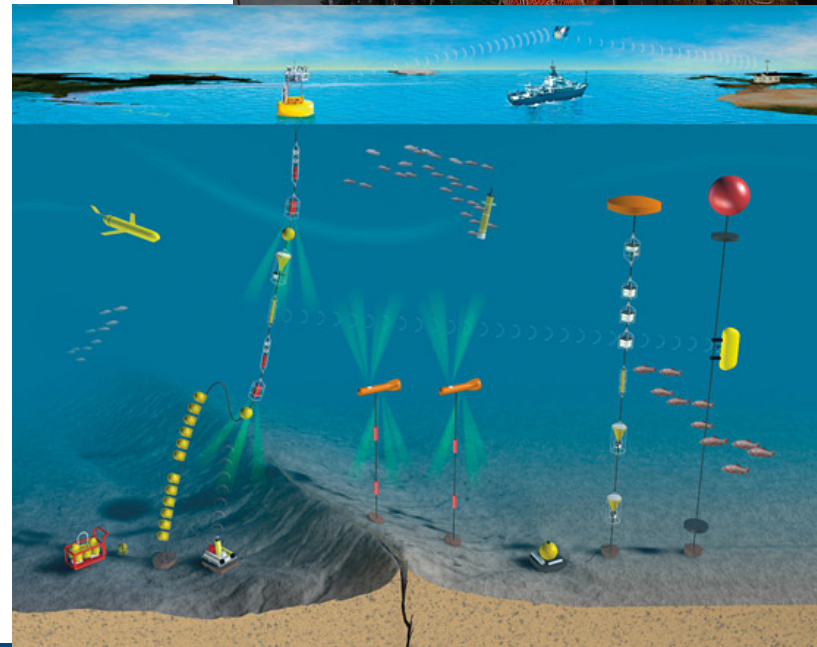


# Technologies

## Now and the Future

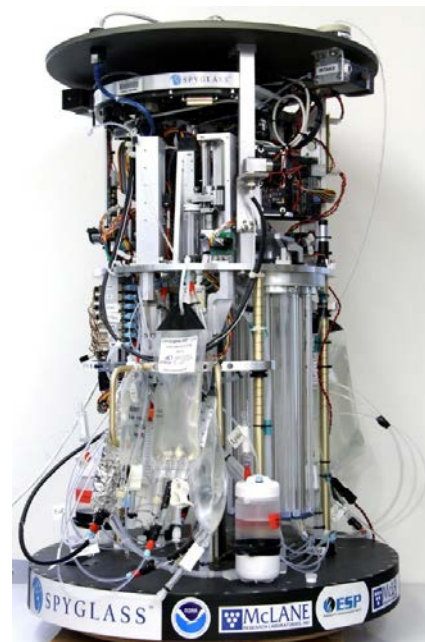
## Possibilities for Fishery and Ecosystem Surveys





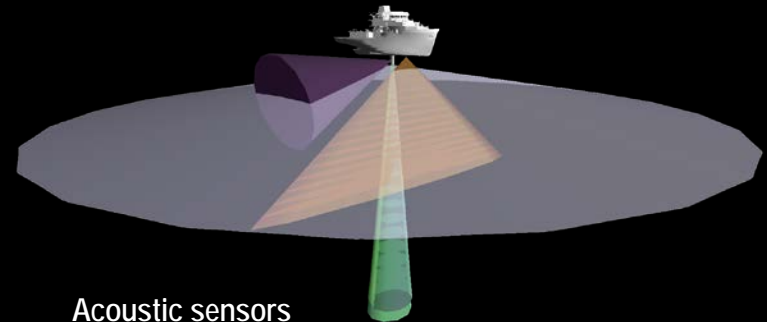
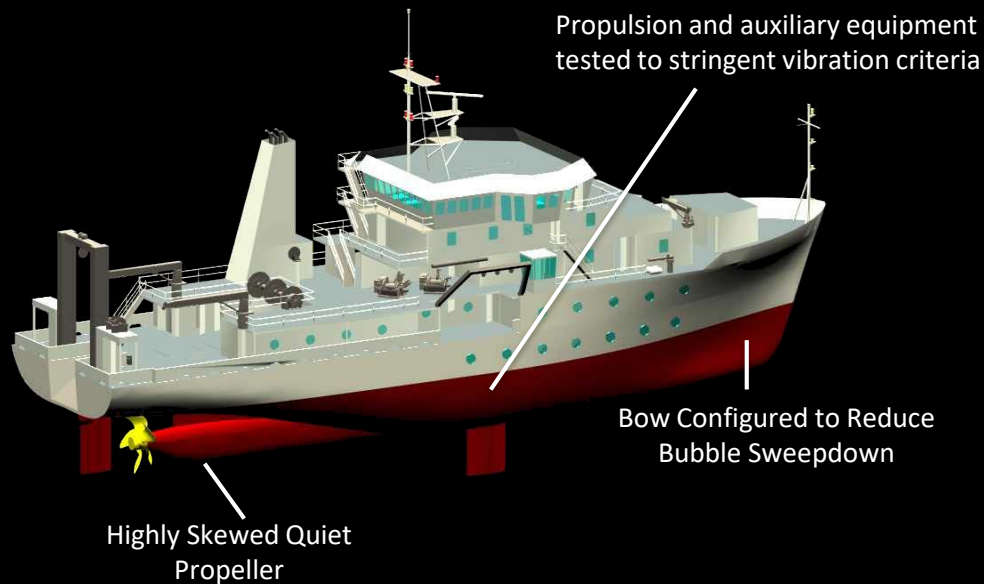
# Why Consider

- **Need for more information:** To increase **certainty** in a time of **increasing uncertainty**
- **Outlook:** next 5 - 10 years foresee limitations to carrying out surveys as we do today
- **Opportunities:** advances in sensor technology, use of remotely operated and autonomous vehicles



## "ROBOTS" AT WORK

# NOAA Ship *Reuben Lasker*

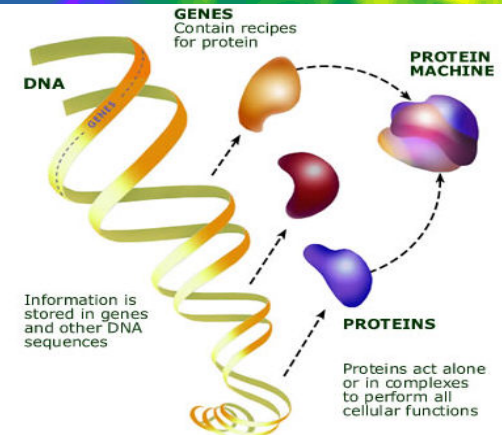
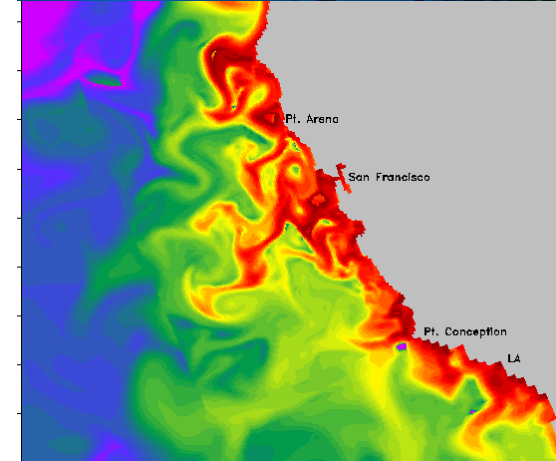
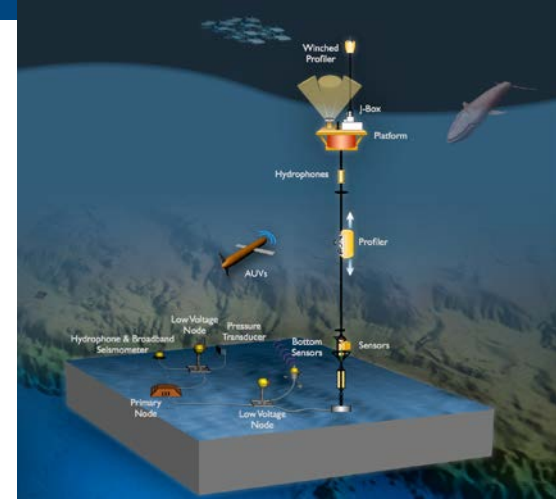


## Acoustic sensors

- Down-looking multi-frequency split-beam echosounders (EK60)
- Multi-beam swath echosounder (ME70)
- Omni-directional sonar (SX90)
- Multi-beam imaging sonar (MS70)
- ADCP current profiler
- Additional hydrophones and transceivers for passive sonar, self-noise monitoring, acoustic releases, ROV and AUV tracking, net mensuration

# Evolution of how we conduct surveys and the possibilities

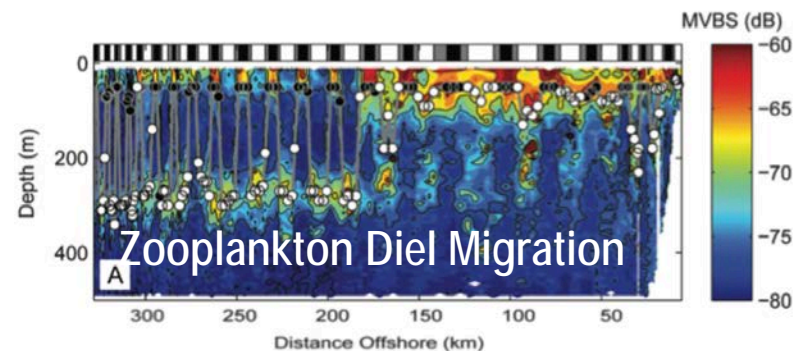
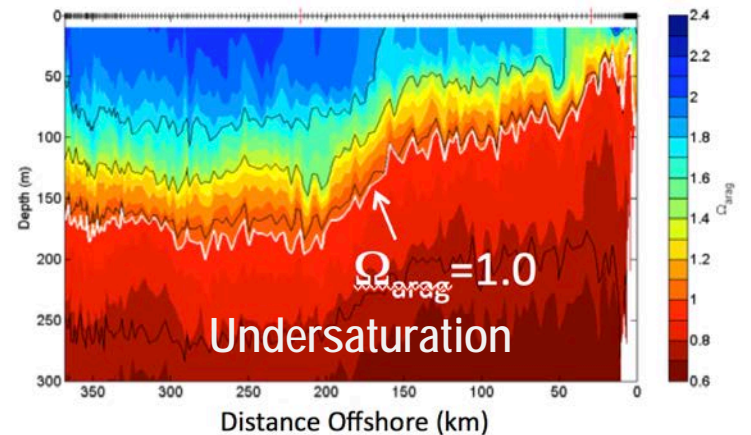
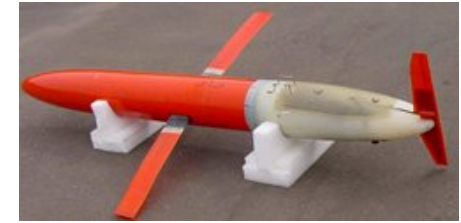
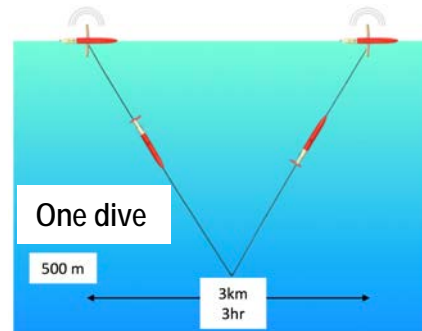
- **Gliders and moorings:** sustained observations
- **Towed instruments:** increased and expanded efficiency while sampling at sea
- **Telemetry:** sustained observations of animals
- **Models:** integrating across space and time to allow for hindcasts and projections
- **'omics:** species composition, indices of abundance—potential is high





# GLIDERS – Space and Time

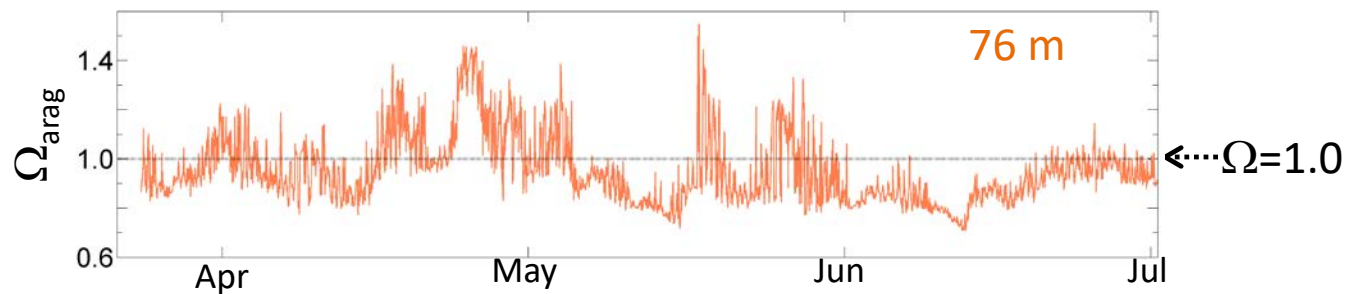
- ADCP
- Temp, Salinity
- Air-sea fluxes
- DO, pH, other biogeochem
- Acoustics
- Optics



# Moorings – Variation over Time



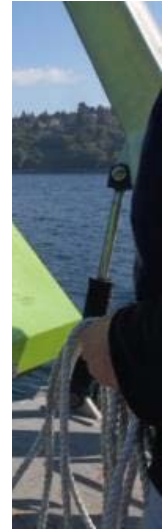
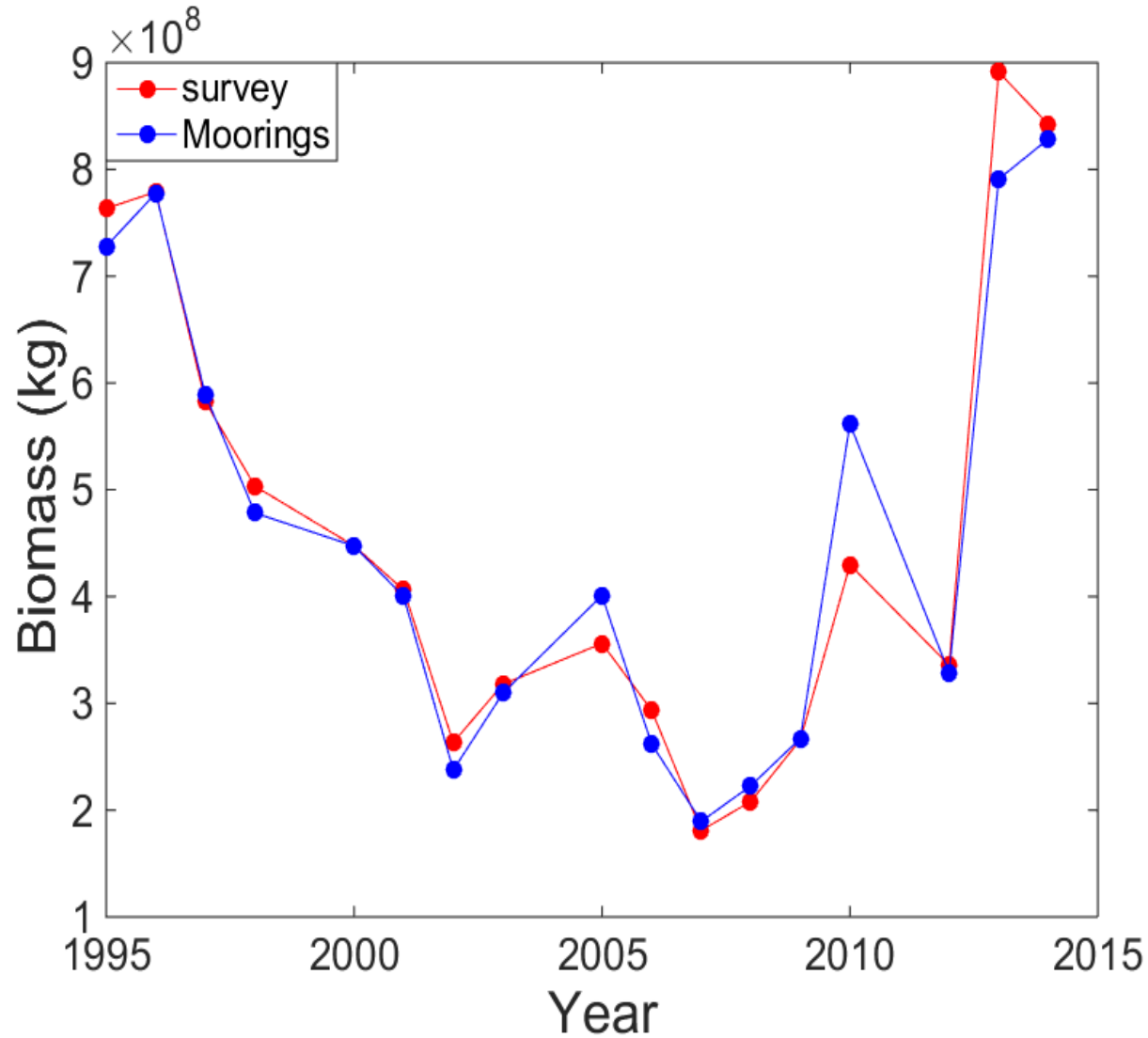
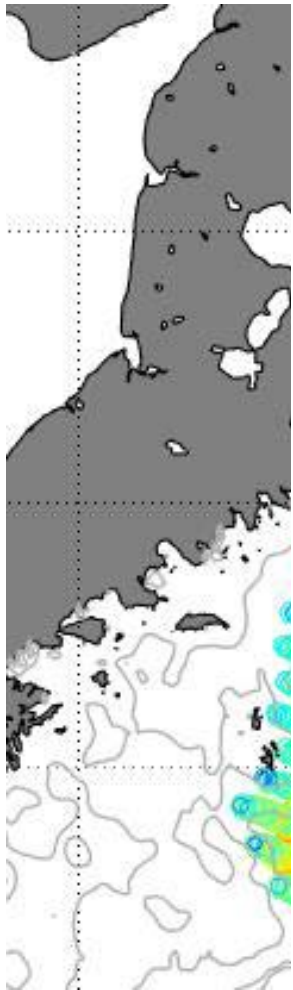
CCE-2 Mooring



Ohman et al. (2013)  
*Oceanography*

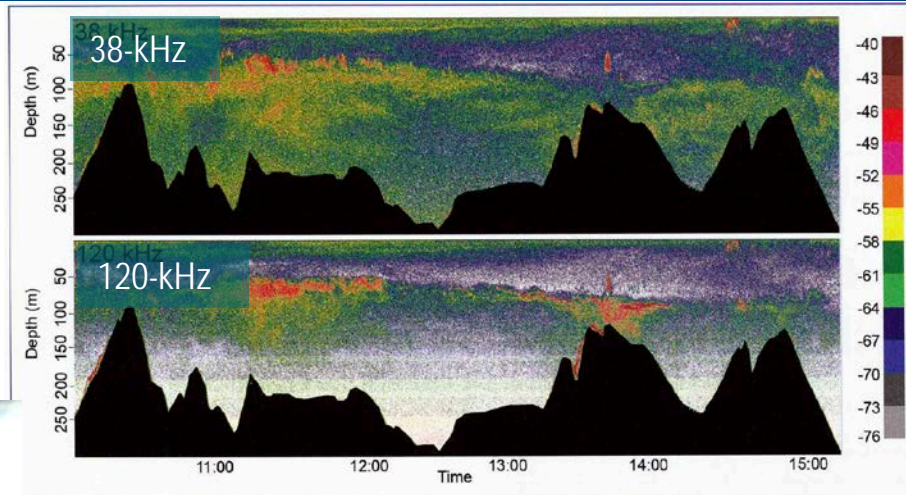


# Acoustics – Seafloor Mounted

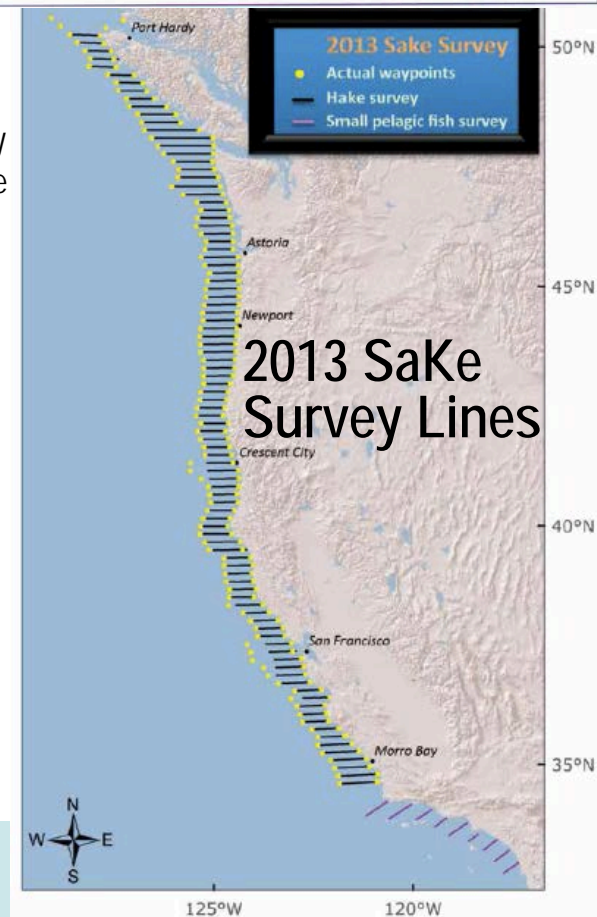




# Acoustics on gliders



Biological scattering layers (krill?) and discrete high intensity regions, thought to be fish schools.



Greene, C.H., E.L. Meyer-Gutbrod, L.P. McGarry, L.C. Hufnagle Jr., D. Chu, S. McClatchie, A. Packer, J.-B. Jung, T. Acker, H. Dorn, and C. Pelkie. 2014. A wave glider approach to fisheries acoustics: Transforming how we monitor the nation's commercial fisheries in the 21st century. *Oceanography* 27(4):168–174, <http://dx.doi.org/10.5670/oceanog.2014.82>.

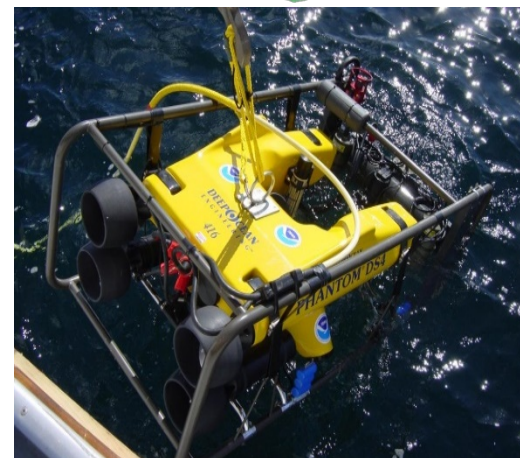
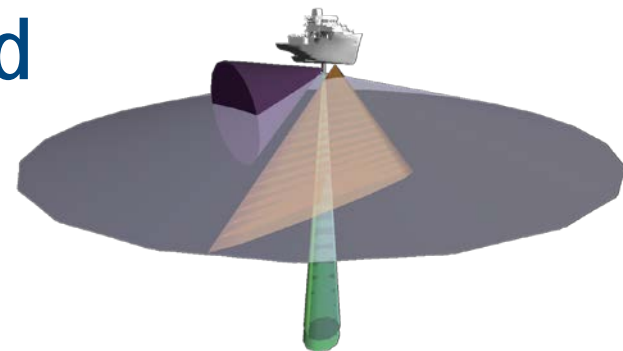
# New Technology – Acoustics on Sail Drone





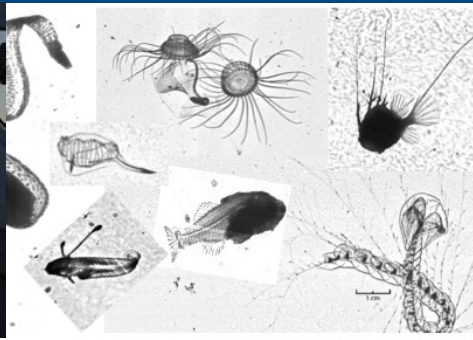
# New Technology – EK80 Wideband Echosounder

- Transition from EK60 to EK80 potentially a significant leap forward
- Challenges – Large amounts of data increasing complexity of storage, processing, and analysis.
- But Real Opportunities:
  - ✓ Improved Species Identification – Wideband Frequencies
  - ✓ Near Bottom Fish Detection – Improved Range Resolution
  - ✓ Improved Range and Detection – Decreased Signal-to Noise Ratio
  - ✓ Autonomous and Buoy Deployment – EK80 Miniaturization

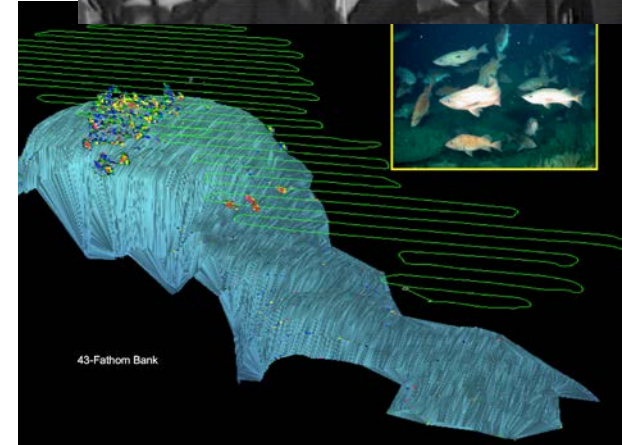




# Towed and unmanned

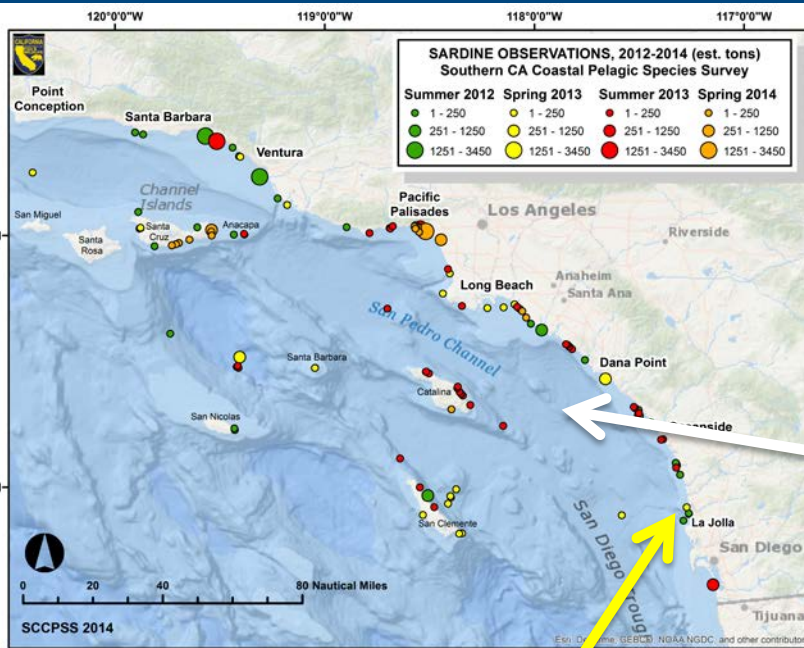


## In-water (species ID)



## Aerial (Nearshore/non-navigable, Minimize takes)



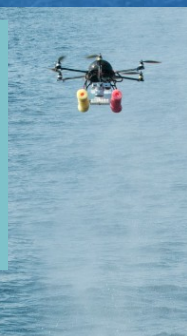


Bluefin tuna schools



Anchovy schools

Protected species:  
social behaviors,  
non-invasive  
sampling, etc.

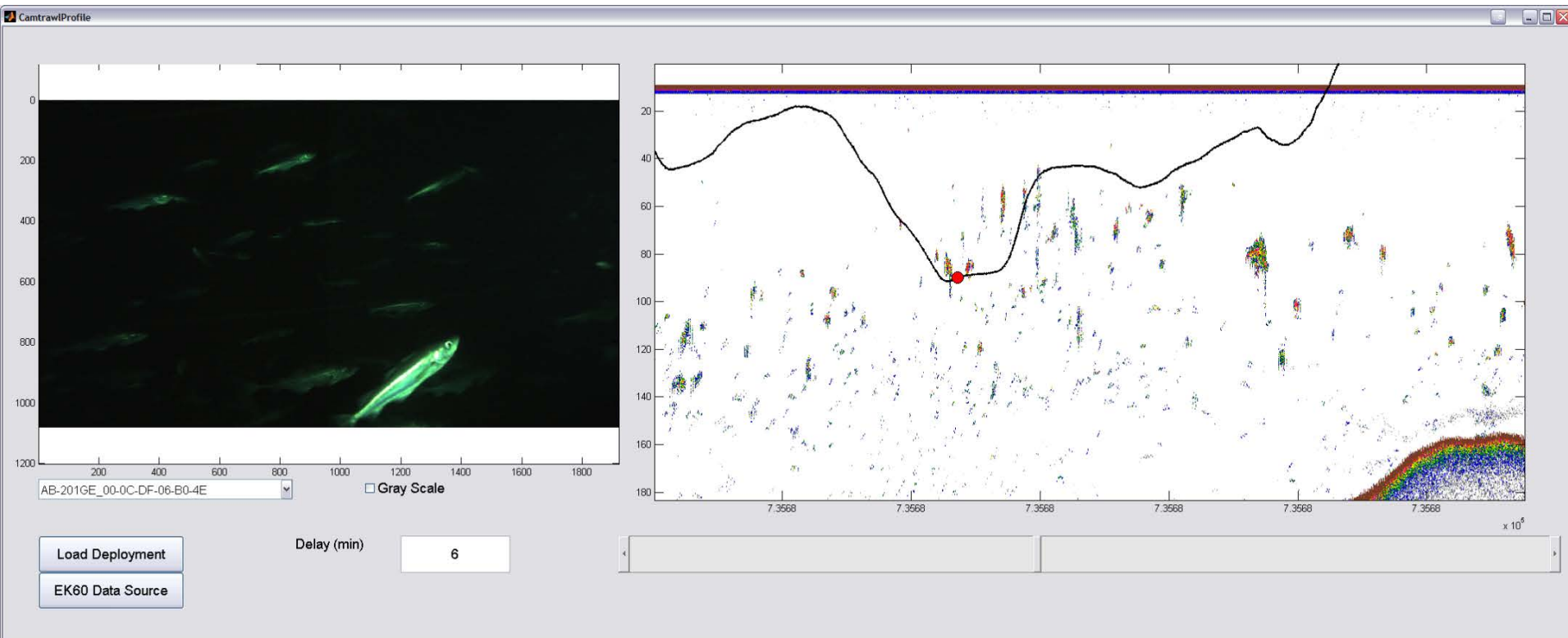




# Enhancing Our Current Survey Tools

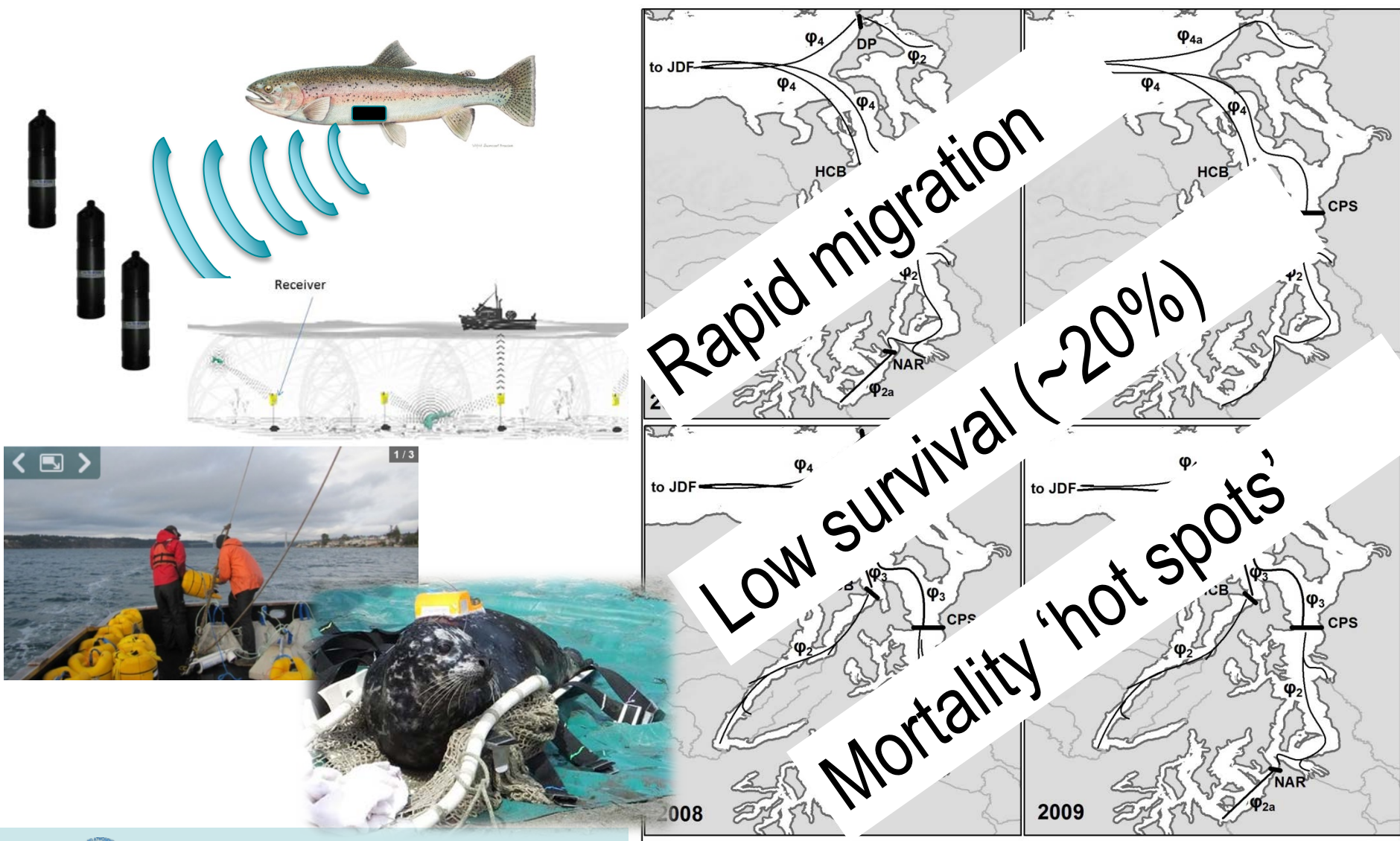
Improves species classification of acoustics

Can be a non-extractive sampling device



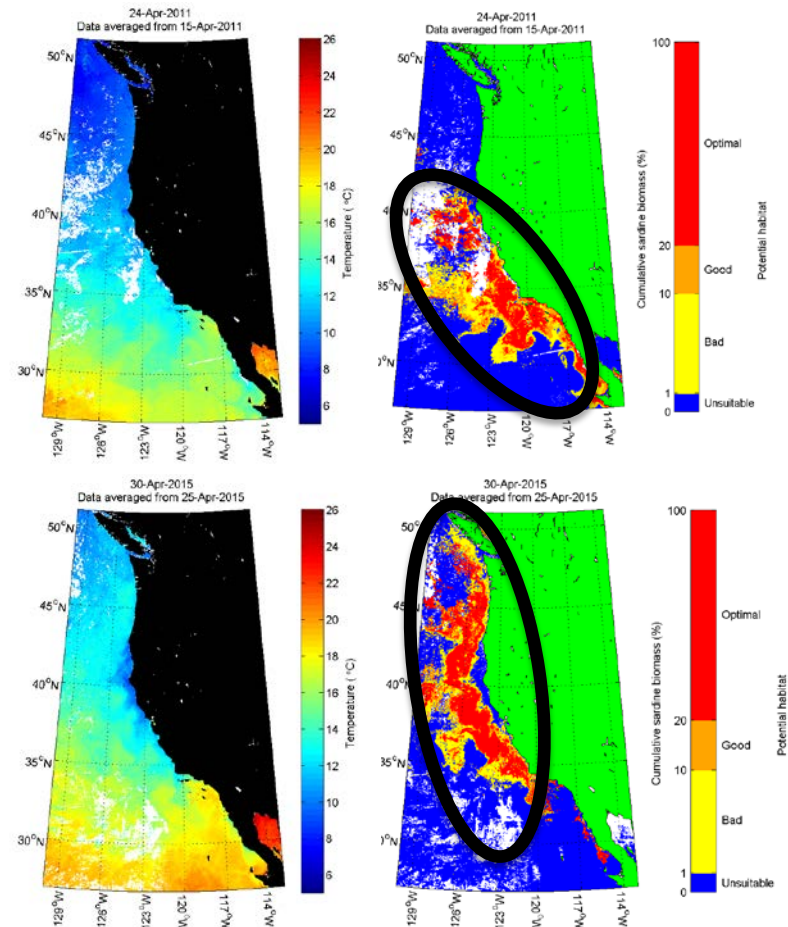


# Acoustic Telemetry – Fish Tags



# Models: forward projections can provide adaptive sampling (predicted “optimal habitat” using SST, Chl and SSH)

Northward shift/extension of habitat, surveys and sampling in 2015



# 'Omics – Biotech for Environmental Intelligence

- Understanding **how** organisms adapt under rapidly changing conditions .
  - ✓ Genetic code has the information
  - ✓ 'Omics technologies are the tools

Metabolomics

Proteomics

Phenomics

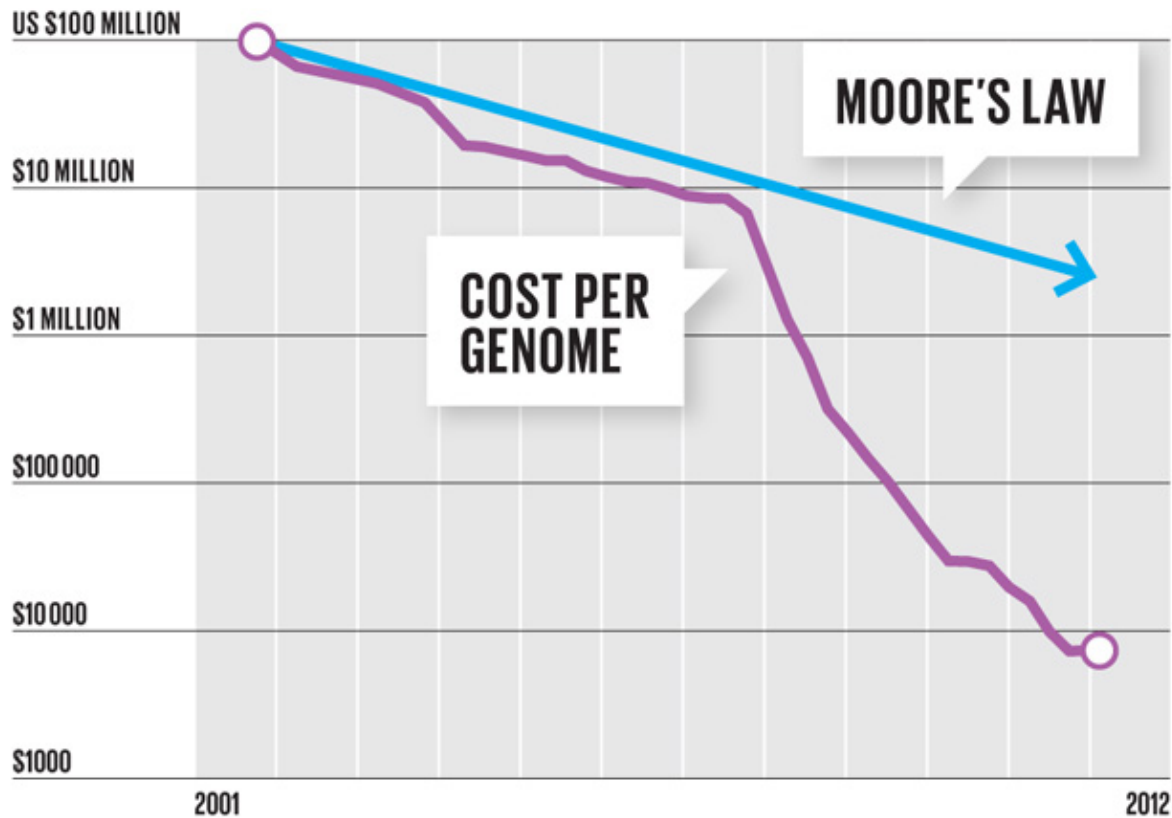
Metagenomics &  
Metatranscriptomics

Epigenetics

Genetics & Genomics



# Why is 'Omics Rapidly Emerging



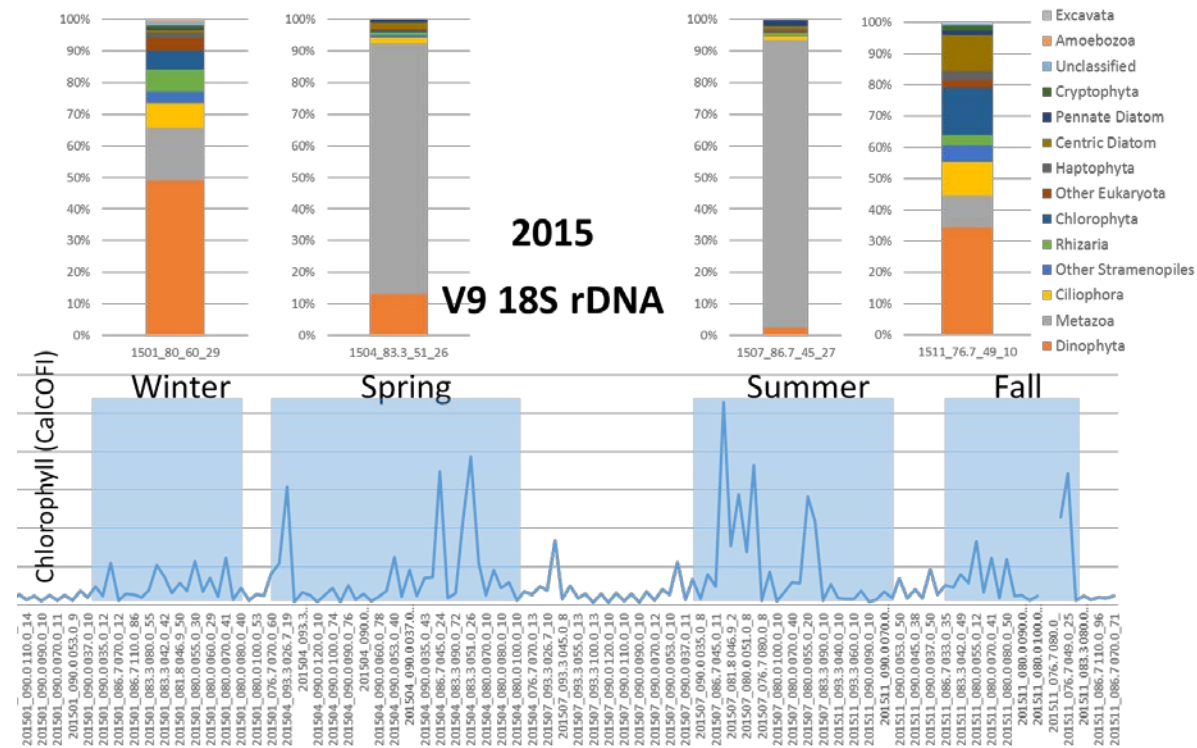
Bioinformatics and enhancement of IT capabilities underpins the success of 'omics



# 'Omics to Support Ecosystem Understanding

## Analytical 'omics – plankton community

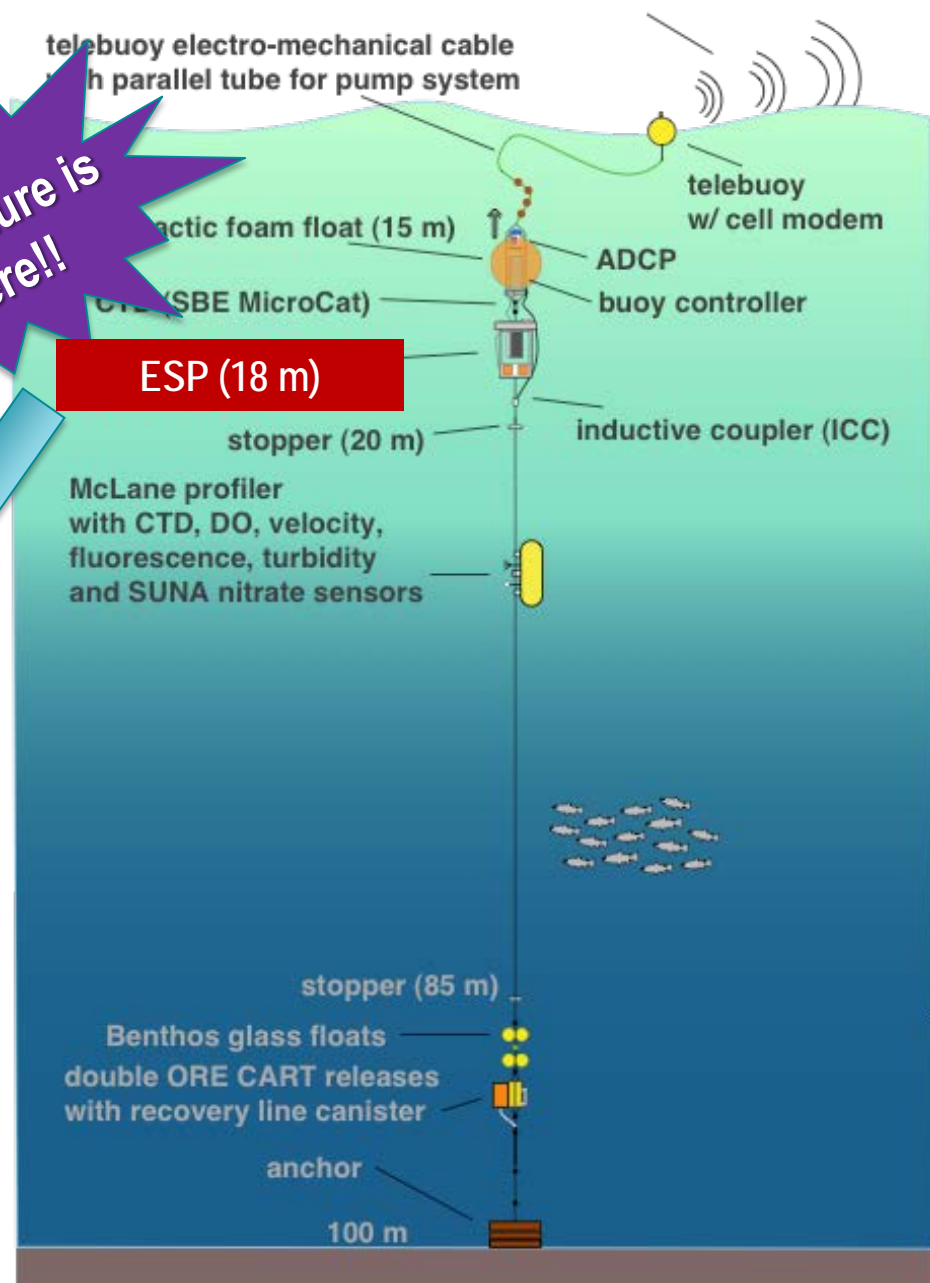
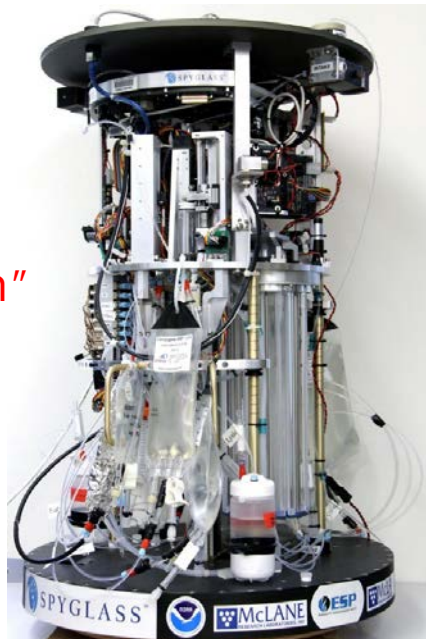
Current – chlorophyll



Near-real time  
offshore  
monitoring data  
→ early warning  
of toxic HABs!

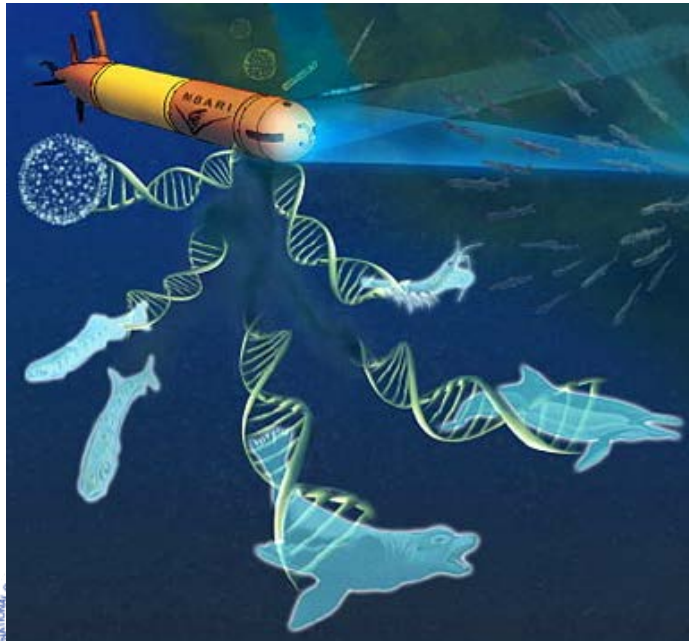
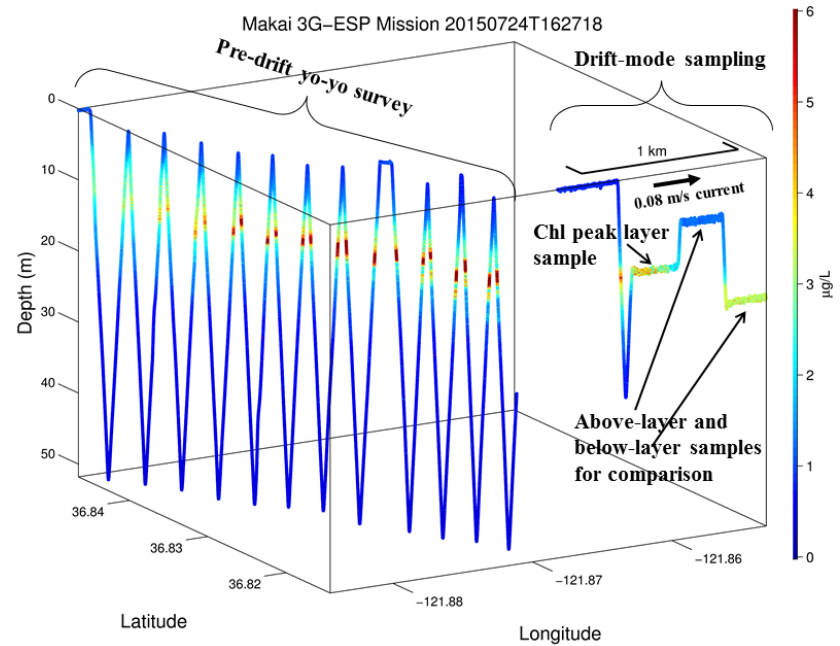
The future is  
here!!

"Lab in a Can"





# Emerging Technology: Mobile 'Omics



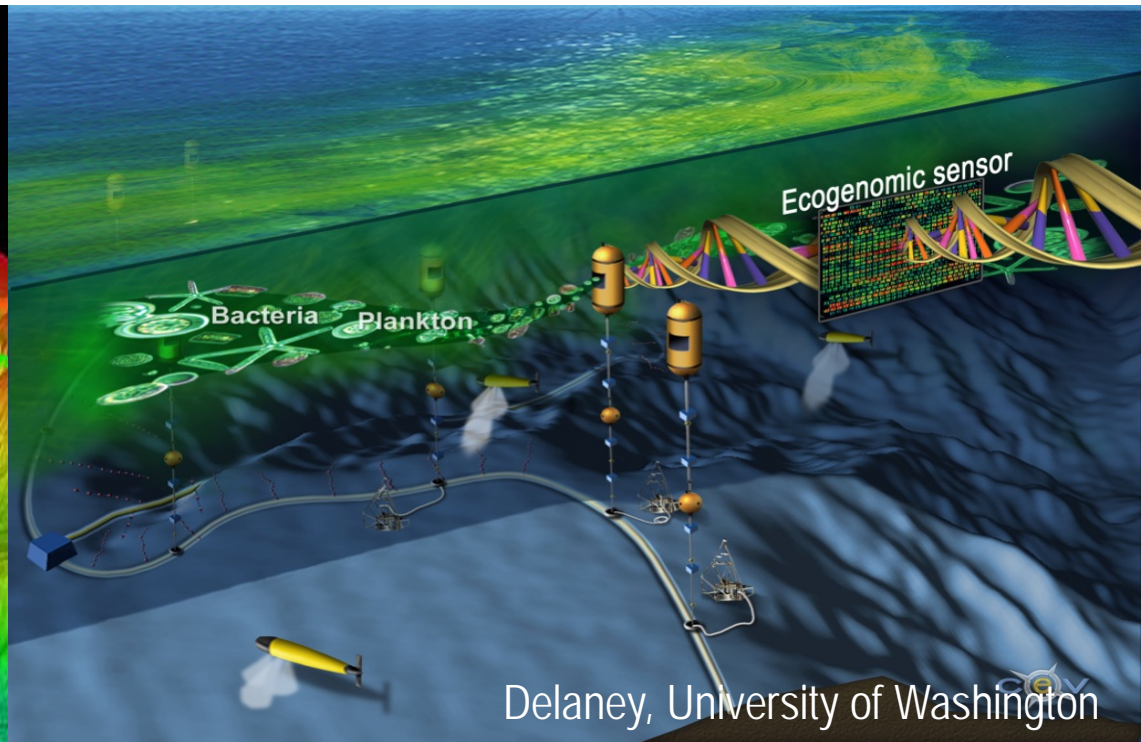
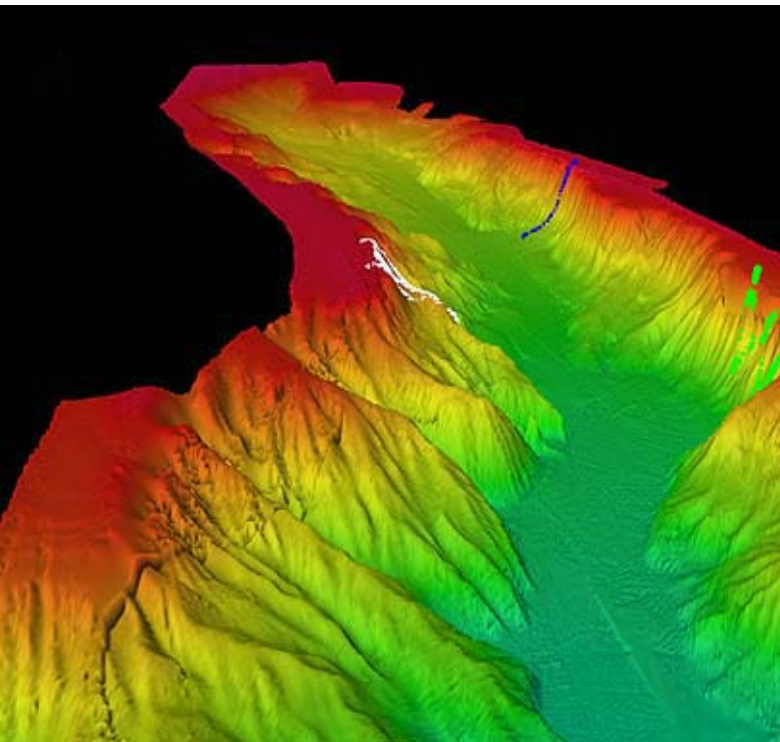
New methods combined with emerging technologies can improve the spatio-temporal coverage

# Challenge

Navigating the  
'Valley of Death'



Research  Operations



*Continued need for  
technologically advanced  
vessels with robust ship-to-  
shore communications, allowing  
for improved survey design*

