Gone, but not forgotten
The blob and the ocean environment off of Washington and Oregon

NWPCC Ocean Forum
October 26th, 2017

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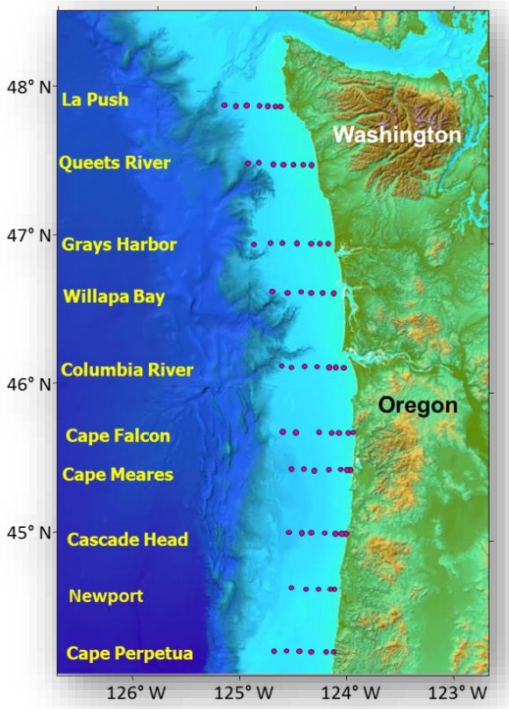
Supported by:

Juvenile Salmon & Ocean Ecosystem Surveys



Juvenile salmon sampling:

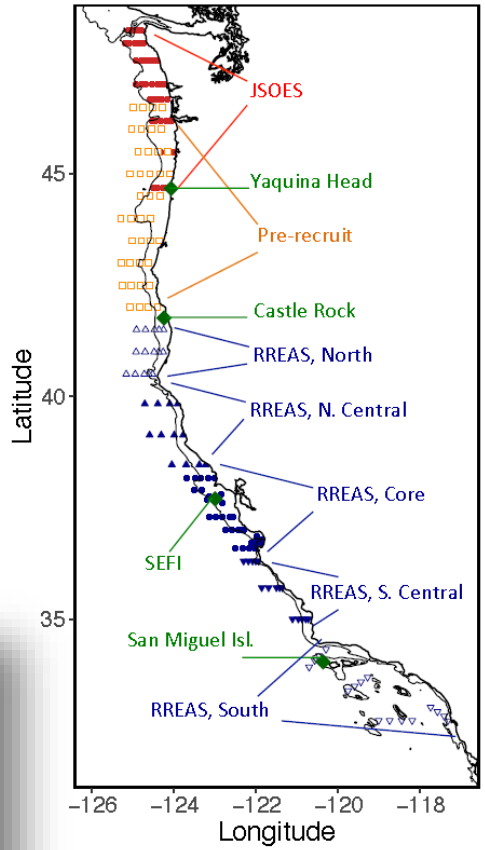
- May (2006 – 2012, 2015 - present)
- June (1998 – present)
- September (1998 – 2012, 2015)

Newport Line

- Biweekly (1996-present)

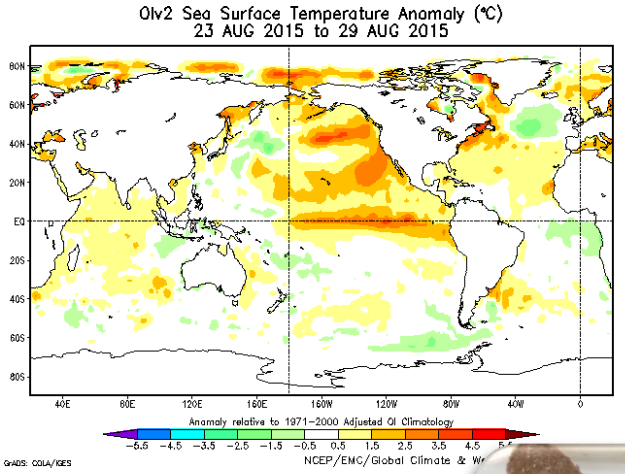
Micronekton Survey, 30 m

- June (2011, 2013 - 2017)



Today's topics

- The physical processes in the coastal ocean
- The biological responses to ocean dynamics
- Salmon growth and survival

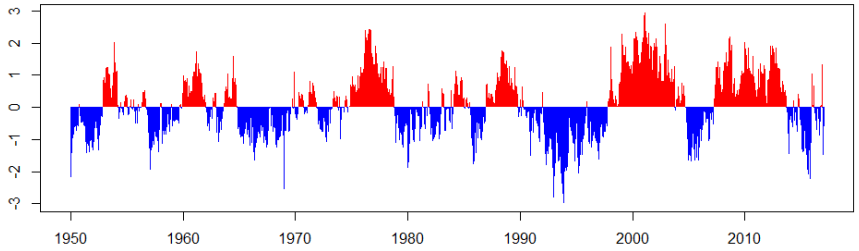


Physical Drivers Act on Different Temporal Scales

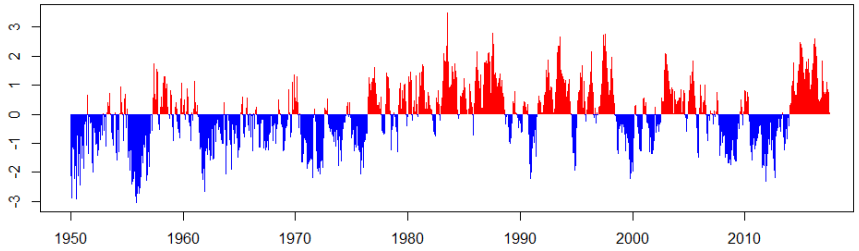
(and biological responses work on different scales, with different lags)

Decadal

NPGO

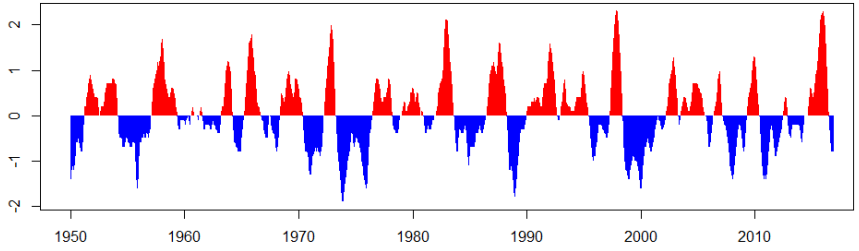


PDO



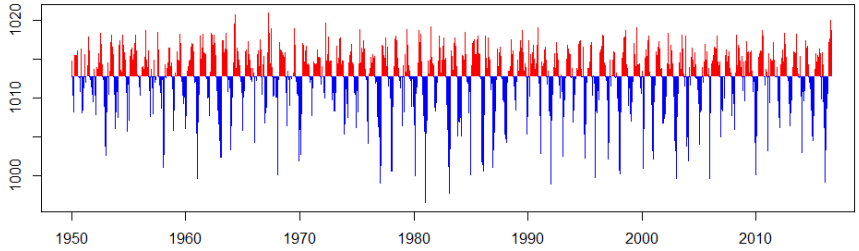
3-7 year

ONI



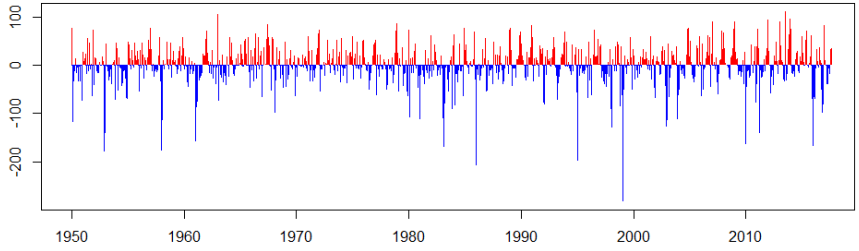
Annual

NPI

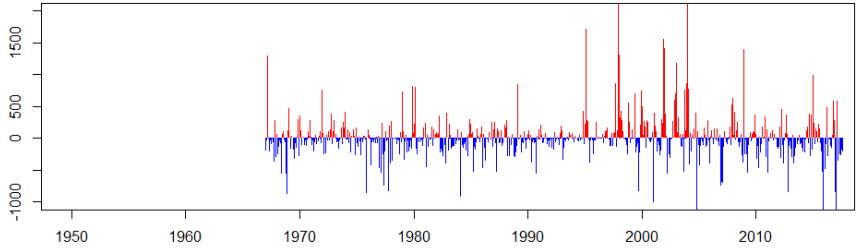


Sub-Seasonal

CUI



Transport

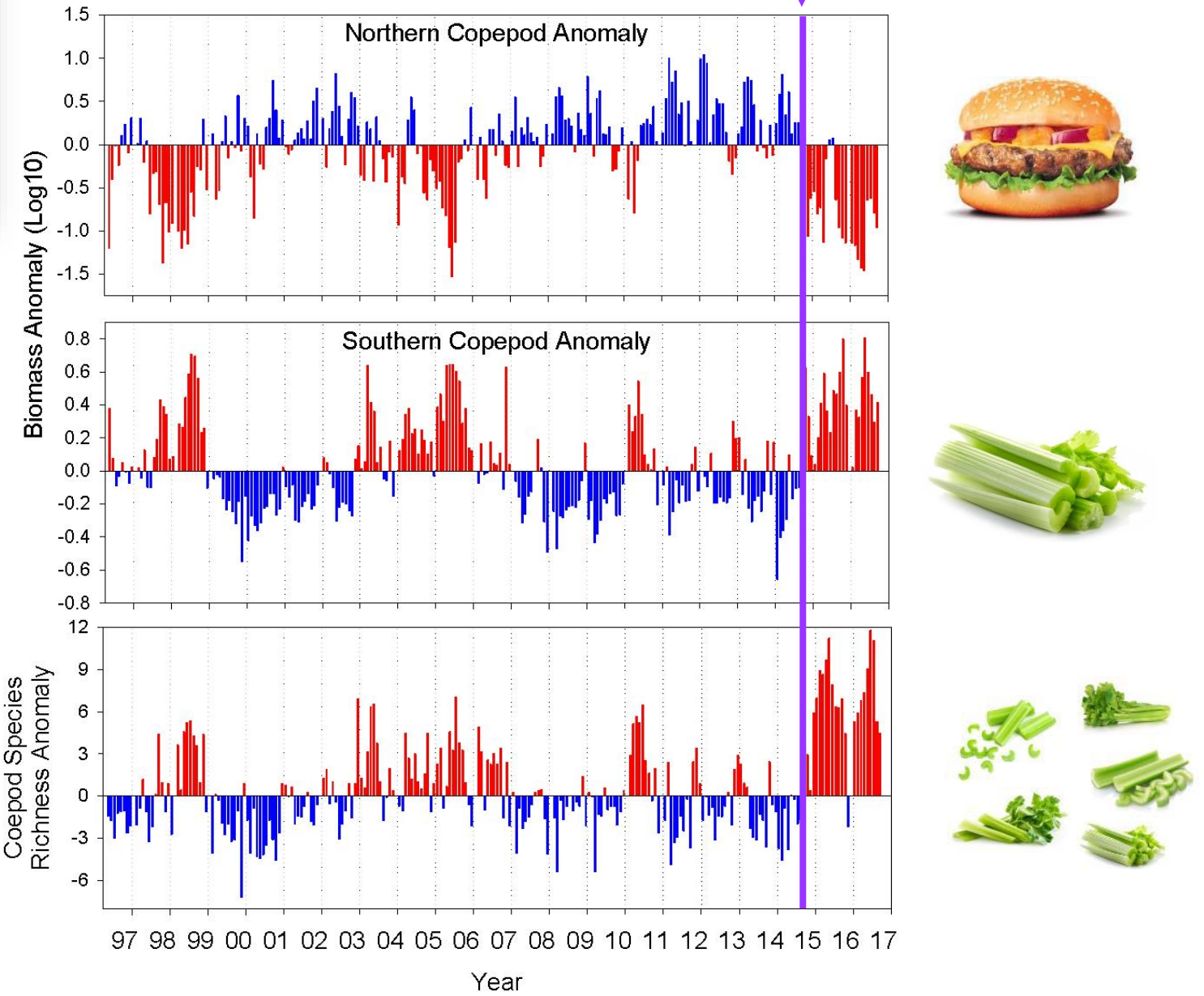


The biological responses to ocean dynamics

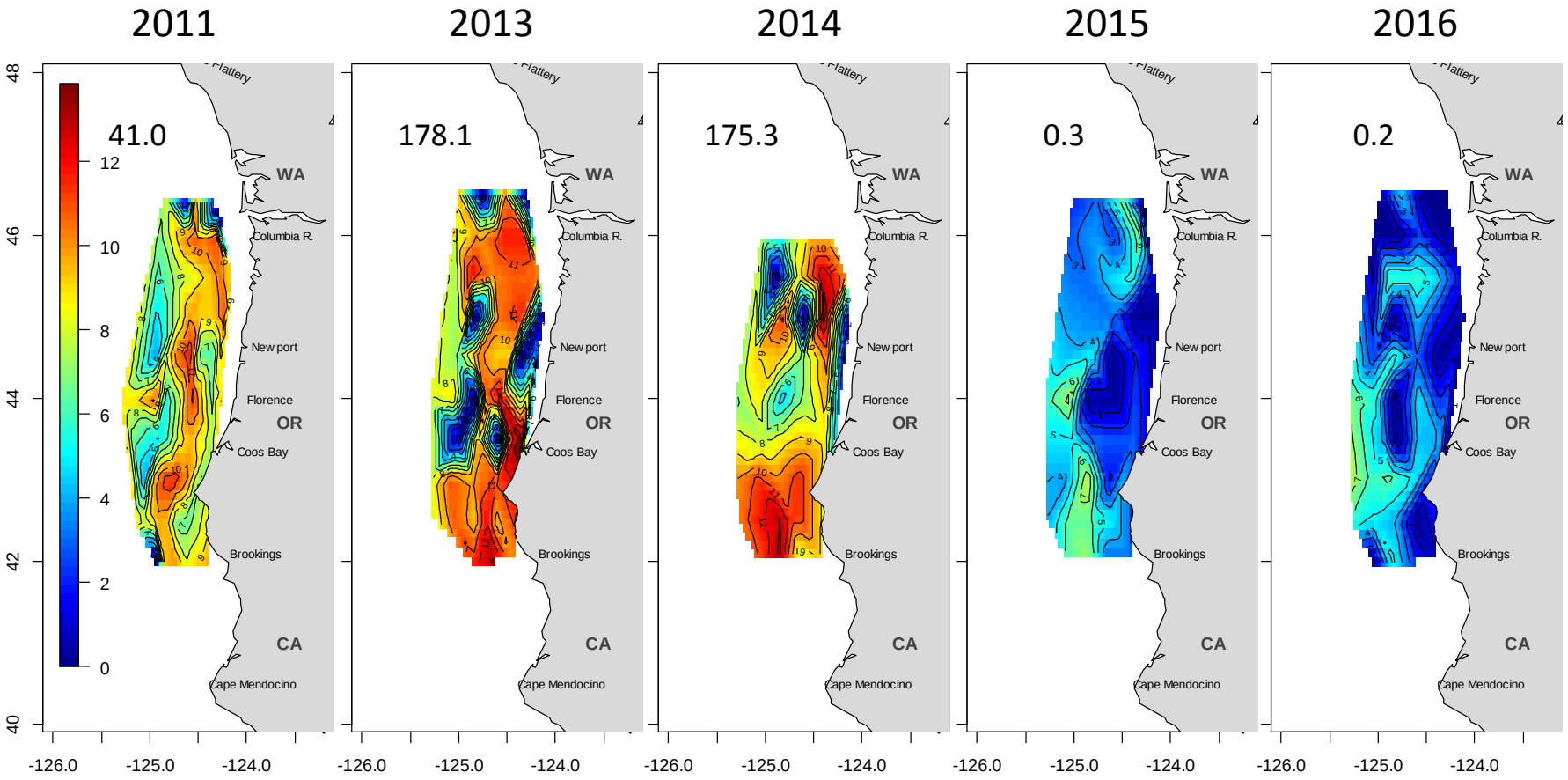
Photo by Pacific Drone

Bill Peterson

Zooplankton

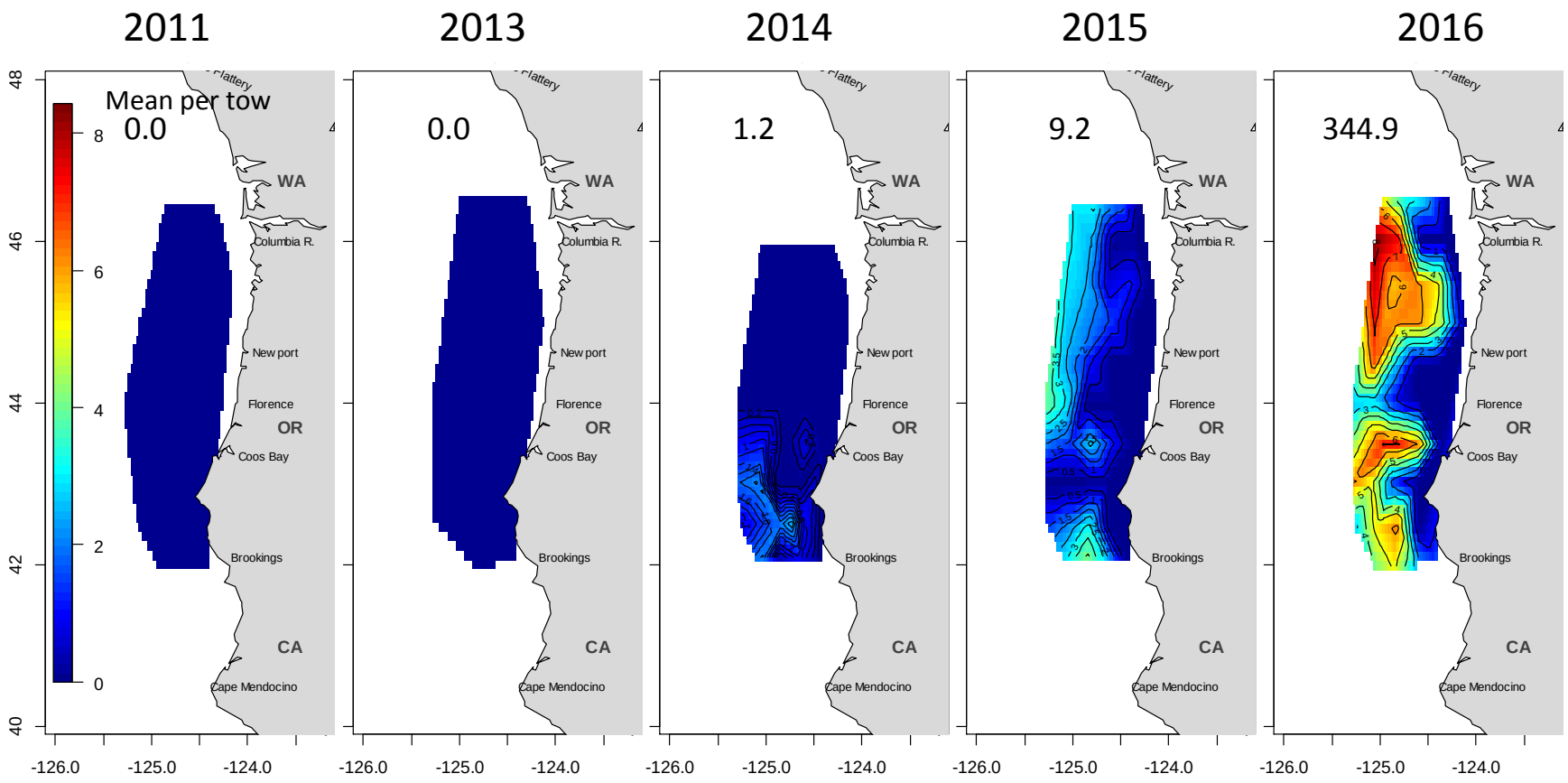


Total Krill
Euphausiidae



Data from Ric Brodeur, NOAA Fisheries

Pyrosomes (*Pyrosoma atlanticum*)

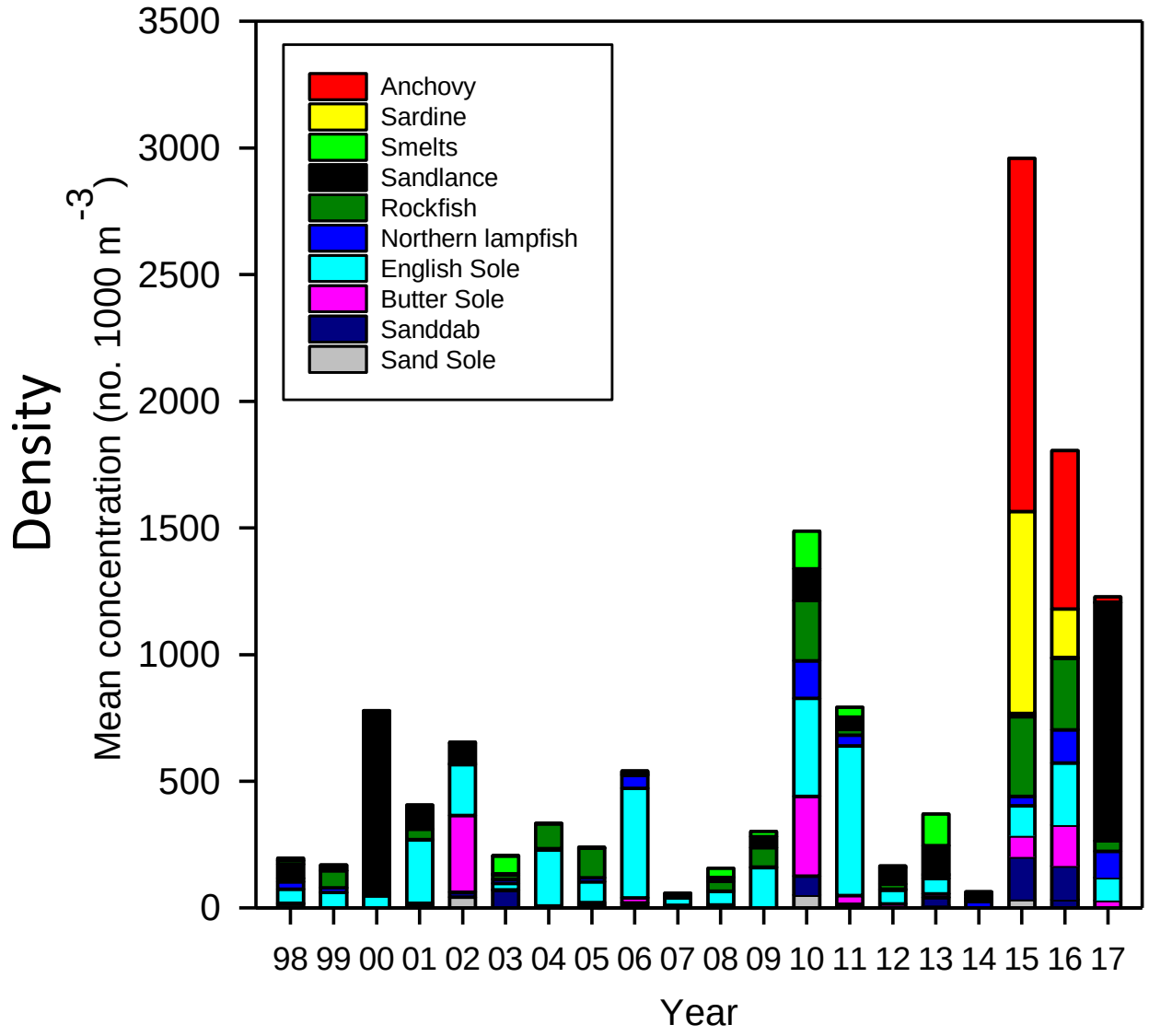


Mean number of pyrosomes per tow in 2017 = **11,752**!

Data from Ric Brodeur

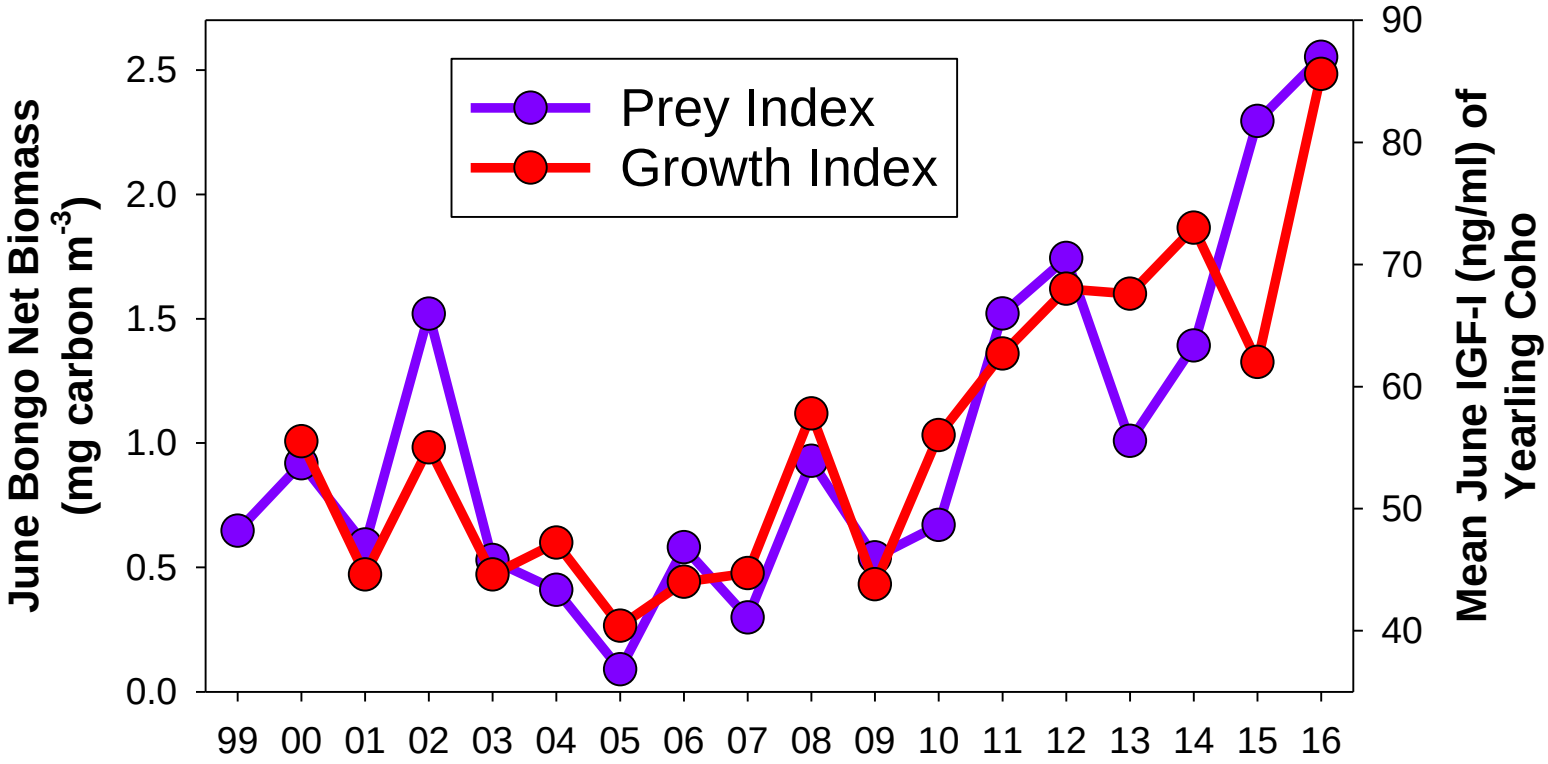
Dramatic Increase in 3 Species of Ichthyoplankton

NH Line in Winter (Jan-Mar)




Salmon growth
and survival
Photo by Pacific Drone

Prey abundance and estimated growth were both high

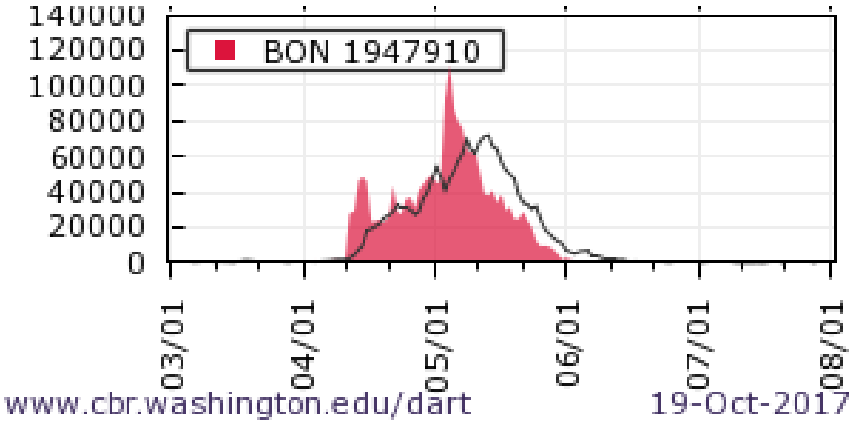


Our project represents more than just the Fish Ecology Division

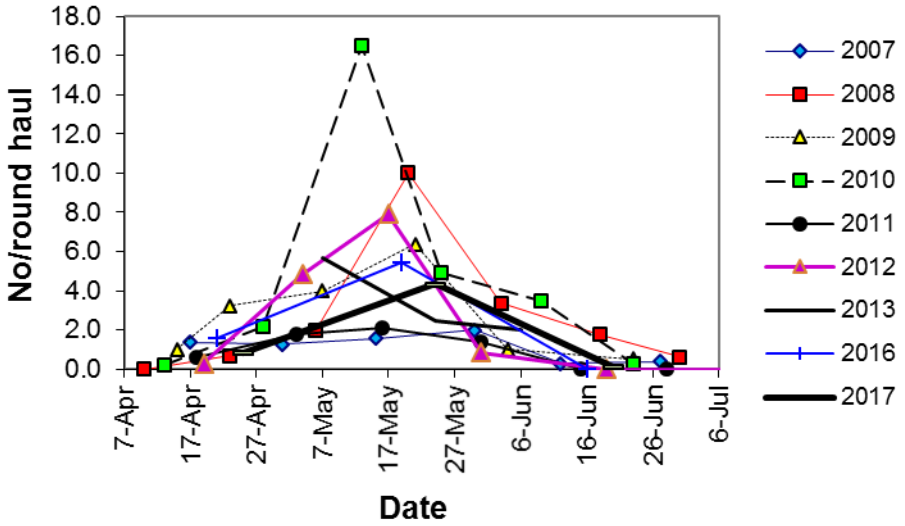
- Growth data from Brian Beckman, EFS Division, NWFSC
- Prey data from Cheryl Morgan, CIMRS, OSU

We saw average abundance of spring Chinook in the river

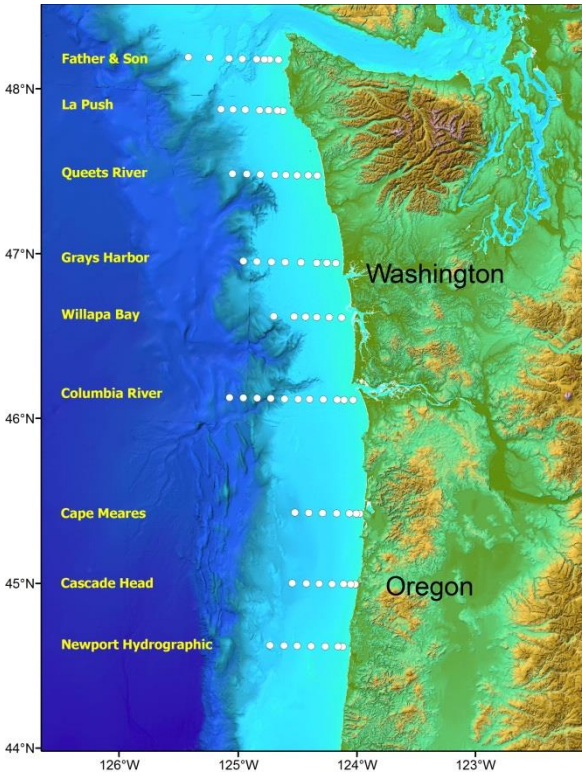
Bonneville Dam juvenile spring Chinook in 2017

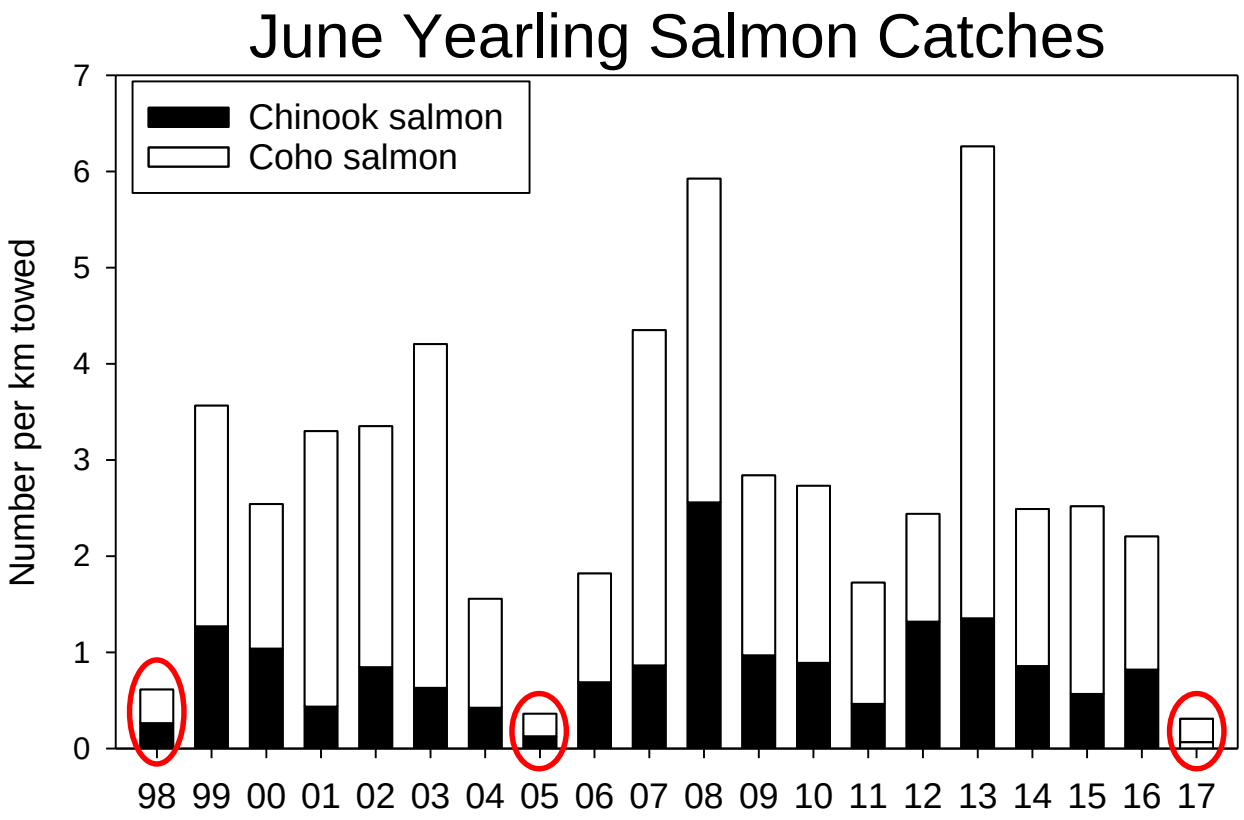


Laurie Weitkamp's (CB Division) estuary catches

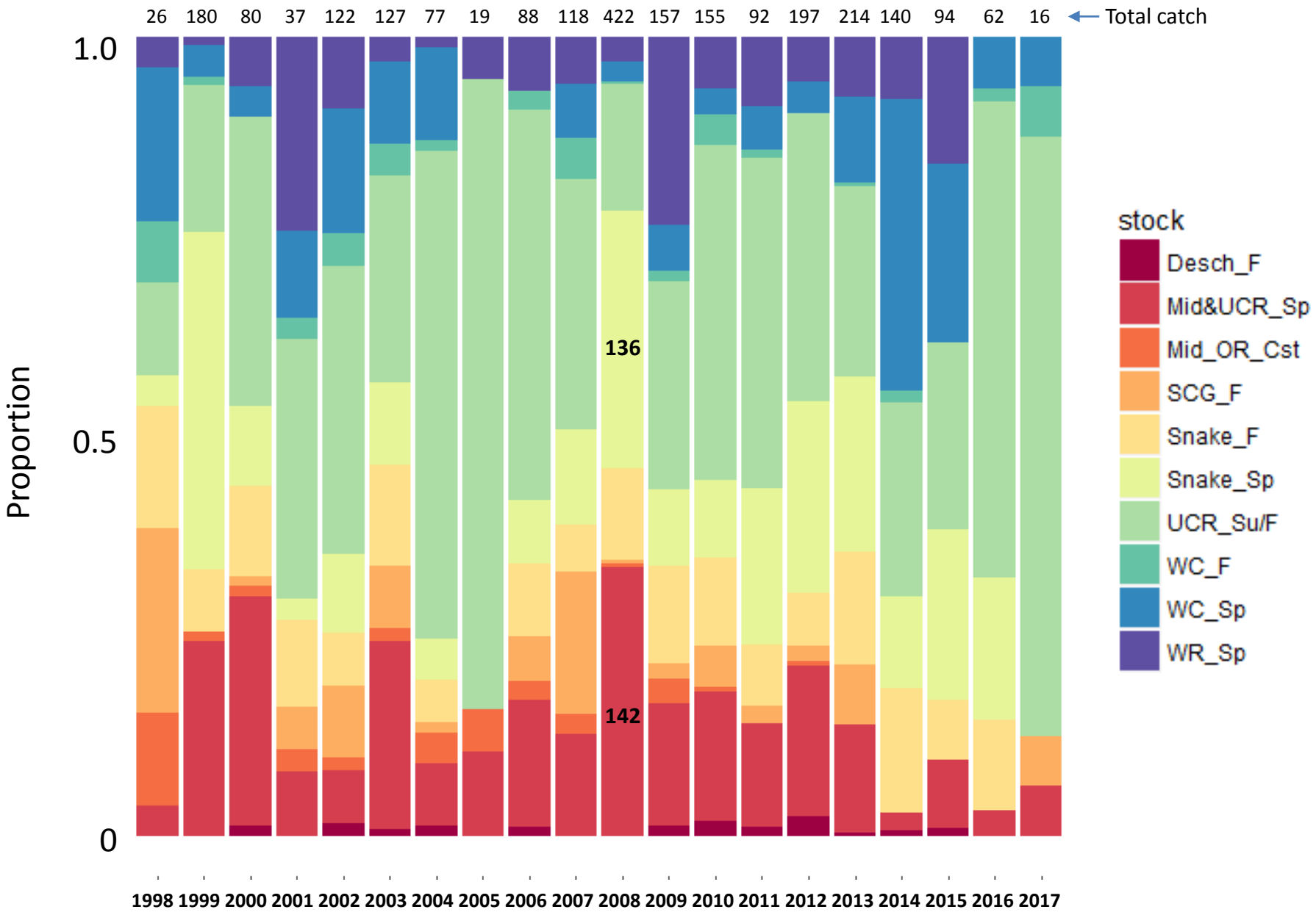


Extremely Low Salmon Abundance





Yearling Chinook Stock Composition in June



Good – Fair – Poor

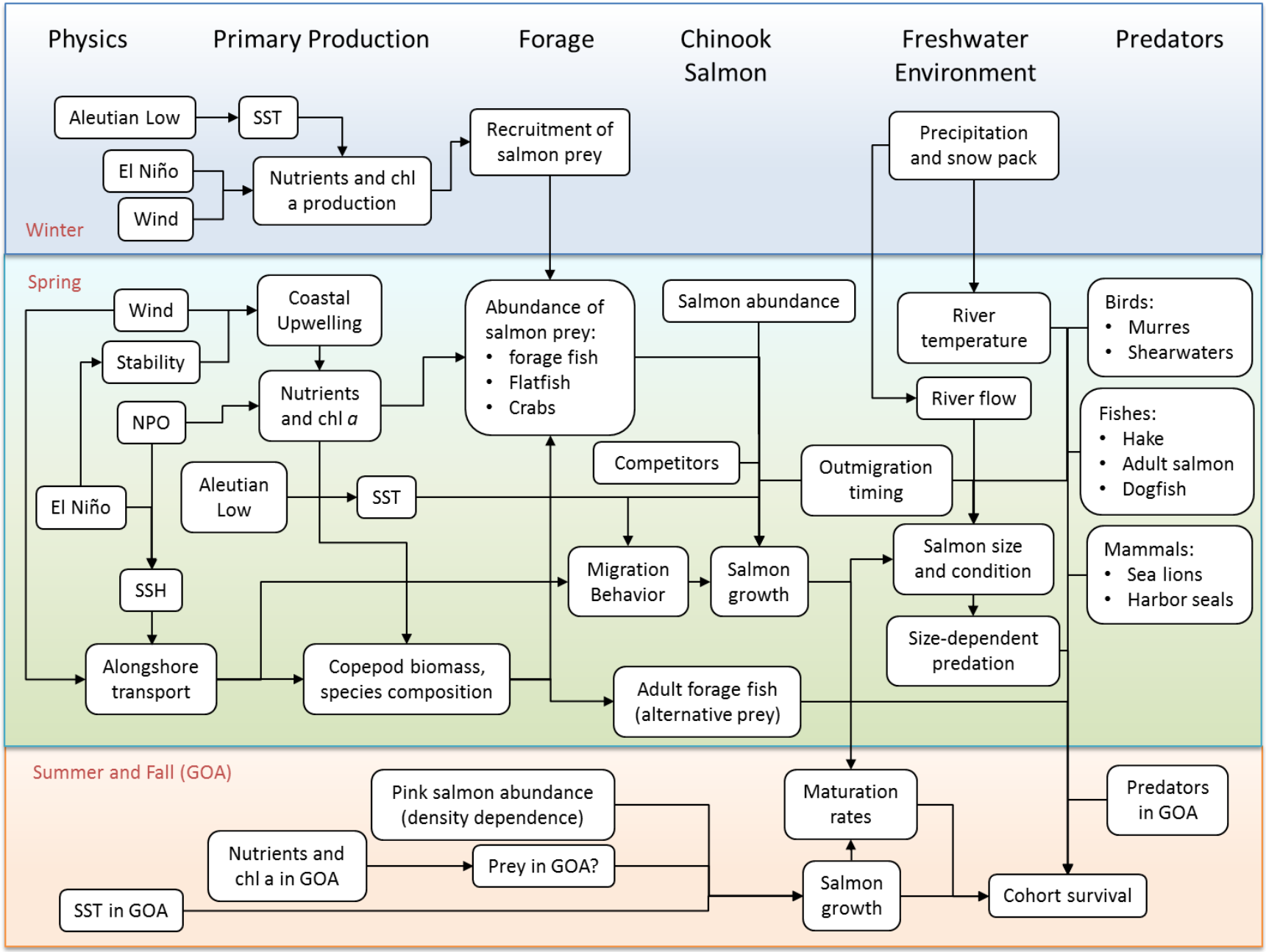
		Year																		
	Ecosystem Indicators	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Basin-scale physical indices	PDO (Sum Dec-March)	17	6	3	12	7	19	11	15	13	9	5	1	14	4	2	8	10	20	18	16
	PDO (Sum May-Sept)	10	4	6	5	11	16	15	17	12	13	2	9	7	3	1	8	18	20	19	14
	ONI (Average Jan-June)	19	1	1	6	13	15	14	16	8	11	3	10	17	4	5	7	9	18	20	12
Regional physical indices	46050 SST (°C; May-Sept)	16	9	3	4	1	8	20	15	5	17	2	10	7	11	12	13	14	19	18	6
	Upper 20 m T (°C; Nov-Mar)	19	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2	20	18	17
	Upper 20 m T (°C; May-Sept)	16	12	14	4	1	3	20	18	7	8	2	5	13	10	6	17	19	9	15	11
	Deep temperature (°C; May-Sept)	20	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	19	18	13	17
	Deep salinity (May-Sept)	19	3	9	4	5	16	17	10	7	1	2	14	18	13	12	11	20	15	8	6
Regional biological indices	Copepod richness anom. (no. species; May-Sept)	17	2	1	7	6	13	12	16	14	10	8	9	15	4	5	3	11	18	19	
	N. copepod biomass anom. (mg C m^{-3}; May-Sept)	17	13	9	10	3	15	12	18	14	11	6	8	7	1	2	4	5	16	19	
	S. copepod biomass anom. (mg C m^{-3}; May-Sept)	19	2	5	4	3	13	14	18	12	10	1	7	15	9	8	6	11	16	17	
	Biological transition (day of year)	17	11	6	7	8	12	10	16	15	3	1	2	14	4	9	5	13	20	20	20
	Ichthyoplankton biomass (log (mg C 1000 m^{-3}); Jan-Mar)	20	11	3	7	9	18	17	13	16	15	2	12	4	14	10	8	19	5	6	1
	Ichthyoplankton community index (PCO axis 1 scores; Jan-Mar)	9	13	1	6	4	10	18	16	3	12	2	14	15	11	5	7	8	17	20	19
	Chinook salmon juvenile catches (no. km^{-1}; June)	18	4	5	15	8	12	16	19	11	9	1	6	7	14	3	2	10	13	17	20
	Coho salmon juvenile catches (no. km^{-1}; June)	18	7	12	5	6	2	15	19	16	4	3	9	10	14	17	1	11	8	13	20
	Mean of ranks	16.9	7.2	5.9	6.9	5.8	12.3	14.9	15.9	11.1	8.9	2.7	8.3	12.1	8.1	6.4	7.6	12.4	15.8	16.3	13.8
	Rank of the mean rank	20	6	3	5	2	13	16	18	11	10	1	9	12	8	4	7	14	17	19	15

http://www.nwfsc.noaa.gov/oceanconditions

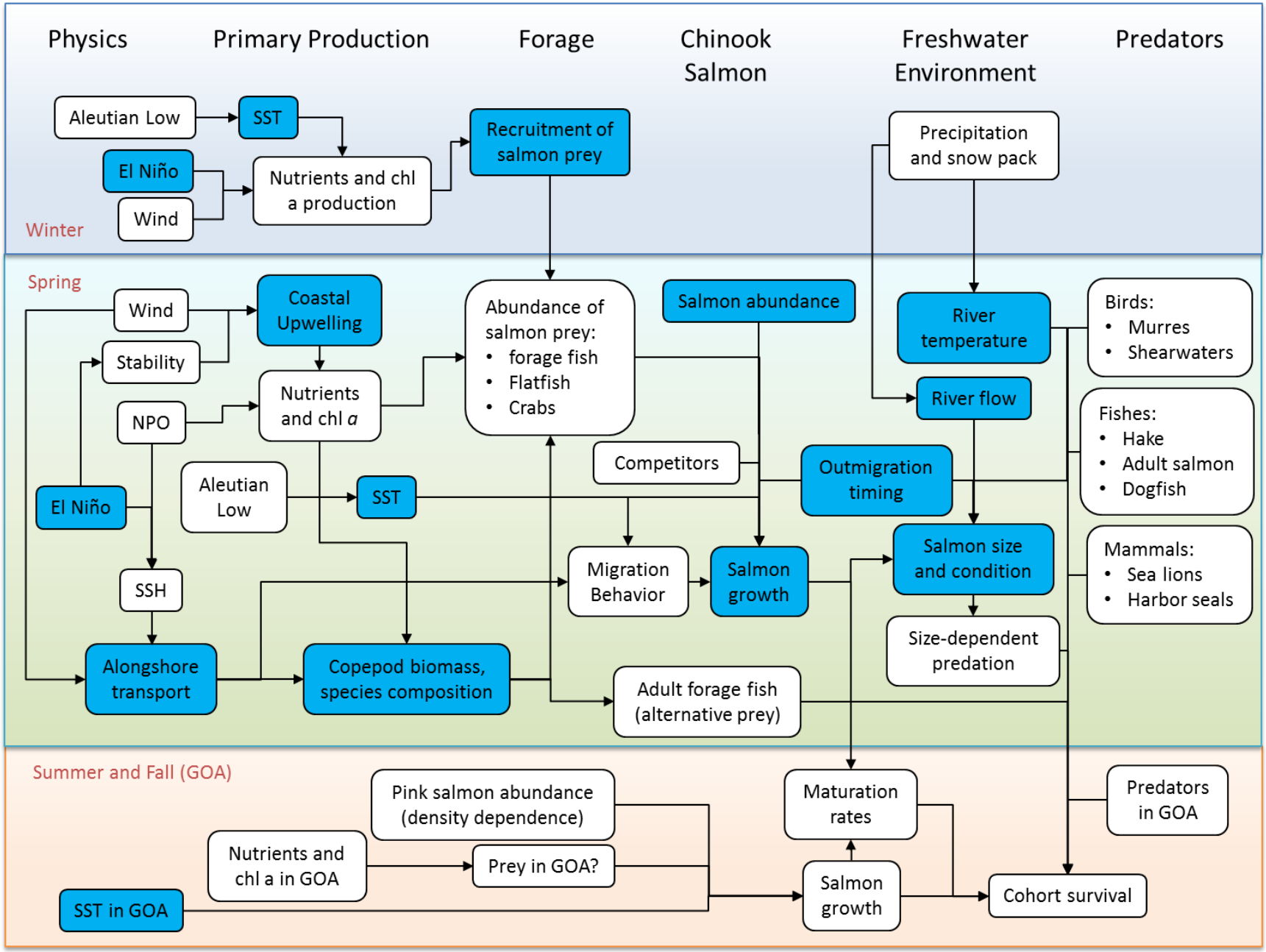
Expand our summaries of ocean conditions to include stock-specific analyses

Caution: A modeler's view of the ocean coming up next…

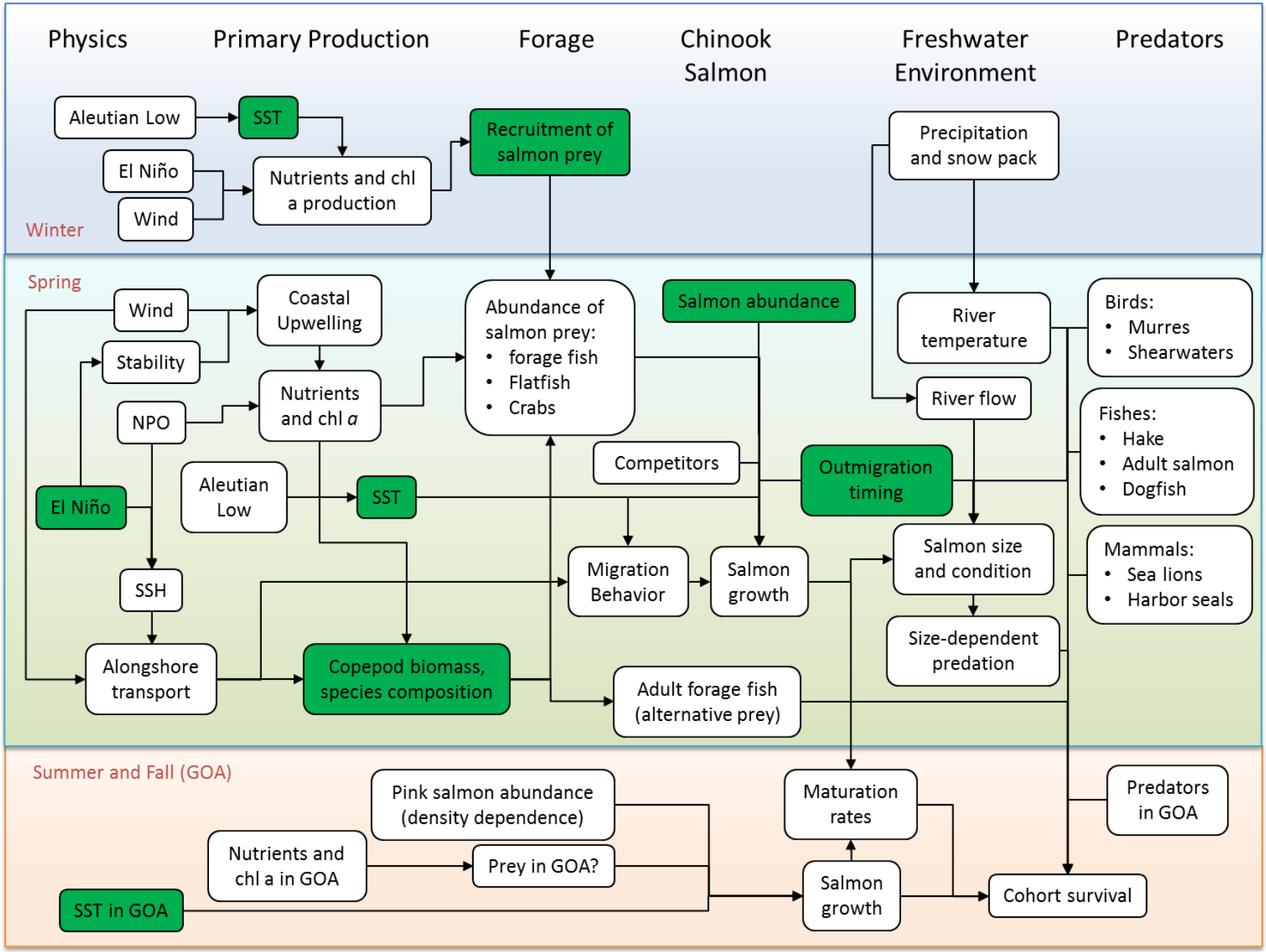
Hypothesized Mechanistic Links to Salmon Survival



Subset of variables ***for which we have data***



Subset of variables ***important in our model***



Spring Chinook

Good – Fair – Poor

	Year																		
Indicators	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PDO (winter)	16	6	1	13	7	18	12	11	15	9	5	3	14	4	2	8	10	19	17
PDO (spring)	16	5	10	9	6	14	13	17	11	8	2	1	12	4	3	7	15	18	19
PDO (summer)	11	5	8	6	10	17	13	15	12	14	1	9	7	3	2	4	16	19	18
NPGO (fall)	8	15	18	17	13	9	6	2	3	10	19	12	14	11	16	4	5	1	7
ONI (spring)	18	1	2	6	14	12	13	16	8	10	2	10	15	4	5	7	8	17	19
SST (WA, spring)	18	4	10	6	2	14	15	16	11	9	1	3	12	5	7	7	13	17	19
SST (WA, summer)	15	6	8	5	4	9	19	11	10	18	1	3	2	13	6	14	11	17	16
SST (coastwide, spring)	14	1	9	6	8	13	15	16	12	5	2	3	11	7	4	10	17	19	18
SST (coastwide, winter)	17	6	4	10	8	16	12	13	14	7	1	3	11	9	2	5	15	19	18
Ichthyo. Biomass	19	10	2	6	8	17	16	12	15	14	1	11	3	13	9	7	18	4	5
S. Cop. Biomass	19	1	4	4	1	13	14	18	12	10	1	7	15	9	7	6	11	16	17
Biological Trans	17	11	6	7	8	12	10	16	15	3	1	2	14	4	9	5	13	19	19

Up next: fall Chinook, coho, and steelhead

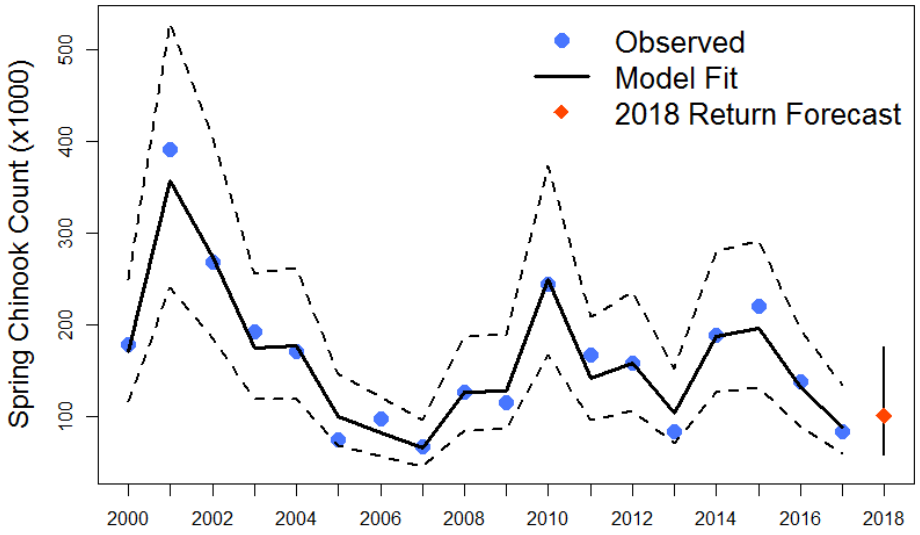
Spring Chinook at Bonneville Dam

Dynamic Linear Models

Sibling Regression and the first Principal Component of the stoplight chart

Spring Chinook

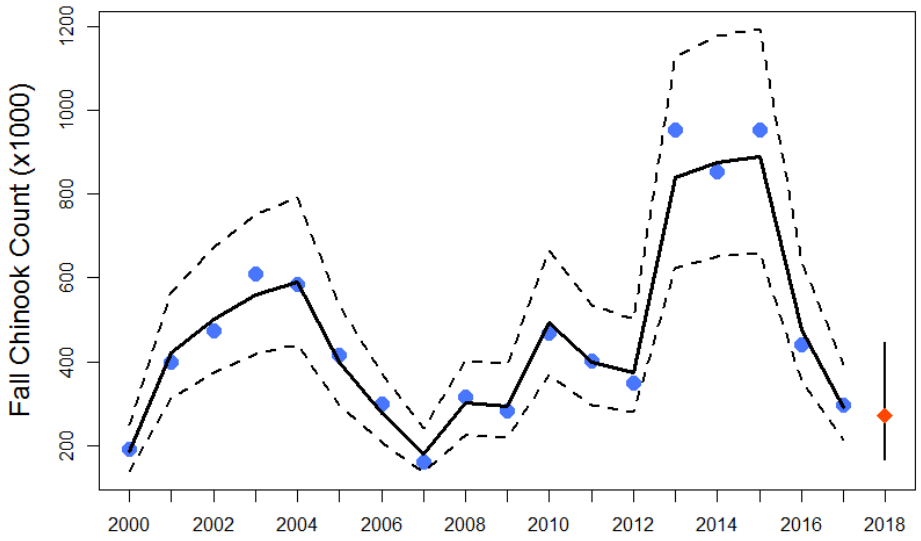
March 15 – May 31



Outlook for 2018: 100K (57-175)

Fall Chinook

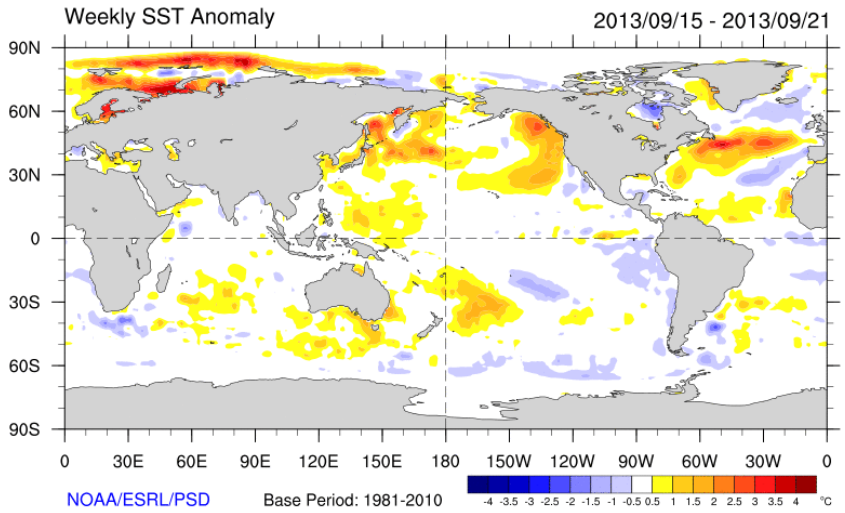
Aug 1 – Nov 15



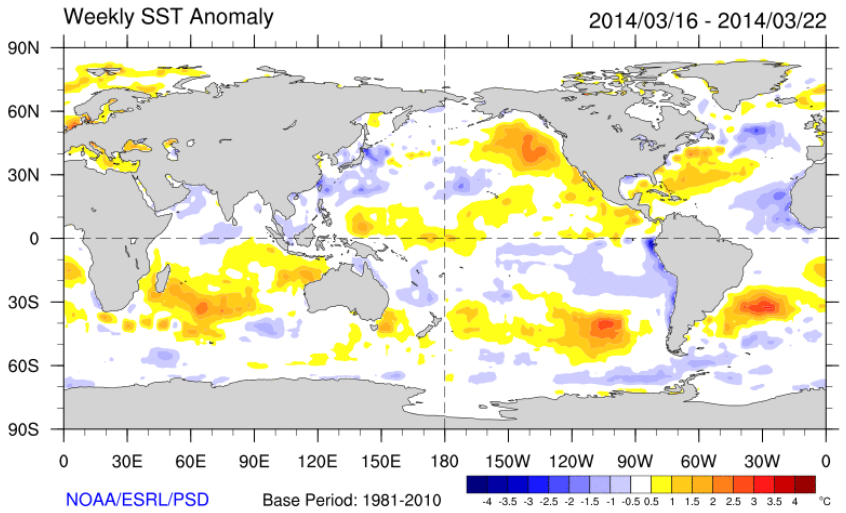
Outlook for 2018: 272K (166-448)

Data from Columbia Basin Research, DART

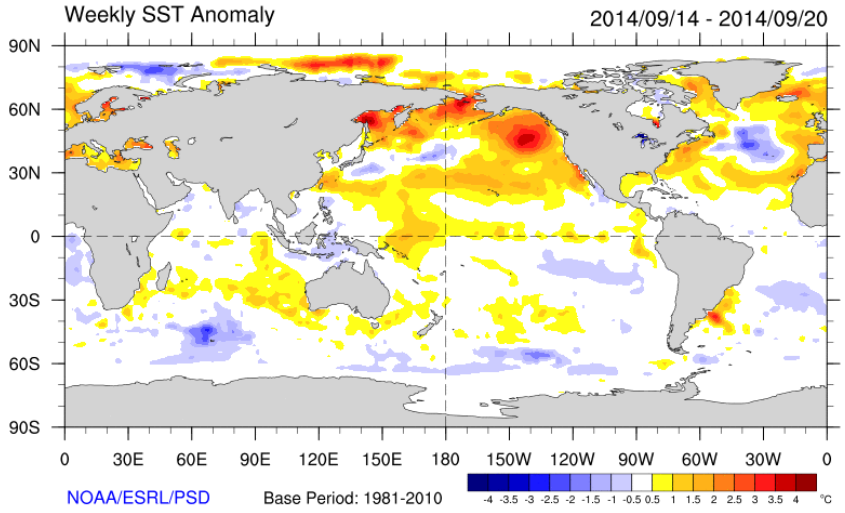
September 2013



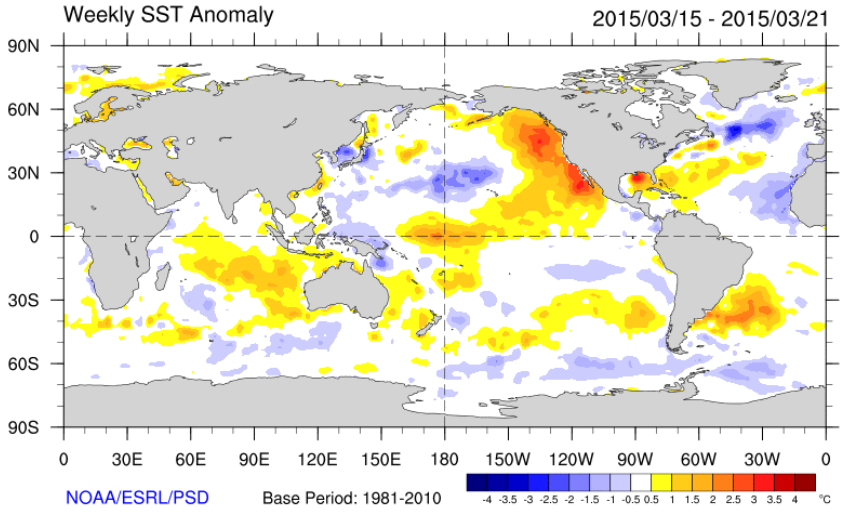
March 2014



September 2014

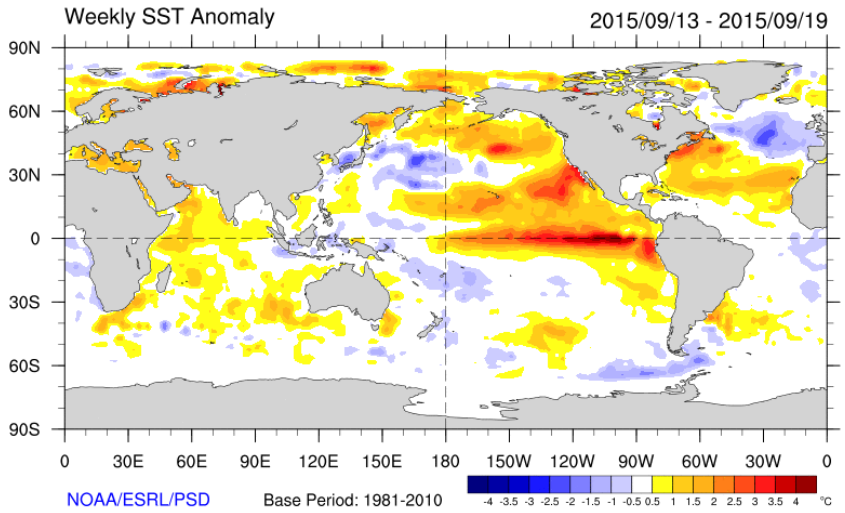


March 2015

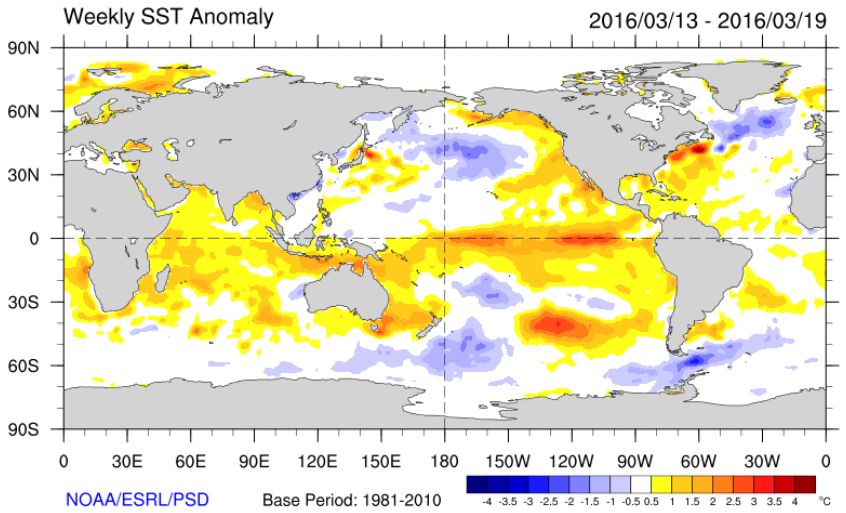


https://www.esrl.noaa.gov/psd/map/clim/sst.shtml

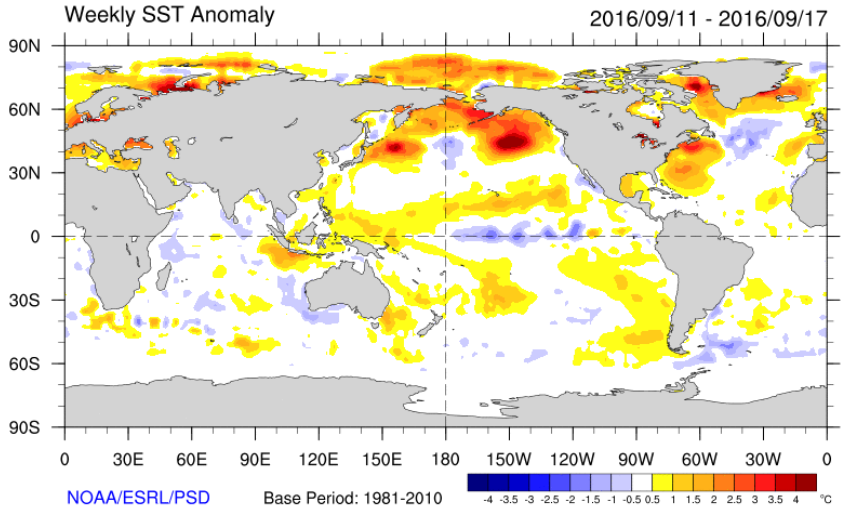
September 2015



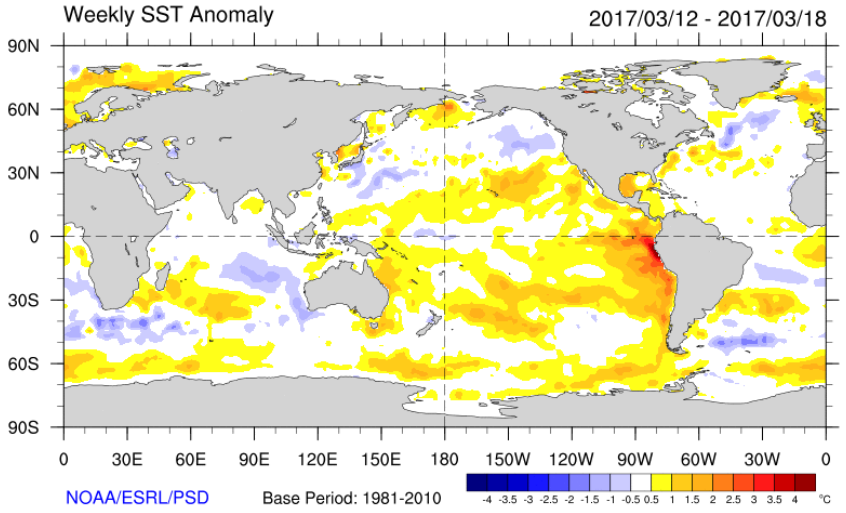
March 2016



September 2016

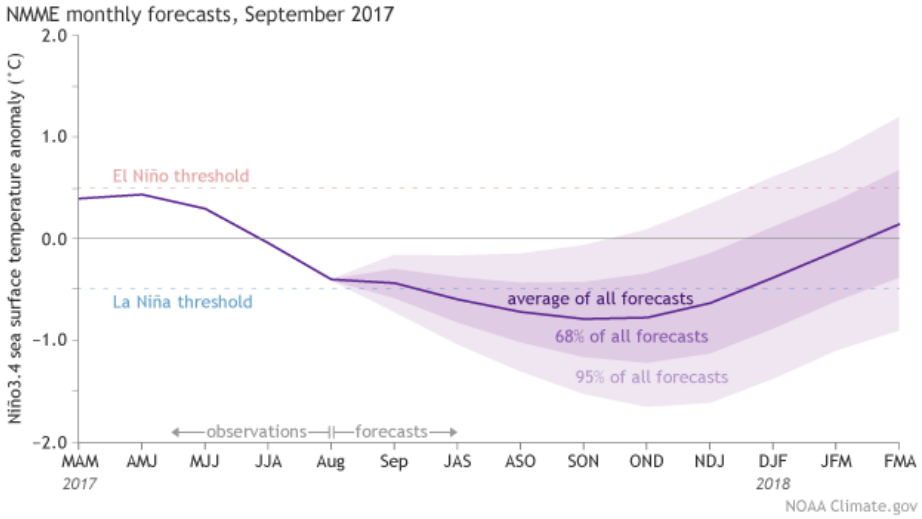


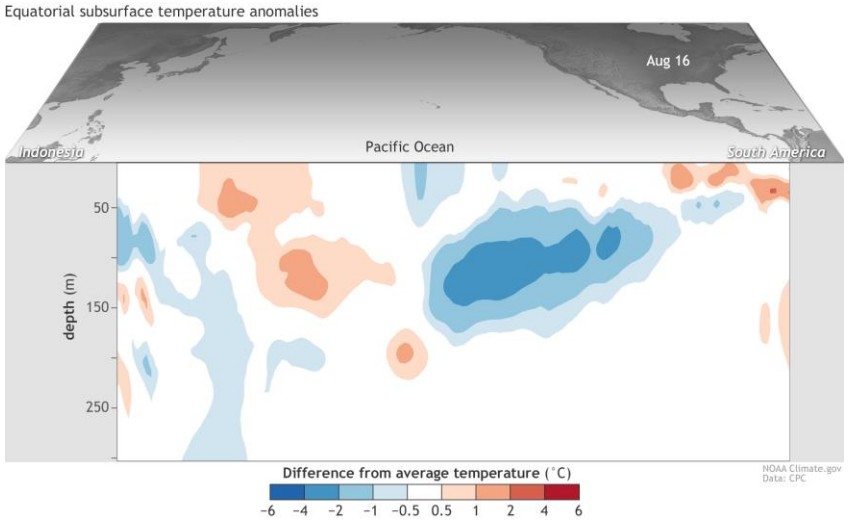
March 2017



https://www.esrl.noaa.gov/psd/map/clim/sst.shtml

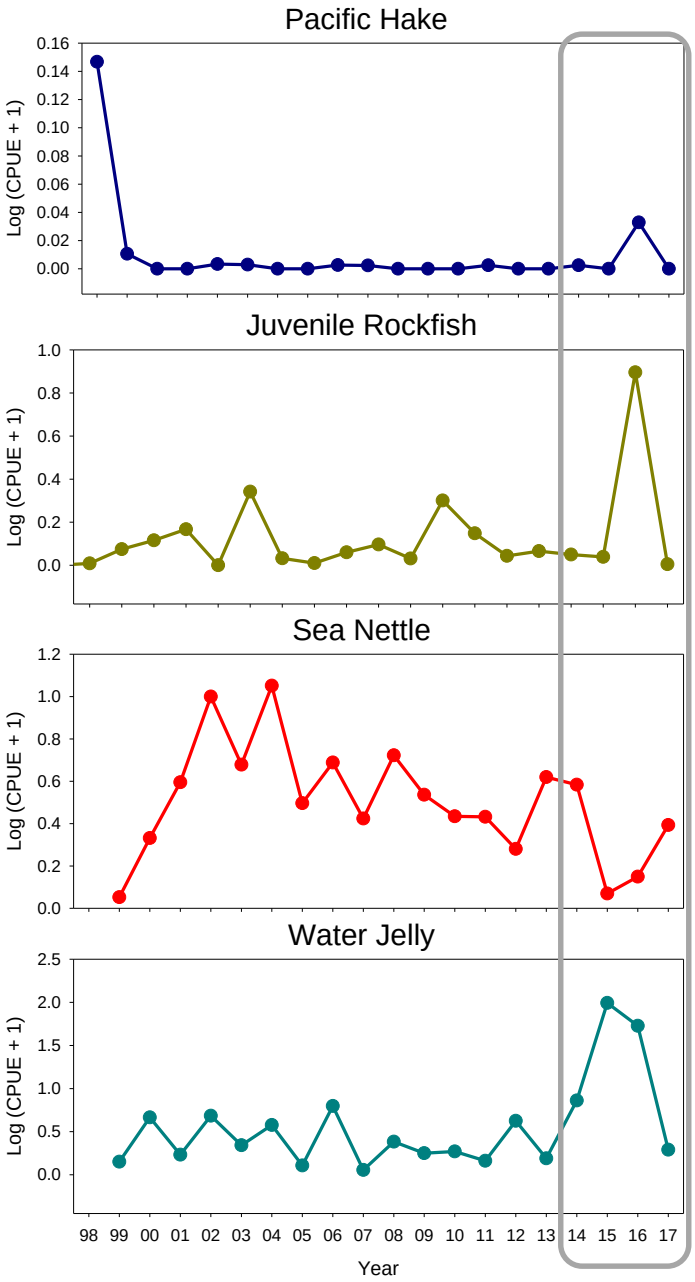
Possible La Niña?





Climate model forecasts for the Niño3.4 Index, from the North American Multi-Model Ensemble (NMME). Darker purple envelope shows the range of 68% of all model forecasts; lighter purple shows the range of 95% of all model forecasts. NOAA Climate.gov image from CPC data.

Unusual patterns of abundance across multiple species



Unusual patterns of abundance across multiple species