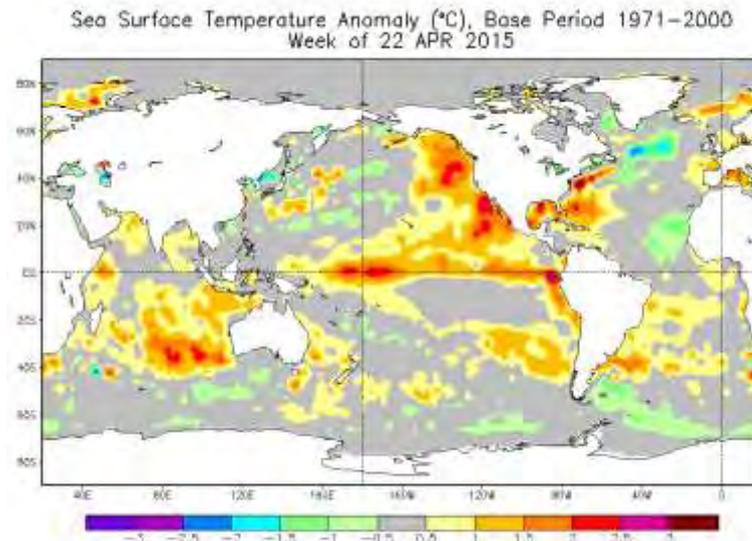


Overview of Recent Ocean Conditions and potential consequences for salmon

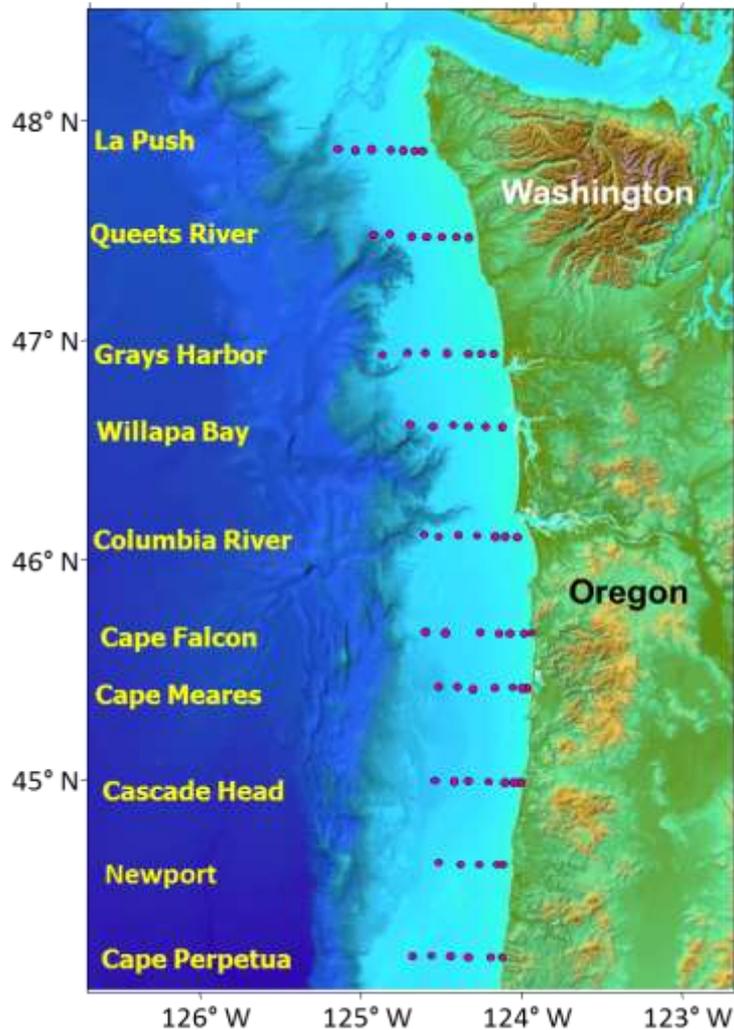
Brian Burke, Bill Peterson, Kurt Fresh, Nate Mantua, Marc Trudel, Joe Orsi, Jamal Moss, Cheryl Morgan, Jay Peterson, Jennifer Fisher, Brian Beckman, Ric Brodner, Tom Wainwright, David Teel, Jen Zamon, Laurie Weitkamp, Elizabeth Daly



Science Work Group
April 28, 2015



Observations



Juvenile salmon sampling:

- May (2006 - 2012)
- June (1998 - present)
- September (1998 - 2012)

Measure physical and biological conditions

Focus on distribution & abundance of juvenile salmonids along with metrics of growth & condition

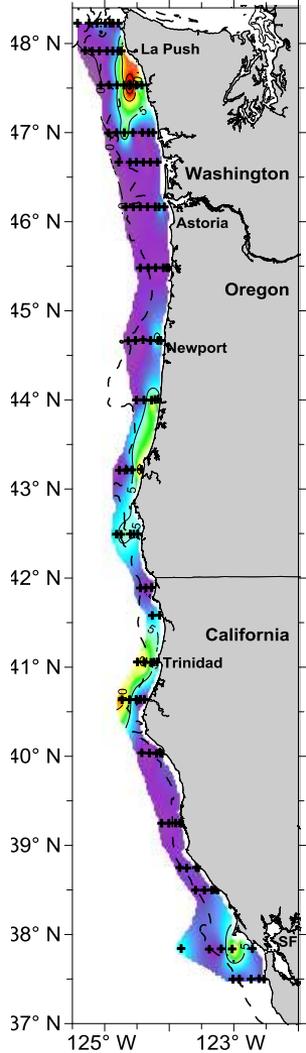
Indicators

(of ocean conditions relative to salmon)

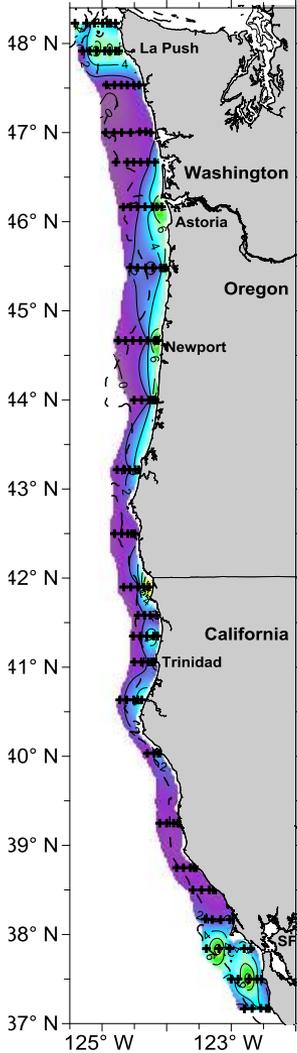
- **Basin Scale:**
 - PDO, NPGO, ONI
- **Local Scale SST:**
 - SST offshore and SST mid-shelf in summer; SST in winter
- **Coastal upwelling:**
 - spring transition; length of upwelling season, upwelling in spring; deep T and S in mid-shelf waters
- **Copepods:**
 - species richness, northern copepod biomass, copepod community structure index, date of biological spring transition
- **Ichthyoplankton:**
 - density in Jan-Mar of the larvae of species of fish that salmon eat
- **Salmon:**
 - catches of spring Chinook in June and coho in September

Chlorophyll was high

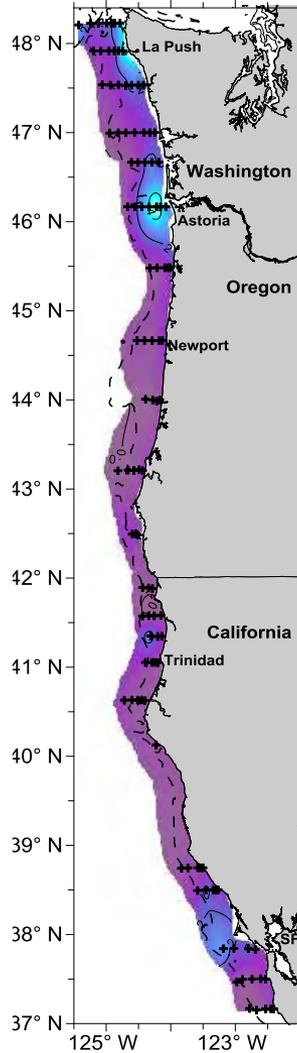
June 21 - July 13, 2010
3m Chlorophyll-a



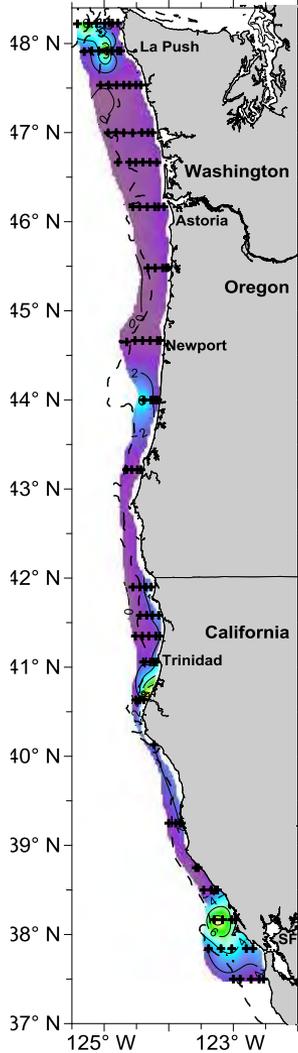
June 20 - July 15, 2011
3m Chlorophyll-a



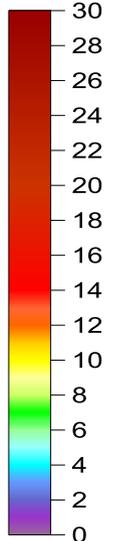
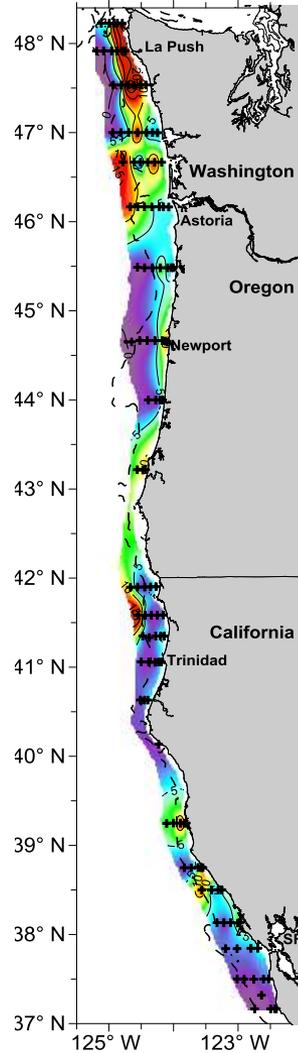
June 11 - 28, 2012
3m Chlorophyll a



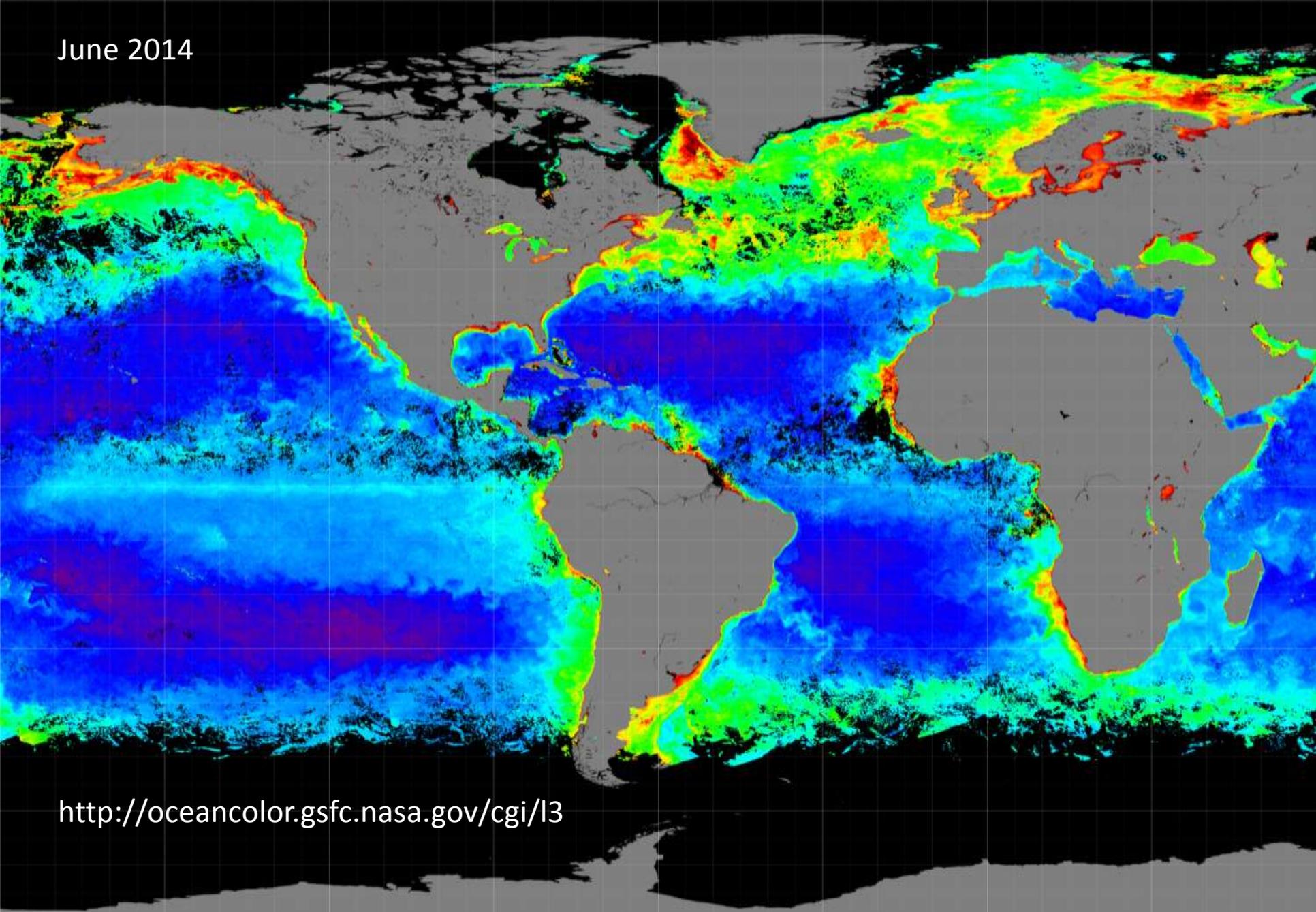
June 20 - July 23, 2013
3m Chlorophyll a



June 20 - July 22, 2014
3m Chlorophyll a

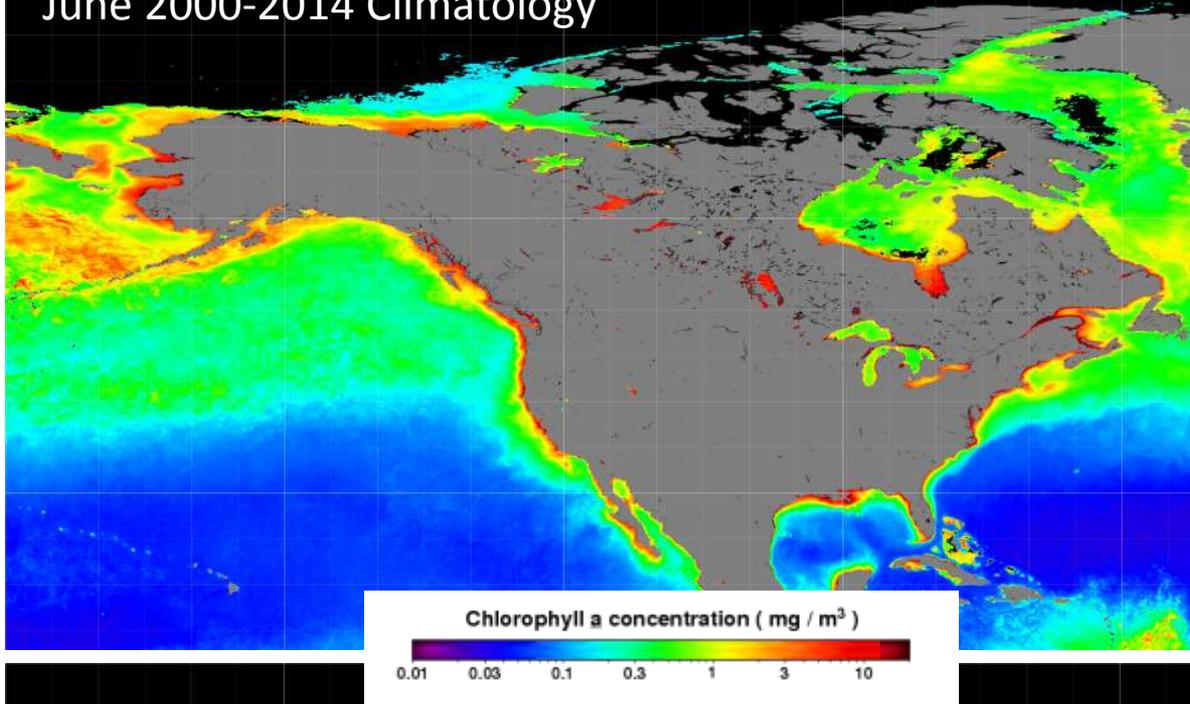


June 2014

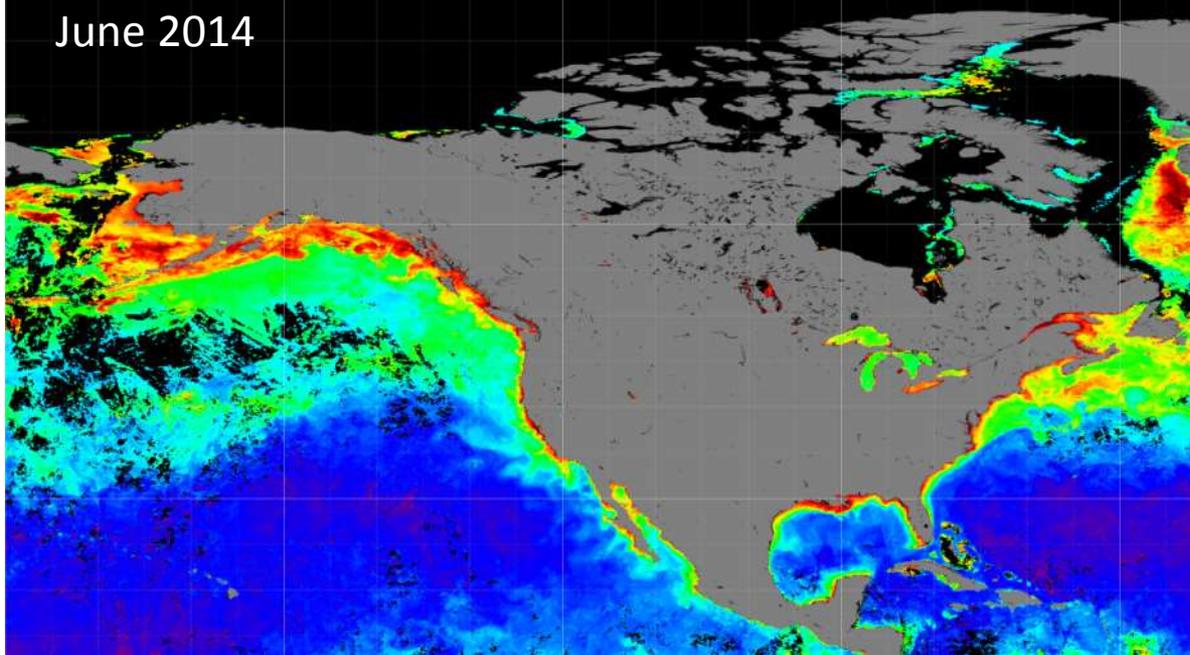


<http://oceancolor.gsfc.nasa.gov/cgi/l3>

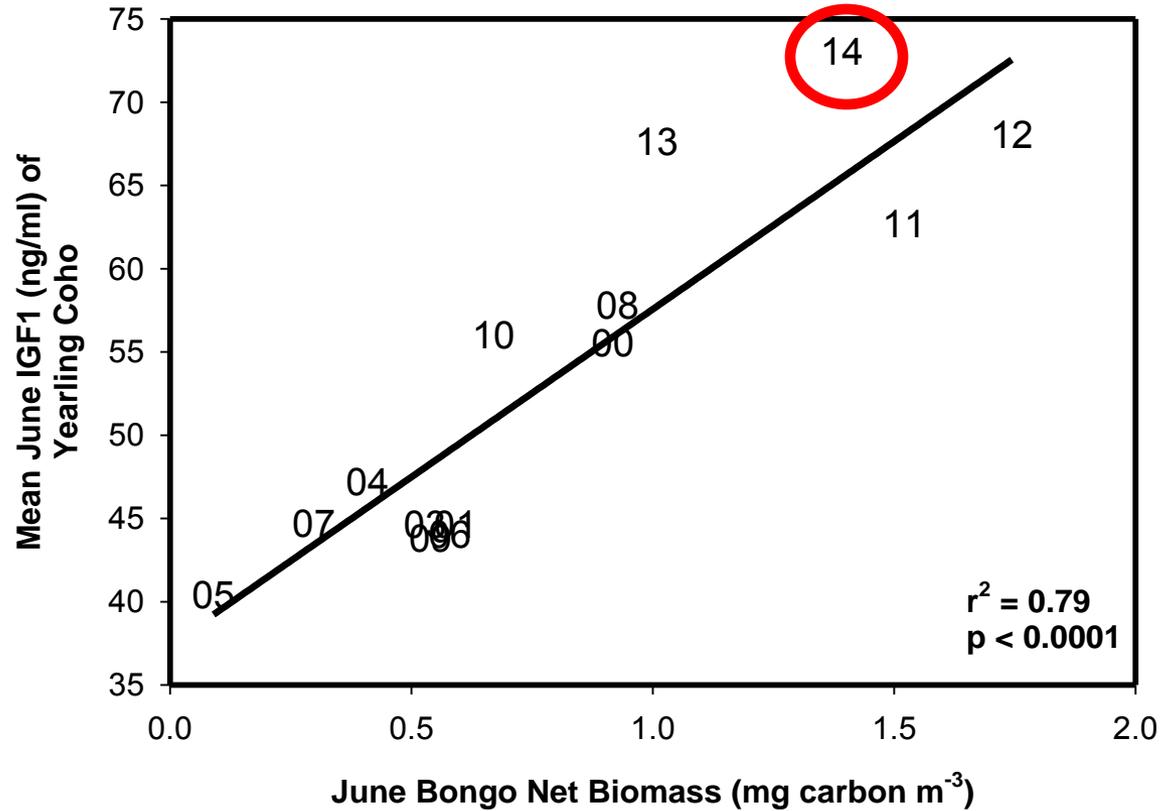
June 2000-2014 Climatology



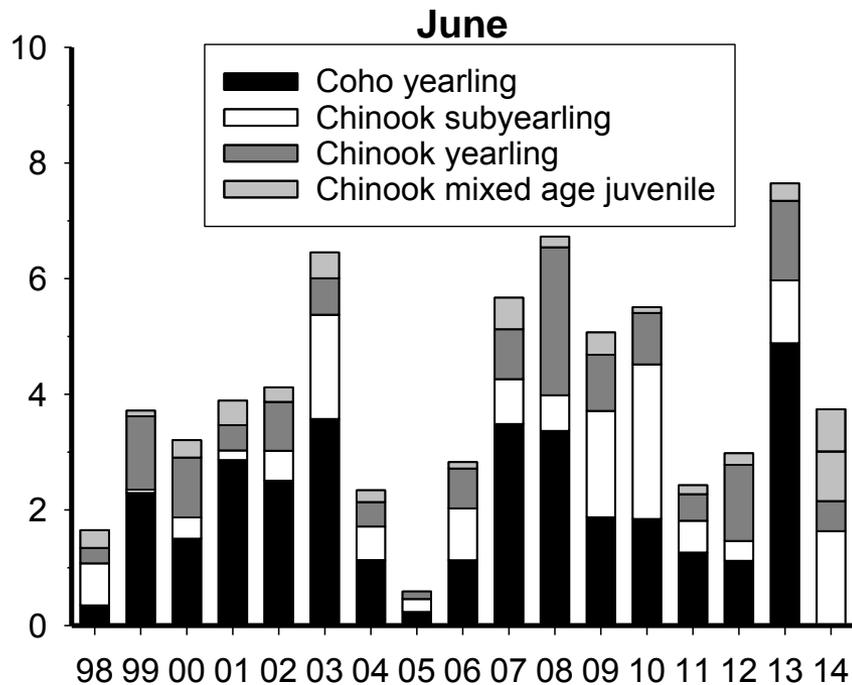
June 2014



Salmon growth was high!



Salmon Catch per Unit Effort



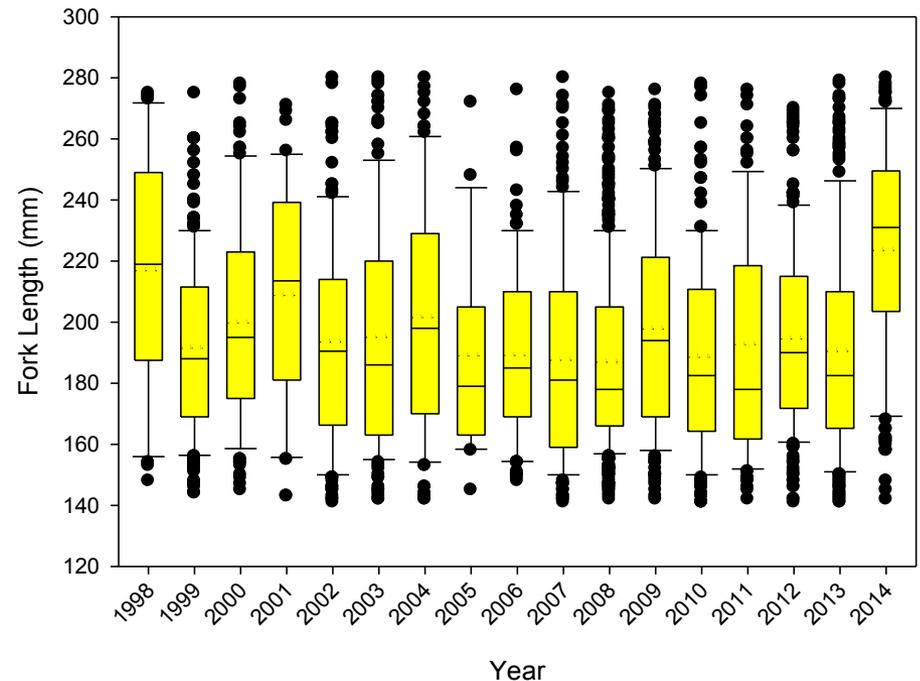
17 June Cruises

Coho yearling – 10th

Chinook subyearling – 11th

Chinook yearling – 9th

Yearling Chinook Salmon Size

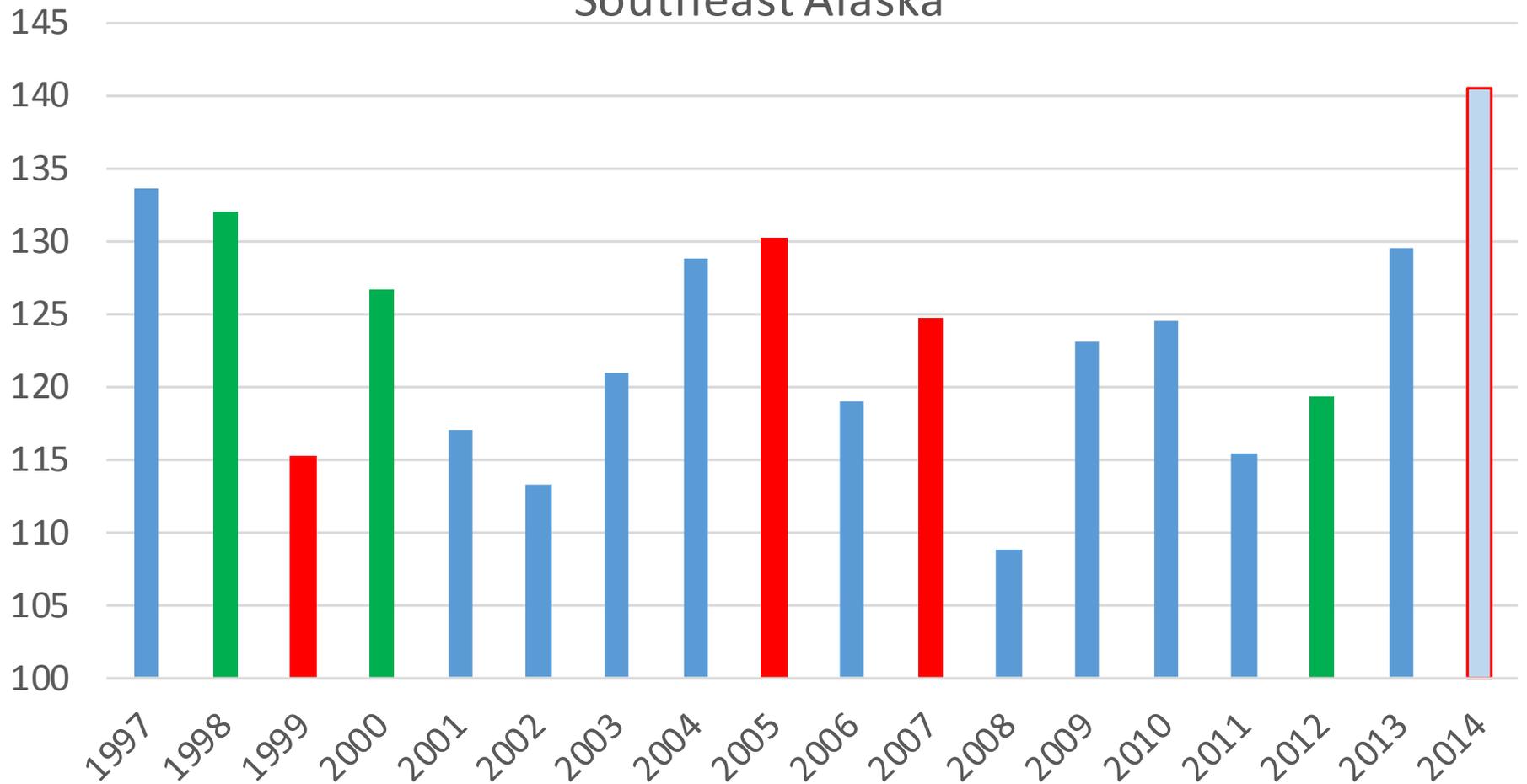


2014: Largest in time series

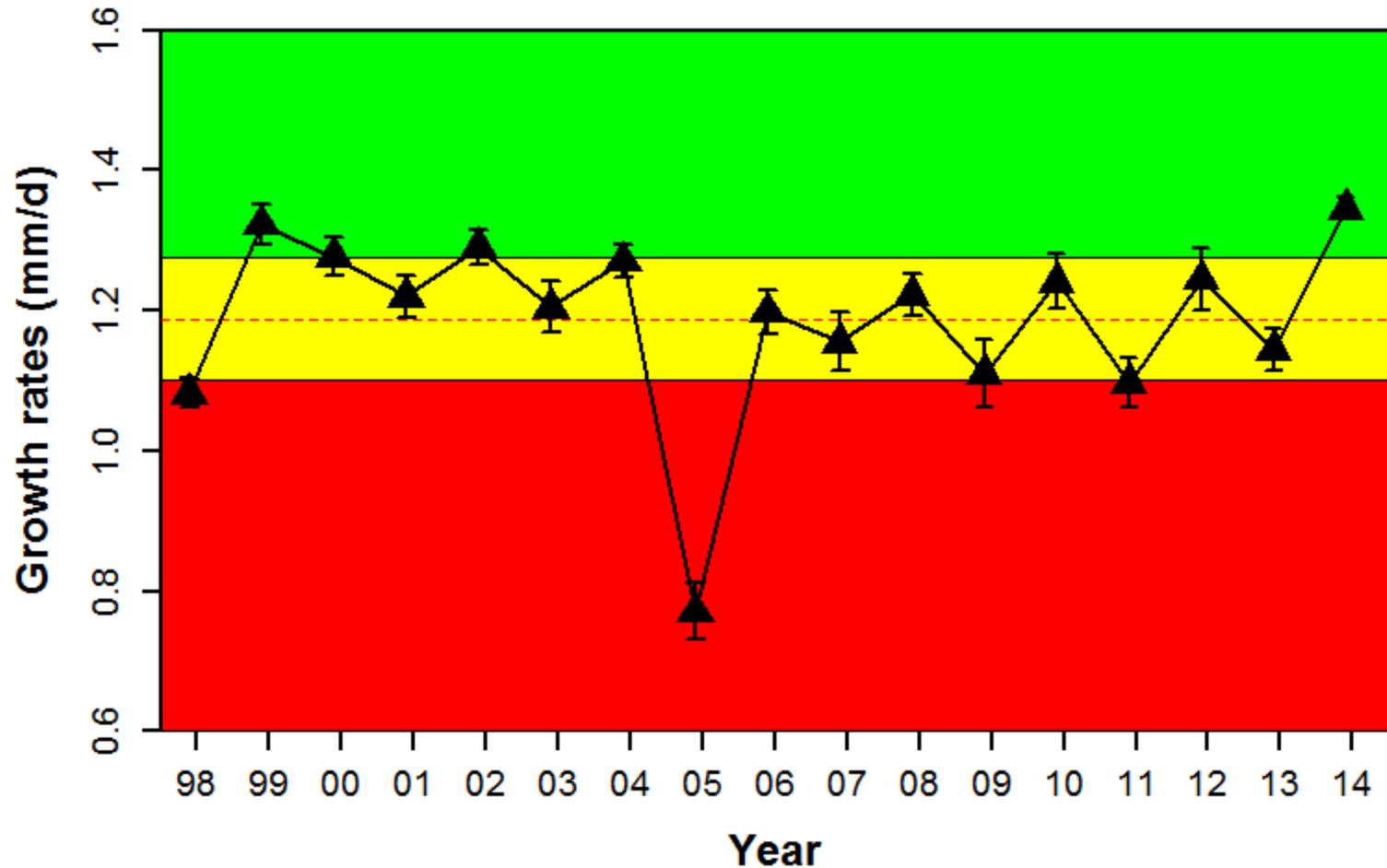
(does this represent good growing conditions or high size-selective mortality?)

Juvenile pink salmon size in SE Alaska - BIG in 2014 - But, note the lack of correspondence of fish size to return strength (highest 3 in green & lowest 3 in red)

Pink size at time 24 July 1997-2014, Icy Strait
Southeast Alaska



Best growth on record off the west coast of Vancouver Island in 2014 for juvenile Coho Salmon

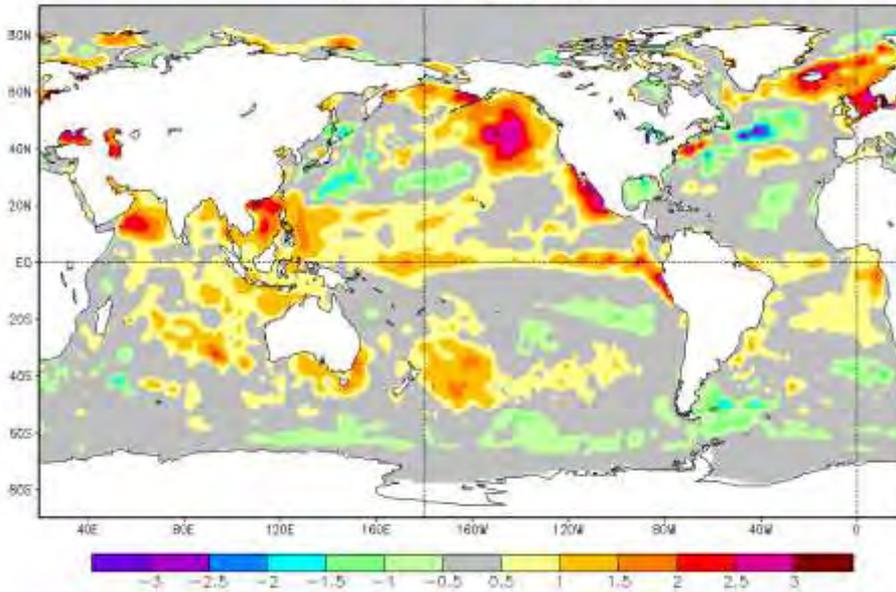


Productivity was good, salmon were fat and happy. Sounds great!

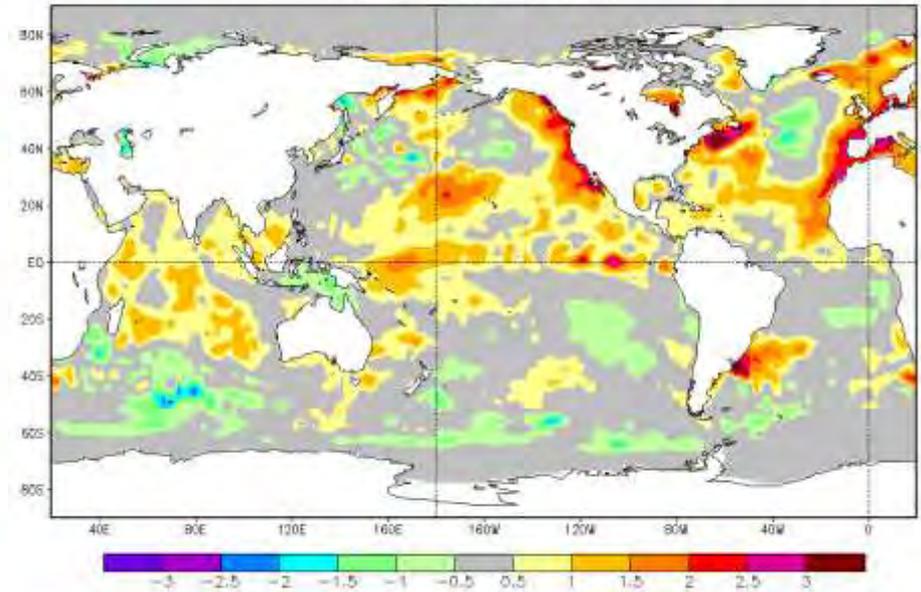


But things changed...

Sea Surface Temperature Anomaly (°C), Base Period 1971–2000
Week of 4 JUN 2014

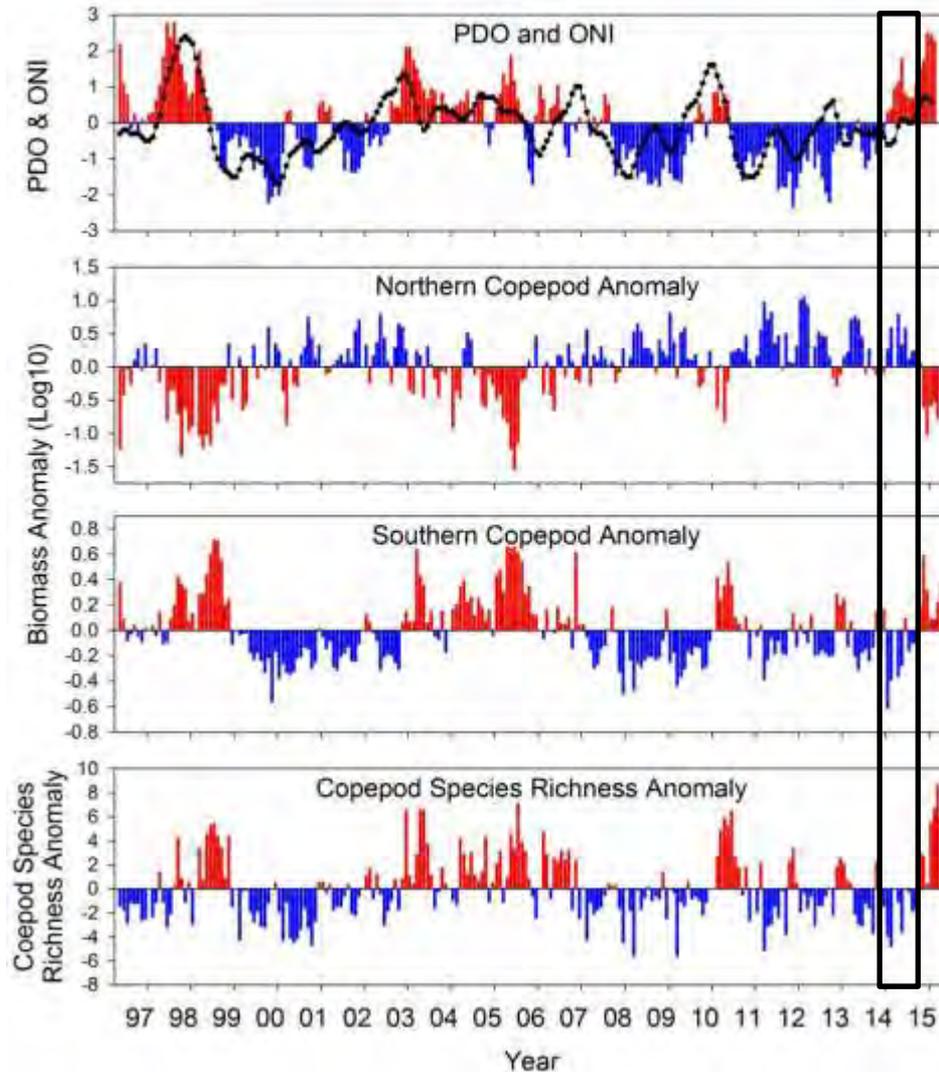


Sea Surface Temperature Anomaly (°C), Base Period 1971–2000
Week of 29 OCT 2014



So what?

Zooplankton



In Alaska...



pomfret



salmon shark



Mola mola



sablefish



thresher shark

In British Columbia...

Sockeye salmon run

A majority of the 2014 sockeye run has diverted round the northern part of Vancouver Island into Canadian waters, leaving U.S. waters with few fish. In normal years the run splits about 50 percent around Vancouver Island with salmon entering U.S. waters through the Strait of Juan de Fuca and Canadian waters through Johnstone Strait.

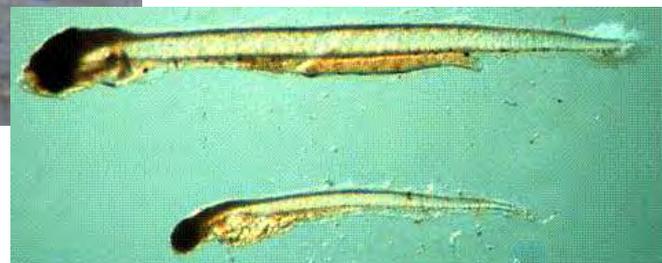


Source: *The Associated Press*

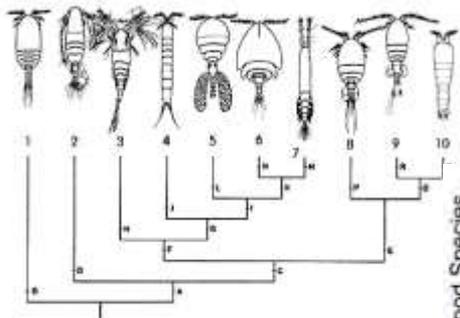
MARK NOWLIN / THE SEATTLE TIMES

In Washington/Oregon...

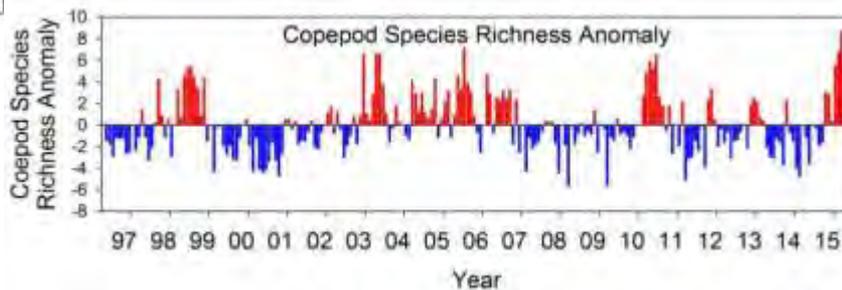
Vellela vellela



larval sardine
and anchovies



copepods



In California...



wahoo



tuna

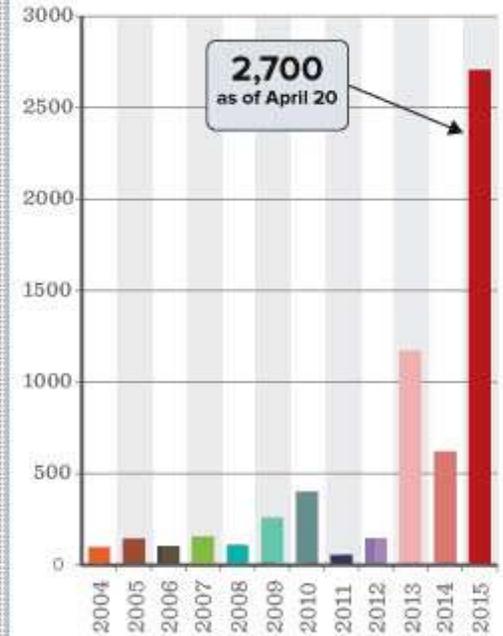


moonfish

California sea lions



Sharp rise in strandings of young California sea lions



Sea lion pups and yearlings strand on California beaches every year, but occurrences are up substantially this year. The number in the first quarter of 2015 alone is more than double all of 2013, which, until now, marked the peak in a decade.

Source: National Oceanic and Atmospheric Administration, National Marine Fisheries Service

VIN News Service / Design by Tamara Rees

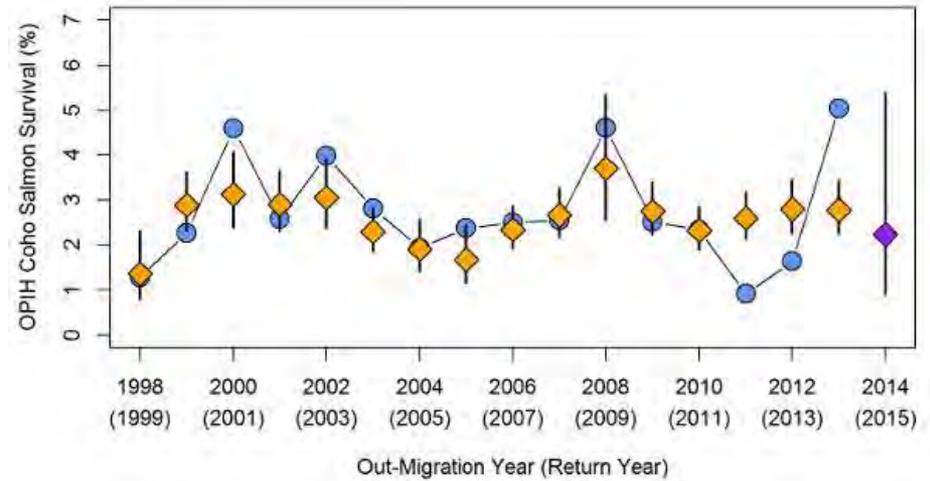
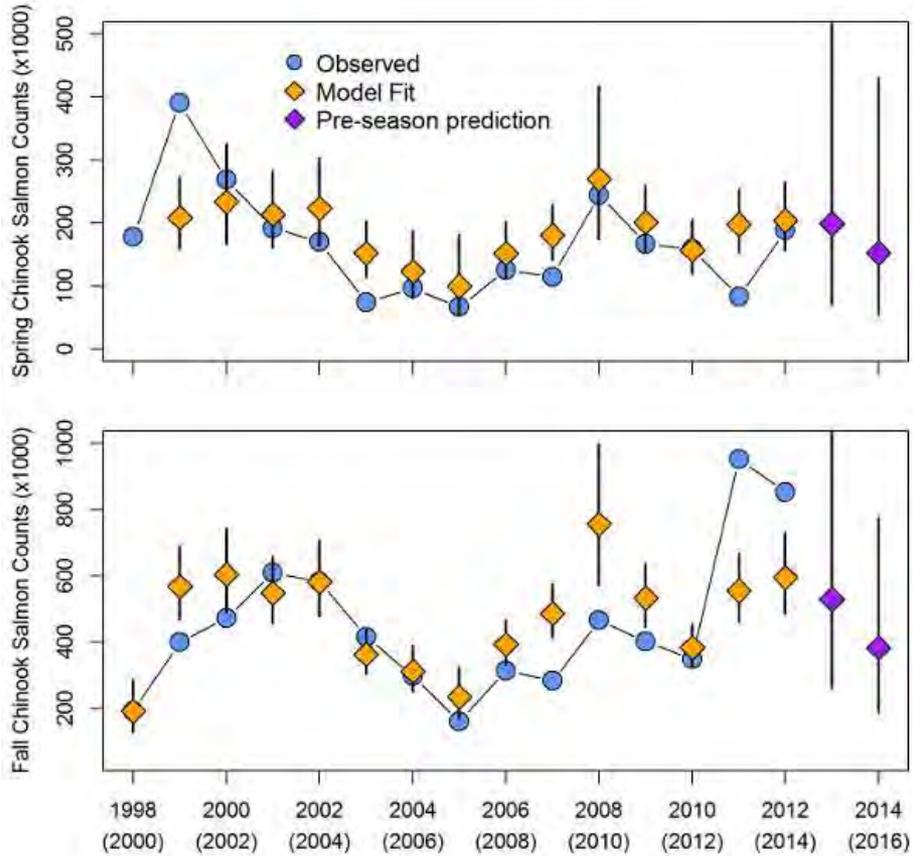


Coast-wide...

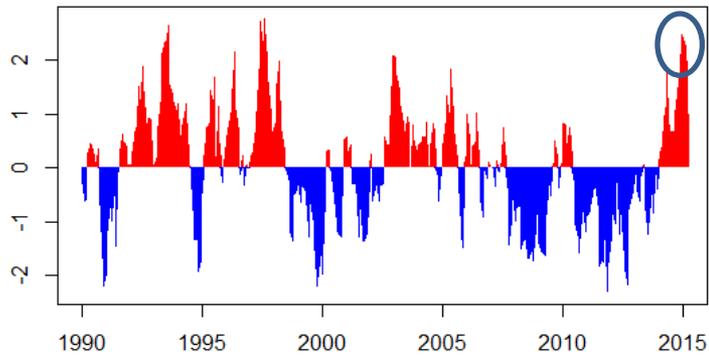


Cassin's auklet

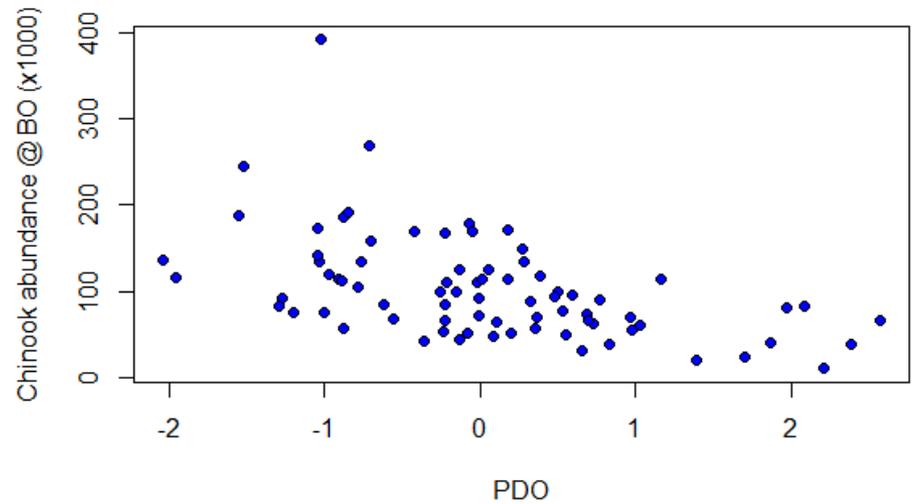
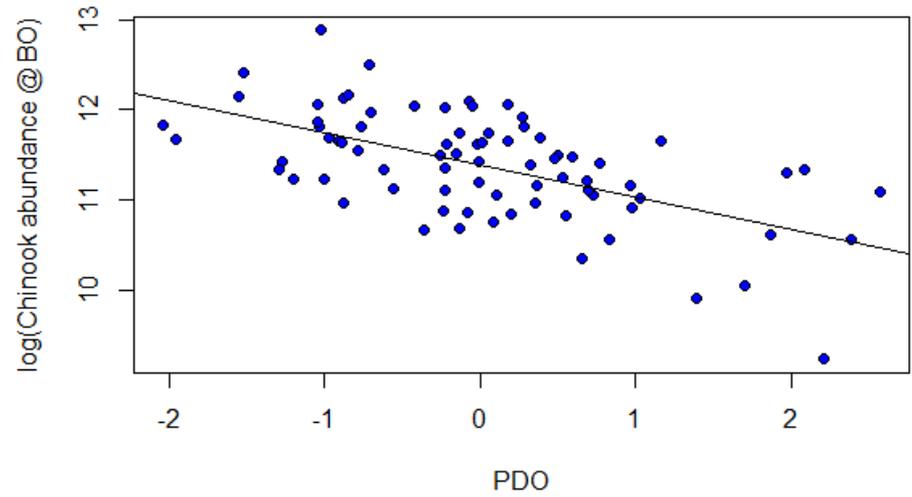
Salmon Forecasts



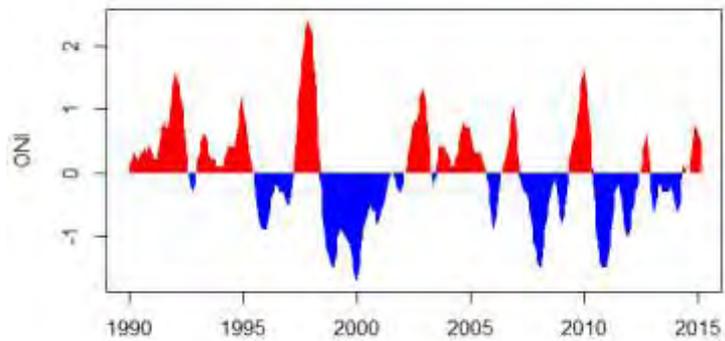
PDO



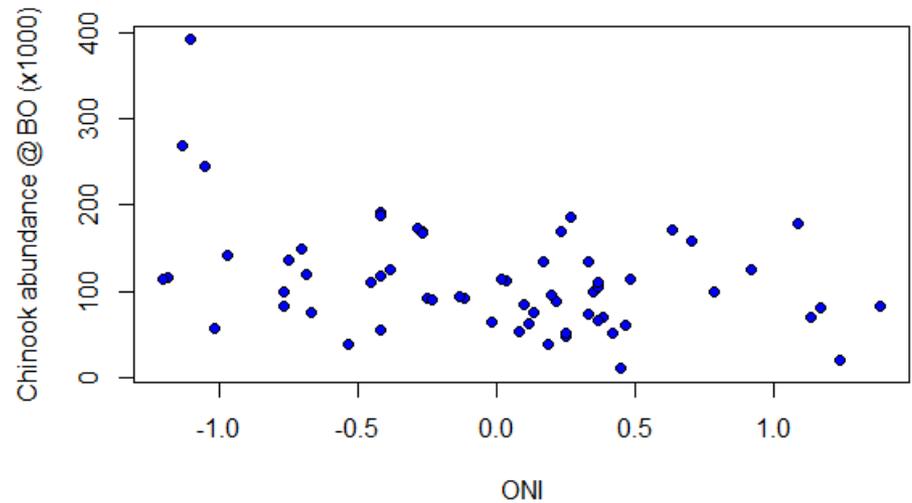
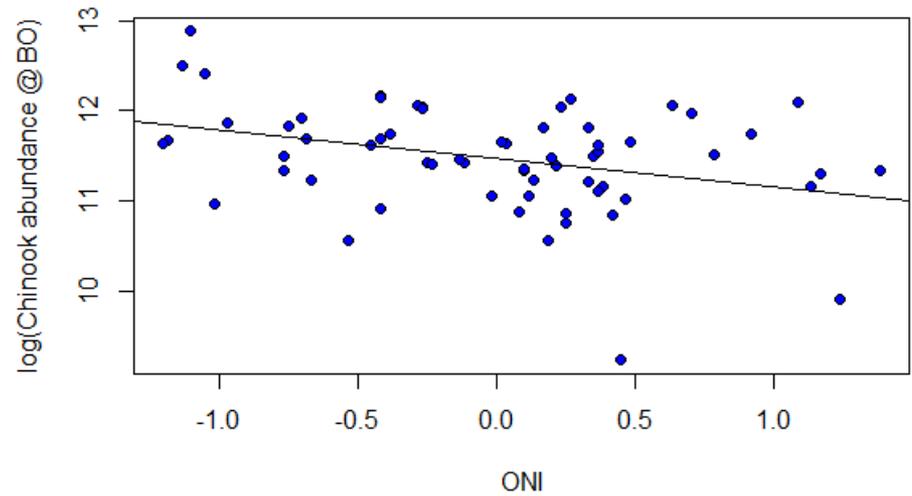
PDO (May-Sept) and
spring Chinook counts at Bonneville
1936-2012



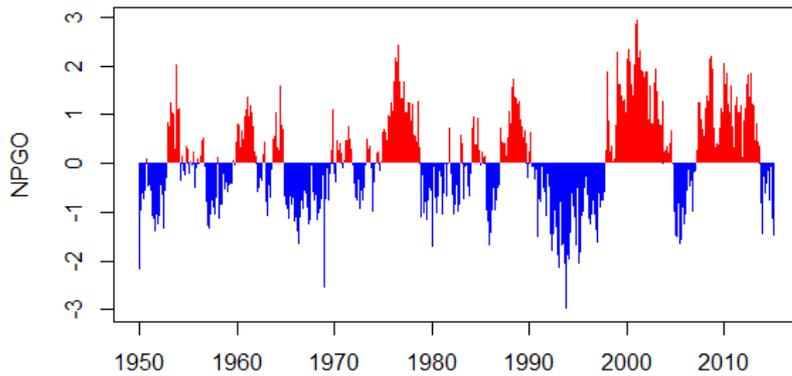
ONI



ONI (Jan-June) and
spring Chinook counts at Bonneville
1950-2012

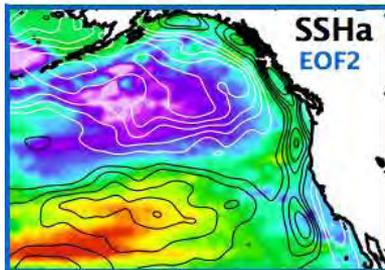


NPGO

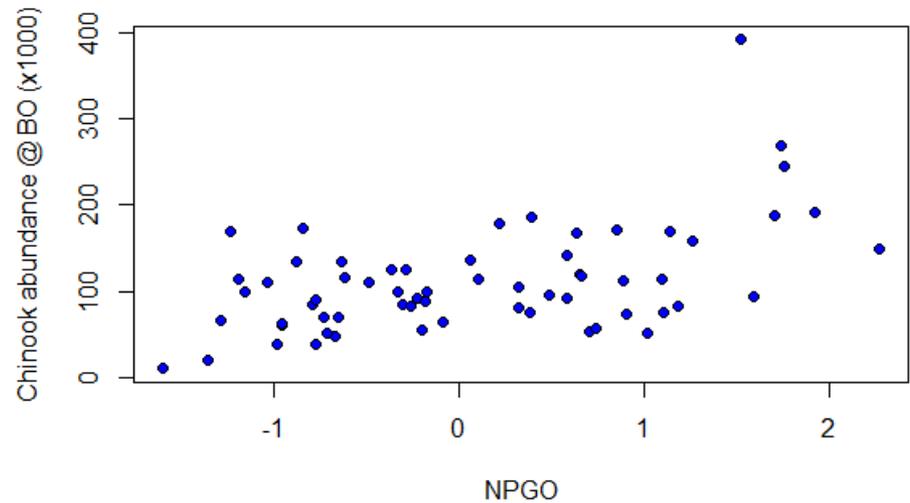
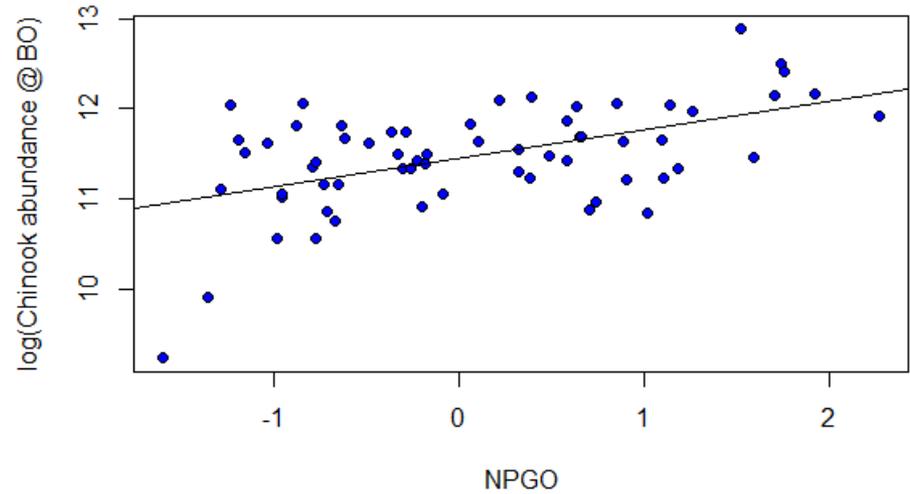


NPGO Mode

defined: as 2nd EOF of SSHa
in the Northeast Pacific



NPGO (May-Sept) and spring Chinook counts at Bonneville 1950-2012



Conclusions

- 2014 was hot (and 2015 is probably worse)
- Primary productivity was high and many stocks/species of salmon were large or showed high growth rates
- The ecosystem that fish entered was dramatically different than normal (think tuna)
- Cumulative effect on salmon?