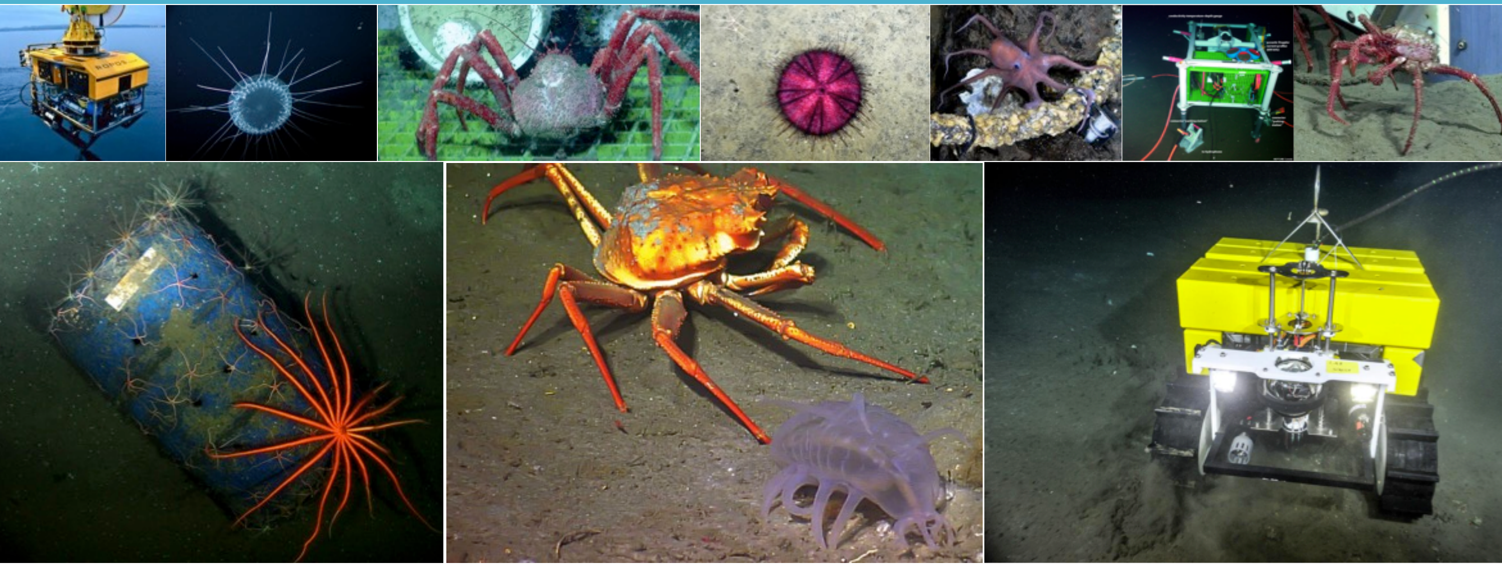
WORLD-LEADING DISCOVERIES AT A CRITICAL TIME



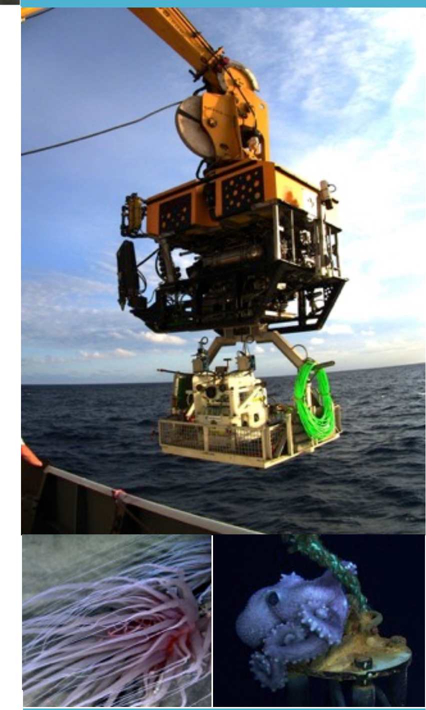
OCEAN NETWORKS CANADA

How can Ocean Networks Canada support long-term monitoring of deep-sea meroplankton communities in the NE Pacific?

Fabio De Leo

Senior Staff Scientist, Ocean Networks Canada
Adjunct Assistant Professor, Department of Biology

ONC Observatory Council Meeting
January 15, 2020



University of Victoria

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Workshop: "Advances in ocean biological observations – sustained system for deep-ocean meroplankton"

Aveiro, Portugal, May 27-29 2019

Participant Institutions:

Ocean Networks Canada
Dalhousie University (Canada)
Woods Hole Inst. Oceanography (USA)
Monterey Bay Aquarium Research Institute (USA)
Western Washington University (USA)
University of Oregon (USA)
Brest University (France)
National Oceanography Centre (UK)
Japanese Marine Technology Institute (Japan)
Okinawa Institute of Science and Technology (Japan)

University of Aveiro* (Portugal)
Institute of Marine Sciences* (Spain)
Ifremer* (France)

Co-funded:

INTER RIDGE
international cooperation in ridge-crest studies

ISblue
The interdisciplinary graduate school for the blue planet

What is meroplankton ?

Meroplankton is a wide variety of planktonic organisms, which spend a portion of their lives in the benthic region of the ocean. Meroplankton consists of **larval stages** of organisms such as sea urchins, starfish, crustaceans (crabs, lobsters, shrimps), etc.

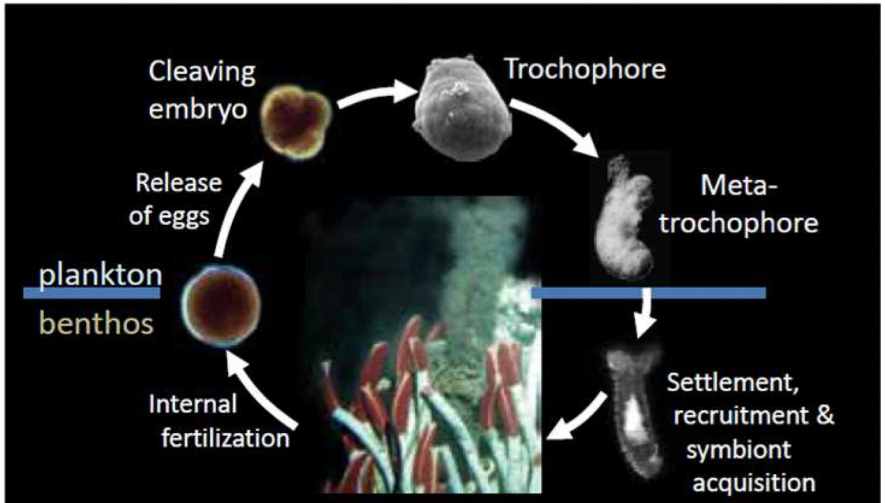
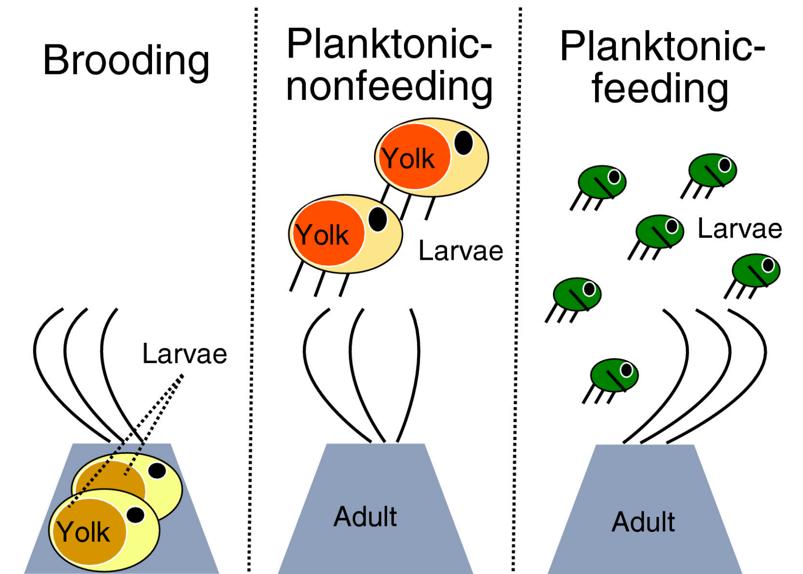
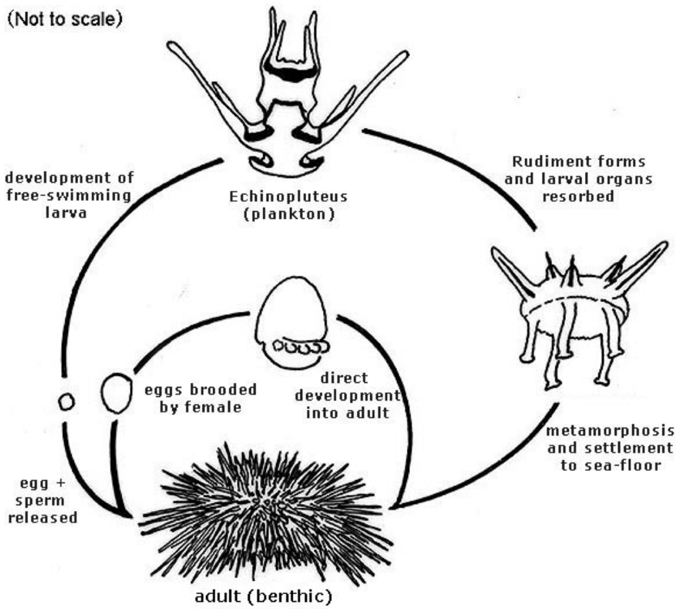


Image: Craig Young

Wide variety of shapes and life-strategies:



Ewers-Saucedo & Papalardo, 2019



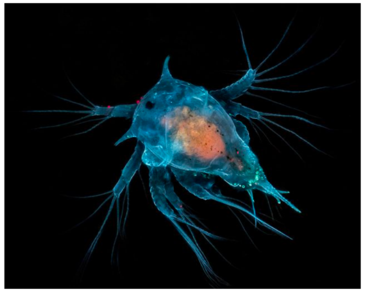
Main Goals of the workshop:

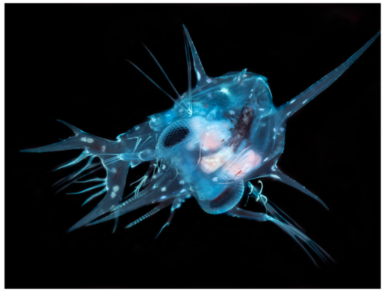
Advance the knowledge of larval distributions to improve model predictions of **connectivity** and **resilience** of marine communities to natural and human impacts.

1) **review state-of-the-art** instrumentation available for plankton observations in shallow and deep waters.

2) develop a strategy to **implement technological innovations for in-situ observations**:

- Design a local/regional pilot study (@ NEPTUNE Observatory??)
- Standardize methodologies using current ocean observing platforms, and available time-series samples





Session themes/Working Groups:

Theme I: Knowledge advances in deep-sea larval diversity and distribution - key challenges and priorities

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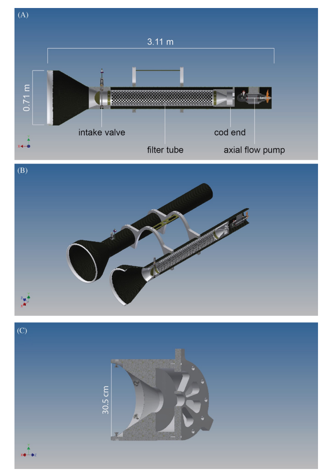
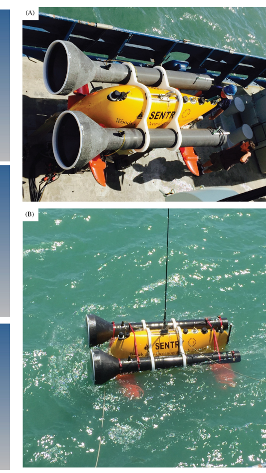
Larvae from deep-sea methane seeps disperse in surface waters

Shawn M. Arellano[1,†], Ahna L. Van Gaest[1], Shannon B. Johnson[2], Robert C. Vrijenhoek[2] and Craig M. Young[1]

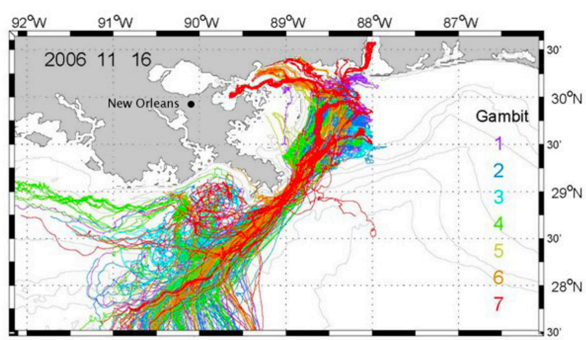
[1]Oregon Institute of Marine Biology, University of Oregon, PO Box 5389, Charleston, OR 97420, USA
[2]Monterey Bay Aquarium Research Institute, 7700 Sandholdt Road, Moss Landing, CA 95039, USA

Theme II: Recent developments in plankton observation technology and approaches





Theme III: Data integration and oceanographic modelling



Current forecasts were used to predict the drift of small larvae of brown shrimp over a period of 60 days (the amount of time it takes for the shrimp to become adults). Some shrimp are predicted to drift at least 180 miles. The different colors show different paths the larvae might take, depending on the current. Credit: NOAA

Why do we need to quantify deep-sea larval diversity?

Bridge the knowledge gaps in the life cycle of deep-sea species:

(1) On **reproduction** (temporal scales, seasonality, fecundity/larval output)
(2) On **larval biology and ecology** (morphology, planktotrophic x lecithotrophic, swimming capabilities, buoyancy) to make inferences about **planktonic larval duration (PLD)**

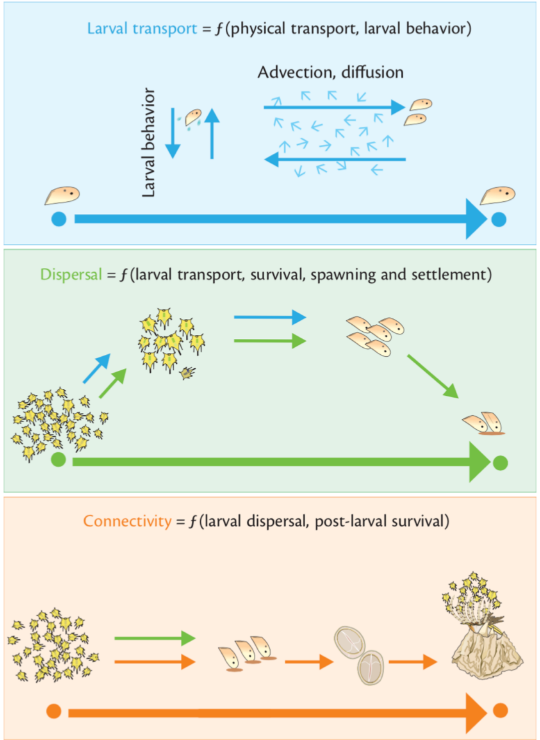
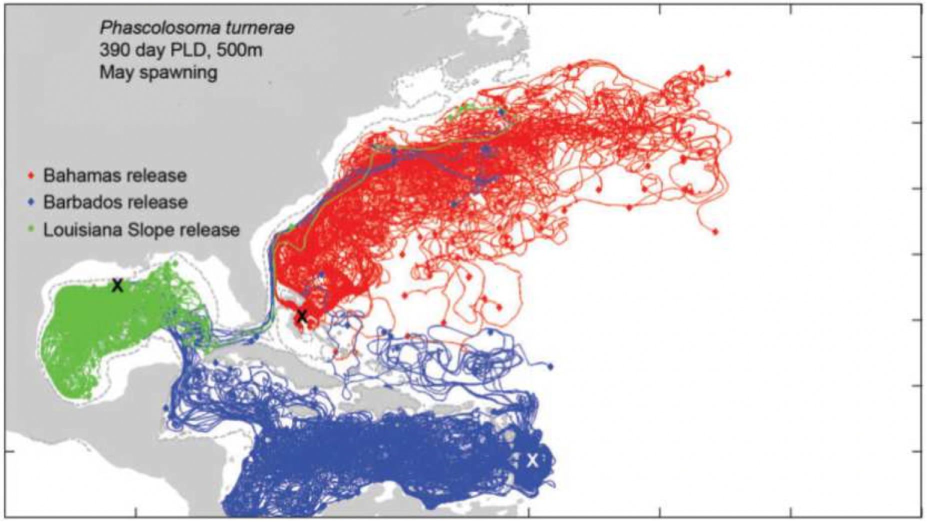


Figure 2. The concepts of larval transport, larval dispersal, and reproductive population connectivity. Colors of arrows distinguish each concept. For example, the green arrow in the connectivity box means dispersal is involved in reproductive population connectivity.

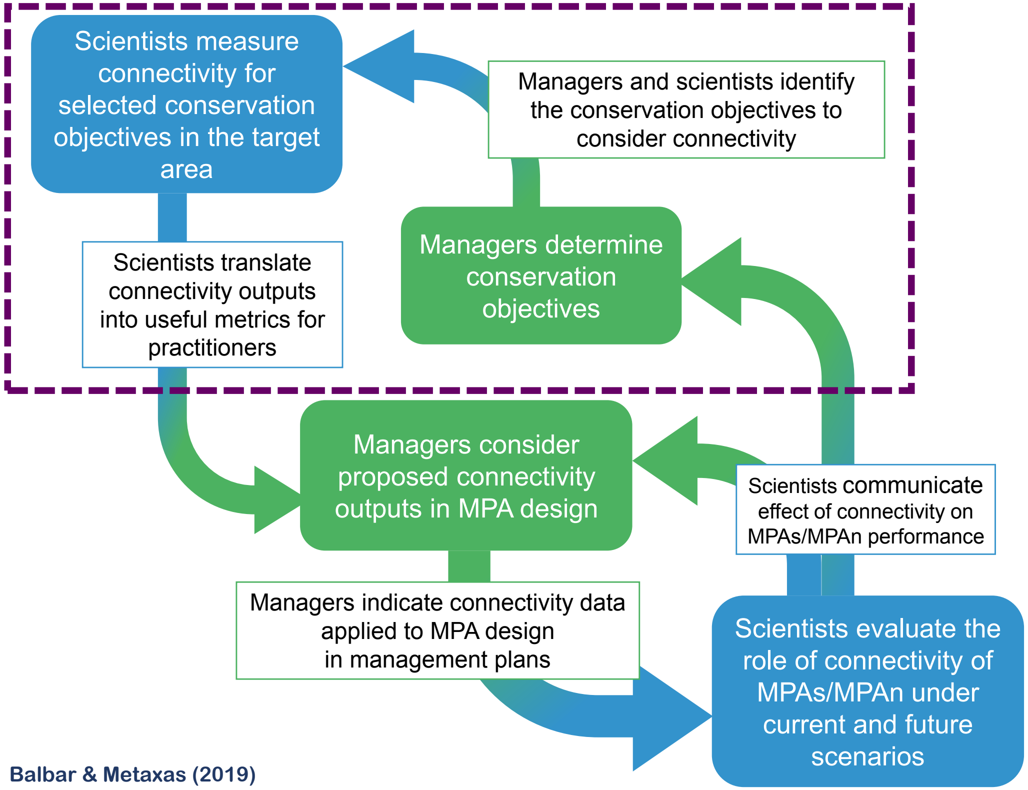
PLD

CONNECTIVITY



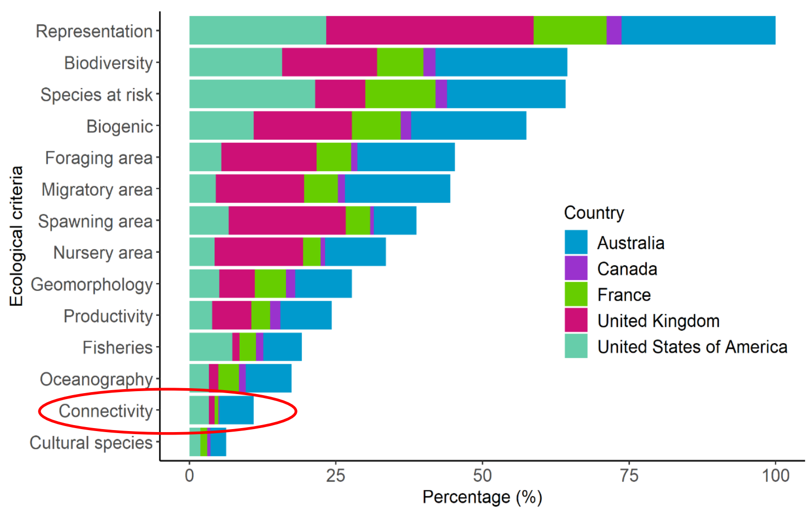
Simulated larval trajectories of deep-sea sipunculans (Young et al 2012)

Connectivity is key!



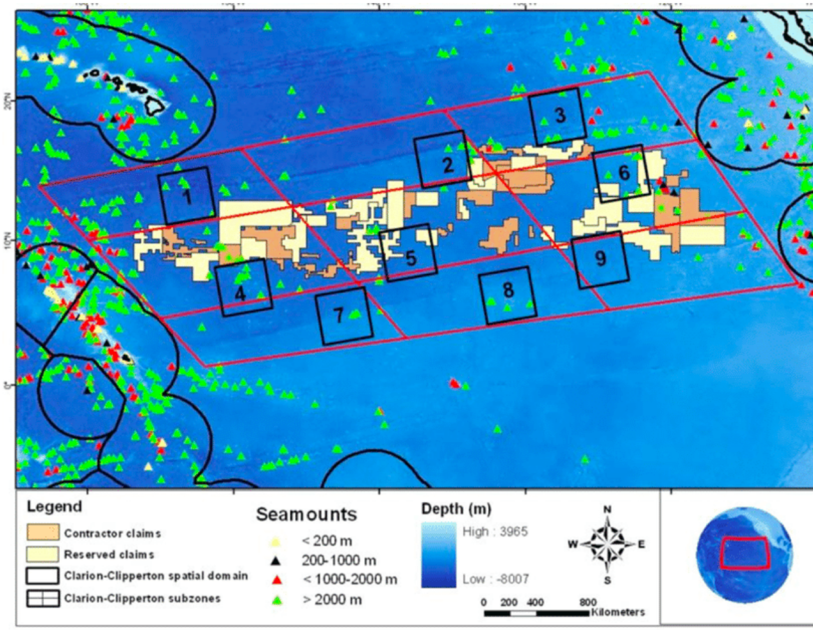
Balbar & Metaxas (2019)

Ecological criteria used in the design of MPAs

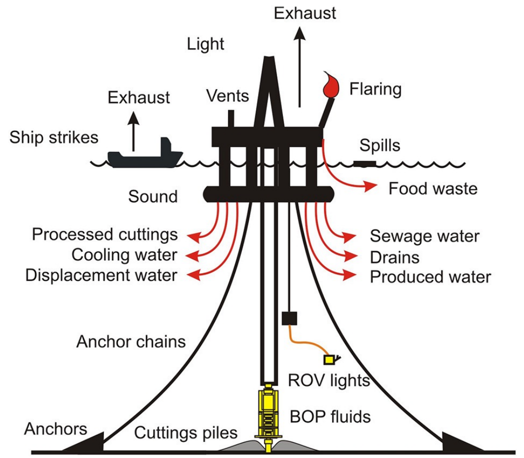


Balbar & Metaxas (2019)

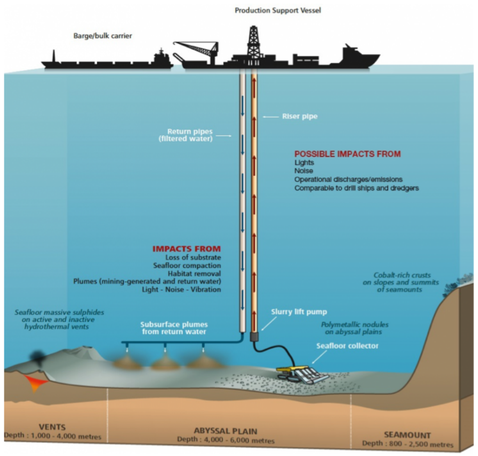
Marine Protected Area design



Oil exploitation



Deep-sea mining

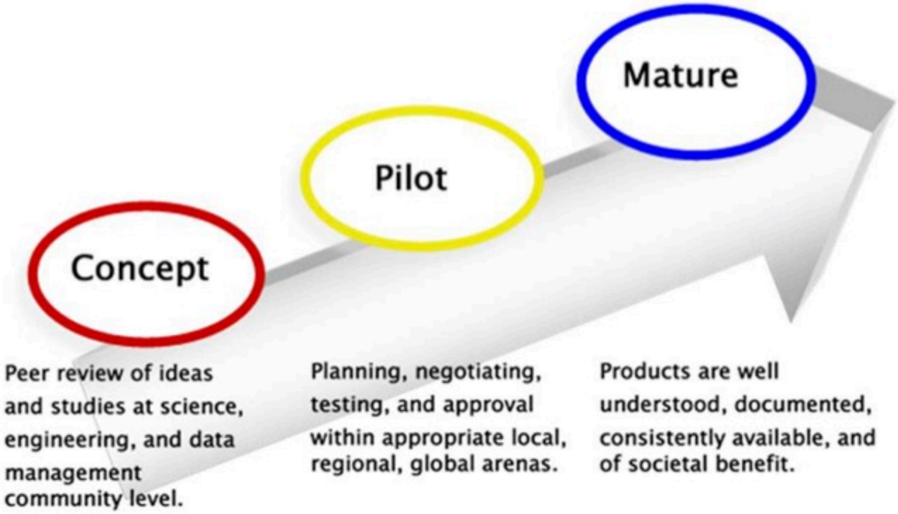


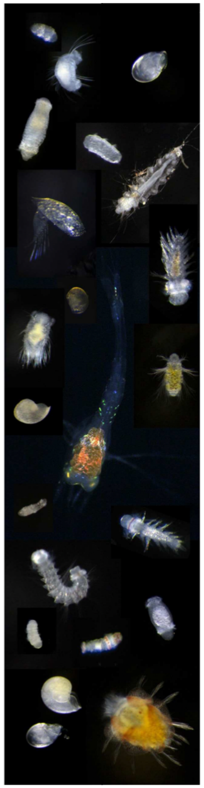
Bottom trawling

Context within the Global Ocean Observing System

Contribute to development of deep-ocean **Biodiversity and Ecosystem Essential Ocean Variables (EOVs)**

- Zooplankton biomass and diversity - pilot
- Benthic invertebrate abundance and distribution – concept
- Connectivity of species – under consideration



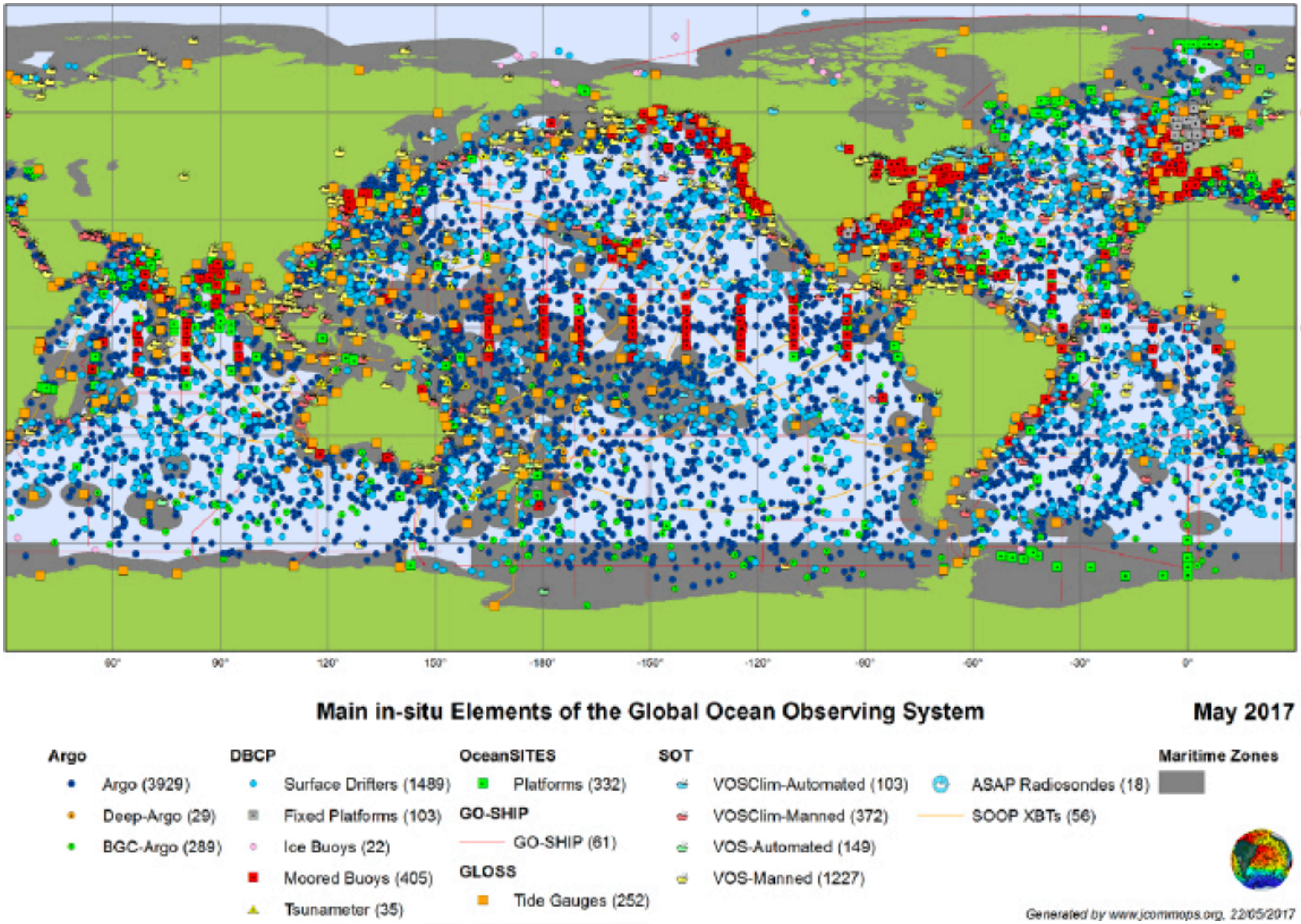


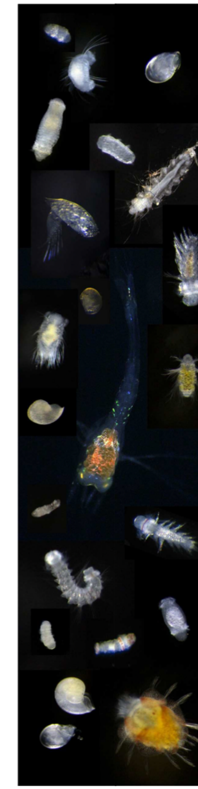
GOOS The Global Ocean Observing System

DEEP OCEAN OBSERVING STRATEGY

EOOS European Ocean Observing System

Context within the Global Ocean Observing System





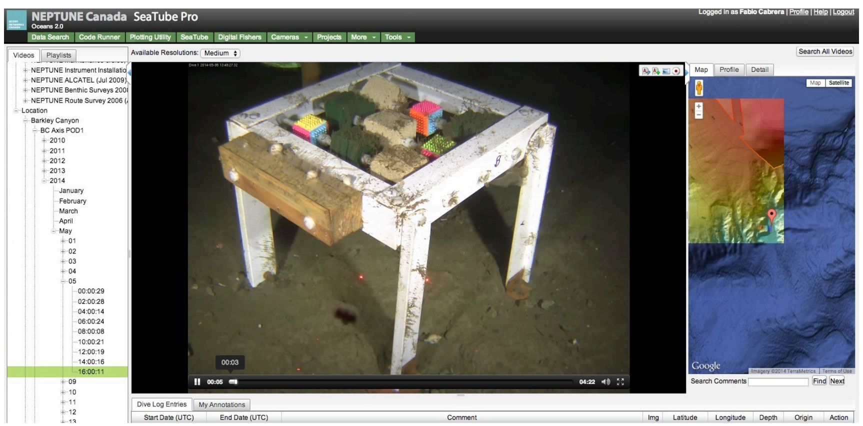
Ongoing efforts to monitor 'meroplankton' communities

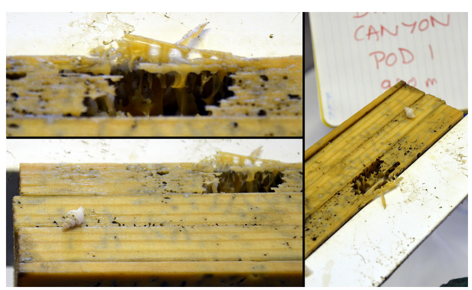
International network for scientific investigation of deep-sea ecosystems

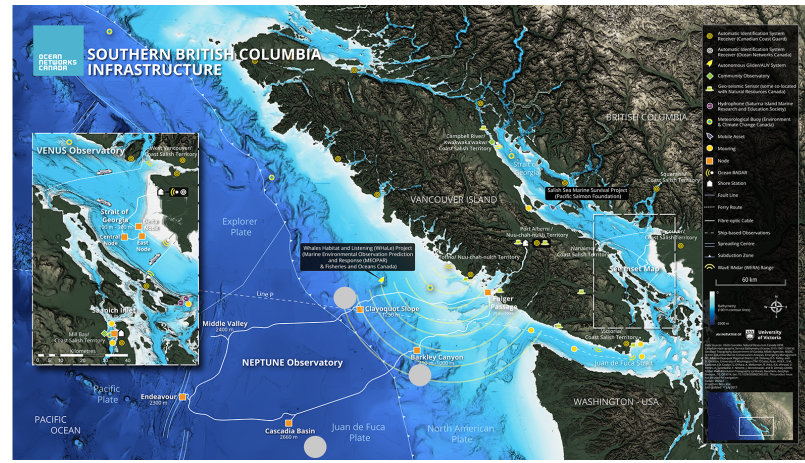
Working Group 3: Population Connectivity

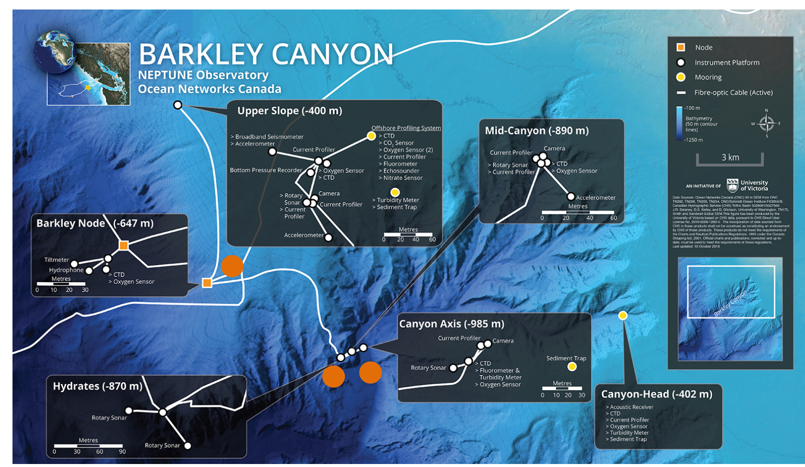
Anna Metaxas (Dalhousie)
Eva Ramirez-Llodra (NIVA)
Ana Hilário (Univ. Aveiro)

- Larval settlement experiment (multiple substrates)
  - Pop. connectivity
  - Vulnerability and recovery from disturbance

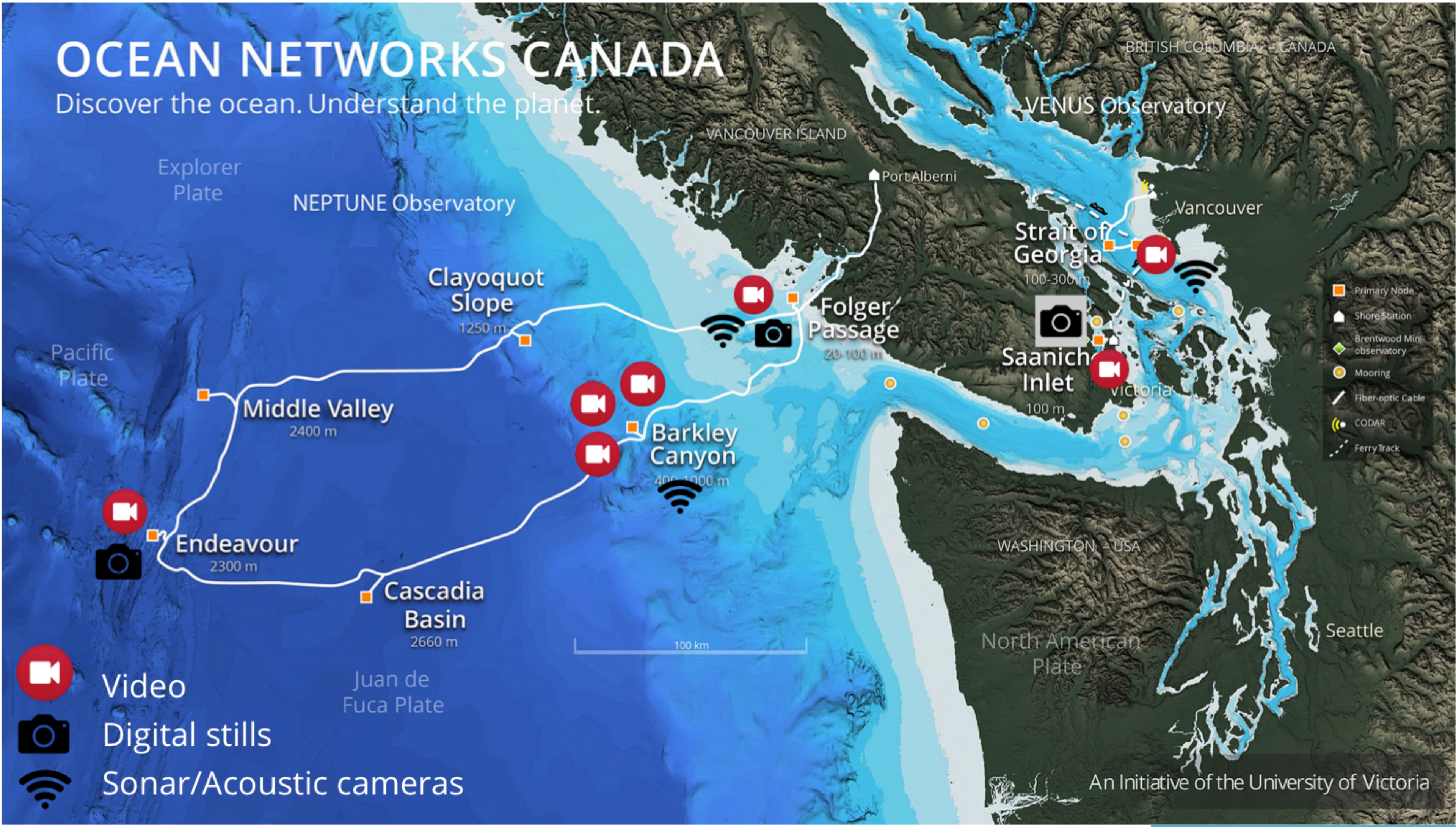






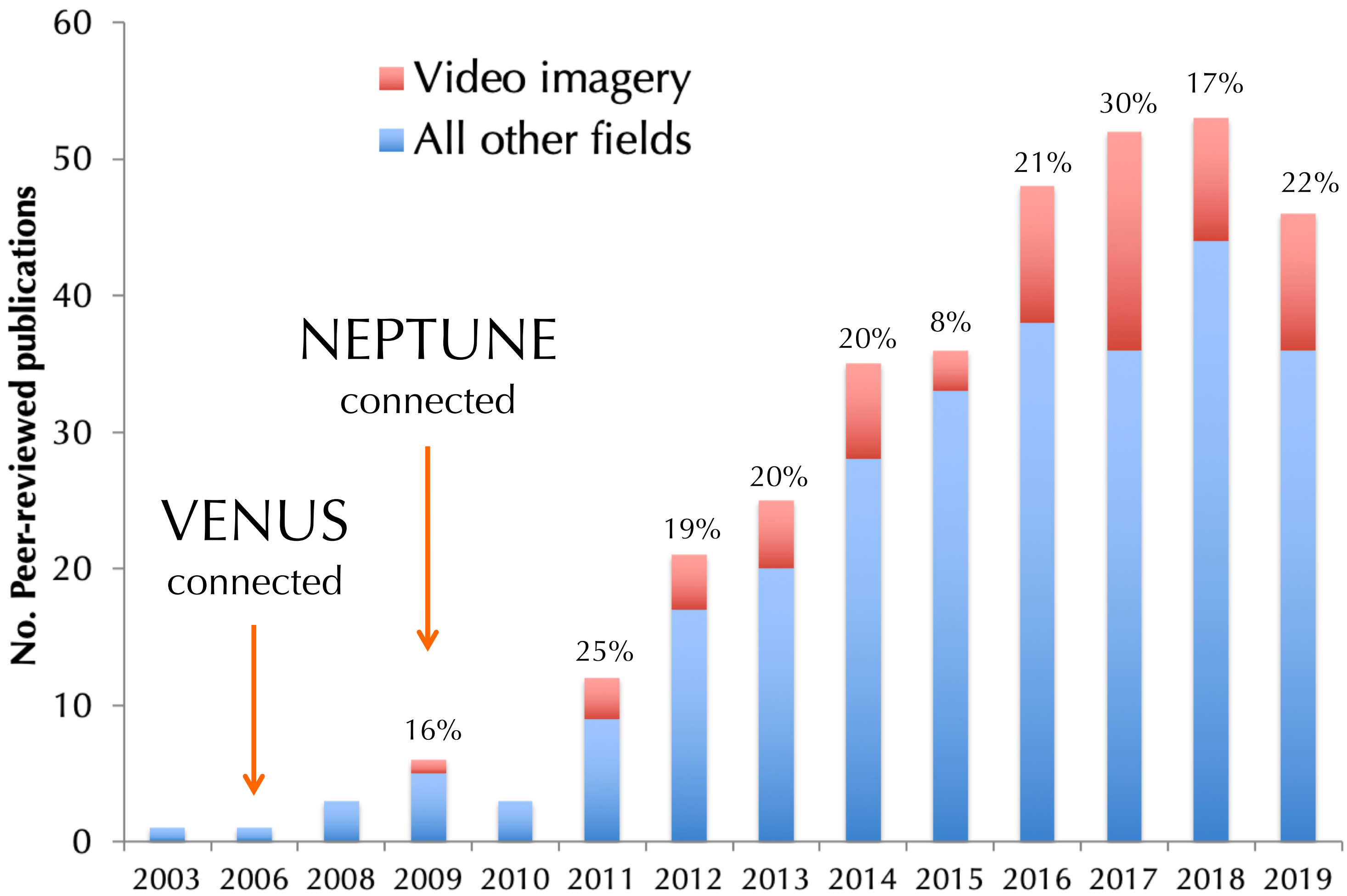


Seafloor cabled observatories – NE Pacific and Salish Sea



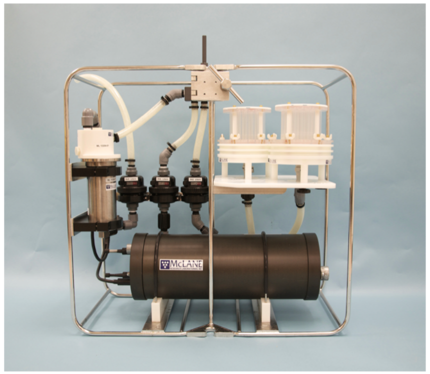
Already existing - successful programs

ONC Publications using video and acoustic imagery



Existing technologies and approaches:

Large Volume Pumps

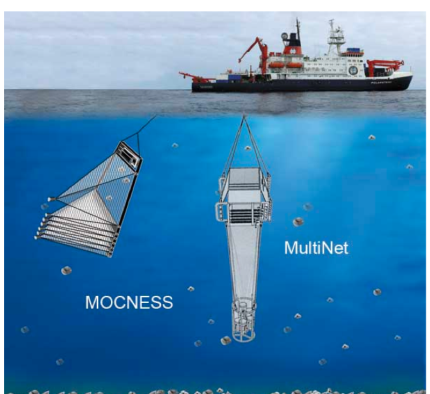


Sediment Traps

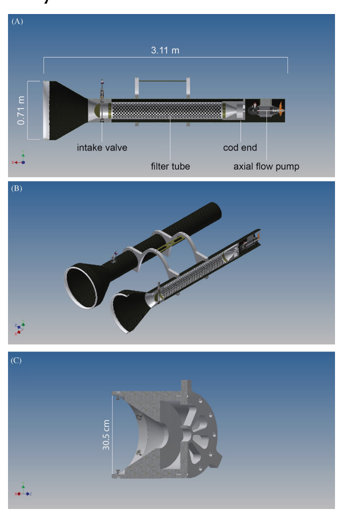
Tool	Advantages	Limitations	Has been used whe
McLane pump/SALSA	Large volumes	Requires power One sample – temporally integrated Or low temporal resolution	Vents Abyssal plain
Sediment trap	Temporal resolution Low power	Biased toward shelled larvae Only collects larvae that are sinking	Canyons Water column Vents Seeps Abyssal plain
SyPRID	Super high volume High specimen quality Spatially precise Can estimate volume	Complex platform (needs ROV/AUV) Temporally limited (during dive)	Seeps
Tube traps	Cheap No power Easy to deploy/recover Geographic spread Opportunistic	Biased toward shelled larvae Temporally integrated (one sample)	Seeps Water column Arctic
MOCNESS	High volume Vertical resolution	Difficult to operate Smears horizontal resolution	Water column Vents Seeps
Settlement panels/blocks	Cheap No power Easy to deploy/recover Geographic spread Opportunistic Samples attached	Settlement/mortality obscured Selective based on material, etc.	Vents Seeps Canyons Abyssal plain Continental slope Water column

Tube traps

MOCNESS



SyPRID



Settlement blocks/panels

Long-term monitoring of meroplankton taking advantage of the NEPTUNE observatory installation

Path for collaboration:

Short-term (2-3 years)

Autonomous samplers (passive larval collectors)

Deployment/recovery of 'low-cost' passive larval collectors

2020!

Discrete Sampling during yearly maintenance cruises

Water pump connected to ROV during video/visual transects ??

Connected 'carrousel-type' passive collectors

Software driver not needed??
Adaptive sampling?

ONC internal proposal:

- **Cost-recovery model (minimal ROV time)**
- **Scientific output**
- **ONC Staff Scientist – project lead**

Long-term (> 5 years)

Long-term monitoring requiring a large new infrastructure/instru-mentation investment

- Multiple samplers at multiple locations
- New technologies
- Imaging devices

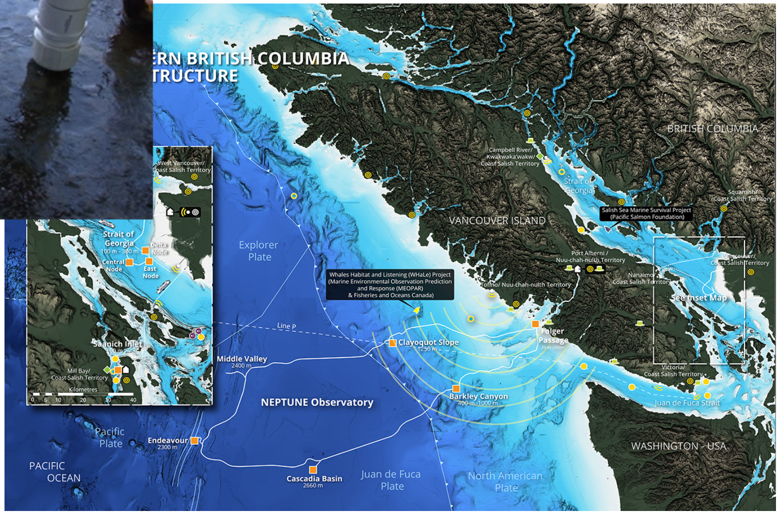
External grant proposal:

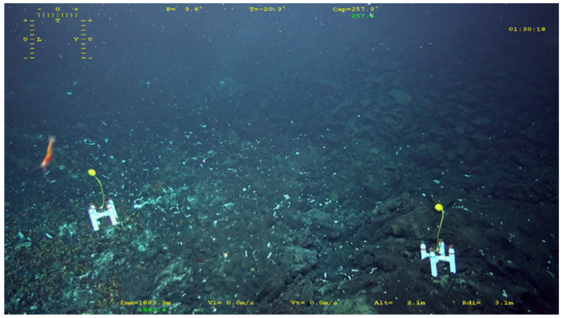
- **Port connection fees**
- **Substantial ROV time**
- **Software Driver Develop., etc**

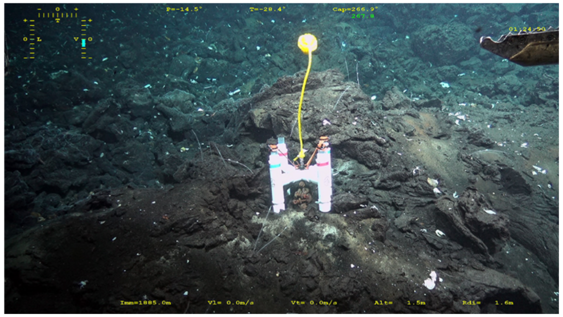
1st ONC commitment/collaboration

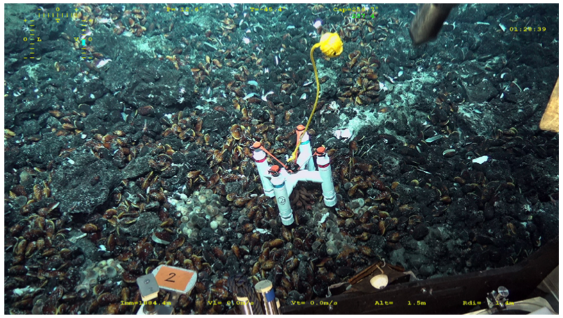
Deploy low cost passive larval 'Tube traps' at NEPTUNE sites

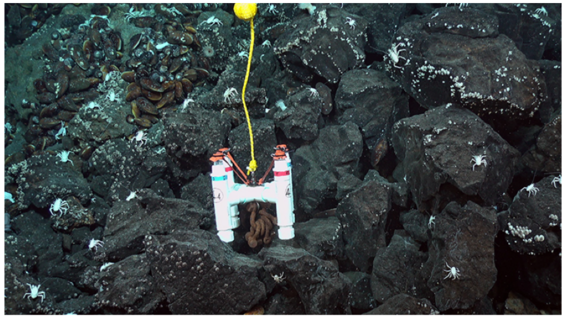
- PVC plumbing pipes
- 2 tubes: NaCl saturated 20% DMSO
- 2 tubes: buffered 10% formalin
- Stretchable rubber cover
- Fusible magnesium link
- 2k ballast (shackles)
- Polypropylene rope

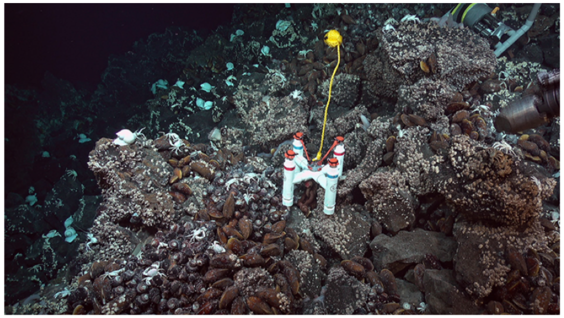












Conclusion remarks

With this new initiative, ONC:

(1) Has a great potential for harnessing an entirely new (and already actively engaged and productive) research community (aligned with ISAB directive).

(2) Help to further increase the scientific output from our observatory network (core CFI metric).

(3) Would be part of a worldwide effort in monitoring meroplankton (strategic partnerships).

(4) Align with large ocean governance and stewardship programs (e.g.GOOS, DOOS, GEO-BON, etc).