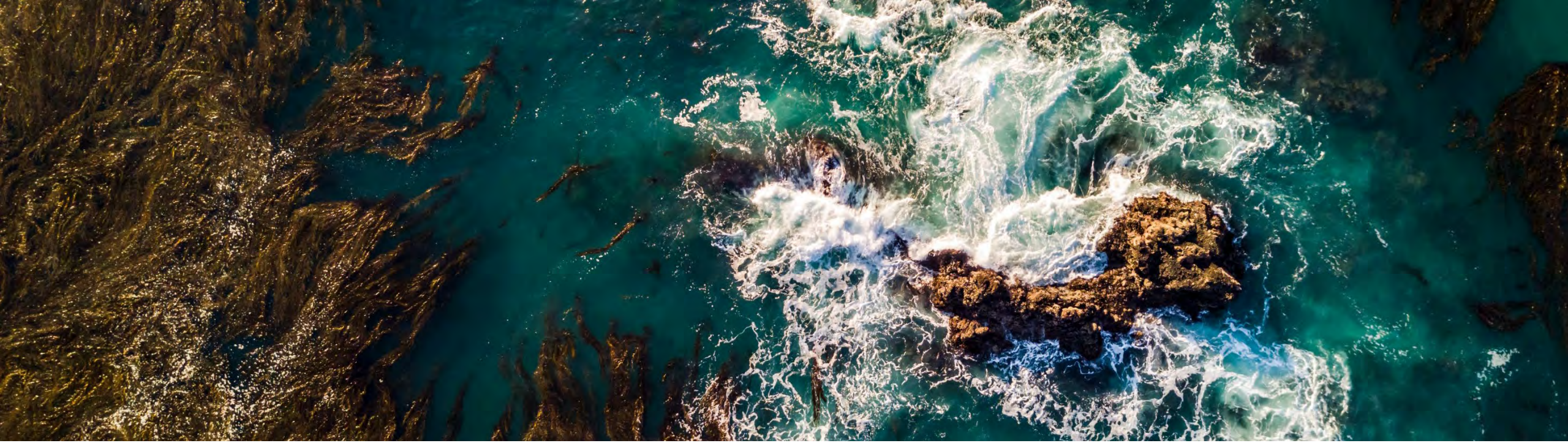


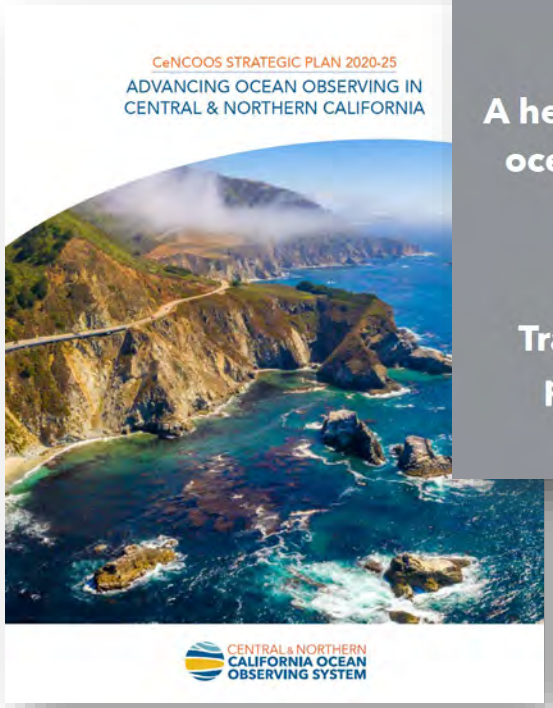
The Central and Northern California Ocean Observing System: Program Office Perspectives

IOOS FAC Meeting
27 June, 2023

IOOS Integrated Ocean Observing System

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Vision, Mission & Strategy

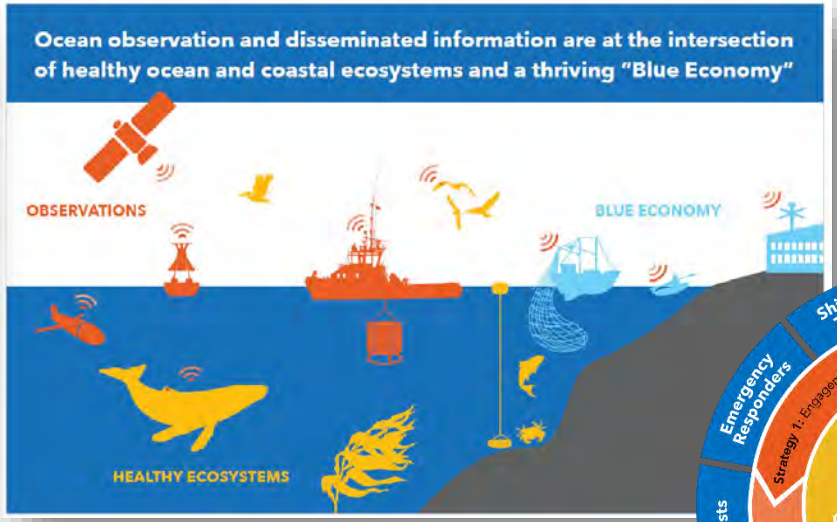


Vision

A healthy and prosperous California coastal ocean powered by information solutions.

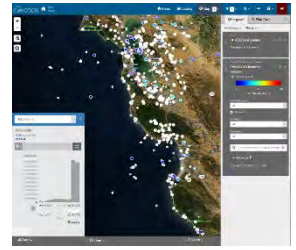
Mission

Translating data into action through the production, curation, and delivery of high-quality ocean information.



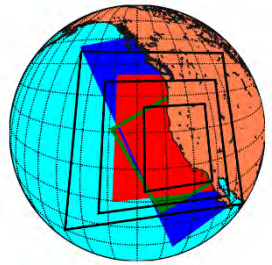
★ **Strategy 1:** Engage marine stakeholders to drive the creation of integrated information products that are valuable for decision-making.

★ **Strategy 2:** Observe coastal and ocean physical, biogeochemical, biology, and ecosystem variables to meet regional stakeholder needs.



★ **Strategy 3:** Streamline access to information, including through a publicly accessible Data Portal.

★ **Strategy 4:** Provide access to improved ocean models and other tools to scale information from individual observations and to make data relevant for policy and management.



https://www.cencoos.org/strategic-plan/

https://data.caloos.org/

CeNCOOS Program Office

Henry Ruhl

Alex Harper
Program Manager

Marine Lebrec

Fred Bahr

Patrick Daniel
Summer Staff

Megan McKinzie

Amy West
Synchro Program Manager

Jason Adelaars
Synchro Technical Manager

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

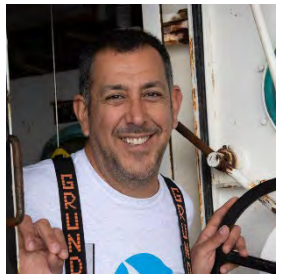
CeNCOOS Investigators


Andrew Moore


Tom Bell


M Garcia Reyes


Holly Bowers


Jaime Jahncke


Katharyn Boyer


Jeffery Abell


Dan Rudnick


Emily Bockmon


Francisco Chavez


Chad Whelan


Barbara Block


James Doyle


Jack Barth


Yui Takeshita


Clarissa Anderson


Dan Costa


Tom Connolly


Tessa Hill


Ryan Walter


Raphe Kudela


John Largier


Chris Edwards


Rob Bochenek

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Beneficiaries and Networks

Users of CeNCOOS information include:

BOEM	Bureau of Ocean Energy Management
CCLEAN	Central Coast Long-term Environmental Assessment Network
CCLME	California Current Large Marine Ecosystem
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CDW	California Department of Water
CCC	California Coastal Commission
CSLC	California State Lands
CEC	California Energy Commission
GNOME	General NOAA Operational Modeling Environment
GTS	Global Telecommunication System
HABMAP	Harmful Algal Bloom Monitoring and Alert Program
NMS	National Marine Sanctuaries (of NOAA)
NMFS	National Marine Fisheries Service (of NOAA)
NCCOS	National Centers for Coastal Ocean Science (of NOAA)
NOS	National Ocean Service (of NOAA)
OAP	Ocean Acidification Program (of NOAA)
OAR	Oceanic and Atmospheric Research (of NOAA)
OEHHA	California Office of Environmental Health Hazard Assessment
OPC	Ocean Protection Council
OSPR	Oil Spill Prevention and Response
OST	Ocean Science Trust
SAROPS	Search and Rescue Optimal Planning System
USCG	US Coast Guard
WCOA	West Coast Ocean Alliance
WCODP	West Coast Ocean Data Portal

Select networks of interest:

AniBOS	Animal Borne Ocean Sensors
ATN	Animal Telemetry Network
CalCOFI	California Cooperative Fisheries Investigations
DOOS	Deep Ocean Observing Strategy
GEO BON	Group on Earth Observation Biodiversity Observation Network
GOA-ON	Global Ocean Acidification Observing Network
GOMO	Global Ocean Monitoring and Observation
GOOS	Global Ocean Observing System
NHABON	National Harmful Algal Bloom Observing Network (of NOAA)
IPCC	Intergovernmental Panel on Climate Change
MARINe	Multi-Agency Rocky Intertidal Network
MBON	Marine Biodiversity Observation Network
OBON	Ocean Biomolecular Observing Network
OBP	Ocean Best Practices
OBIS	Ocean Biodiversity Information System
OTN	Ocean Tracking Network
PCSGA	Pacific Coast Shellfish Growers Association
PISCO	Partnership for Interdisciplinary Studies of Coastal Oceans
POGO	Partnership for Observing the Global Ocean
ROWG	Radiowave Operators Working Group
SACNAS	Soc. for Adv. of Chicanos/Hispanics & Native Americans in Science
WAML	Western Association of Marine Laboratories
Synchro	Synchronize and evolve technology

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Bodega – Climate & Coastal Resilience Mtg.

- May 24/25 – UC Davis, Bodega Marine Lab
- Refreshed our detailed unfunded planning / scoping towards
  - Feasible, impactful climate & coastal resilience activities
  - Improved education, outreach, accessibility & equity

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Storms & Swells!

Los Angeles Times

Storm leaves California coastal towns badly damaged -- with more danger on the way

A support piece from the Capitola Wharf is seen inside the storm-damaged Zelda's restaurant in Capitola, Calif., on Thursday. Giant ocean swells pushed debris through the front wall and a window, filling the interior with several inches of seawater. (Shmuel Thaler / Santa Cruz Sentinel via AP)

https://lookout.co/santacruz/weather/story/2023-01-05/santa-cruz-county-storm-coast-ocean

https://worldview.earthdata.nasa.gov, Aqua/MODIS, 15 March

Headlines – HABs

The New York Times

Cancel or pause anytime.

Hundreds of Sea Lions Are Dying. Is an Algal Bloom to Blame?

Rescuers have been inundated with calls about sick and dying sea lions and dolphins along California's central coast. They believe the cause is a toxin produced by a harmful algae.

Give this article 11

A dead dolphin and California sea lions showing symptoms of domoic acid poisoning. Staci Kaye-Carr, Channel Islands Marine & Wildlife Institute

By Livia Albeck-Ripka
Reporting from Los Angeles

June 21, 2023

https://www.nytimes.com/2023/06/21/us/algae-bloom-california-sea-lion-dolphin.html

NOAA FISHERIES

Menu

NEWS

Toxic Algal Bloom Suspected in Dolphin and Sea Lion Deaths in Southern California

June 16, 2023

Stranding Network asks beachgoers to keep a safe distance and report strandings.

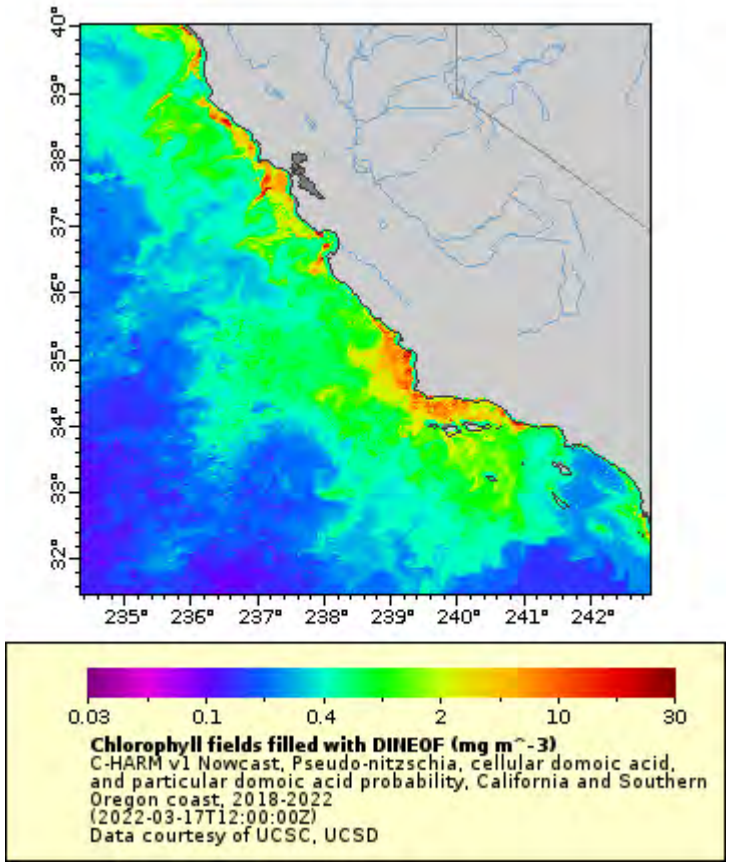
Feature Story | West Coast

Deceased dolphin as a result of domoic acid poisoning. Credit: Channel Islands Marine & Wildlife Institute

The rapid growth of harmful algae along parts of the Southern California Coast is believed to
California sea lions and close to 60 dolphins in the first weeks of June.
The Channel Islands Marine & Wildlife Institute has fielded more than 1,000 reports of sick and

Send Us Your Feedback

https://www.fisheries.noaa.gov/feature-story/toxic-algal-bloom-suspected-dolphin-and-sea-lion-deaths-southern-california

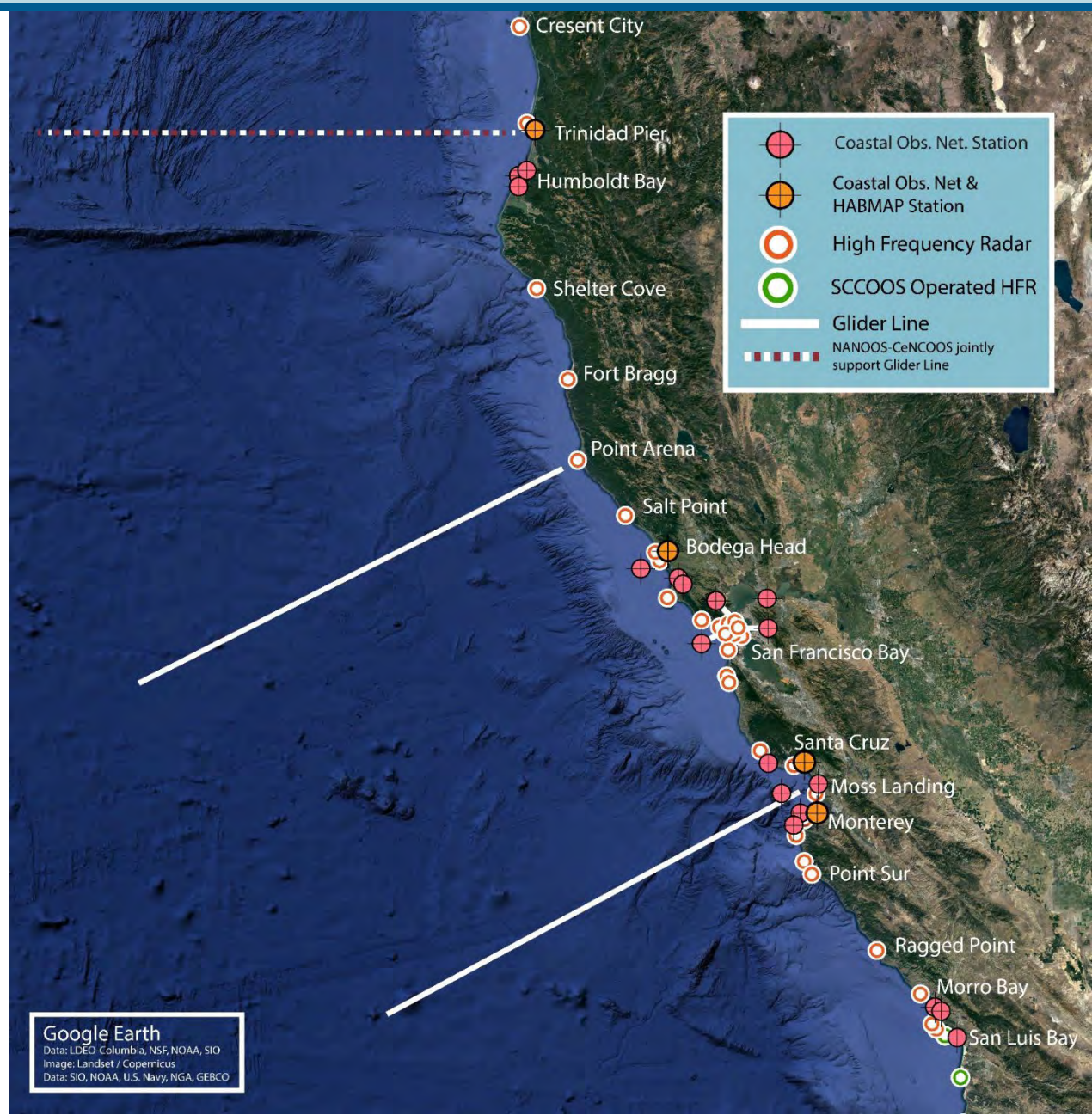


- Likely an offshore dynamic as coastal stations not yet seeing HAB spikes.
- "Animals are coming in at a record clip to TMMC, CIMWI, MMCC-LA, and PMMC. Many are just dead on beaches. We are in constant contact with these centers, providing C-HARM and other updates." – Clarissa Anderson

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Current Core Activities

- Maintain CeNCOOS Program Office;
- Operations and maintenance of:
  - **31** high-frequency radars (HFR), with recapitalization of 7% of our infrastructure;
  - **Three** glider lines;
  - **15(+)** Coastal Observing Network stations;
  - **Four** HAB sampling sites;
  - Zooplankton, bird and ship sampling;
  - Two stations of eDNA sampling
  - Elephant seal and shark tagging.
- **DMAC** & regional data assembly center;
- Hindcast, nowcast and forecast models with new **biogeochemistry and biology** outputs;
- New **high-resolution coastal nowcasts** in Monterey Bay with ~160 m grid cells;
- **>250** data products - new support for kelp cover, climate, fisheries, marine protected areas & aquaculture indicators;
- Engagement activities to support the above including product development, and working with IOOS Association in better serving underrepresented communities and **building a diverse workforce**.



HFR Update

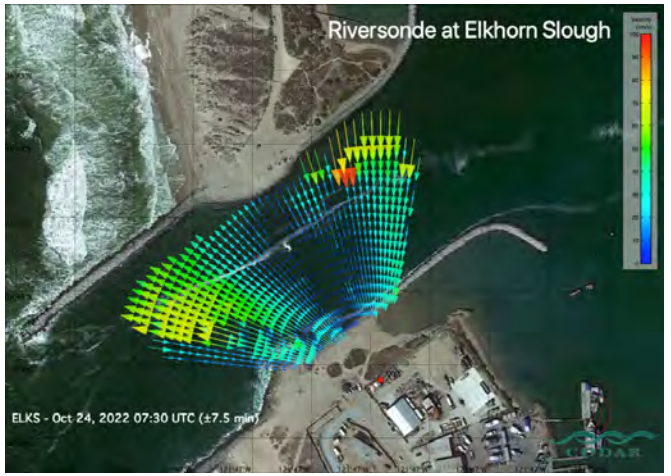
- Nation-leading uptime!

Location	Q1	Q2	Q3	Q4	FY
CENCOOS	92%	81%	85%	-	86%

- *CeNCOOS recently installed a new SeaSonde HFR station (site code: MBAC) at the Monterey Bay Academy in La Selva Beach, CA.*
- *MBAC station is also co-located with a suite of radar, lidar and optical atmospheric sensors operated by NRL.*
- *Infrastructure updates ongoing*
- *RiverSonde now operating in Moss Landing (temporary instillation)*

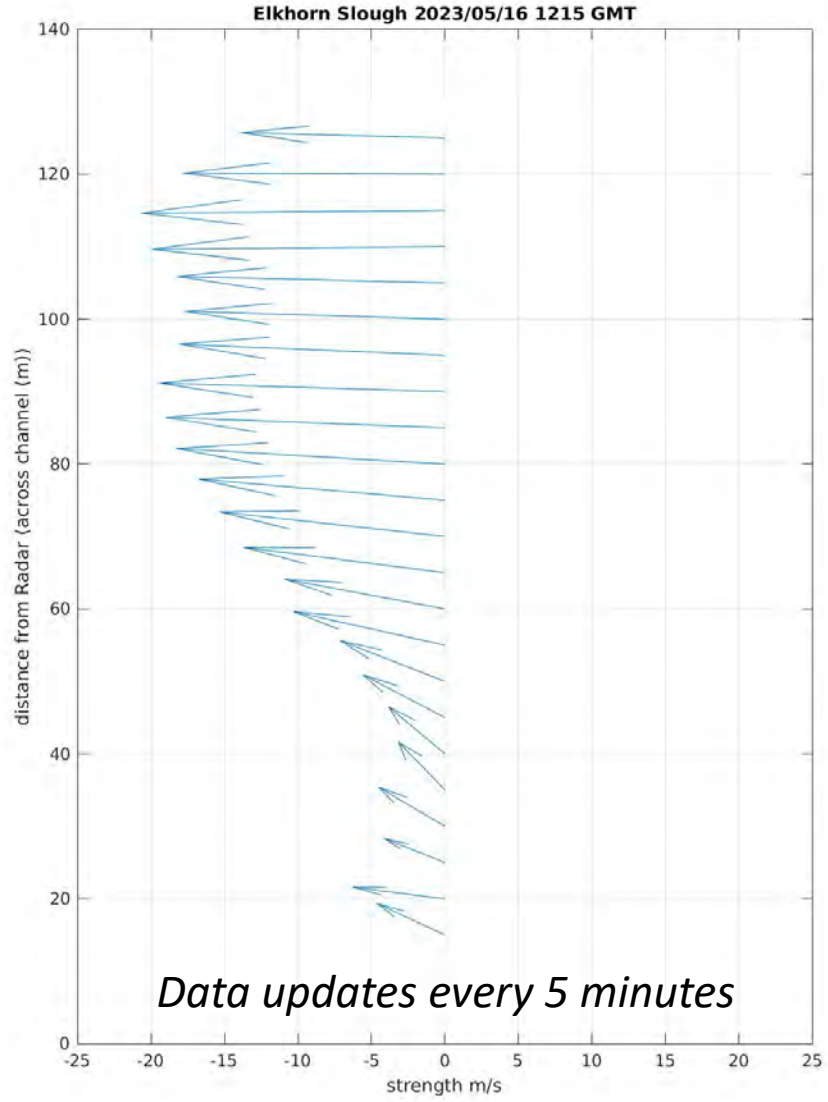
RiverSonde at Moss Landing, CA

Observing the Elkhorn Slough Entrance Channel



Radial Surface Current Vectors

Cross Channel Vector Profile

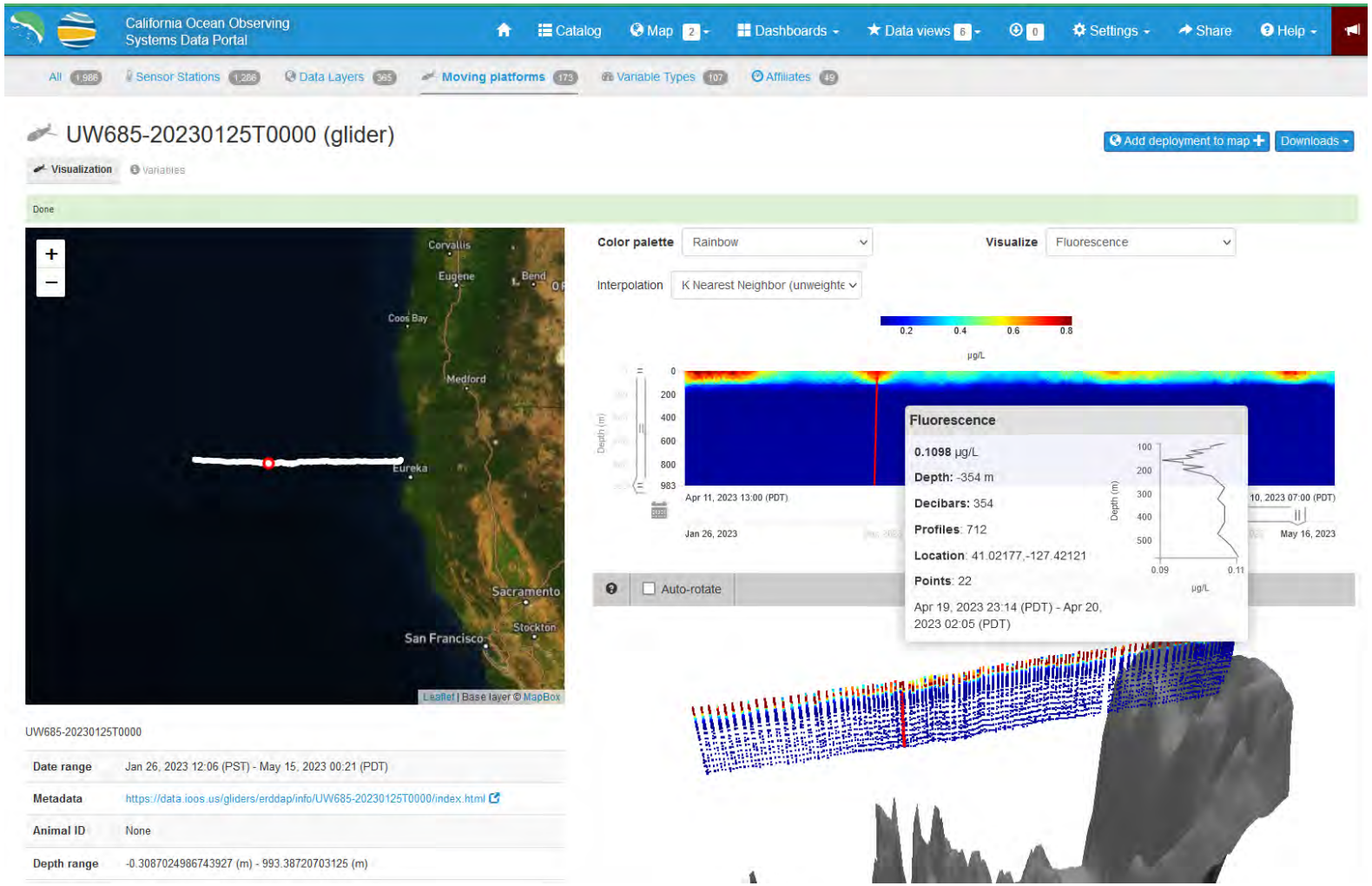


Data updates every 5 minutes

https://cencoos.org/images/RiverSonde_ELK_latest.jpg

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

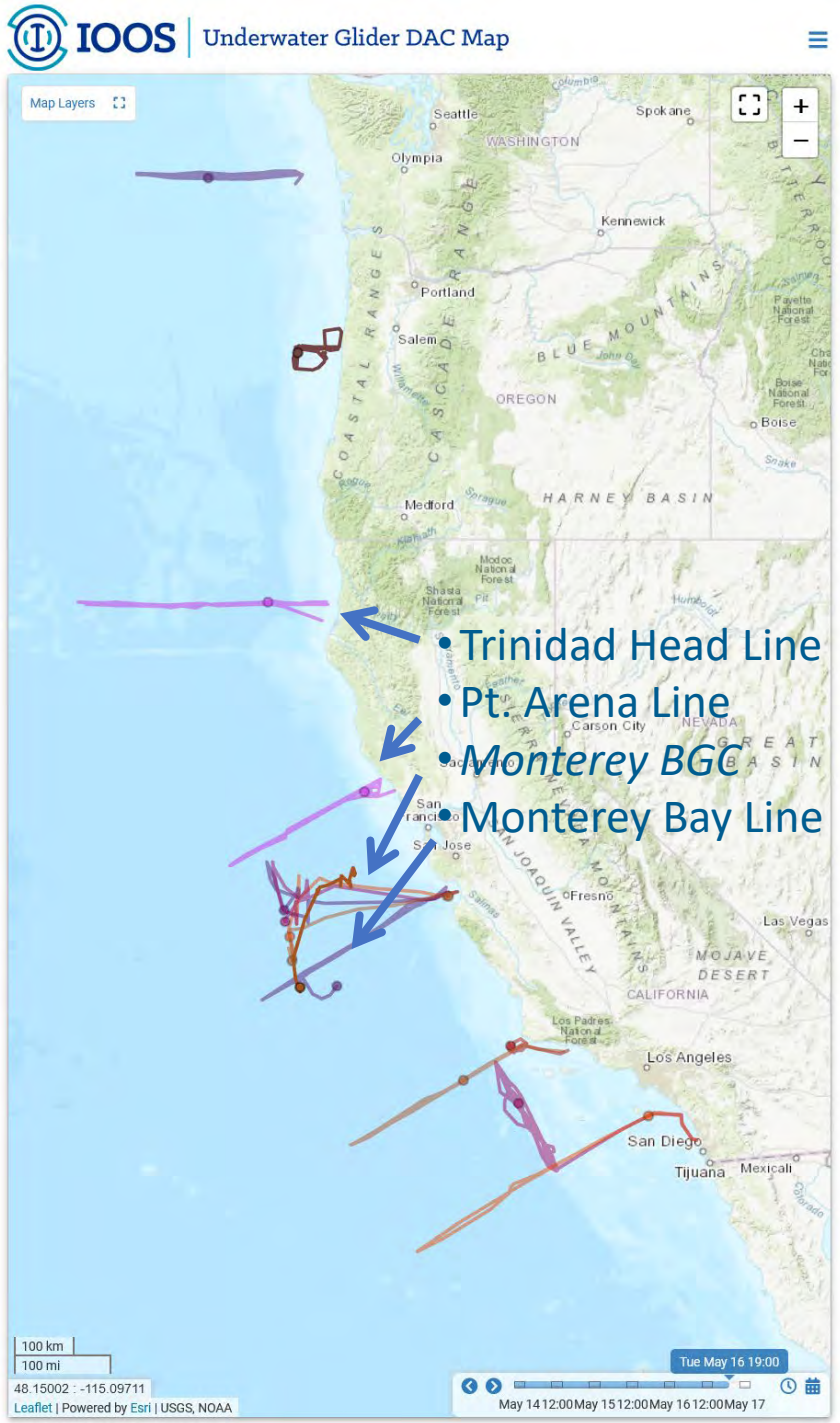
Glider Update



https://data.caloos.org/

http://spraydata.ucsd.edu/projects/cugn/

First Spray 2 on order w/BGC sensors!



CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Shore Station Update

UC Davis
- Bodega Marine Lab
- Bodega Bay Buoy
- Fort Point
- Tomales Bay
- Hog Island, Tomales

CalPoly Humboldt
- Humboldt Bay
- Trinidad
- Hog Island, Humboldt

Cal Maritime
- Carquinez

Wiyot Tribe
- Tuluwat (Indian) Island

SFSU EOS
- Tiburon Water Quality
- Tiburon Weather Station
- Bay Ocean Buoy (BOB)

Exploratorium
- Exploratorium

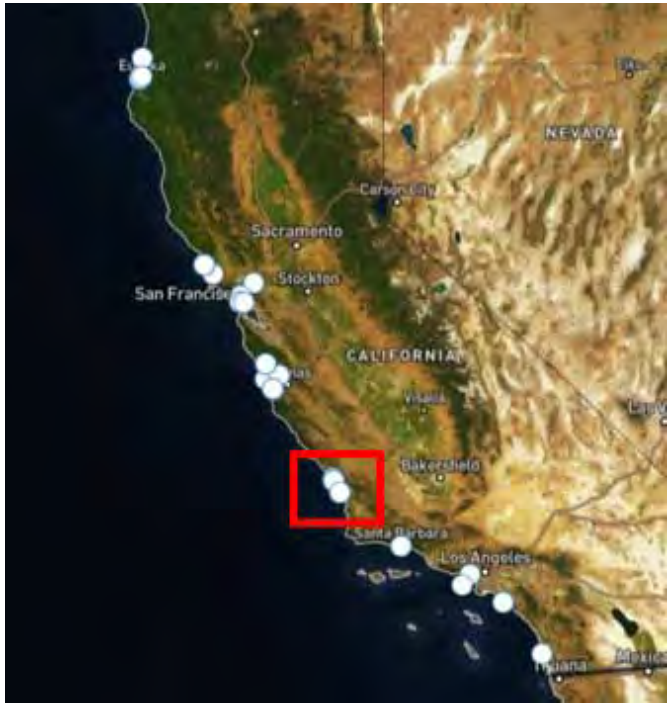
UC Santa Cruz
- Santa Cruz Wharf
- Santa Cruz Wharf Weather Station

Moss Landing Marine Labs
- Moss Landing
- Moss Landing Weather Station
- Monterey Wharf II

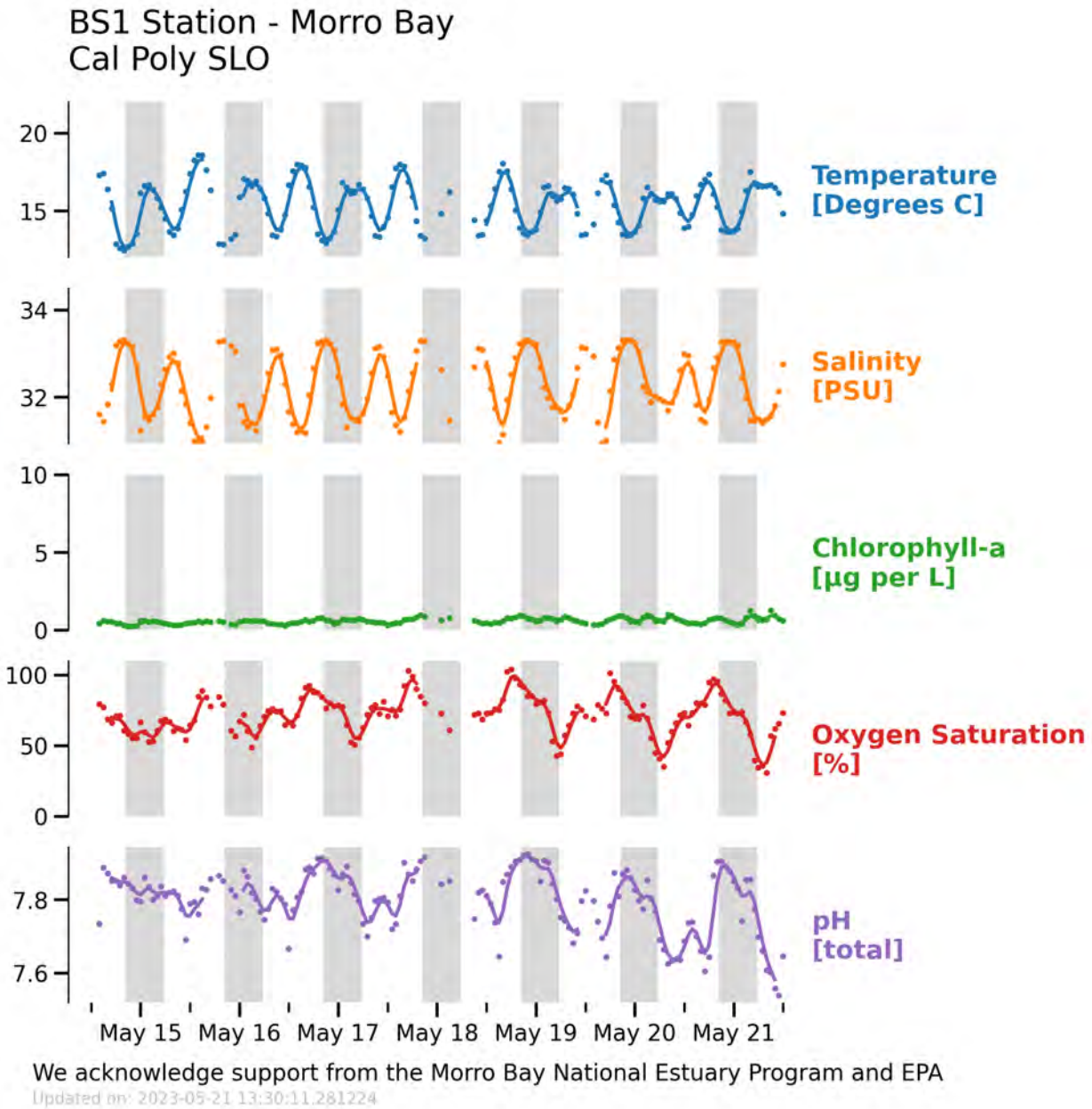
Monterey Bay Aquarium
- Monterey Bay Aquarium

Cal Poly
- Morro Bay, T-Pier
- Morro Bay, Back Bay
- Morro Bay, Back Bay Weather Station
- Cal Poly Pier
- Cal Poly Pier Weather Station

MBARI
- M1 Monterey Bay



- Limited re-cap including OAH sensing
- "A Proposal to Scale from a Regional to a National Webcam Coastal Observation System (WebCOOS)"
- Impact areas:
  - HABs;
  - Aquaculture;
  - OAH & coastal climate signal.

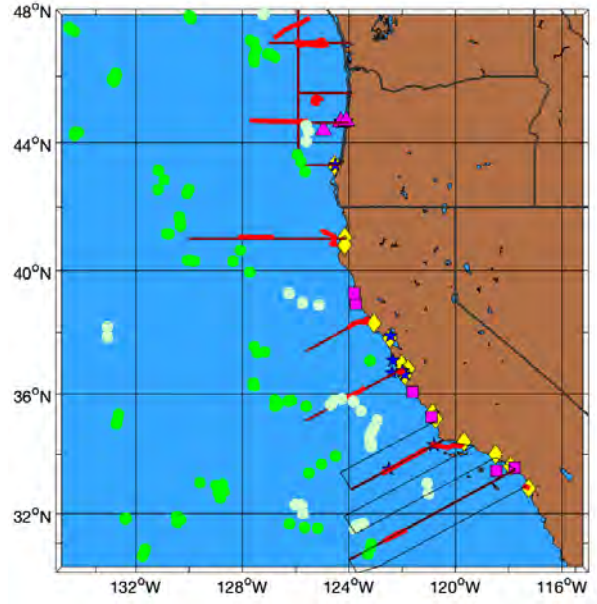


CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

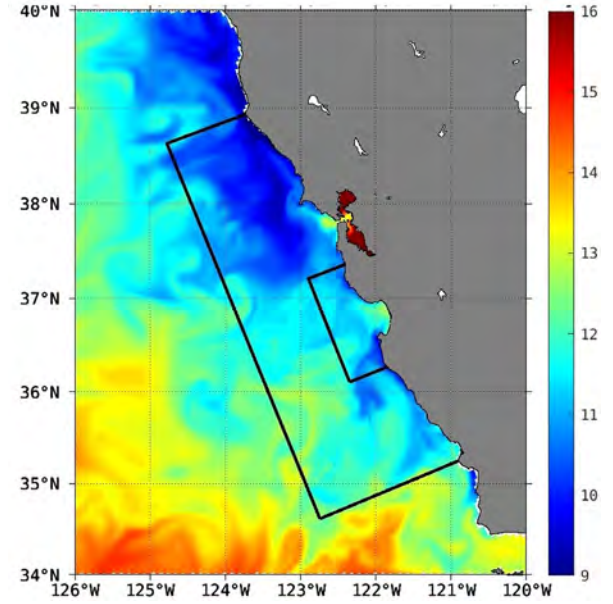
Modeling Update

- NRL COAMPS
  - 4D-Var DA 12-4km Atmospheric model (Doyle)
  - 1999-present (in various grid configurations)
- West Coast ROMS
  - 1/10º (~10km) ROMS nowcast (Edwards/Moore, UCSC)
  - NEMURO in Portal staging
- California-Harmful Algae Risk Mapping (C-HARM)
  - 3.3 km WCOFS/VIIRS (Anderson, UCSD/SCCOOS/Coast Watch)
- West Coast Operational Forecast System (WCOFS)
  - 4D-Var DA 4km ROMS nowcast/forecast (Kurapov, NOAA)
  - Hi-resolution nests
- San Francisco Bay Operational Forecast System (SFBOFS)
  - Now in Portal and supporting bay currents
- WCOFS project exploring efficiencies and NEMURO BGC

Assimilation



Model nesting



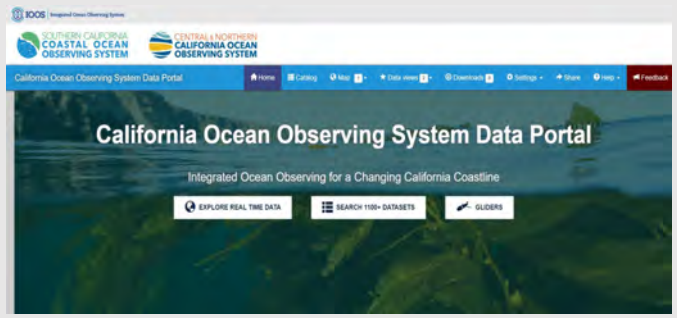
U.S. NAVAL RESEARCH LABORATORY

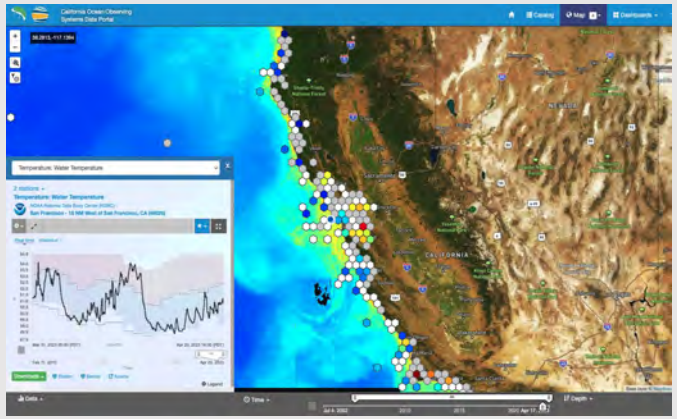
SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

NOAA COASTWATCH

https://data.caloos.org/

CalOOS Data Portal Overview





Total number of sensor stations: **1,387**
Number of sensor types: **87**
Number of affiliates: **54**
Number of moving platforms: **65**
Number of data layers: **320**
Number of observations per week: **~4.5 million**

California Ocean Observing System Data Portal (CalOOS)

https://data.caloos.org/

CeNCOOS and SCCOOS statewide data portal

Provides discovery and access to diverse types of coastal and ocean observation data to statewide stakeholders

Planning for Next Gen

Current version launched 2018

Growing complexity in data landscape

Addresses needs for more flexible architecture, faster performance, scalability, and improved integration

Beginning 2 year, user-driven development

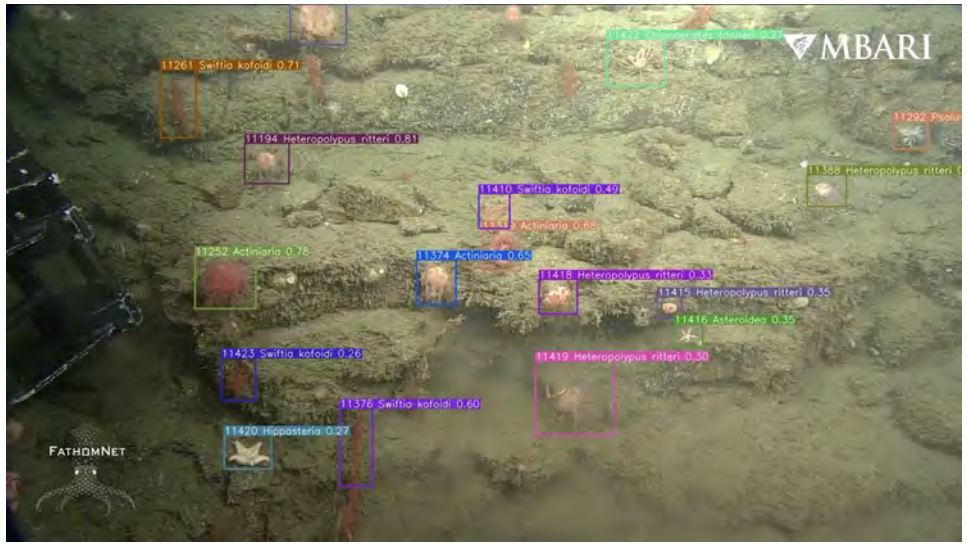
CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

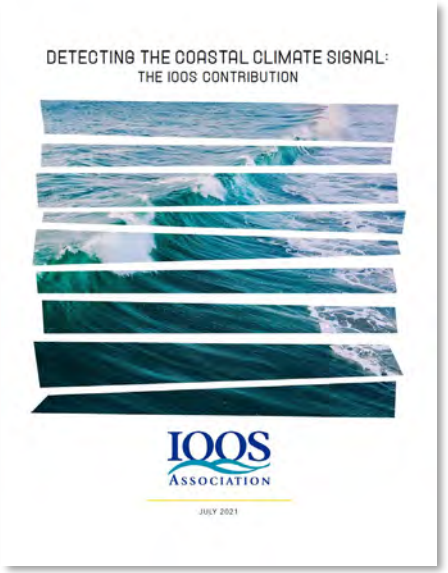
Next Gen: Planned Features

Improvements to portal load time	• Quicker load of layers, grids, and time series data • Integration of spatially enabled time series database
Coupling of data assets	• Data and metadata organized into groups (‘data packages’) of related data sets • Improvements to search and discovery for connected data sets
User-login based system	• ‘My CalOOS’ concept for log-in, user accounts, and saved configurations • Improvements to portal usage tracking
Catalog and search refactor	• More intuitive search and browsing aids • Spatial enabled search tools • Dedicated catalog for archived assets
Other UI/UX enhancements	• Optimized for mobile • Animations (model data, animal movement) • Jupyter Hub integration • ….and more

CeNCOOS Extramural Projects

- HAB Community Technology Accelerator – HAB DAC, SCCOOS-led
- An Integrated Early Warning System for HABs in CA – IFCB Network, SCCOOS-led
- Implementing the Deep Ocean Observing Strategy, UT Austin-led
- Ocean Vision AI: Scaling up visual observations of life in the ocean using artificial intelligence, MBARI-led
- California's ocean acidification and hypoxia monitoring network - enhancing data management and collection, CeNCOOS/SCCWRP-led
- A California OAH Portal to enable synthesis and understanding of state-wide status & trends CeNCOOS/SCCWRP-led
- Advancing OAH science off northern California: a critical expansion of monitoring and research to quantify OAH exposure, assess ecosystem impacts, and support model development, Cal Poly Humboldt-led
- The CeNCOOS MBON: Marine biodiversity information in support of a healthy Blue Economy in the central California Current, MBARI-led
- Synchro: Co-Design Lab for Synchronizing Technology Evolution for Industry, Ocean Science and Conservation, MBARI-led
- CeNCOOS Infrastructure, MBARI-led





CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

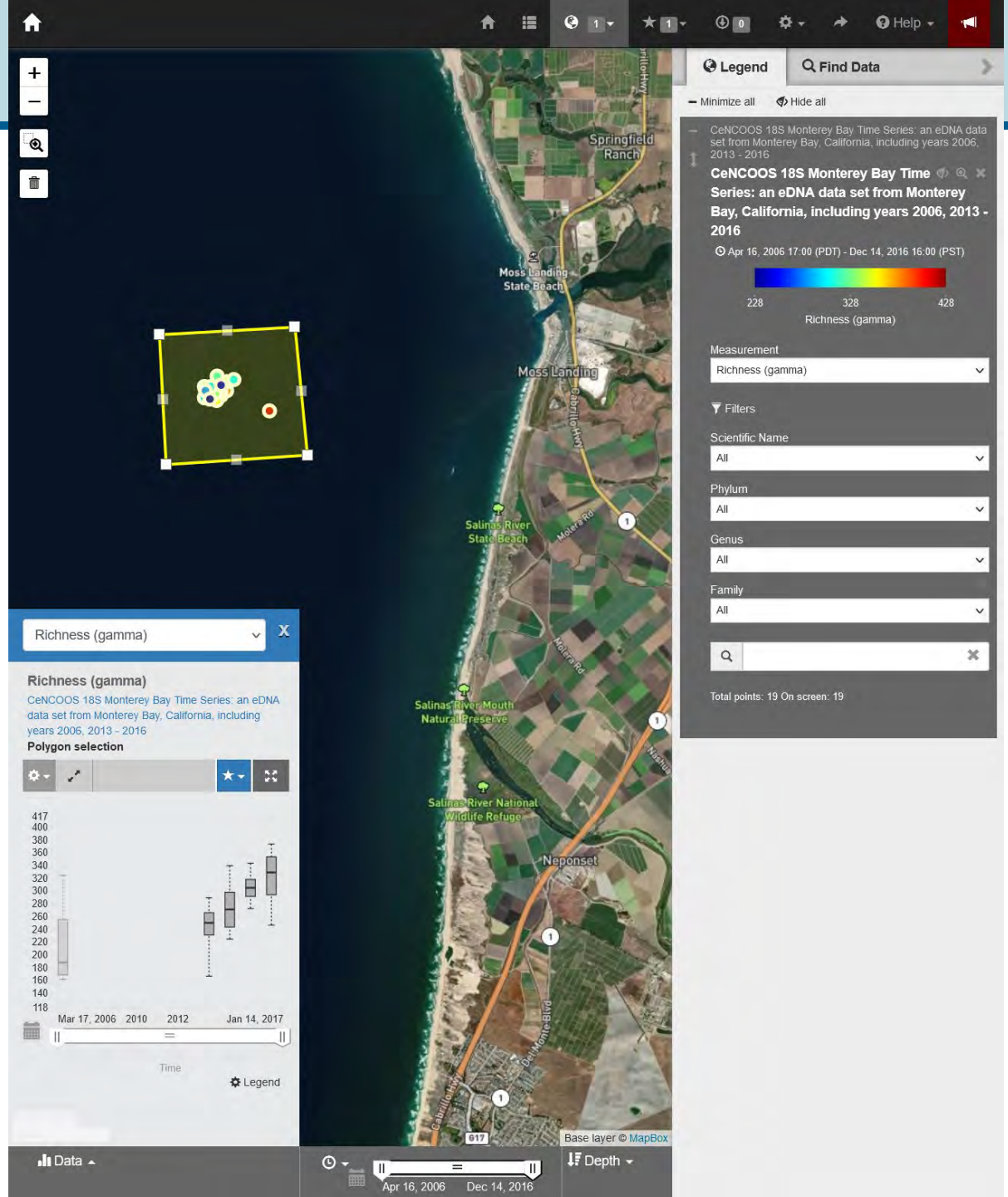
BioEco - The Bottom Line

- **Need/impact**: BioEco observations at the root of a myriad of resources and serves
- **People/teams**: There's an array of organizations evolving to observe BioEco
- **Feasibility/capacity**: Many tools are progressing from research to operations
- **Scalability**: Data integration can inform macroecological assessment

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

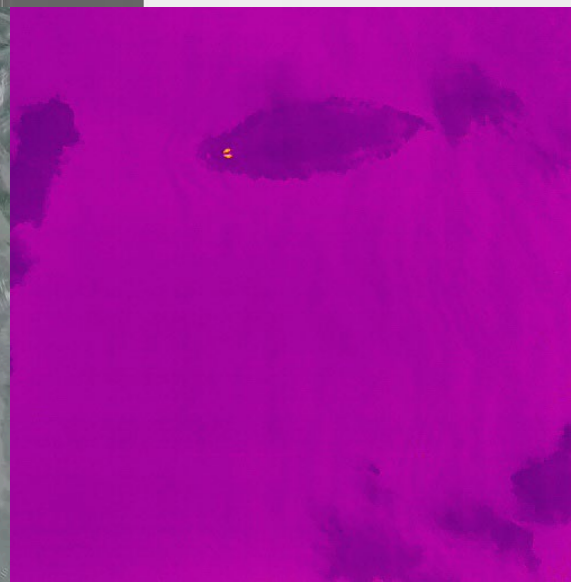
eDNA

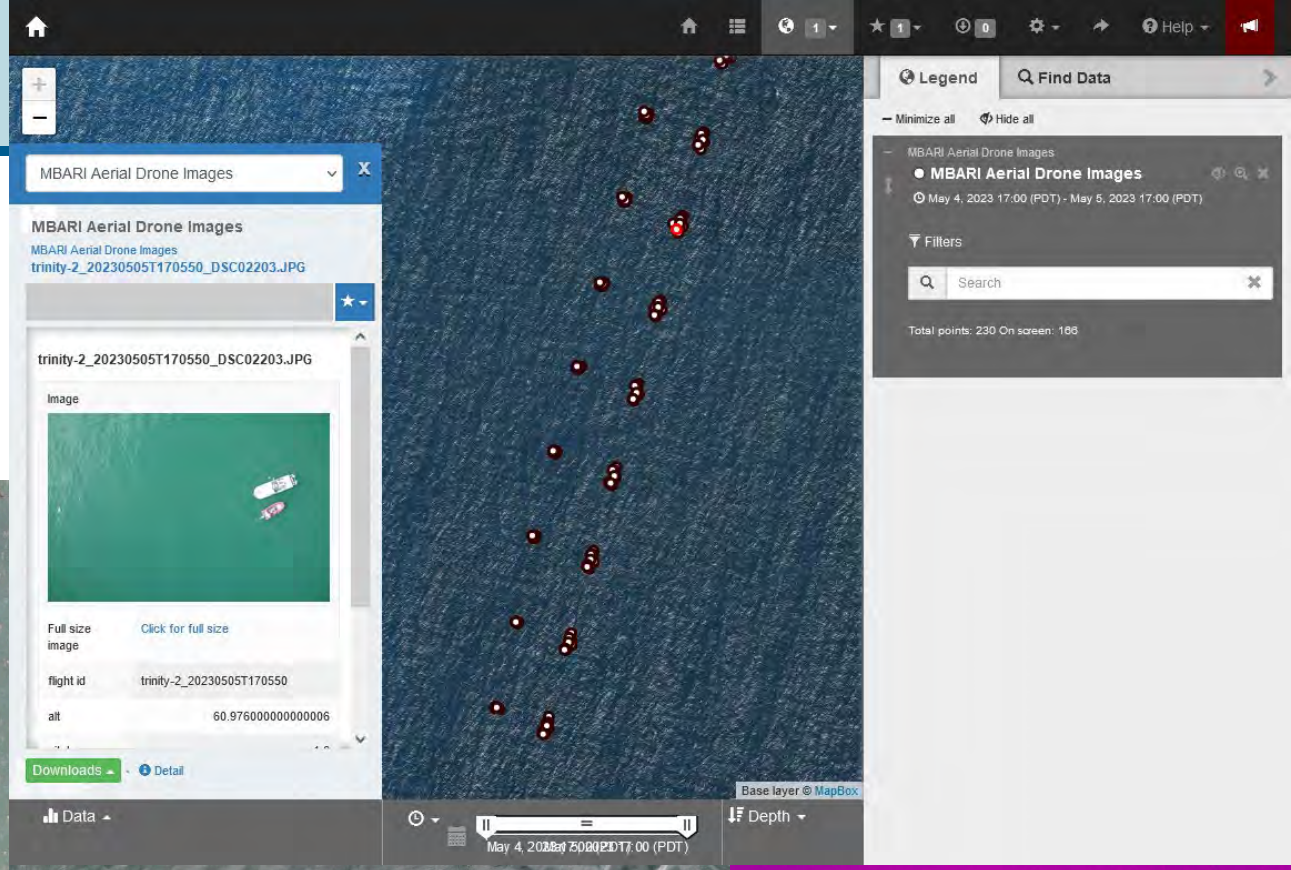
- Monterey Bay Timeseries
- Long-term studies on regime shifts with anchovies and sardines
- eDNA providing powerful estimates of change
- Records going into OBIS and GBIF
- Greater Farallones & Cordell Bank NMS, Humboldt



Drones

- Pathfinder work to scope drone program
- MBARI, NMFS, Axiom



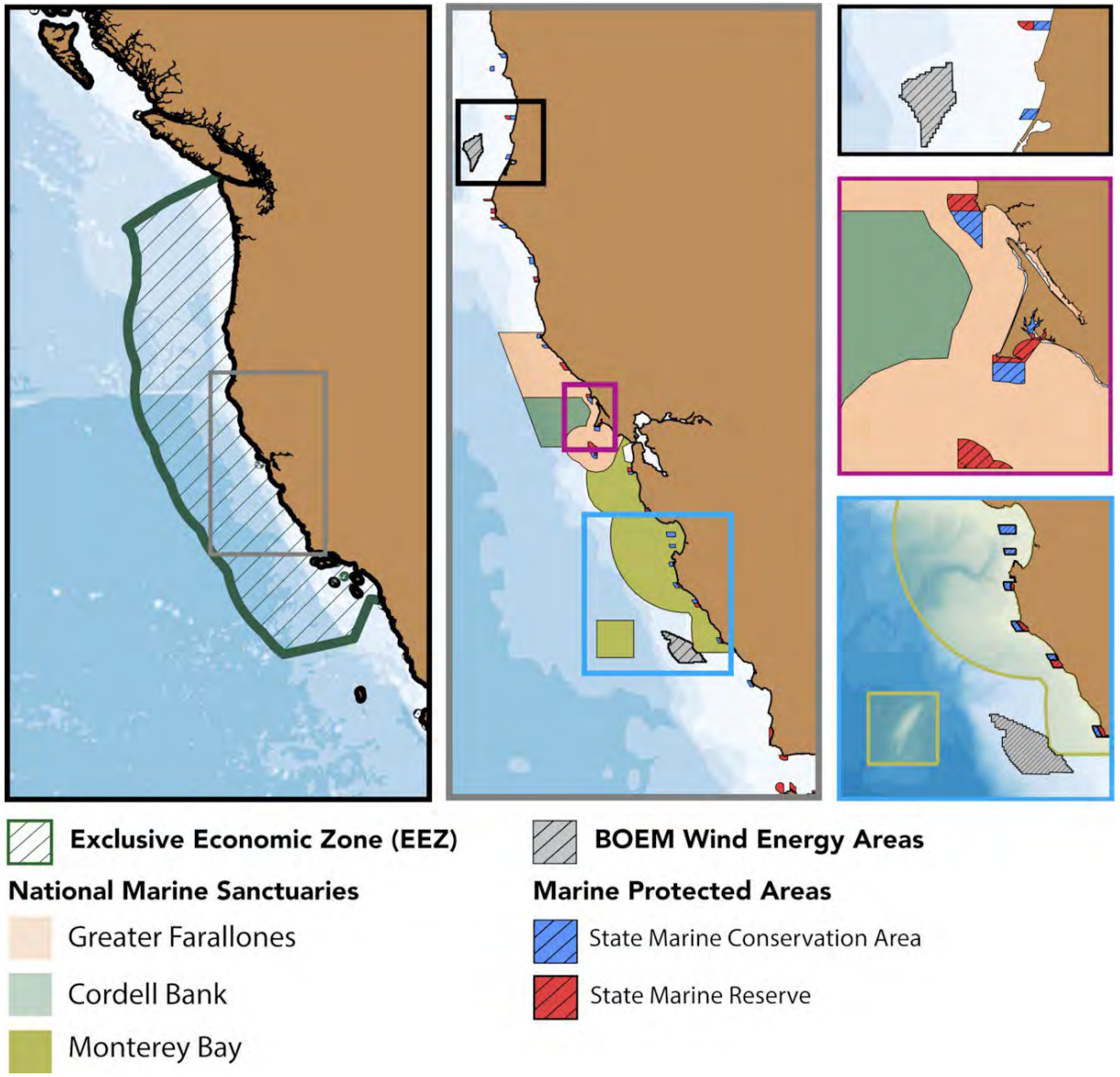


CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Deep Ocean Observing Strategy (DOOS)

DEEP OCEAN OBSERVING STRATEGY

- NSF AccelNet Program
- Deep-ocean community ↔ GOOS
- Bringing IOOS concepts e.g. data lifecycle planning with information user inputs
- EOV concept/specification evolution
- West Coast case study for habitat and ecological
- Climate and modeling work re: deep ocean change
- DOERs – Deep Ocean Early Career Researchers are empowered!



CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

DOOS/MBON/GOOS

Researchers outline best practices for understanding life on the ocean's vast seafloor

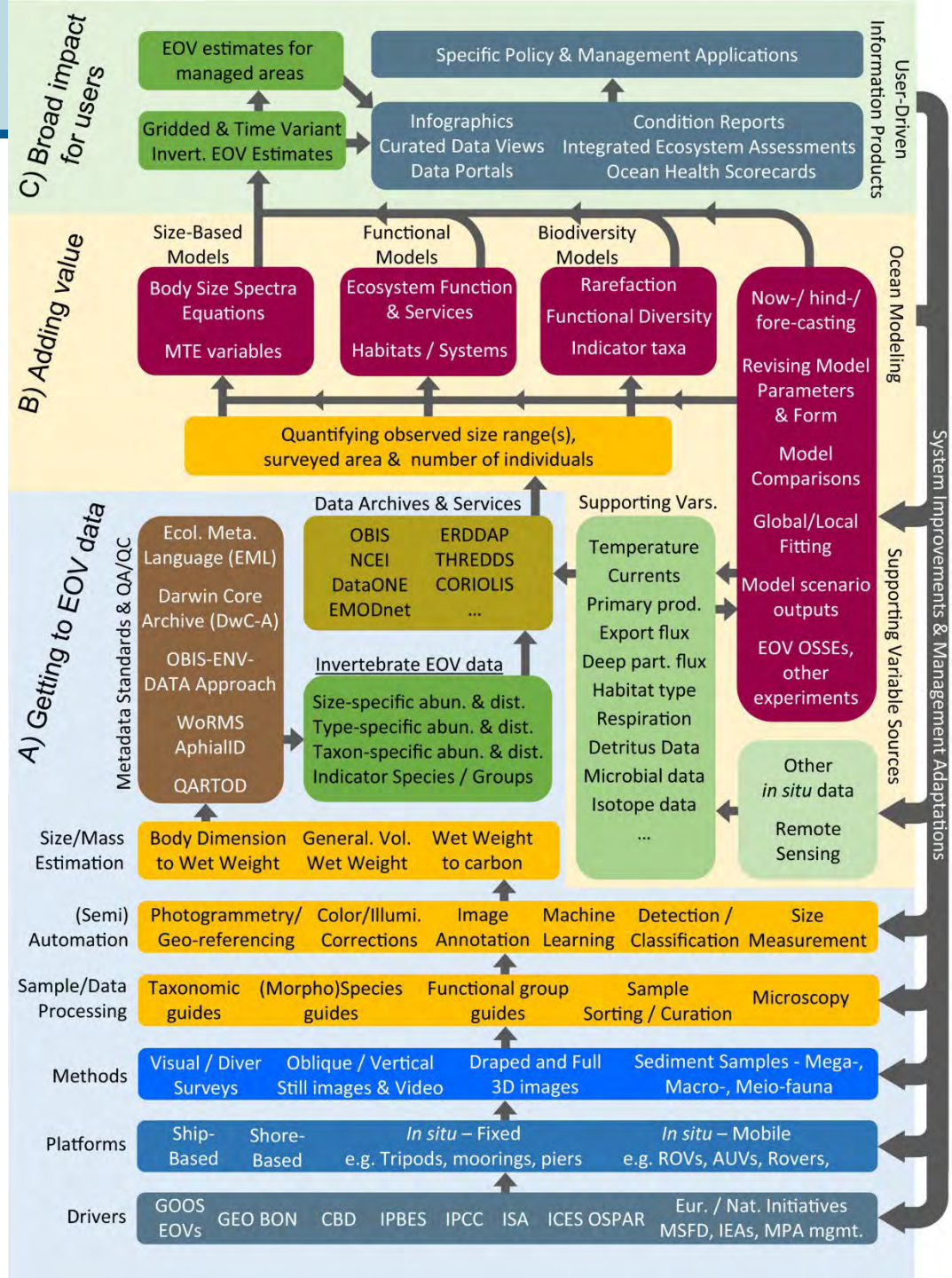
- A new set of research practices—developed, in part, through the **Deep Ocean Observing Strategy** and **Marine Biodiversity Observation Network**—can help standardize the information researchers and ocean industry contractors collect about seafloor invertebrates.
  - Quantify individual body size.
  - Identify the well-quantified portions of sampled body-size spectra.
  - Take advantage of automated and semi-automated information processing via artificial intelligence and machine learning.
  - Apply metadata standards, such as Darwin Core.
  - Make data available through internationally recognized access points.

GOOS Biology and Ecosystems Panel

Marine Life 2030

DEEP OCEAN OBSERVING STRATEGY

MBON Marine Biodiversity Observation Network



Ruhl, H.A., et al. *Limnology and Oceanography Letters*. doi.org/10.1002/lol2.10332

https://www.mbari.org/news/researchers-outline-best-practices-for-understanding-life-on-the-oceans-vast-seafloor/

CeNCOOS Engagements

- CalCOFI Conference
- MBON National Meeting, Monterey, CA
- IOOS Association spring meeting,
- Congressional engagements with Duarta, Mullin, Lofgren, Huffman, Valadao, Eshoo, Hardar et al.
- MBON National Meeting, College Part, MD
- Shared Axiom User Retreat, Seattle, WA
- California OAH Monitoring Stakeholder & Technical Workshop, MBARI
- Other Effective Conservation Measures (OECMs) in California's Coastal Waters, MBARI, OST-led
- mCDR Proposal planning
- Synchro co-design session I, II, III - Testing & evaluation, MPAs, OSW
- iDOOS Annual Meeting

- Regular engagements
  - MBNMS Research Activity Panel, Bi Monthly
  - West Watch, Bi Monthly
  - PCMHAB Transition Advisory Committee (TAC)
  - SCCOOS Board of Governors & Executive Steering Committee Meeting
  - IOOSA, ExComm, OSW Committee, Monthly
  - […]

- IOOS FAC @ MBARI in June!

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Challenges & Opportunities

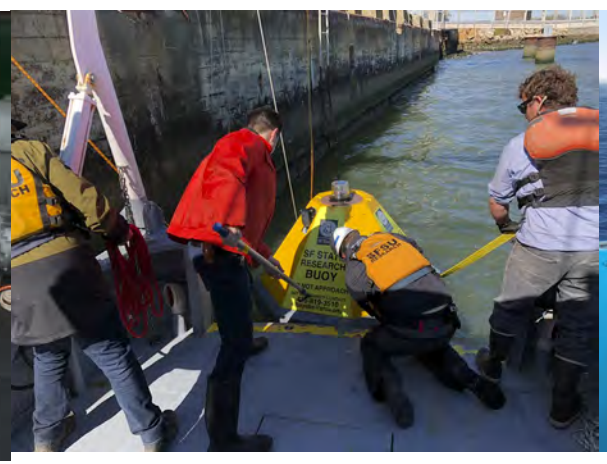
Challenges

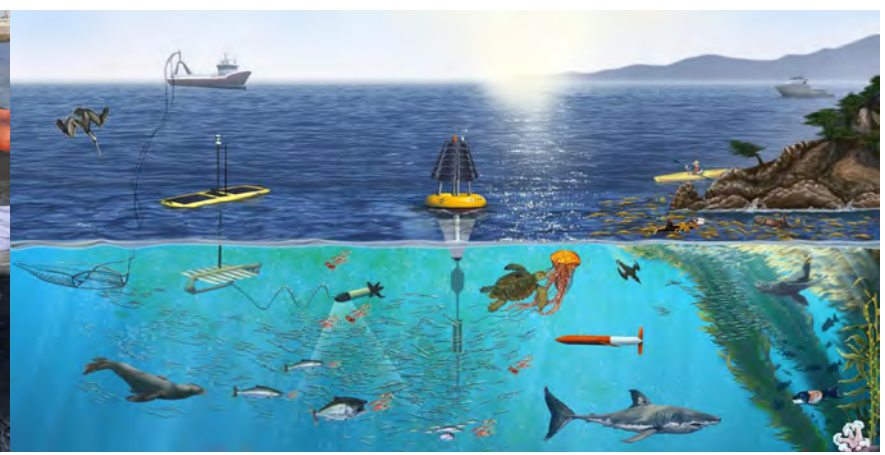
- Limited program office capacity
- Offshore wind development
- Tribal engagement
- Product development and ongoing maintenance
- Axiom services vs external
- Comms, outreach, education
- Sustaining activities beyond BIL & IRA

Opportunities

- Uncrewed and autonomous observing systems
- Community-led observing
- AI and machine learning
- Data ingestion automation
- Cloud computing and big data
- Workforce development and capacity building
- Pan-regional projects ….





CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

Regional Prospective Priorities

Governance
- Coastal and climate resilience project manager

DMAC
- Next gen DMAC
- CA Acoustic Telemetry Network
- Ocean Vision AI
- Drone data integration

Products
- Mobile and tablet apps
- Fisheries and maritime navigation
- Drop a drifter
- Plume tracking
- Particle tracking
- BioTrack
- Glider zooplankton products

Observations
- HABMAP/HABON – buildout
- Ocean Sound Obs. Net.
- HFR - Preventing / filling gaps
- Offshore wind obs. Gliders
- Water level - webcams/sensors
- Backyard Buoy's - waves/kelp/community obs.
- Co. Obs. Net – eDNA, Noyo, Crescent City
- CA Fish. Ves. Opp. (CFVOP)
- UxS - drone network
- Planktivore obs.

Models
- WCOFS/NEMURO
- Nested regional models

Outreach, engagement, & Education
- Education, Outreach & Training
- Partnerships

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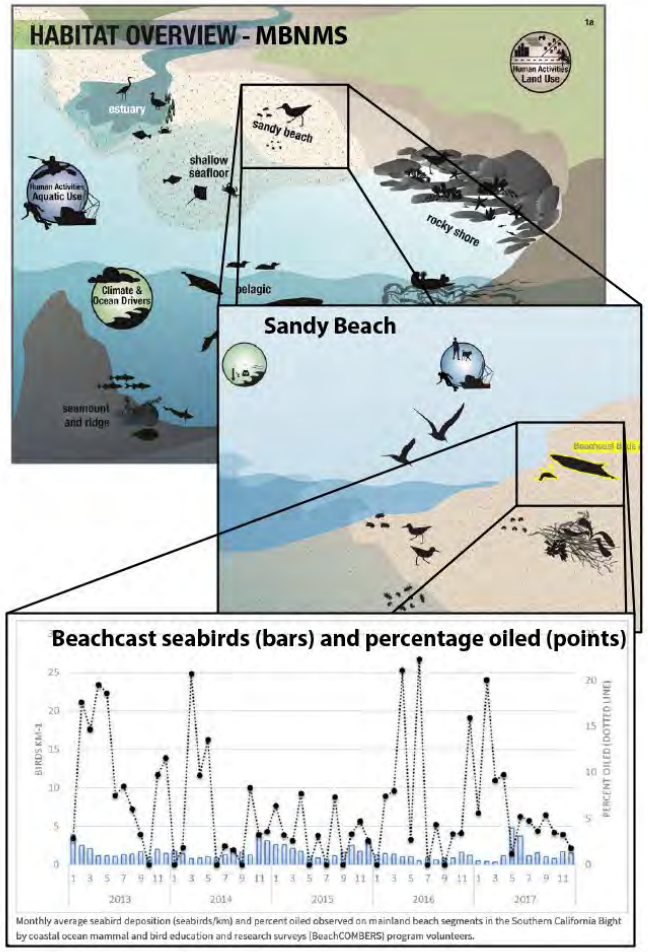
Clear/Specific Discovery & Use Points

(a) INFOGRAPHICS

Task: Information discovery

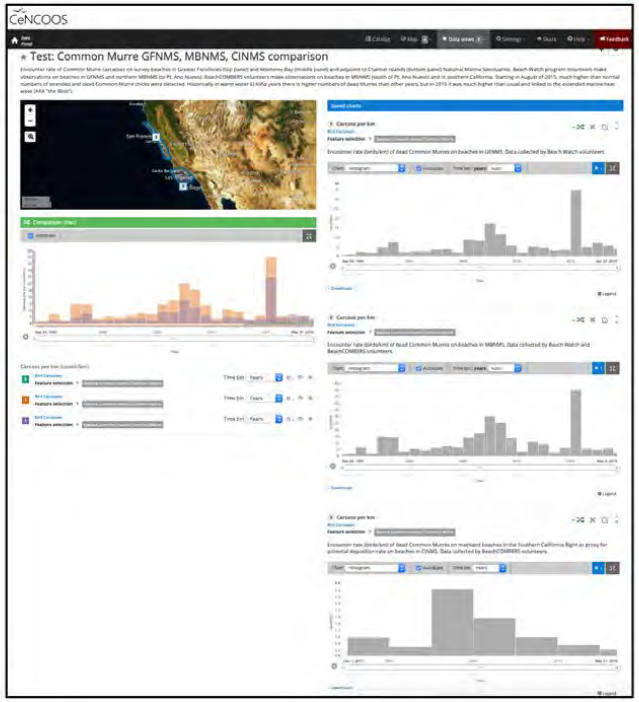
Users: Public, managers, educators



(b) CURATED DATA VIEWS

Task: Periodic information updates

Users: Advisory groups, researchers, managers



(c) DATA PORTALS

Task: Data exploration

Users: Technical experts

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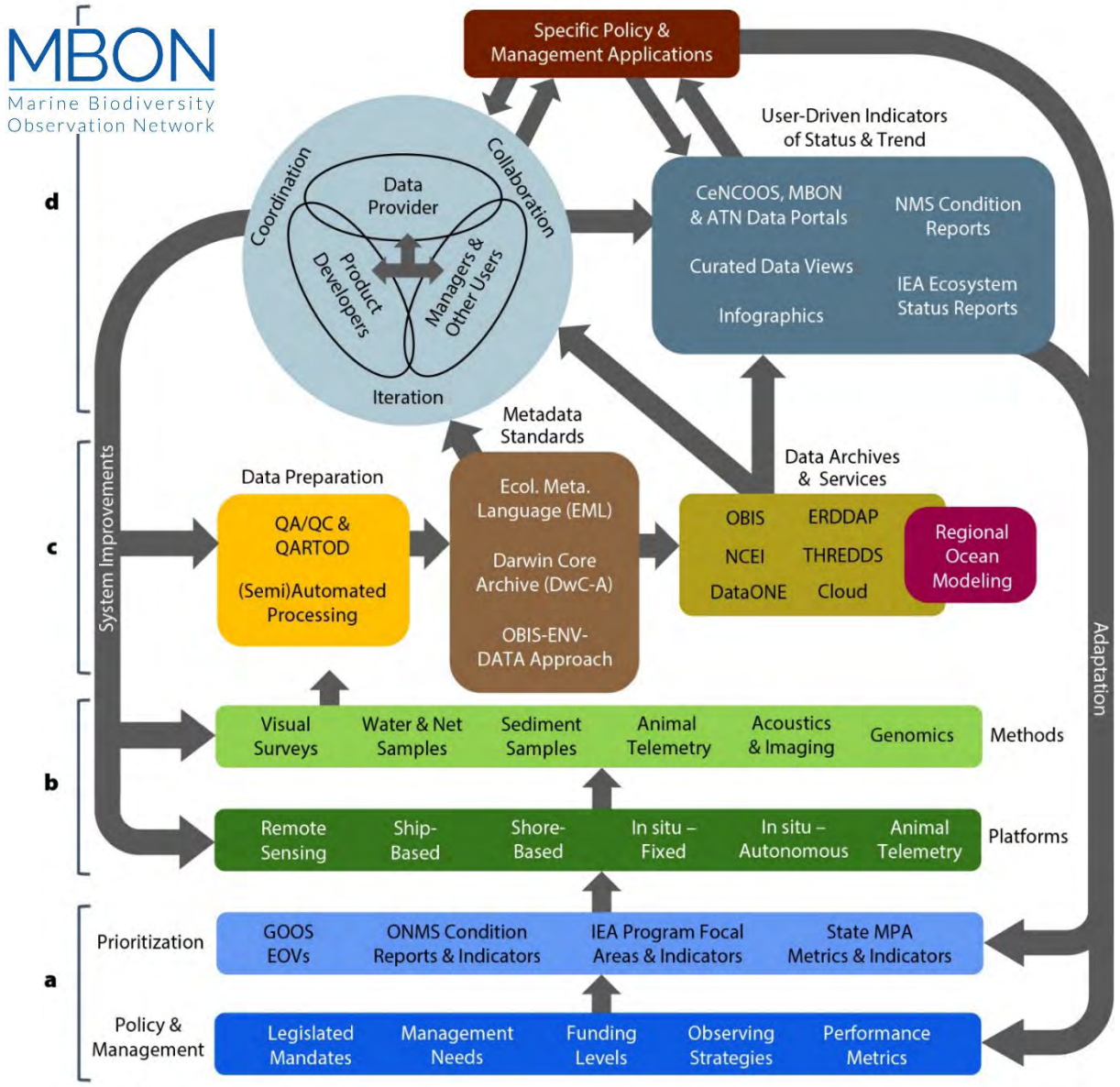
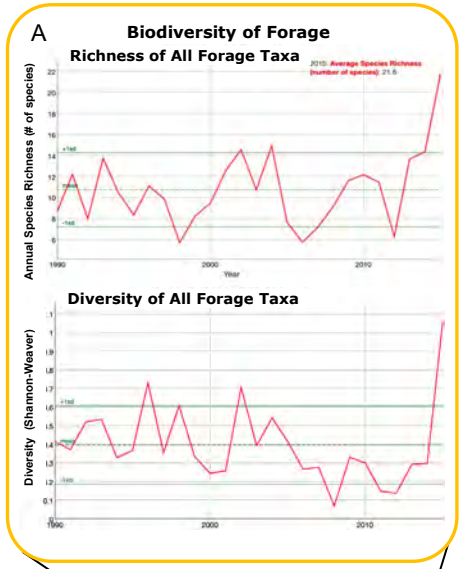
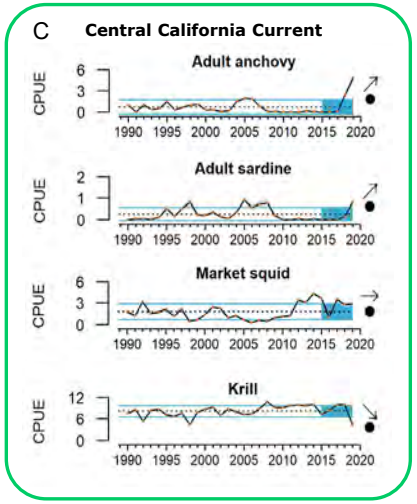
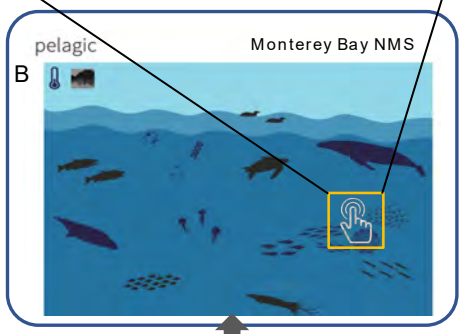
MBON – A Systems Approach

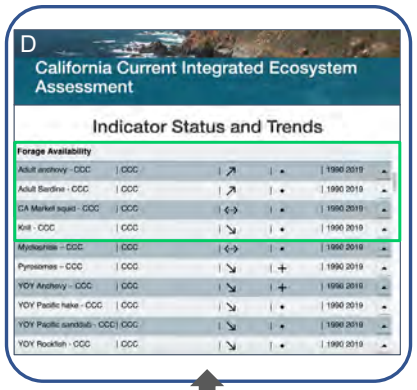
MBON
Marine Biodiversity Observation Network

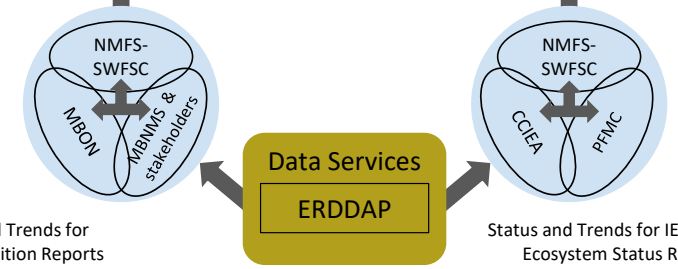












Ruhl et al., https://doi.org/10.5670/oceanog.2021.221

Datastream Plans ☞ Roadmap for Improved Data

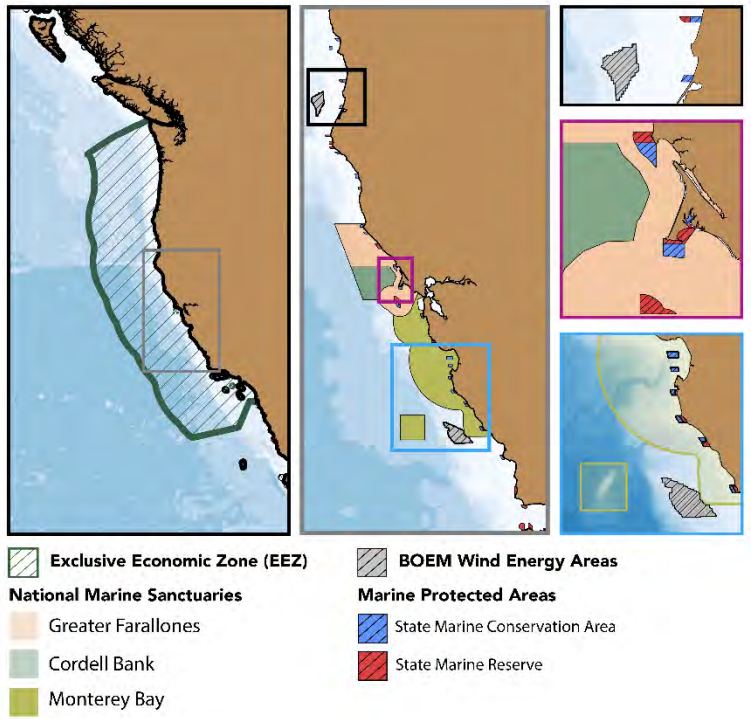
ICES Journal of Marine Science, 2022, 0, 1–5
DOI: 10.1093/icesjms/fsac145
Food for Thought

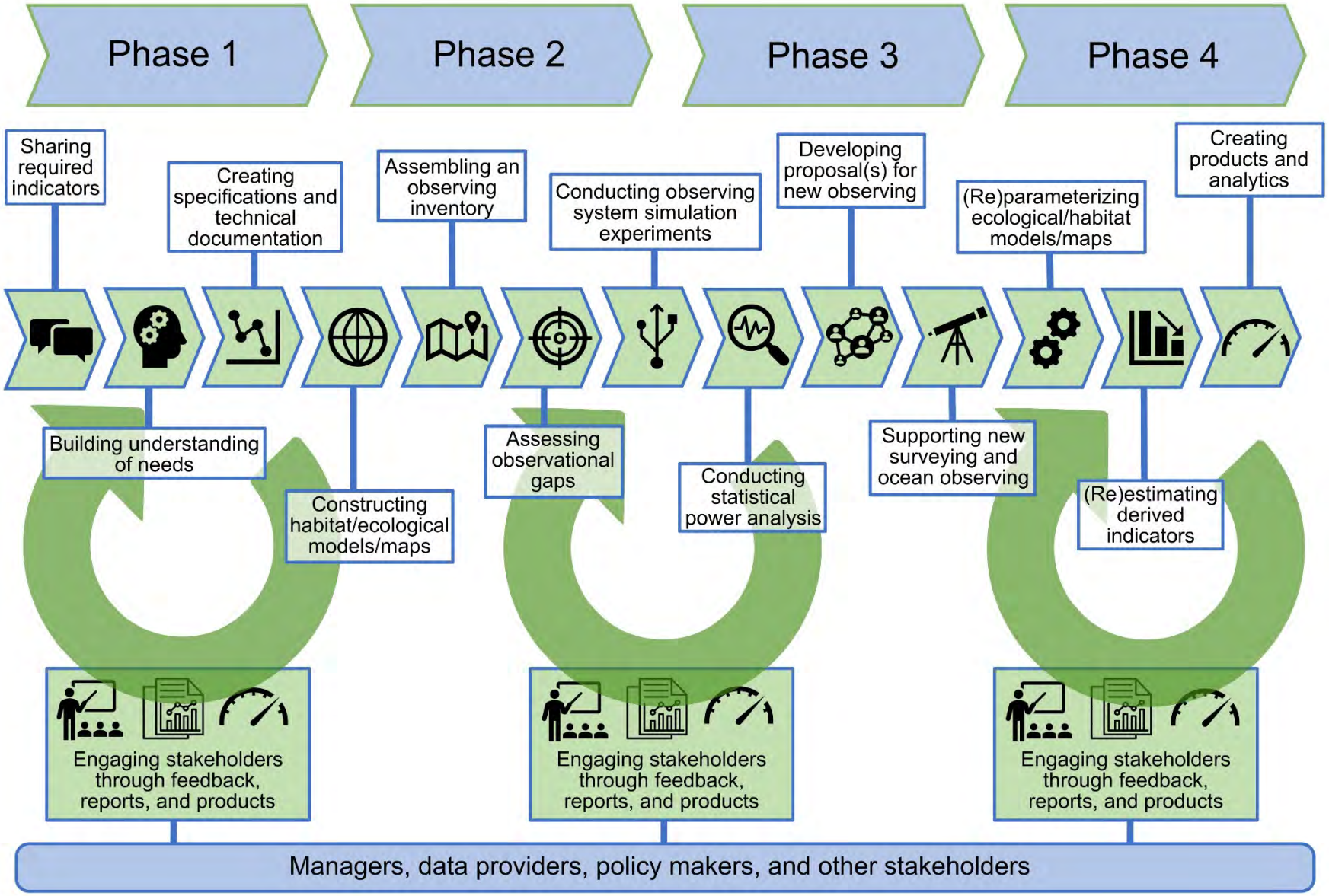
Building on a human-centred, iterative, and agile co-design strategy to facilitate the availability of deep ocean data

Diana E. LaScala-Gruenewald[1], Natalie H. N. Low[1], James P. Barry[1], Jennifer A. Brown[2,3], Chad King[3], Francisco P. Chavez[1] and Henry A. Ruhl[1,*]

[1]Monterey Bay Aquarium Research Institute (MBARI), Moss Landing, CA 95039 , USA
[2]ECOS Consulting, LLC, Lafayette, CA 94549, USA
[3]Monterey Bay National Marine Sanctuary (MBNMS), Monterey, CA 93940, USA
*Corresponding author: tel: 831-775-2126; e-mail: hruhl@mbari.org

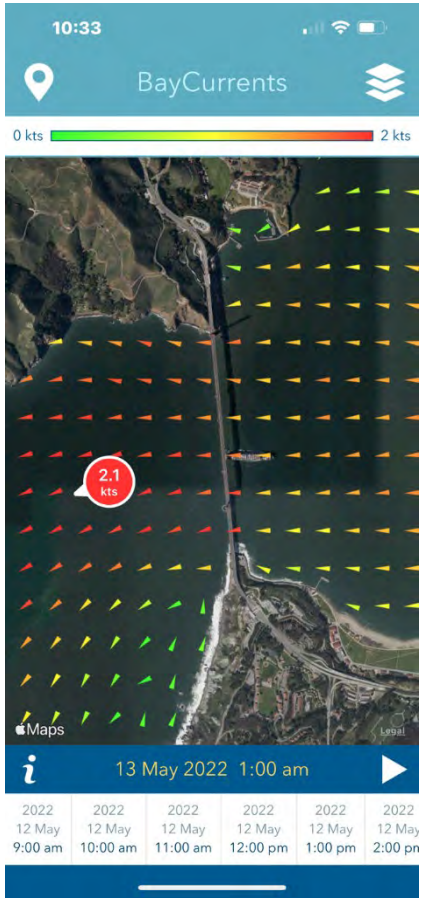
https://doi.org/10.1093/icesjms/fsac145

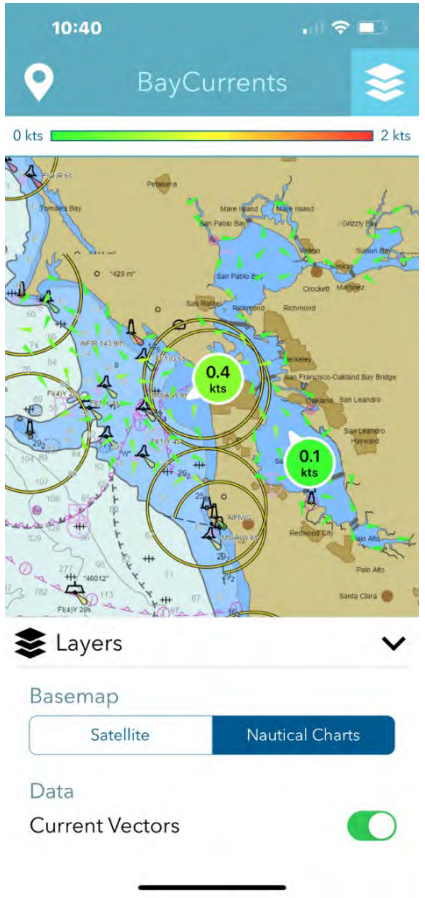




BayCurrents Mobile App

- Refresh of app in use several years ago
- Multiplatform web app
- Leverages PORTS/SFBOFS
- Available now
- Table version coming soon
- SST, waves, wind, and visibility under consideration





https://apps.apple.com/us/app/baycurrents/id1591997070

https://play.google.com/store/apps/details?id=org.cenoos.baycurrentsandroid&hl=en_US&gl=US

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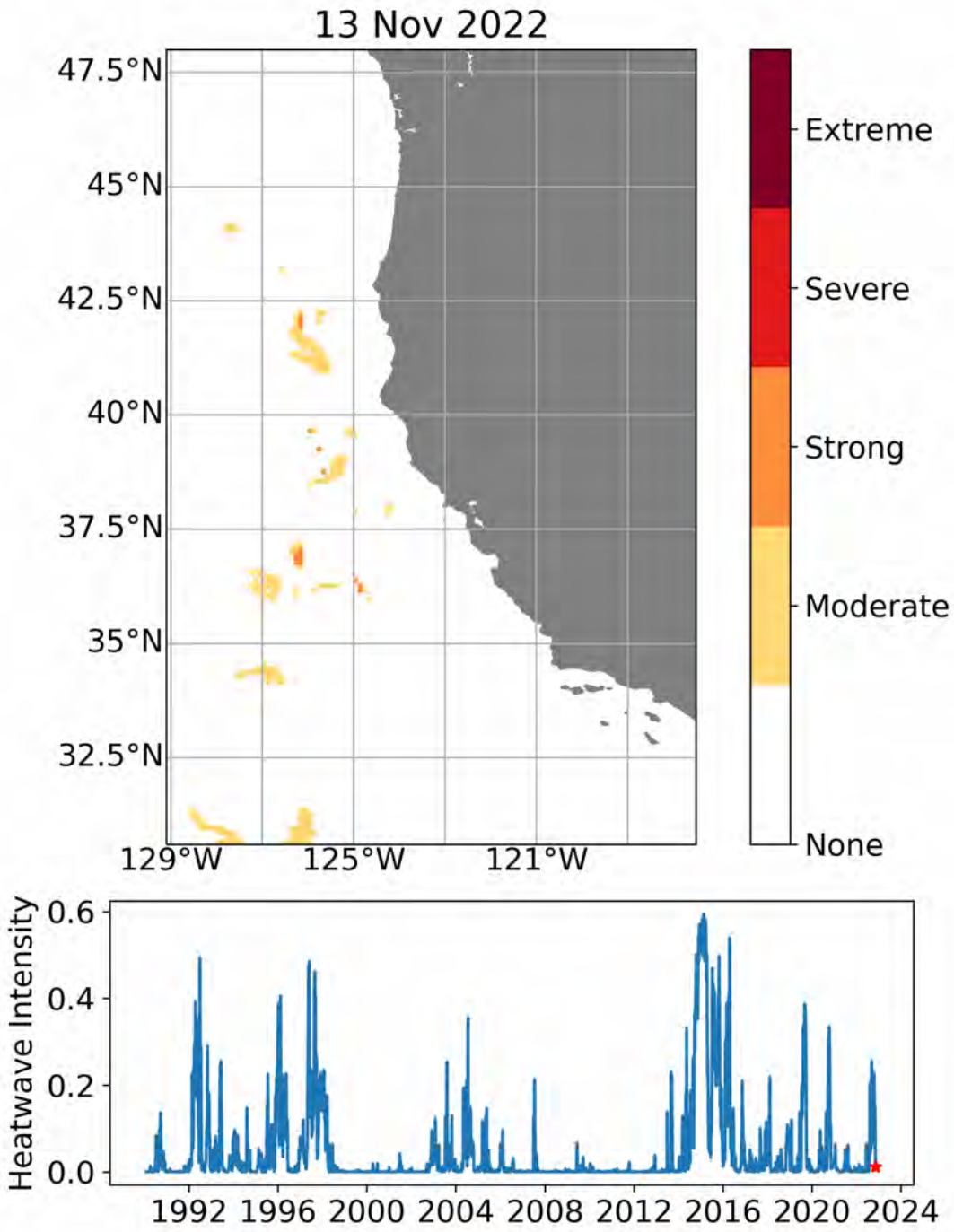
Heatwave Classification

Computed using SST from WCOFS with the climatology from the UCSC ROMS reanalysis run.

Daily time series of SST at each 10 km grid point is run through the marine heatwave code and an estimate of whether it is none, moderate, strong, severe or extreme is computed. These are plotted on a map for each time step.

SST was used instead of satellite data as it optimally interpolates what would be gaps in potential satellite data and we also have a 3 day forecast.

… Tools for a climate-ready Blue Economy



•Hobday, A.J. et al. (2016), A hierarchical approach to defining marine heatwaves, Progress in Oceanography, 141, pp. 227-238, doi: 10.1016/j.pocean.2015.12.014

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Climate and Coastal Resilience Meeting

Goals/objectives:

- Update the community and gather feedback on feasible, impactful climate resilience activities that promote equity and environmental justice;
- Hear from partners to understand ongoing activities, synergies, and to avoid duplicating efforts;
- Review existing and emerging high-priority requirements and climate resilience plans to understand what's already included in the CeNCOOS 5-year work plan;
- Develop consensus and shared understanding for priority activities, particularly related to new areas of work including water level and ecosystem measurements;
- Engage with partners to understand priorities and opportunities to partner/leverage investment.

Definitions:

Climate resilience: The capacity of a system to retain essential functions before, during, and after a hazard strikes. [NOAA Climate Resilience Toolkit]

Coastal resilience: The ability of populations, ecosystems, and economies to prepare for, absorb, respond to, recover from, and successfully adapt to the impacts of natural and human-caused hazards, such as hurricanes and oil spills and long-term environmental changes, such as habitat loss and sea level rise. [NOS draft definition March 2023]

U.S. Integrated Ocean Observing System CERTIFIED REGIONAL ASSOCIATION

IOOS Integrated Ocean Observing System

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Who is using our data?

Global/national
- National Weather Service
- USGS
- EPA
- Modelers

State
- OPC
- CDFW
- CDPH
- OEHHA
- Cal Water Boards
- Cal Coastal Commission

Local
- County/city water programs
- Harbormasters
- Recreators
- Indigenous communities








Headlines – Salmon Closure

FISHING

Pacific fishery council moves to close California salmon fishing in 2023

Dan Bacher Special to The Stockton Record

Published 6:00 a.m. PT March 15, 2023

The California Department of Fish and Wildlife is transporting 19.7 million hatchery-raised fall-run and 960,000 spring-run chinook salmon to Bay Area release sites this year to protect the fish from poor water conditions on Central Valley rivers. *CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE/COURTESY*

SEATTLE — For the first time since the fishing closure of 2008-2009, federal regulators have moved to close all recreational and commercial salmon fishing off the California coast.

https://www.recordnet.com/story/sports/outdoors/fishing/2023/03/15/pacific-fishery-council-to-close-california-salmon-fishing-in-2023/69981901007/

https://www.gov.ca.gov/2023/04/06/newsom-administration-requests-federal-fishery-disaster-ahead-of-salmon-season-closure/

- **Prolonged drought, severe wildfires, and associated impacts** to spawning and rearing habitat, harmful algal blooms, and ocean forage shifts have combined to result in some of the lowest stock abundance forecasts on record for Sacramento River Fall Chinook and Klamath River Fall Chinook.
  - In large part, the low returns and abundance forecasts are due to difficult environmental factors faced by these salmon on their initial journey out to the ocean three years ago.
- **The low ocean abundance forecasts, coupled with low 2022 returns,** led the Pacific Fishery Management Council (PFMC) to recommend full closure of California's commercial and recreational ocean salmon fisheries.
- **Commercial fishing in southern Oregon** is also projected to face closures through the end of 2023.

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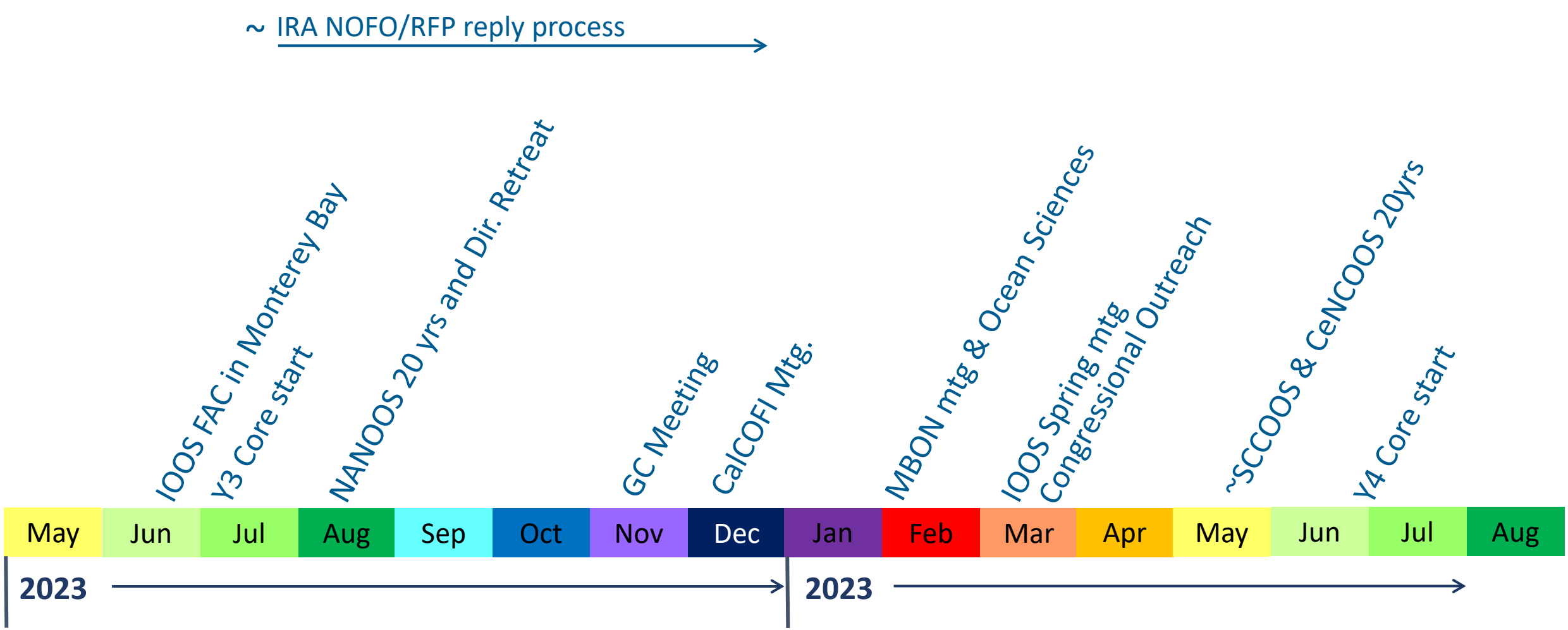
What's Going On?



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