

# (Phyto)plankton Observations

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UC SANTA CRUZ

*Aqua/MODIS composite, September 24, 2019.*

NASA Ocean Biology Distributed Active Archive Center.

# Why Develop a (very non-exhaustive) Plankton Ocean Observing program?

## Harmful Algal Blooms (Human & Ecosystem Health, Blue Economy)

Monitoring Needs:

**Discern Toxin Producing Species (and toxins)**

**Rapid Response** (hours or days) – Early warning Systems

**Predictive Skill** – Modelling likelihood

## Food Web & Ecosystem Dynamics

**Phytoplankton are not all equal!**

Monitoring Needs:

**Phytoplankton Community Structure**

**Spatial & Temporal Resolution:** resolve important processes

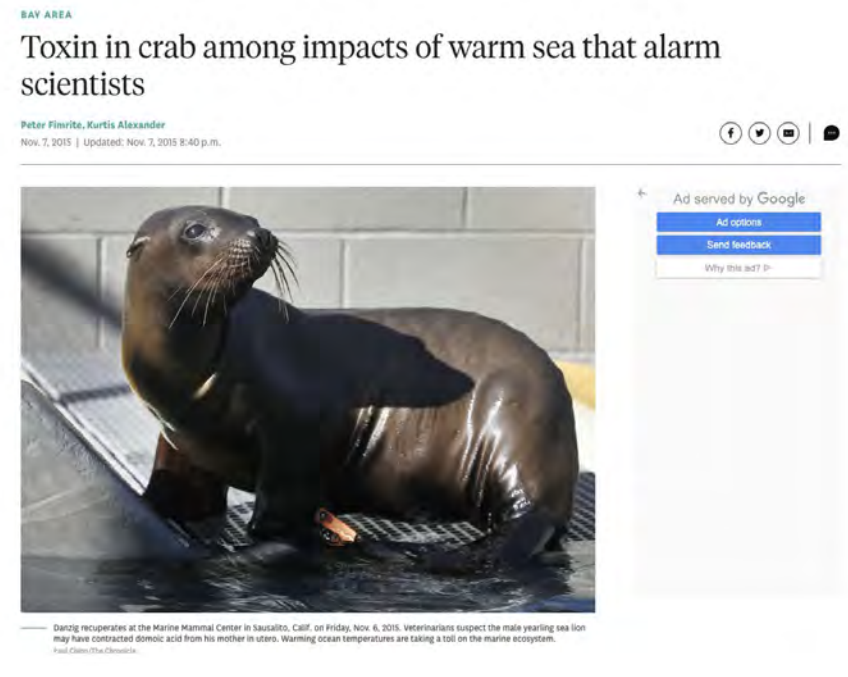
## Carbon Cycling, Biodiversity, & Climate Variability

Monitoring Needs:

**Community and Abundance**

**Size Distributions**

**Data Standardization and Aggregation**



**San Francisco Chronicle, Nov 2015**

FACTORS CONTRIBUTING TO VARIABLE RECRUITMENT OF THE NORTHERN ANCHOVY  
(*ENGRAULIS MORDAX*) IN THE CALIFORNIA CURRENT: CONTRASTING YEARS,  
1975 THROUGH 1978

REUBEN LASKER

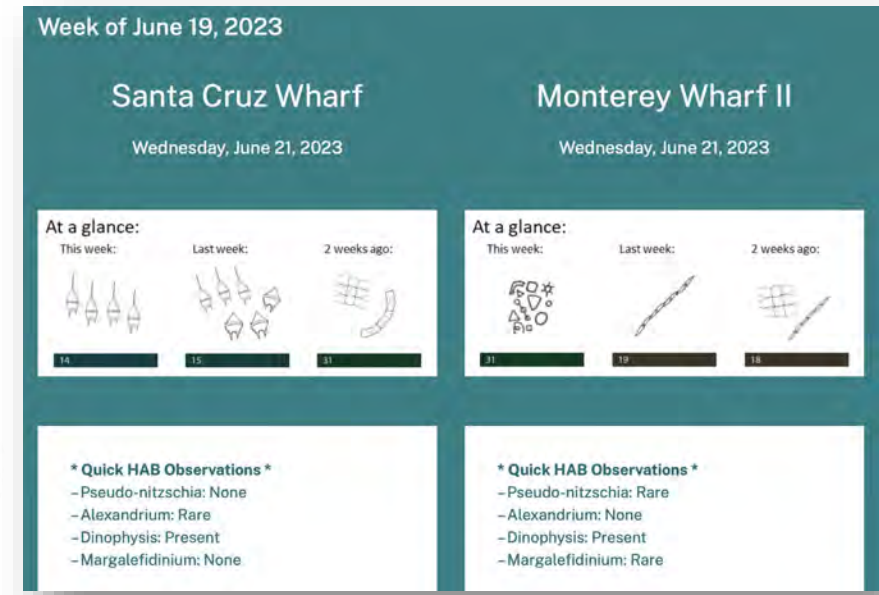
National Oceanic and Atmospheric Administration,  
National Marine Fisheries Service,  
Southwest Fisheries Center,  
La Jolla, California 92038, USA



# Calhabmap: Weekly HAB Monitoring

## Weekly Water Sampling:

- Since ~2008
- **Targets HAB spp. (8-9 taxa)**
- Chl-a, Temp, Salinity, Nutrients
- **Domoic Acid + SPATT (toxins)**
- Weekly alerts to HABMAP
- Monthly QC'd data via ERDDAP
- Data Synthesis w/ models: **CA HAB Bulletin (SCCOOS)**



<https://sccoos.org/california-hab-bulletin/>

Supported by CeNCOOS and SCCOOS

Limited in resolution (weekly). Data is not real time.



# The California IFCB (Imaging Flow CytoBot) Network

## Quick Overview:

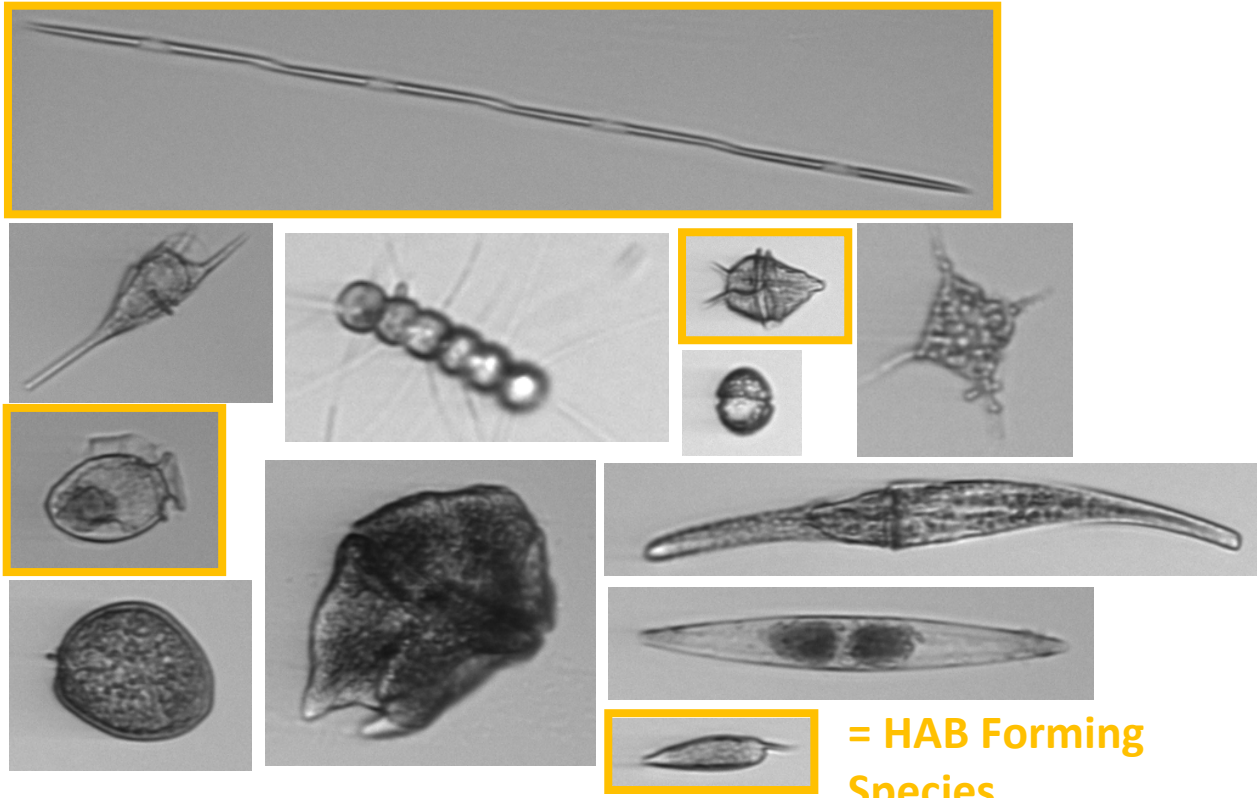
- Developed by Heidi Sosik (WHOI)
- *In situ*, automated microscope-in-a-can
- Images cells with chlorophyll-a

### By the Numbers:

- 5 ml every 20 mins
- $< \sim 10 \mu\text{m}$  -  $150 \mu\text{m}$  size range
- 1000s of images per hour



# McLane Labs

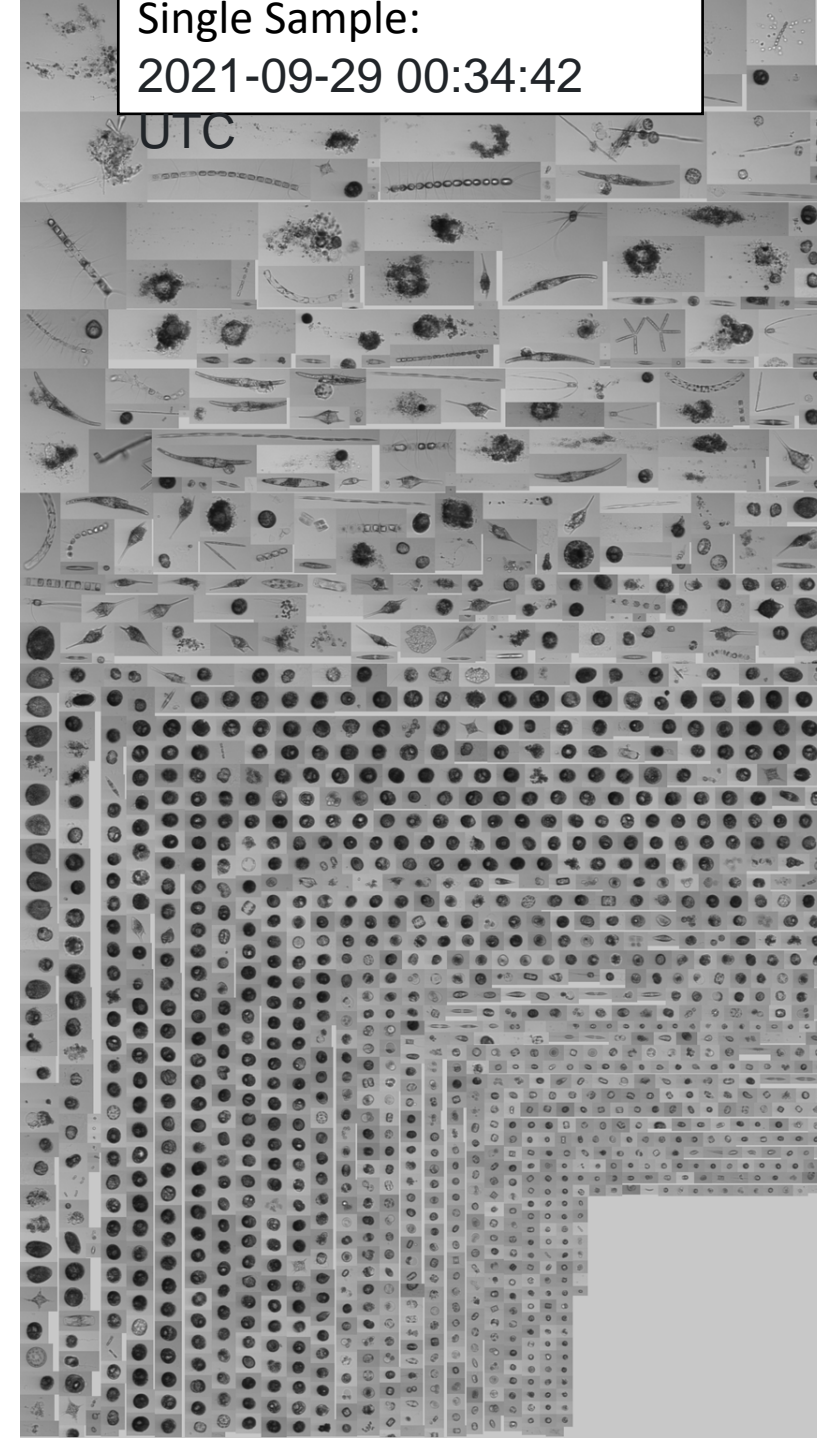


**= HAB Forming Species**

## Single Sample:

2021-09-29 00:34:42

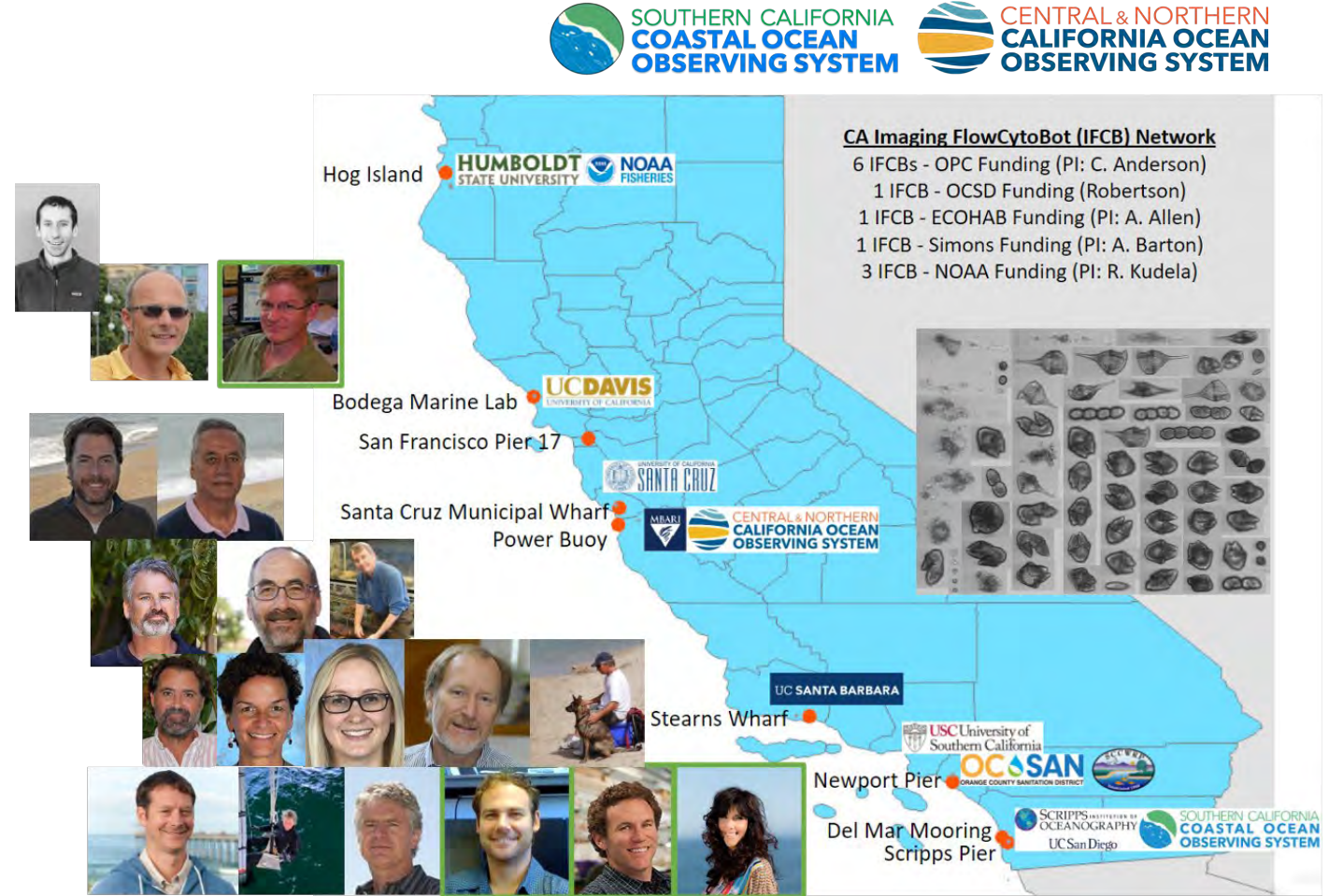
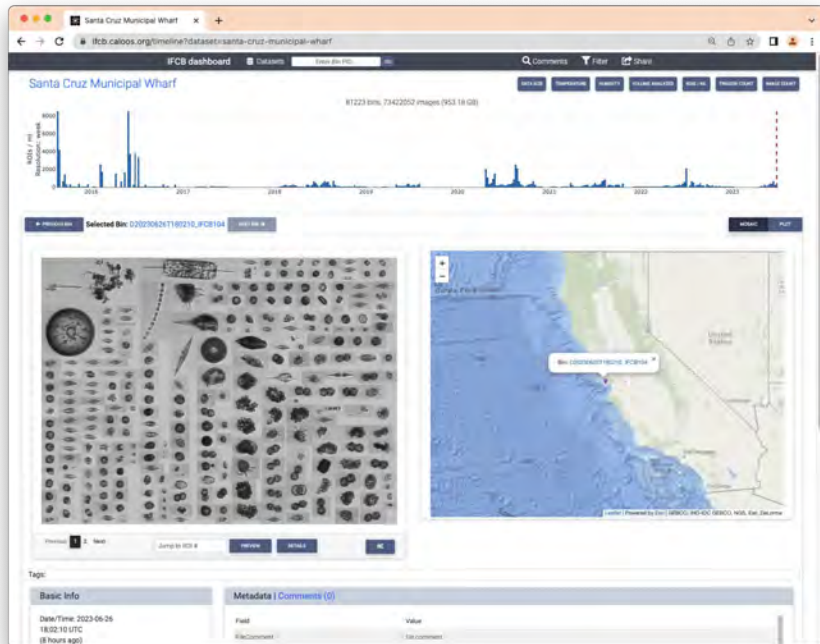
# UTC





# The California IFCB (Imaging Flow CytoBot) Network

- 12 (9 real-time) IFCBs total in the network
- Generates up to 60 gb/day
- Centralized Data Infrastructure
- Developing Technical Support Community
- Highly Leveraged (federal, state, private funding)



PIs: C. Anderson, R. Kudela, A. Barton, K. Kenitz, U. Send, F. Chavez, H. Ruhl



<https://ifcb.caloos.org/>



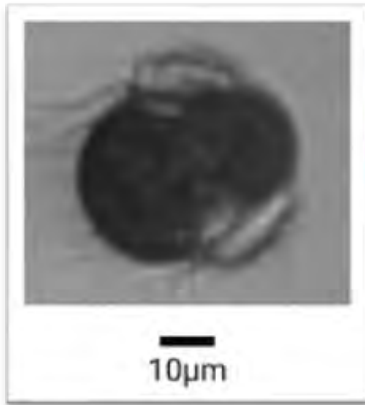
# Image Classification: How it works

**Goal: Generate time-series of phytoplankton class abundance and biovolume**

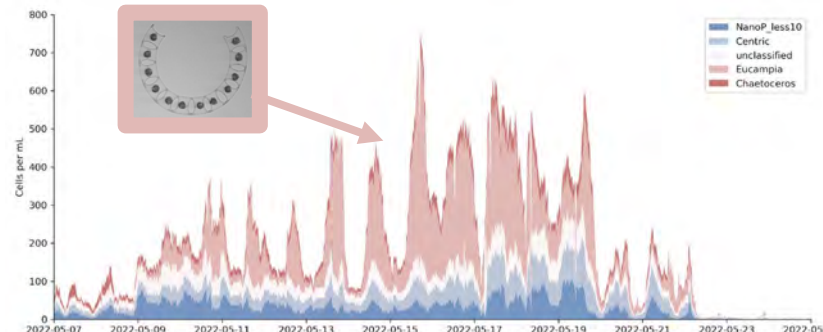
Classified Data

Classifying Model

D20190503T071727\_IFCB104\_00586



Integrated into a real-time framework ? **Know what is in the water within an hour**



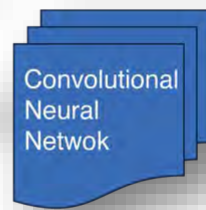
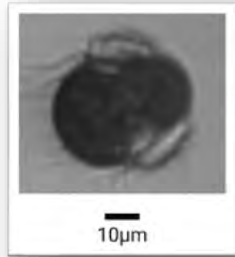
**Diatom *Eucampia* Bloom in Monterey Bay**

# Automatic Classification:

From image to information

**Not Enough just to Produce a Prediction**

D20190503T071727\_IFCB104\_00586



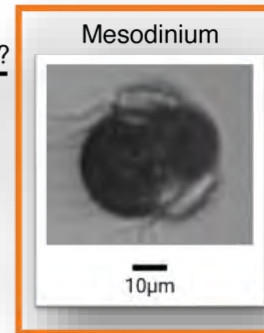
- Akashiwo
- Mesodinium
- Pseudo-nitzschia
- ⋮
- Other Ciliate

Model Metadata:  
Version  
Model Architecture  
Training Set  
Validation Metrics  
DOI



Prediction	Threshold	> Thresh?
.00	.80	False
.55	.42	<b>True</b>
.00	.74	False
⋮	⋮	⋮
.28	.54	False

Taxonomic Metadata:  
Functional group?  
WoRMS ID (taxa database)  
Name Mappings



Derived Products:  
Biovolume & Shape  
Sample Volume

Class Specific Thresholds



Instrument Metadata:  
User Defined Settings  
Environmental Conditions  
Software Versions



# IFCB Data Management

Where the sum of the data becomes greater than the whole

**FathomNet + Ocean Vision AI + Zenodo**

Hosting Training Sets (gold nuggets)

Model Zoo: Sharing and Archiving Classifiers

**Standards and practices for reporting plankton and other particle observations from images**  
**Technical Manual**

From Neeley et al 2021

The data processing levels are described as follows:

Level 0: Raw images collected by the imaging-in-flow cytometer

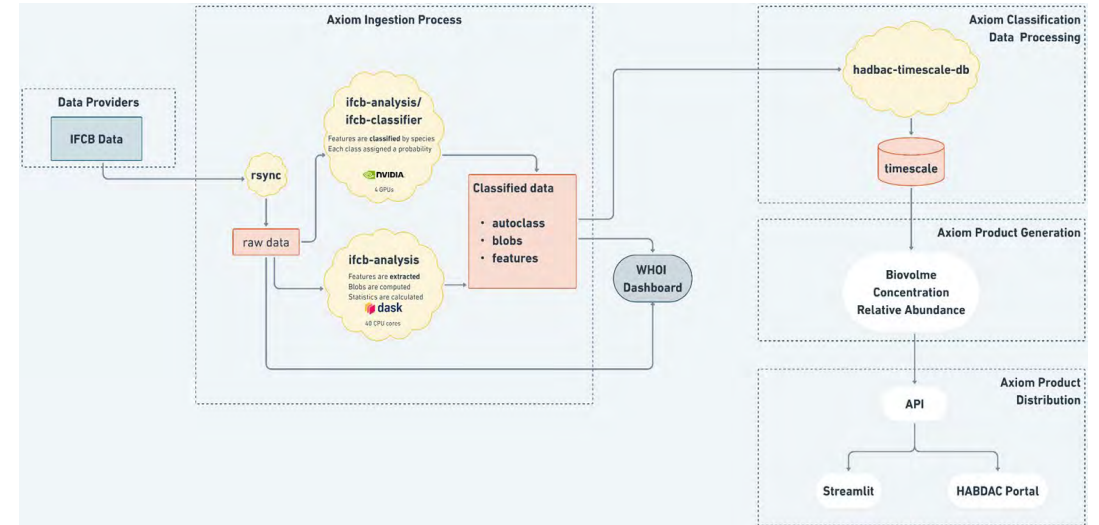
Level 1a: Automated classification by an algorithm (automated annotation) and/or manual annotation

Level 1b: Individual level counts with automatic (including interpretation of class scores or probabilities) and manual classifications, and biovolume and size parameters for each ROI

Level 2: Summary data for sample e.g., taxonomic groupings

Formatting IFCB data SeaBASS & BCO-DMO

# PCM HAB 2020: Harmful Algal Bloom Community Technology Accelerator

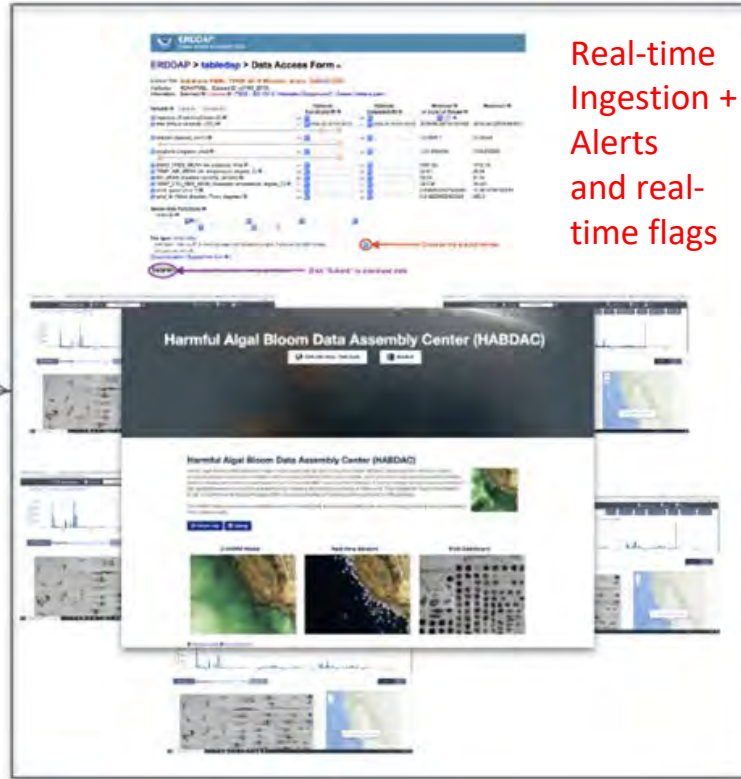




# NOAA NCCOS PCMHAB Project to build a national repository & computational framework for IFCB data

Central clearing house where Level 1 data are QCd, Level 2 and 3 products generated

## HAB Data Assembly Center (DAC) Development



Real-time  
Ingestion +  
Alerts  
and real-  
time flags

WHOI, PI Brosnahan, MERHAB



HABHub



### Team Leads

C. Anderson, SIO  
R. Bochenek, ADS  
H. Sosik, WHOI  
S. Beaulieu, WHOI  
H. Ruhl, MBARI  
R. Kudela, UCSC

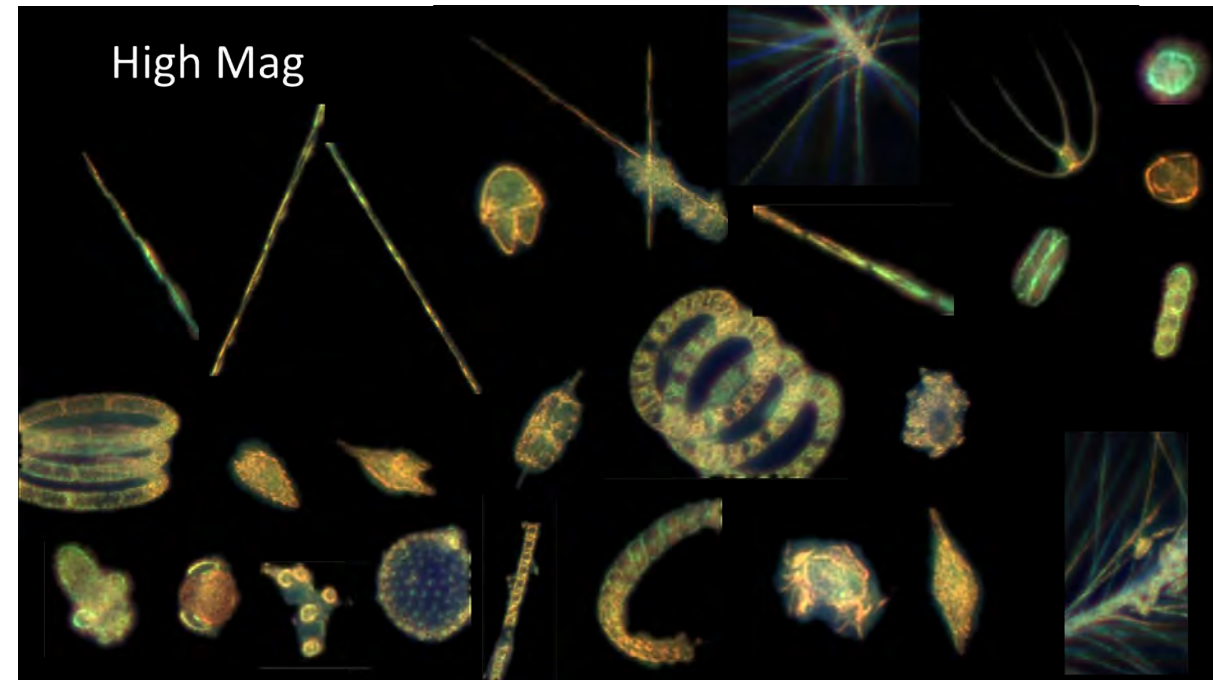
*Ocean Observing systems driving creation of community analysis tools for facilitating downstream improvements in ecosystem science and prediction*

# Other Plankton Imaging

- Planktivore: Builds on Zooglider of Ohman et al.

## Other examples:

- Holly Bowers (MLML) et al. leading OTT effort re: Aqusens & HABs
- Underwater Vision Profiler (UVP)
- In-Situ Ichthyoplankton Imaging System technology (ISIIS) – Bellmare
- Scripps Plankton Camera System
- [...]

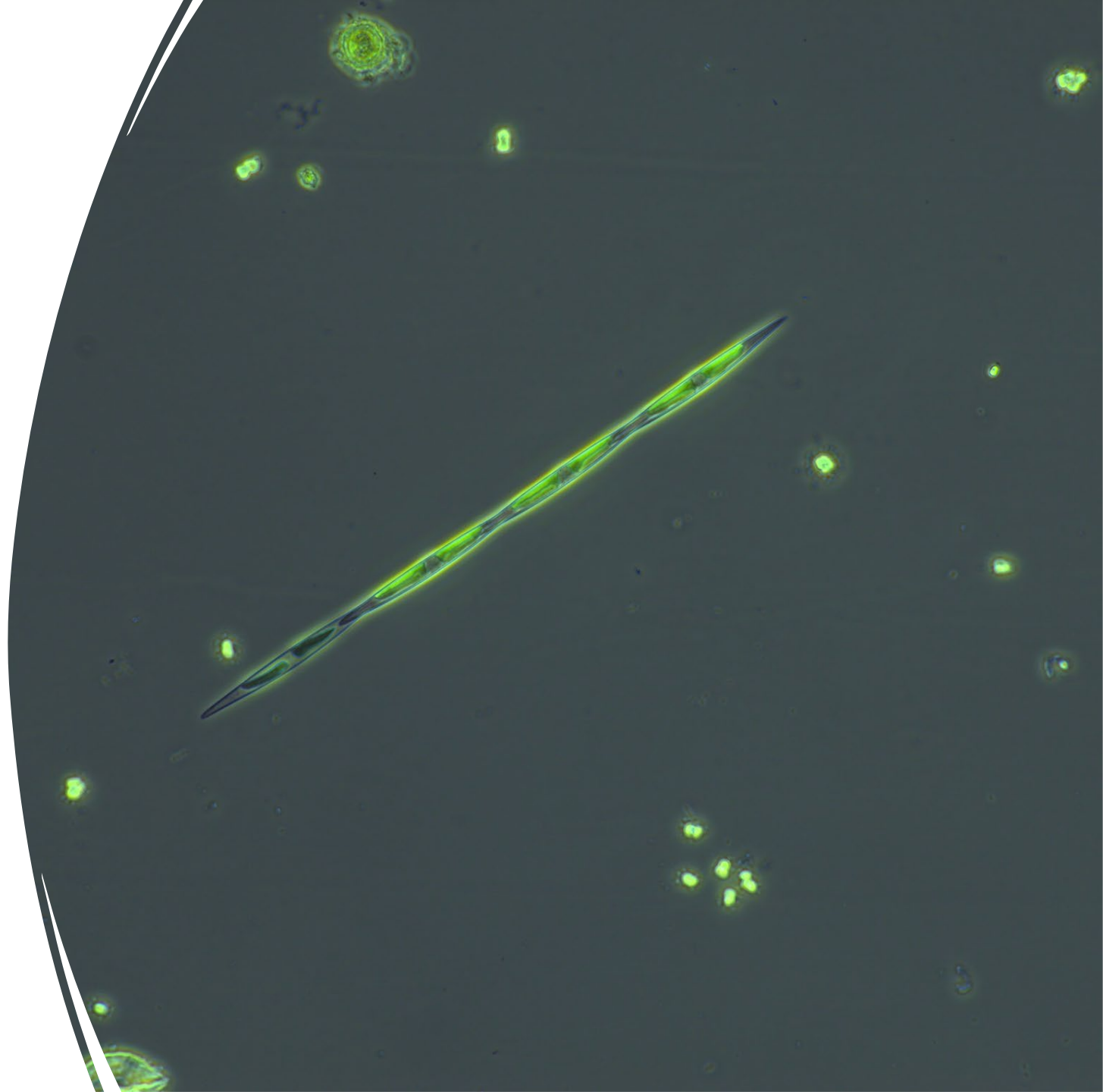


# Thank You and Questions?

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**Rich Datasets!**

**All sorts of other Science (my thesis work!) + Education + Outreach**





# To Date: CA IFCB Network Successes

## **Strong Technical Network**

- monthly calls, Slack channel, and email threads
- Adaptable and capable of rapid response

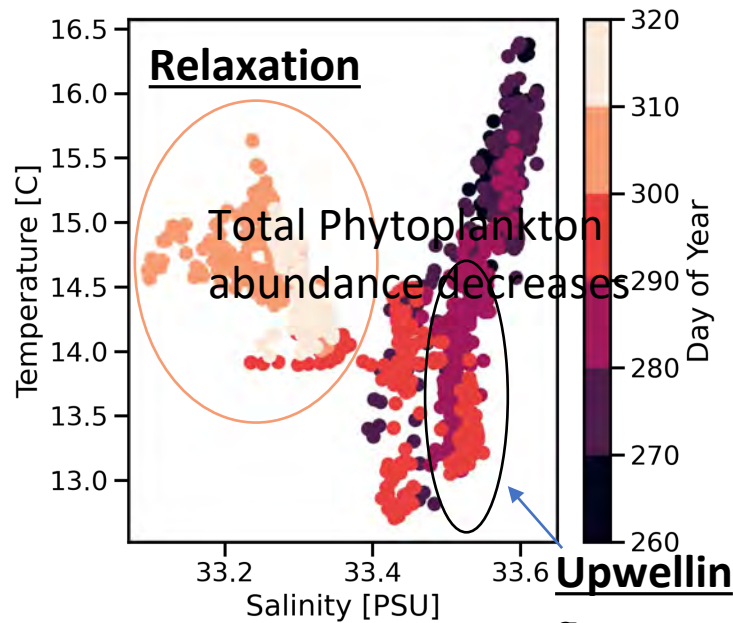
## **Centralizing Data Infrastructure**

- All data is available: **ifcb.caloos.org** (16 datasets = Stations + Cruises)
- Model Development: manual classification, training, and validation
- Processing: Feature Extractions + Classification (Biovolume, particle size)

## **Massive Volumes of Accessible Data Being Collected**

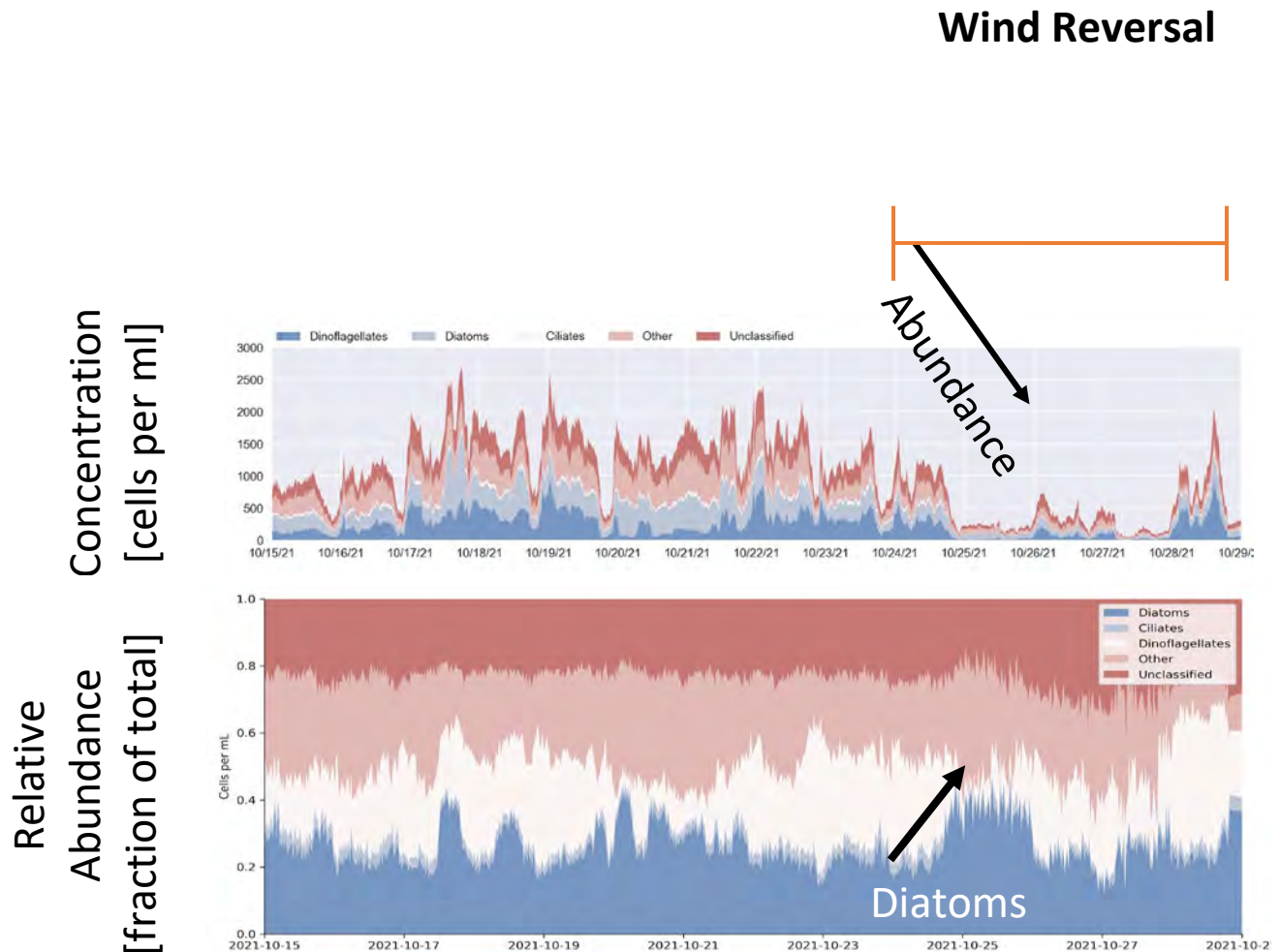
- Multi-disciplinary science applications will/are spinning up

# Case Study: Wind Reversal Events in M. Bay



T/S plots from buoy g

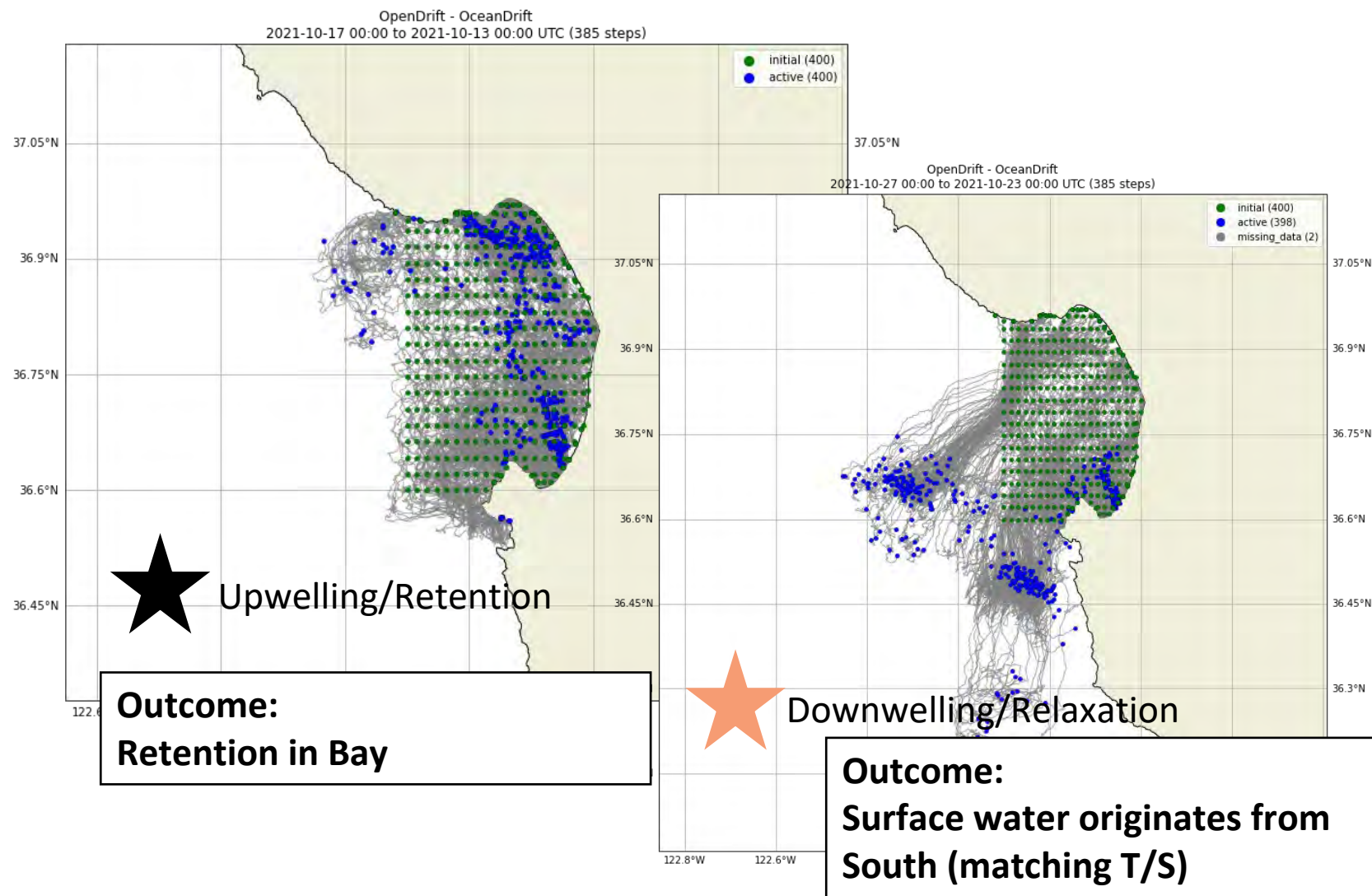
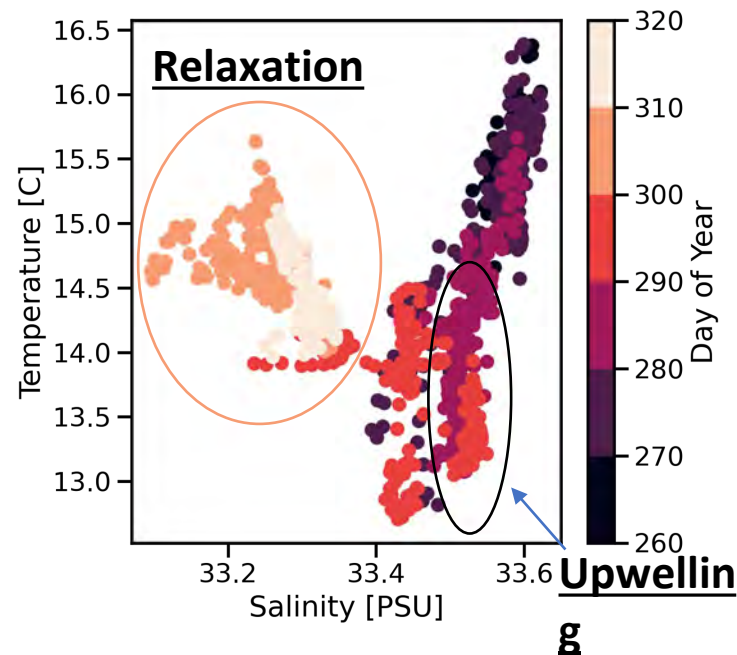
Relative fraction of Diatoms increases



# Reverse Particle Tracking

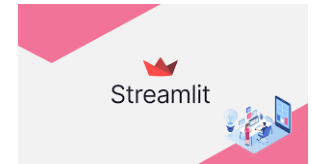
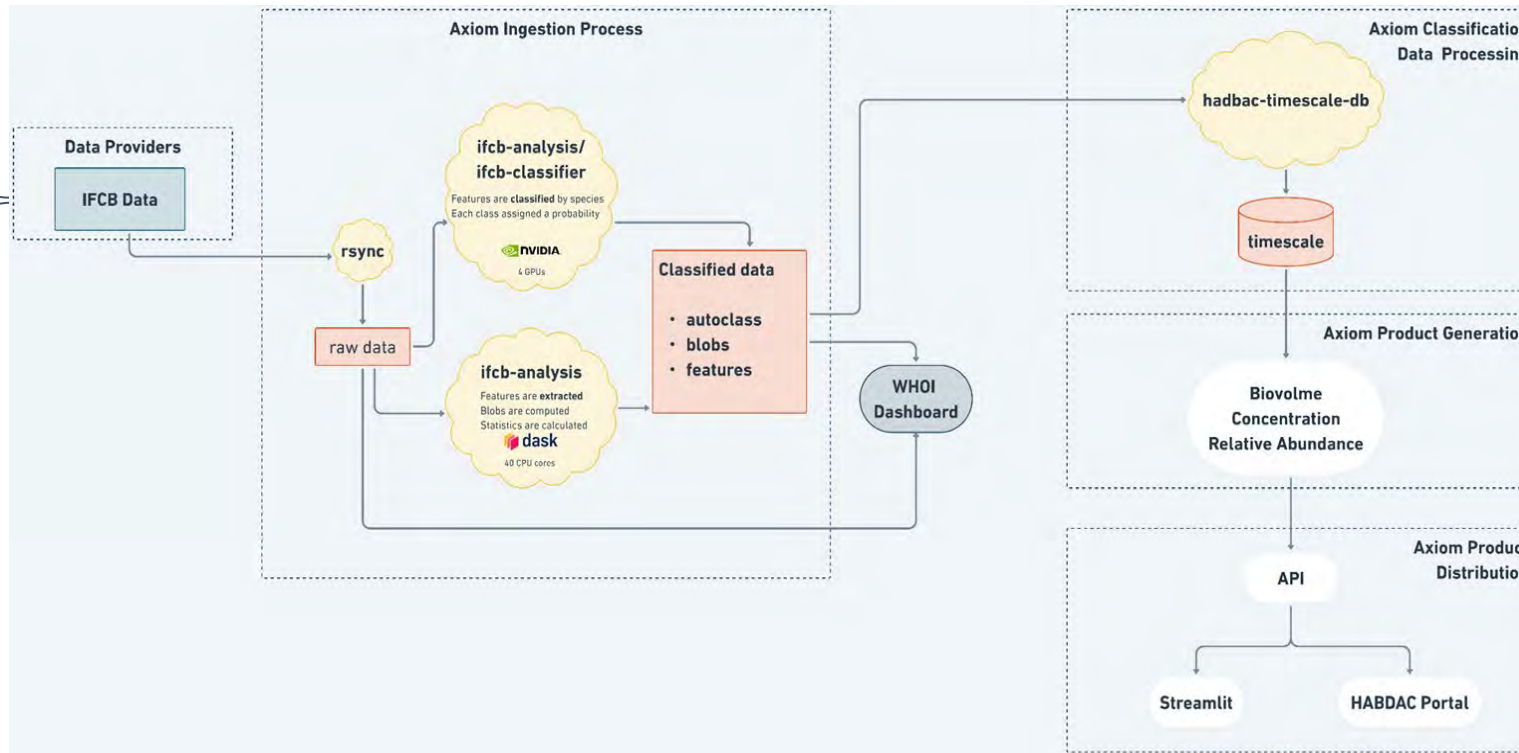
- Release Point
- Backward Path

2km HF Radar Surface Current Maps  
OpenDrift (RK4 Scheme)  
96-hour backward propagation  
Many caveats





# HAB DAC development



## PCM HAB 2020: Harmful Algal Bloom Community Technology Accelerator

*NOAA NCCOS funding us to establish a national  
HAB Data Assembly Center that uses the CA & GoM IFCB Networks as a prototype*