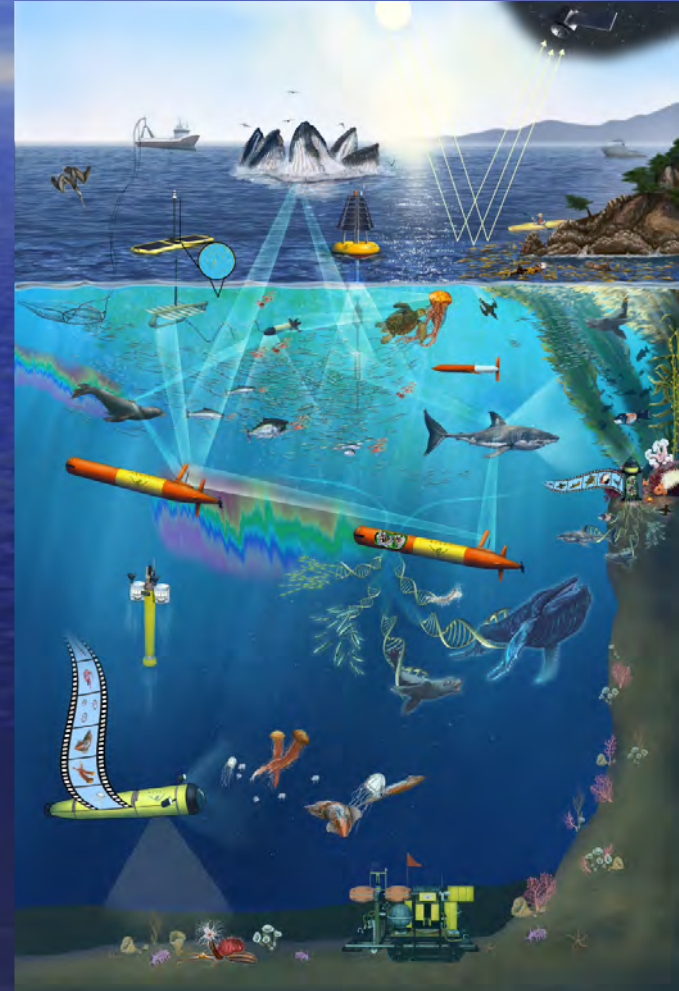
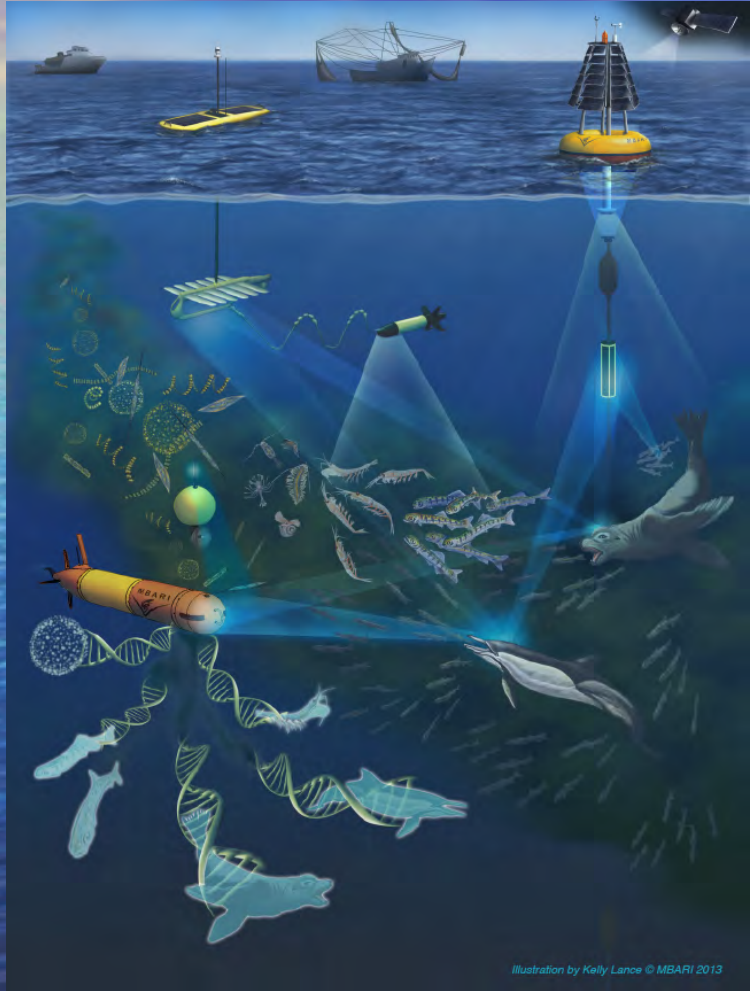


CANON – Controlled, Agile and Novel Observing Network

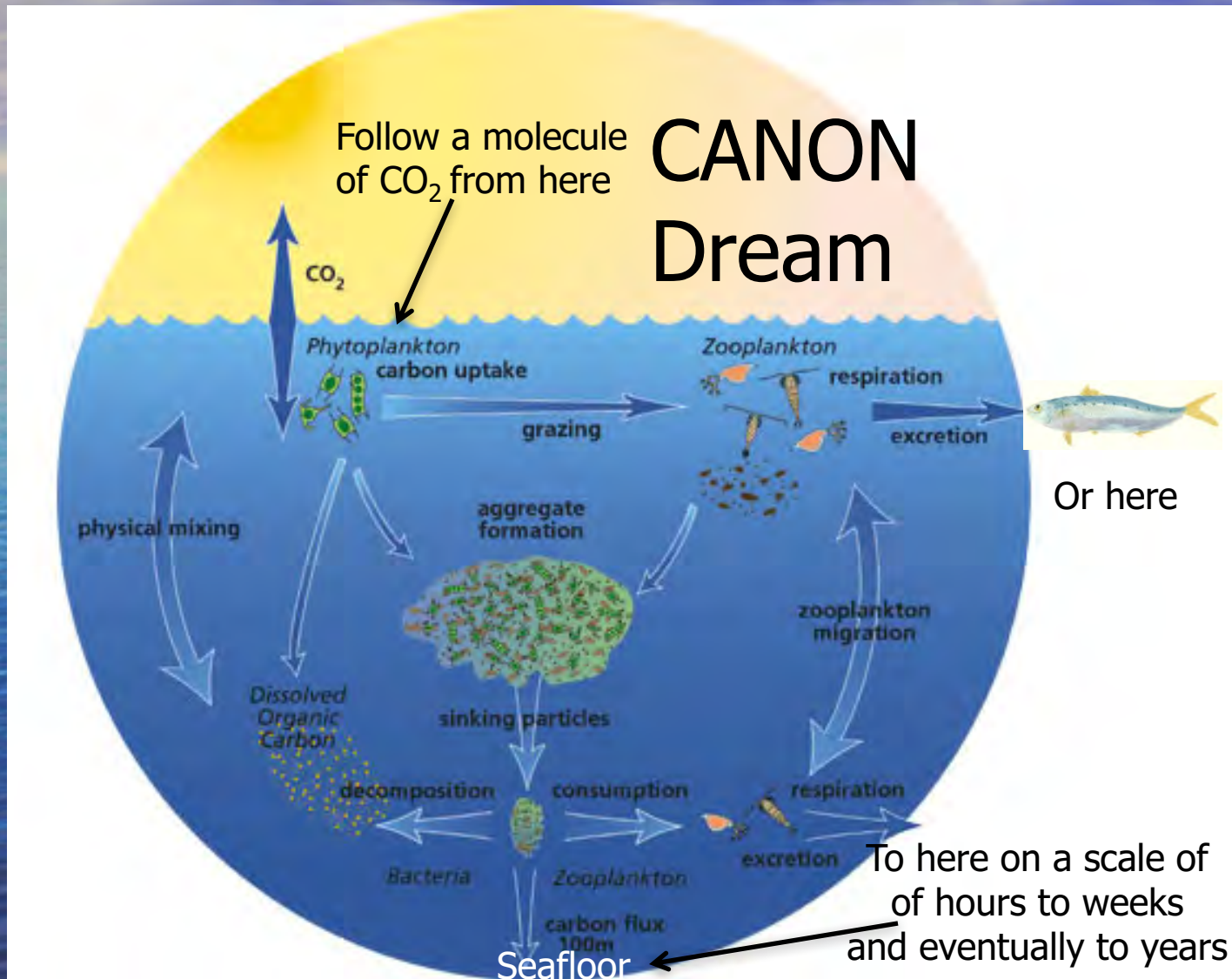


Francisco Chavez and CANON team (Scholin, Bellingham, Hobson, Gomes, Messie and others)

CANON goals

- Improve predictive understanding of the long term and large scale consequences of global change **by**
- Development of an ecosystem processes following and resolving ocean observing system **that leads to**
- Improved parameterizations of ocean models

The biological pump: a complex process in an ever-changing and fluid ocean – sharp contrast to land



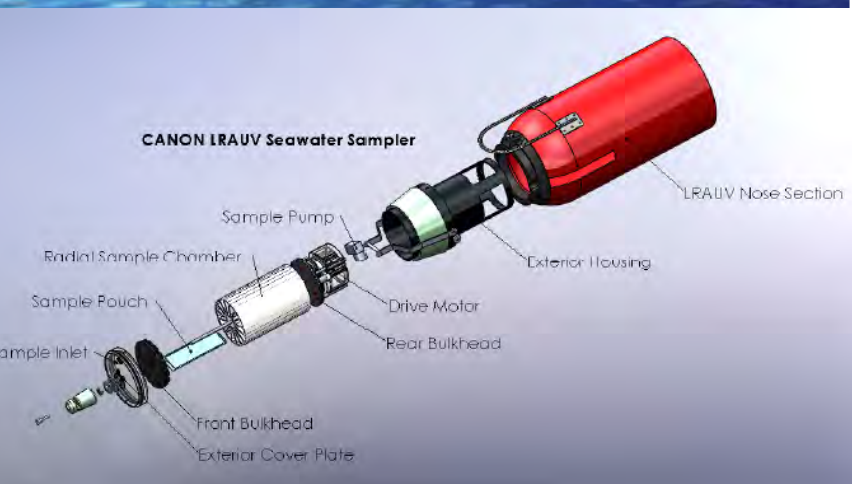
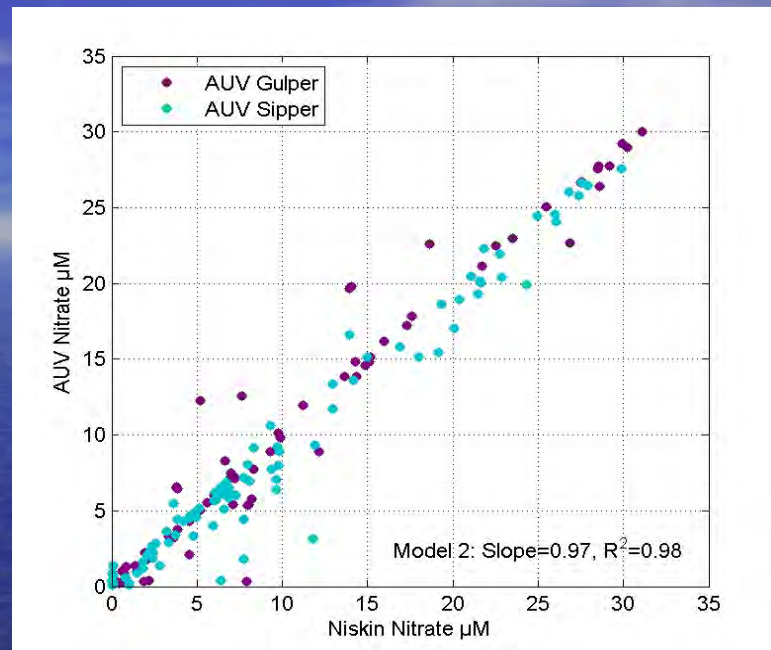
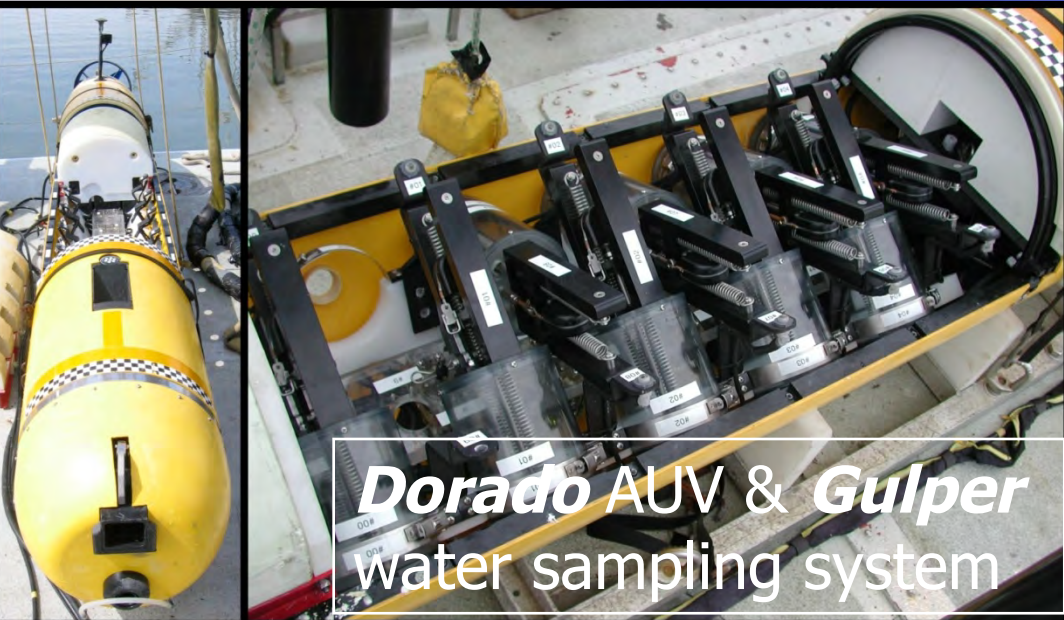
A dream that today has a semblance of reality

Requirements for following in 4-D

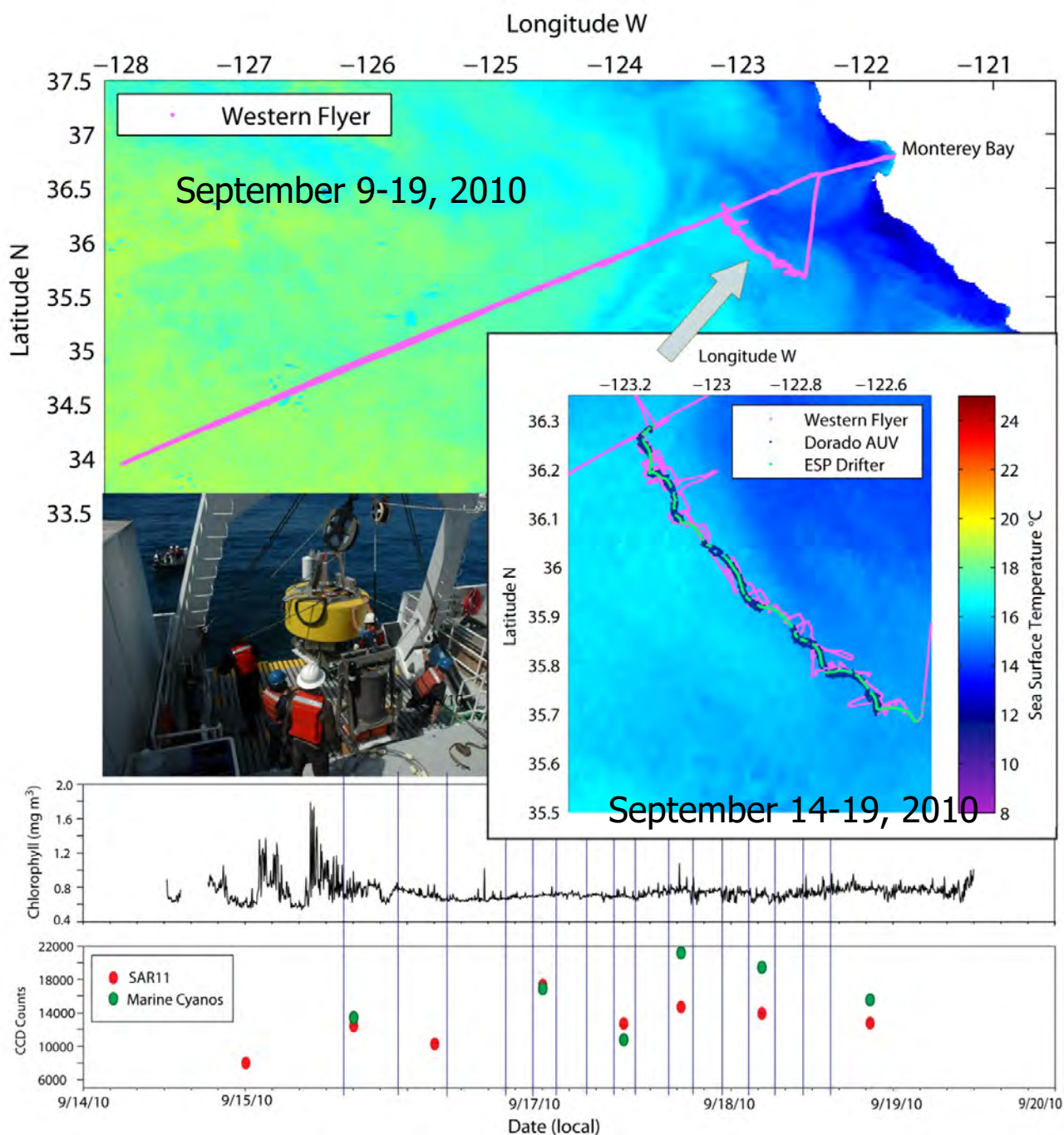
- Mobile and fixed platforms
- Instrumentation and “samplers” for water, particles, rates
- Novel analytical methods
- Software to intelligently sample and control *in situ* assets
- Decision Support System (DSS) to integrate information, planning and analysis tools

A revolution of autonomous platforms and sensors (optical and genomic) is underway.

MBARI AUVs with samplers



Following the ESP drifter

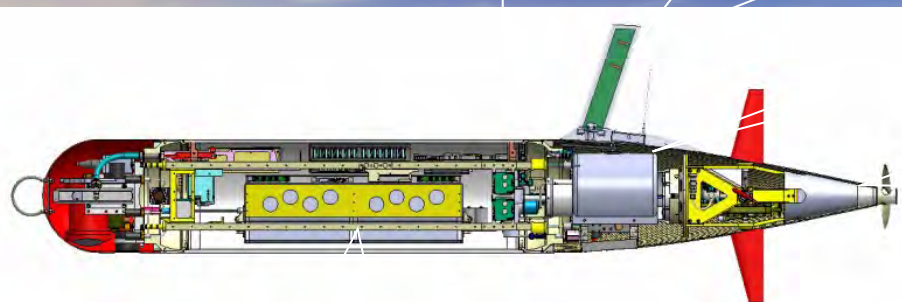


MBARI LRAUV Specifications

Core sensors: DVL/ADCP (Rowe),
Fluorometer/ Backscatter (WetLabs),
CTD (Seabird), PAR, O2 (Aanderaa)

Iridium, GPS, WiFi and
Cellular in mast
Backup argos and VHF

Buoyancy Engine allows
neutral drift in water
column

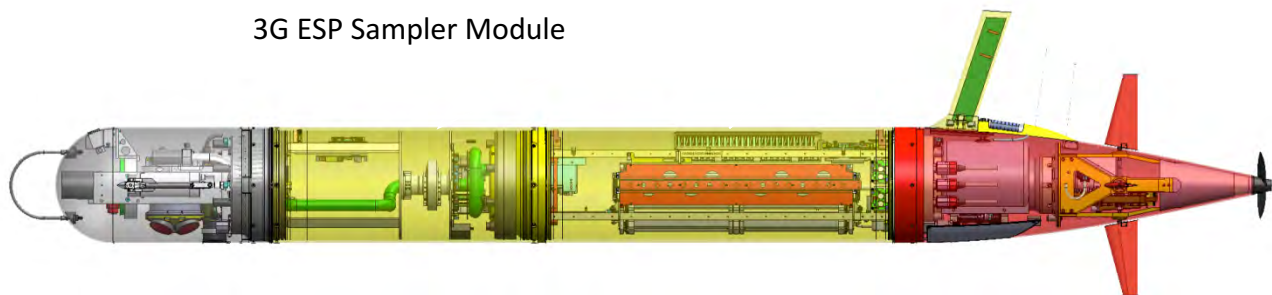


Efficient low-speed
propeller
Paired Rudder and Elevator
Control Surfaces

Load Control System
18 configurable channels
Isolates load, circuit breaker,
ground fault detection

6 kWh rechargeable,
11 kWh expendable
Shifting Mass allows controlled
angle of attack during flight

3G ESP Sampler Module



With 3G ESP Nose

Mass:	110 kg (240lb) dry weight	160 kg (354 lbs)
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Size:	0.3m (12") diameter, 2.47m long	3.18 m long
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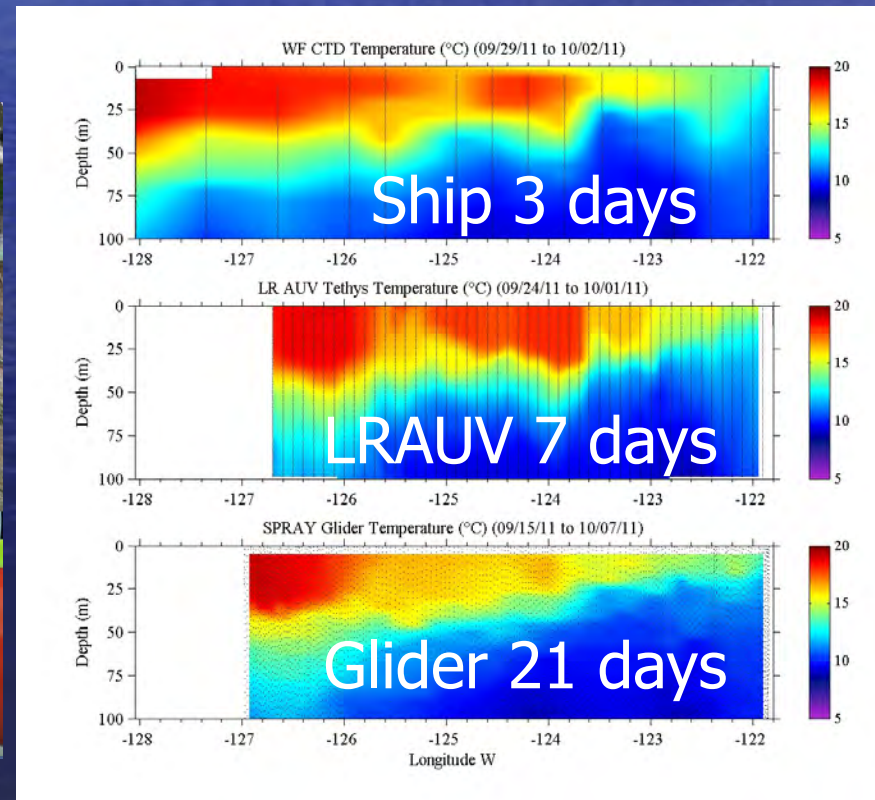
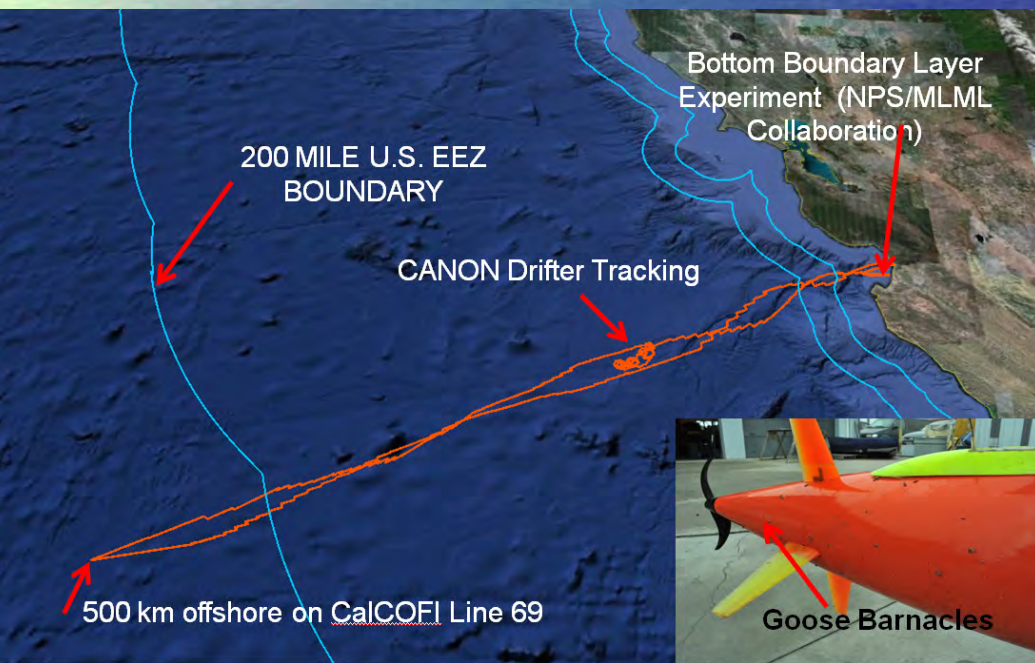
Speed:	0.5 – 1.2 m/s plus hover	
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~3km/h: Long Nose Range Est.: 400 Ah energy, ~1 Ah/h rate,

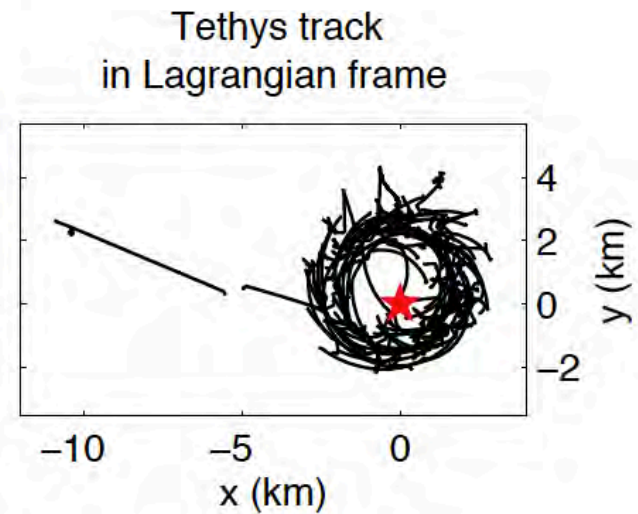
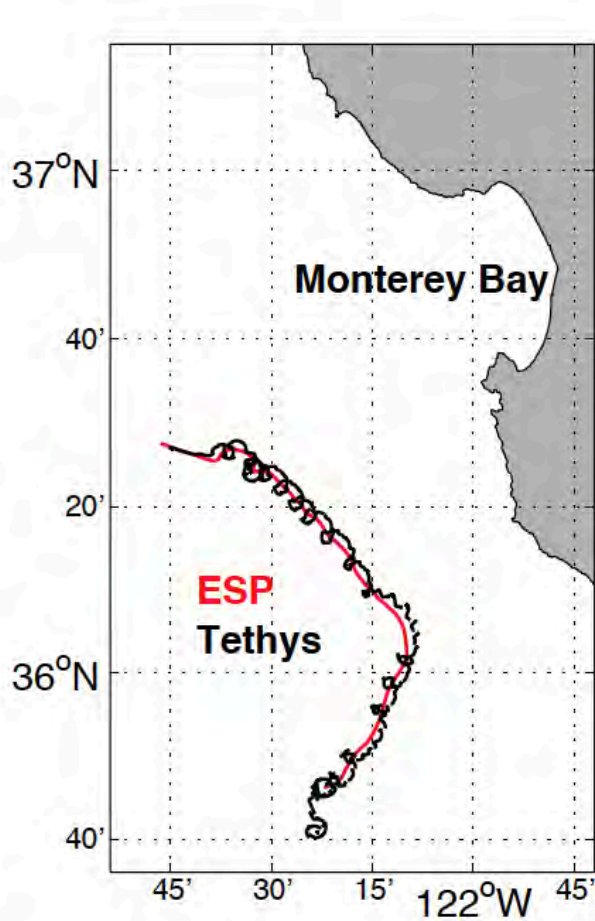
~3km/h:

~14 days, 945 km at full speed

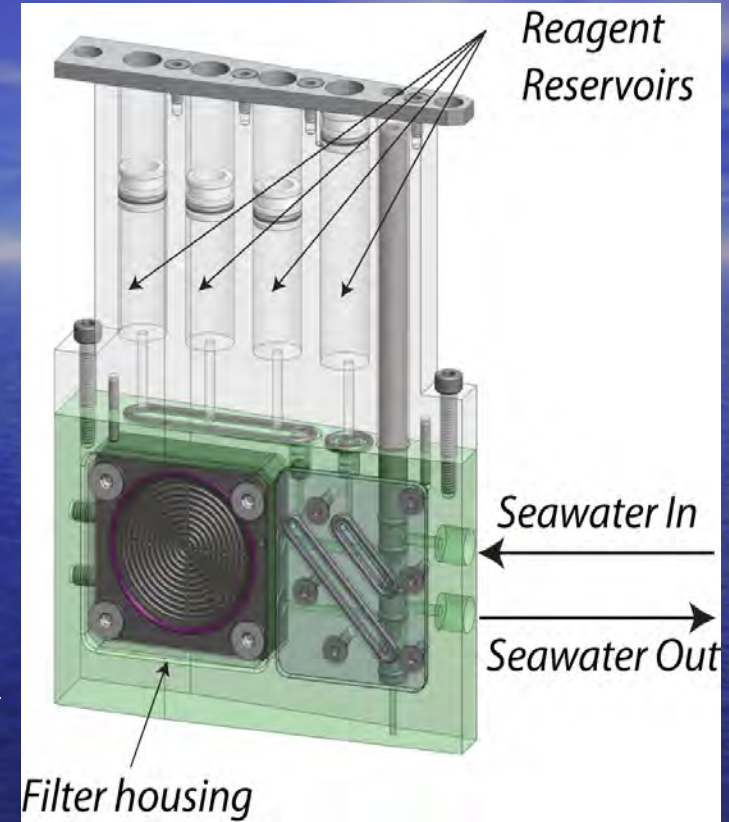
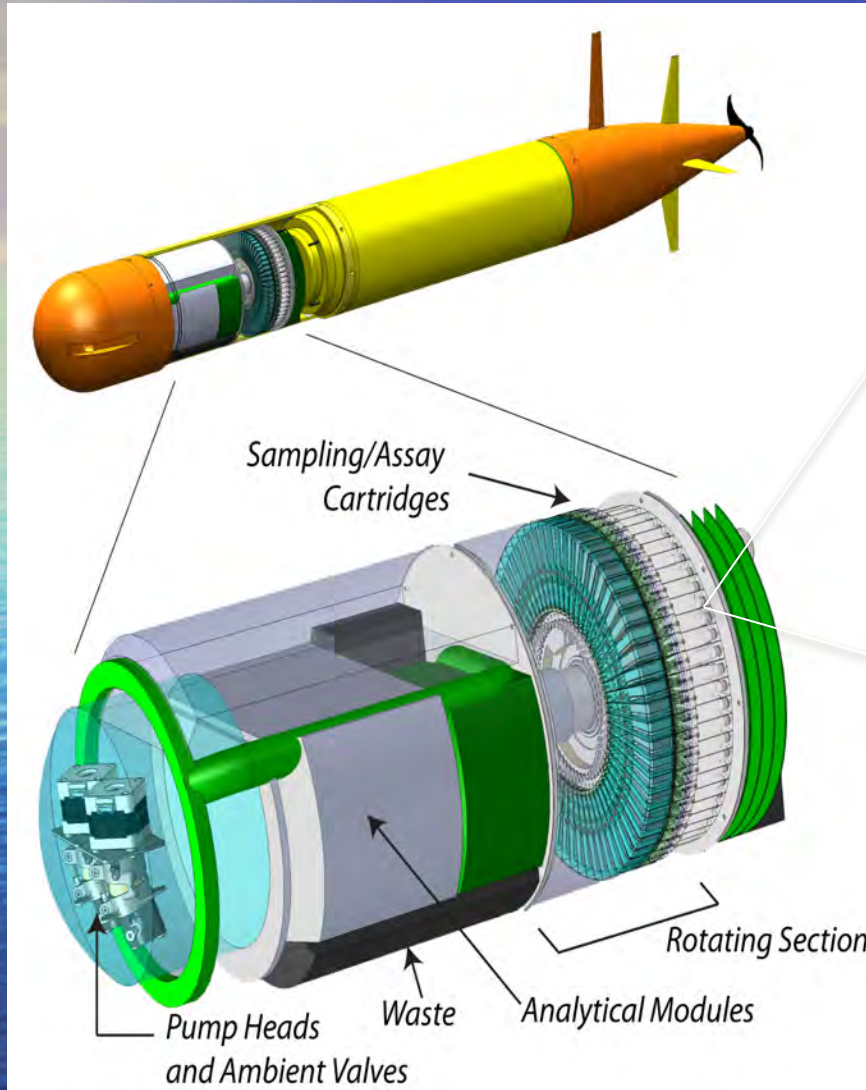
LRAUV capable of 1800 km missions, three times faster than glider, with greater science payload



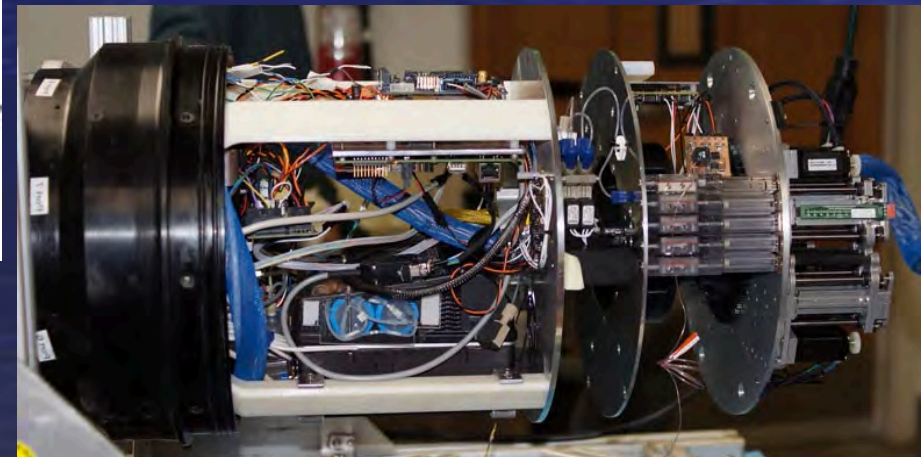
LRAUV followed drifting ESP autonomously for 5 days



LRAUV coupled 3rd Generation(3G) ESP



- Requirements:
- Small size, low power, self-contained
 - Archive sample, or process sample



Environmental DNA

Bacteria and
Phytoplankton



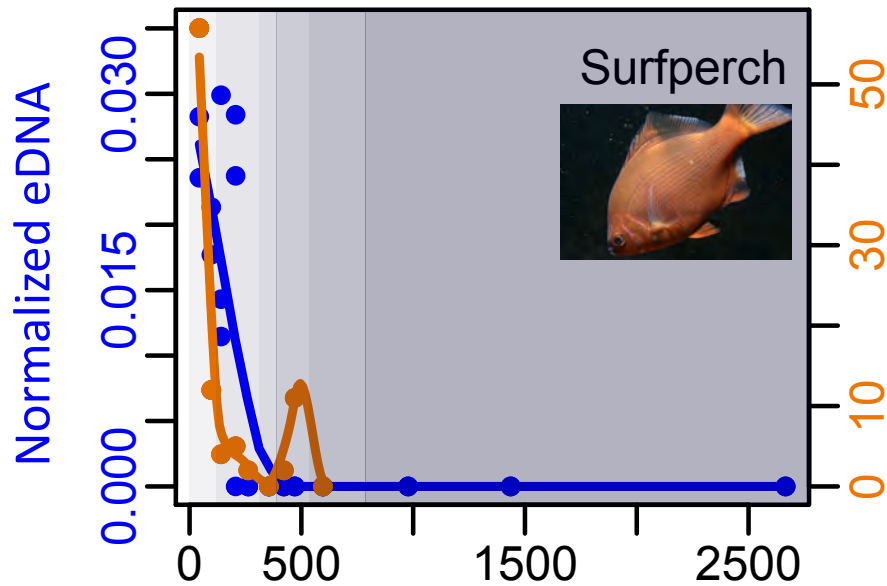
Skin and
Tissue Cells

Free DNA

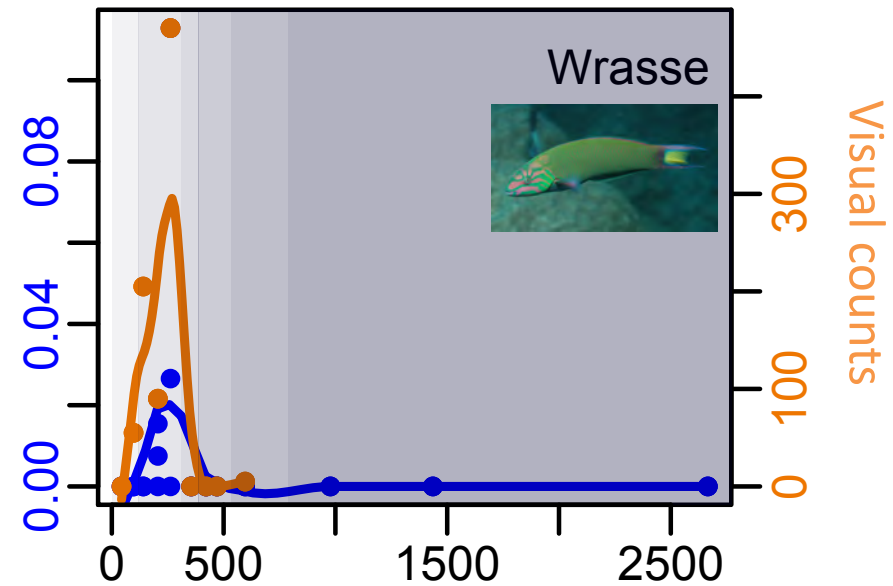
Viruses

“Ocean is a *genetic soup* of its resident species.”

Potential to go from microbes to whales from water samples – NGS or species specific primers, latter is easier



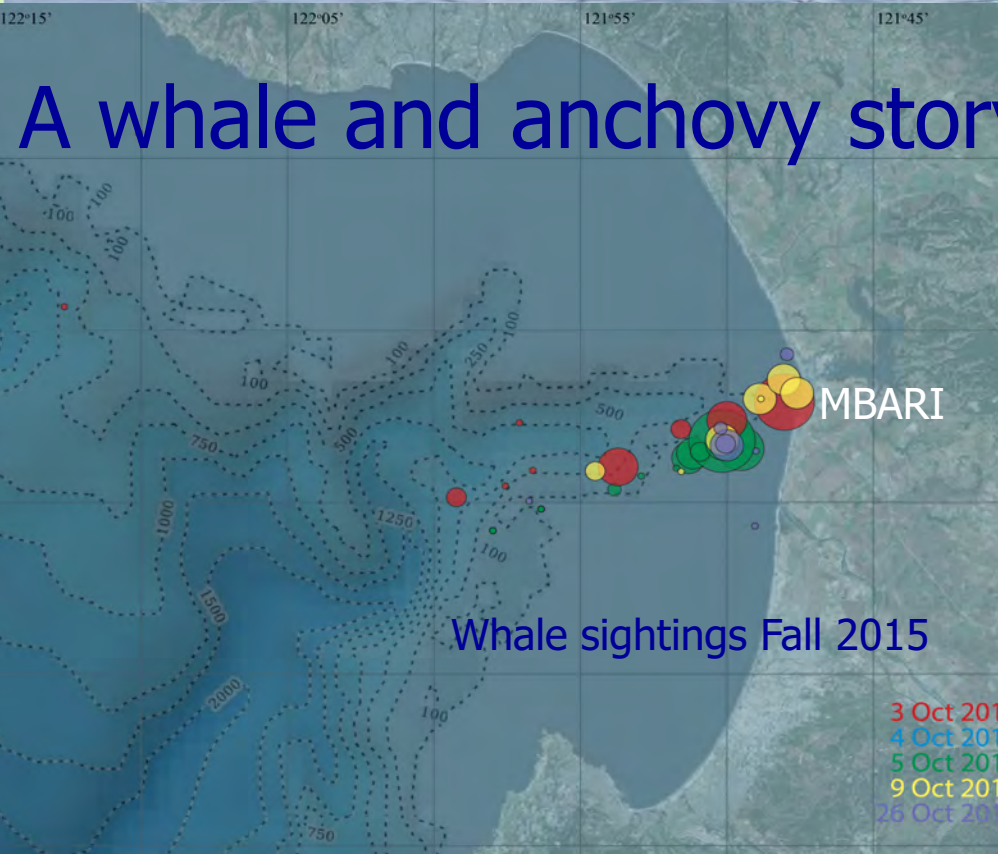
Surfperch



Wrasse

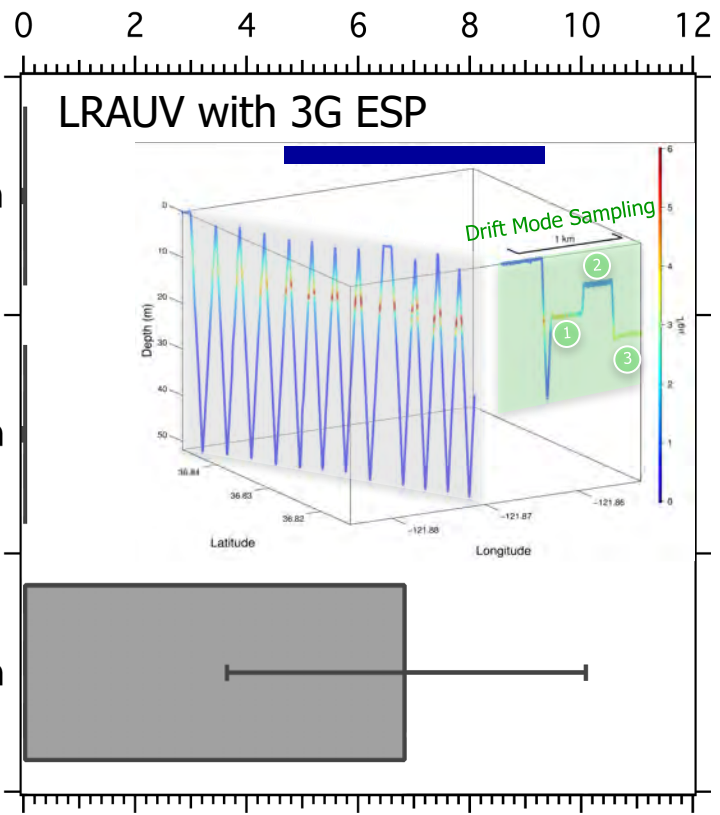


Distance from shore (meters)

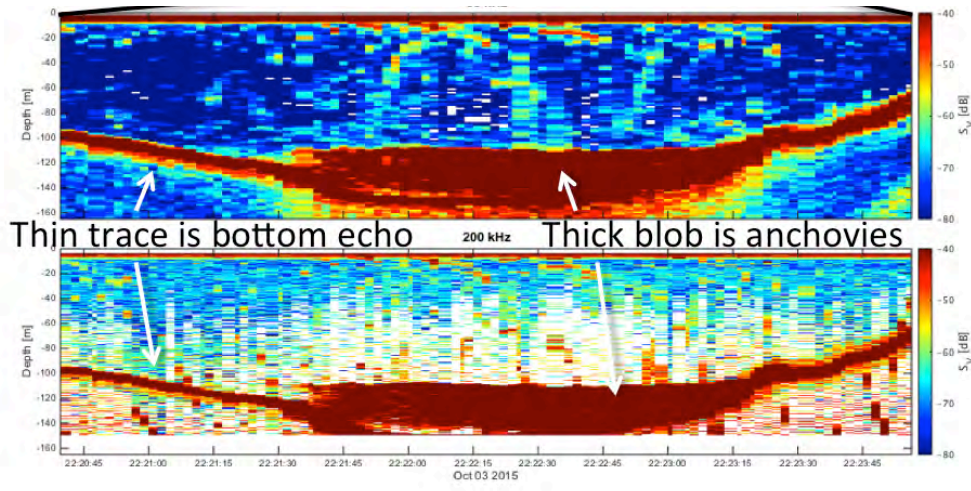
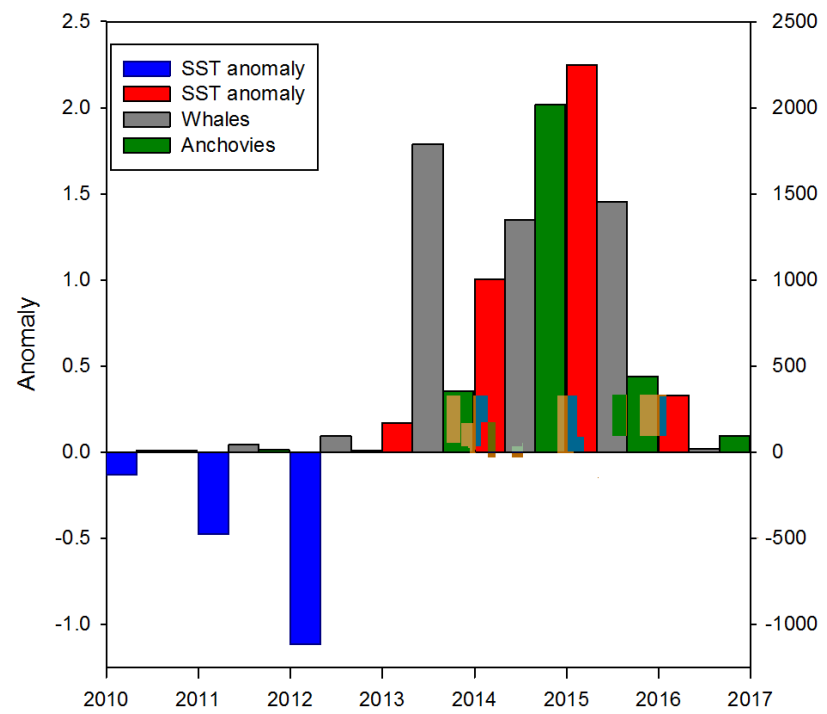


Historical samples analyzed for anchovy eDNA in relation to whale watching sightings at the mouth of the Monterey Canyon near Moss Landing. Anchovies aggregate at the bottom of the Canyon during the day.

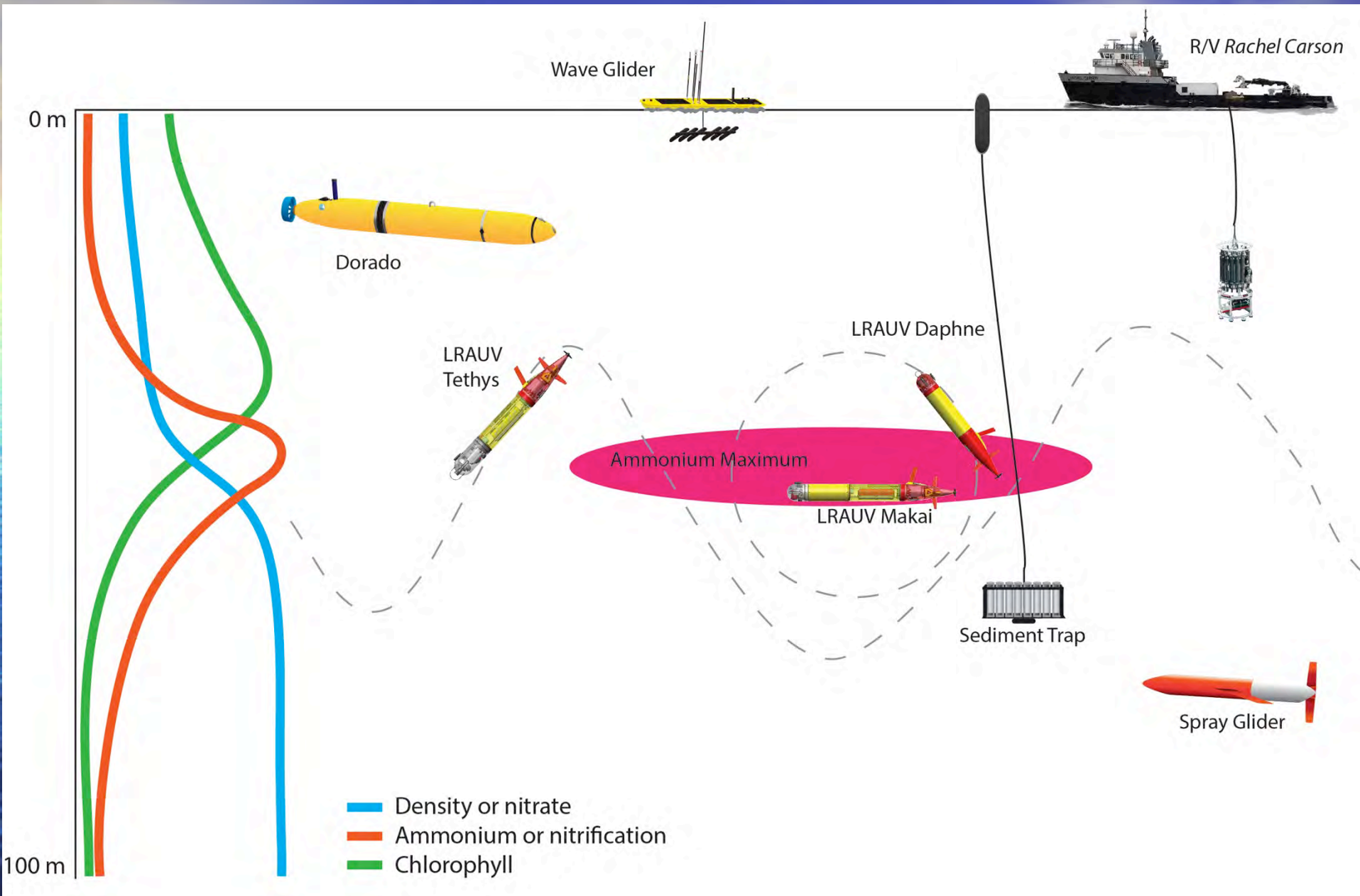
Anchovy eDNA (pg/mL seawater)



Monterey Bay, CA, station C1



Wave glider and Daphne followed Makai autonomously for 3 days as Makai drifted at depth

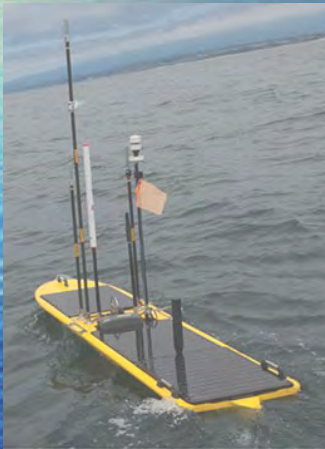


Autonomously tracking ecosystem processes

Makai



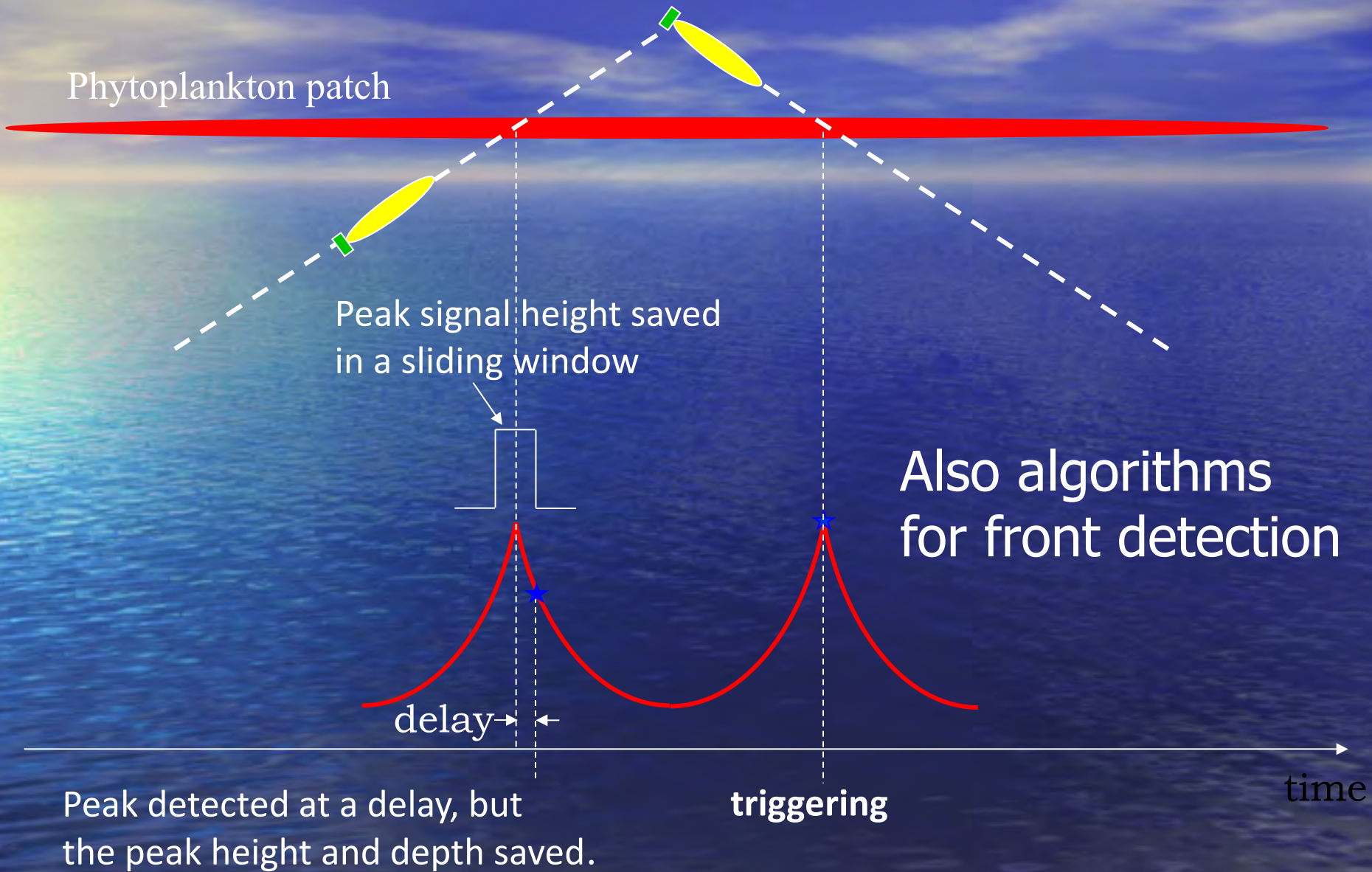
Wave Glider



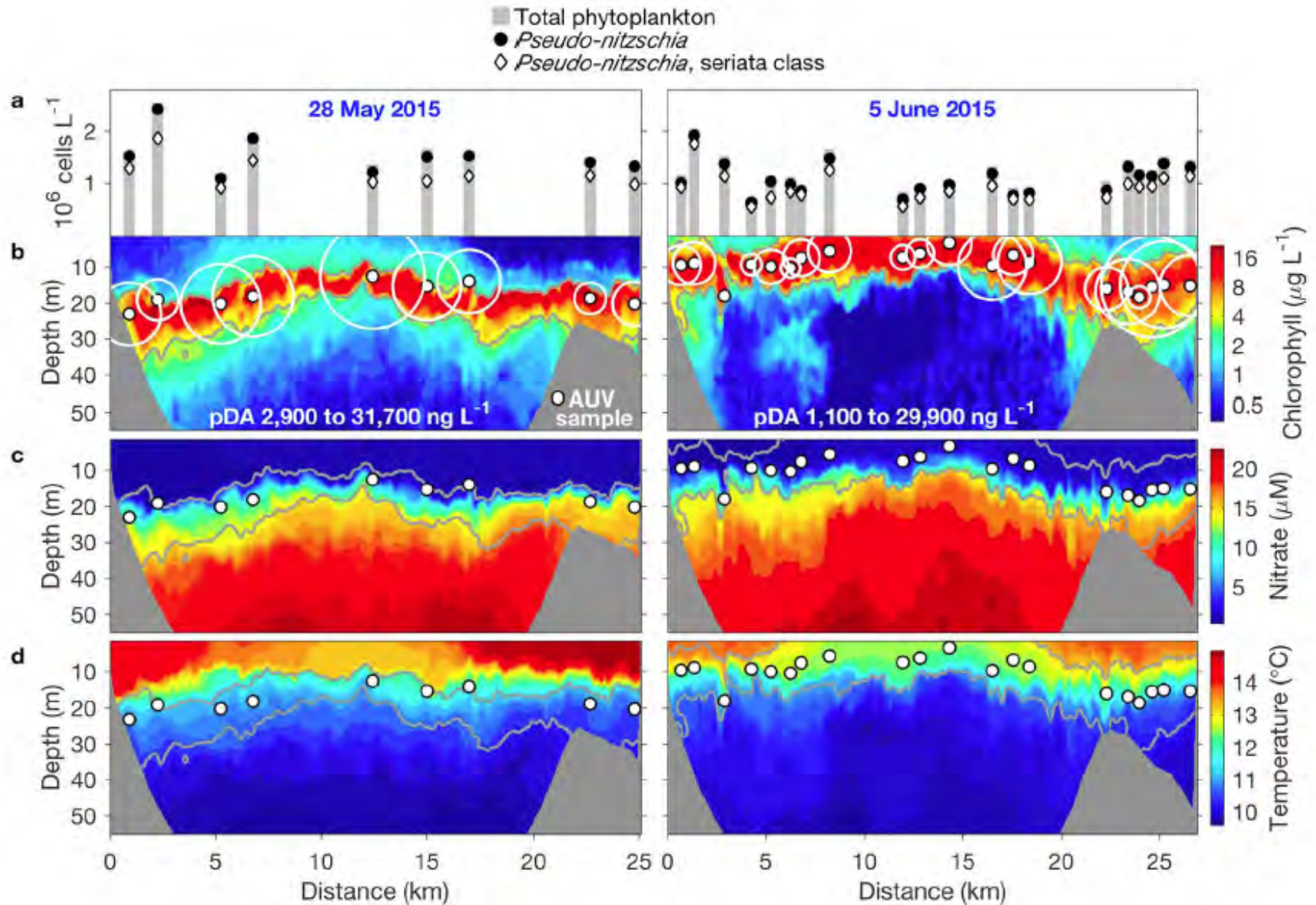
Daphne



Targeted sampling of plankton patches

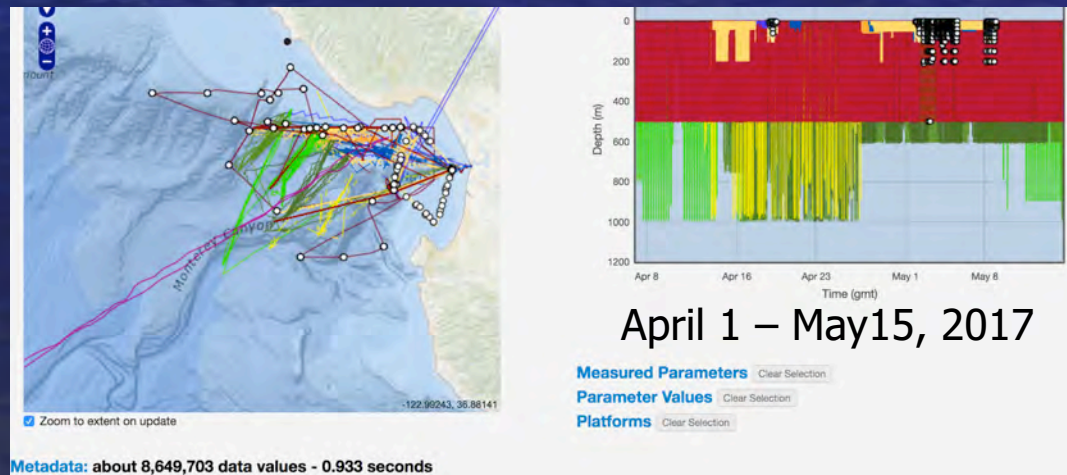


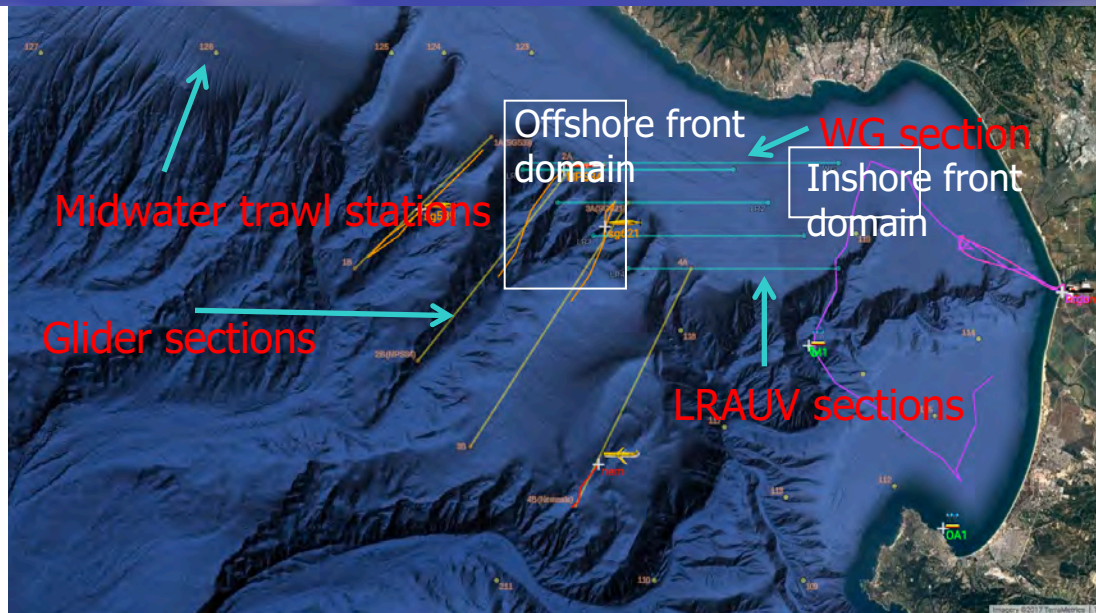
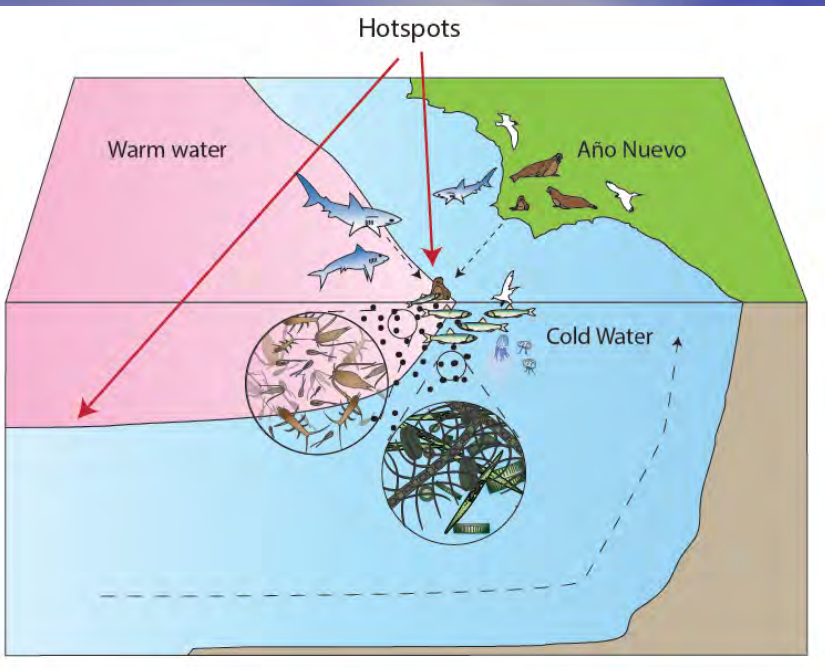
AUV targeted sampling of HABs (*Pseudos*) and toxin



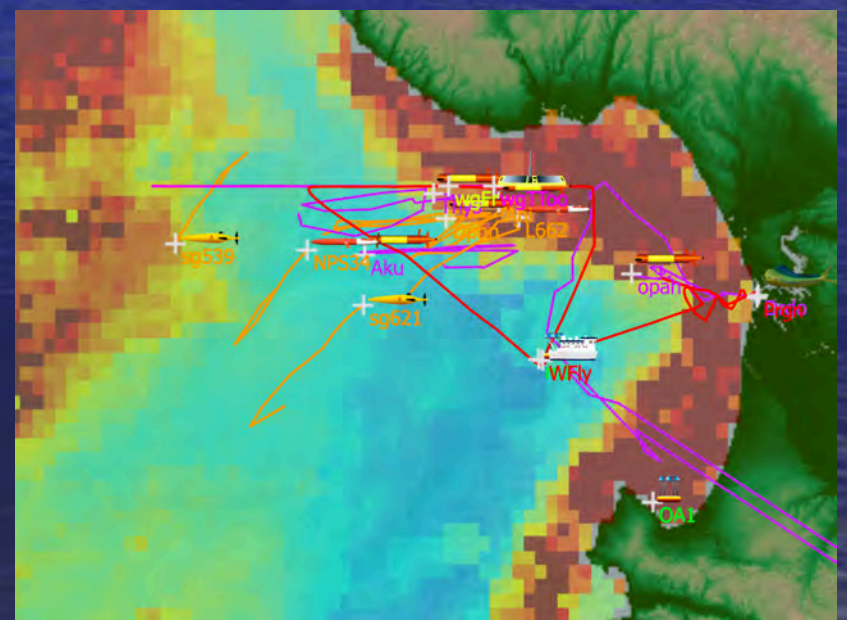
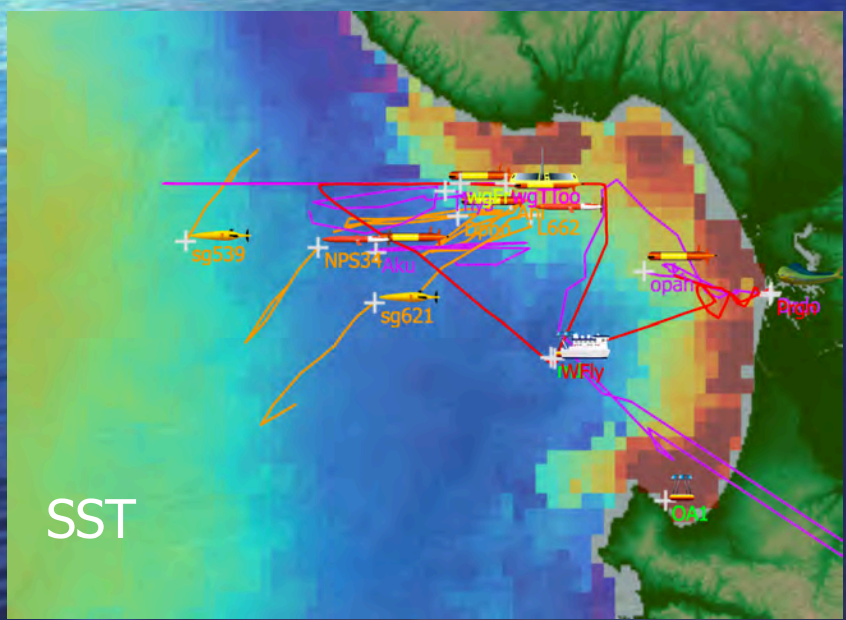
Presently, we worry about what to do about overfishing, ponder possible sub-lethal effects of oil or sewage discharge into the coastal oceans, and are scared by red and brown tides; and we struggle to calculate how fast and by how much the climate will become warmer with and without controls. A century from now, these separate concerns will have been integrated into a single management system because of objective needs, but perhaps also because of broad intolerance of the mismanagement of nature. Our great-grand children “will live on a wired earth”. Using the data so gathered, however, will demand massive improvements in scientific concepts, and this improvement is already the task for the present generation. It is a challenge that goes well beyond marine biology.

-Karl Bause, 1995



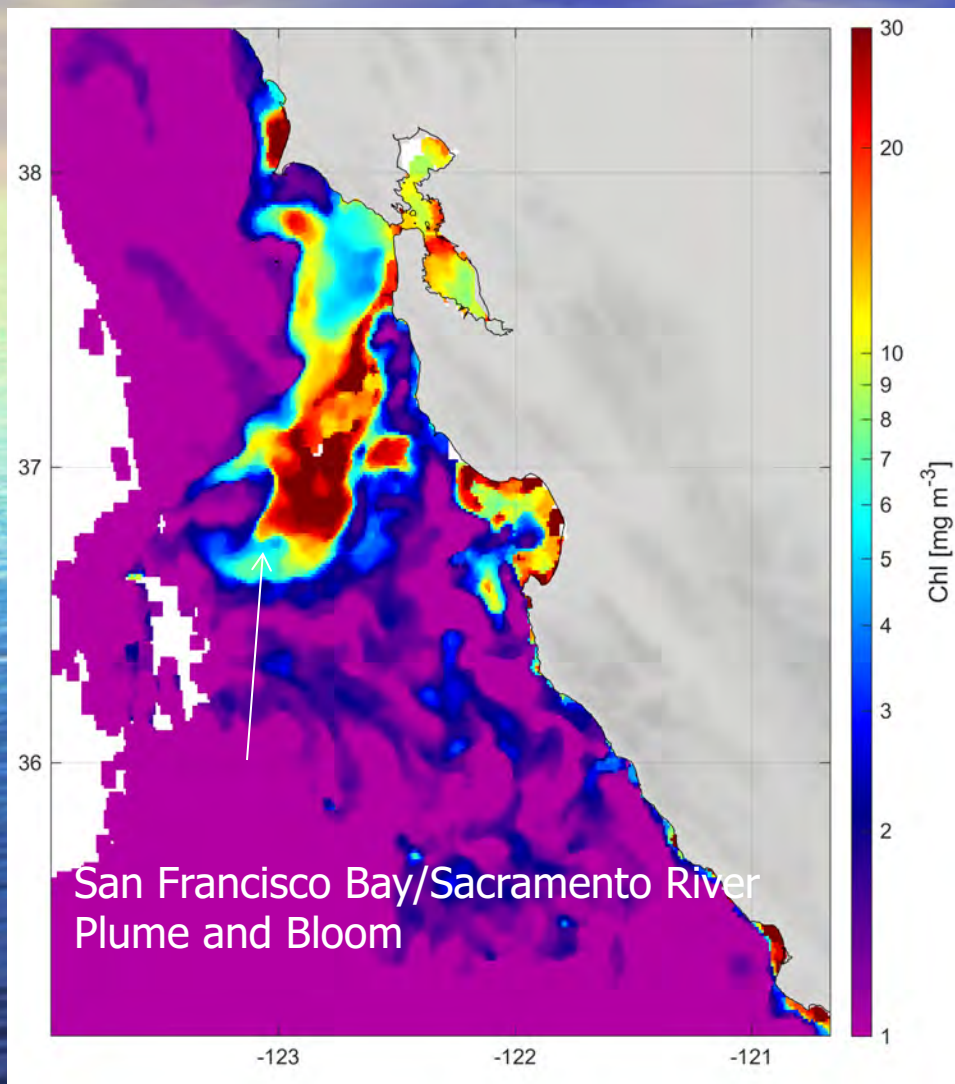


April 28-May 8, 2017

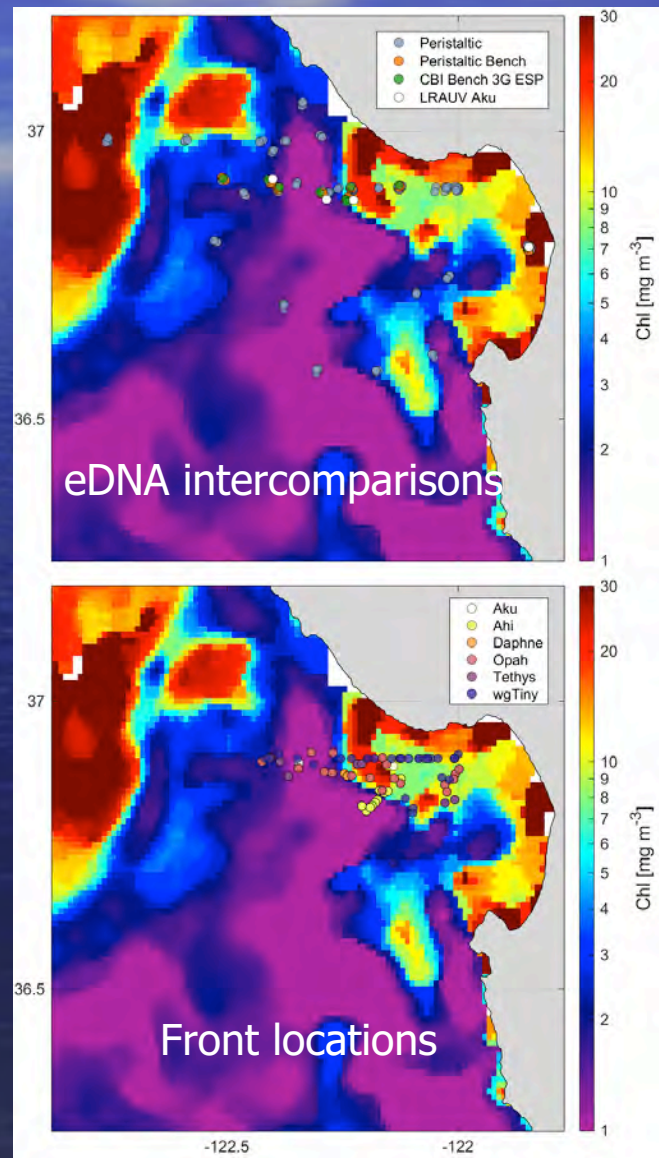


Collaboration with NOAA Fisheries, Reuben Lasker net tows for comparison with ESP samples

Sampled front locations identified by AUVs and WG, required careful coordination with two ships



May 2, 2017



Automating the Monterey Bay Time Series

A future of process time series?

