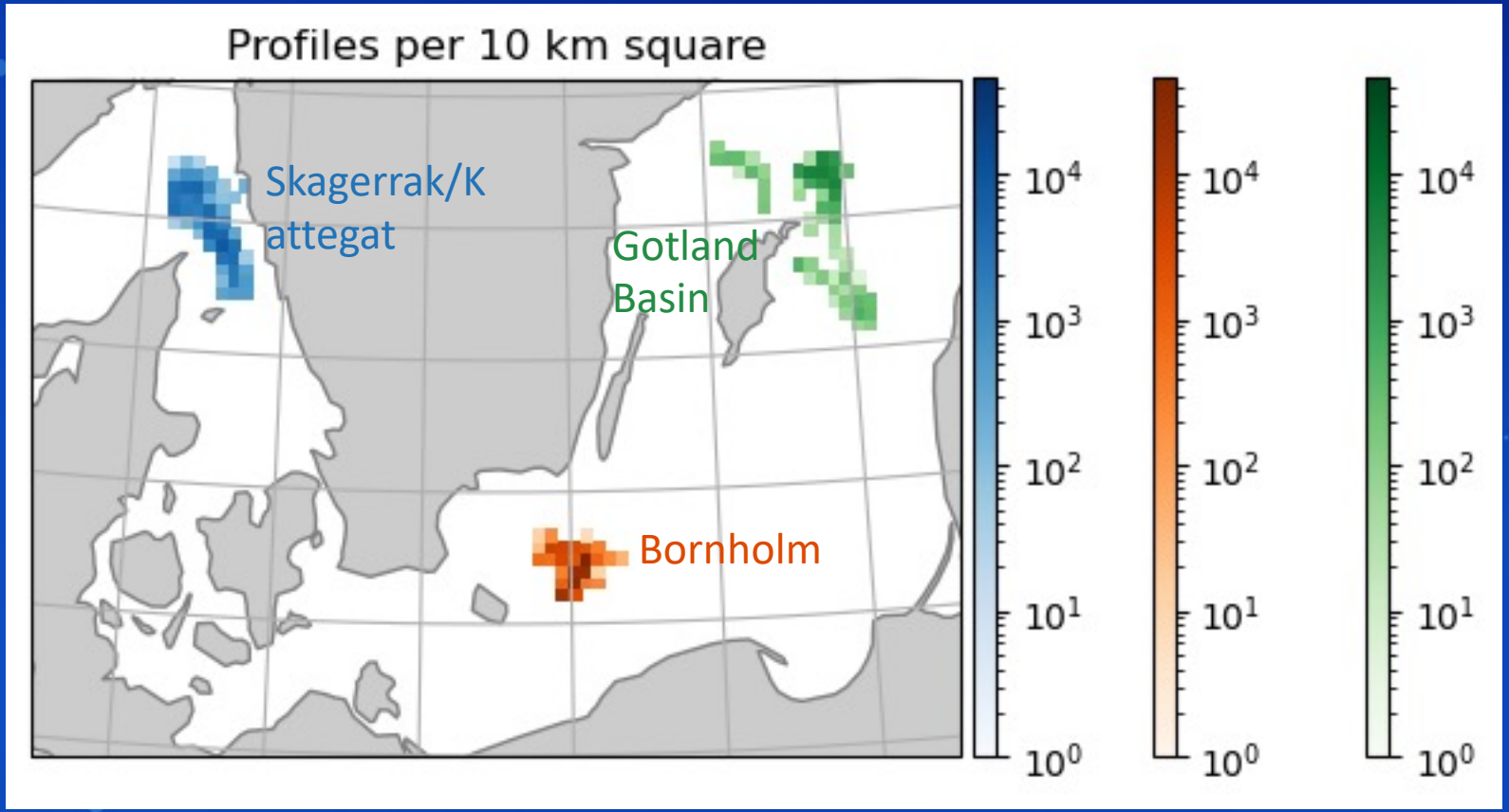
Limitations:

- Need >40 m water depth for effective forward motion
- Battery usage
- **EEZ permits and access**

Future development:

- New sensors (acoustics, pH, microstructure …)
- Endurance
- Shallow gliders

Ocean observatories



September 2022 – September 2023

Occupancy:

Skagerrak	85%
Bornholm	99%
Gotland	93%

Total profiles: 118,925

Deployments/recoveries: 75

Since March 2021…

Total profiles: 301,378

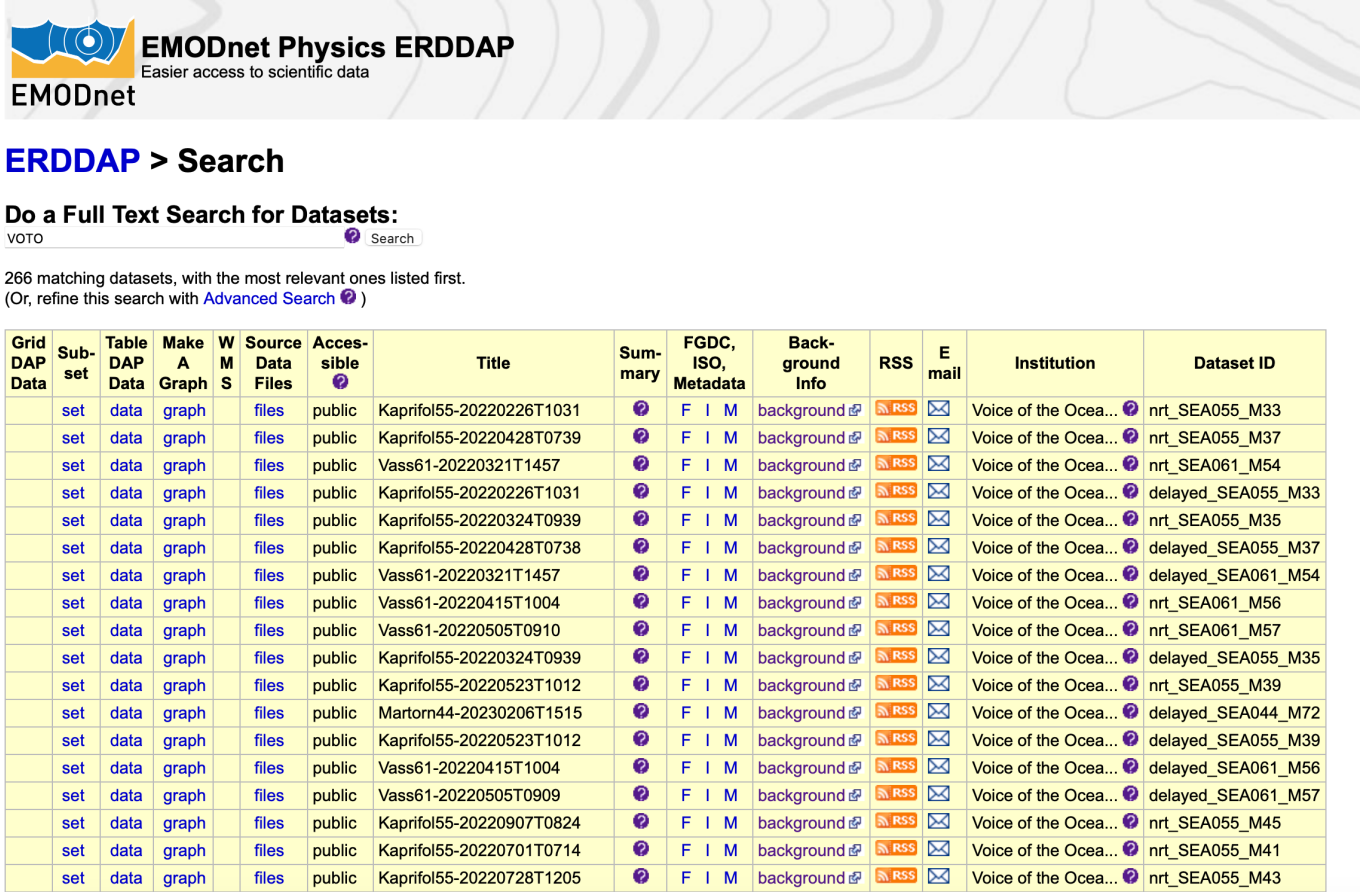
Total data points: 789,541,650

Share the data...

Glider comes to the surface

Glider talks with satellite

Data comes to our server



Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	WMS	Source Data Files	Acces-sible	Title	Sum-mary	FGDC, ISO, Metadata	Back-ground Info	RSS	E mail	Institution	Dataset ID
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	set	data	graph		files	public	Kaprifol55-20220428T0739		F I M	background	RSS		Voice of the Ocea...	nrt_SEA055_M37
	set	data	graph		files	public	Vass61-20220321T1457		F I M	background	RSS		Voice of the Ocea...	nrt_SEA061_M54
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Data freely available

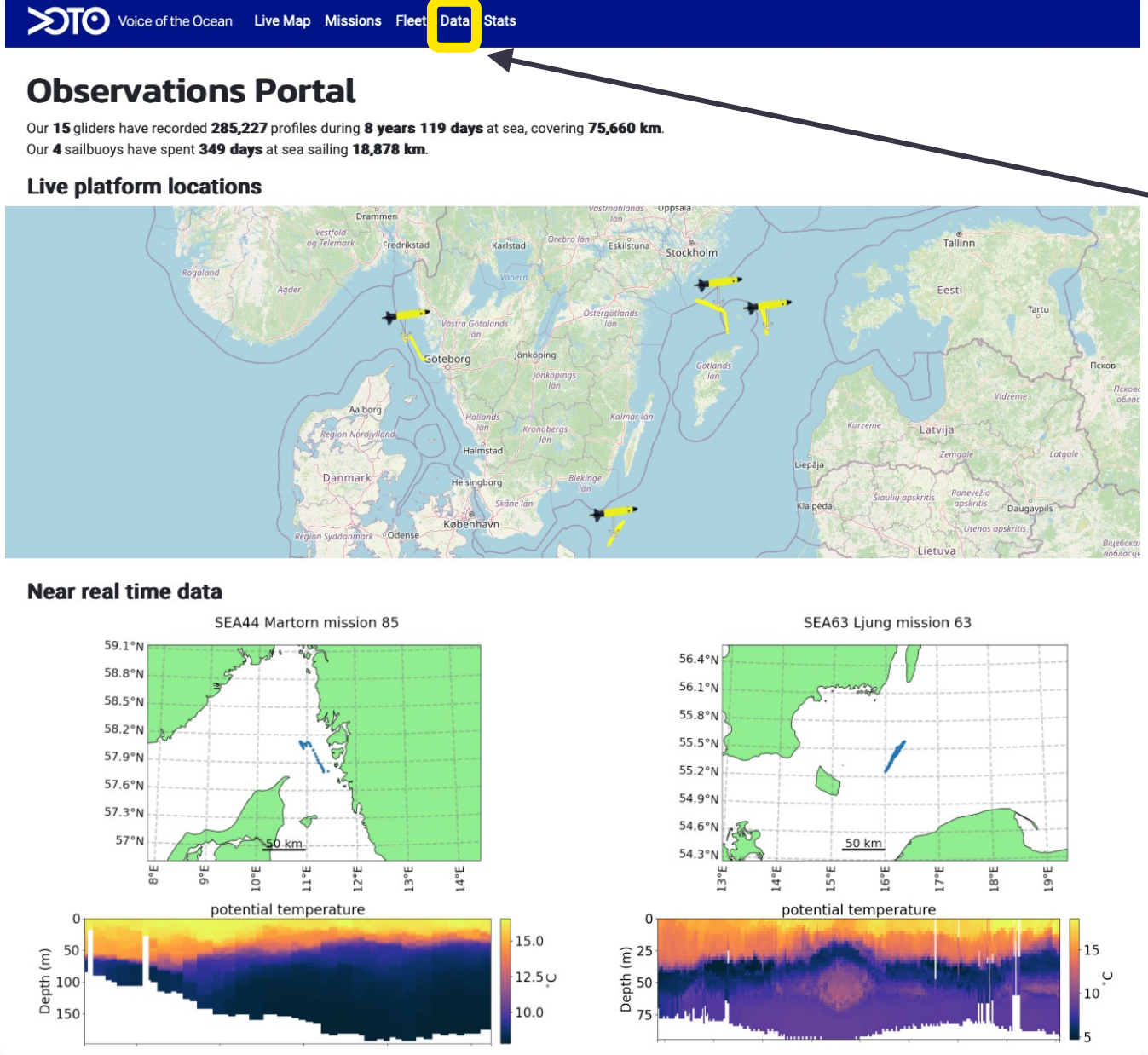
ERDDAP distribution, download in a format you are familiar with

Data is pushed to EMODnet

Scripts for download/processing available on Github

Quick, organised, **interchangeable**

But not a very user friendly interface...



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Data & Knowledge transfer

1. **FAIR data principles; work on how we find and access the data**

2. **Make the data usable – how we collect data may not translate to how the end user wants to use it**

louise.biddle@voiceoftheocean.org

VOTO's actions for the Blue Mission...

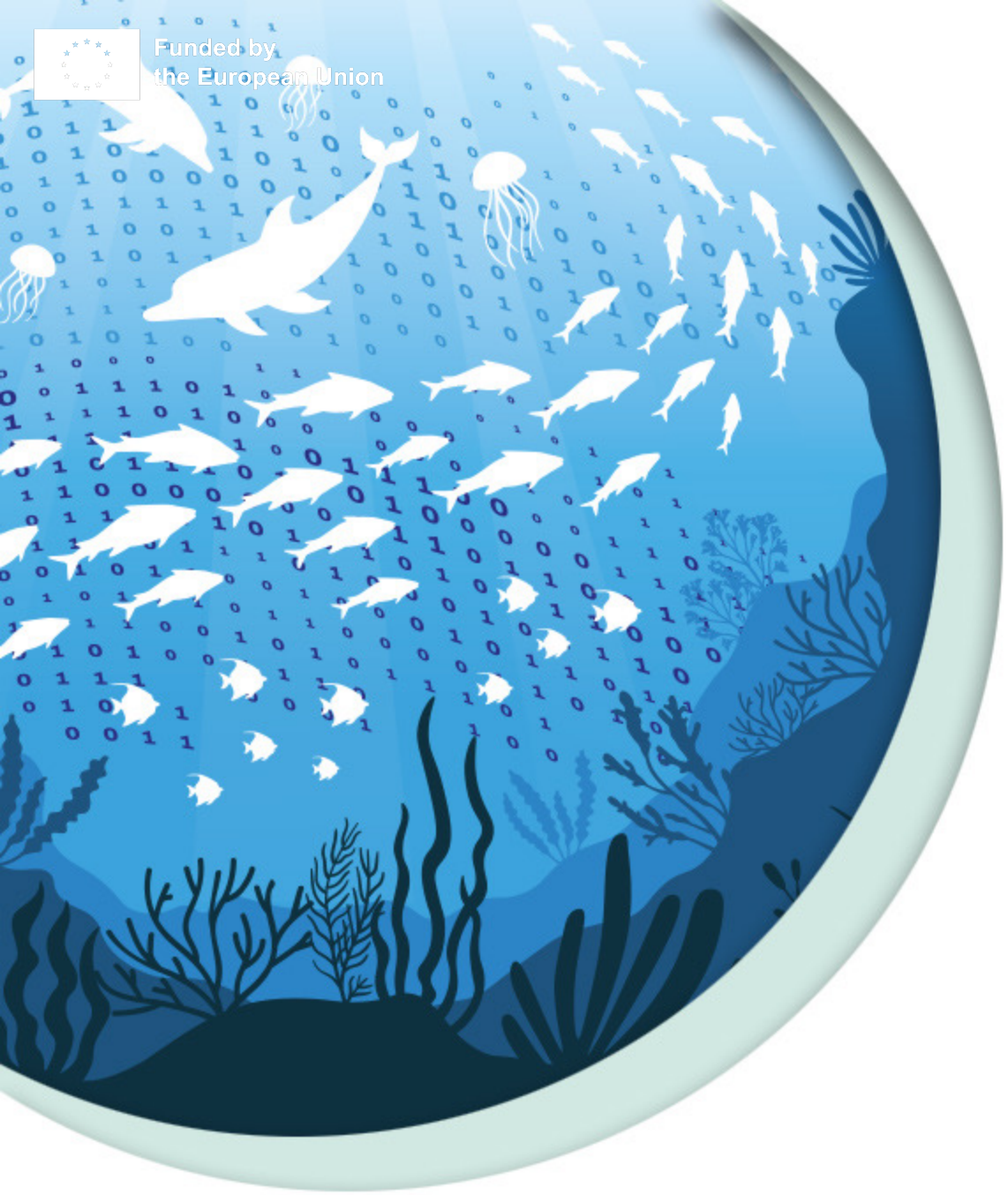
1. Reach out to wider group of end-users (e.g. FORMAS, HaV, OWFs) to understand what data they want and how they want it delivered

2. Develop "derived products" for easier usability of data (e.g. Mixed Layer Depths, Maximum Subsurface Temperature)

louise.biddle@voiceoftheocean.org

Matthias Obst

Digital Twin



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UNIVERSITY OF GOTHENBURG

Data usability and the Digital Twin of the Ocean (DTO)

Matthias Obst

Department of Marine Sciences, University of Gothenburg, Sweden

Banos workshop
Monitoring our oceans - Needs and Solutions

15. November 2024

THE OCEAN DECADE

The Science We Need for the Ocean We

Challenge 1

Understand and beat marine pollution

Understand and map land and sea-based sources of pollutants and contaminants and their potential impacts on human health and ocean ecosystems and develop solutions to remove or mitigate them.

Watch the video

Challenge 2

Protect and restore ecosystems and biodiversity

Understand the effects of multiple stressors on ocean ecosystems, and develop solutions to monitor, protect, manage and restore ecosystems and their biodiversity under changing environmental, social and climate conditions.

Watch the video

Challenge 7

Expand the Global Ocean Observing System

Ensure a sustainable ocean observing system across all ocean basins that delivers accessible, timely, and actionable data and information to all users.

Watch the video

Challenge 8

Create a digital representation of the ocean

Through multi-stakeholder collaboration, develop a comprehensive digital representation of the ocean, including a dynamic ocean map, which provides free and open access for exploring, discovering, and visualizing past, current, and future ocean conditions in a manner relevant to diverse stakeholders.

Watch the video

Challenge 3

Sustainably feed the global population

Generate knowledge, support innovation, and develop solutions to optimise the role of the ocean in sustainably feeding the world's population under changing environmental, social and climate conditions.

Watch the video

Challenge 4

Develop a sustainable and equitable ocean economy

Generate knowledge, support innovation, and develop solutions for equitable and sustainable development of the ocean economy under changing environmental, social and climate conditions.

Watch the video

Challenge 9

Skills, knowledge and technology for all

Ensure comprehensive capacity development and equitable access to data, information, knowledge and technology across all aspects of ocean science and for all stakeholders.

Watch the video

Challenge 10

Change humanity's relationship with the ocean

Ensure that the multiple values and services of the ocean for human wellbeing, culture, and sustainable development are widely understood, and identify and overcome barriers to behaviour change required for a step change in humanity's relationship with the ocean.

Watch the video

Challenge 5

Unlock ocean-based solutions to climate change

Enhance understanding of the ocean-climate nexus and generate knowledge and solutions to mitigate, adapt and build resilience to the effects of climate change across all geographies and at all scales, and to improve services including predictions for the ocean, climate and weather.

Watch the video

Challenge 6

Increase community resilience to ocean hazards

Enhance multi-hazard early warning services for all geophysical, ecological, biological, weather, climate and anthropogenic related ocean and coastal hazards, and mainstream community preparedness and resilience.

Watch the video

What’s a Digital Twin

- Digital twins are **virtual representations** of physical objects or systems
- They are **used for modelling and design** purposes. These virtual models are used to digitally represent performance, identify inefficiencies, and design solutions to improve their physical counterparts.

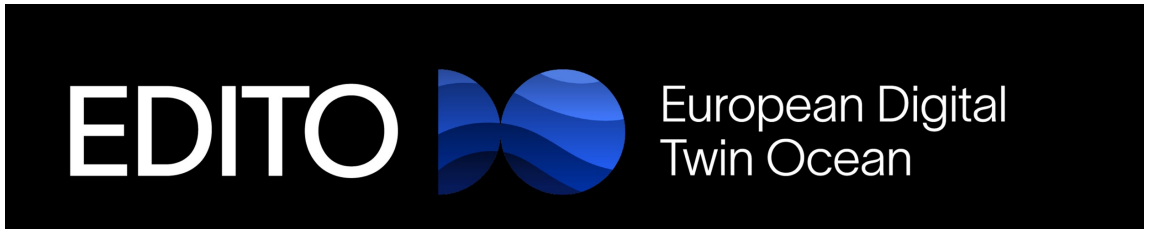
What’s new about Digital Twins

- Digital twin vs. simulation. Digital twins ”model specific real-world assets”. In contrast to simulations, which operate in entirely virtual environments the **Digital twins are outfitted with sensors** that continuously update their virtual counterparts in real time with high-quality data.
- **New assets** include the Internet of Things (IoT), Artificial Intelligence (AI), Virtual Reality (VR), Extended Reality (ER), and Cloud computing

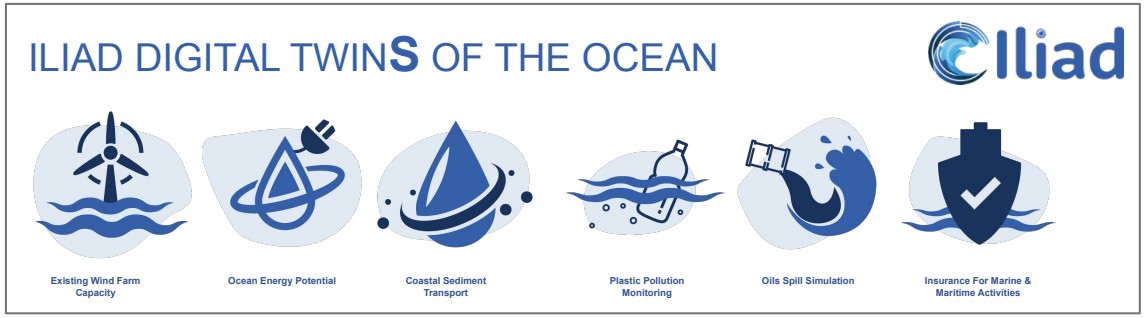
There are several Digital Twins of the Ocean

Decade program

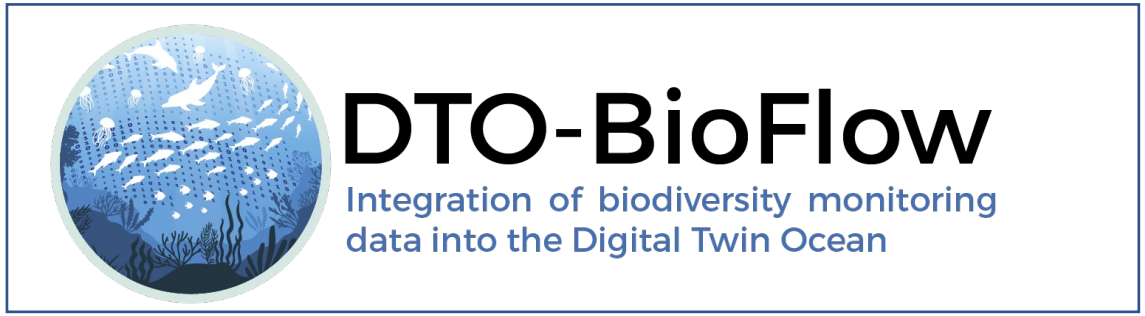
IT infrastructure



Interoperability



Biodiversity



DTO-BioFlow

Integration of biodiversity monitoring data into the Digital Twin Ocean

Monitoring networks (WP2)

Data Streams (WP3)

- Genetic
- Image-based
- Biologging
- Acoustic
- Citizen science
- other

Applications (WP4)

- Invasive species management
- Adaptive offshore construction
- Assessment of plankton diversity
- Marine aquaculture
- Marine spatial planning
- Low impact fisheries
- Blue carbon sequestration

European Digital Twin of the Ocean

A leap in ocean knowledge and sustainable action

European Commission

EU MISSIONS
RESTORE OUR OCEAN & WATERS

MERCATOR OCEAN INTERNATIONAL

VLIZ

Demonstrator use cases

- DUC-1: demonstration for **invasive species management.**
- DUC-2: demonstration for adaptive offshore **construction and energy harvesting.**
- DUC-3: demonstration for **assessment of plankton diversity** in relation to human impact.
- DUC-4: demonstration for spatial planning of **sustainable mariculture.**
- DUC-5: demonstration for **ecosystem based spatial planning and MPA management.**
- DUC-6: demonstration for **low impact fisheries.**
- DUC-7: demonstration for Ecosystem services, esp. **carbon sequestration.**

European Commission

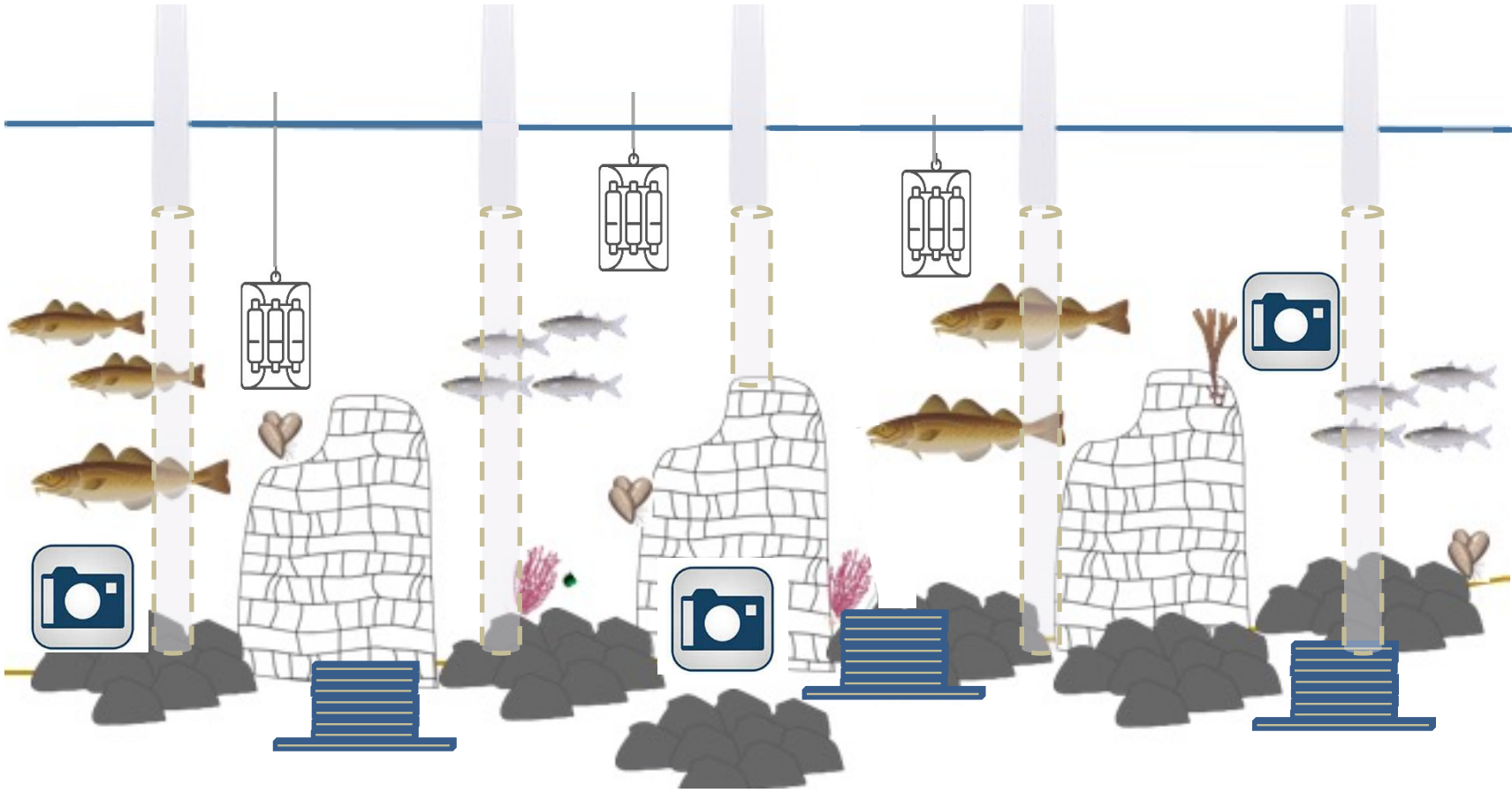
SBDI
SWEDISH BIODIVERSITY DATA INFRASTRUCTURE

Vetenskapsrådet

EMBRC
EUROPEAN MARINE BIOLOGICAL RESOURCE CENTRE

VINNOVA
Sweden's Innovation Agency

Integrated monitoring biodiversity monitoring in offshore wind power plants

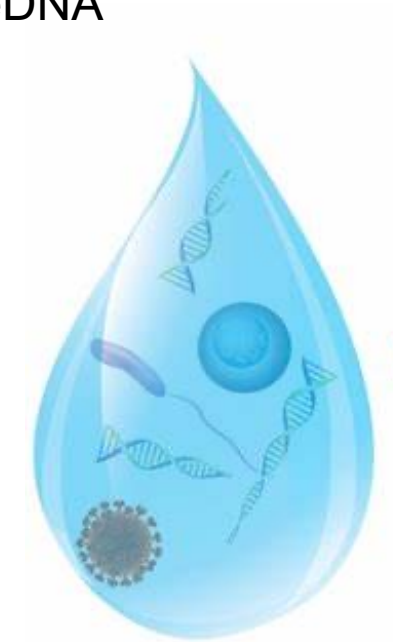
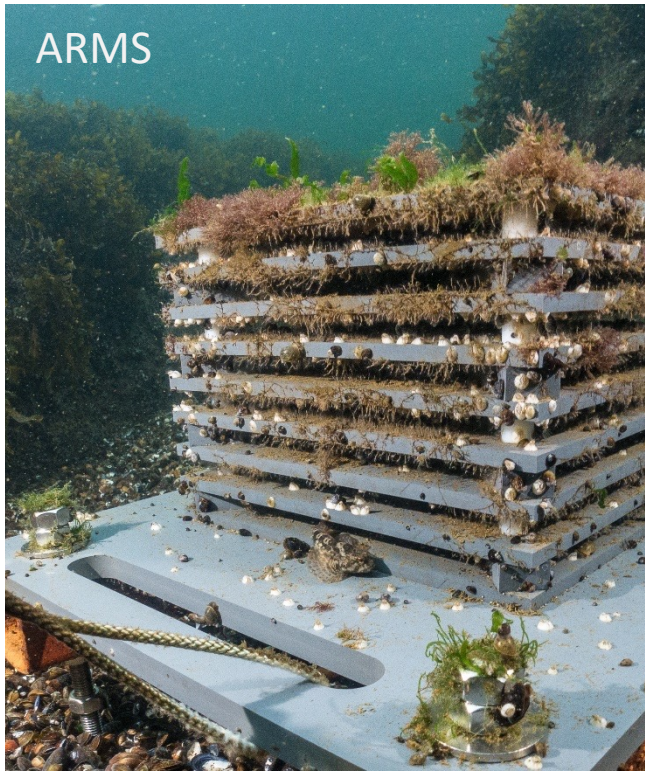
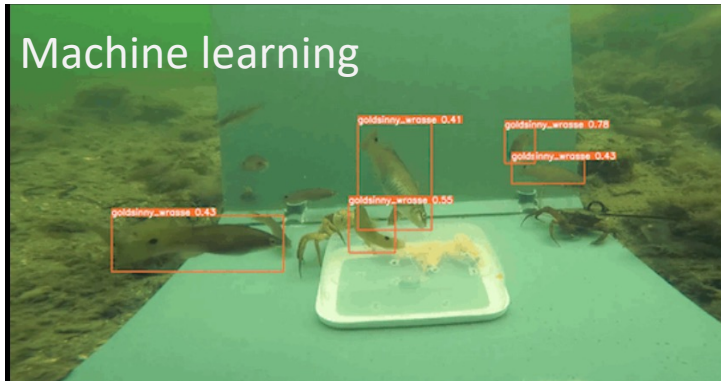
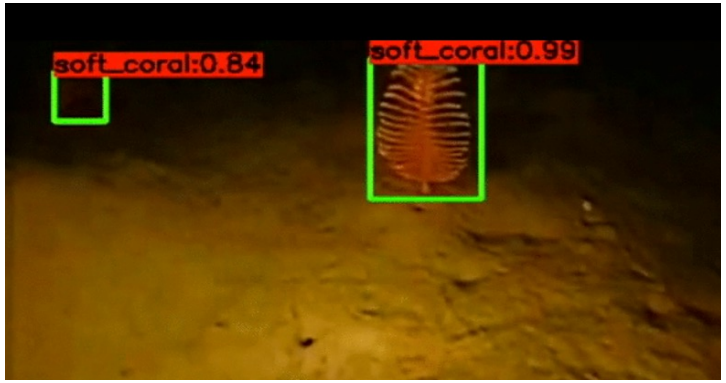


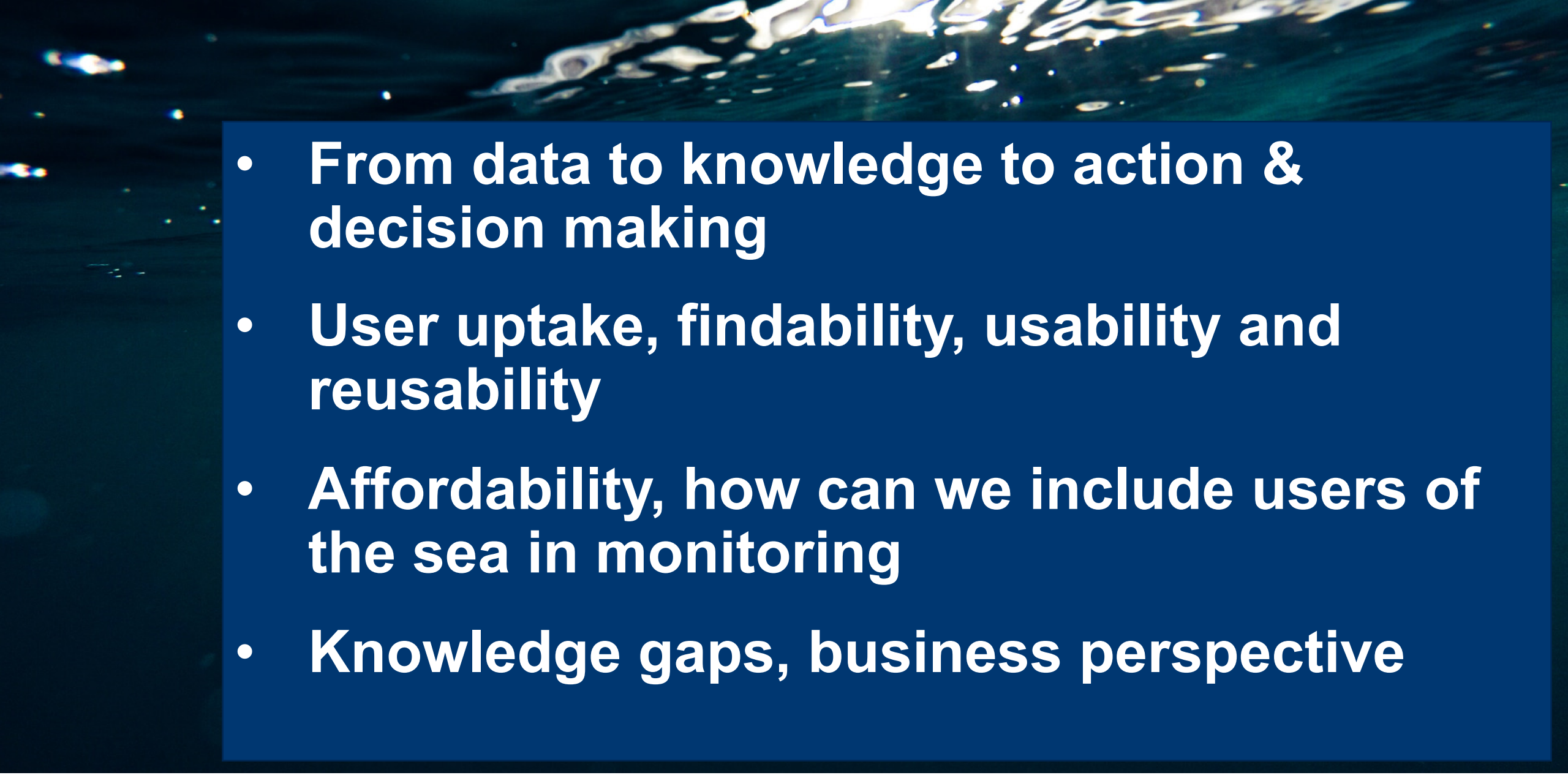
Water samples for eDNA

Automomous Reef Monitoring Structures (ARMS)

Camera observatory

Integrated monitoring biodiversity monitoring in offshore wind power plants

		DNA-based	Image-based
Method	eDNA 	ARMS 	Machine learning  
Analysis	• Abundance of target species	• Community composition • Intra-specific diversity • Ecological key species	• Size & age class distribution • Abundance • Community composition



- From data to knowledge to action & decision making
- User uptake, findability, usability and reusability
- Affordability, how can we include users of the sea in monitoring
- Knowledge gaps, business perspective

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BLUE MISSION BANOS

What are the actions needed?

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BLUE MISSION BANOS

What action can you contribute to?

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BLUE MISSION BANOS

Who else is needed in the actions?

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BLUE MISSION BANOS

Next step & New partnerships

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