
Orange County Register

2020 California Current Ecosystem Status Report

NOAA California Current IEA Team

Presented to the Pacific Fishery Management Council
March 5, 2020, Rohnert Park, CA


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Summary

- **Large-scale climate indices in 2019 were consistent with low productivity**
  - Along the equator, weak El Niño conditions transitioned to neutral conditions in June 2019
  - Negative NPGO and neutral/positive PDO in 2019 indicate lower productivity
  - A new large marine heatwave emerged in May, reached a maximum in October and lasted through December

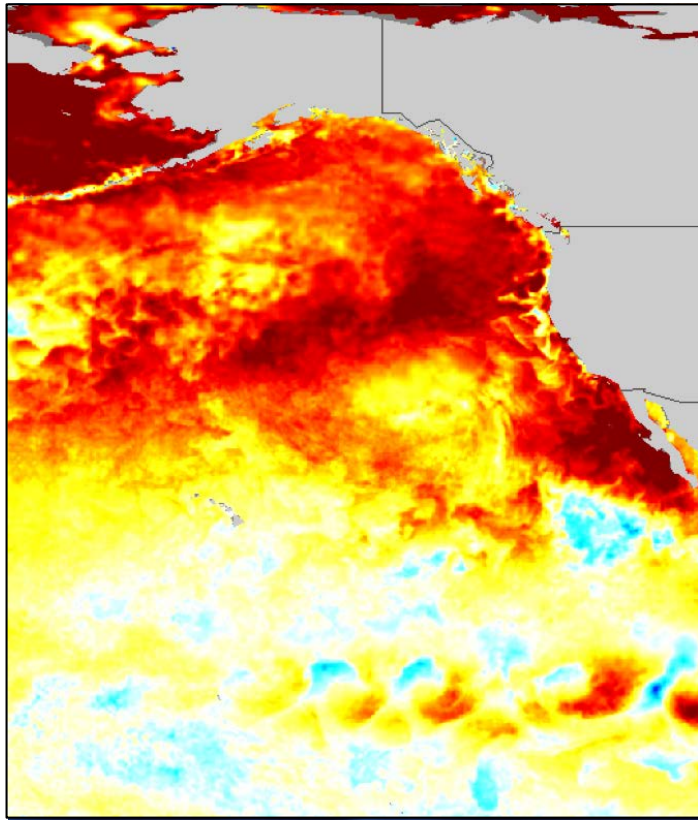
- **Regional climate and oceanography indicators were mixed**
  - Surface and subsurface temperatures generally above average
  - Upwelling was average to above average, but upwelling habitat was compressed
  - Snowpack in 2019 was below average in north, generally above average elsewhere

Summary

- **Many ecological indicators were average or above average**
  - Lipid-rich copepods off Newport
  - Highly abundant anchovy off CA
  - Average densities of juvenile salmon off OR & WA
  - Above-average abundance and growth of CA sea lion pups
- **Signs of concern in the central California Current**
  - Poor catches of krill, high densities of pyrosomes (warm-water tunicates)
  - Poor production of several seabird species off central and northern California
  - Poor outlook for *naturally produced* fall Chinook salmon returns to Central Valley
- **Fisheries landings and revenue dipped in 2018, and probably again in 2019***

Physical Conditions

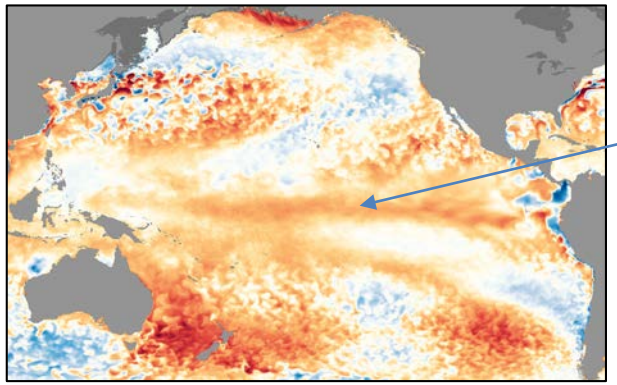
Warm, weak circulation, and a short but significant marine heatwave



Basin-scale climate indices consistent with poor productivity

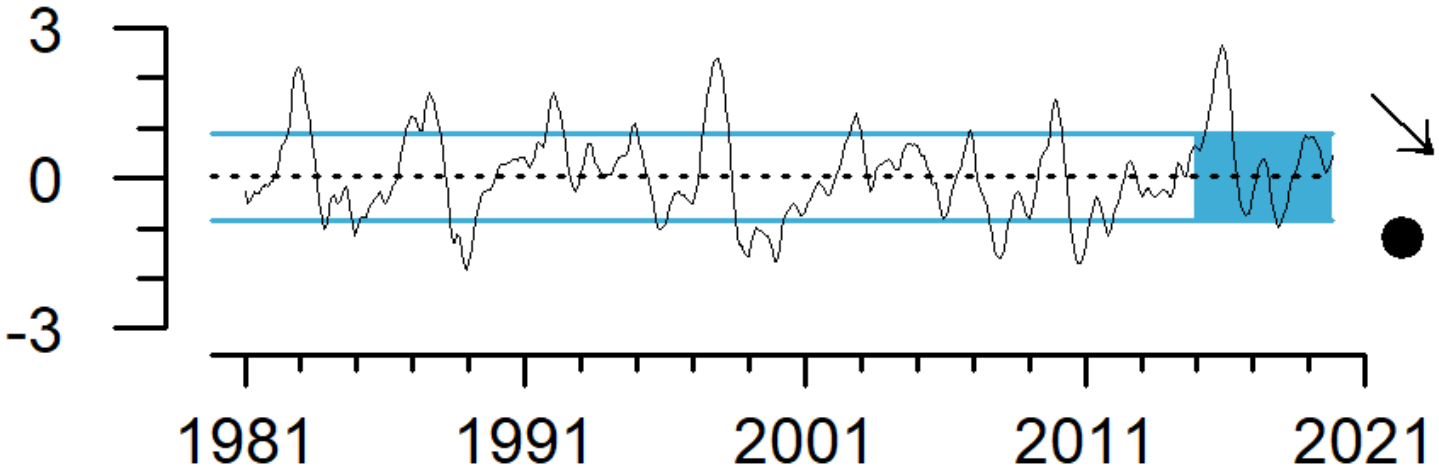
Oceanic Niño Index (ONI)

Positive ONI = El Niño conditions
Negative ONI = La Niña conditions



March 2019 image of weak El Niño, from www.nnvl.noaa.gov

Monthly ONI through January, 2020

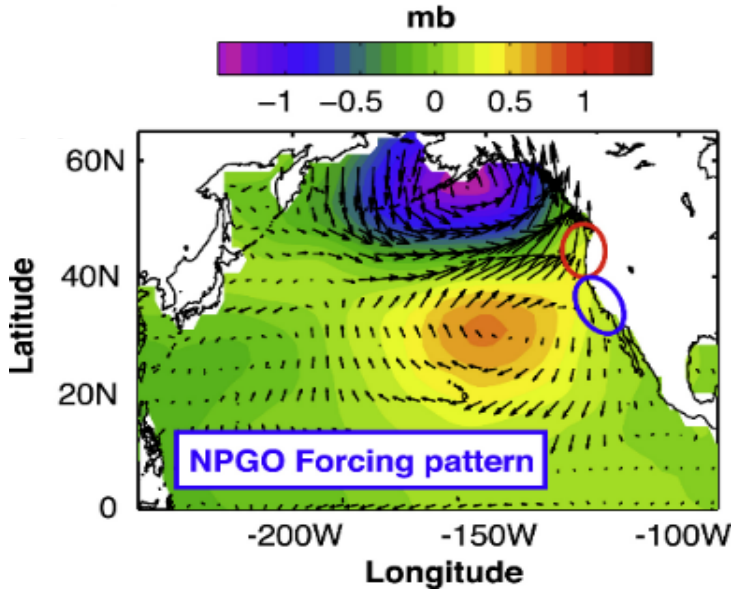


- Strong El Niño, 2015-2016
- Variable since then
- ***Weak El Niño from Sept 2018 to June 2019***
- ***ONI is neutral at present***
  - ***50% chance of neutral conditions persisting through Summer 2020***

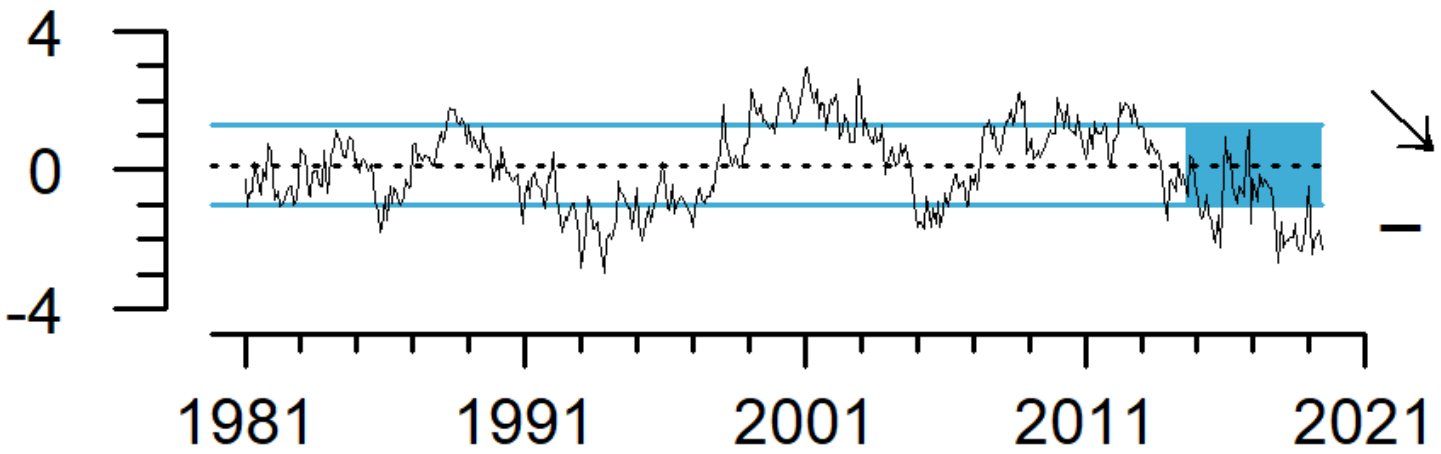
Basin-scale climate indices consistent with poor productivity

North Pacific Gyre Oscillation (NPGO)

Positive NPGO = stronger circulation, higher productivity in CCE
Negative NPGO = weaker circulation, lower productivity in CCE



Monthly NPGO through January, 2020

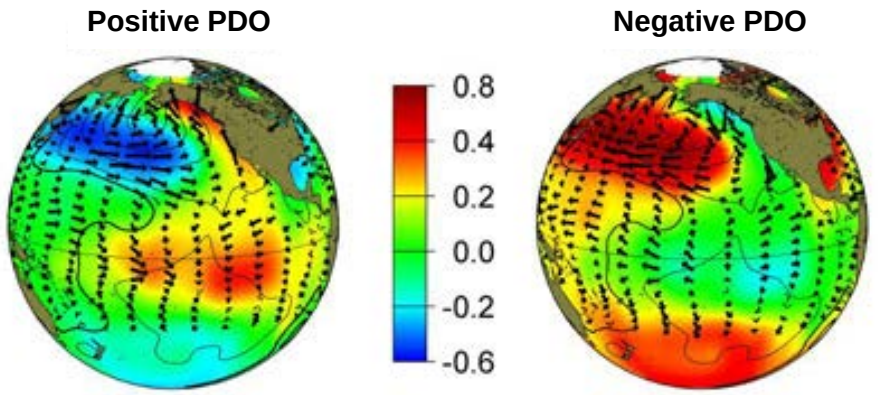


- Varied between negative and neutral from 2015-2017
- ***Strongly negative in 2018-2019***

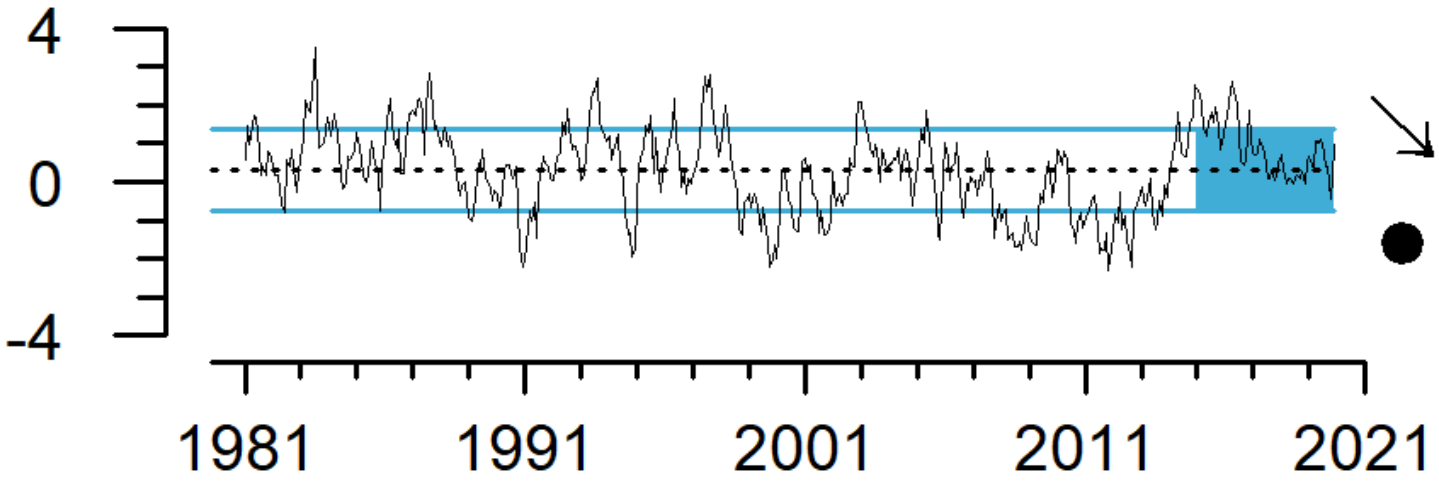
Basin-scale climate indices consistent with poor productivity

Pacific Decadal Oscillation (PDO)

Positive PDO = warm, lower productivity in CCE
Negative PDO = cool, greater productivity in CCE



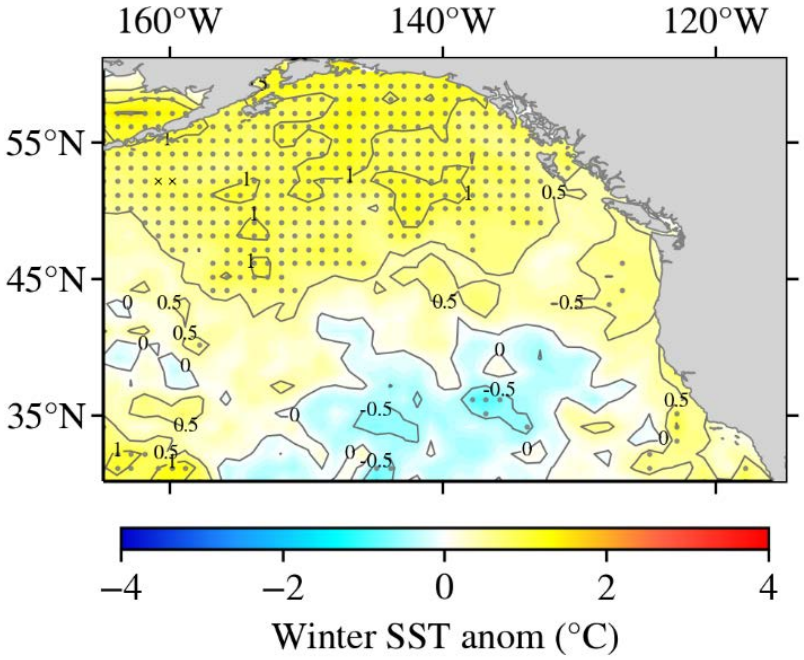
Monthly PDO through January, 2020



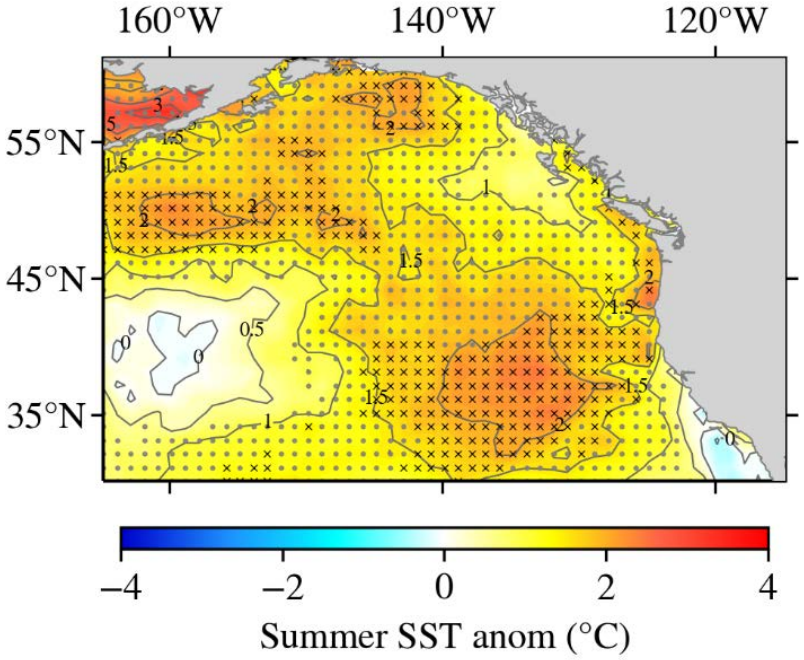
- Strongly positive from 2014-2016
- Returned to neutral in July 2016
- ***Neutral in most of 2019***
  - ***But, positive in April-June***

Sea surface temperatures were above average

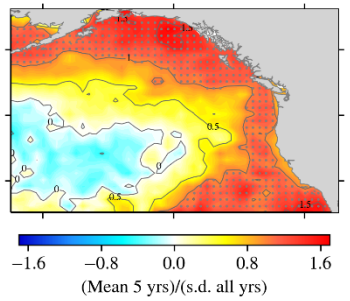
Winter (Jan-Mar 2019)



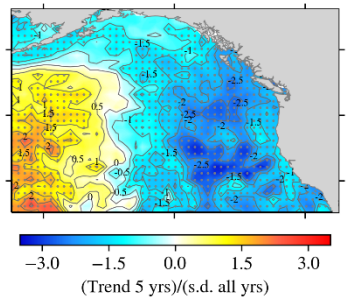
Summer (Jul-Sept 2019)



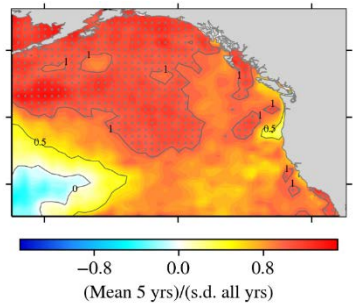
5-year mean



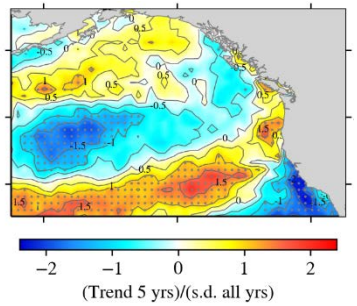
5-year trend



5-year mean



5-year trend

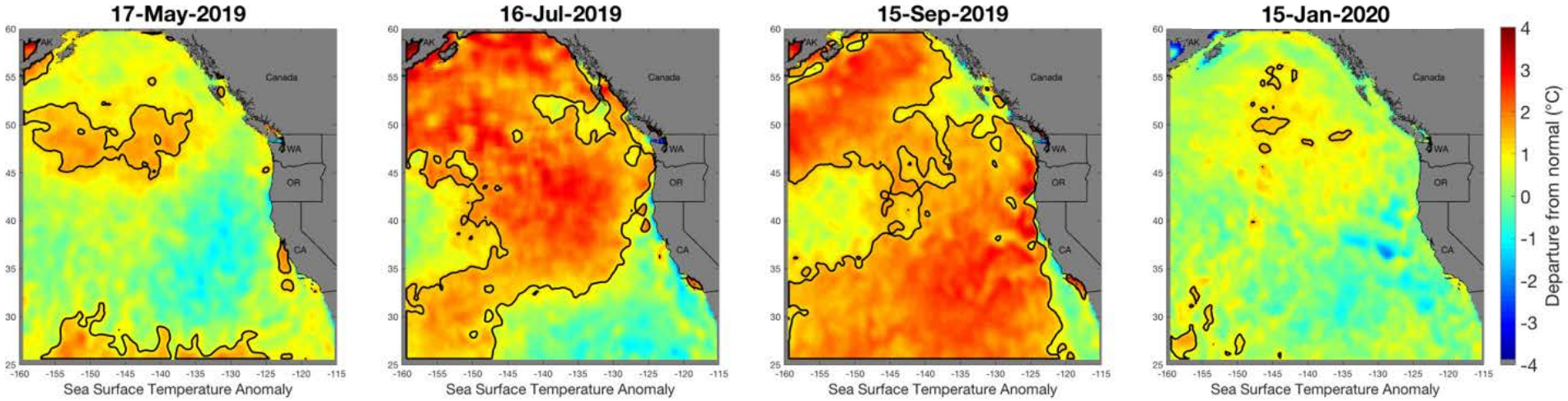


- ***2019 SST_a was warm in both winter and summer in the California Current***
  - ***And in most of the NE Pacific***
- ***Summer-fall: a marine heatwave similar in size and intensity to "Blob"***
- *NE Pacific warmer than average over last 5 years*
- *Cooling trend in winter, mixed trend in summer*

2019 large marine heatwave

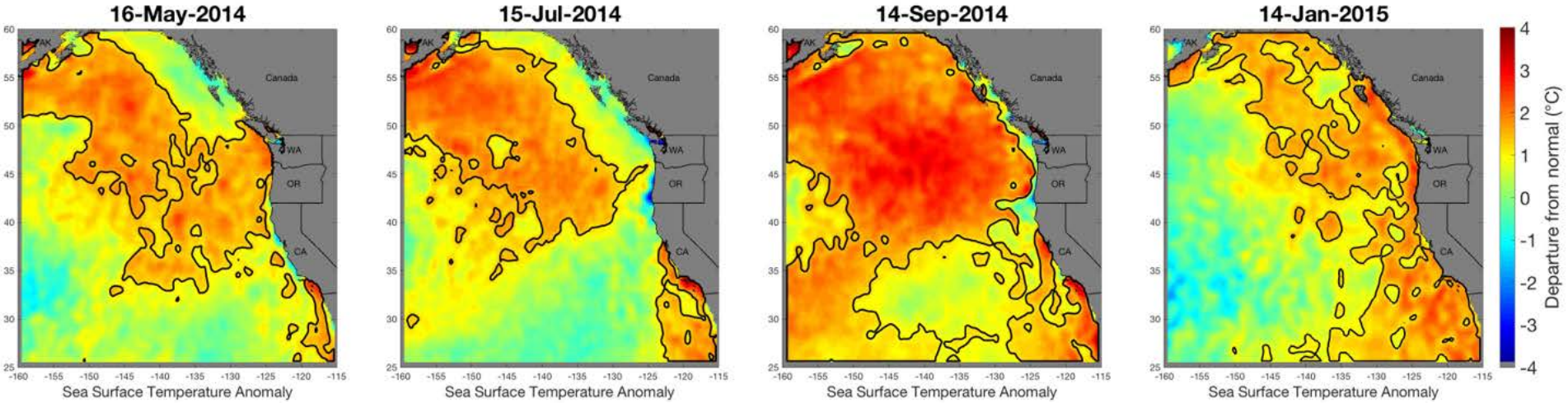
- Mapped using criteria IEA team members developed
- ***2019 event: lasted from May to December, reached coast July-September, then weakened:***

2019 event:



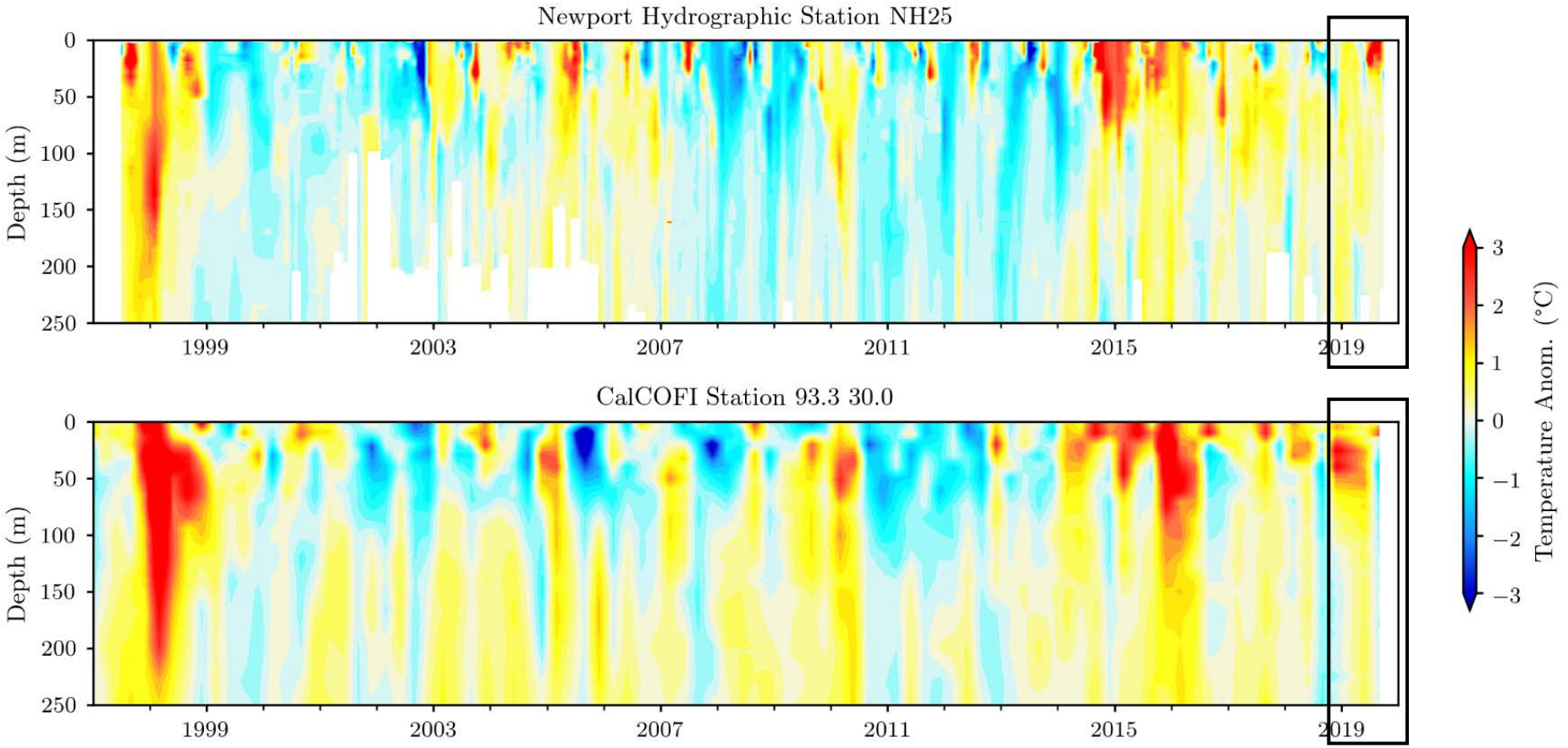
- ***Compare to similar period of evolution of the Blob:***

Blob, 2014-2015:



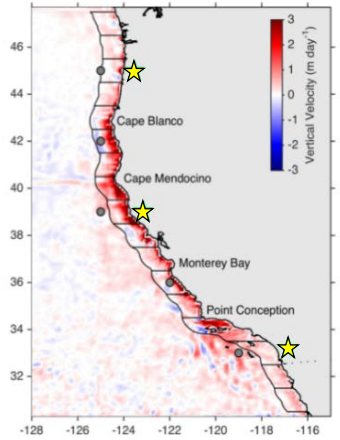
Subsurface temperatures warm for much of 2019

- Temperature anomalies at depth off Newport, OR & San Diego
- Last 5 years: surface warming events and stored heat at depth



- ***Newport: extreme warming in upper 25 m, summer/fall***
- ***Warmer than average in all of water column***
- ***San Diego: extreme warming in upper 50 m, winter/spring***
- ***Warmer than average at greater depths for first half of year, then cool except at surface***

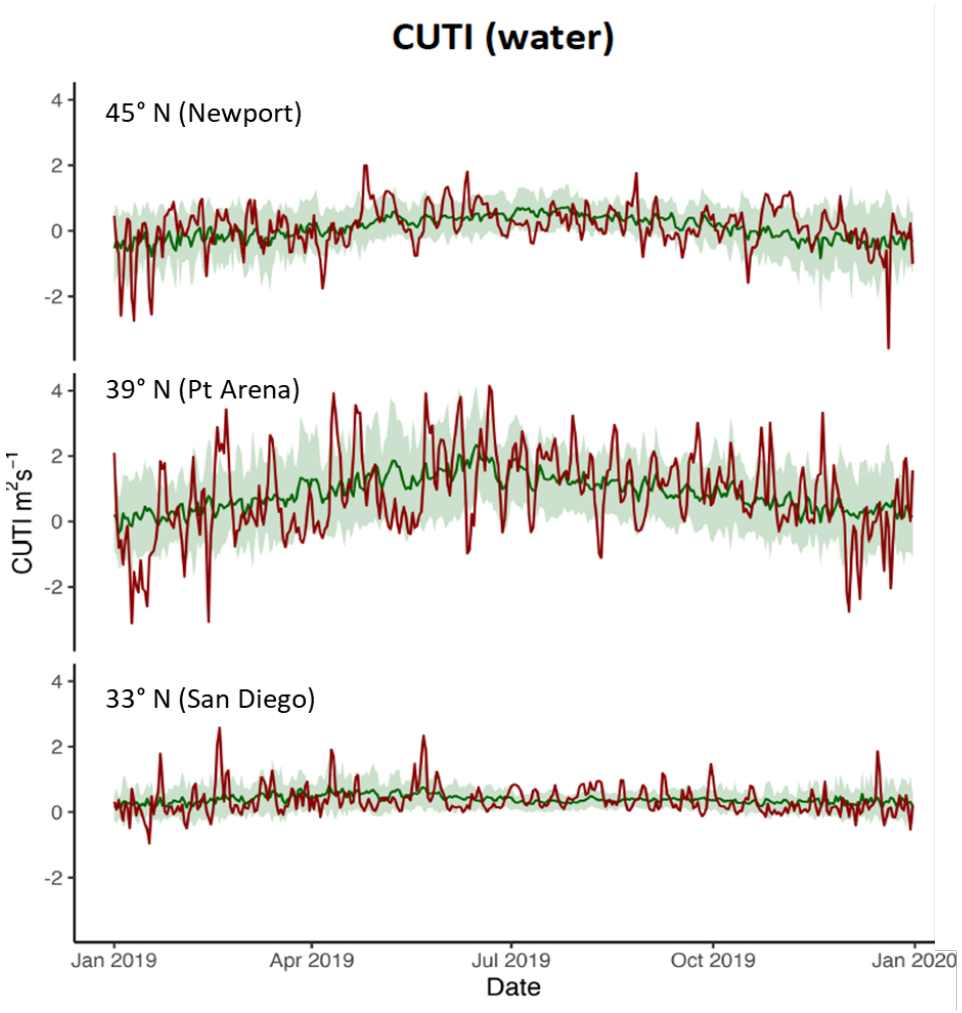
Upwelling of water and nitrate

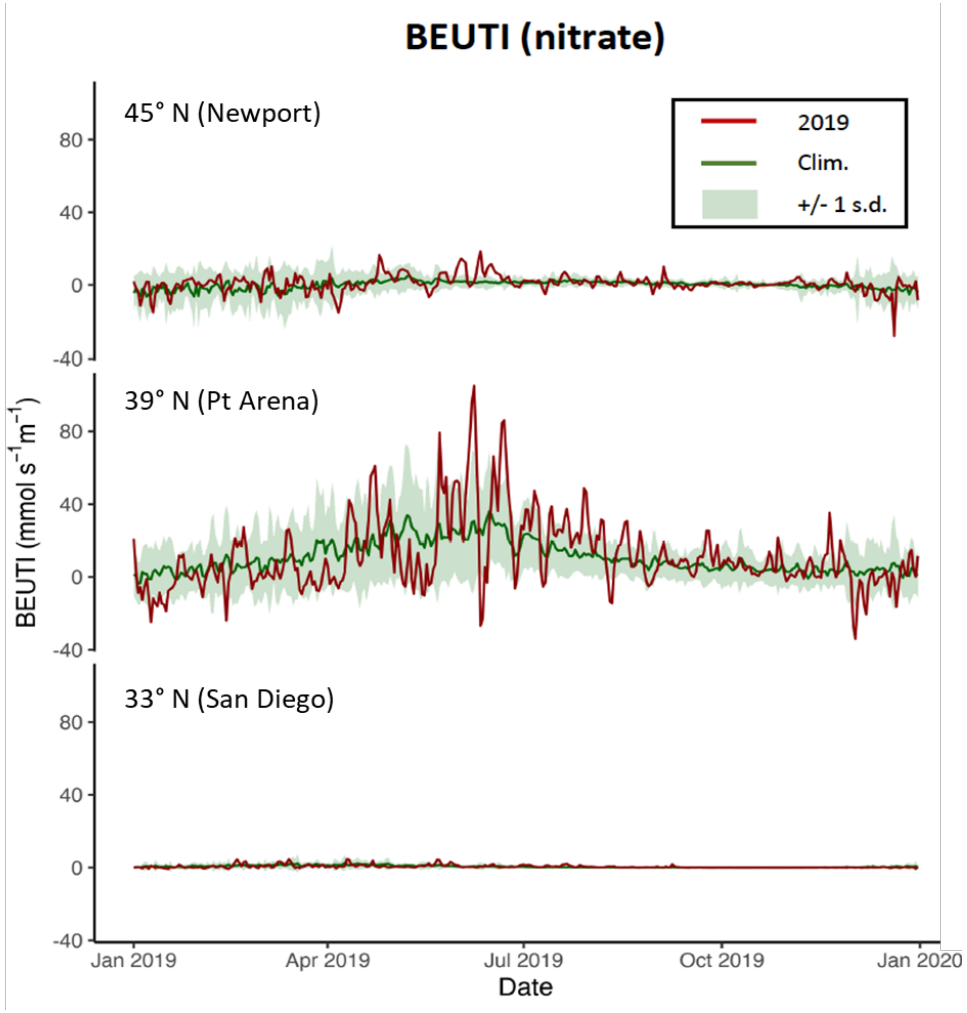


Coastal Upwelling Transport Index (CUTI): vertical water flux

Biologically Effective Upwelling Transport Index (BEUTI): vertical nitrate flux

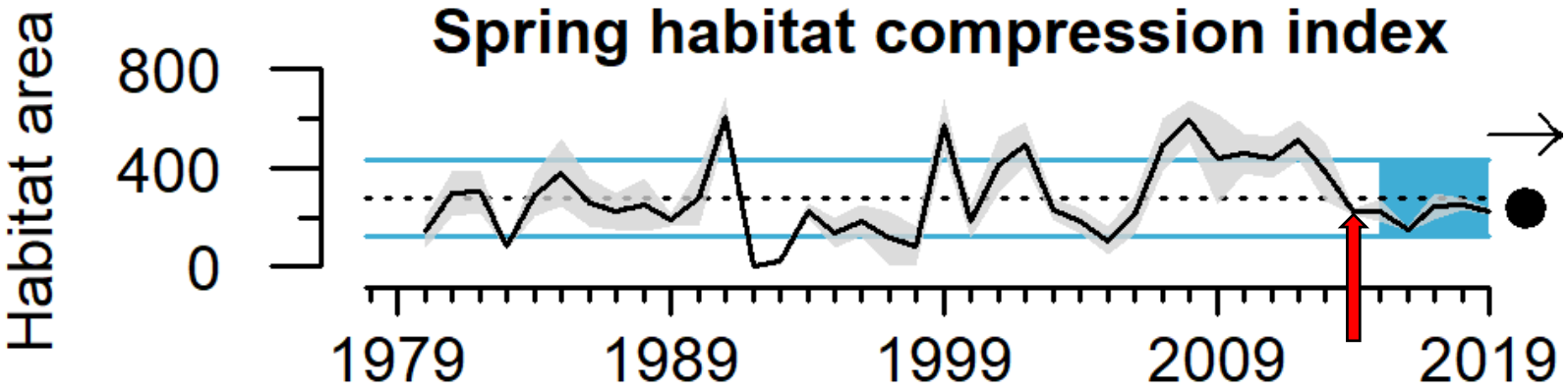
- ***North: average/above average in spring 2019, average/below average in summer***
- ***Central and South: average/below average in spring 2019, above average in summer***
- Nitrate flux greatest by far in central region



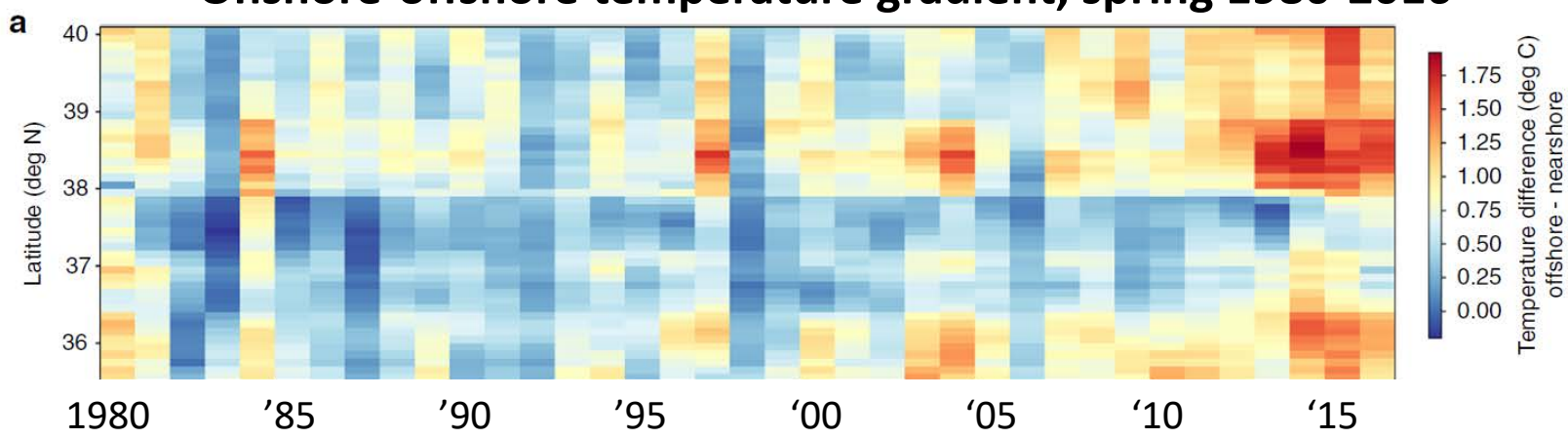


Coastal “habitat compression” between 35-40°N

- The upwelling zone is not fixed in space, time or area; it’s influenced by regional and basin-scale drivers
- When upwelling habitat is “compressed” along coast, ecological interactions can intensify (Santora et al. 2020)



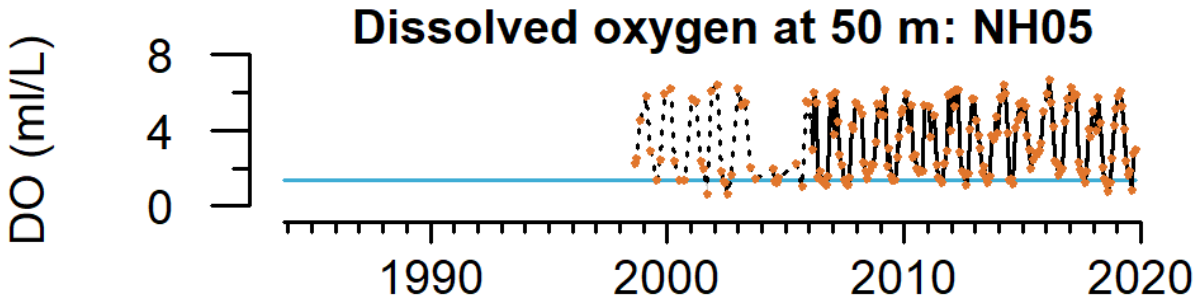
- ***Starting with “Blob” in 2014, Habitat Compression Index declined***
- ***Decline = greater habitat compression***
- These levels of compression are ***not*** unprecedented, but large **onshore-offshore temperature gradient** is
- Impacts like whale entanglement are driven by a suite of factors
  - Compression, onshore/offshore temp gradient, prey fields, HAB, delay in fishery opening, whale population, etc.

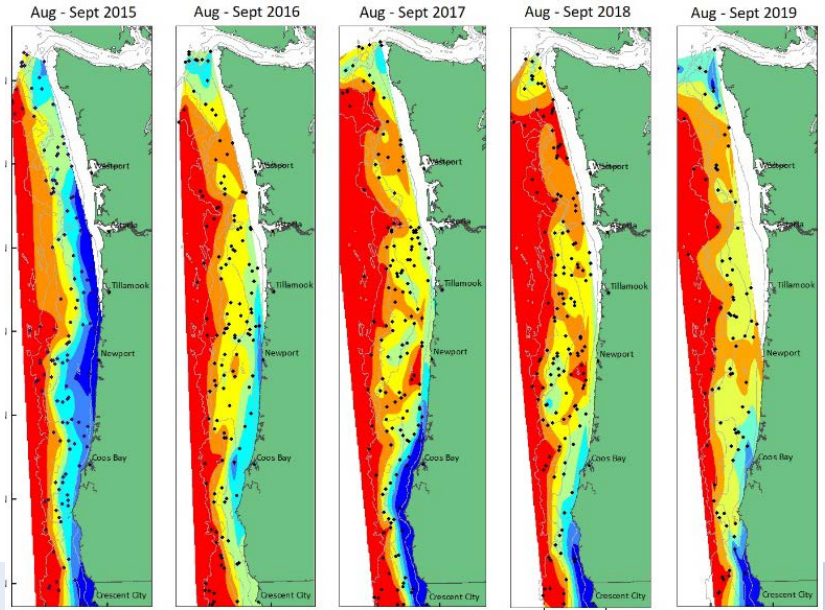


Dissolved oxygen: low in north, average in south

Hypoxia threshold: below 1.4 ml O_2 / L

- ***DO values off Newport were hypoxic in summer 2019***
- ***Extensive hypoxia on shelf in late summer (yellow/orange/red on map)***





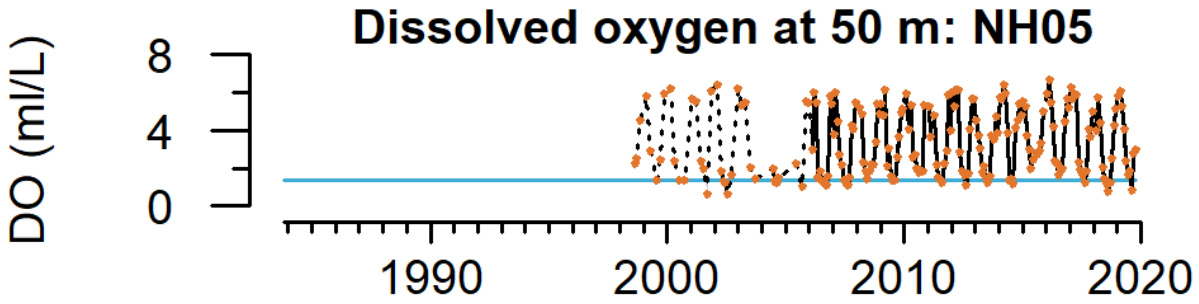
Benthic DO maps from NWFSC groundfish trawl survey, late summer 2015-2019 (P. Frey, NOAA)

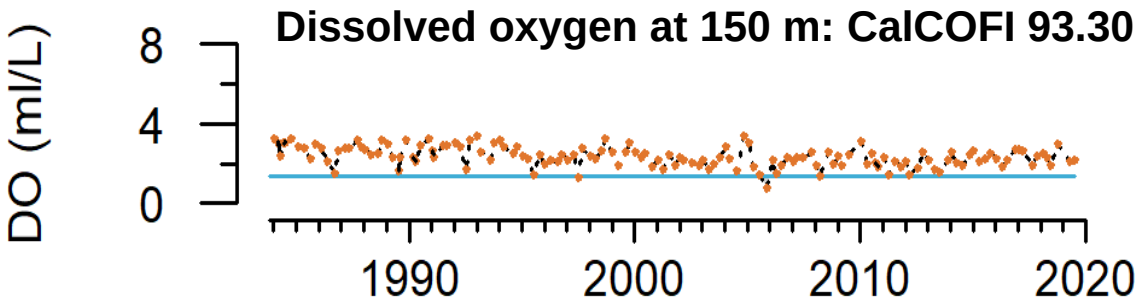
Dissolved oxygen: low in north, average in south

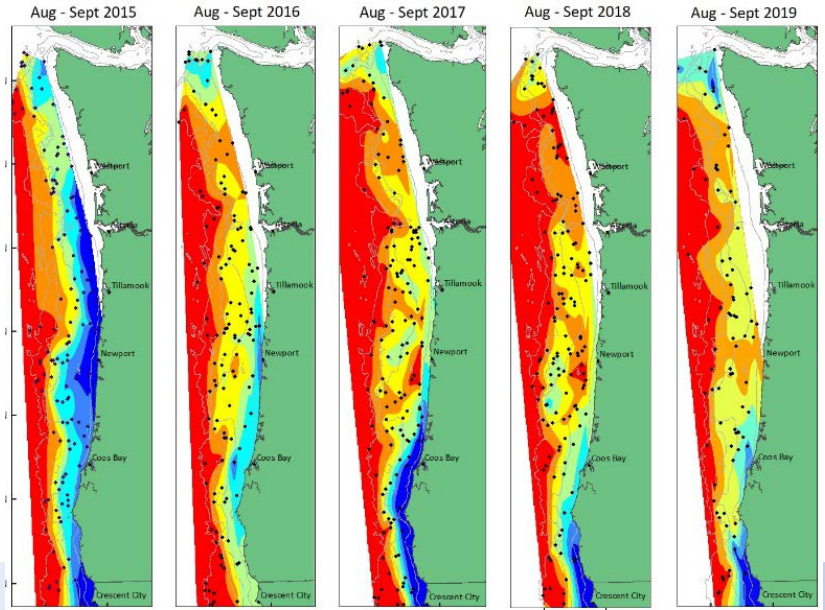
Hypoxia threshold: below 1.4 ml O_2 / L

- ***DO values off Newport were hypoxic in summer 2019***
- ***Extensive hypoxia on shelf in late summer (yellow/orange/red on map)***

- ***DO off San Diego was fairly typical of the past 20 years, and above the hypoxia threshold***
- ***Typical DO throughout CalCOFI region as well***

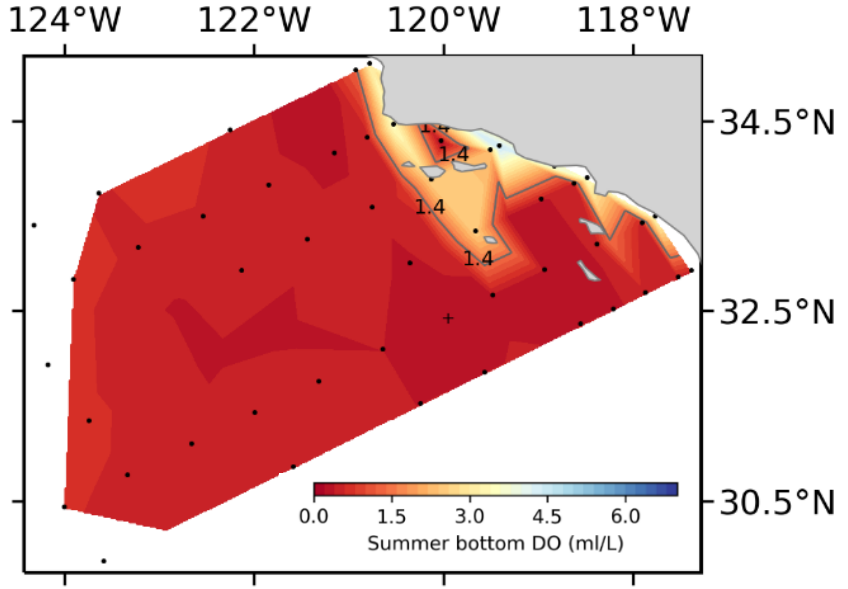




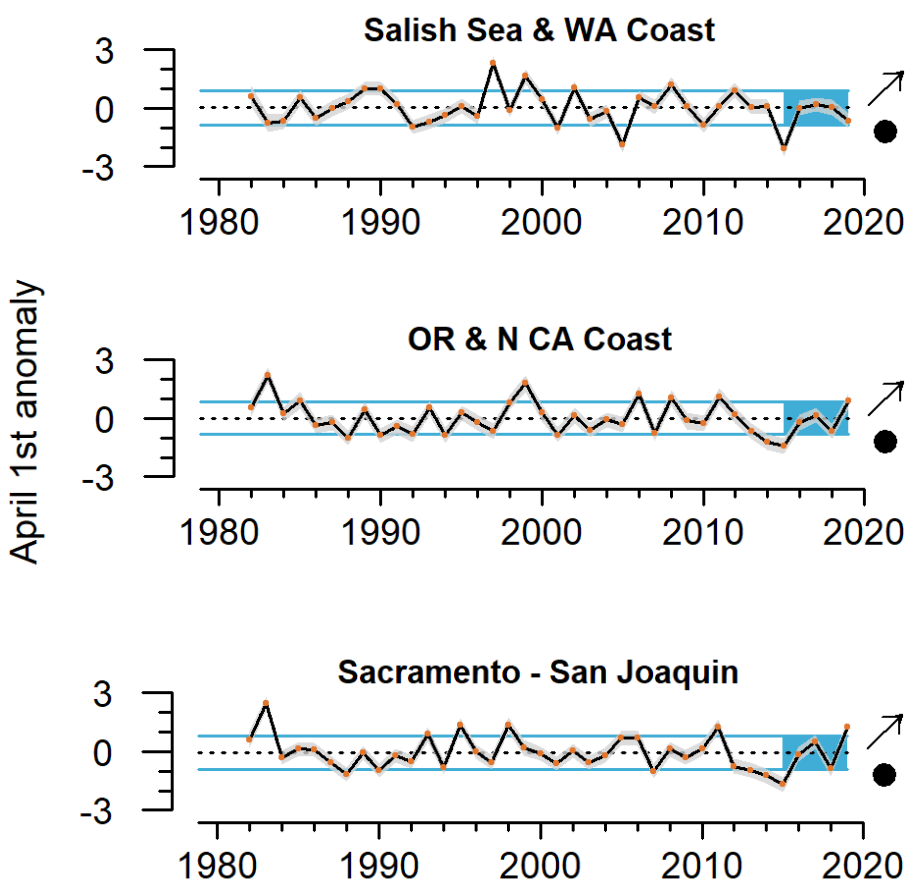


Benthic DO maps from NWFSC groundfish trawl survey, late summer 2015-2019 (P. Frey, NOAA)

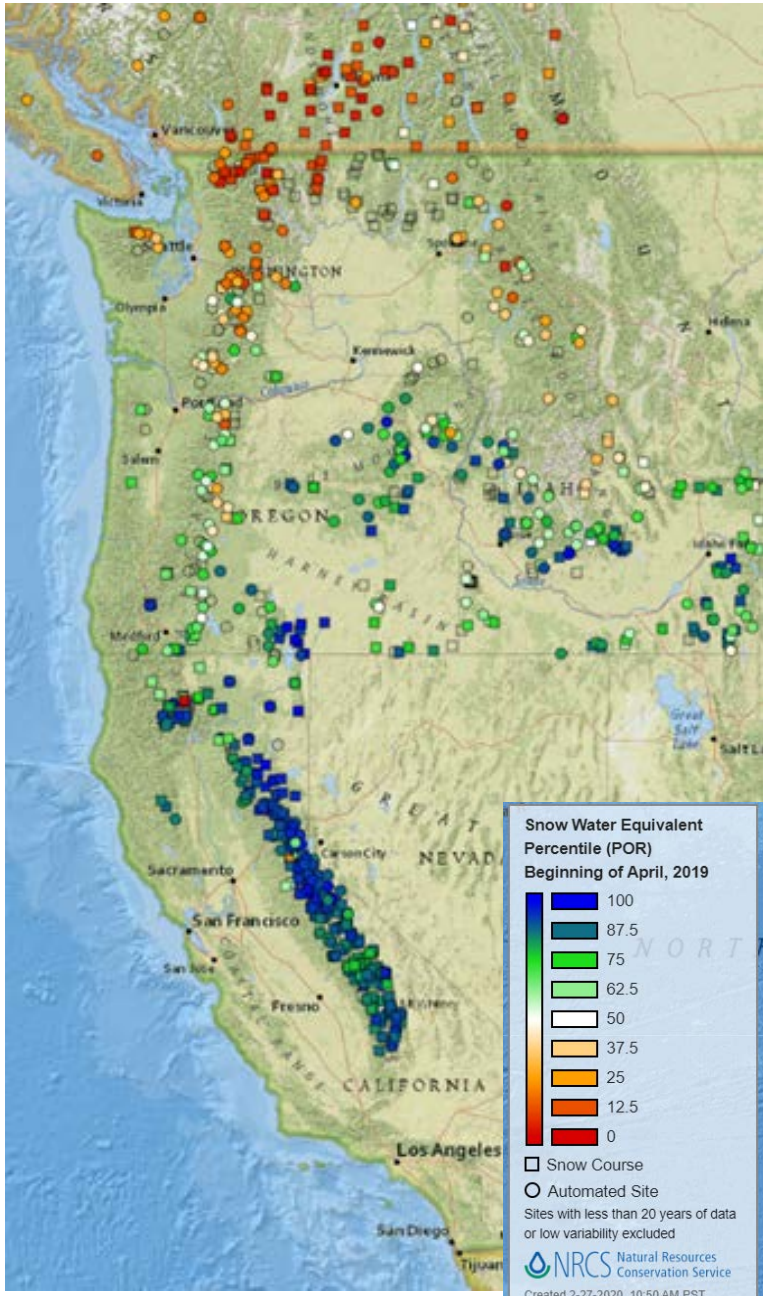
500 m / benthic DO map for 2019 from the CalCOFI region



Snow Water Equivalent in 2019: below average in north, well above average in central & south



- ***This regional SWE pattern was generally reflected in stream flows in 2019***

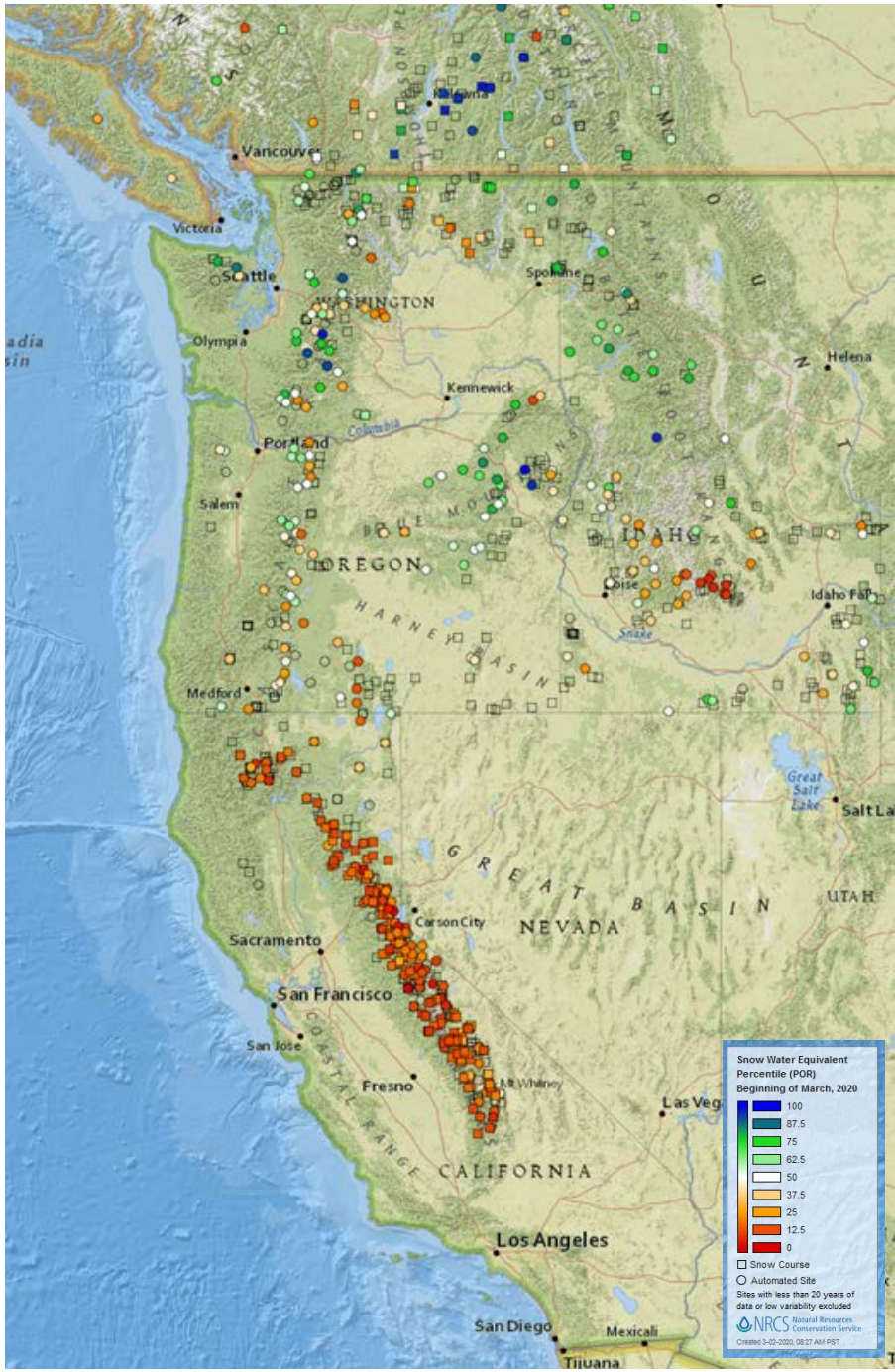


Snowpack as of March 1, 2020

- ***California: below the median (1981-2010)***
- ***Oregon, Washington and Idaho: mixed***

- Official 2020 measure will be made on April 1st
  - Approximate date of maximum snow accumulation
  - Much can change between now and then

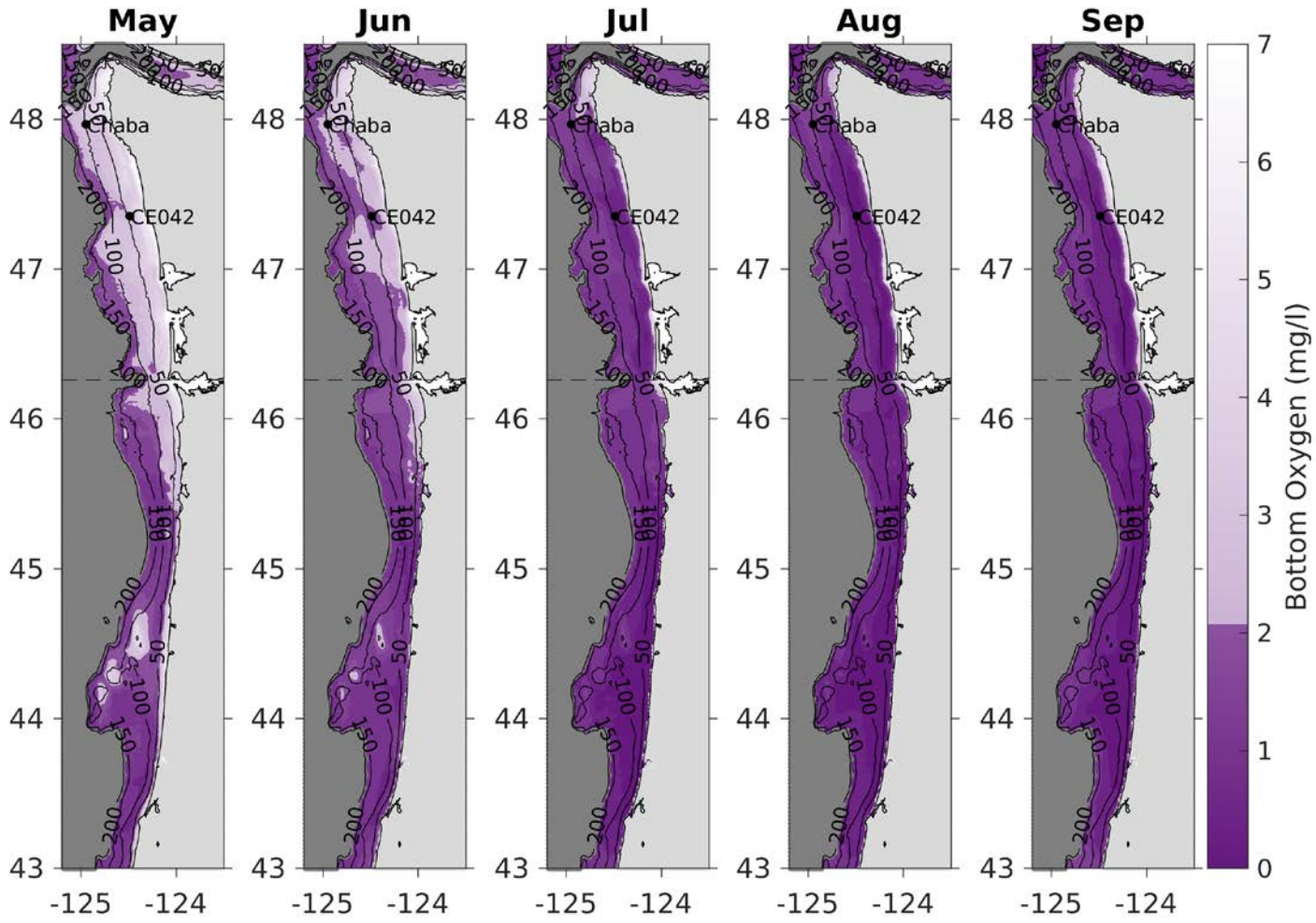
- Nat'l Weather Service Drought Outlook for Feb-May
  - Drought expected to persist or develop anew in much of region:
    - Central Washington
    - Western/central Oregon
    - Central Idaho
    - Most of California



J-SCOPE forecasts of ocean conditions off WA, OR

- J-SCOPE model system forecasts physical and biological conditions off WA, OR from Jan-Sept each year
- ***2020 forecast:***
  - ***Average temperatures; warmer-than-average SST by July/August***
  - ***Bottom hypoxia (dark purple) widespread and intense by June throughout the region (earlier than normal)***
  - ***High uncertainty for hypoxia forecast***

Benthic dissolved oxygen forecast, 2020

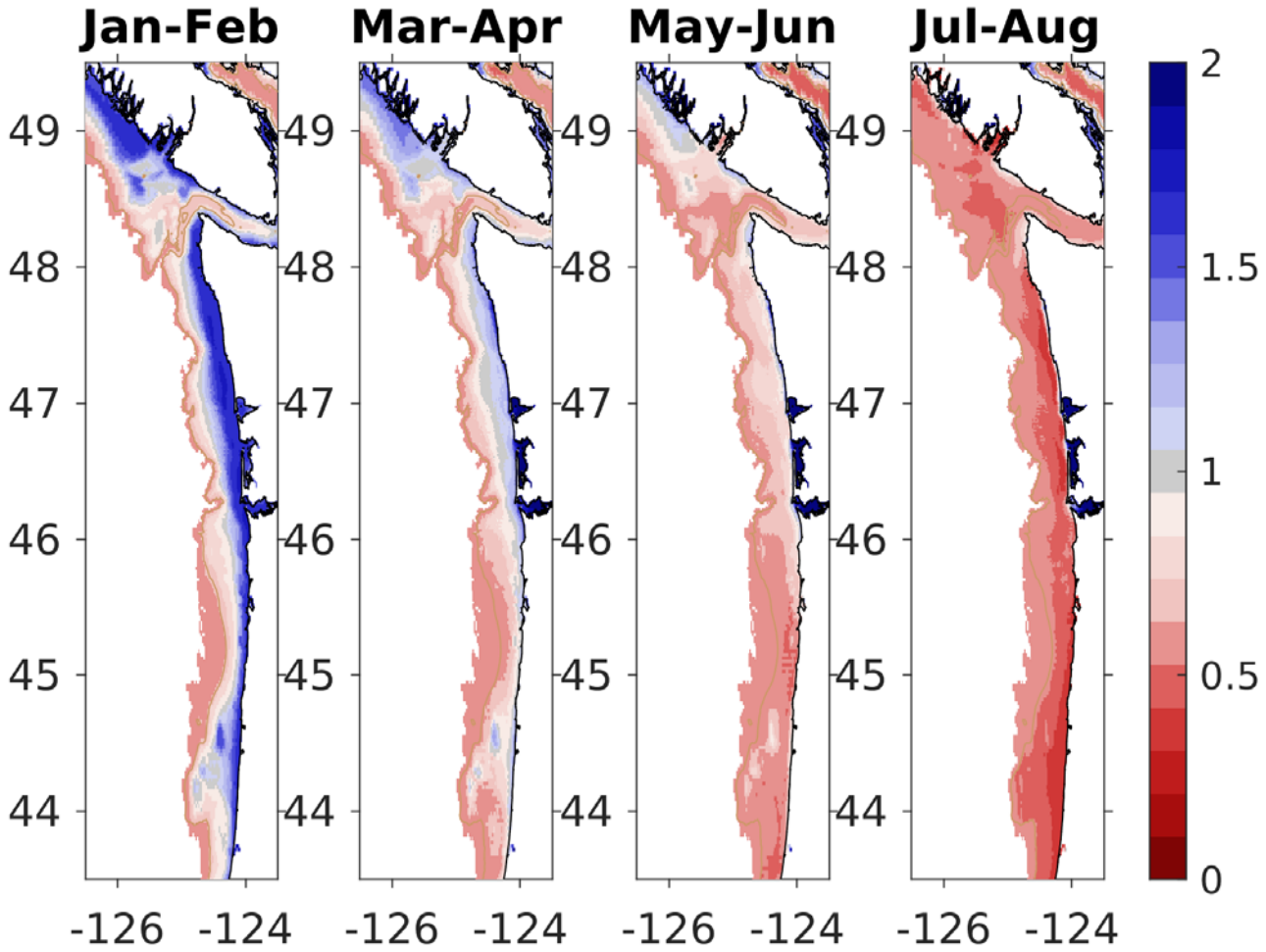


courtesy Dr. Samantha Siedlecki, University of Connecticut

J-SCOPE forecasts of ocean conditions off WA, OR

- J-SCOPE model system forecasts physical and biological conditions off WA, OR from Jan-Sept each year
- ***2020 forecast:***
  - *Average temperatures; warmer-than-average SST by July/August*
  - *Bottom hypoxia (dark purple) widespread and intense by June throughout the region (earlier than normal)*
  - *High uncertainty for hypoxia forecast*
  - ***Aragonite along bottom becomes undersaturated (corrosive) throughout region by late spring***

Benthic aragonite saturation forecast, 2020

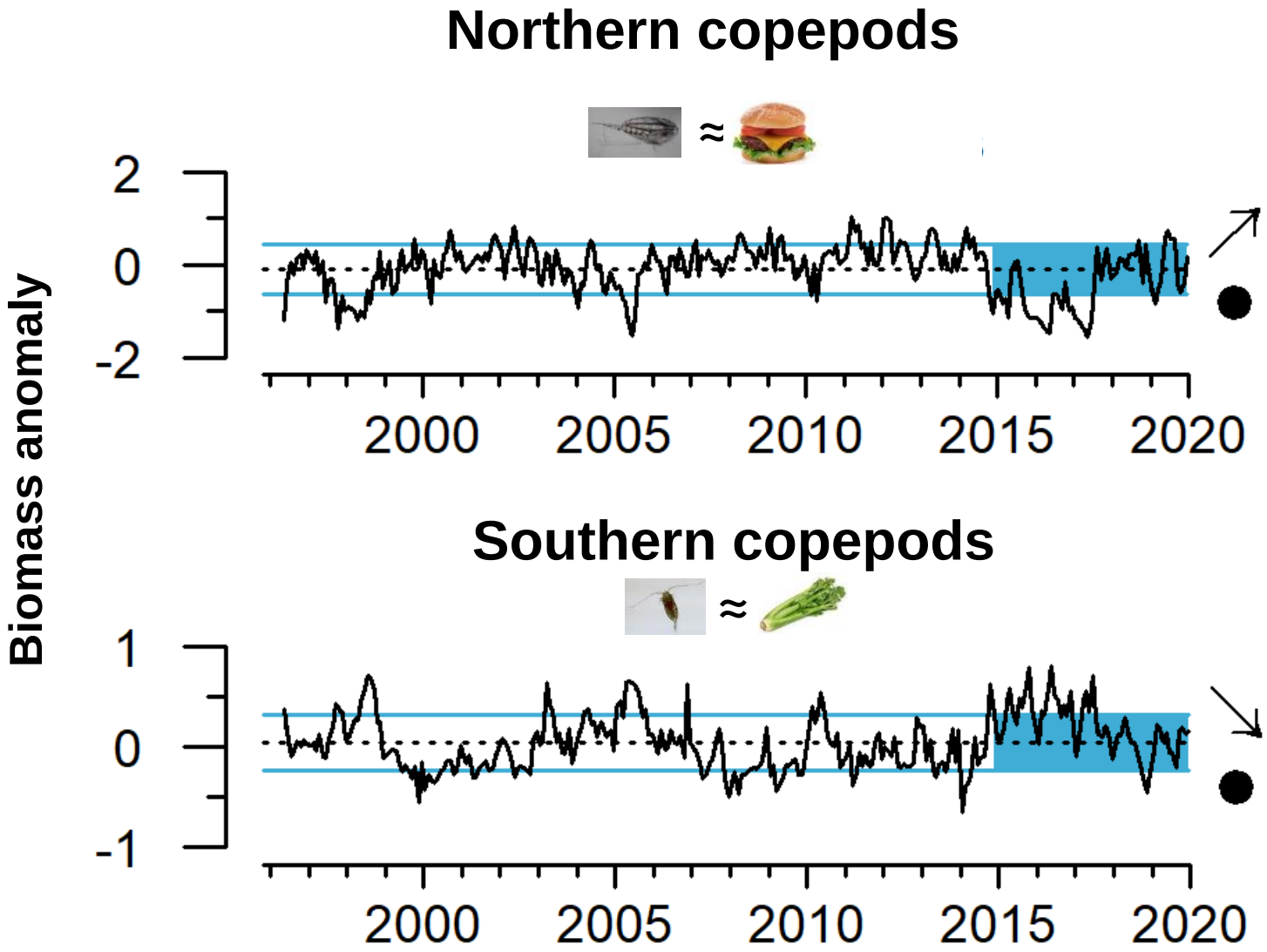


courtesy Dr. Samantha Siedlecki, University of Connecticut

Ecological responses in 2019, Part 1

Average or above-average in the north and the south

Copepods off Newport: productive in 2019

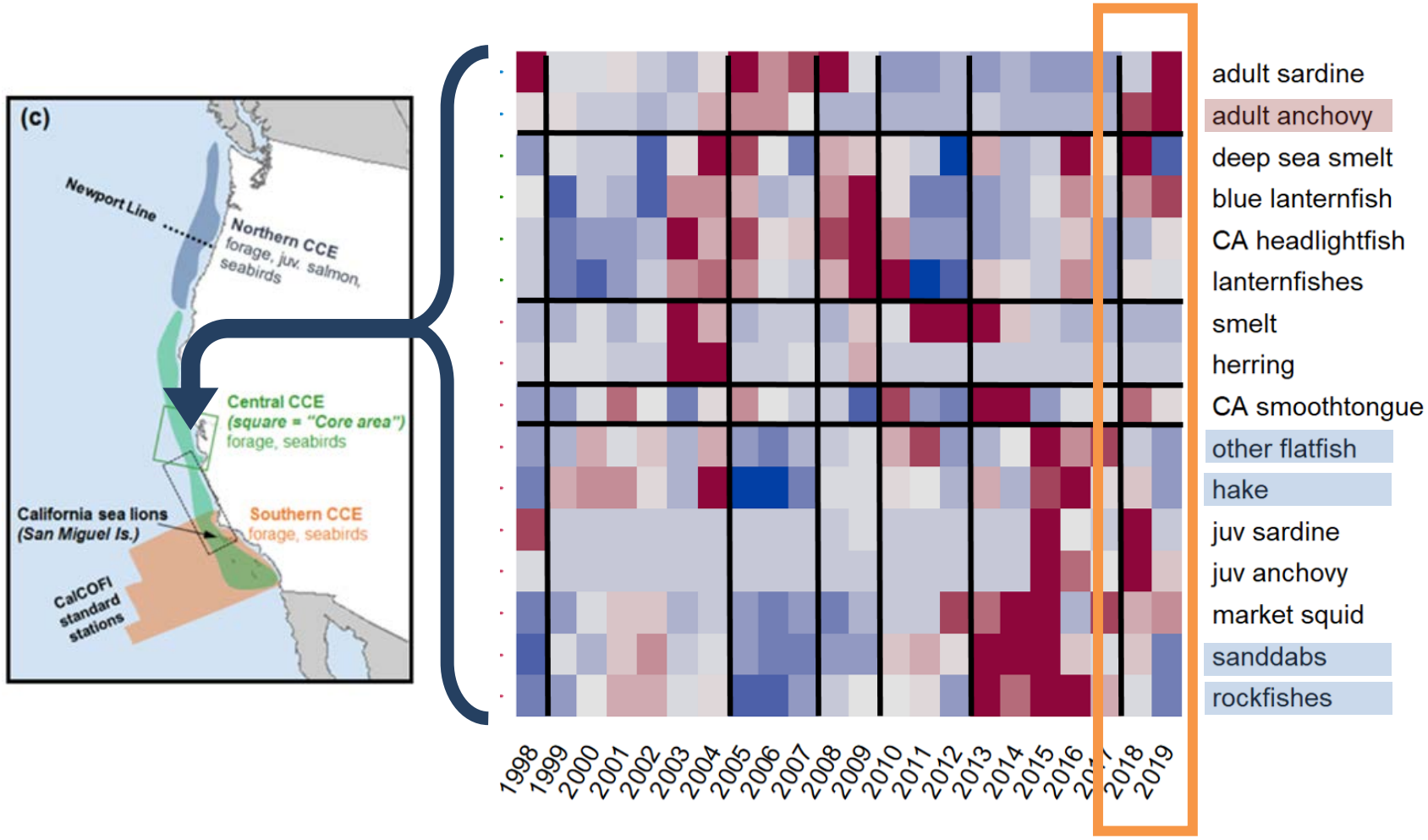


- ***Energy-rich northern copepods were above average in the spring/ summer of 2019***
- *They've been increasing overall since very low biomasses of 2014-2016*
- ***Energy-poor southern copepods were average to below-average in 2019***

Forage community in Central region: anchovy are dominant

Vertical lines = temporal breaks; horizontal lines = co-occurring forage groups

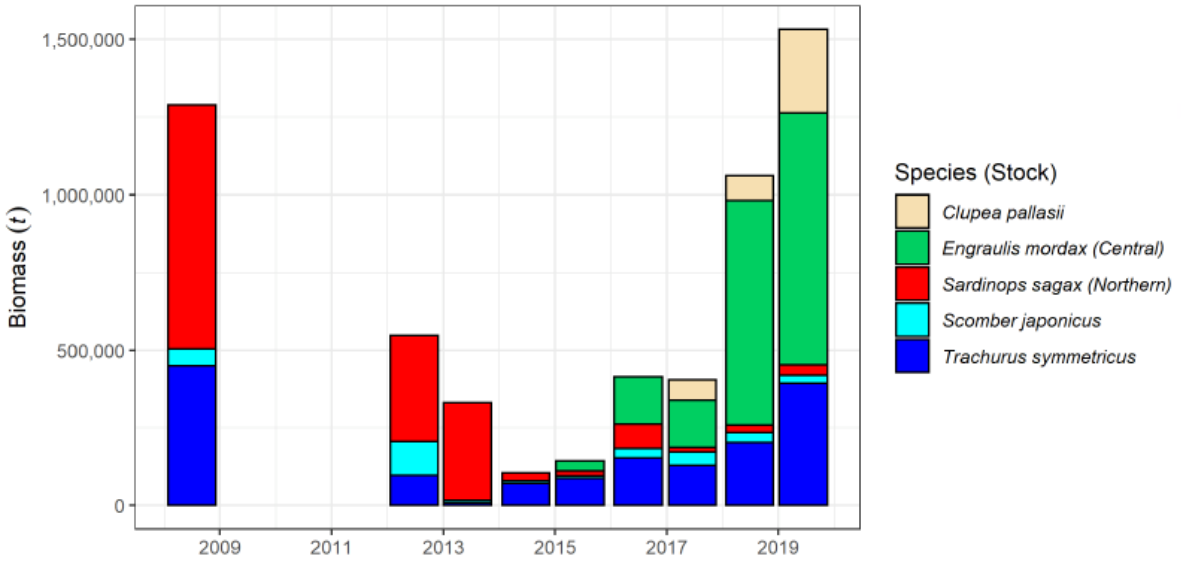
Abundance is color coded from dark blue (very rare) to dark red (abundant)



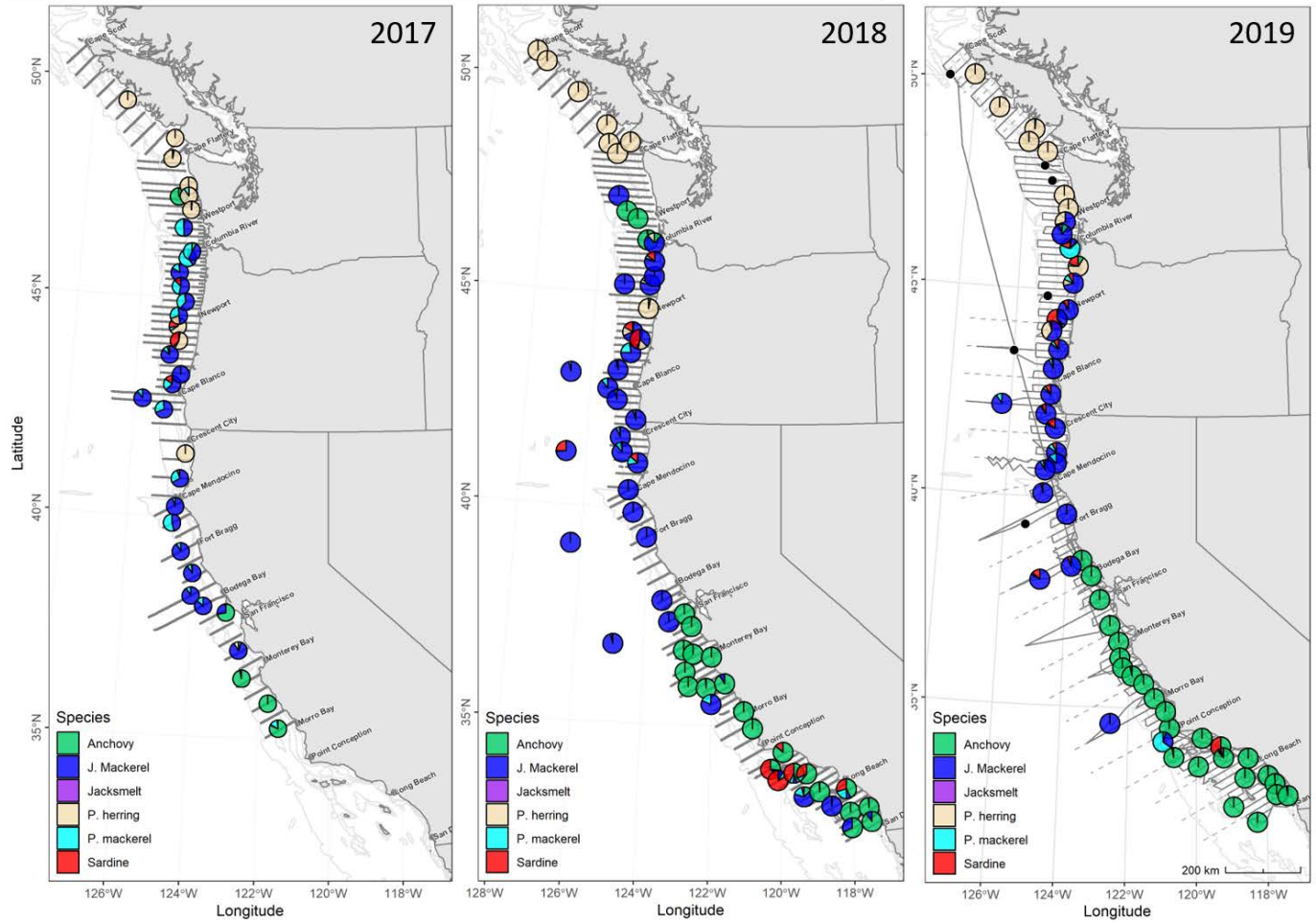
- ***Community since 2018 defined by very abundant anchovy***
- ***Juvenile groundfish have declined steeply relative to previous community regime***
- Larval anchovy also major component of 2019 forage in Southern Cal Bight

Several CPS stocks appear to be increasing

- ***Acoustic-trawl estimates of CPS finfish biomass increased in 2018 & 2019:***
  - ***Anchovy in central and southern California***
  - ***Jack mackerel in northern California and Oregon***
  - ***Herring in Washington***

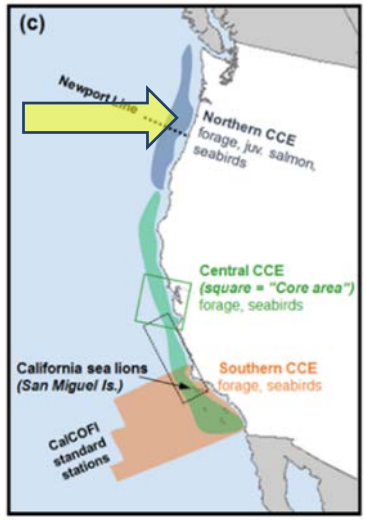


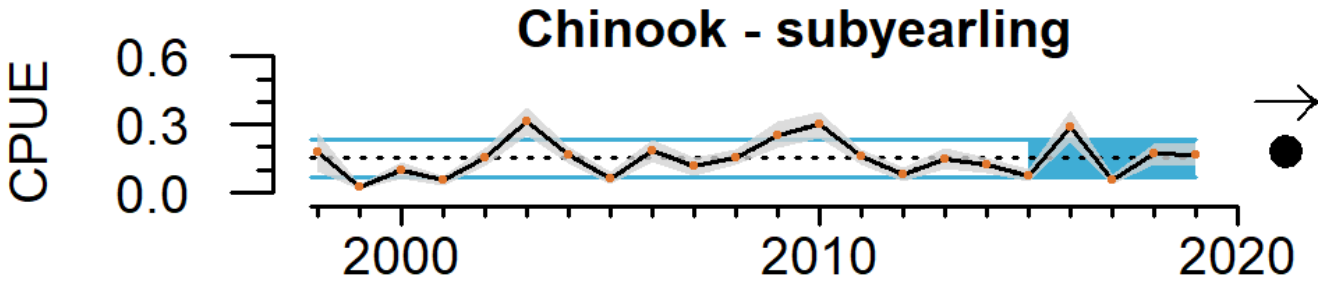
Acoustic weight proportions in trawl groupings (*not* biomass)

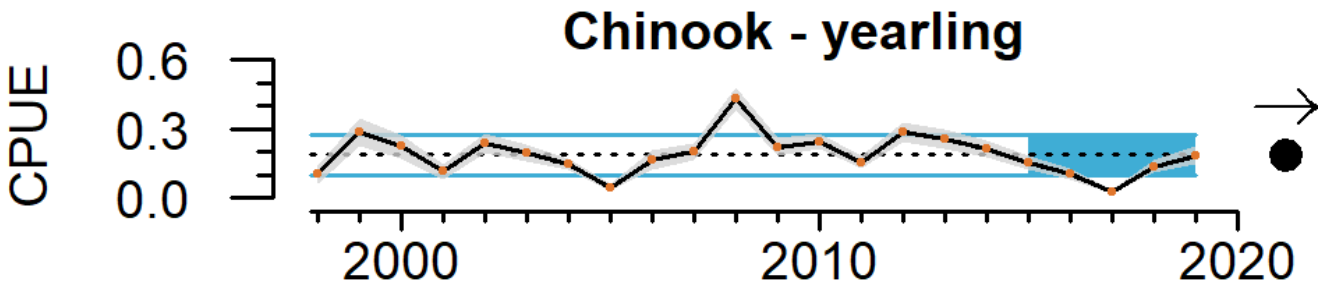


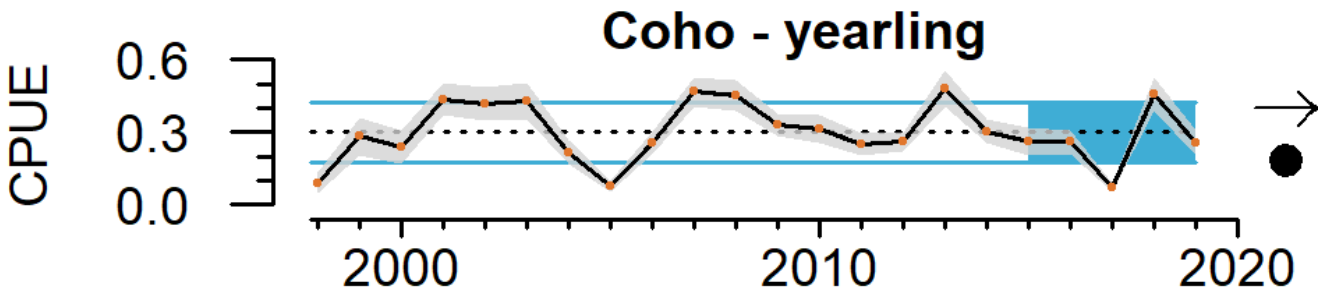
- From Stierhoff et al. 2020, NOAA Tech Memo

Juvenile salmon catches off WA, OR were average









- ***2019: catches of juv Chinook and coho were at the long-term means***
- *This continues the rebound from the very low catches in 2017*

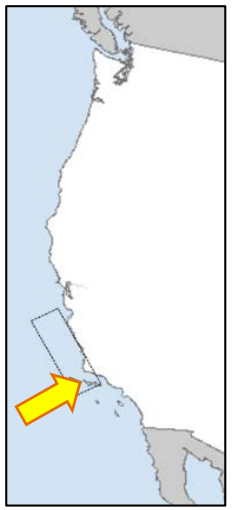
“Stoplight” table for salmon returns to WA/OR in 2020: a mixed bag

Chinook counts at Bonneville Dam, coho returns to Oregon coast streams

	Smolt year				Adult return outlook	
Scale of indicators	2016	2017	2018	2019	Coho, 2020	Chinook, 2020
Basin-scale						
PDO (May-Sept)	◆	■	■	◆	◆	■
ONI (Jan-Jun)	◆	■	●	◆	◆	●
Local and regional						
SST anomalies	◆	■	■	◆	◆	■
Deep water temp	■	◆	◆	◆	◆	◆
Deep water salinity	■	■	●	◆	◆	●
Copepod biodiversity	◆	◆	■	■	■	■
Northern copepod anomaly	◆	◆	■	●	●	■
Biological spring transition	◆	◆	■	■	■	■
Winter ichthyoplankton biomass	■	■	■	◆	◆	■
Winter ichthyoplankton community	◆	◆	◆	◆	◆	◆
Juvenile Chinook catch (Jun)	◆	◆	■	■	■	■
Juvenile coho catch (Jun)	■	◆	●	■	■	■

- Indicators of conditions for last 4 smolt years in the northern CCE
- Color = rank of all years
  - ● Green: top third
  - ■ Yellow: middle third
  - ◆ Red: bottom third

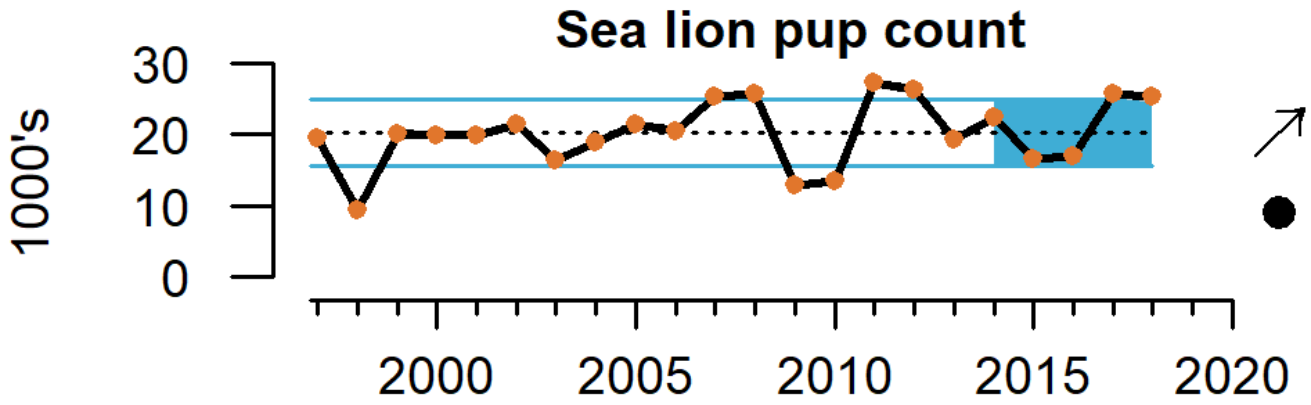
- ***Consistent with average returns of Chinook to Columbia Basin***
- ***Below-average returns of coho to OR coast***

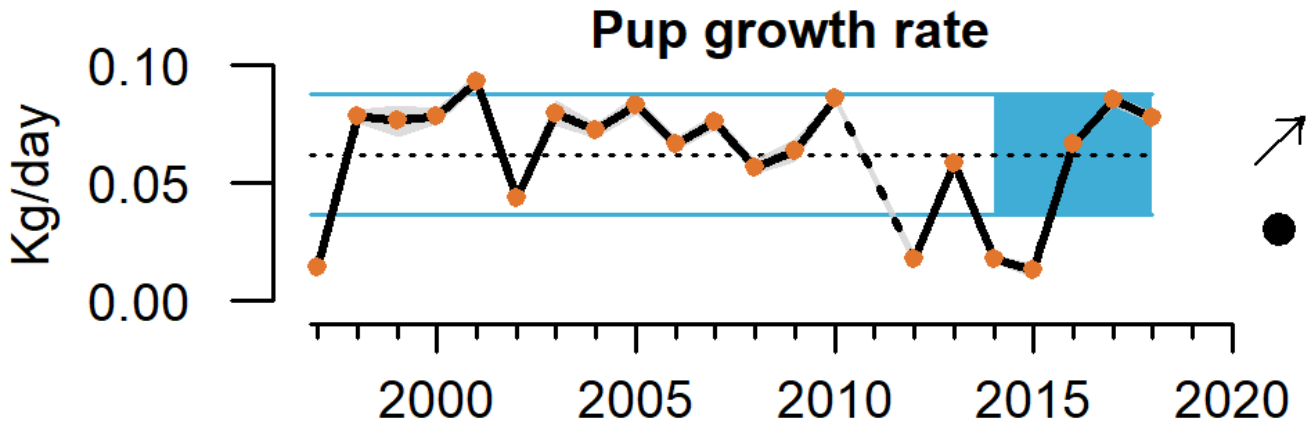


Sea lion pups indicate good feeding conditions

San Miguel California sea lion colony (arrow on map)

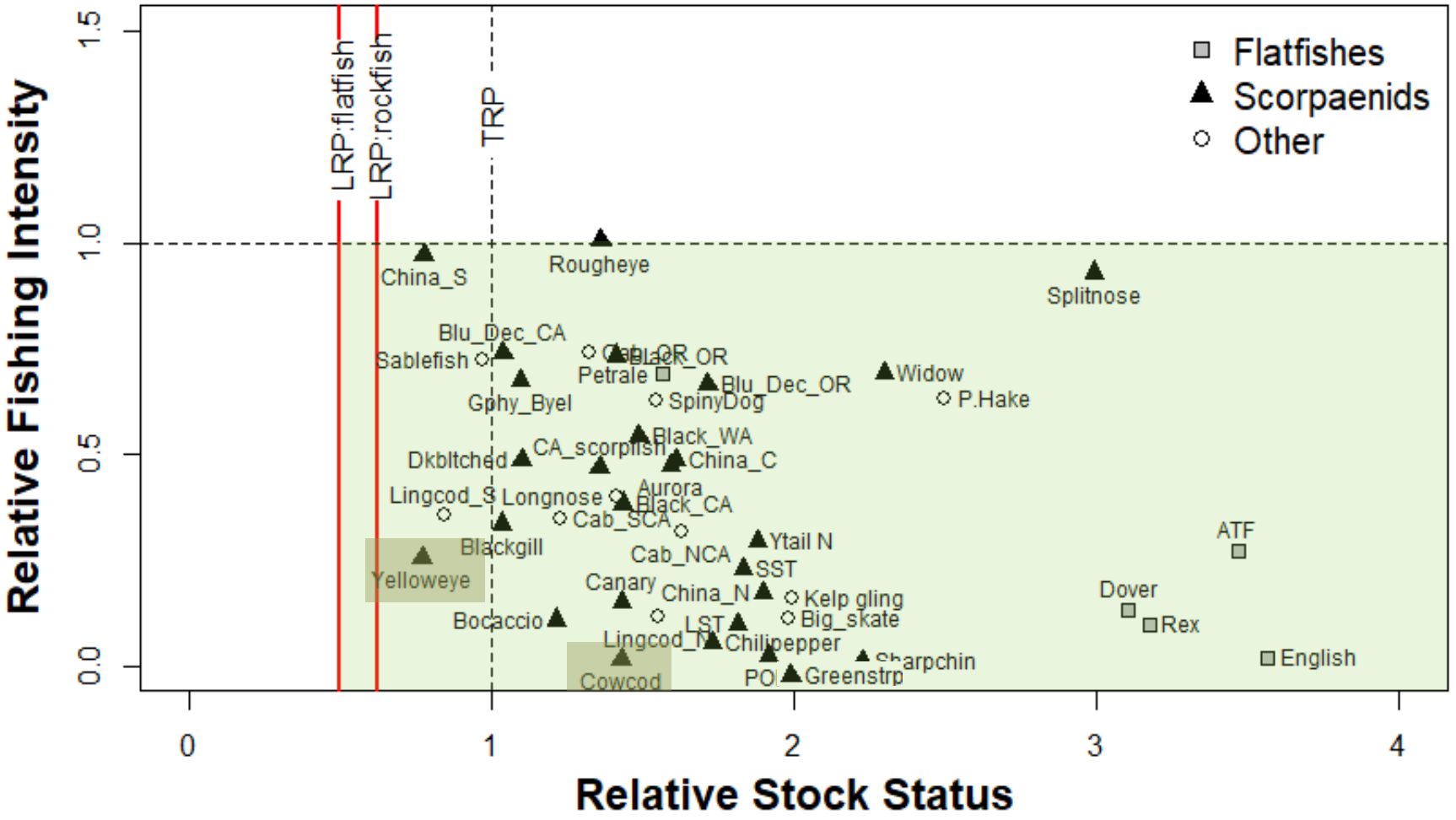
Maternal feeding grounds in southern and central California (rectangle on map)





- ***2018 cohort: high pup count and above-normal winter growth***
  - ***Good feeding conditions for gestating mothers, October '17-June '18***
  - ***Good feeding conditions for nursing mothers, June '18-February '19***
- Maternal diets: anchovy, mackerels, squid, hake, sardine
- ***Preliminary info on 2019 cohort: above-average pup count; among the highest growth ever observed***

Groundfish assessment outputs: news is generally good



- This plot includes updates for multiple species in 2019
- ***No assessed stocks are "overfished"***
  - Cowcod rebuilt, yelloweye not yet
- ***Rougheye rockfish just above "overfishing" proxy***
  - Black and China rockfish now below overfishing proxy
  - Greenstriped in report is an error!

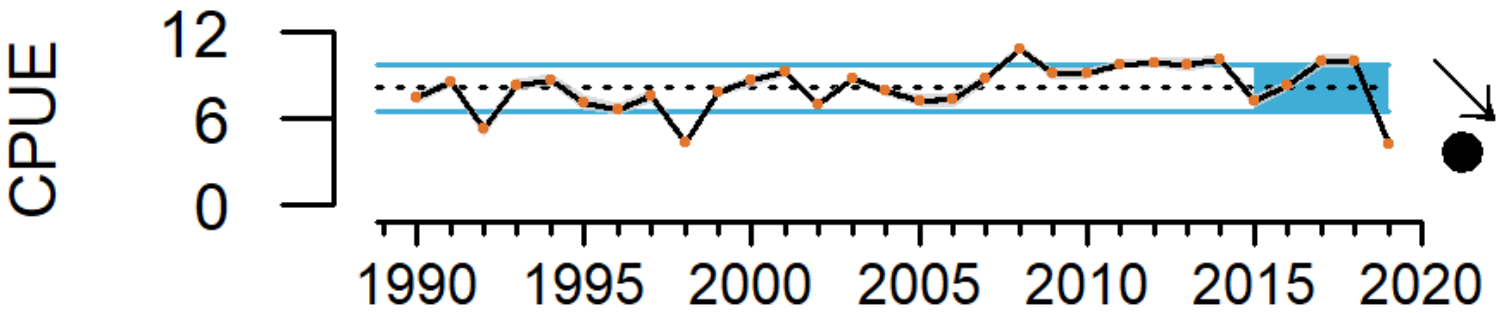
Ecological responses in 2019, Part 2

Signs of concern off central and northern California

Sarah Grimes / Fort Bragg Advocate-News

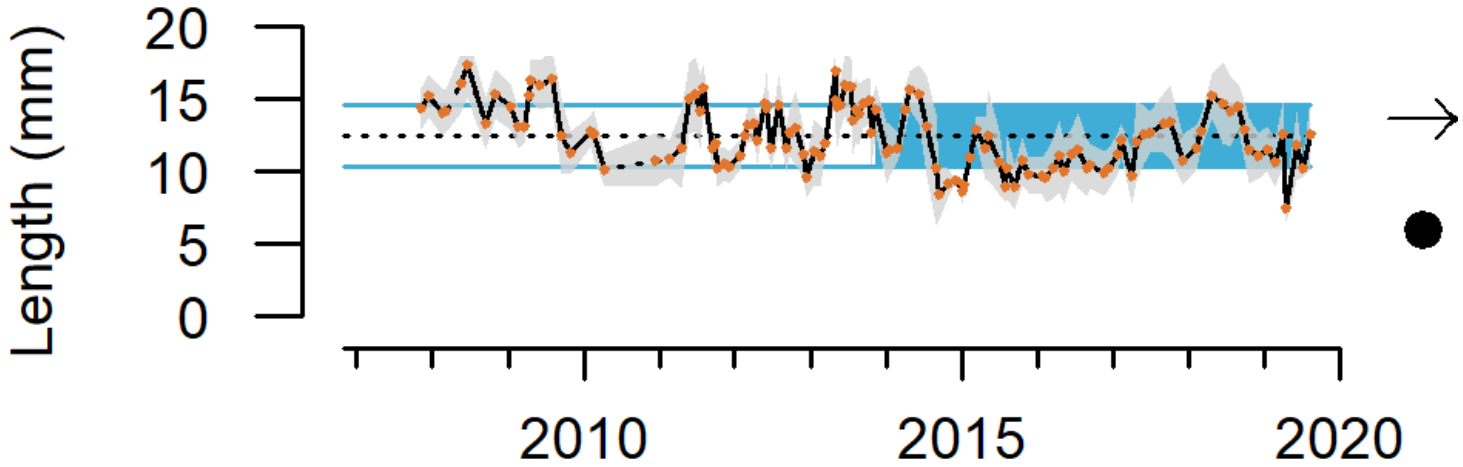
Krill off California: fewer and smaller

Krill CPUE off Monterey Bay, 1989-2019

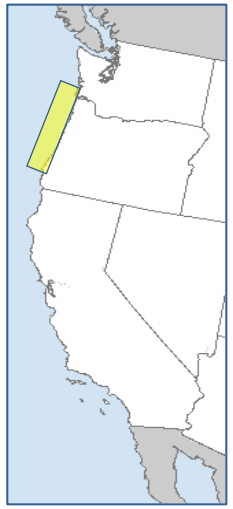


- ***Krill catches in 2019 off Monterey Bay were near the lowest of the time series***

Krill length off Trinidad Head, 2007-2019

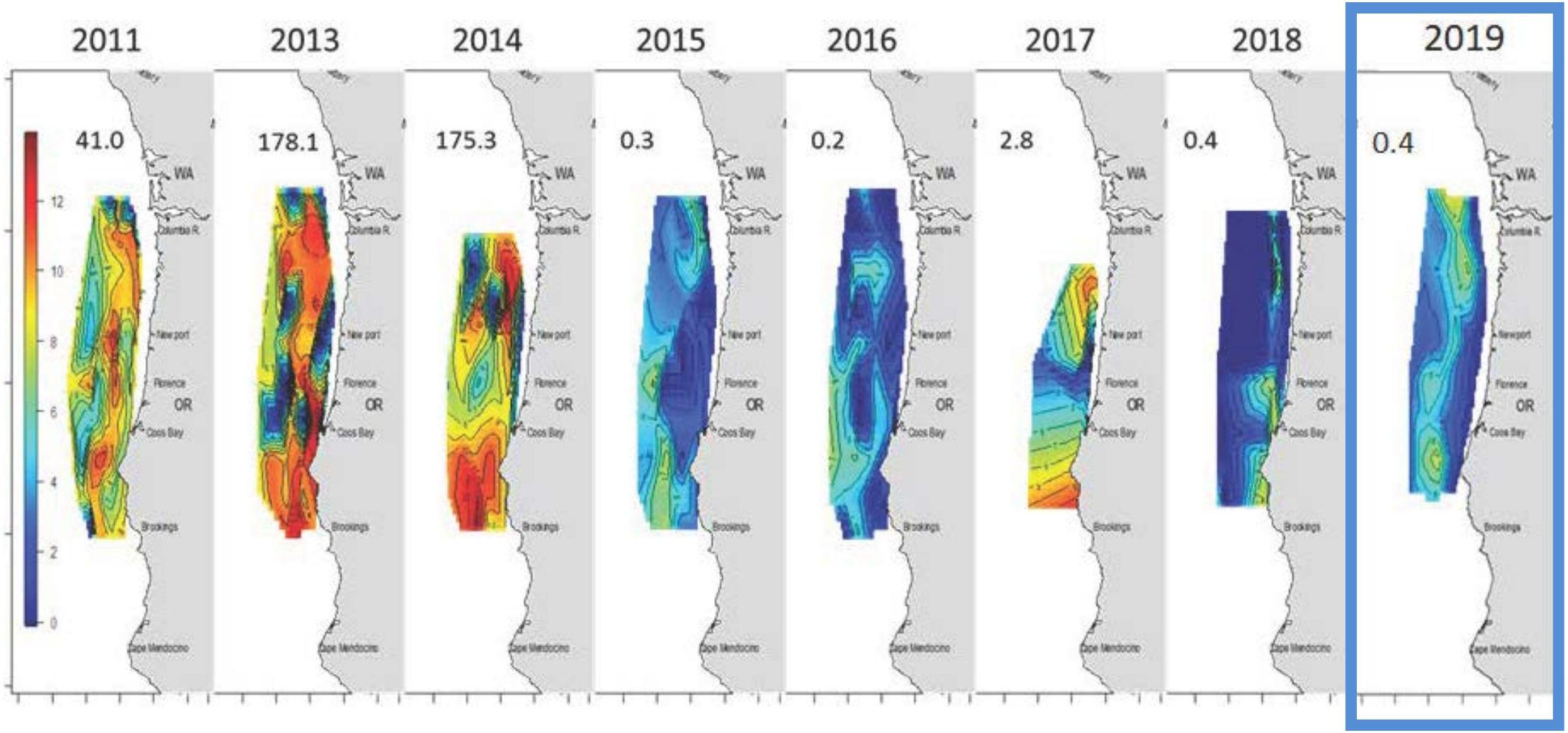


- ***Krill lengths were below average in 2019***
  - A change after several years of improvement

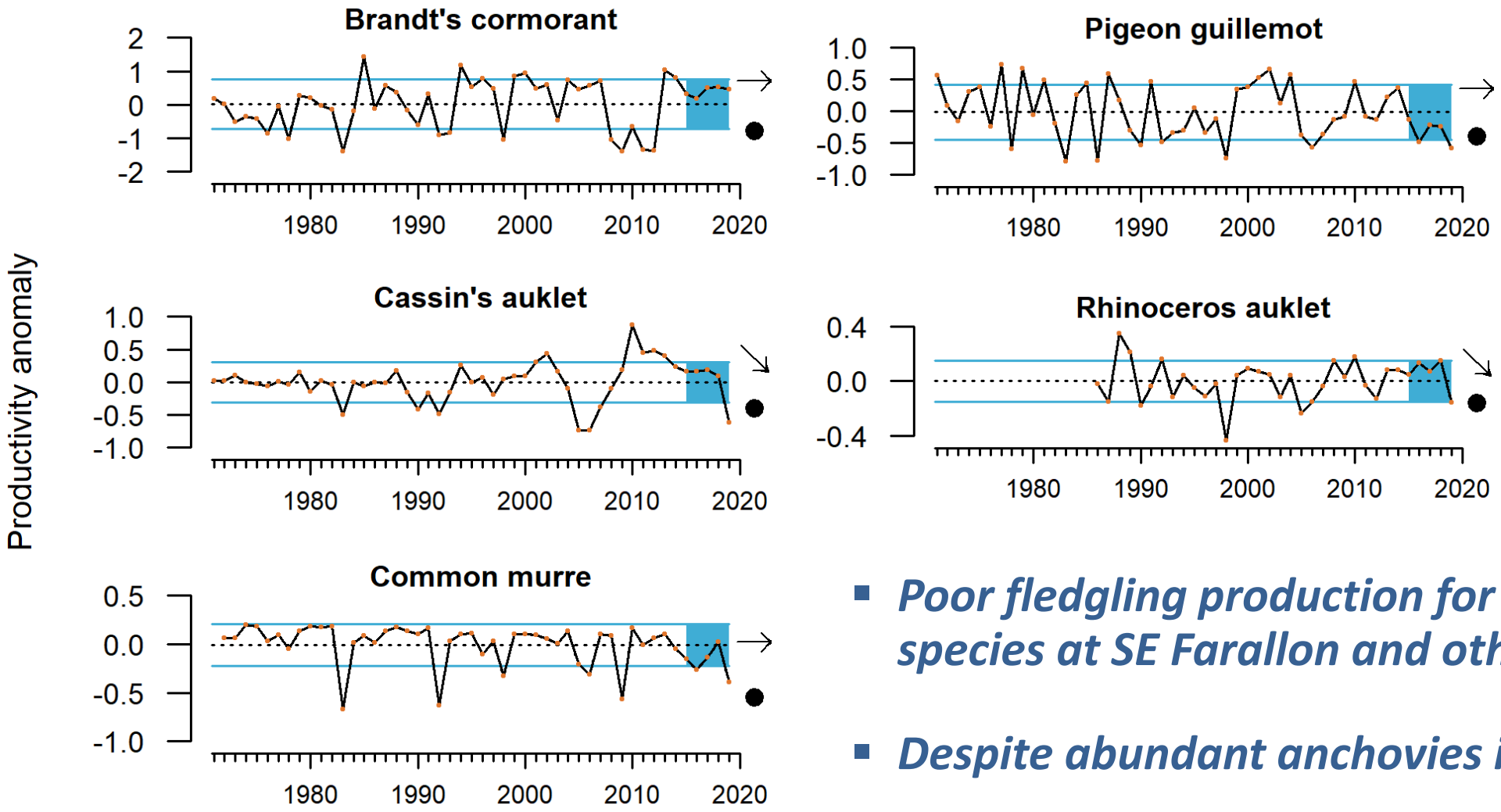


Krill off Oregon: relatively low CPUE

- Some evidence that krill were present, but deeper than normal



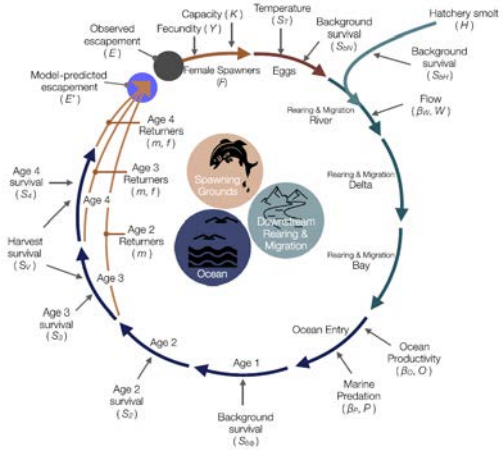
Seabirds struggled off central & northern CA



- ***Poor fledgling production for several species at SE Farallon and other colonies***
- ***Despite abundant anchovies in diets***
- ***Wreck of common murres in northern CA***

New “stoplight” for naturally produced Central Valley fall Chinook: consistent with poor returns in 2020

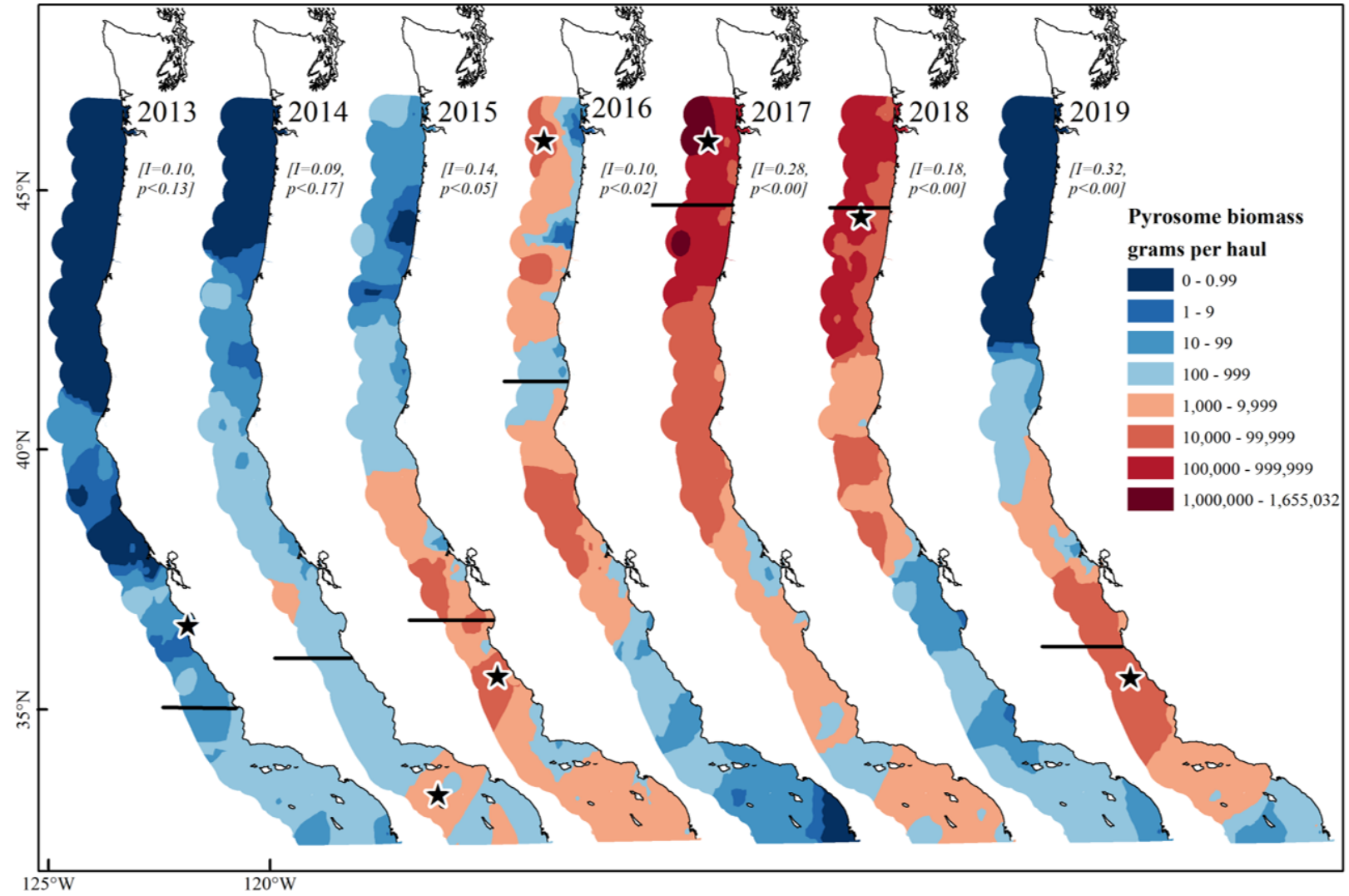
- **Naturally produced fish only, not hatchery**
- Links ecosystem drivers to key stages in a life cycle model for Sacramento/San Joaquin fall Chinook (Friedman et al. 2019)
- ***Conditions unfavorable for dominant year class (2017) that will return in 2020***



Natural spawning escapement (year *t*)	Egg incubation temperature (Oct-Dec, year *t*)	Median flow (Feb, year *t+1*)	Seabird marine predation index (year *t+1*)	Chinook age in fall 2020
2016: 56,000 (low)	11.8C (poor)	48,200 (very high)	Near average	4
2017: 18,000 (very low)	**11.8C (poor)**	**5,525 (very low)**	**Near average**	**3**
2018: 72,000 (low)	11.7C (poor)	21,700 (high)	Near average	2

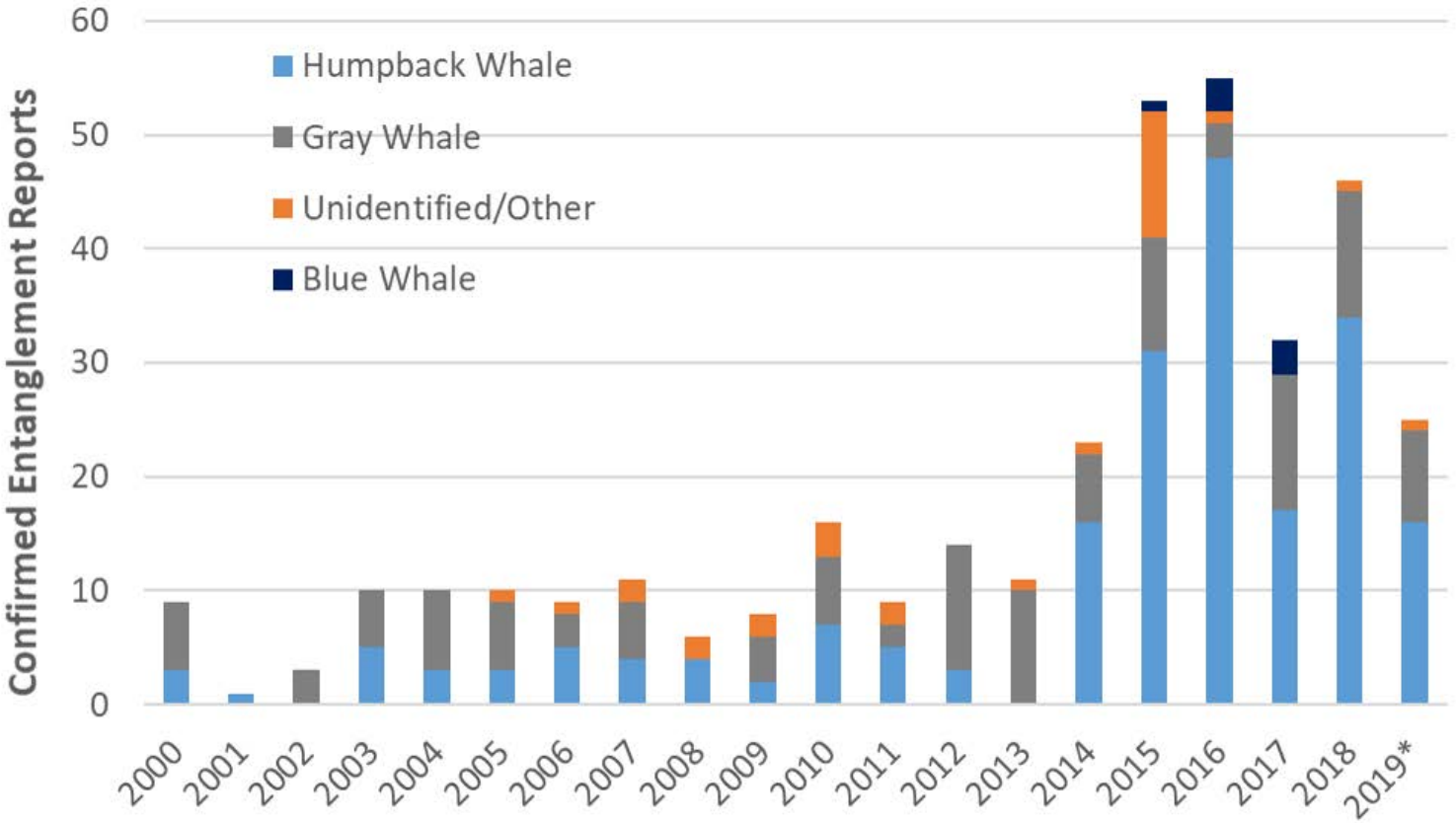
Pyrosomes shifted south

Pyrosoma atlanticum: a warm-water pelagic tunicate



- *From 2014-2017, pyrosome numbers increased, became more widespread*
- *Greatest densities in 2016-2018 were off WA/OR*
- ***In 2019, pyrosomes were basically absent from WA/OR***
- ***Greatest density (★) was between SF Bay and Pt Conception***

Whale entanglements remain a problem

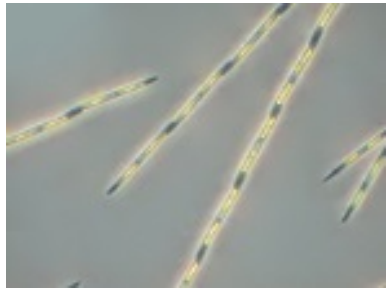


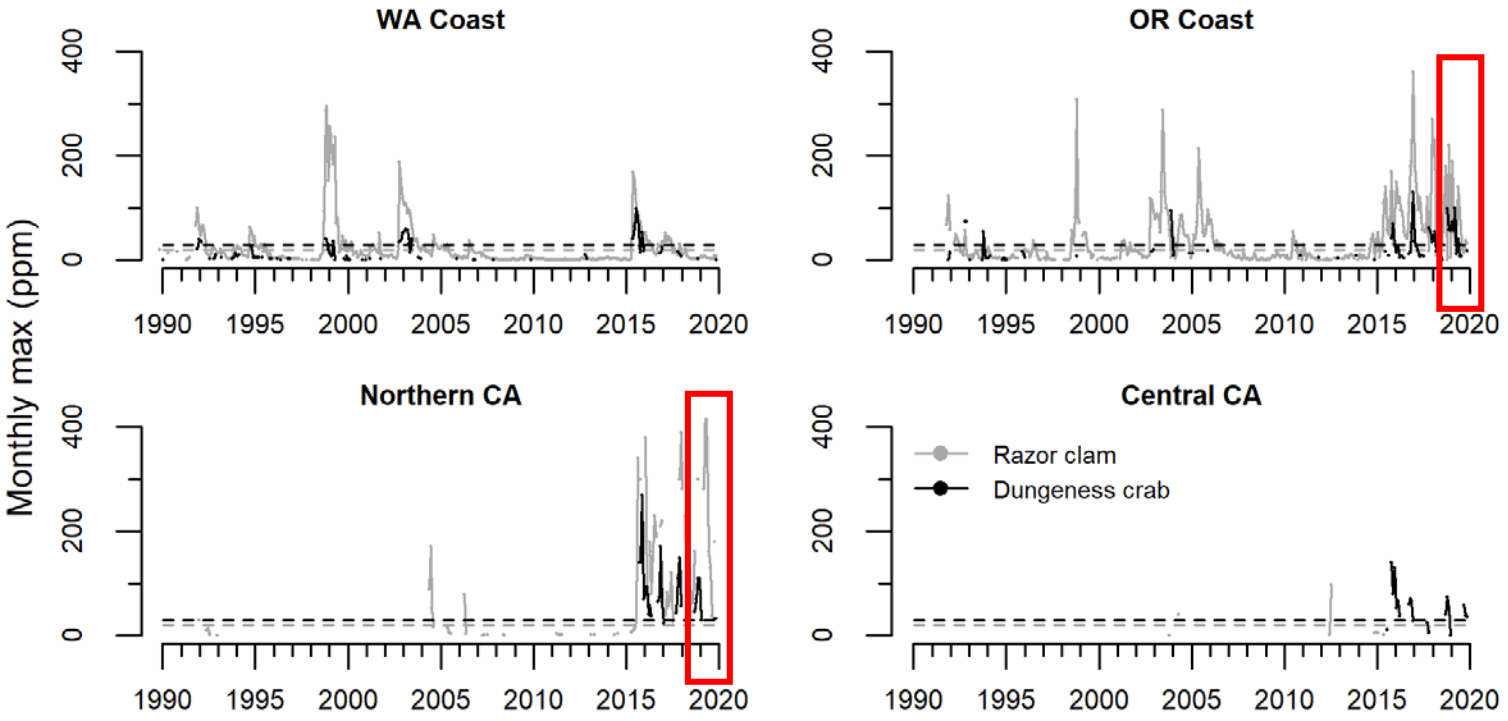
**2019 data are preliminary*
courtesy Mr. Dan Lawson, NMFS West Coast Region

- ***Whale entanglements in fishing gear were above average in 2019, though down from 2015-2018***
  - May reflect precautionary management actions
- ***Confirmed reports were widely distributed, although most were from California***
- ***Most entanglements: humpbacks***
- Most gear: unidentified
  - ID'd gear: commercial Dungeness crab, recreational Dungeness crab, commercial Rock crab, and gillnet

Harmful algal blooms

Domoic acid: toxin produced by *Pseudo-nitzschia* diatom (causes paralytic shellfish poisoning)



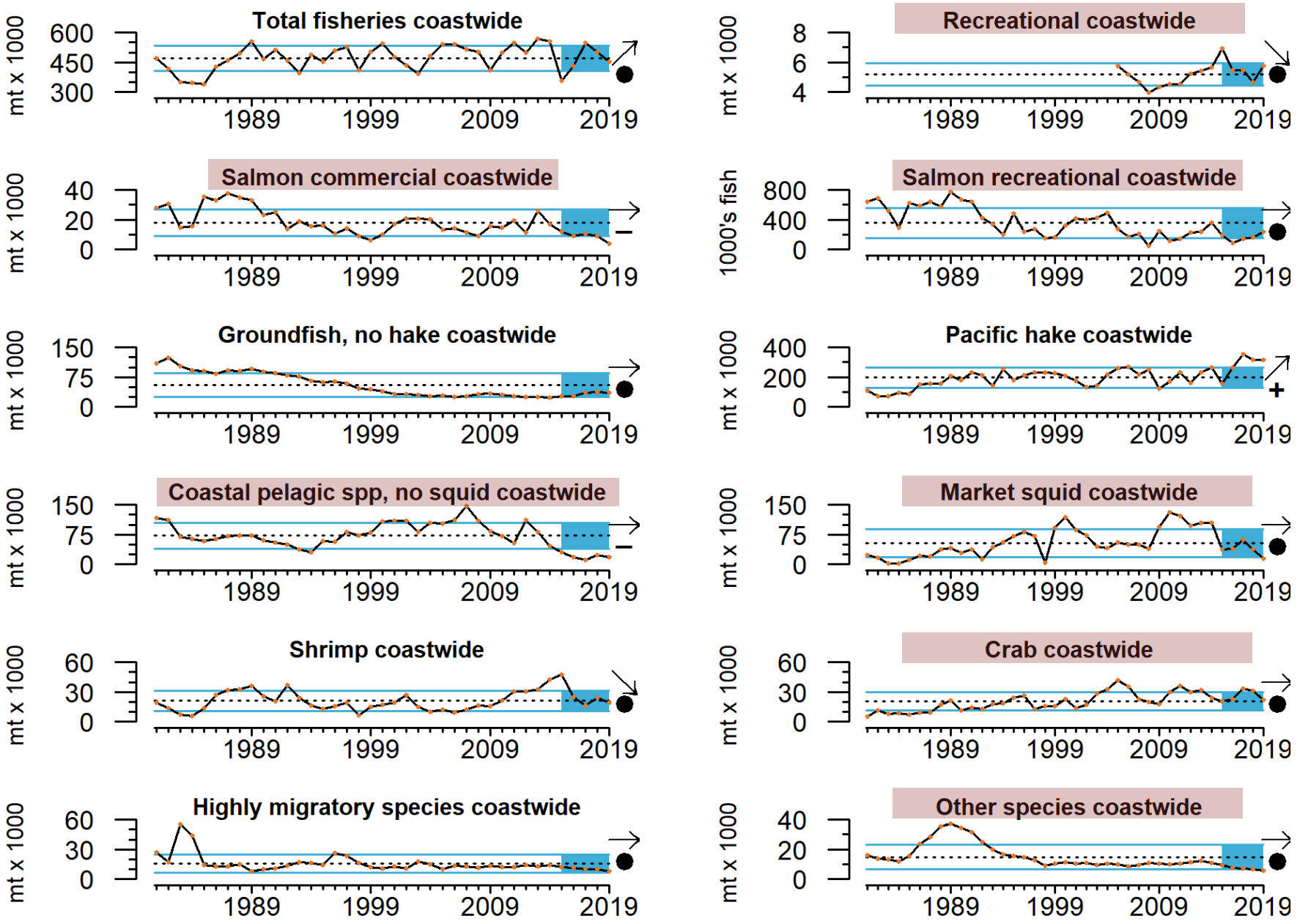


- *WA: Domoic acid below thresholds for razor clams, Dungeness crabs in 2019*
- ***OR and Northern CA: Razor clams and Dungeness crabs well above safety thresholds for much of 2019***
  - *Fishery closures and delays*
- ***Central CA: Dungeness crabs above safety thresholds in some areas***
  - *But, did not contribute to fishery delays*
- *Southern CA: no 2019 closures for rock crabs or spiny lobster (not shown)*
  - *But rock crab closed in much of N CA*

Human activities and wellbeing

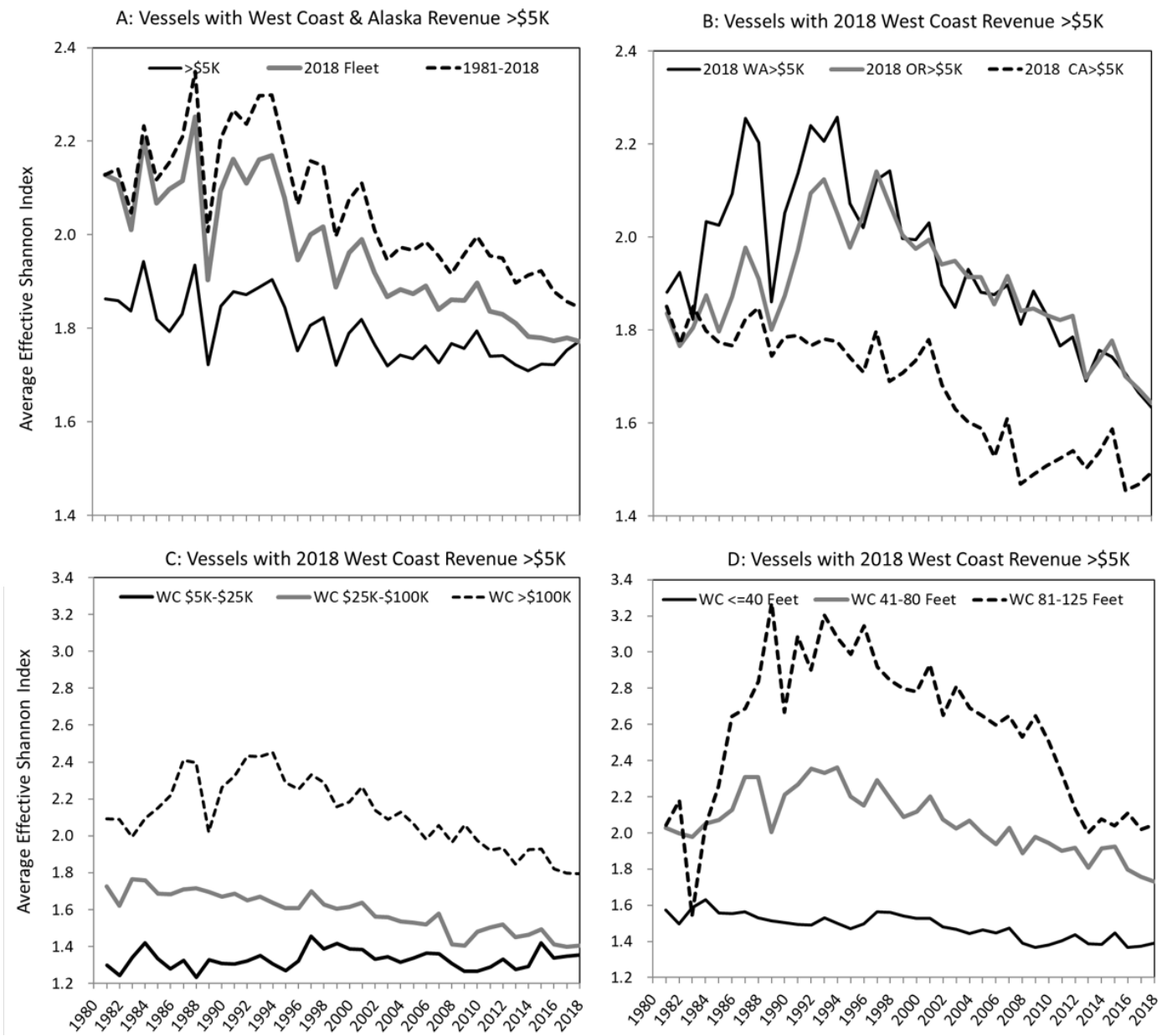
Ken Gagne

Landings through 2019*



- ***Landings & revenues decreased from 2017 to 2018***
  - In the briefing book
  - 8% decrease in landings, 7% decrease in revenue relative to 2017
- ****Preliminary data for 2019: landings appeared to decrease further***
  - due to possible drops in squid, crab, salmon
  - Hake similar to 2018
  - ***Shaded groups: probably still underreported***

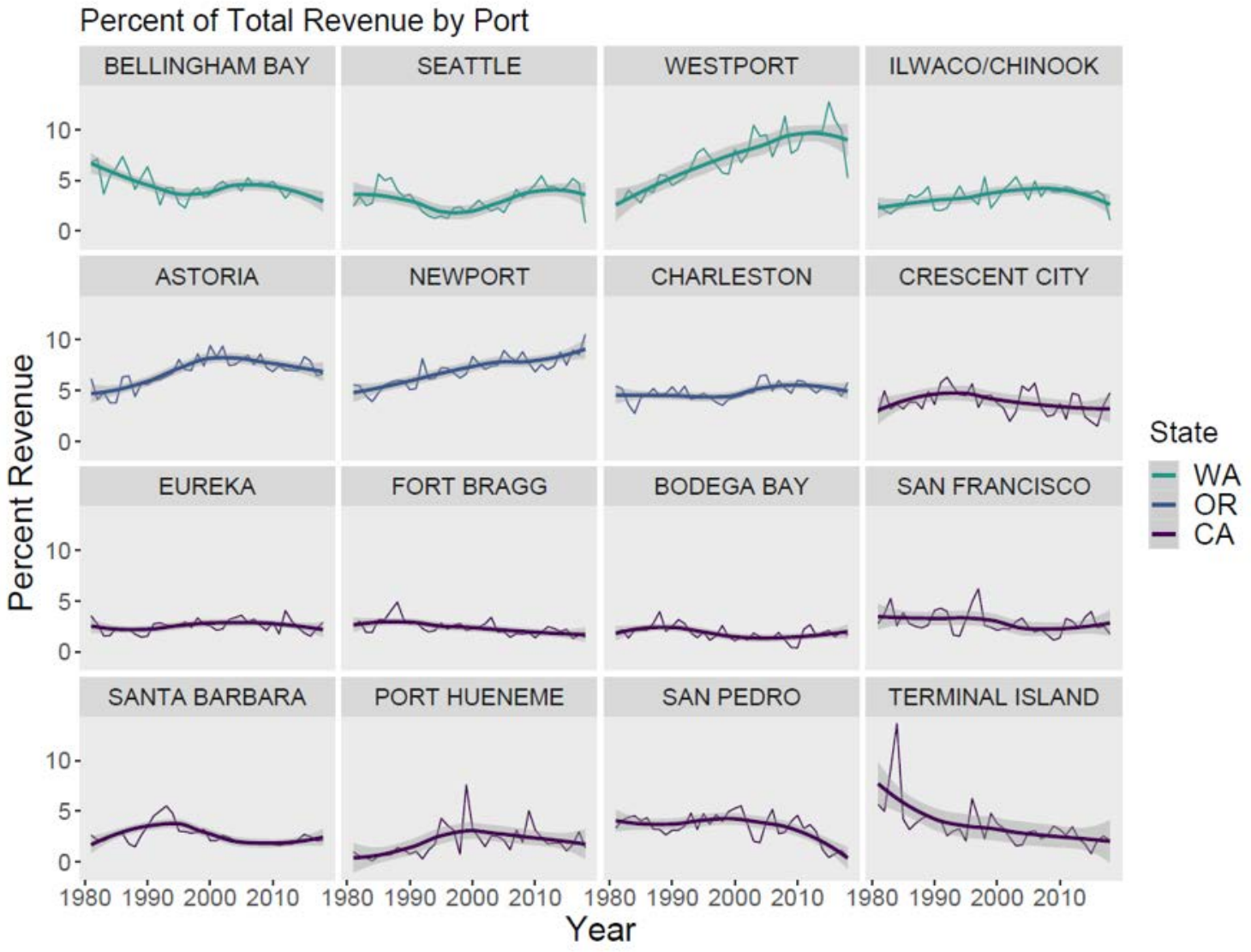
Diversity of vessel revenues still low as of 2018



- Index of how broadly and evenly revenue is spread across different fisheries
  - Lowest score is 1 = all revenue from a single fishery

- ***Diversification remains historically low across all classifications of West Coast vessels***
  - ***Size, state, total revenue***
  - ***Little change from 2017 to 2018***

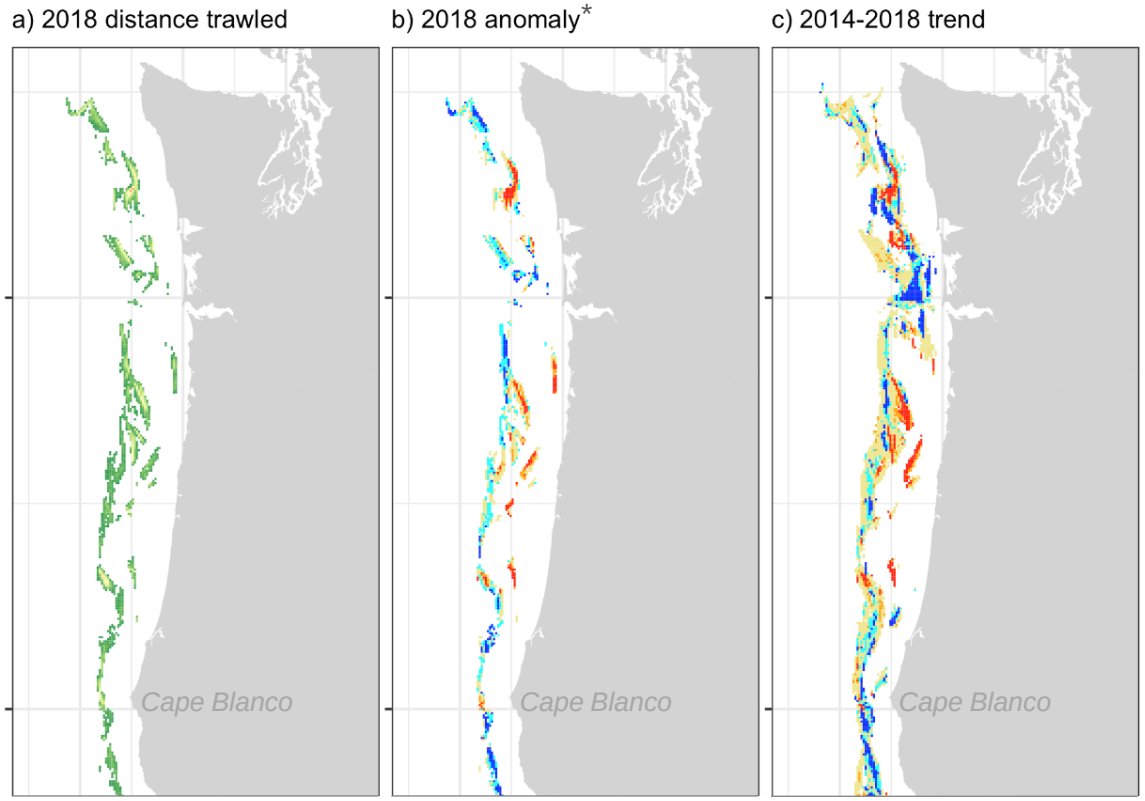
Percent of total commercial fishing revenue by port



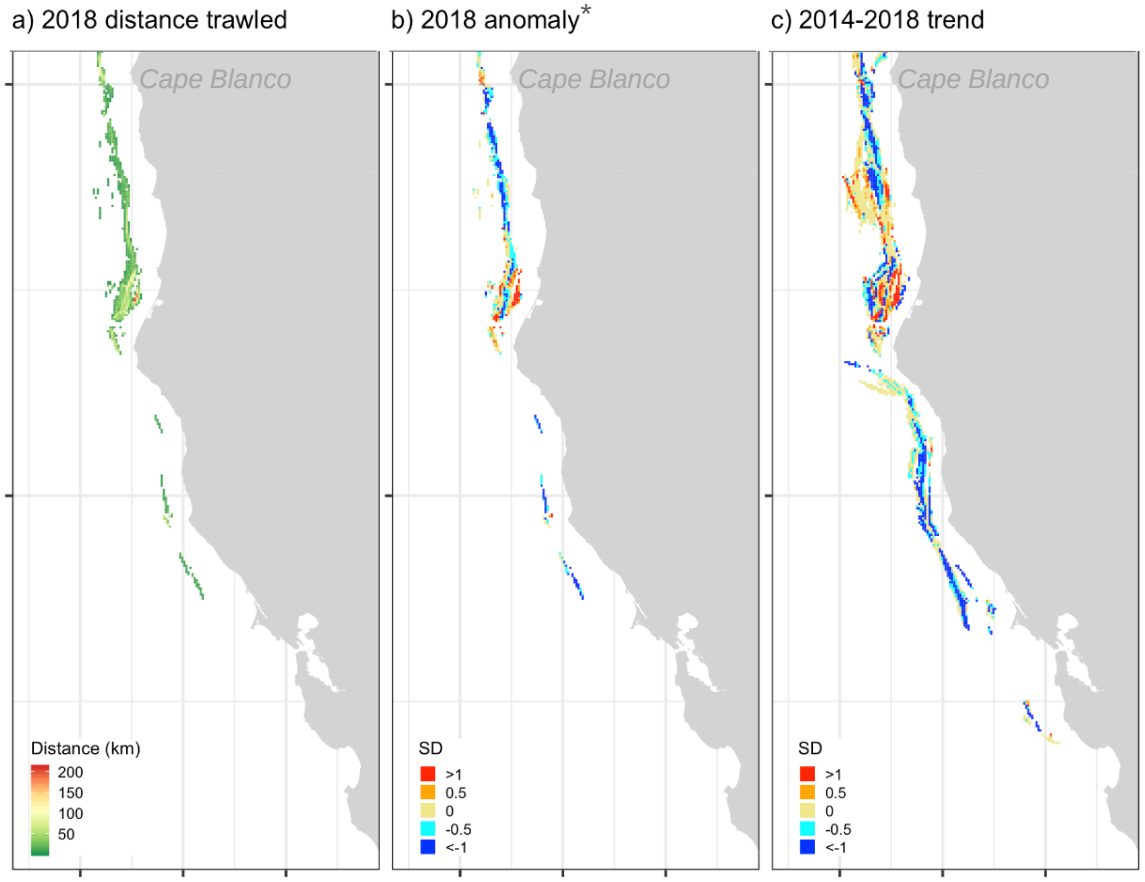
- This is a preliminary new metric for our report; possibly related to consolidation, NS-8
- % of total revenue for 16 ports most commonly in the top ranks for landed revenue since 1981
- ***Long-term increases: Westport, Newport***
- ***Long-term decreases: Bellingham, Crescent City, Fort Bragg, San Pedro, Terminal Island***
- Others: stable or variable trends

Seafloor contact by federal bottom trawl gear in 2018

- ***Above-average and increasing activity in patches off central WA, central and northern OR, north of Cape Mendocino***
- We will follow these patterns as trawl fishery regs change, and as wind power discussions continue



*anomalies relative to 2002-2018 averages




Ethan Righter

Conclusions


Steve Martarano, USFWS

Conclusions

- **Throughout most of 2019, water temperatures were warmer than normal at the surface and at depth in much of the system**
  - It is too early to attribute impacts to the marine heatwave that occurred in summer / fall
  - The system has a lot of stored heat, so we will be monitoring for heatwave reemergence

- **Despite relatively warm waters, anchovy abundance is very high, and is benefiting some but not all predators**

- **Ecological indicators were largely average/above average in much of the north and south, but there were average/below average signals in the central CCE**
  - Krill, naturally produced salmon, seabirds, pyrosomes, whale entanglement

Thank you

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Orange County Register

Matthew Savoca