Agenda Item D.1.a
Supplemental PPT
March 2016

2016 STATE OF THE CALIFORNIA CURRENT ECOSYSTEM REPORT

DELIVERED TO THE PACIFIC FISHERY MANAGEMENT COUNCIL, MARCH 9, 2016, SACRAMENTO, CA

NOAA California Current IEA Team

SUMMARY

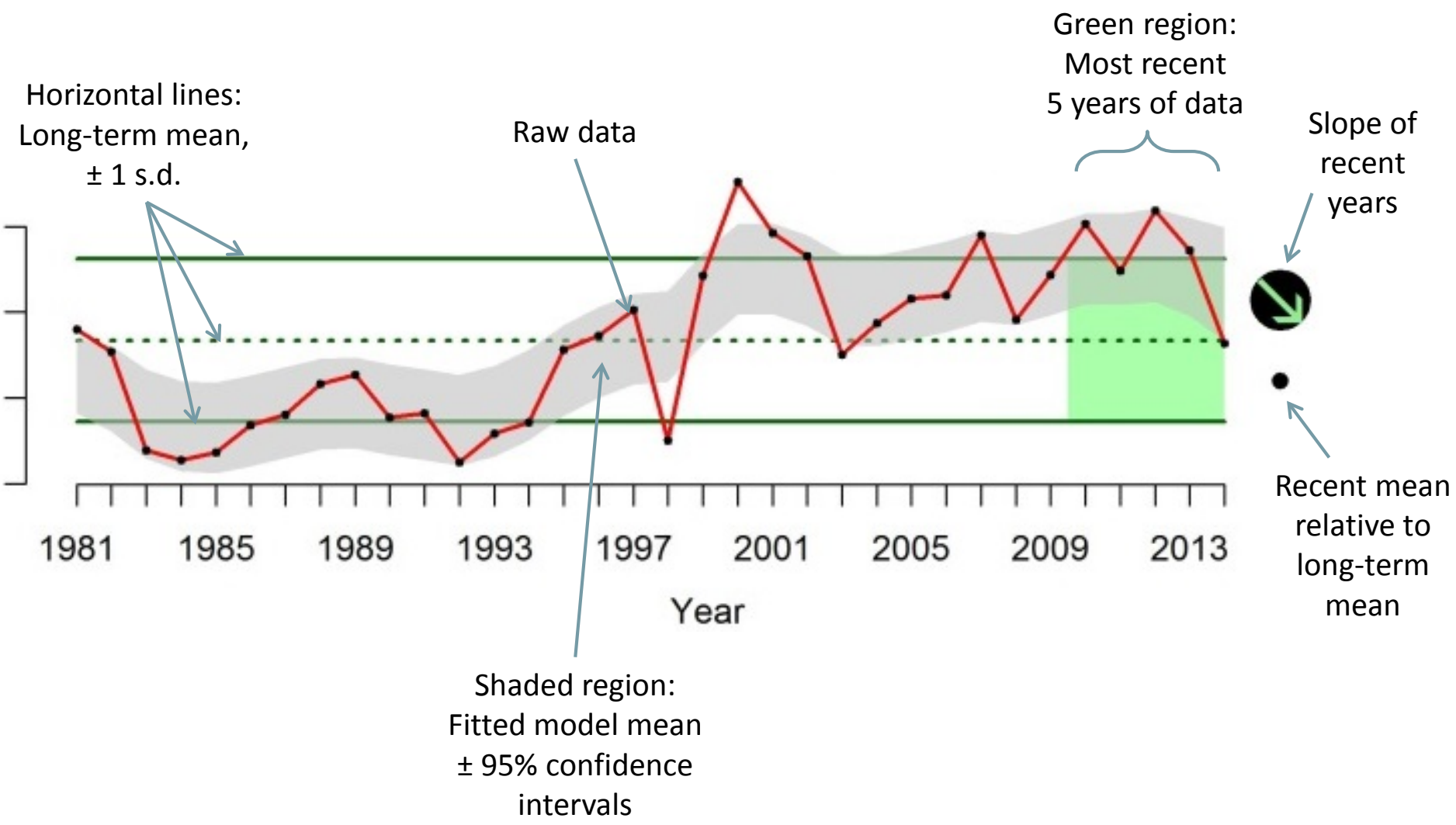
- Climate drivers continue to be a major story
  - Record-high sea surface temperature anomalies in the NE Pacific and off Baja California in 2014–2015
  - One of the largest El Niño events of the past 100 years in 2015-2016; its impacts are now reaching the West Coast
  - Oceanographic indices (MEI, PDO, NPGO) indicated warmer conditions throughout
- Ecology of the system is responding
  - Northern copepod index decreased off of Newport, indicating lower energy content for higher trophic levels
  - High-energy forage species were at low levels
  - Other forage species were patchy; juvenile rockfish and market squid were high south of Cape Mendocino

SUMMARY, CONTINUED

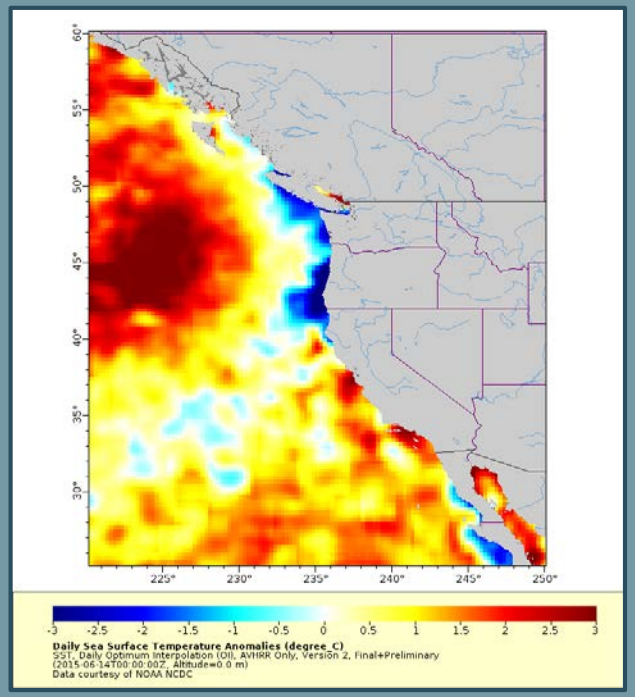
- Salmon faced drought, warm water, minimal snowpack and poor feeding conditions in 2015; snowpack in 2016 is improved but still below normal
- Unusual mortality events for California sea lions and Guadalupe fur seals
- Anomalously large, coast-wide common murre wreck

- Other indicators we are tracking
  - Salmon escapements through 2014 were generally stable or rising
  - Groundfish stocks and mortality generally in favorable status
  - Commercial fishing landings through 2014 remained high, driven mainly by landings of Pacific hake and coastal pelagic species
  - Socioeconomic vulnerability increased in fishery-dependent coastal communities from 2000 to 2010

Interpreting time series plots

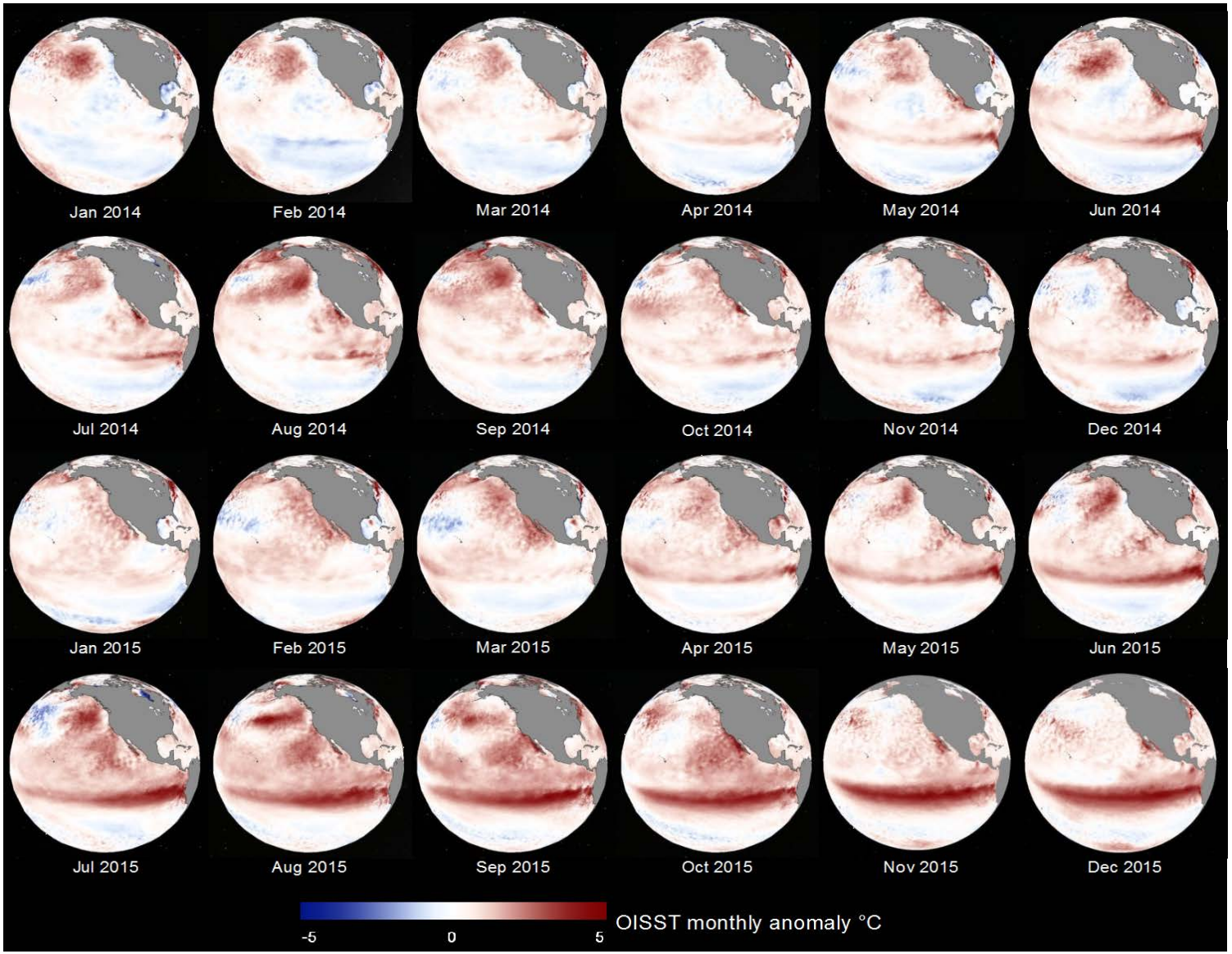


Unprecedented physical conditions: The "Warm Blob" and El Niño



Sea surface temperature anomalies, June 14, 2015 (NOAA NCDC)

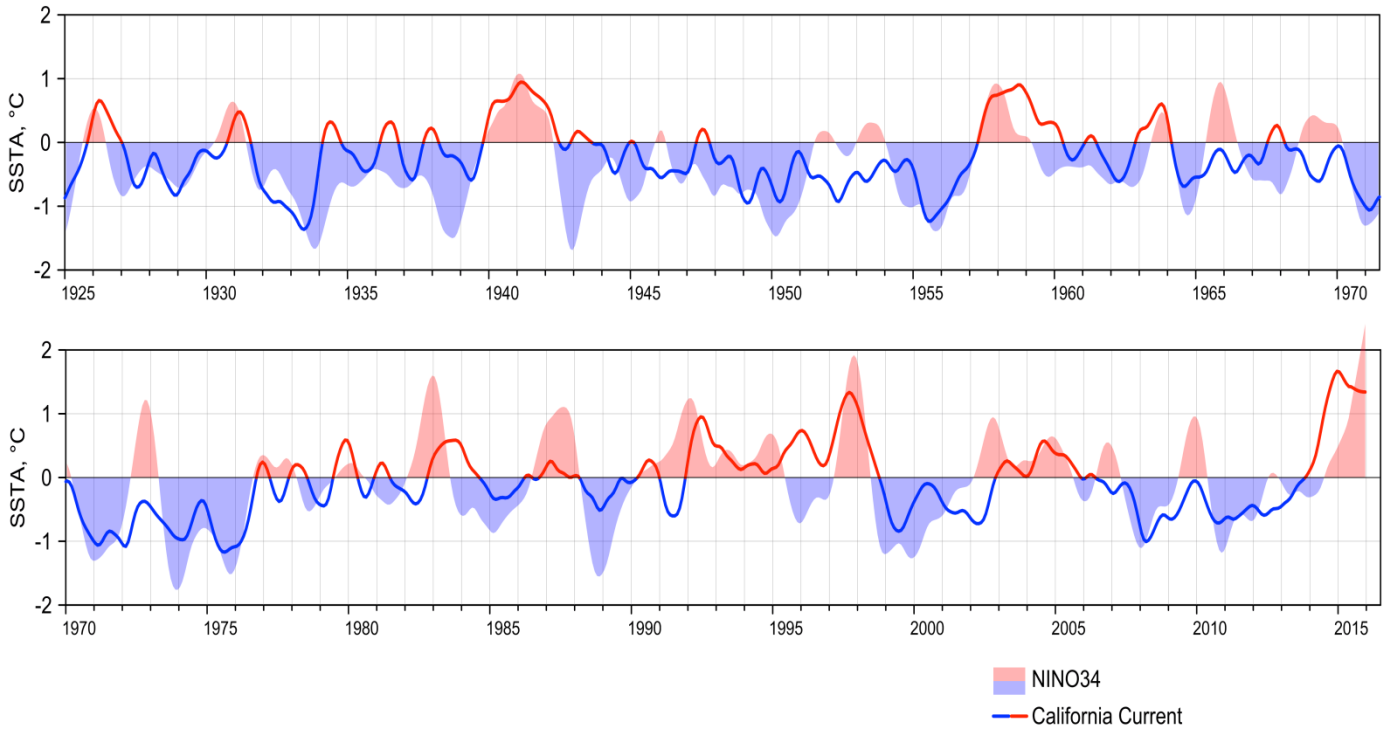
Eastern Pacific SST evolution – 2014 - 2015

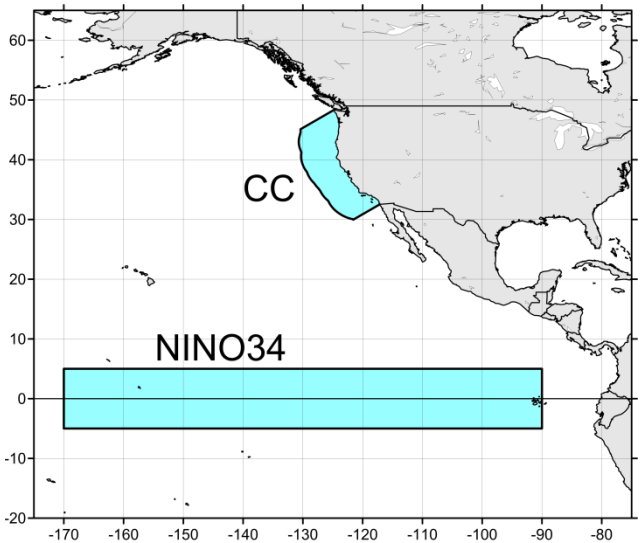


2014

2015

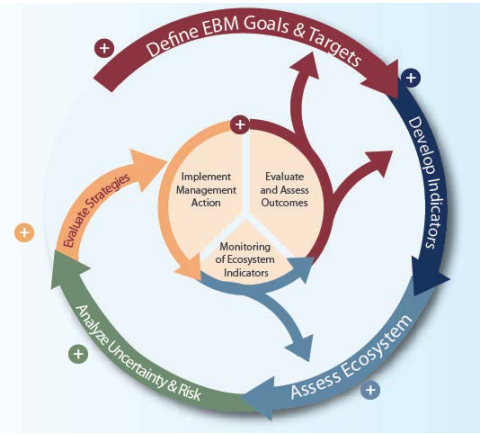
El Niños are important, but certainly not the whole story.





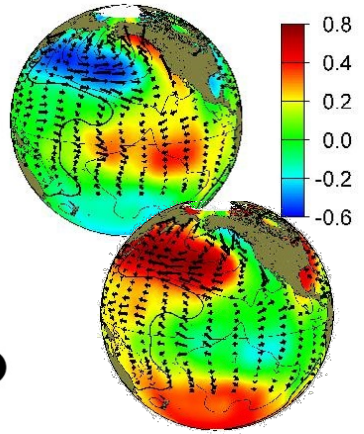
The sea surface temperature average in the California Current isn't directly coupled to El Niño. North Pacific Atmospheric conditions dominate.

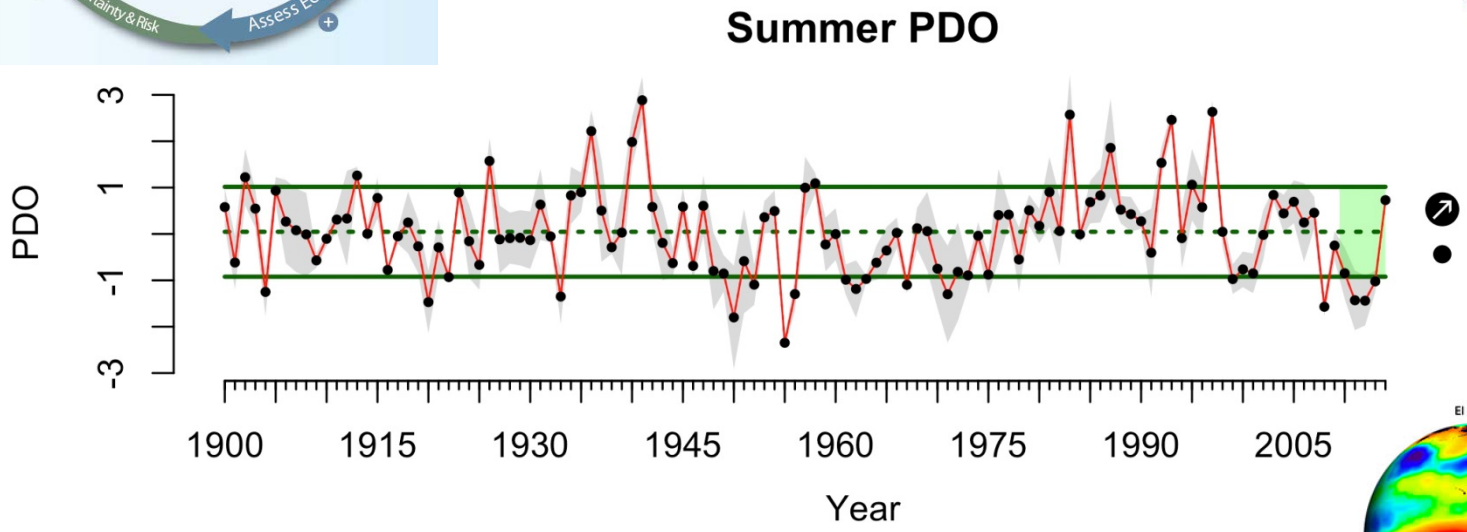
Figure from Fiedler & Mantua 2016

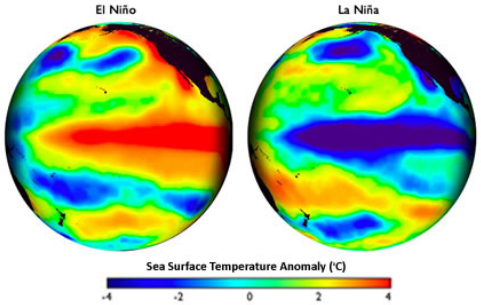


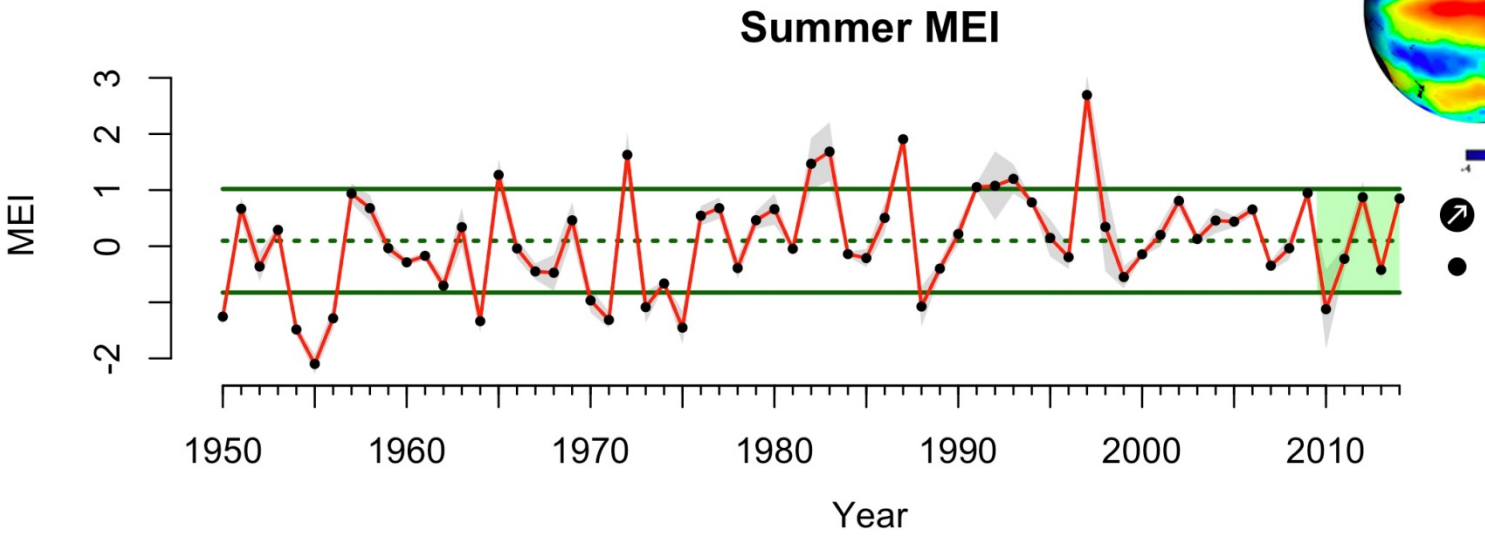
BASIN SCALE INDICATORS

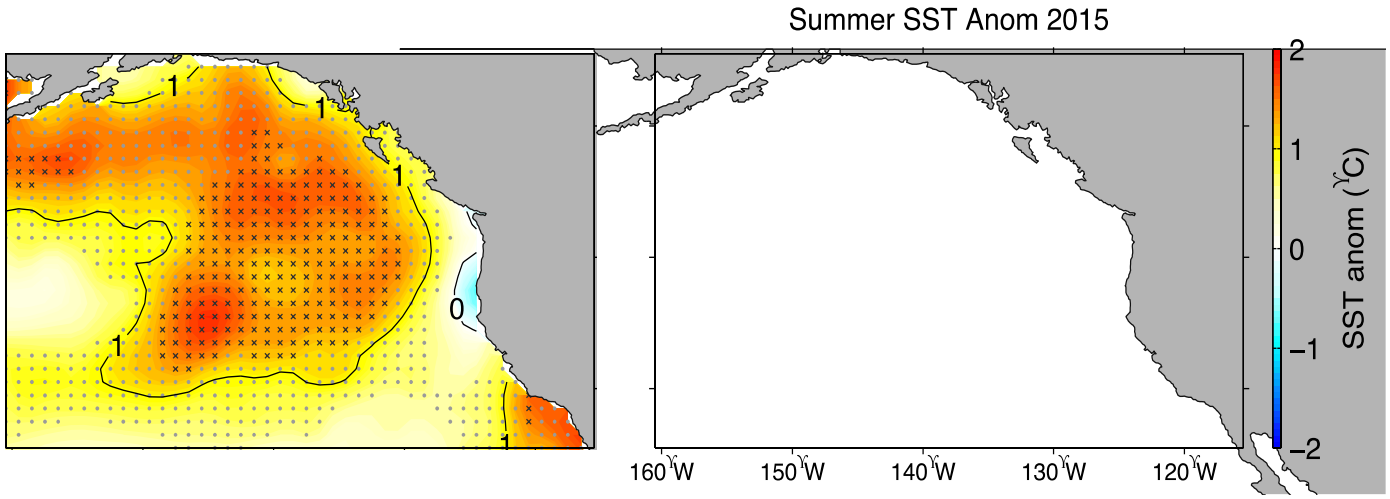
Pacific Decadal Oscillation (PDO) and Multivariate ENSO Index (MEI)

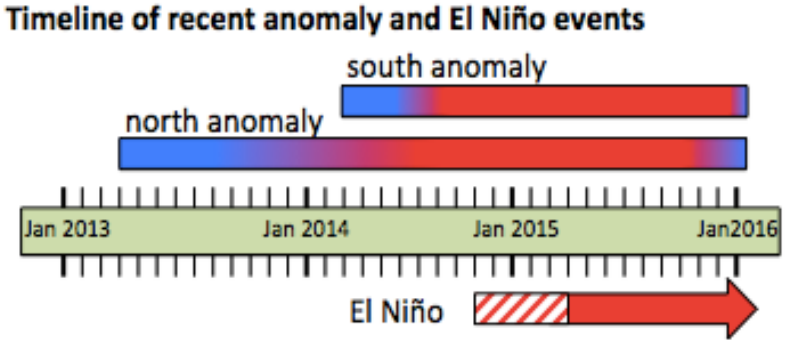


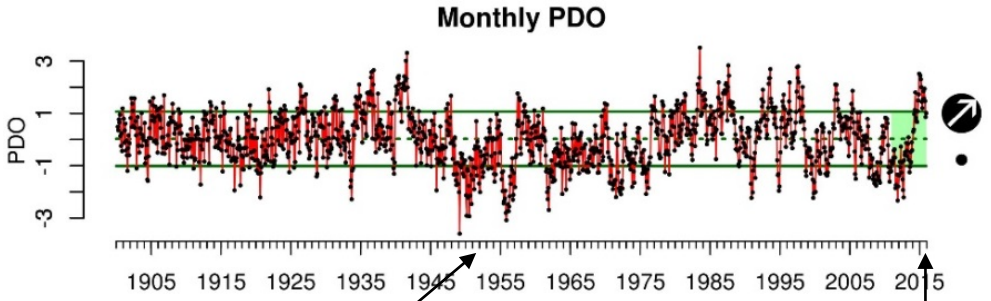


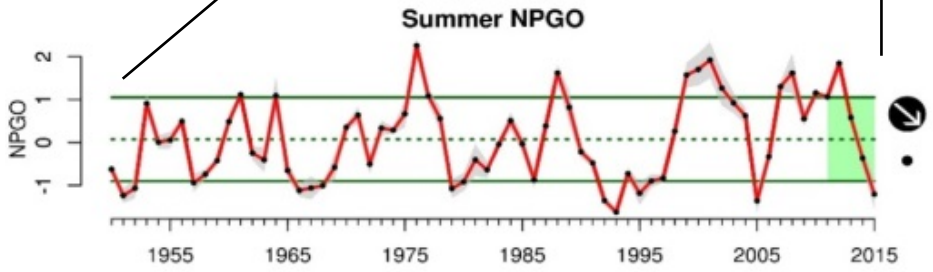




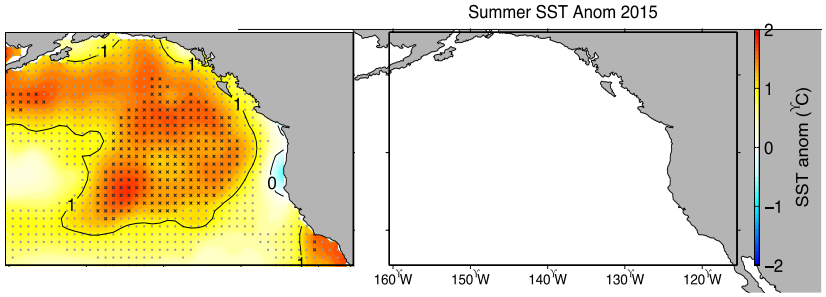

Summer SST Anom 2015
SST anom (°C)
2
1
0
−1
−2
160°W
150°W
140°W
130°W
120°W

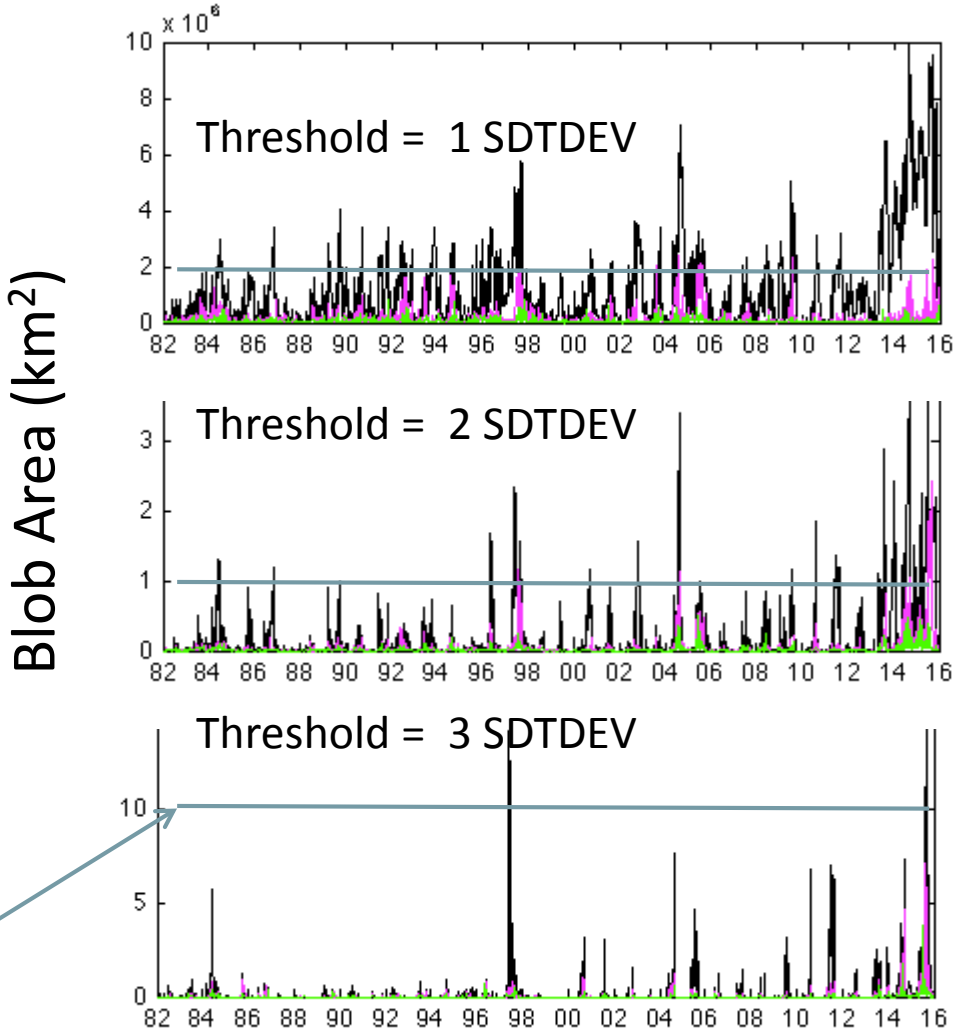

Timeline of recent anomaly and El Niño events
south anomaly
north anomaly
Jan 2013
Jan 2014
Jan 2015
Jan2016
El Niño


Monthly PDO
PDO
3
1
-1
-3
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015


Summer NPGO
NPGO
2
1
0
-1
1955
1965
1975
1985
1995
2005
2015

Blob “areas” vs Time



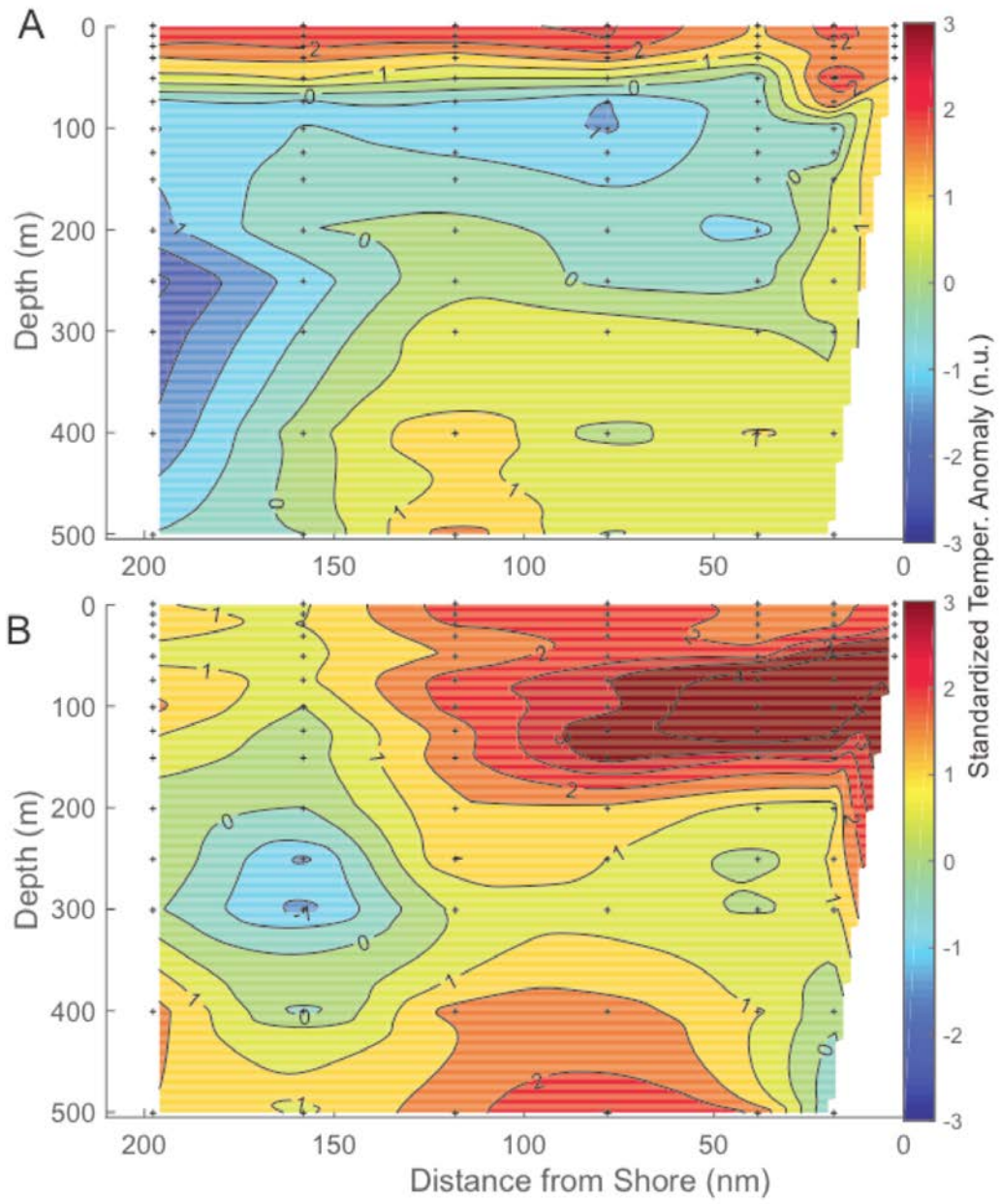


Calculated blob size depends on the threshold

Colored lines show the three largest blobs from any timepoint

Blue Line = Area of Alaska

Figure 38

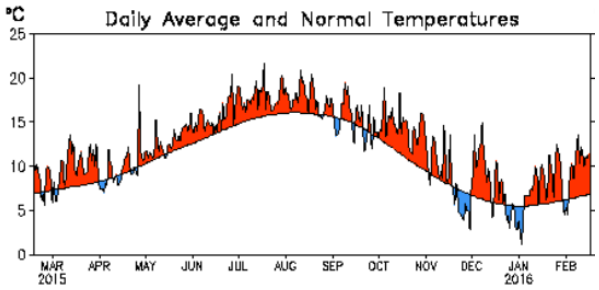


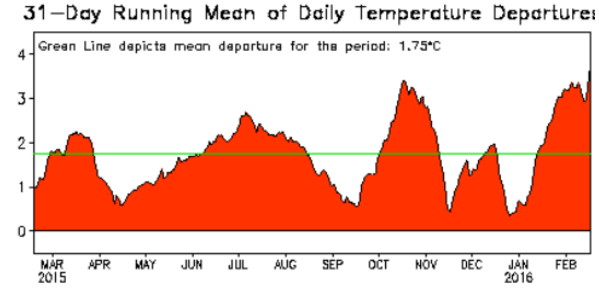
Warm Blob ≠ El Niño

2014 Southern California warming

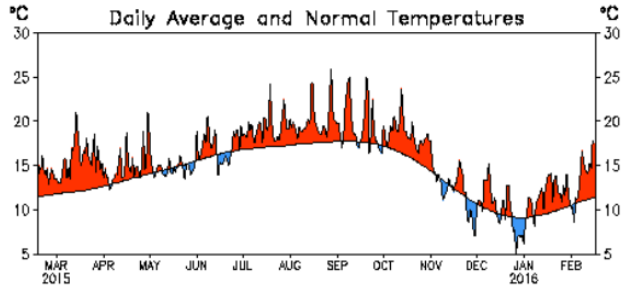
1998 El Niño

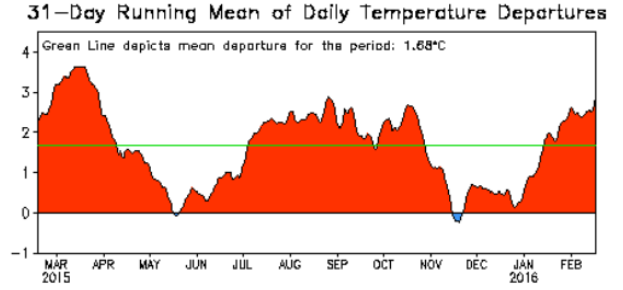
ASTORIA, OREGON



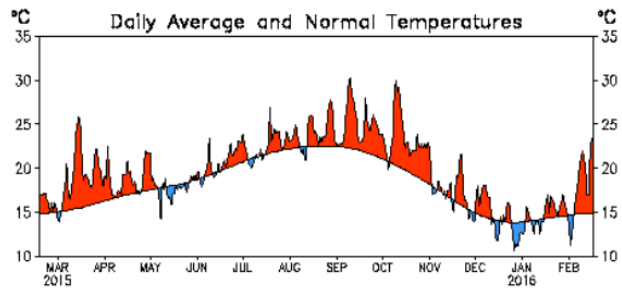


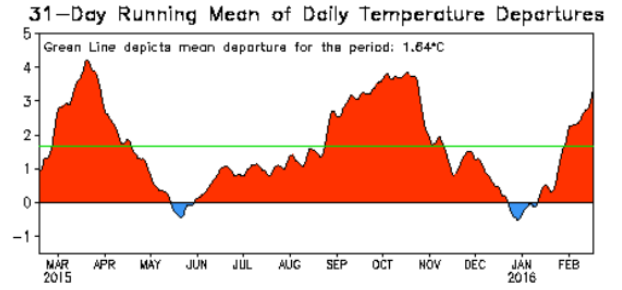
SAN FRANCISCO, CALIFORNIA

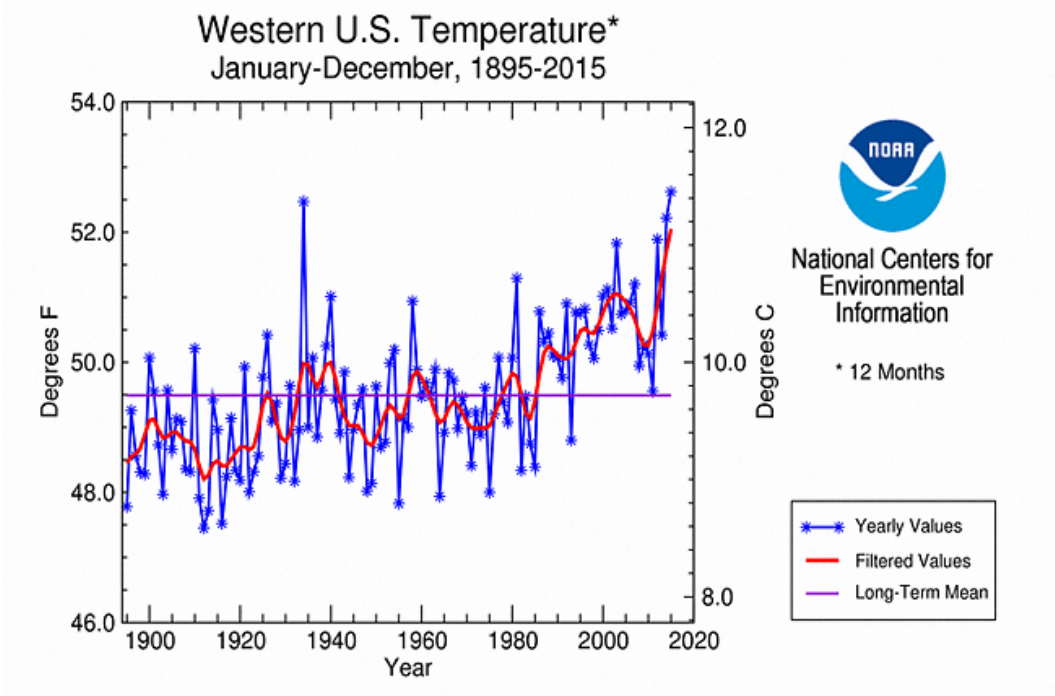


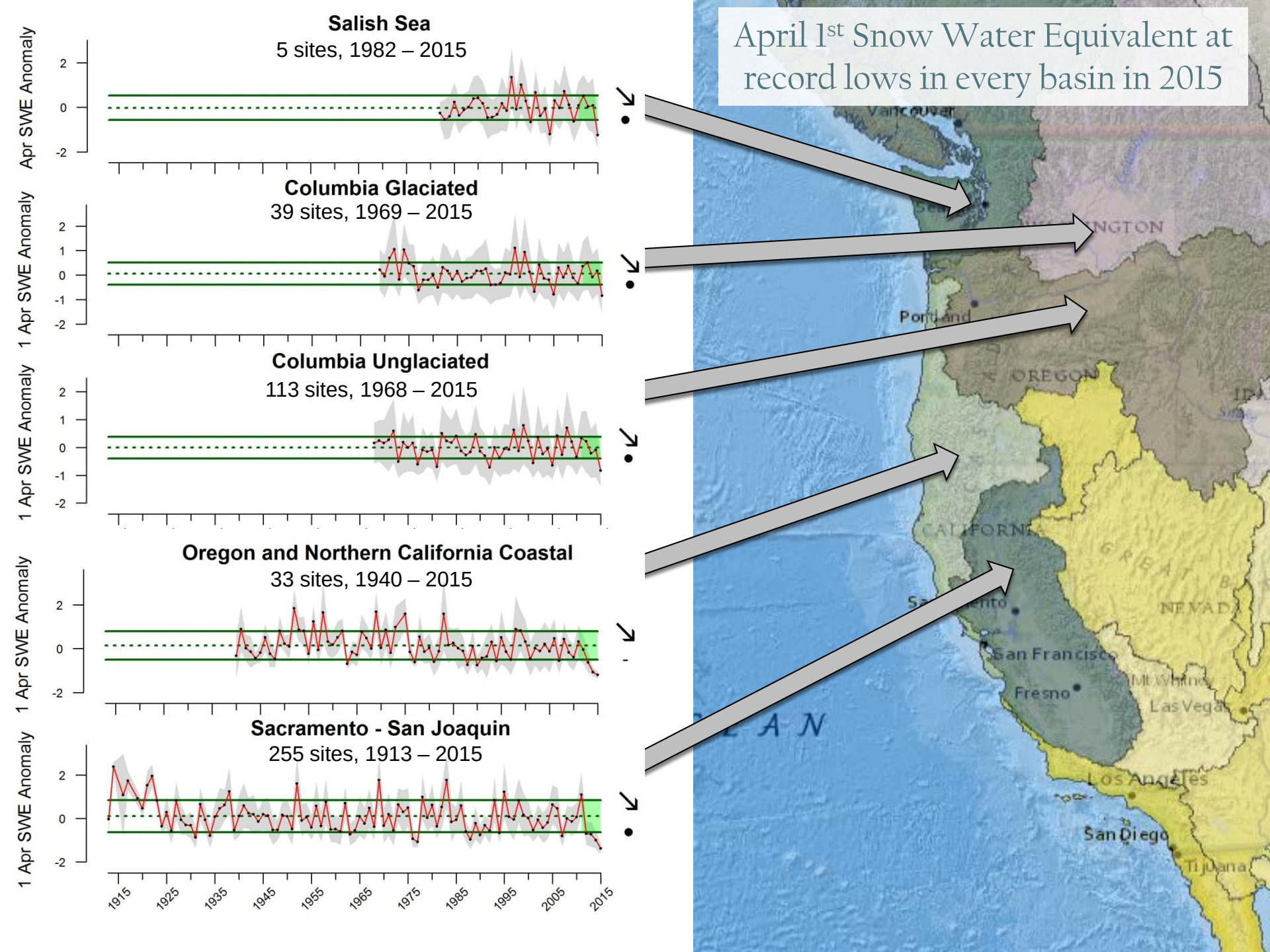


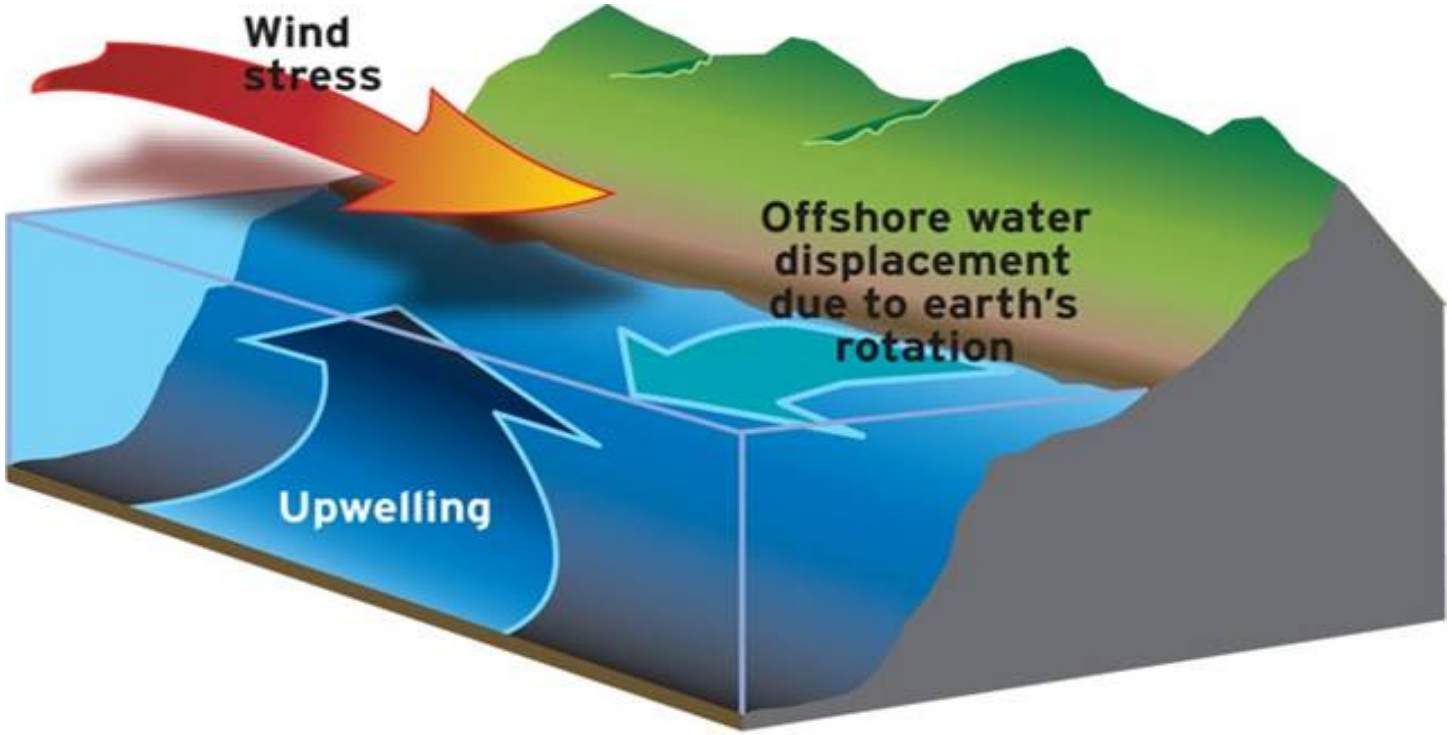
SAN DIEGO/LINDBERGH, CALIFORNIA








Salish Sea
5 sites, 1982 – 2015
Columbia Glaciated
39 sites, 1969 – 2015
Columbia Unglaciated
113 sites, 1968 – 2015
Oregon and Northern California Coastal
33 sites, 1940 – 2015
Sacramento - San Joaquin
255 sites, 1913 – 2015
1 Apr SWE Anomaly
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
April 1st Snow Water Equivalent at record lows in every basin in 2015
Vancouver
Portland
OREGON
San Francisco
Fresno
Las Vegas
Los Angeles
San Diego
Tijuana



Wind driven coastal upwelling
(From http://www/nwfsc.noaa.gov)

WESTERN REGIONAL ACTION PLAN (WRAP): PART OF THE NMFS CLIMATE SCIENCE STRATEGY

Last March Jason Link presented the NMFS Climate Science Strategy to the Council.

The two Science Centers and the Regional Office have developed a draft Western Regional Action Plan that is almost ready for public comment.

The West Coast NMFS WRAP draft is being submitted as an Informational Report for the April briefing book.

The recent climate anomalies have provided a natural “stress test” of potential climate change in the CCLME.

This year both Centers will undergo a review of ecosystem science. The WRAP and our efforts with the Council FEP will be review components.

Unprecedented physical conditions: Ecological responses

Joe Orsi and friend, off SE Alaska, June 2015 (NOAA AFSC)

Northern copepod biomass anomaly

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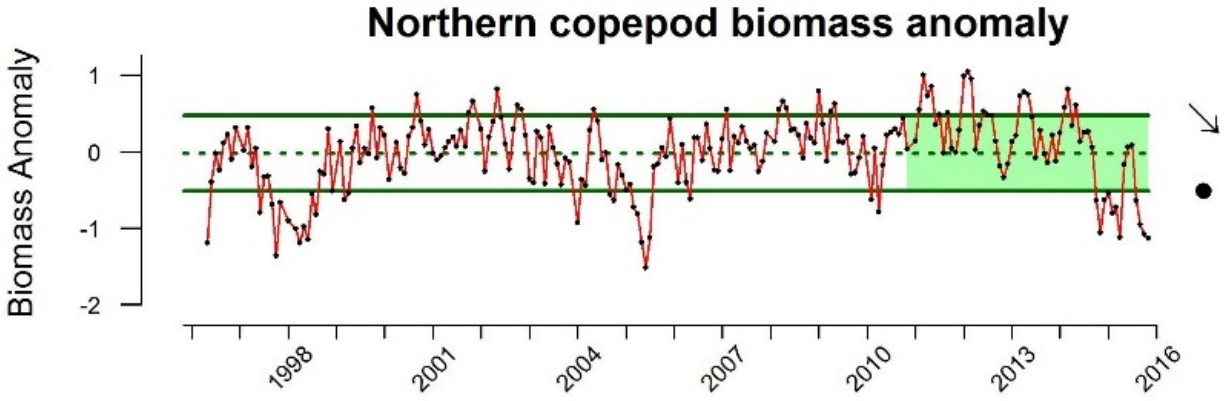

- **"Northern" copepods are cool-water species and rich in lipids that support fish production**
- **Off Newport, OR: Northern copepods abundant, 2011-2014**
- **Major shift in late 2014, continued in 2015; less-fatty "Southern" copepods now dominant**

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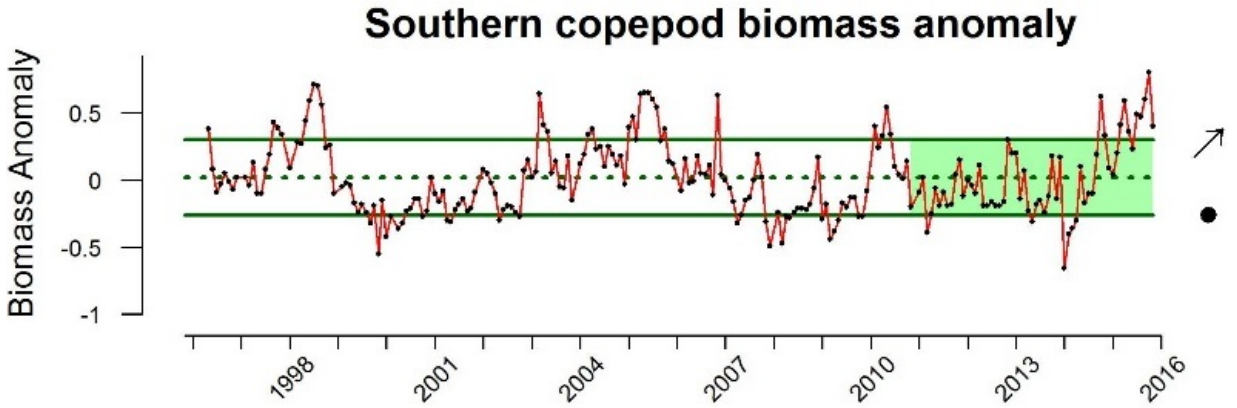

Northern copepod biomass anomaly

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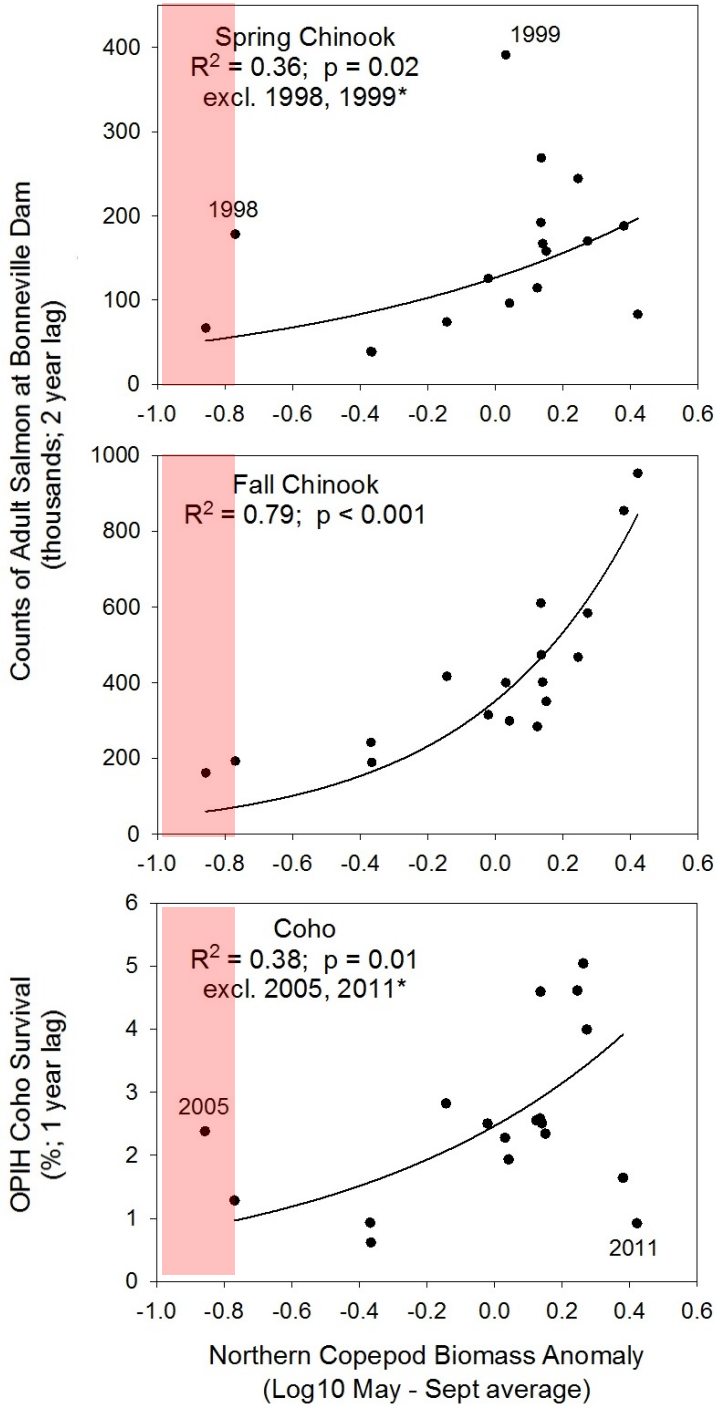
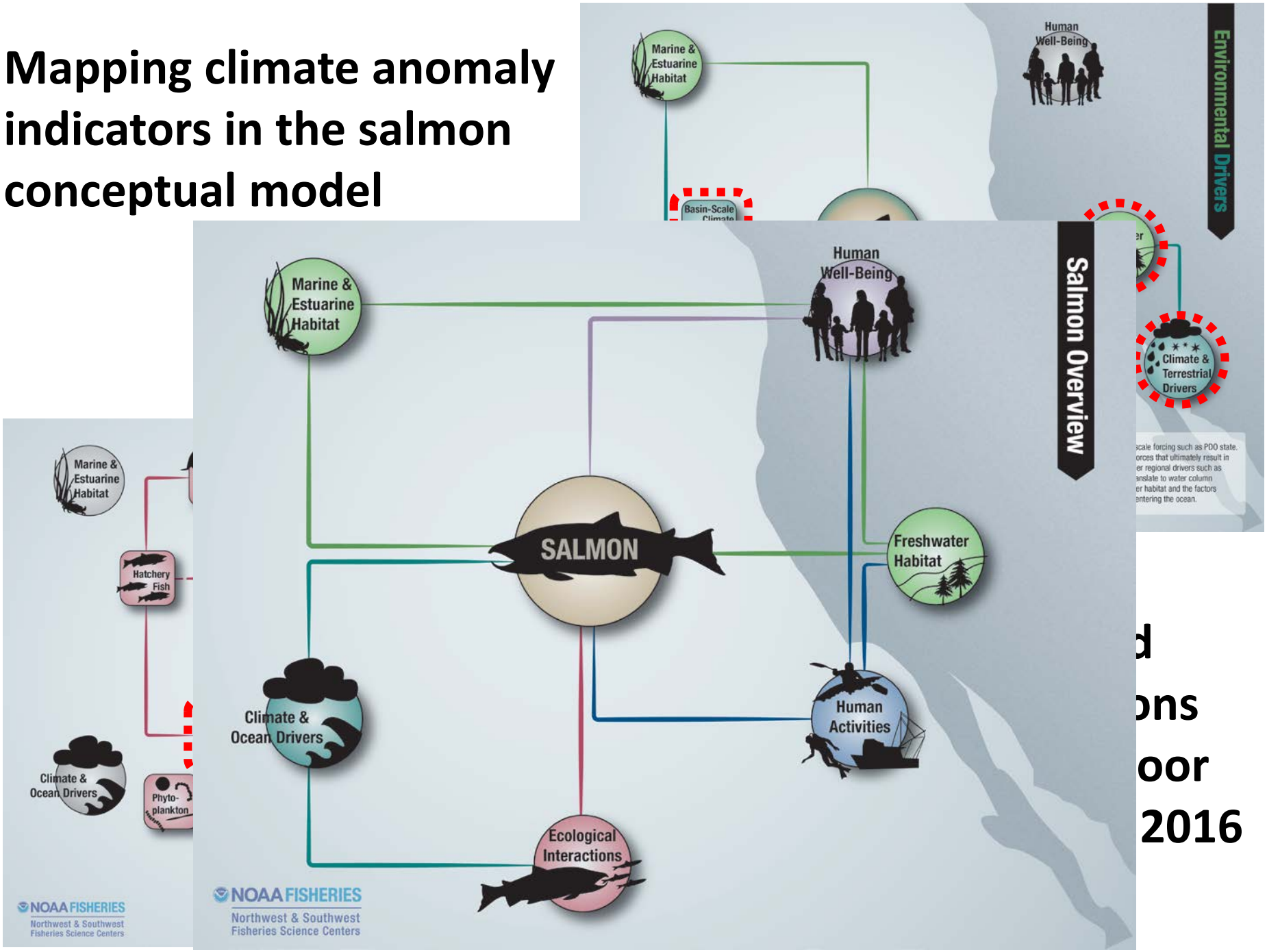
- **Value of indicator is its relationship to fish production off Newport area, particularly salmon**

- **Examples: correlation between Northern copepod anomaly and salmon returns to Bonneville Dam (*data from Bill Peterson, NOAA*)**



Mapping climate anomaly indicators in the salmon conceptual model



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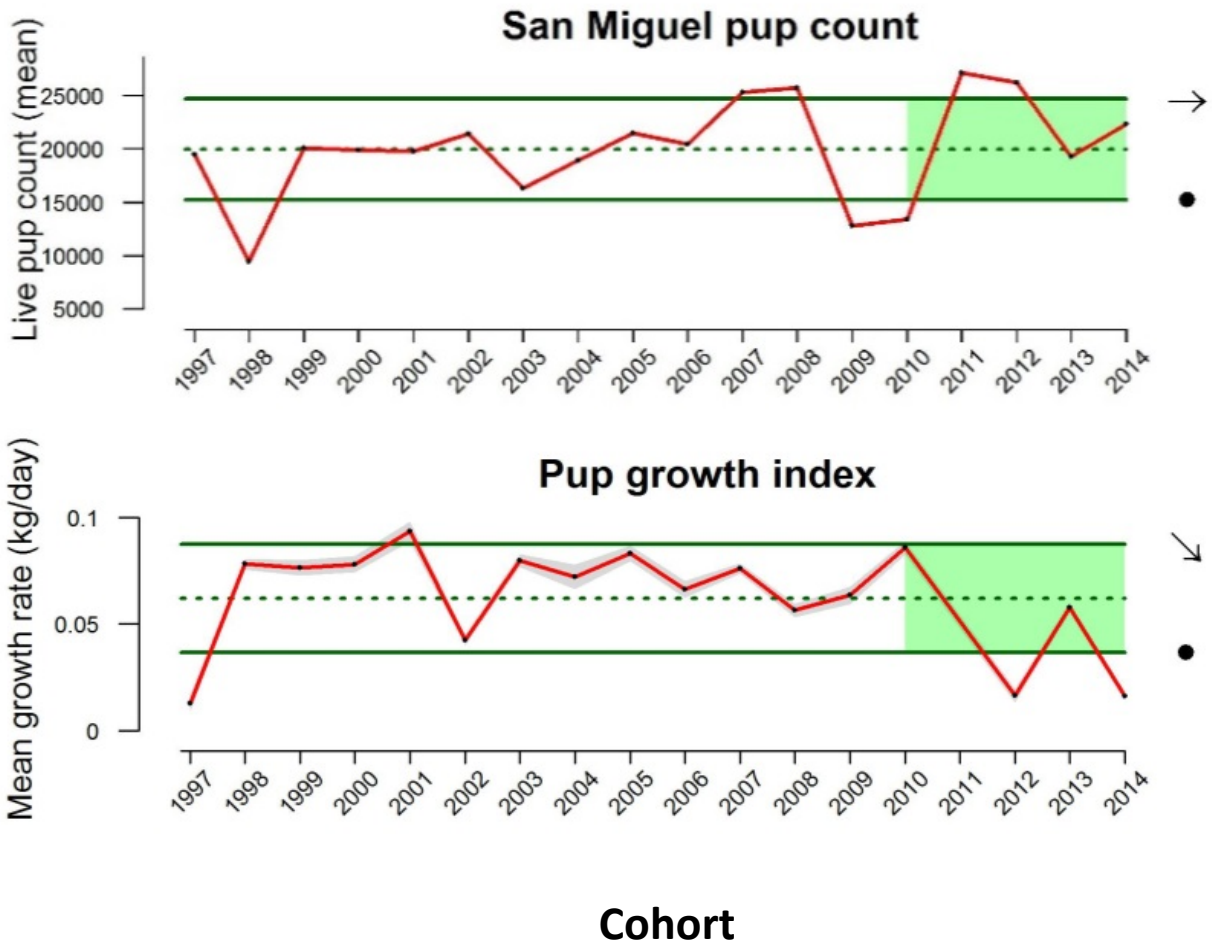
2016

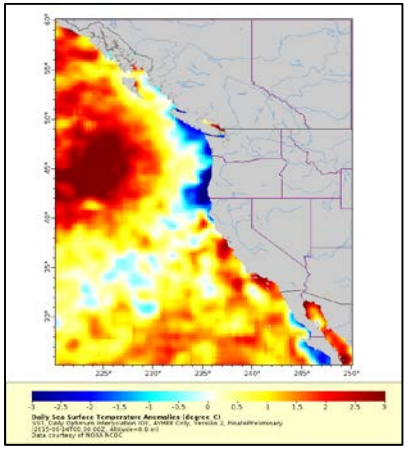
Top predators suffered due to poor foraging conditions

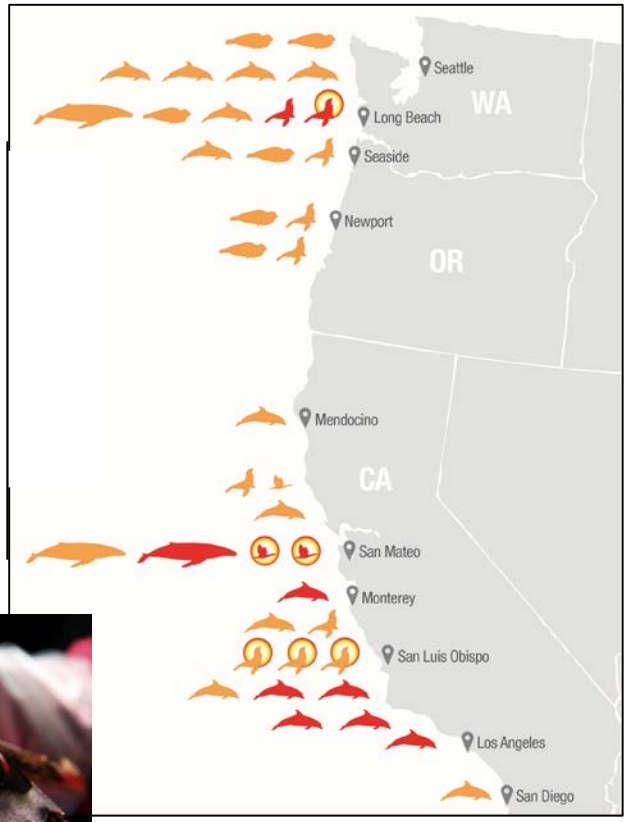
- California sea lions again experienced unusual mortality event (UME)
- 2014 pup cohort had very poor growth from fall 2014 to early 2015
- Reflects poor foraging conditions for mothers
- UME also occurred for Guadalupe fur seals, which feed further offshore
- Also apparent die-off of abundant piscivorous seabird, common murres



Other anomalies in 2015 (Warm Blob)

- Massive coastwide harmful algal bloom (HAB), leading to domoic acid toxicity
- Mass pre-spawn mortalities of sockeye salmon in Columbia River, due to high river temperatures
- Record numbers of baleen whales entangled in nearshore crab gear
- Large numbers of juvenile loggerhead turtles in Southern California Bight





What's in store for 2016? (El Niño arriving, remnants of Blob)

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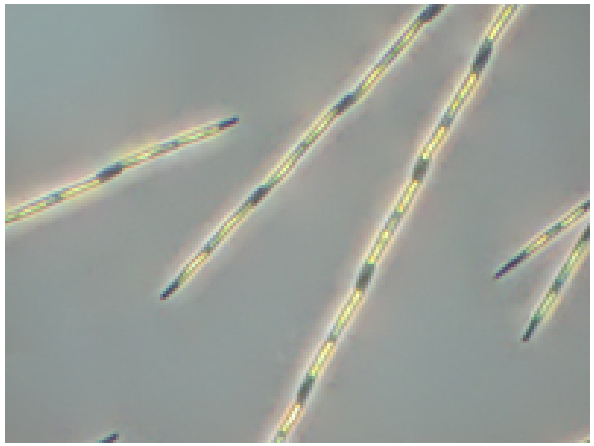
- Off Newport: still seeing Warm Blob copepods; already observing the HAB diatom *Pseudo-nitzschia*



- Krill species consistent with El Niño appearing off N. California
- Returns of Chinook and coho salmon expected to be below average
- El Niño years often produce poor year classes of groundfish

- Early findings for 2015 cohort of California sea lions: very poor growth; expecting fewer pups in 2016 cohort

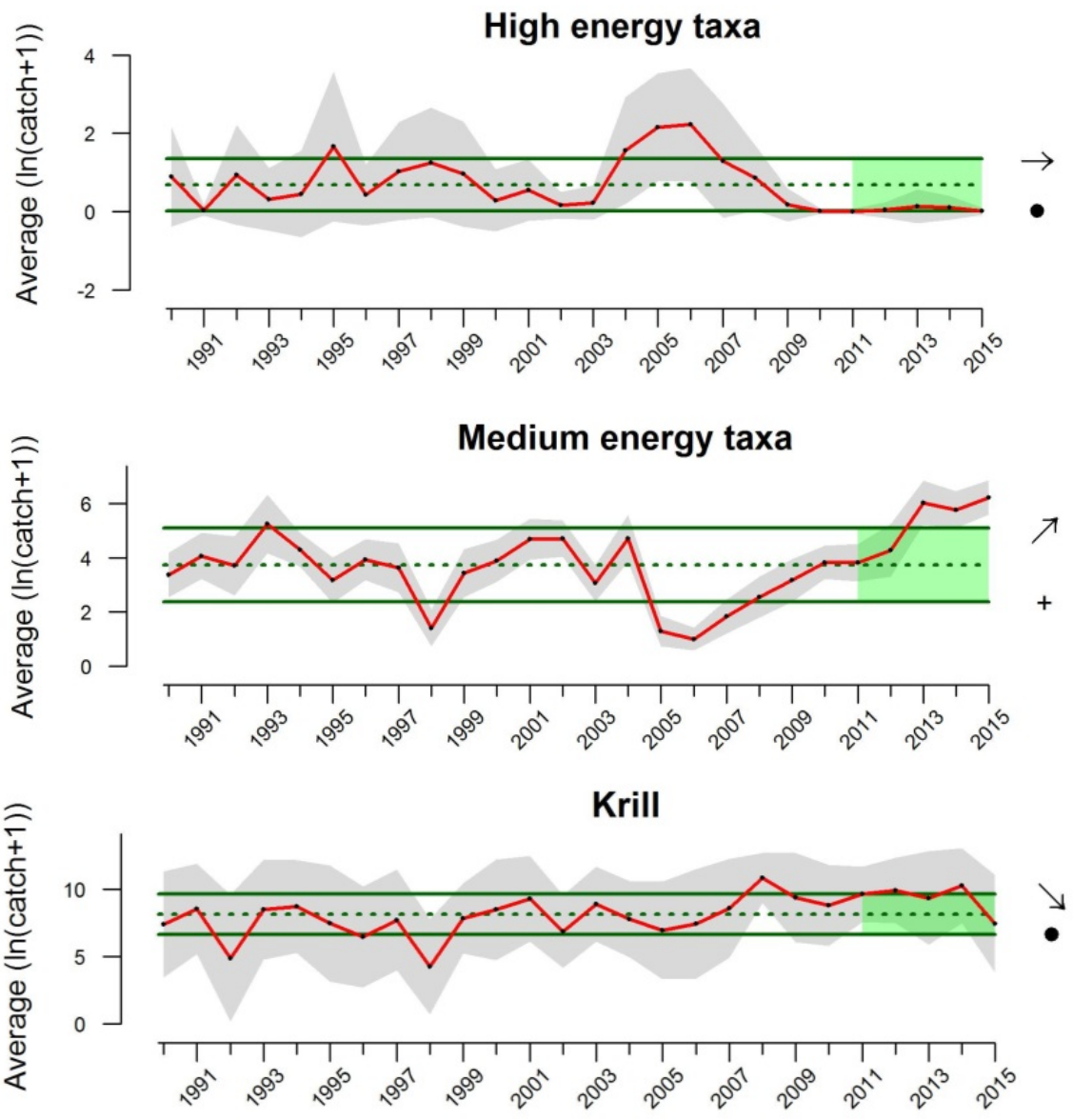
Other indicators of ecological integrity

Yellowtail and canary rockfishes over sponges (NOAA)

Forage availability

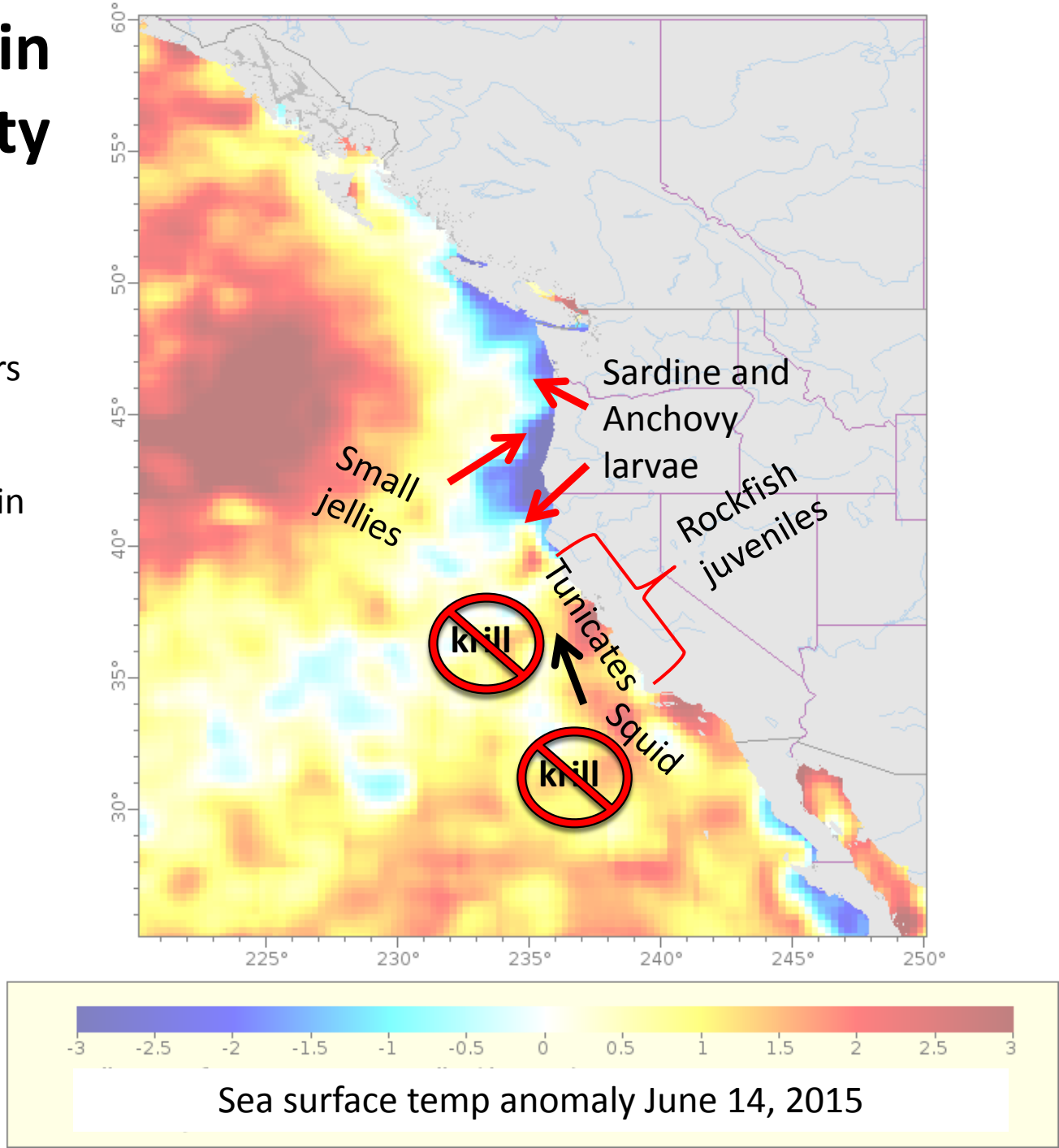
- High-energy forage very low, though lots of larval sardines and anchovy
- Medium-energy forage very high, esp. rockfish and squid
- Krill declining
- Also, patchy large catches of low-energy taxa (salps, jellies, swimming crabs)

Central California Current



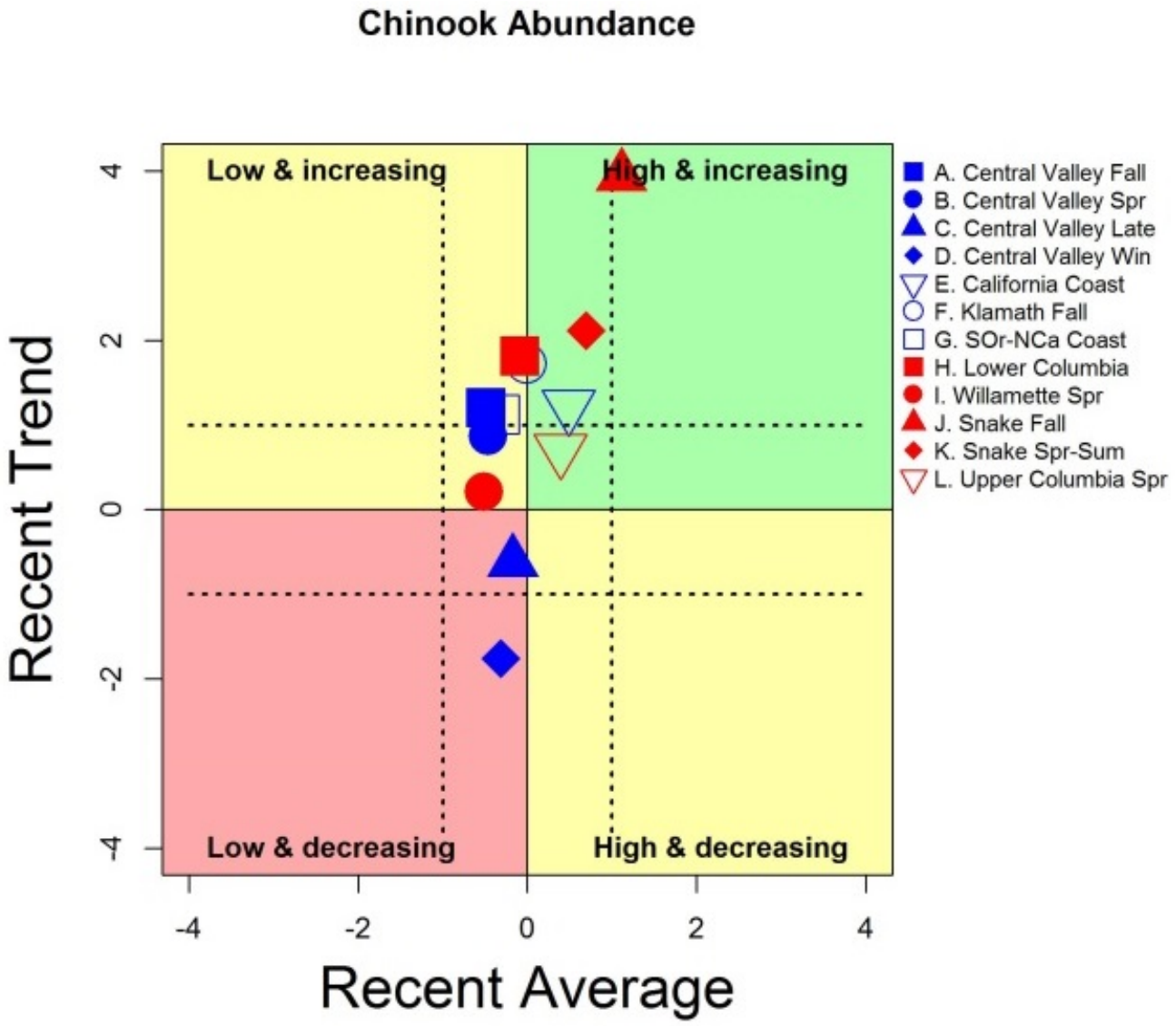
Spatial changes in forage availability

- Phytoplankton was patchy and lower than previous years
- Sardine and Anchovy went north; larvae very abundant in some areas
- Market squid shifted north
- Krill decreased
- Rockfish juveniles catches very high along central coast
- Relatively poor forage availability in southern area



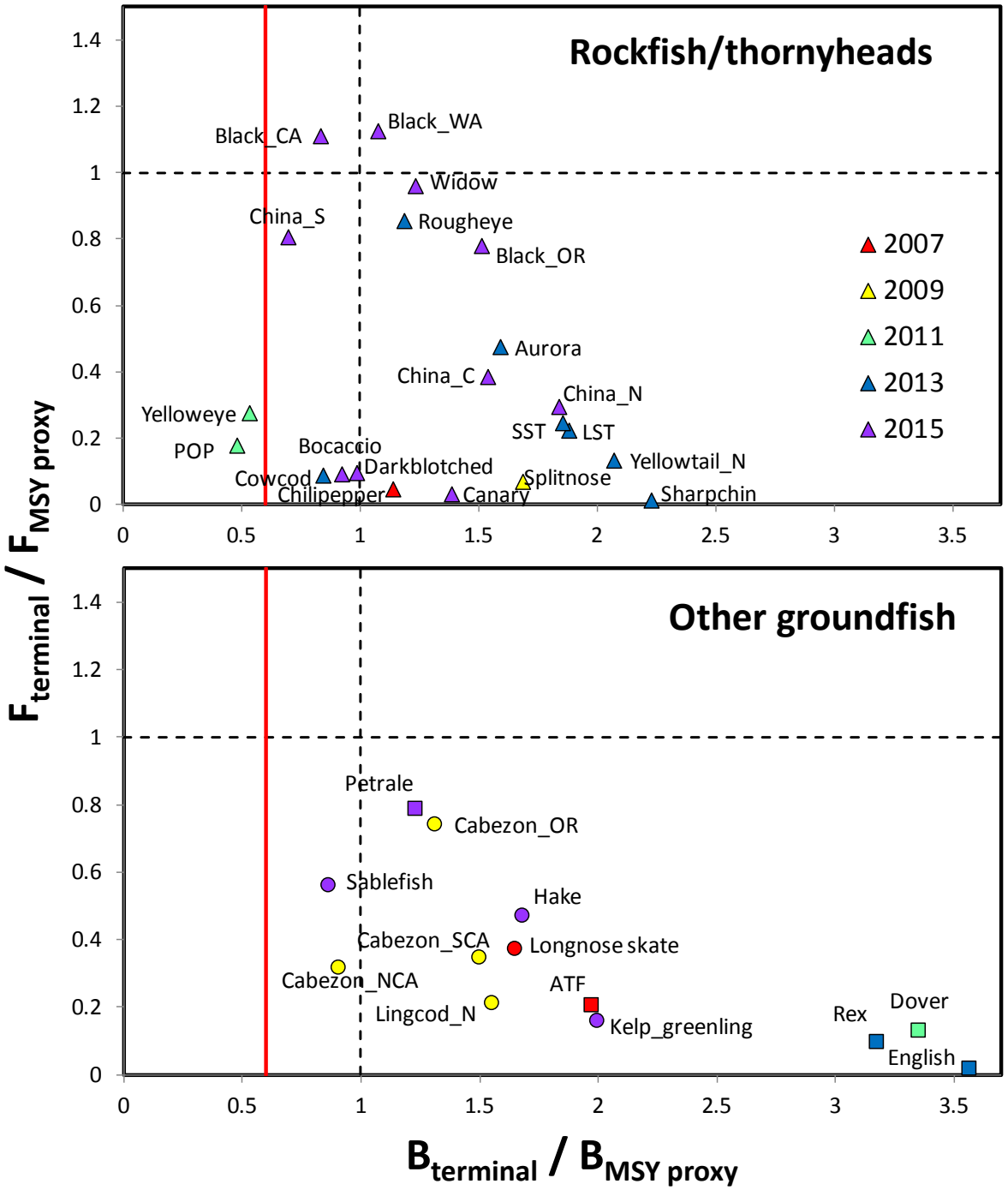
Chinook salmon escapement trends through 2014

- Most stocks near long-term averages
- Central Valley winter Chinook trending downward since 2005
- Coastal and Columbia River stocks generally trending up since 2005
- These data precede the anomalous warming



Groundfish

- Most stocks at or above biomass target (to the right of the vertical dashed line)
- Only 2 overfished stocks: yelloweye and POP
- Most stocks below proxy for heavy fishing mortality (below the horizontal dashed line)
- Only two stocks above fishing mortality target, both black rockfish
- Note: 2015 may prove to be a good year class

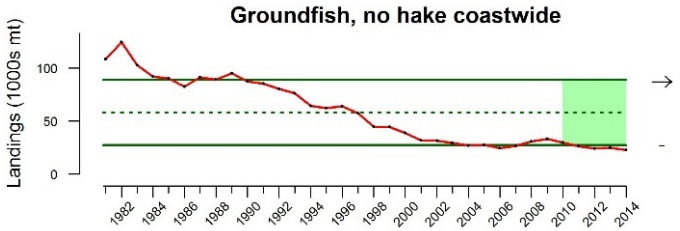


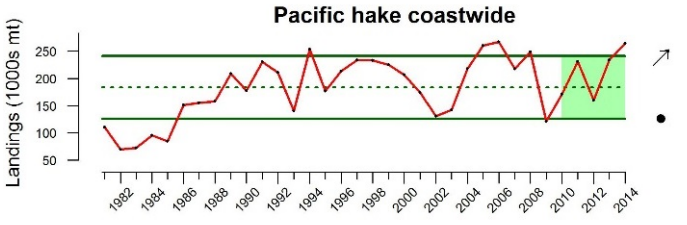
Human activities

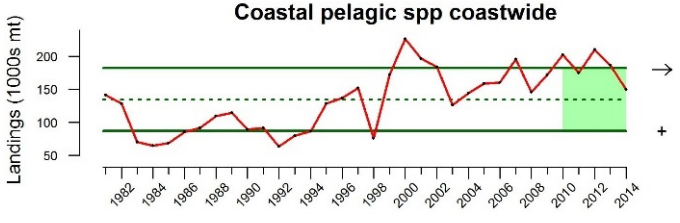
Commercial fishing vessels in Westport, WA (Craig D'Angelo, NOAA)

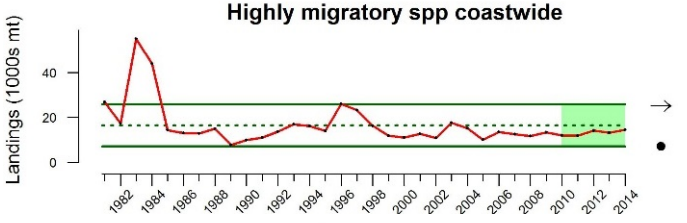
Landings through 2014

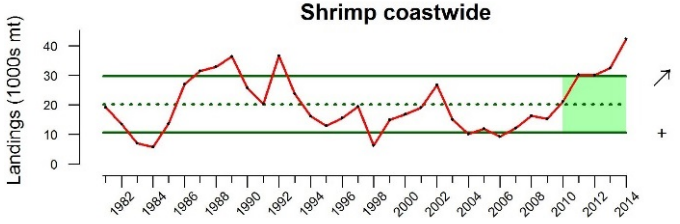
- Total landings have increased and are near recorded high, driven mainly by hake and CPS
- Crab and shrimp catches near historic highs
- Groundfish landings historically low
- Salmon landings highly variable
- HMS stable

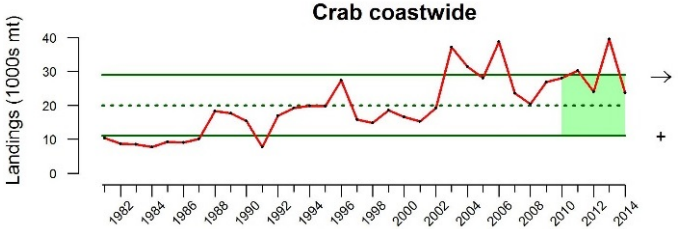


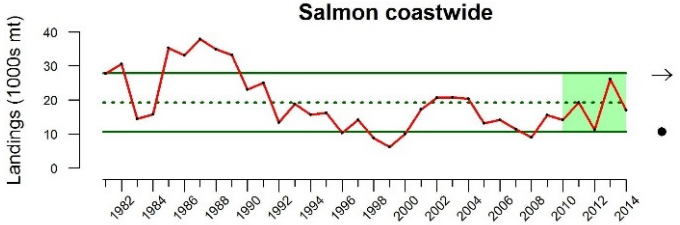


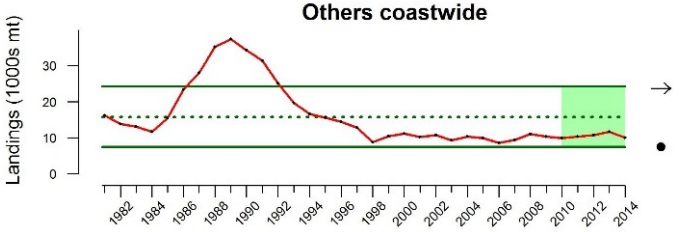


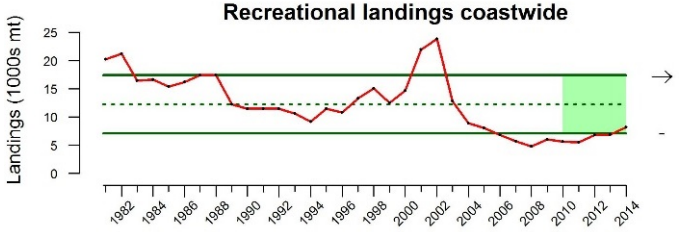


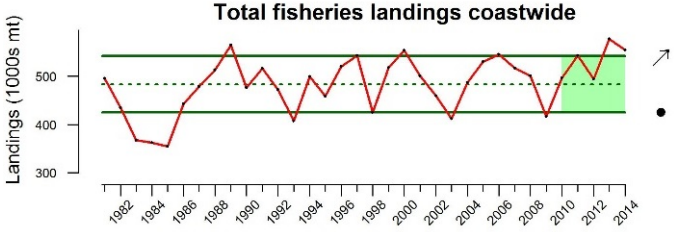






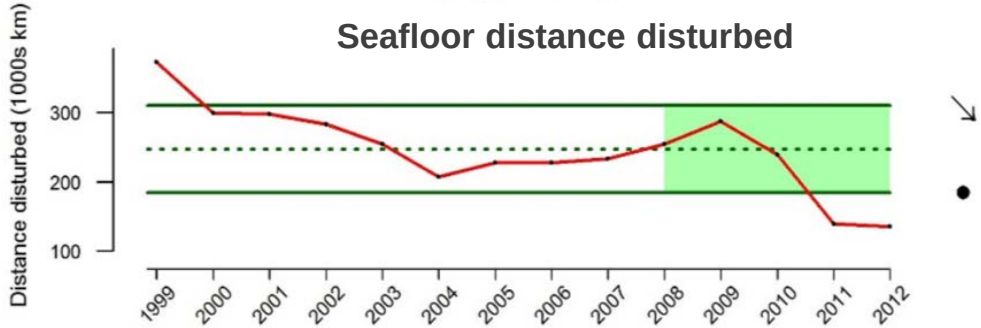




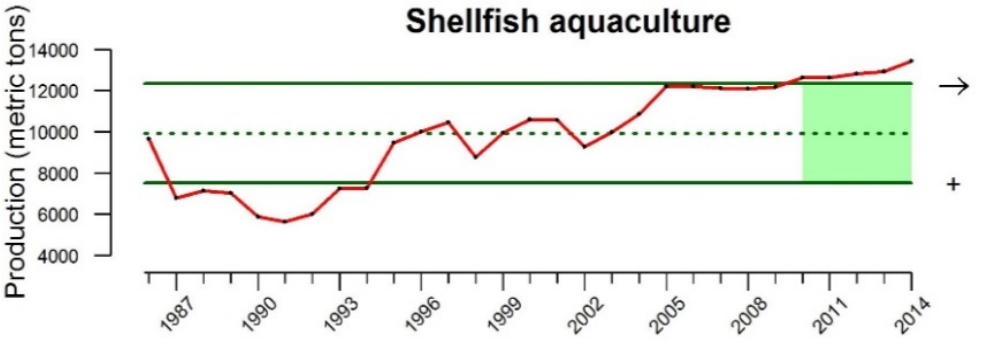


Other activities

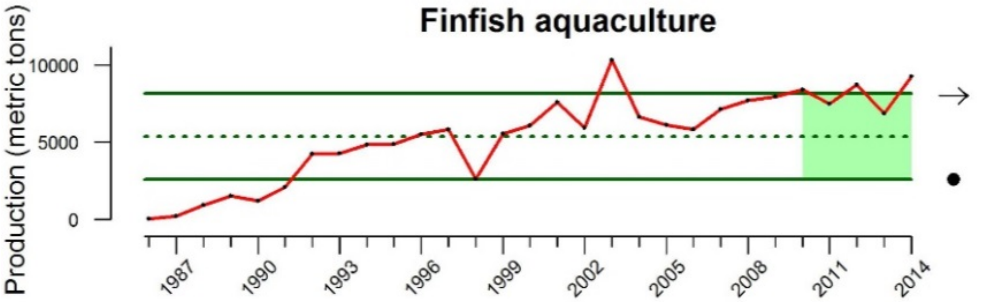
- **Seafloor disturbance by bottom-contact gears has declined steadily on most shelf and slope habitat types**



- **Shellfish aquaculture production on West Coast is at record level**



- **Finfish aquaculture also near historic high**

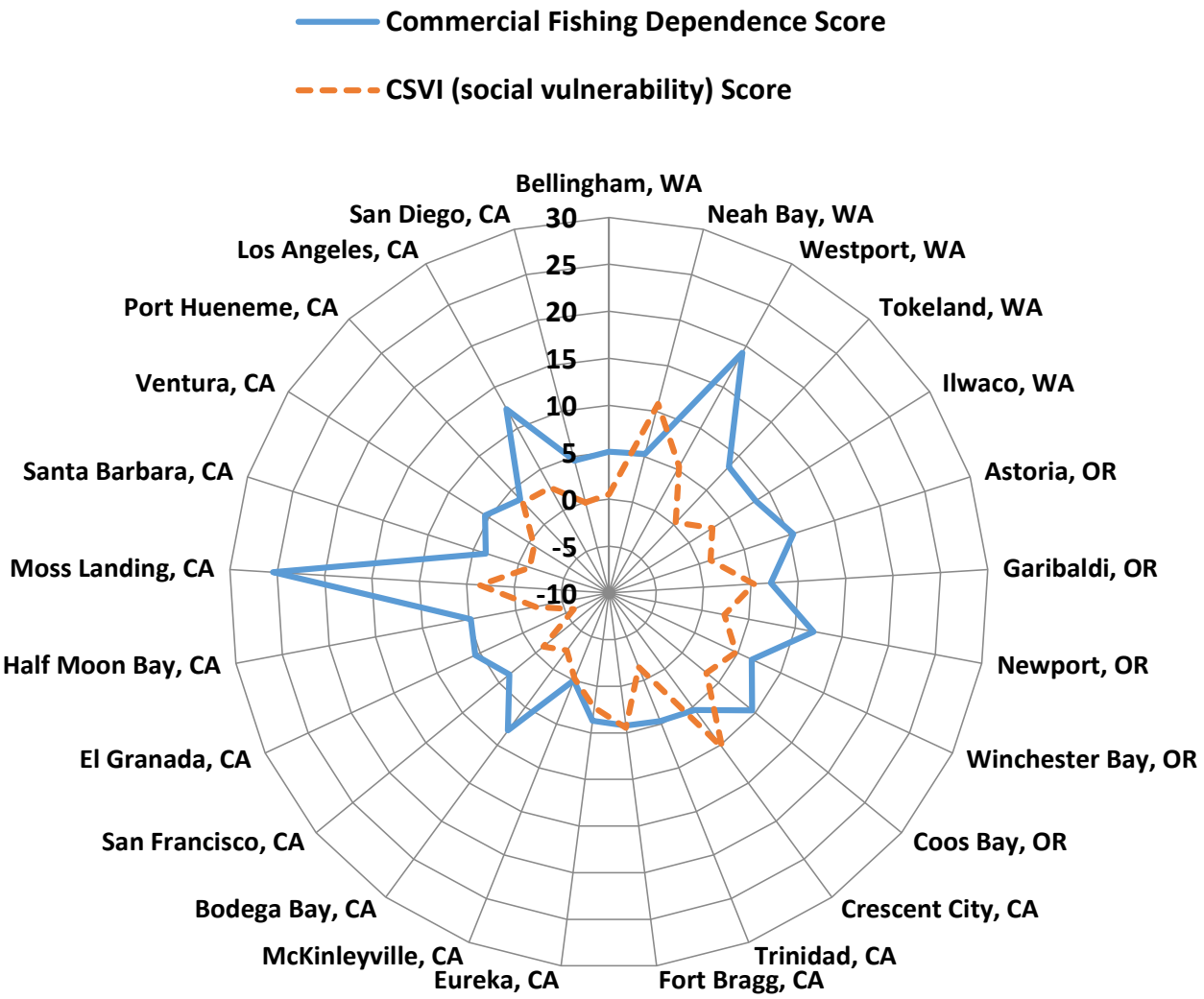


Human wellbeing

Harbor area of Westport, Washington (photo: Joe Mabel)

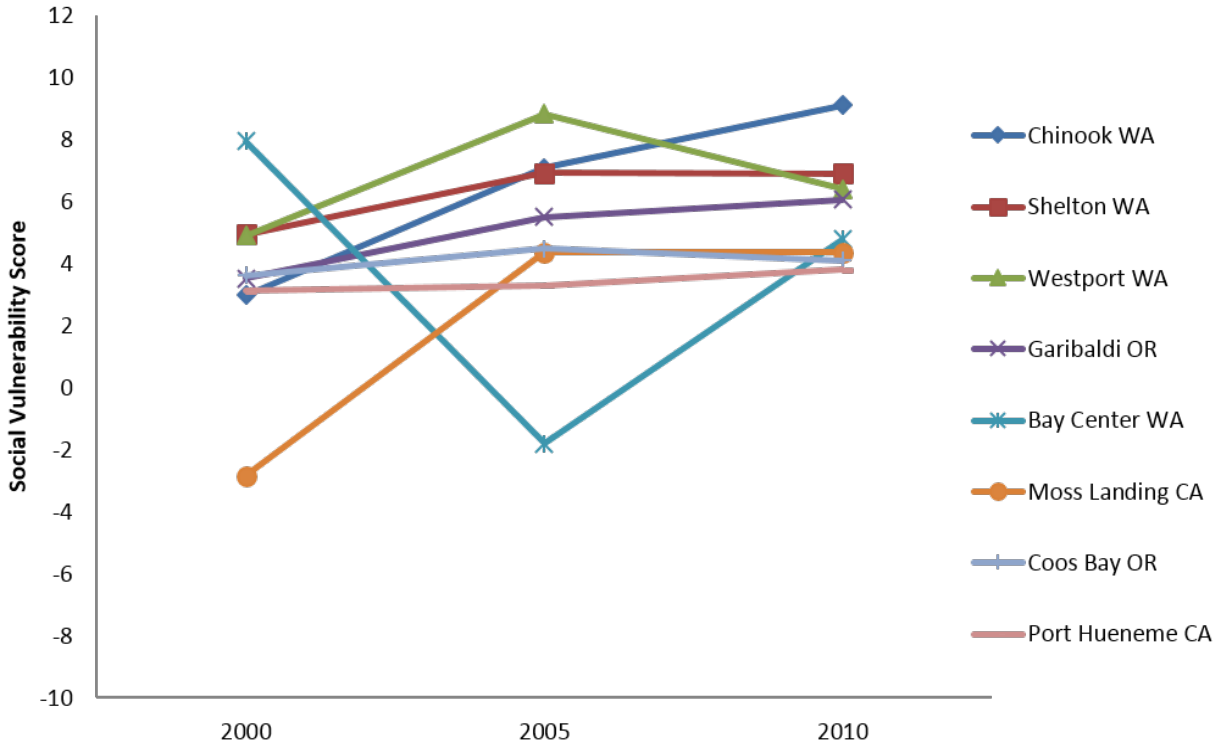
Social vulnerability in fishery-dependent coastal communities

- We compiled composite indexes of fishing dependence and social vulnerability for 880 coastal communities
- Top five fishing dependent communities from WA, OR, N CA, C CA and S CA are shown here
- Gives relative idea of how changes in fishing might affect overall community wellbeing



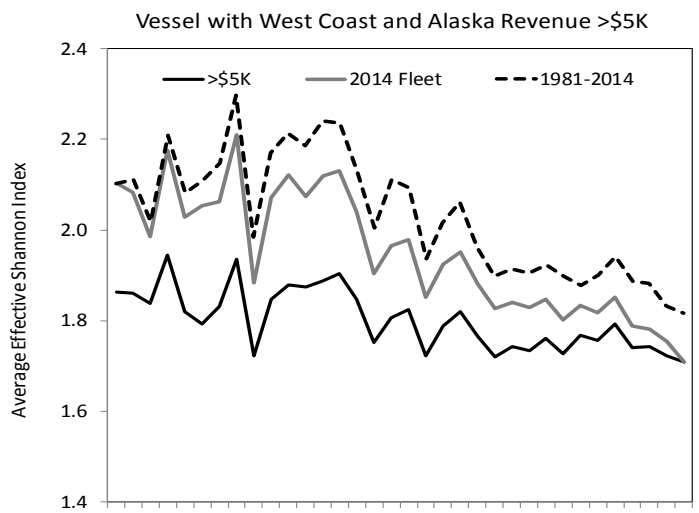
Social vulnerability in fishery-dependent coastal communities

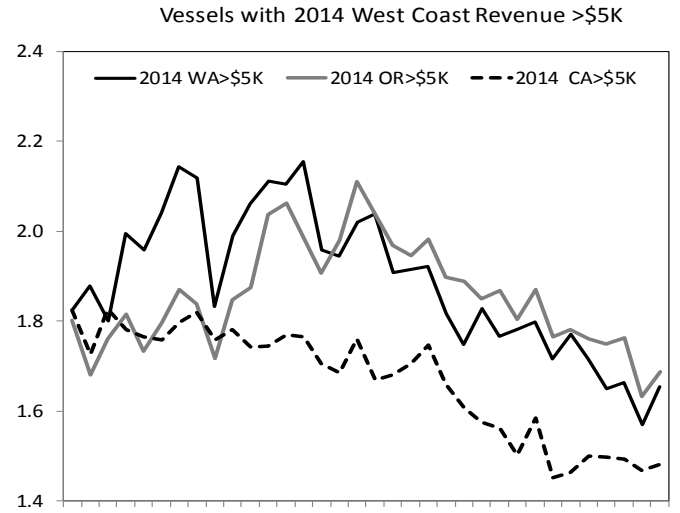
- We now have enough data to compile "time series" of changes in coastal community vulnerability
- In eight communities with consistently high fishery dependence, vulnerability is generally increasing

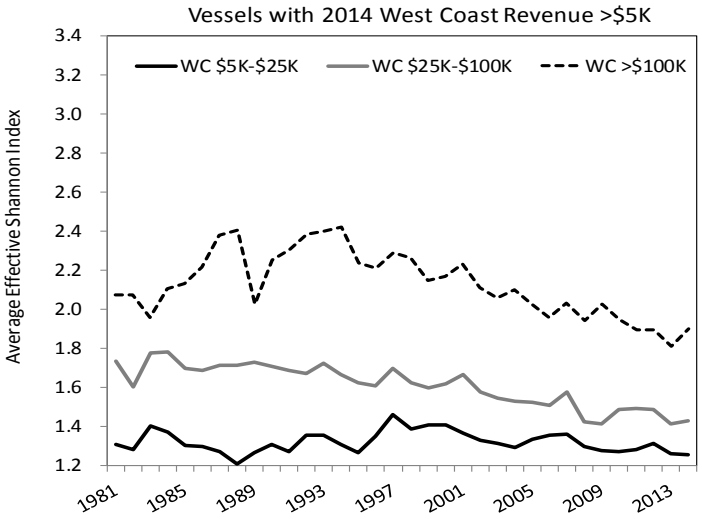


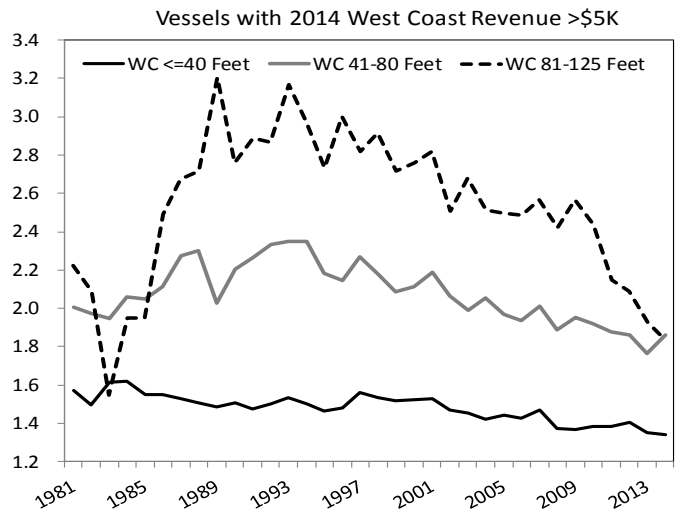
Fishery diversification

- **Measures how evenly revenues are distributed across fisheries in which vessels participate**
- **Through 2014, diversification continues to decline across nearly all regions, vessel sizes, and revenue classes**
- **Newer participants tend to be less diverse than long-standing participants, but all are declining**



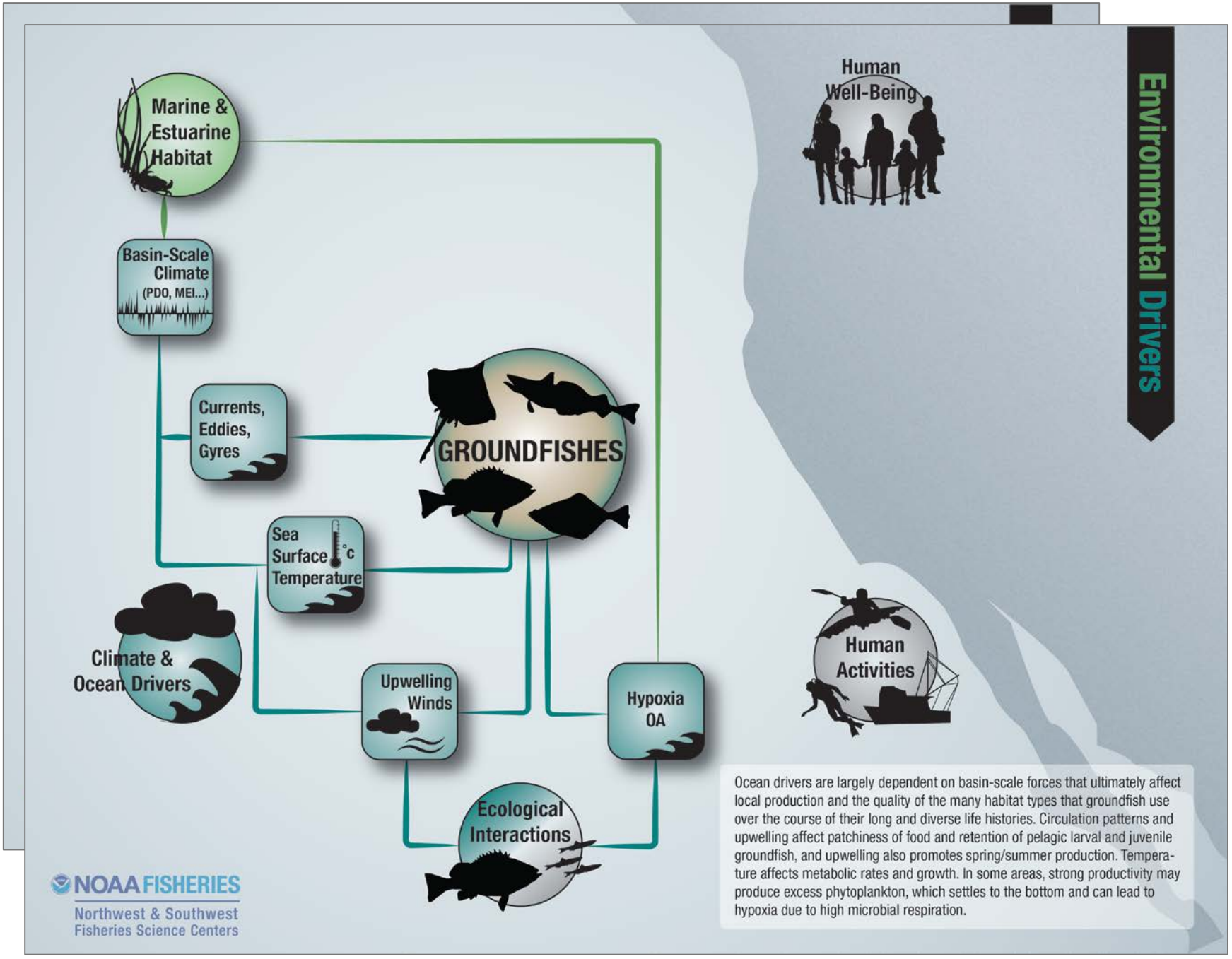






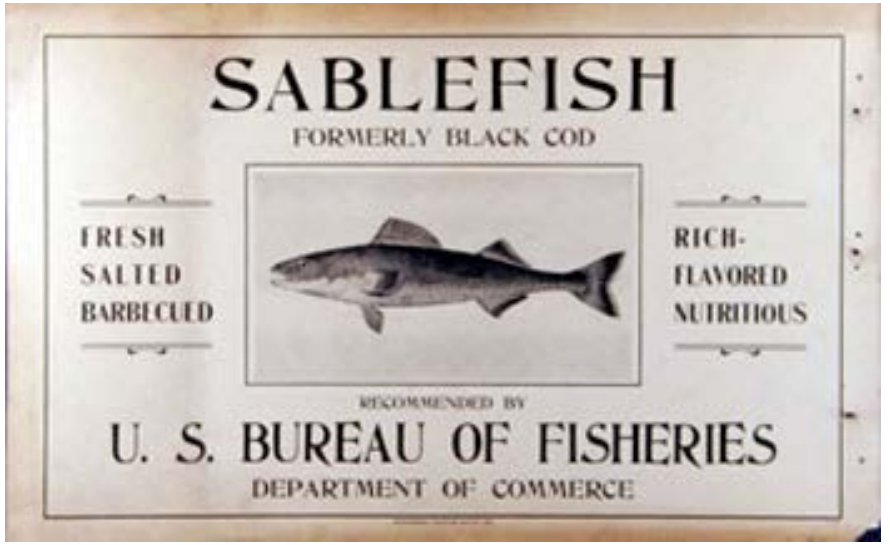
Synthesis

The NOAA Research Vessel* Reuben Lasker *(SWFSC/NOAA)


Marine & Estuarine Habitat
Basin-Scale Climate (PDO, MEI...)
Currents, Eddies, Gyres
GROUNDFISHES
Sea Surface °C Temperature
Climate & Ocean Drivers
Upwelling Winds
Hypoxia OA
Ecological Interactions
Human Well-Being
Human Activities
Environmental Drivers
NOAA FISHERIES
Northwest & Southwest Fisheries Science Centers
Ocean drivers are largely dependent on basin-scale forces that ultimately affect local production and the quality of the many habitat types that groundfish use over the course of their long and diverse life histories. Circulation patterns and upwelling affect patchiness of food and retention of pelagic larval and juvenile groundfish, and upwelling also promotes spring/summer production. Temperature affects metabolic rates and growth. In some areas, strong productivity may produce excess phytoplankton, which settles to the bottom and can lead to hypoxia due to high microbial respiration.

Mechanisms driving recruitment variability of sablefish across contrasting climate conditions

(Tolimieri, Haltuch, Lee, Jacox, Bograd)



To develop a *mechanistic framework* for testing hypotheses regarding oceanographic drivers of sablefish recruitment, in order to improve assessments and forecasts

Life-history model – detailed conceptual model to identify potential drivers from pre-spawning female conditioning to age-1 recruits

Potential drivers – specific to stage, time, location

- Transport
- Temperature
- Predators
- Prey

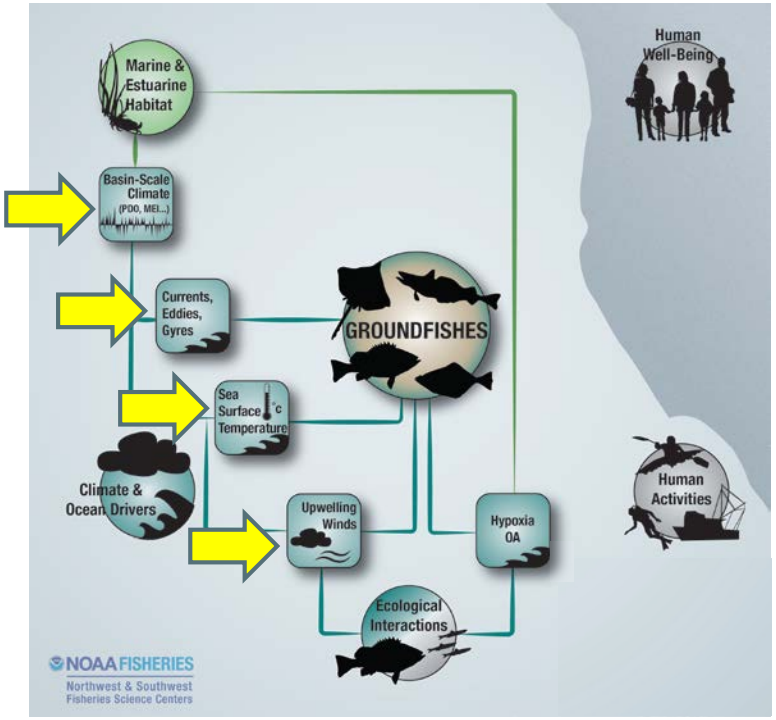
Framework should apply to other groundfish of PFMC interest

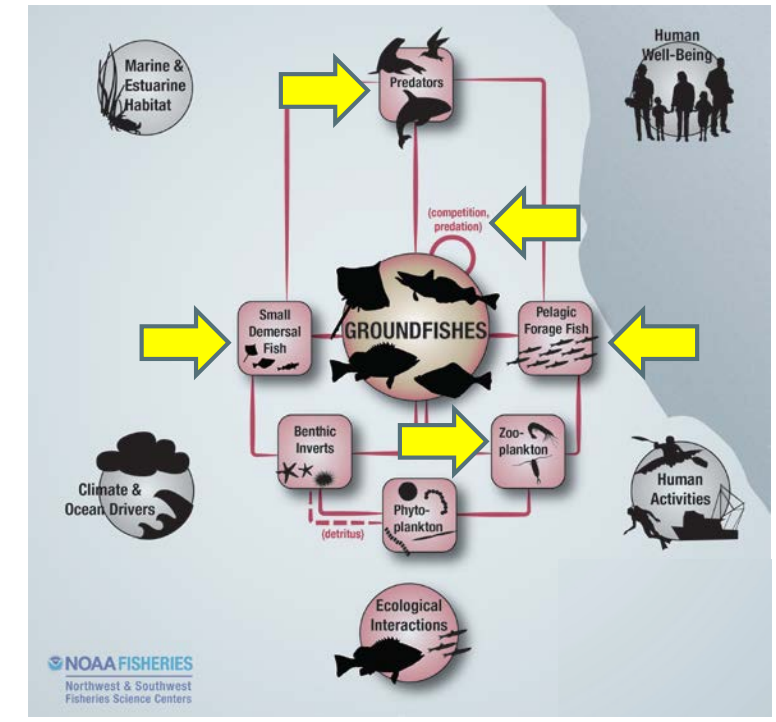
Potential drivers – specific to stage, time, location

- Transport
- Temperature
- Predators
- Prey

(represented at right by yellow arrows, ⇨)

- **The sablefish project is supported by indicators work**
- **It will also improve our indicator sets and assessments (spatial & temporal scales, gaps)**
- **Similar approaches can be taken for other Council-relevant concerns, such as:**
  - Effects of climate anomalies
  - Short-term forecasts of target spp distributions
  - Fishery interactions with protected species
  - HABs





Questions and Discussion

School of jack mackerel near Catalina (Adam Obaza, NOAA)