



**NOAA  
FISHERIES**

**MBON**  
Marine Biodiversity  
Observation Network

# Building an operational MBON: Vision and Opportunity

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Cross-MBON Virtual Meeting  
Toward a National Operational MBON  
Applied Ecosystem Function Case Studies

# Marine Biodiversity Observation Network (MBON)

... a growing global initiative composed of regional networks of scientists, resource managers, and end-users working to **integrate** data from existing long-term programs to improve our understanding of changes and connections between marine biodiversity and ecosystem functions.

Integrate independent historical and current biology and ecosystem surveys with

- new observations,
- expanding application of remote sensing methods,
- novel molecular (eDNA) technologies,
- traditional environmental research tools, and
- coordinated experiments.



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- requirements for an operational MBON and what it would deliver, and
- how to engage NOAA and other external agencies nationally (and internationally)
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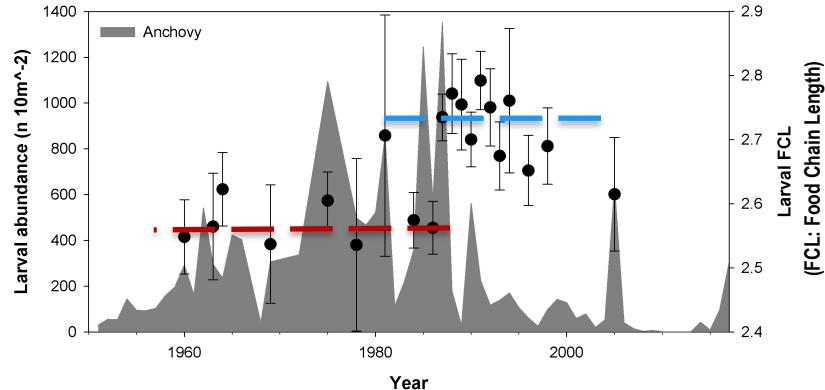
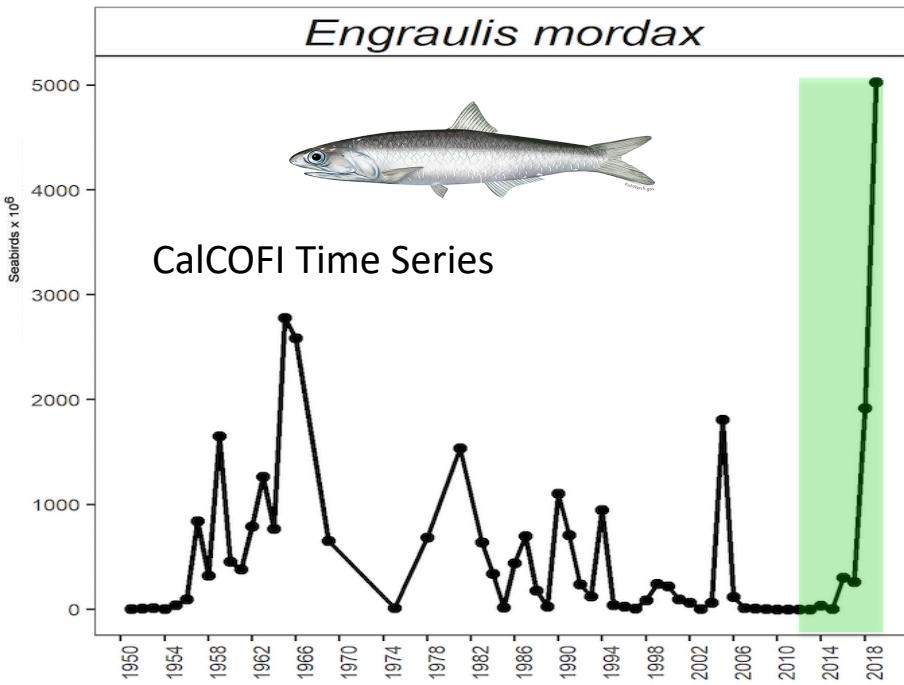


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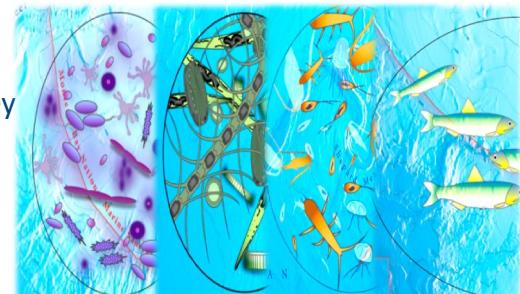
# Drawing on (seemingly) unrelated threads...



# Changes in food web structure and interactions



- Anchovy populations were low from 2011-2014, yet, 2015-2018 (a warm period) produced some of the strongest year classes.
- eDNA-based characterization of prey & predators has the potential to provide insight on recruitment fluctuations.



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(Courtesy of Rasmus Swalethorp, Scripps Inst. Oceanography, and Andrew Thompson, SWFSC, 2019)

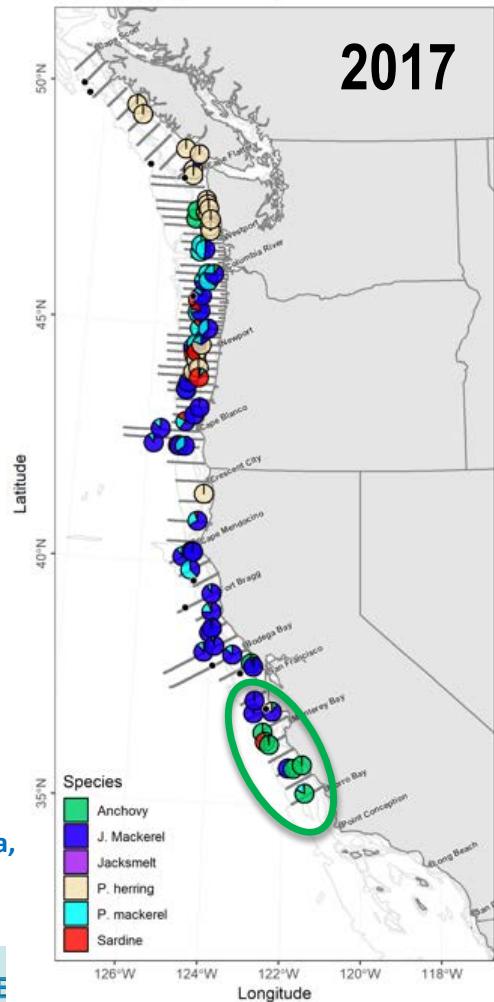
Central California anchovy stock biomass and north end of their distribution expanded greatly from 2017-2019 summer CPS trawl surveys.

(NMFS Tech Memos)

(Courtesy of Nate Mantua, NOAA SWFSC)

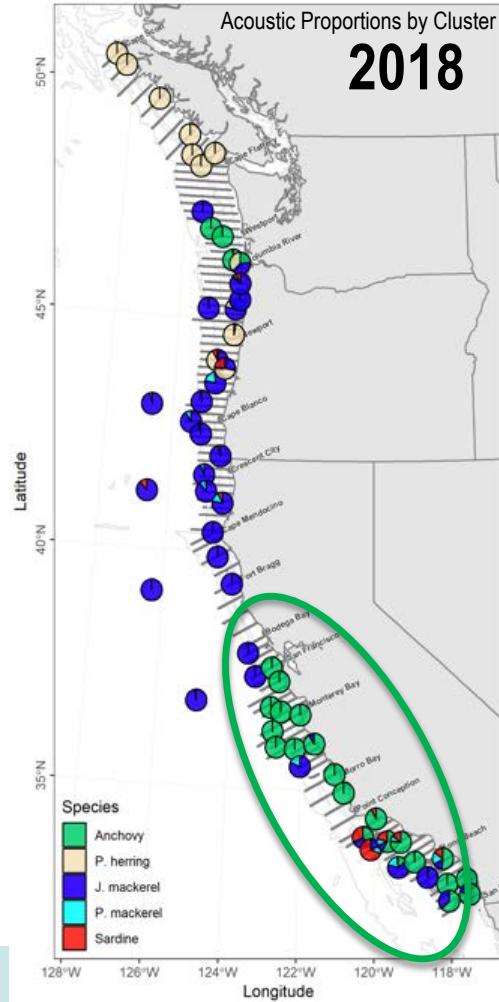
CPS Species Proportions in Trawls

2017



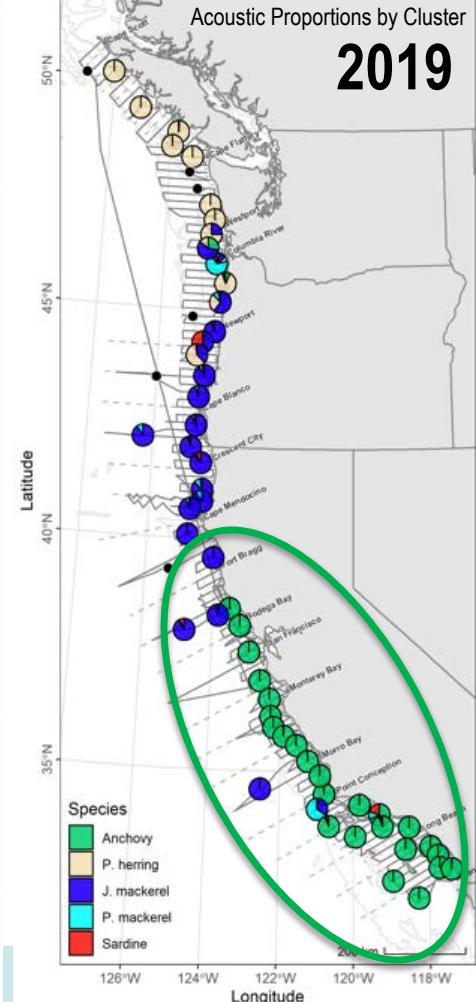
Acoustic Proportions by Cluster

2018



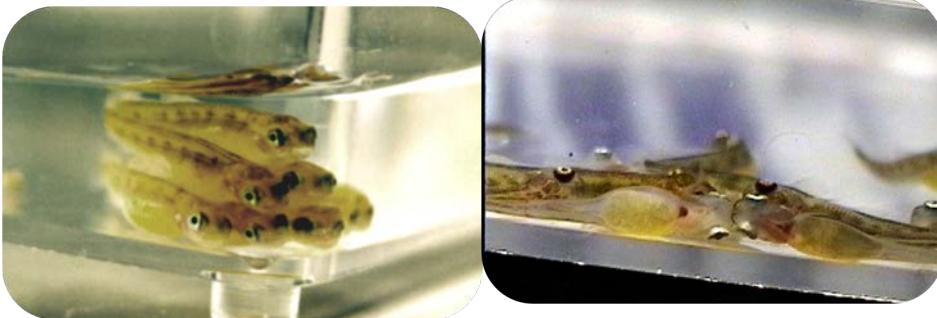
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2019



# Mechanisms, impacts, and mitigation for thiamine deficiency in Central Valley salmon

<https://www.latimes.com/environment/story/2021-01-26/king-salmon-vitamin-deficiency-sacramento-river>  
<https://www.hakaimagazine.com/features/the-oceans-mysterious-vitamin-deficiency/>



## Thiamine Deficiency Complex (TDC)

Thiamine is **Vitamin B<sub>1</sub>** (Fish don't produce it)

It is an essential vitamin (we all require)

Observed between hatch and first feeding and characterized by:

- Loss of equilibrium
- Swimming in a spiral pattern
- Lethargy
- Hyperexcitability
- Hemorrhage, etc.



**Neurological  
Symptoms**

**Healthy**



**B<sub>1</sub> deficient**



Photos courtesy Dale Honeyfield, USGS

# Identify the cause: Are anchovies to blame?



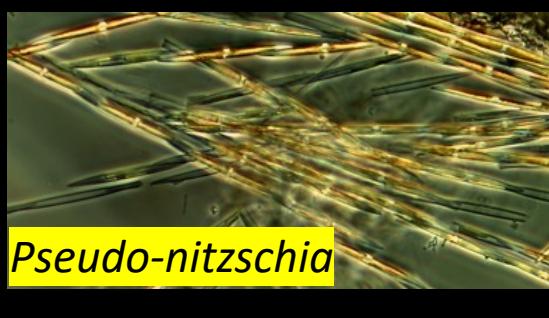
- Anchovies produce an enzyme (**thiaminase**) that breaks down B<sub>1</sub>
- Early evidence salmon in 2019 narrow diet only anchovy [not squid, krill, or rockfish]
- Ongoing efforts to measuring thiamine, thiaminase, and stable isotopes in salmon prey from 2019 and 2020

- Fishing industry partners and CDFW Ocean Salmon Project collected and stored Chinook salmon stomachs in 2020 for gut content analysis.
- 2020 Chinook stomachs (N=337) dominated by anchovy (65%), empty (20%), Krill (7%); **97% anchovy by weight**

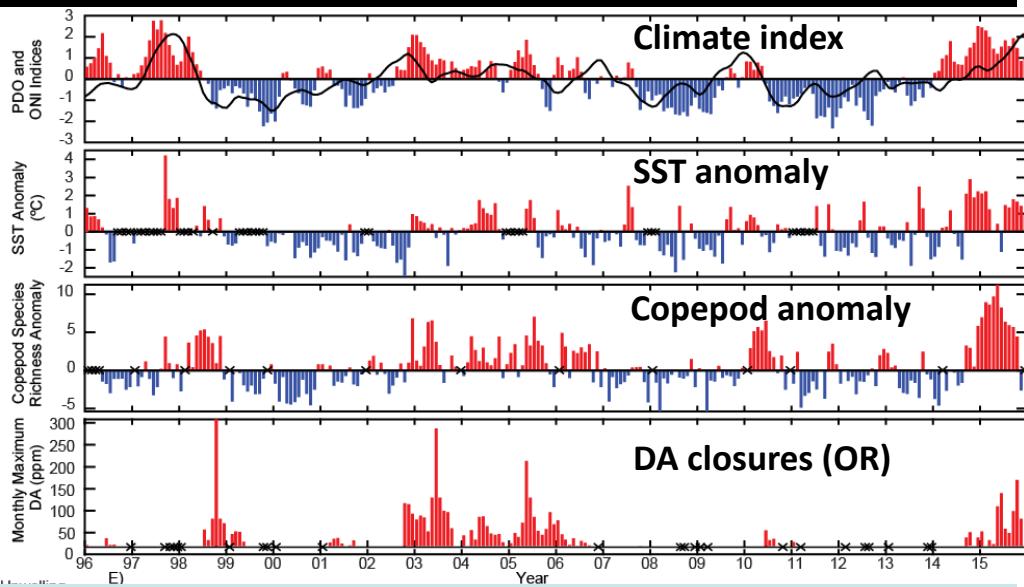


# Domoic acid events more frequent with warming

- Domoic acid first identified in 1991 in Pacific Northwest
- Linkage to warmer ocean conditions



*Pseudo-nitzschia*



(Courtesy of Vera Trainer, NWFSC)

**Scientists: Clam toxin, warmer ocean go together**

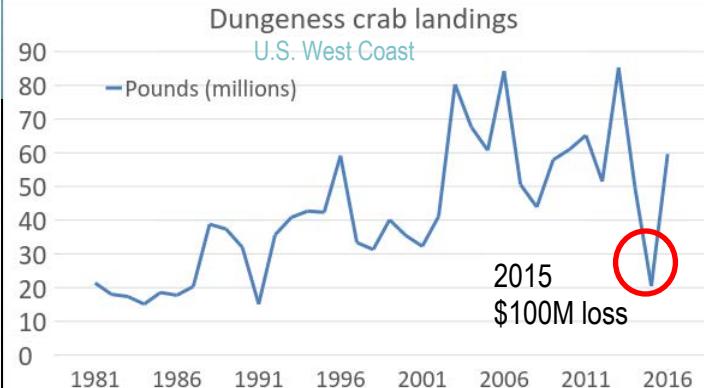
Published on January 17, 2017 2:45PM



NASA PHOTO  
Darker green colors near the West Coast of the U.S. reflect blooms of phytoplankton and high algal levels, some of which are toxic.



# HAB: U.S. West Coast Domoic Acid



(Courtesy of Vera Trainer, NWFSC)

## 2015 Impacts



Understanding whale entanglements  
off the U.S. west coast



## Other cascading effects of HABs

### Changes in ocean conditions

- Persistent marine heat wave
- Massive bloom of toxic algae

### Changes in whales' prey

- Lower krill abundance off shelf break
- Switch to low abundance anchovies nearshore
- Humpback whales seek other prey further north

KRILL

ANCHOVIES

### Changes in whale presence & abundance

- Recovering whale populations
- Humpback whales switched prey, found closer to shore



Santora et al. 2020

"Seizing" sea  
lion (off WA coast)

400%

increase of confirmed  
whale entanglements

Record increases in whale  
entanglements in recent years.  
confirmed whale entanglements  
on the WA, OR, CA coast increased  
400% to a historic high of 50 in  
2015, from an average of 10 per  
year pre-2014.

While many entanglements in  
recent years have been reported in  
central CA, we know at least some  
of these entanglements occurred  
elsewhere along the west coast.

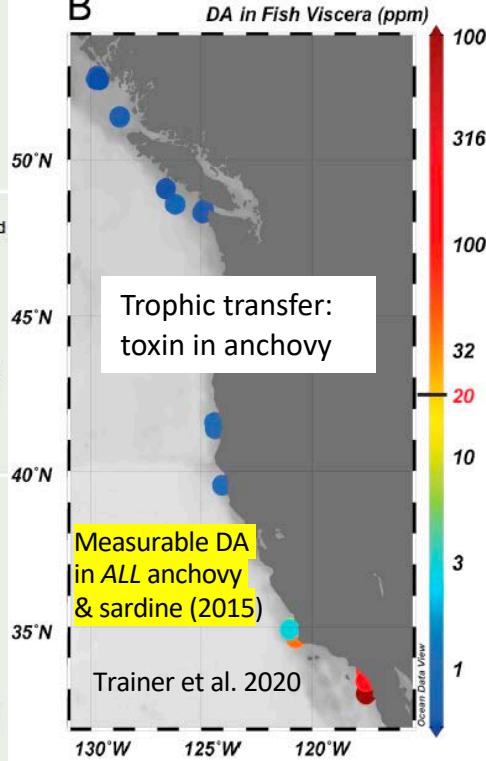
### Changes in dungeness crab fishery

- Harmful algal bloom delayed opening of fishery in 2016
- More crab shing gear when whale concentrations were high

### Fishing gear

Most of the whale entanglements  
are due to unknown types of  
fishing gear, or the fishing gear  
that we can identify, trap/pot  
fisheries are the primary source.

B



(Courtesy of Vera Trainer, NWFSC)

High domoic acid levels (via consumption of prey, e.g.,  
*(anchovies)* known to impact sea lions – can it also affect whales?

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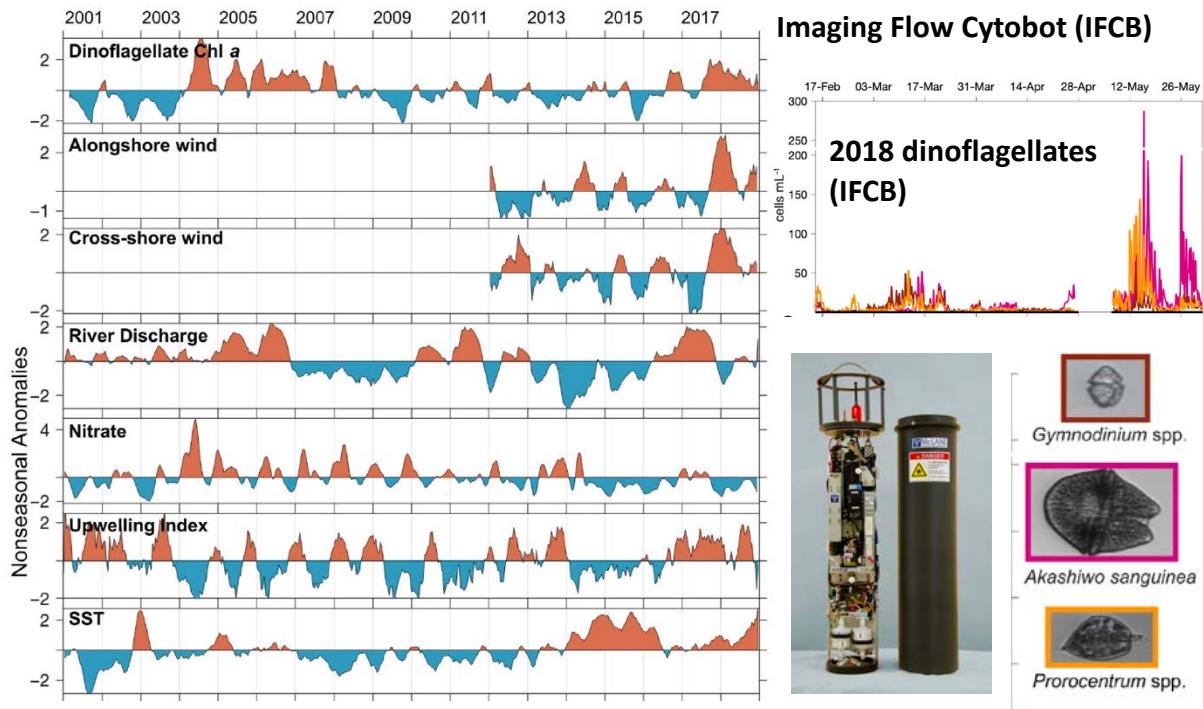


# Shifts at the base of the food web - from microbiomes on up...

"Eastern boundary current coastal upwelling systems are among the most biologically productive regions in the global ocean (e.g., Ryther 1969).

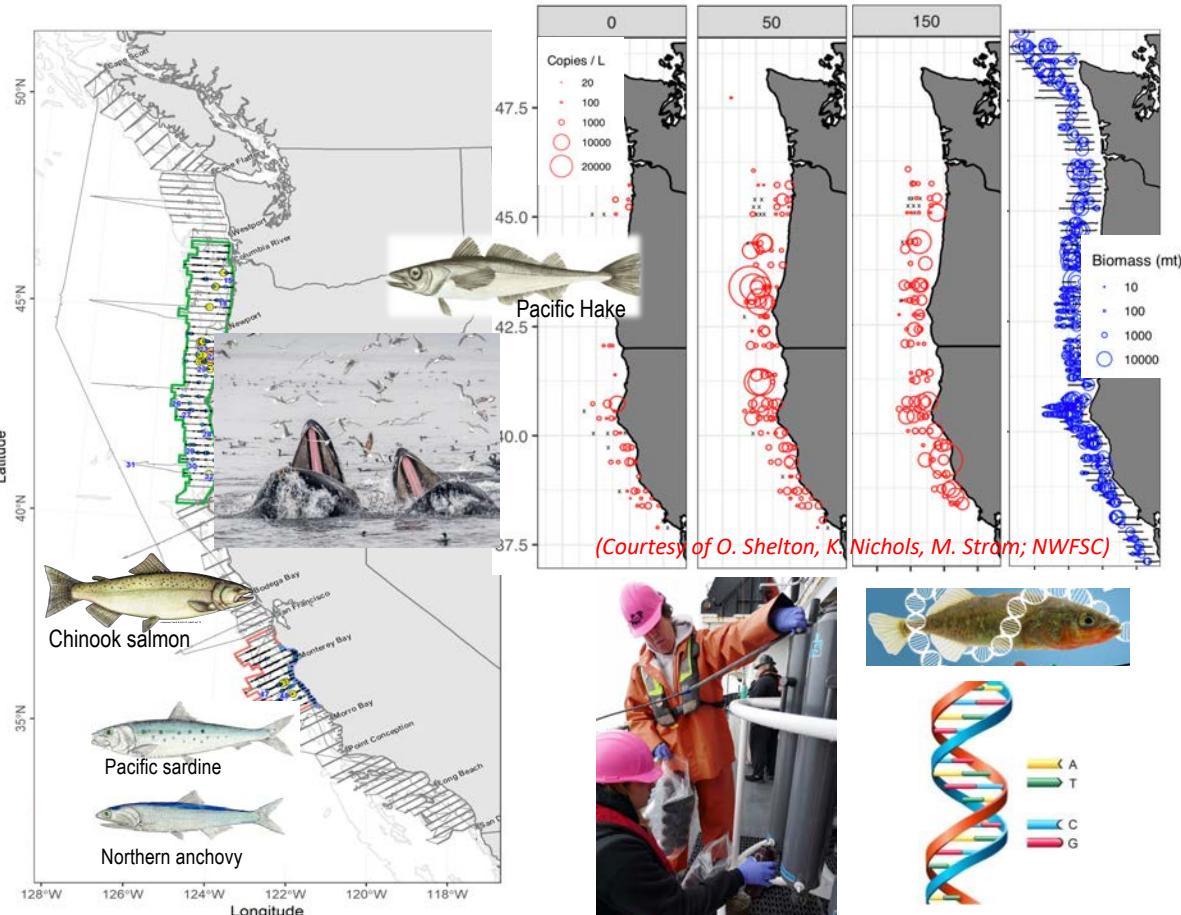
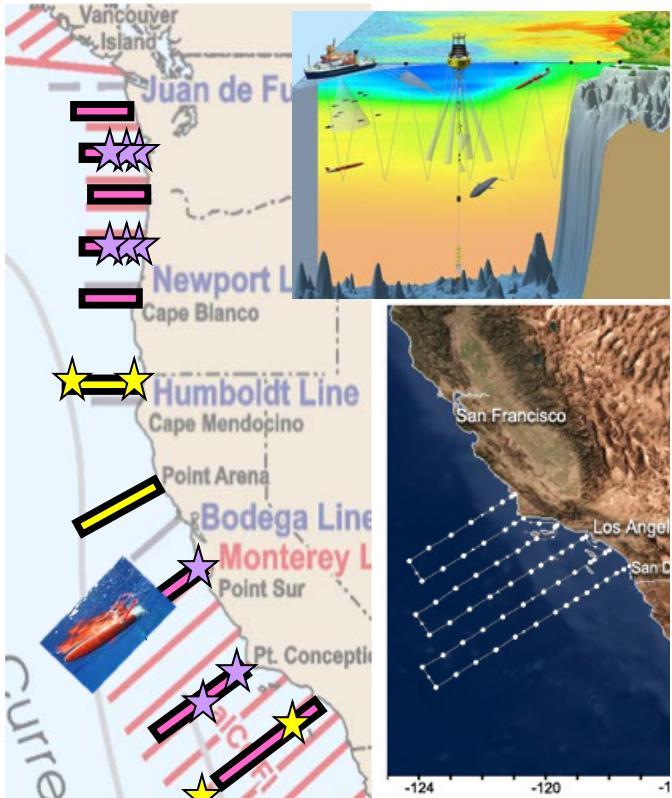
...

In the past two decades, short-term shifts in the dominant phytoplankton group from diatoms to dinoflagellates have been observed in the CCS ... with ecological and economic impacts related to increased dinoflagellate harmful algal blooms (HABs). When dinoflagellates dominated the CCS **phytoplankton community and base of the food web in 2005–2006, zooplankton biomass, forage fish biomass, and seabird fecundity decreased, and marine mammal foraging was altered...**"



Fischer, A., Hayashi, K., McGaraghan, A., and Kudela, R. (2020). Return of the “age of dinoflagellates” in Monterey Bay: Drivers of dinoflagellate dominance examined using automated imaging flow cytometry and long-term time series analysis: Dinoflagellate anomalies in Monterey Bay. *Limnology and Oceanography*, **65**. 10.1002/lo.11443.

# ... to fisheries & protected species...

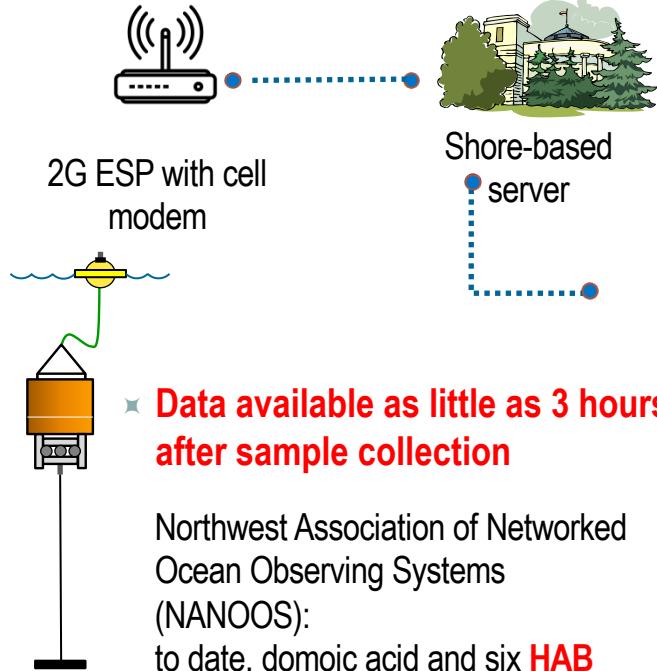


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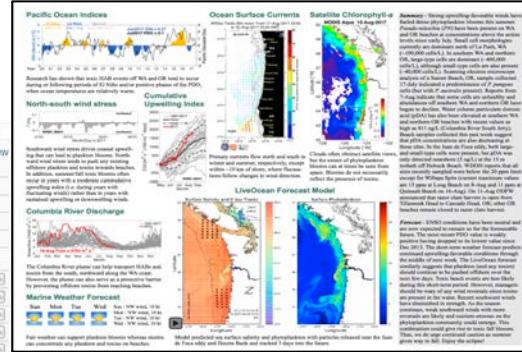
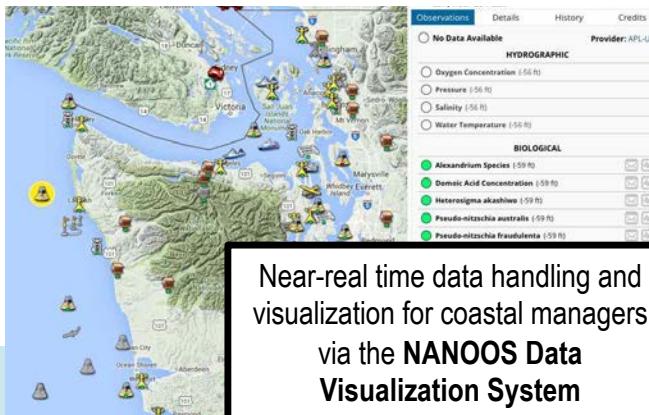
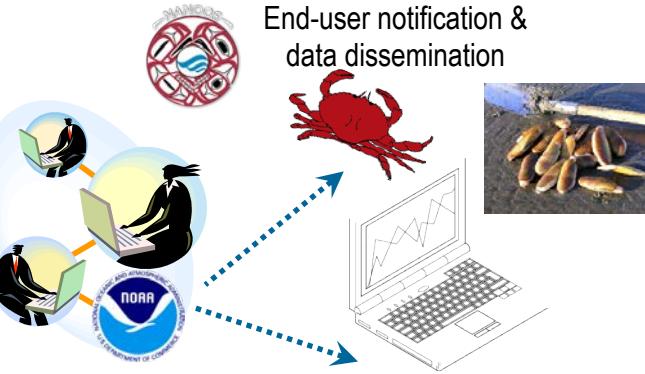
# to human health...

# Environmental Sample Processor

- Laboratory in a can
- Identifies organisms through DNA-DNA hybridization
- Data integrated into management decisions, with data products available in near real-time



Pacific Northwest HAB Bulletins  
[www.nanoos.org/products/habs/](http://www.nanoos.org/products/habs/)  
[www.orhab.org](http://www.orhab.org)



**MBON is more than about “*observing biodiversity*”.**

**It’s about understanding the changes in ecosystem structure and function to anticipate future states of our marine systems, services, and resources, and develop actions for the benefit of the communities that depend on them.**

**It’s time (we know the questions and we have the tools) to  
*think BIGger!***

# Thank you

**Special thanks** to Rachel Johnson, Nate Mantua, Andrew Thompson, Vera Trainer, Kelly Goodwin, Frank Muller-Karger, and many others for thoughtful discussions and invaluable input.

