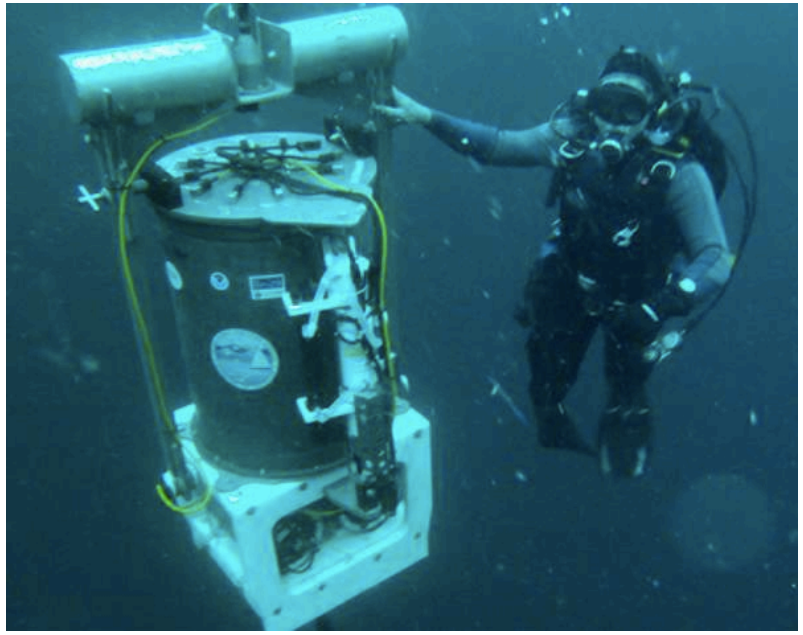
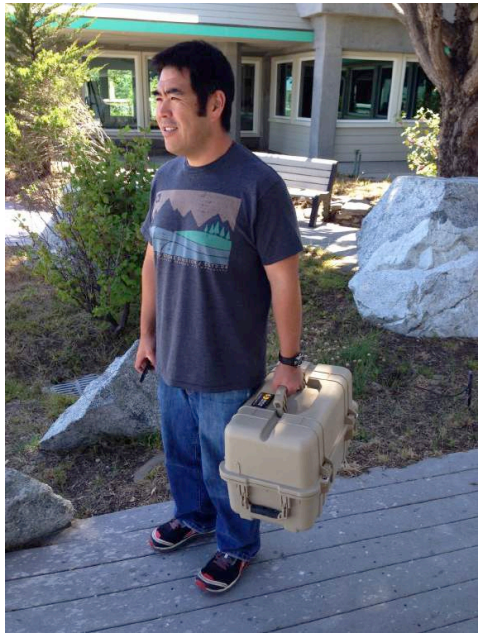
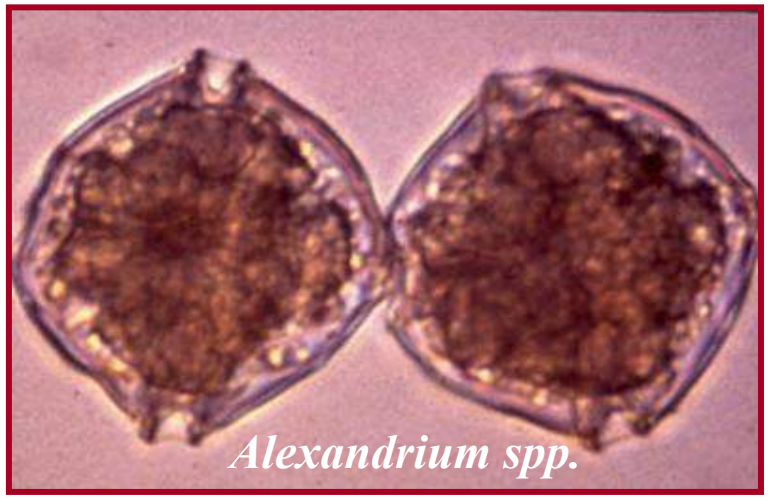
Ecogenomic Sensors: From Land to Sea and Back Again

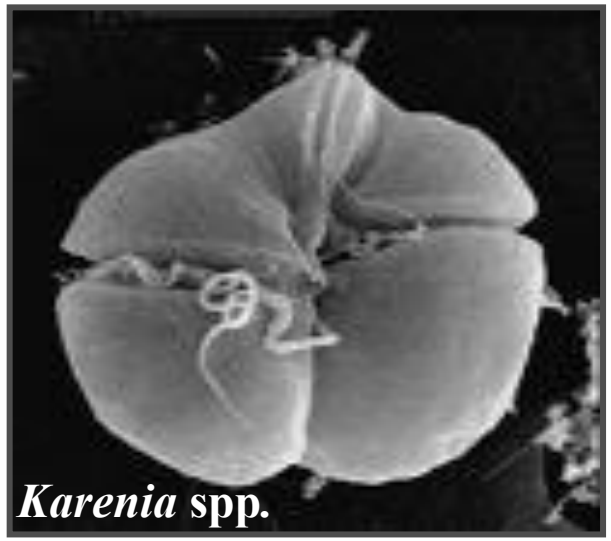
Chris Scholin
Monterey Bay Aquarium Research Institute

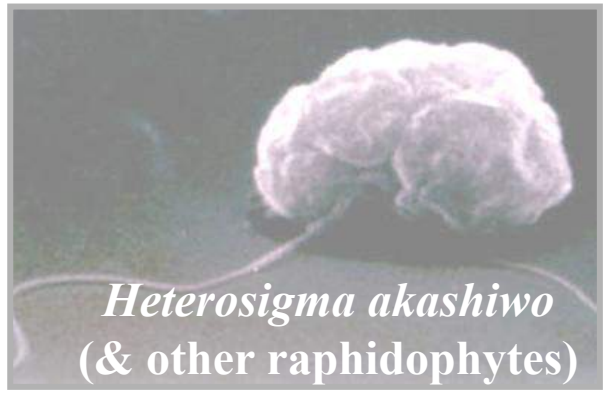




Harmful algal blooms (HABs) are an issue of global concern







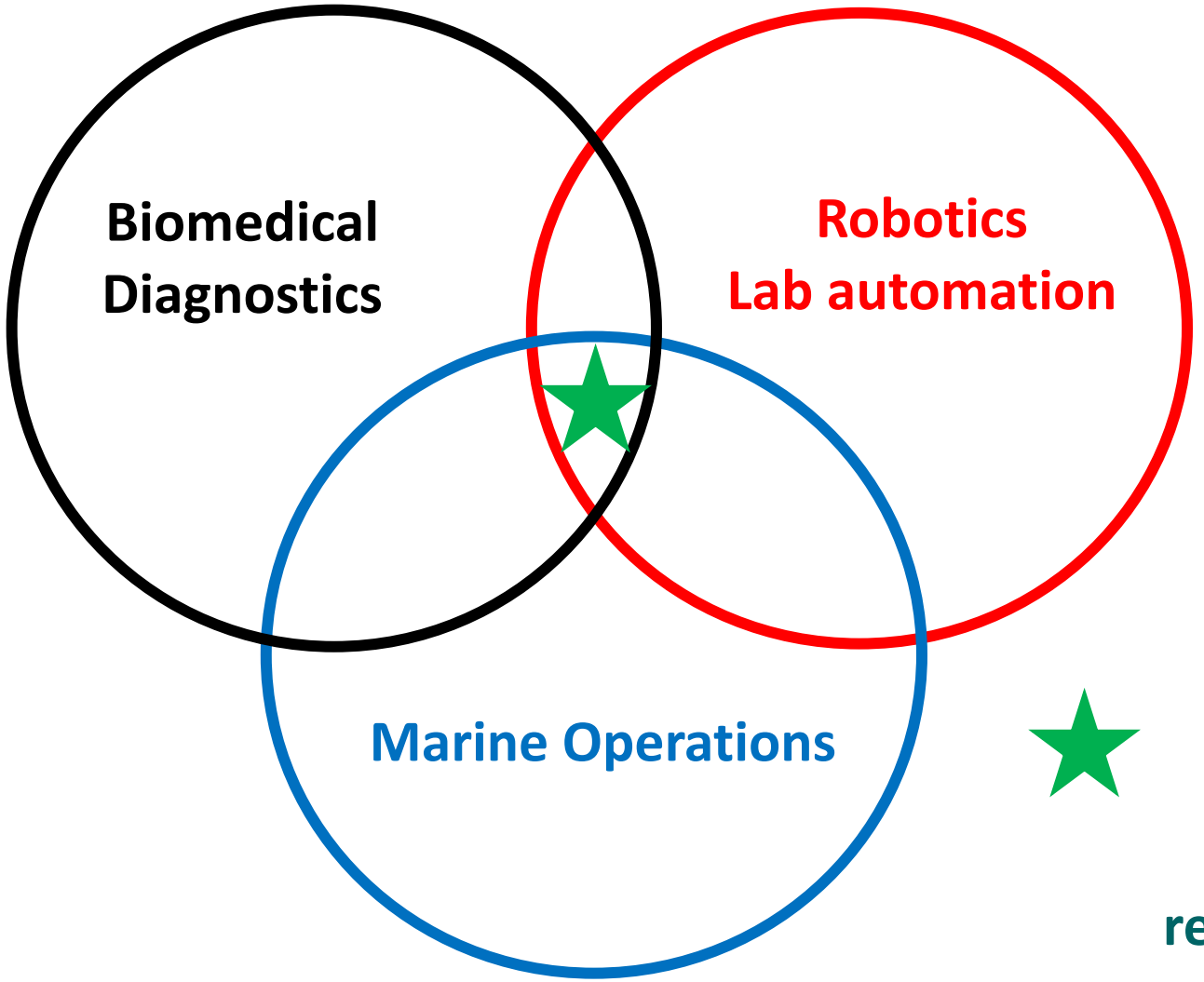
Some well known marine harmful algae

Where are they, how many, and where might they be headed?

That brings up some long-standing challenges….

- **Being there – processing samples without requiring a human presence**
- **Application of molecular probe technology outside of a laboratory setting**
- **Extended, unattended operations of ecogenomic sensor arrays**
- **Onboard data processing/data visualization/predictive modeling**

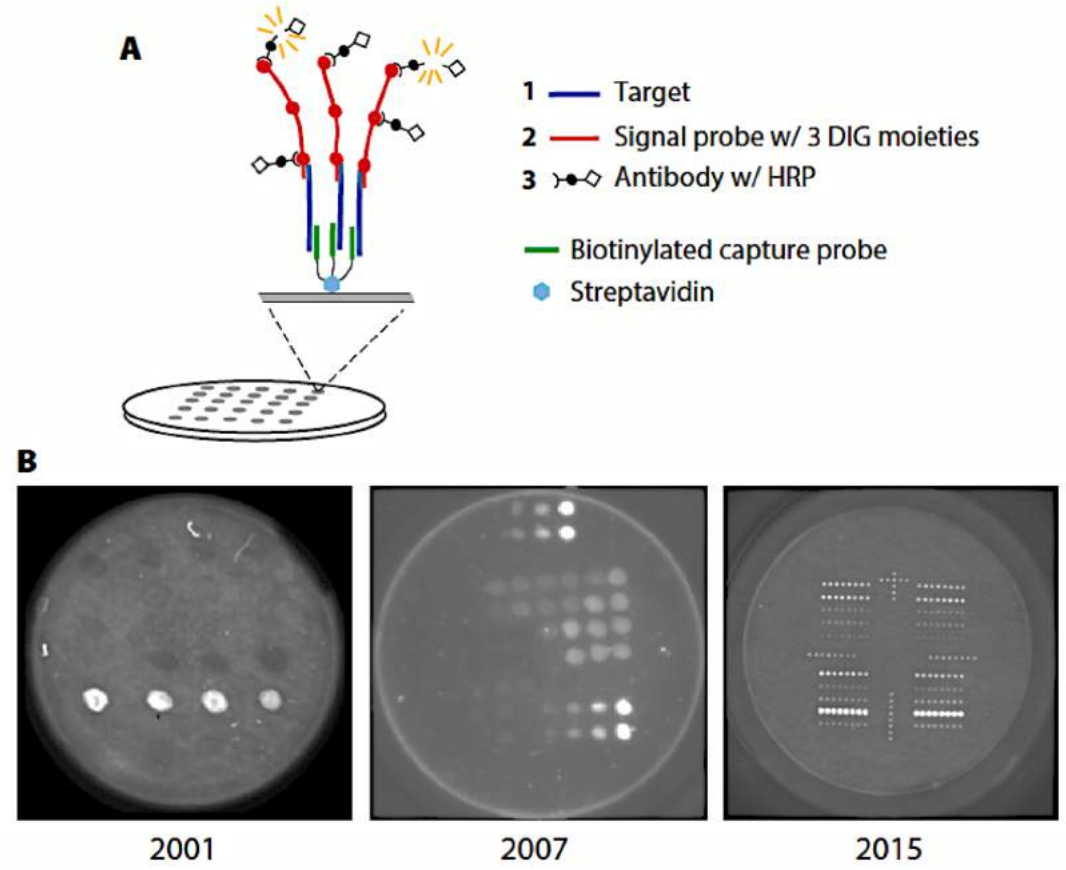
How do we get there?

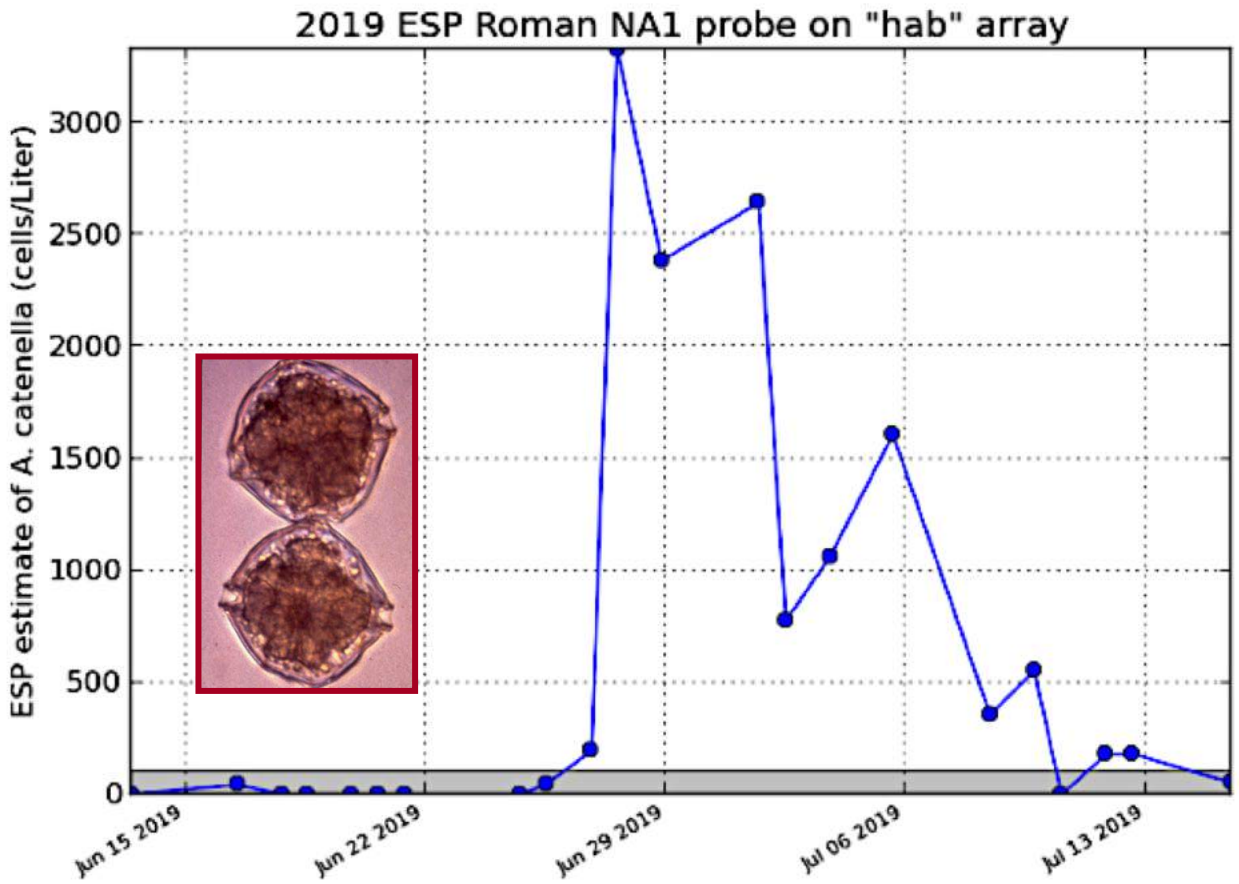


The development of ecogenomic sensors requires expertise in all three domains

Point-of-care diagnostics offered a rich source of inspiration….

Putting the pieces together





Scholin et al. 2017 *Oceanography*

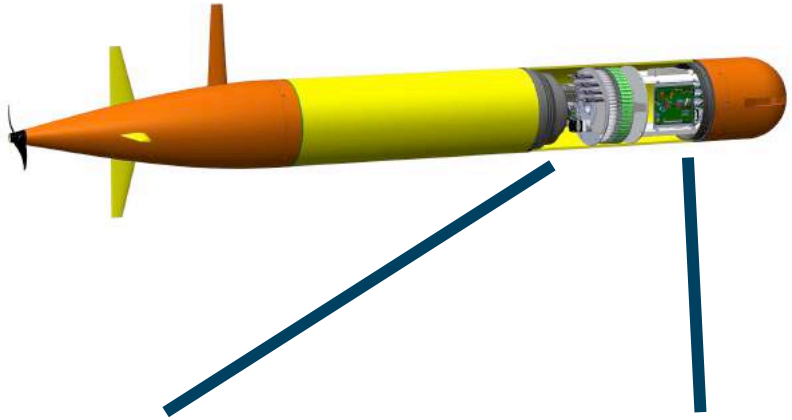
http://science.whoi.edu/esp/fieldcelldata

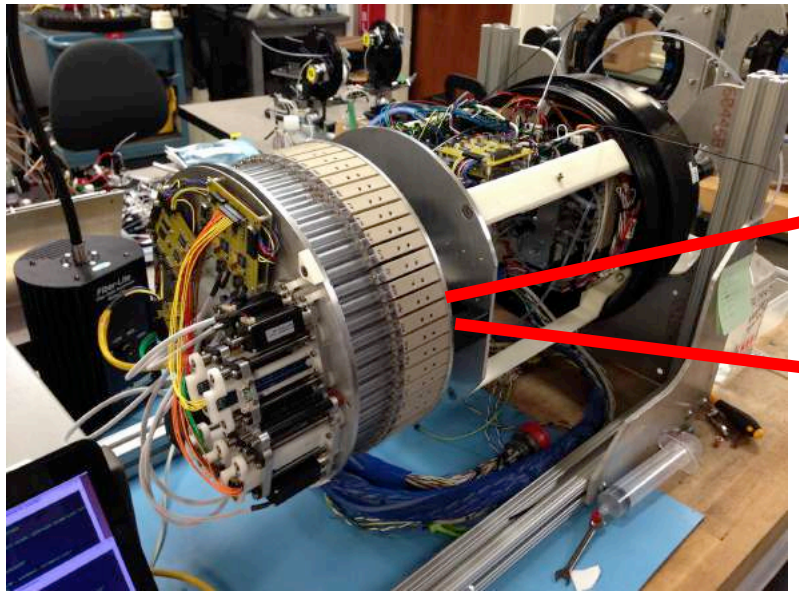
Beyond who's there and how many

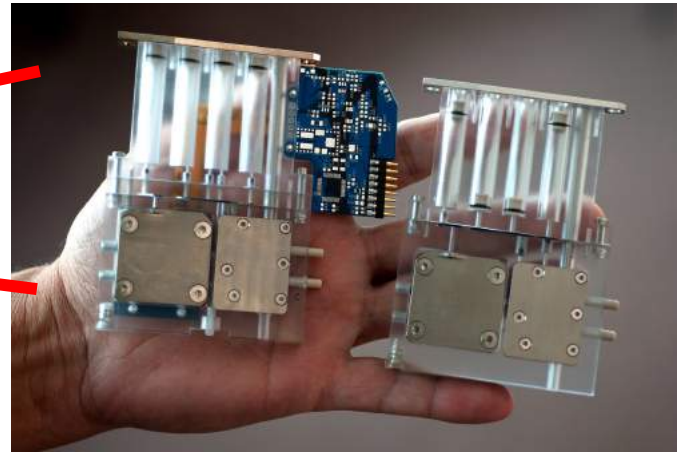
Karl/Delong UH

Can we use microbial community gene expression as a sensor system?

Achieving that goal points to the need for a new system







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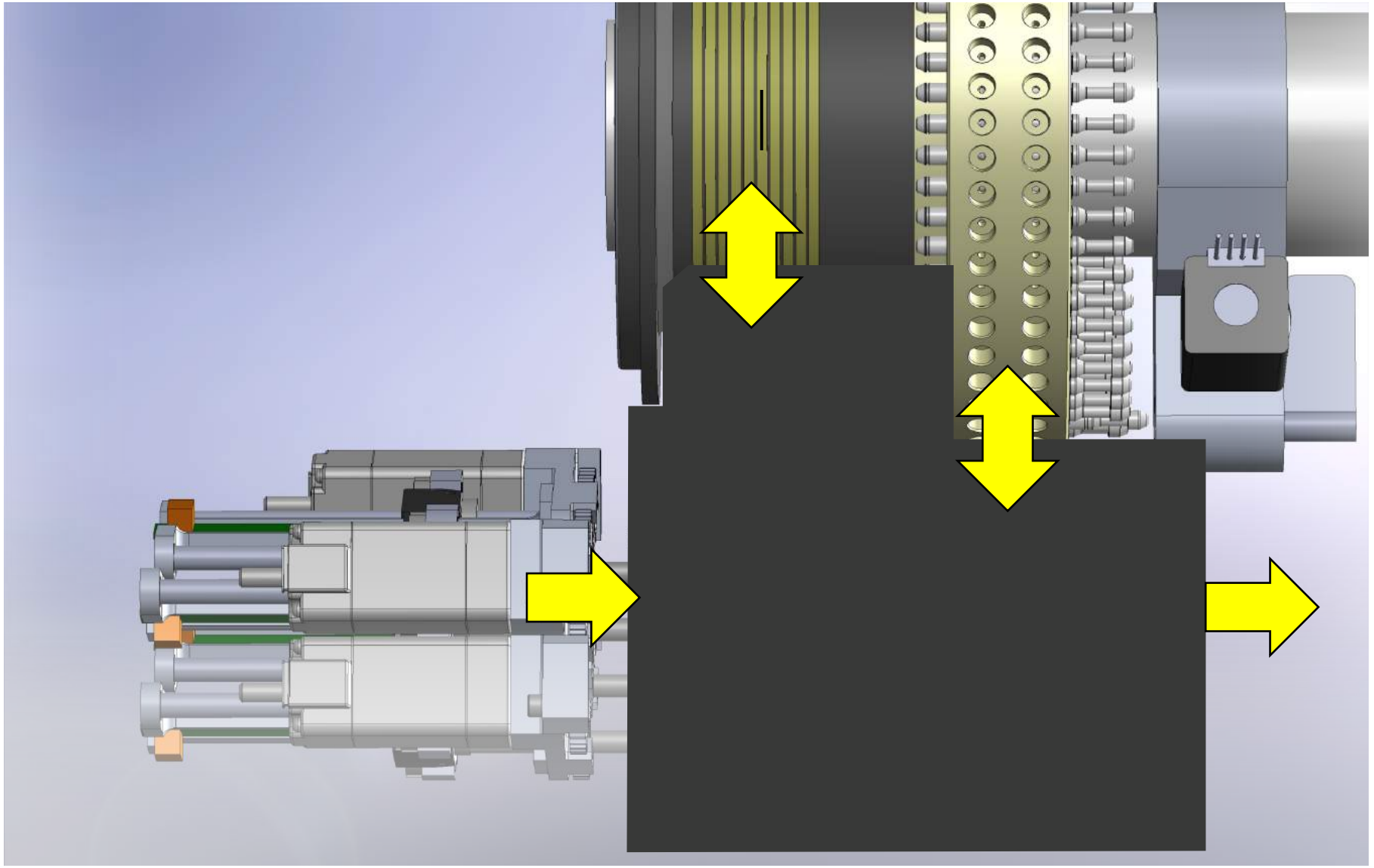
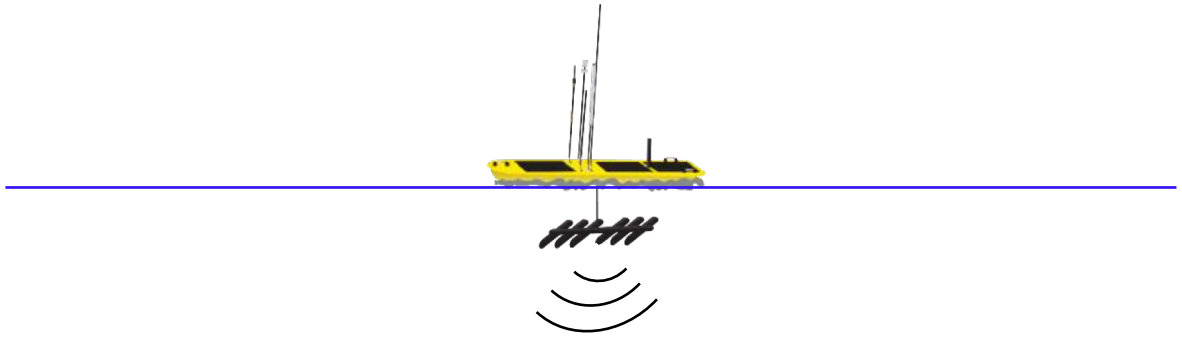
Modularity and standardized interfaces offer flexibility



Eddy Exploration
March 10 to April 10, 2018

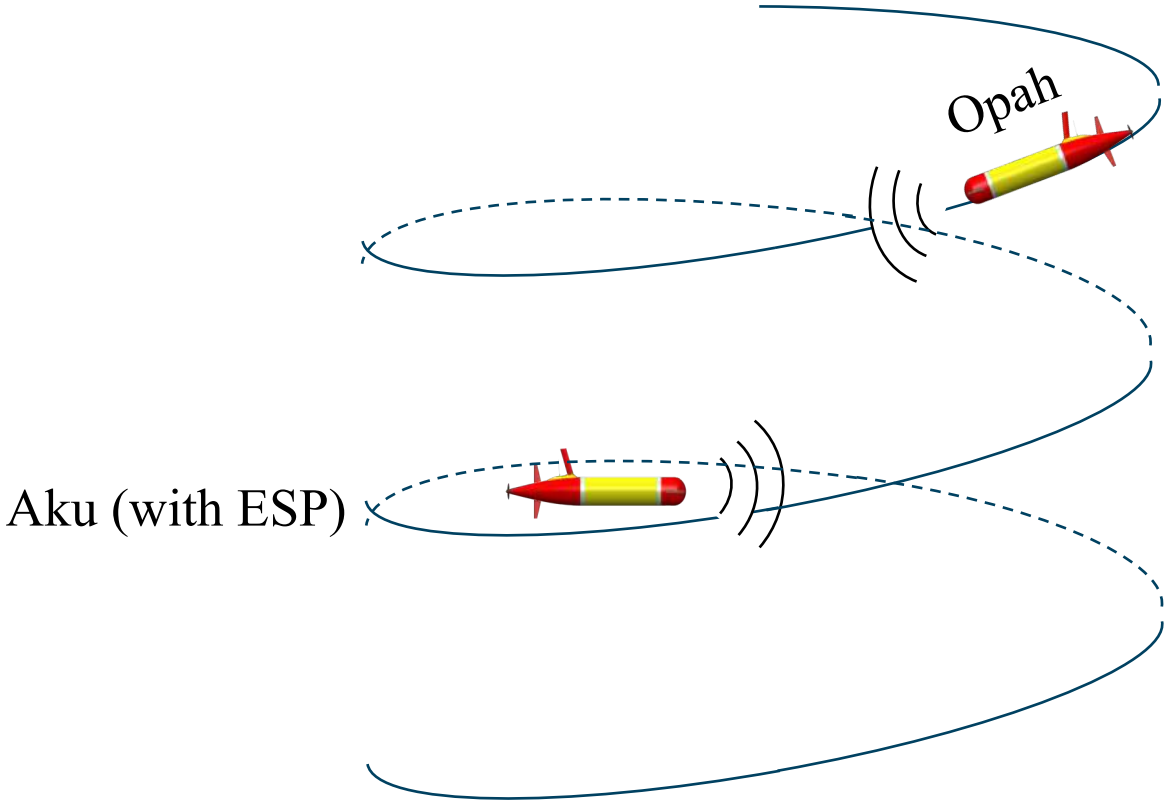
Following a cohort of organisms that make up the DCM



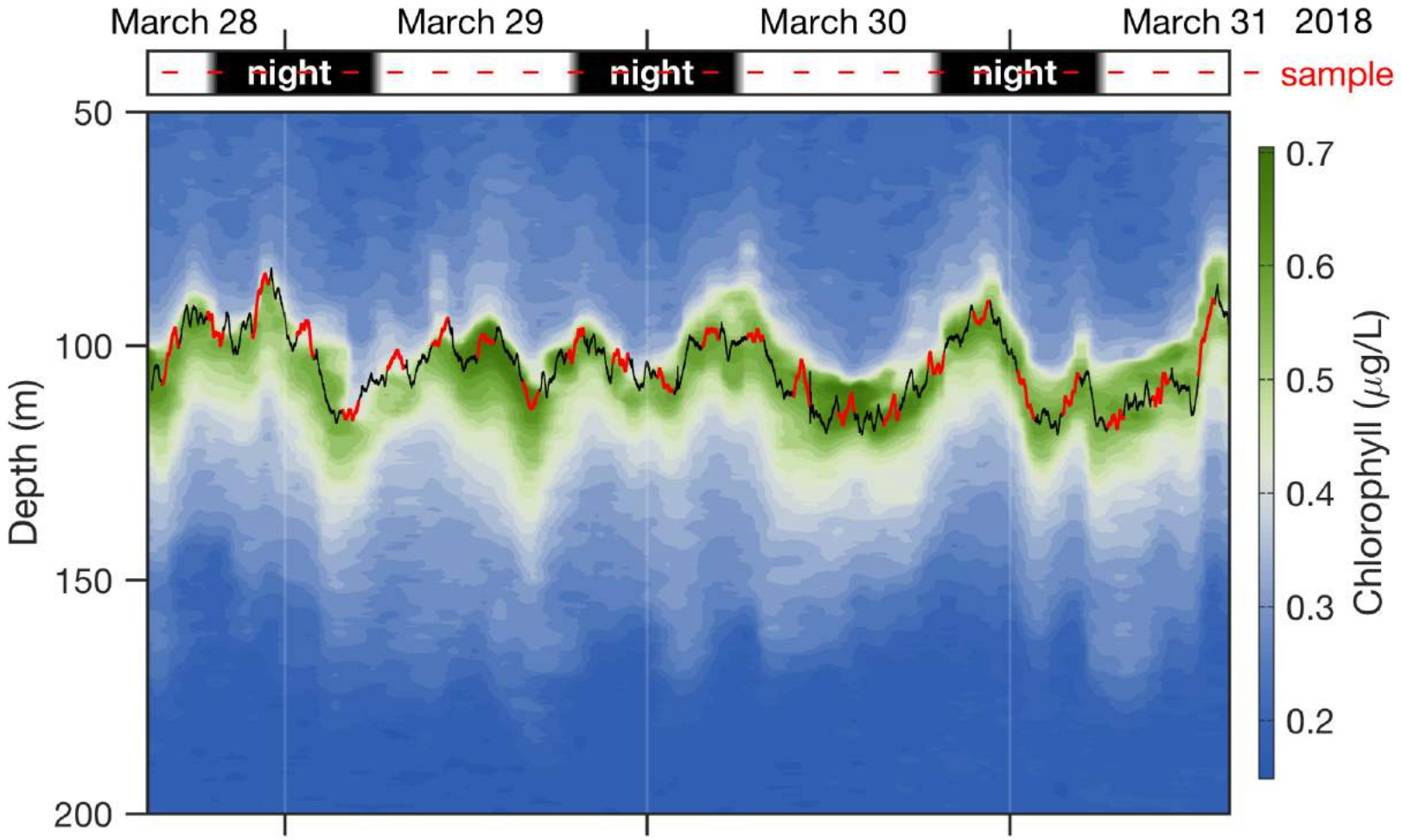
Aku: track and drift within DCM

Wave Glider: follow Aku

Opah: spiral around Aku for contextual measurements

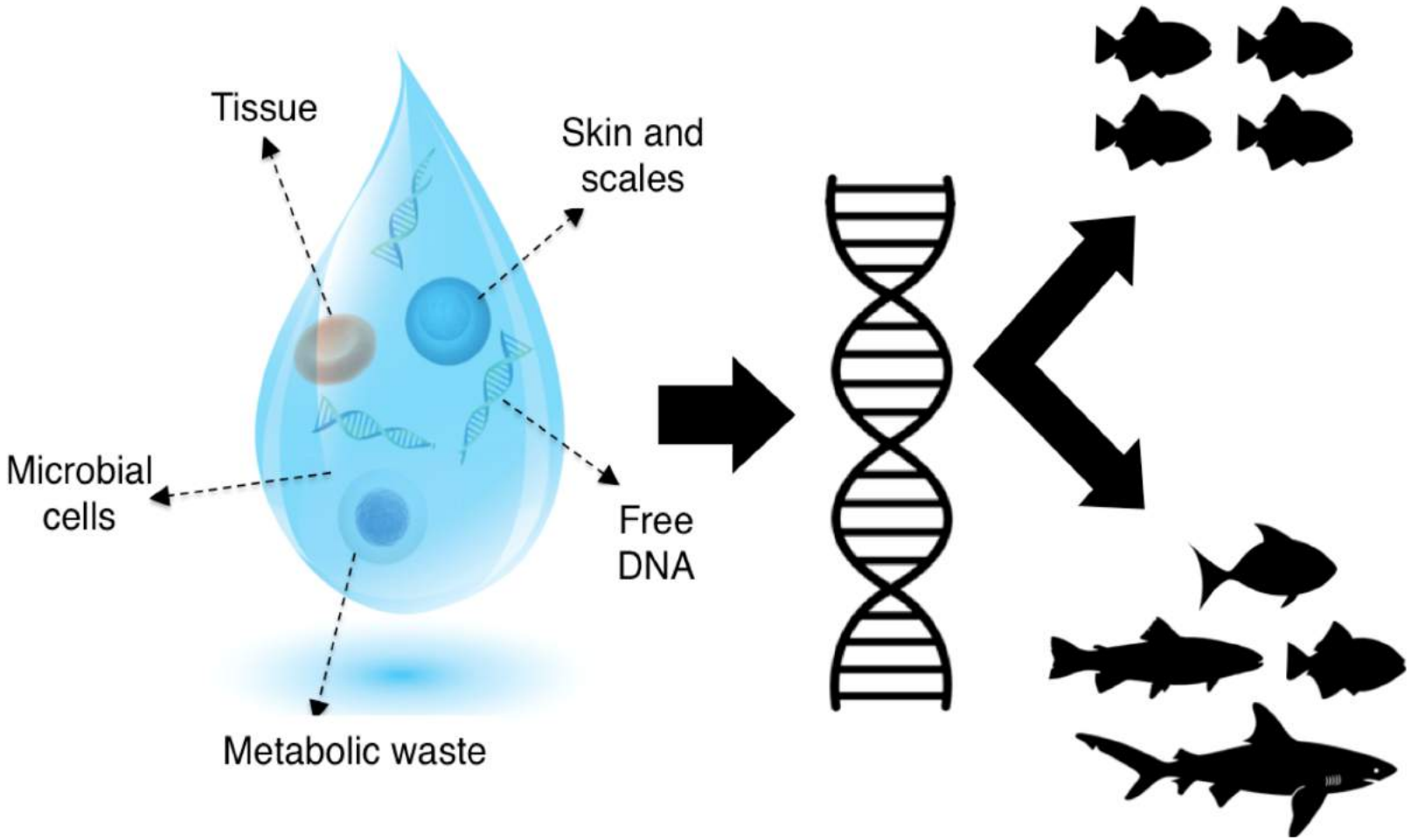


Repeatedly acquire samples without surfacing



Zhang et al. 2019 *Front. Mar. Sci.*

Rethinking “environmental DNA” (eDNA)



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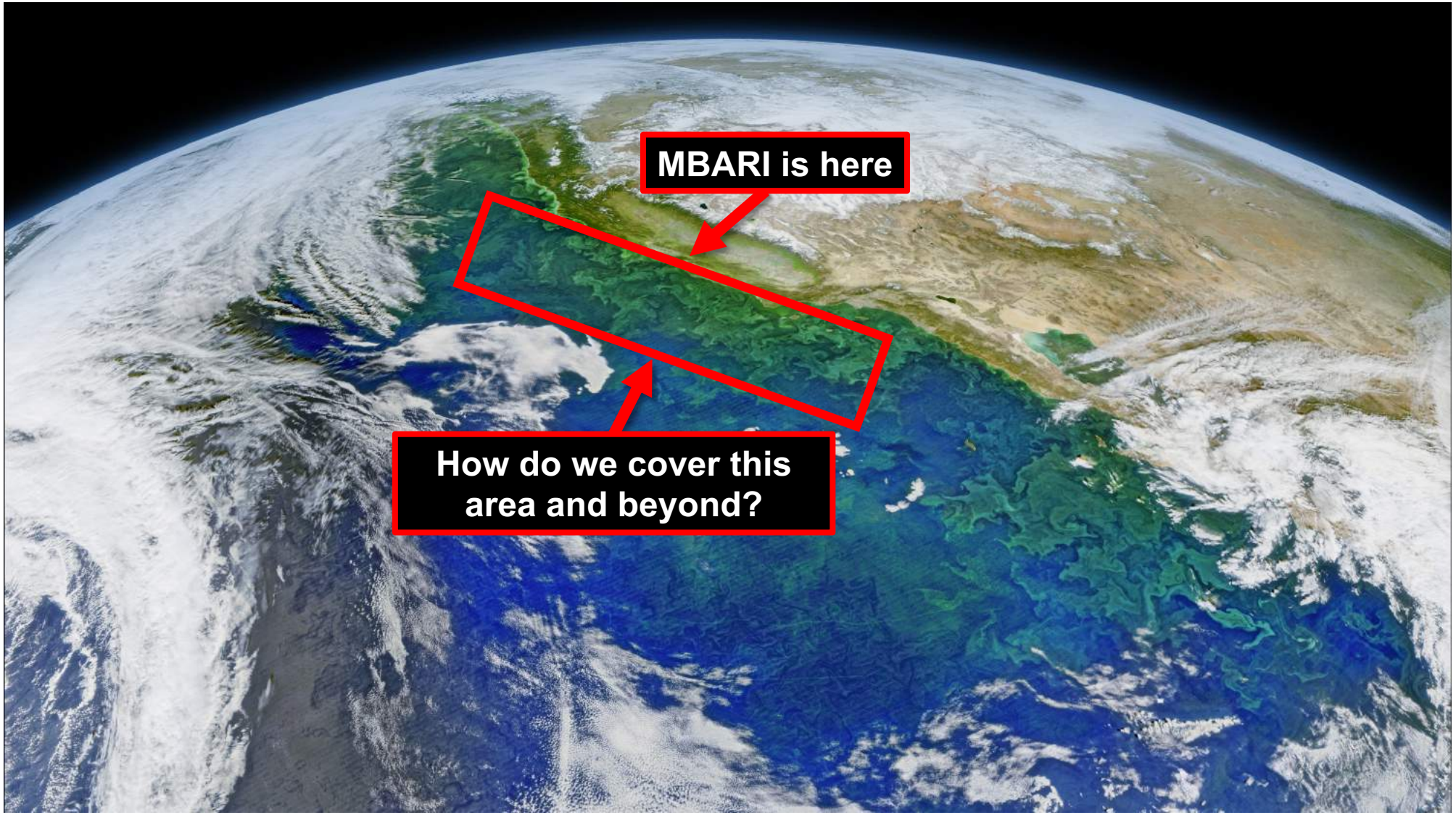
eDNA as a fisheries management tool?

Autonomous, free-ranging robots can accomplish many of the routine tasks currently carried out by people on ships for lower cost and with greater coverage

How do we scale up eDNA analyses?



Fleets of autonomous vehicles equipped with sensors and samplers offers a new paradigm for ocean science and resource management

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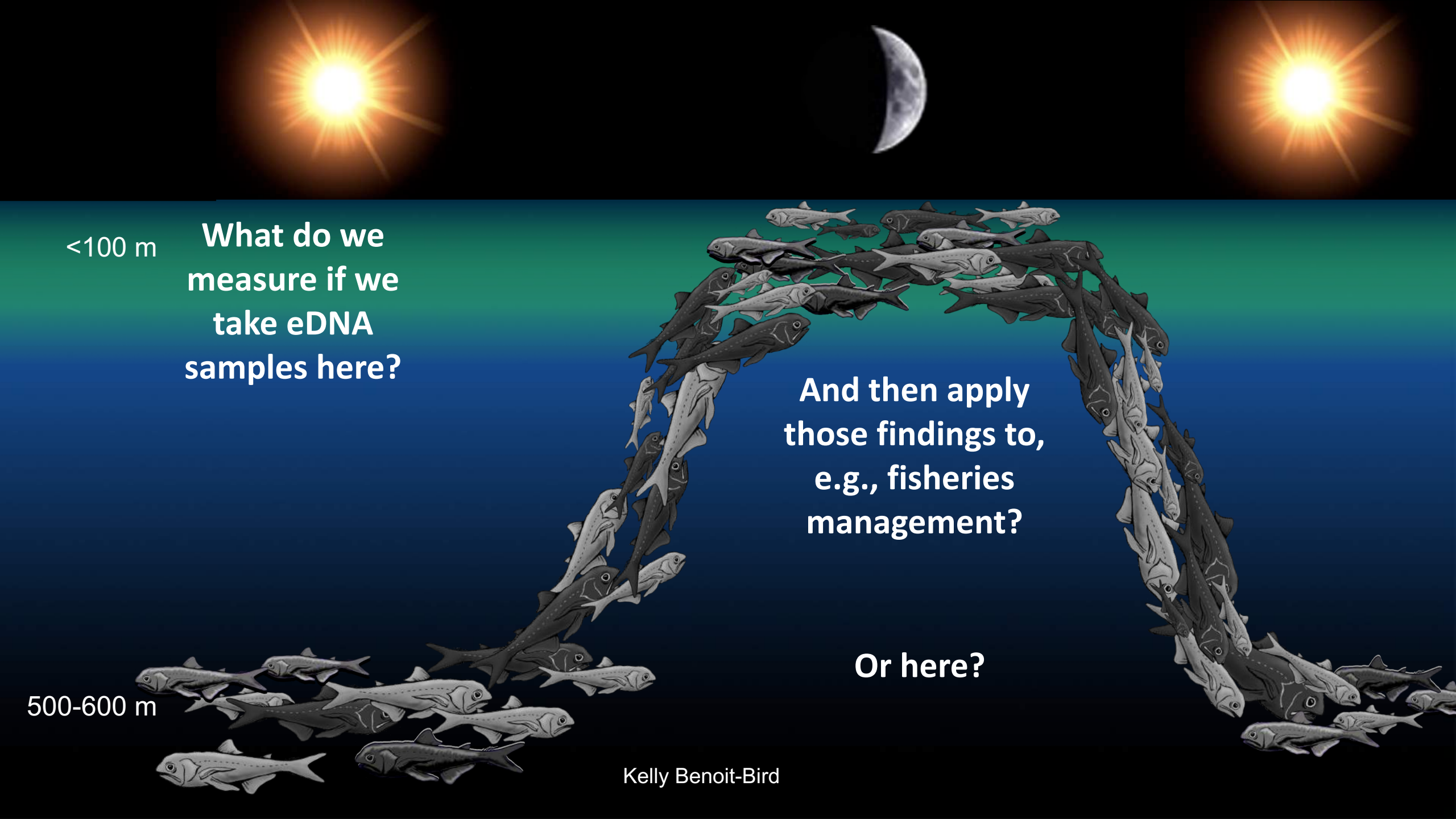
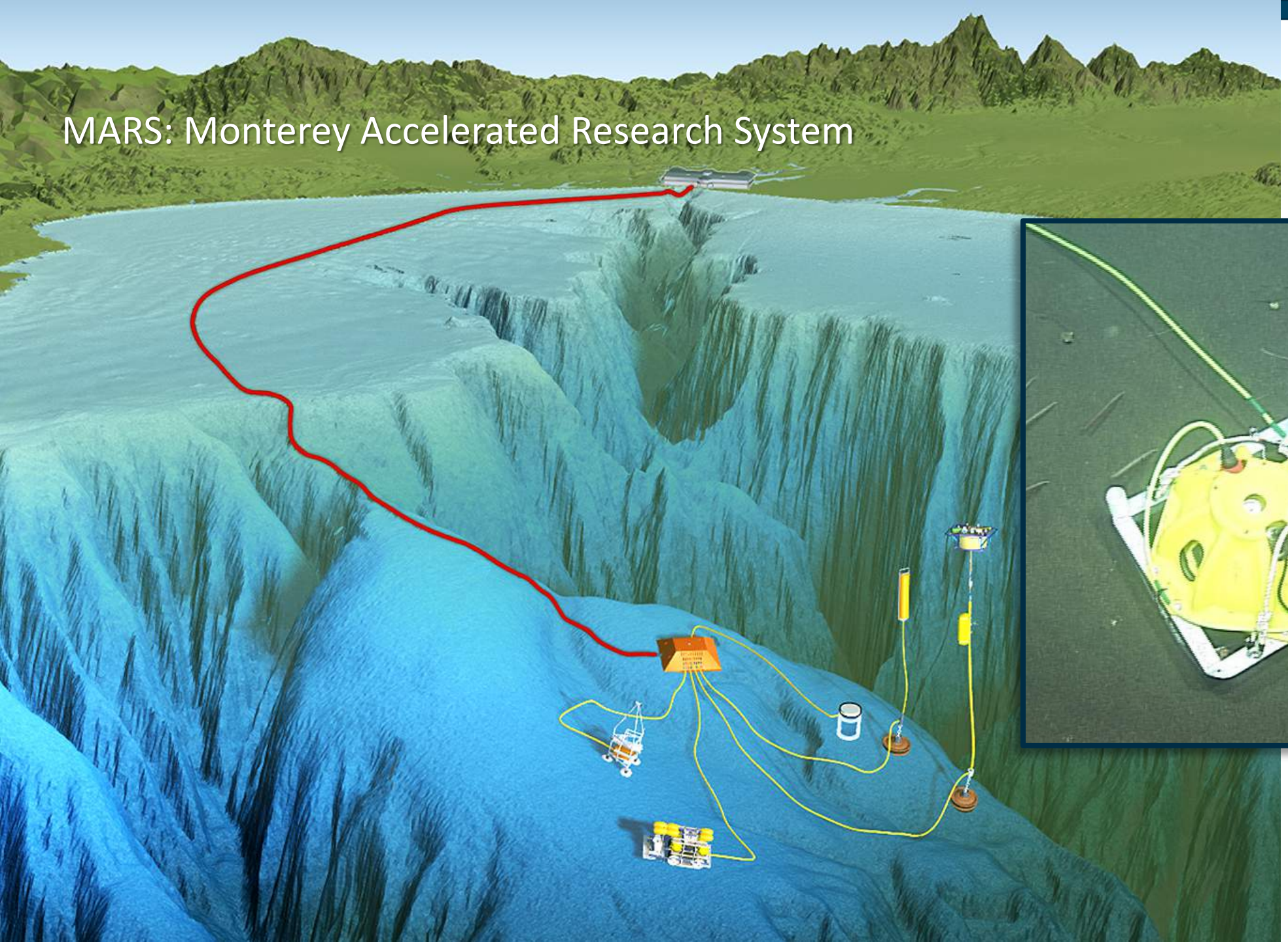
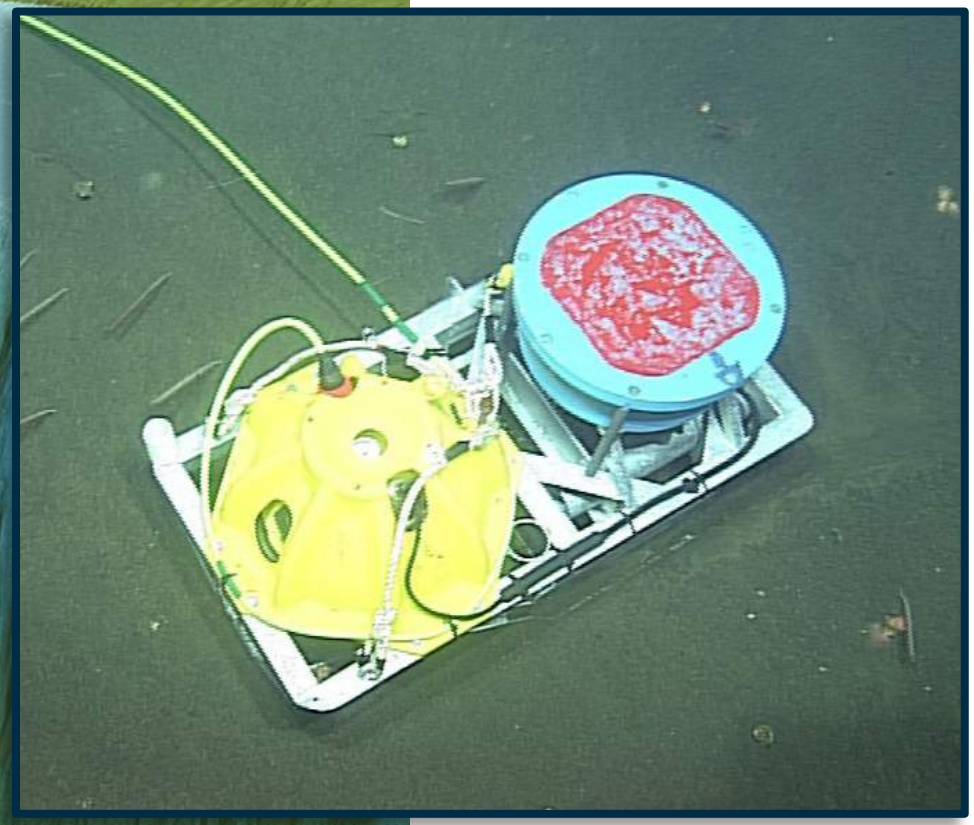
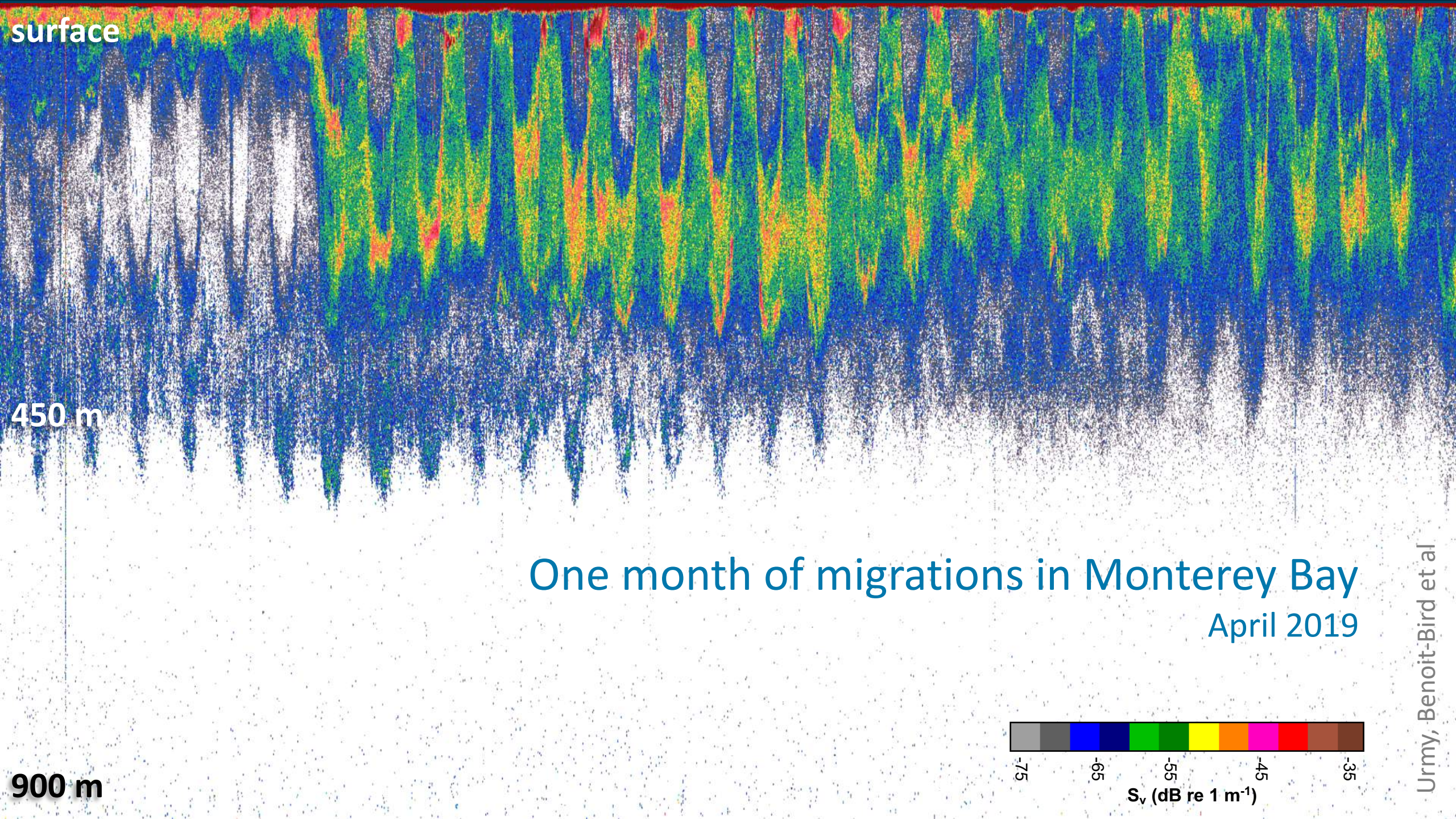

<100 m
What do we measure if we take eDNA samples here?
And then apply those findings to, e.g., fisheries management?
Or here?
500-600 m
Kelly Benoit-Bird

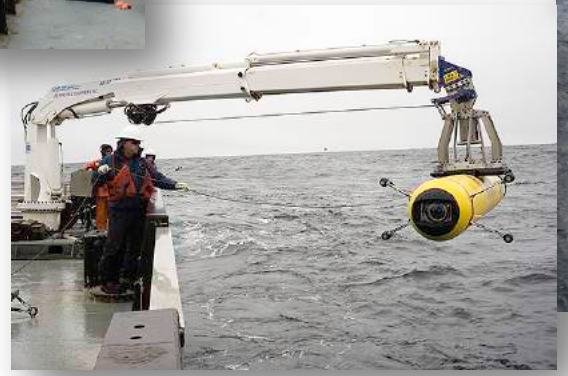
MARS: Monterey Accelerated Research System






surface
450 m
900 m
One month of migrations in Monterey Bay
April 2019
-75
-65
-55
-45
-35
S_v (dB re 1 m^{-1})
Urmy, Benoit-Bird et al

Observing the greatest daily migration on Earth with a fisheries application in mind



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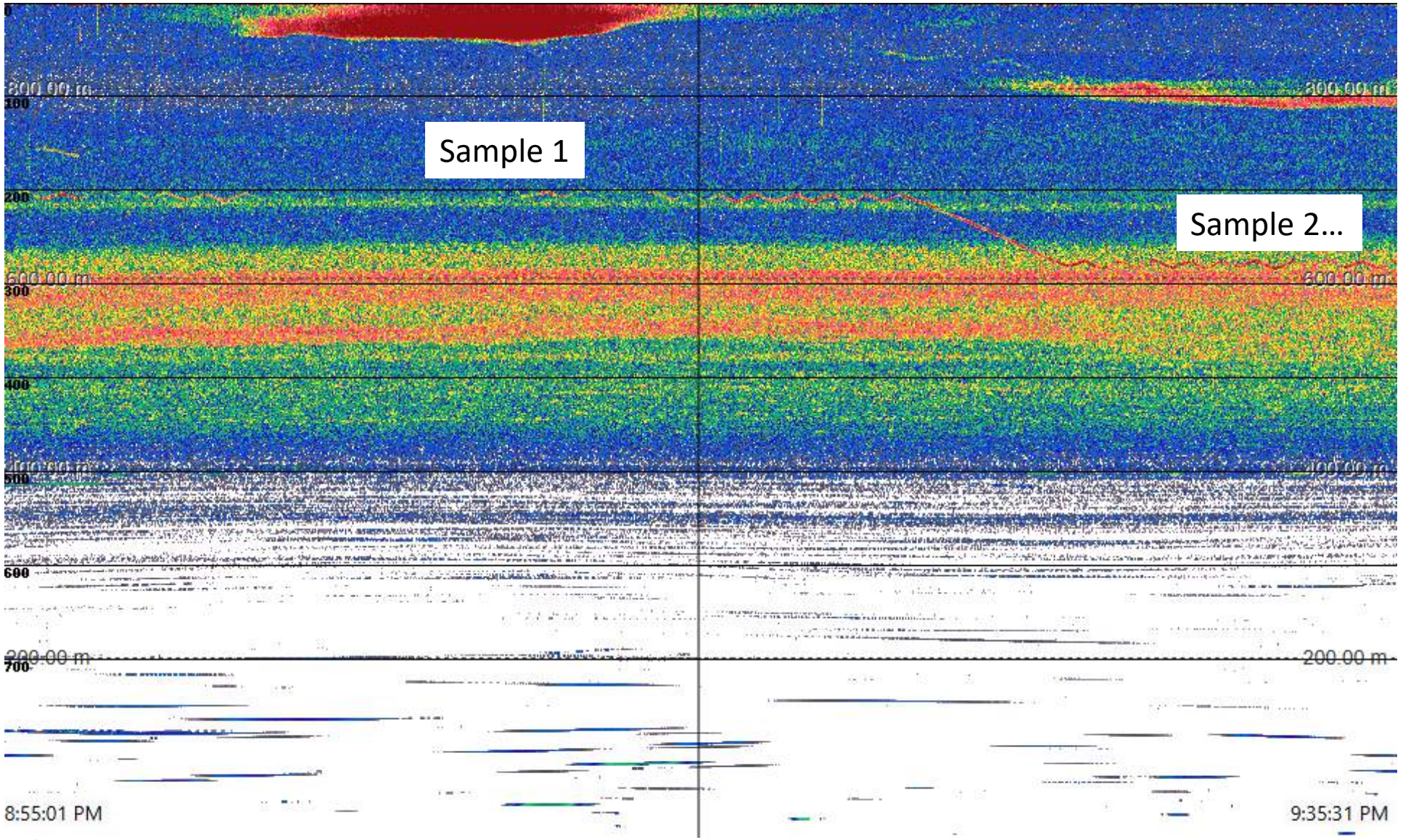
Using acoustics to guide autonomous eDNA sample collections



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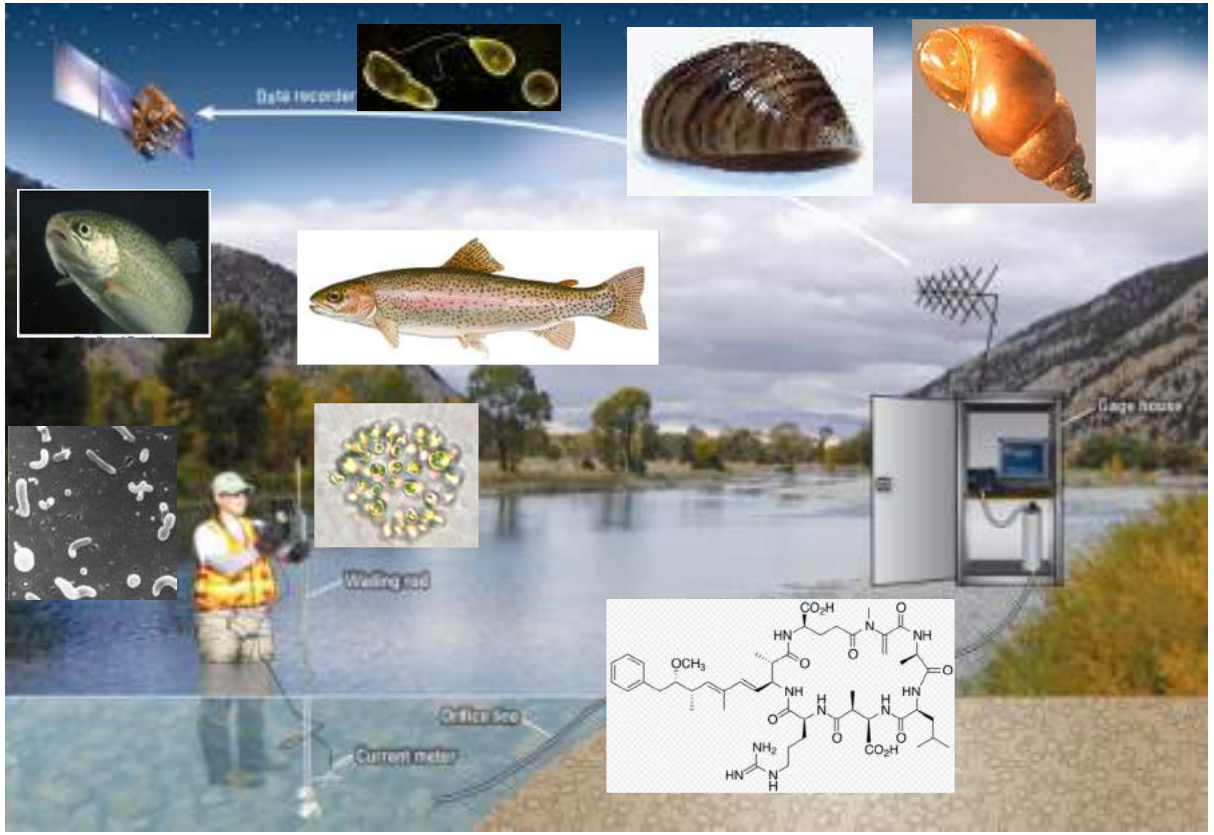
Courtesy: Sam Urmy and Kelly Benoit-Bird (MBARI)

The same sampling/analytical system used on an AUV can also be hand-portable

Or configured for remote applications

Can we use real-time DNA sampling/analysis throughout the stream gage network to detect pathogens, toxins, invasive and managed species?



Thank you!

Questions?

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