# Overview of Recent Ocean Conditions

## and potential consequences for salmon

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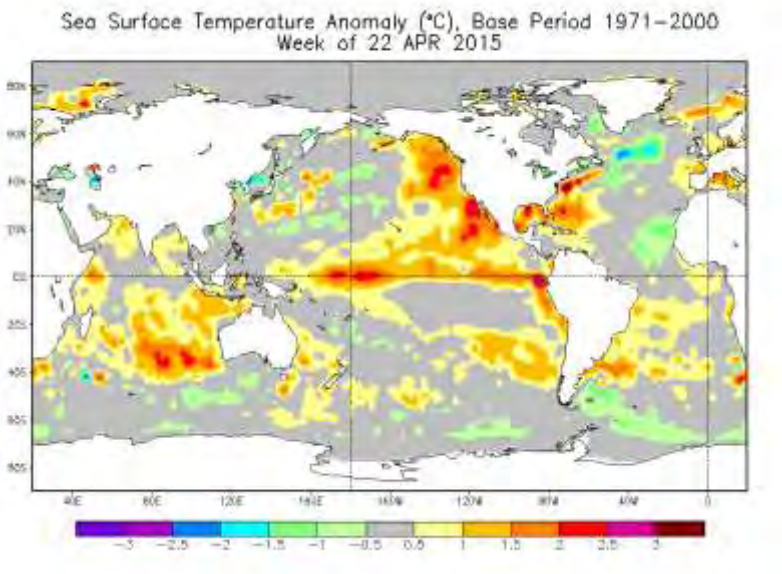
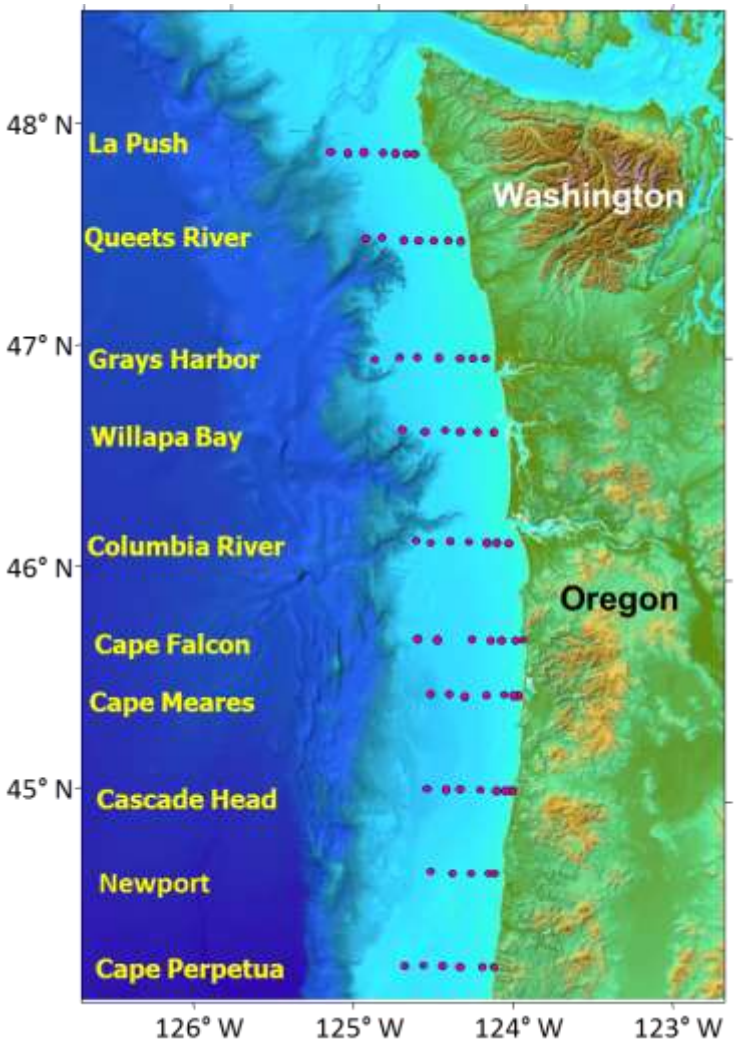
Lower Columbia Estuary Partnership

***Science Work Group***
***April 28, 2015***




http://www.ncdc.noaa.gov/teleconnections/enso/indicators/sea-temp-anom.php




# 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

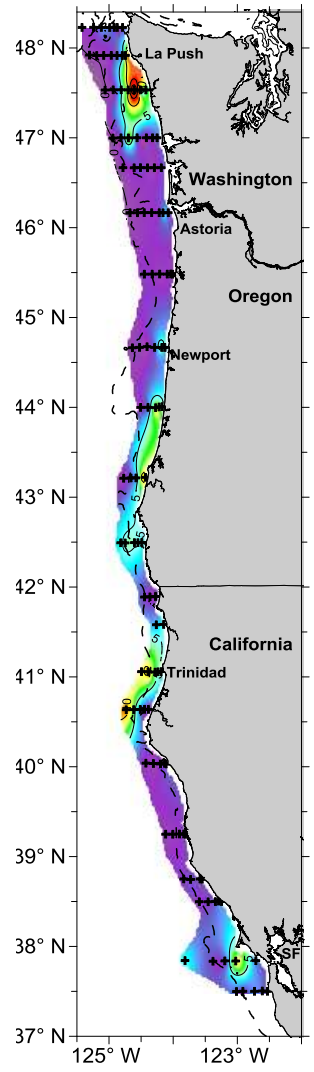
(of ocean conditions relative to salmon)

- **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

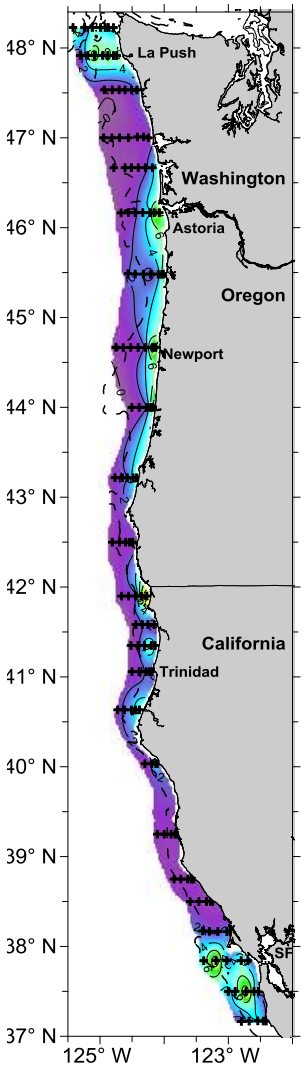
http://www.nwfsc.noaa.gov/oceanconditions

# Chlorophyll was high

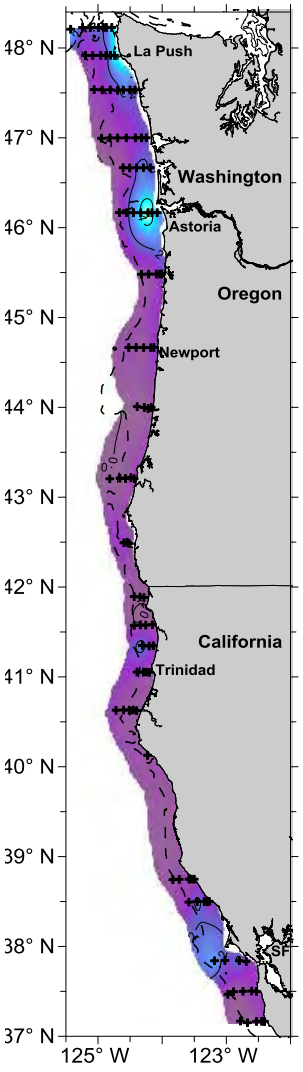
June 21 - July 13, 2010
3m Chlorophyll-a



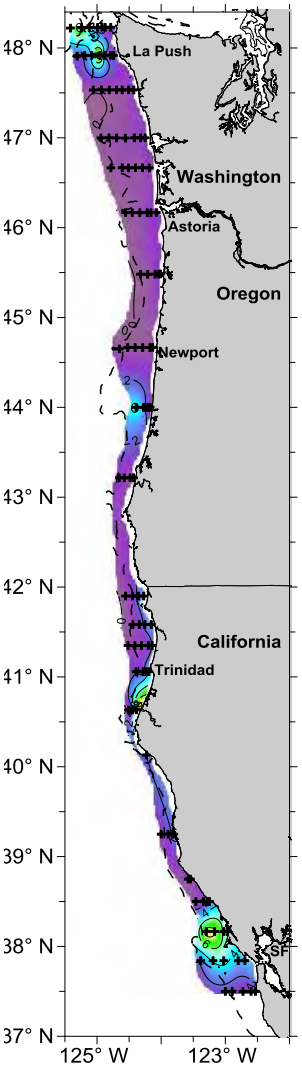

June 20 - July 15, 2011
3m Chlorophyll-a



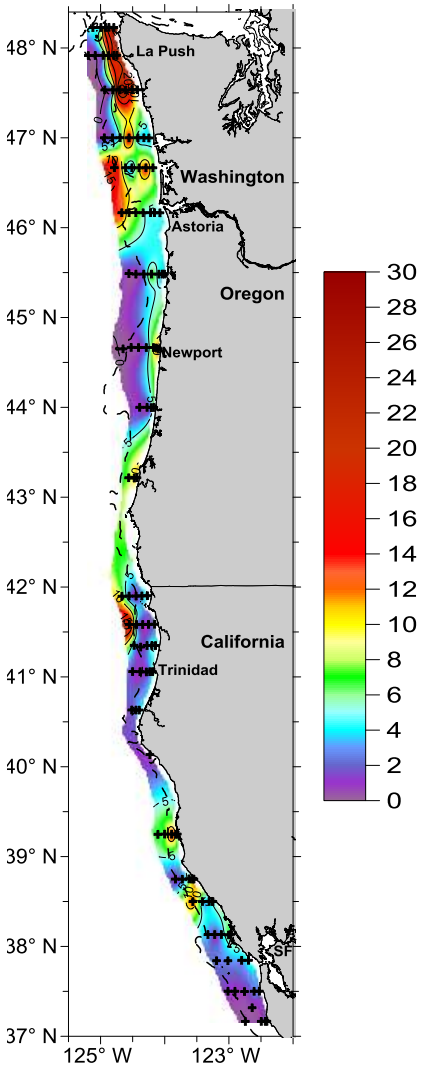

June 11 - 28, 2012
3m Chlorophyll *a*

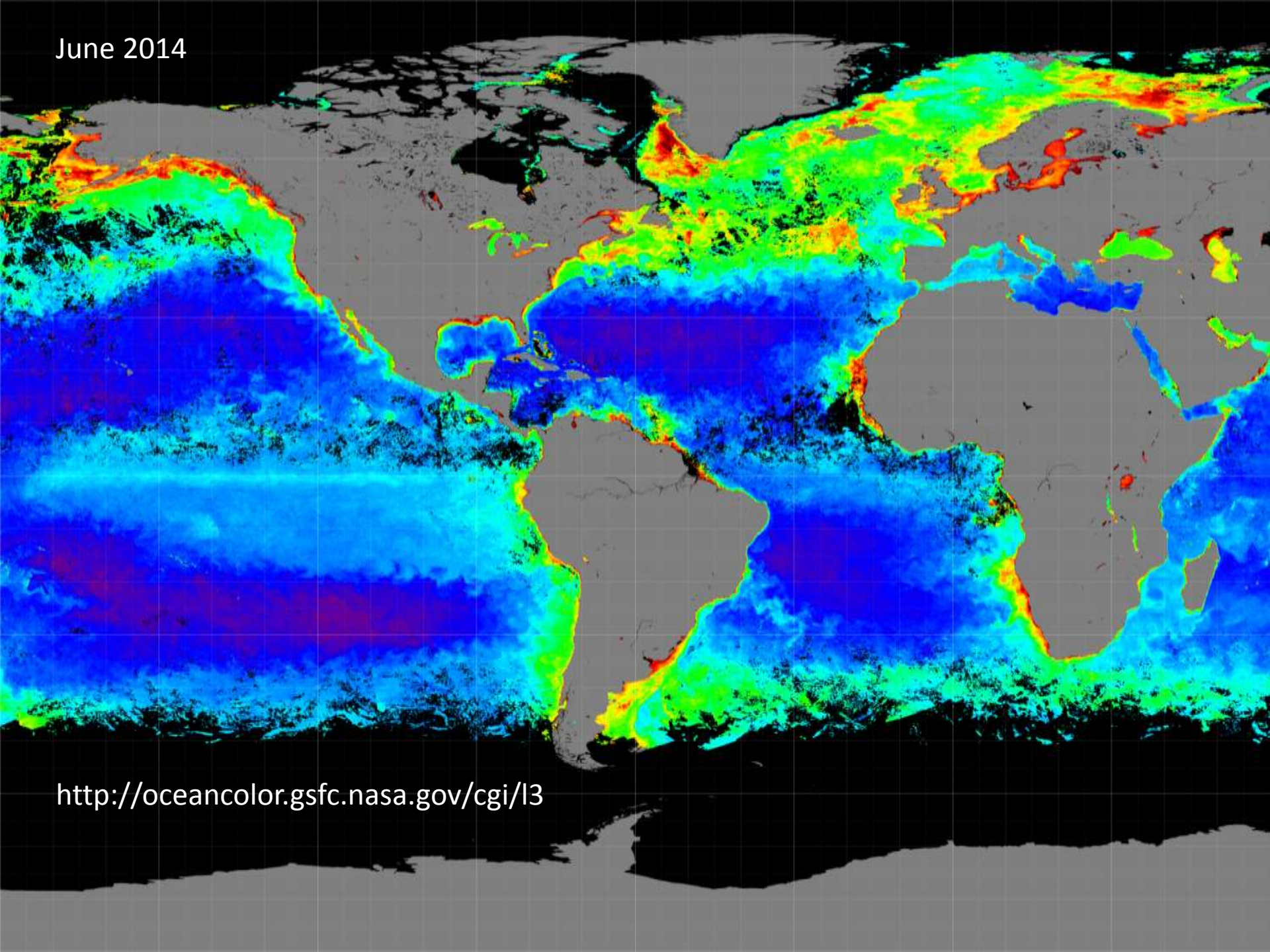


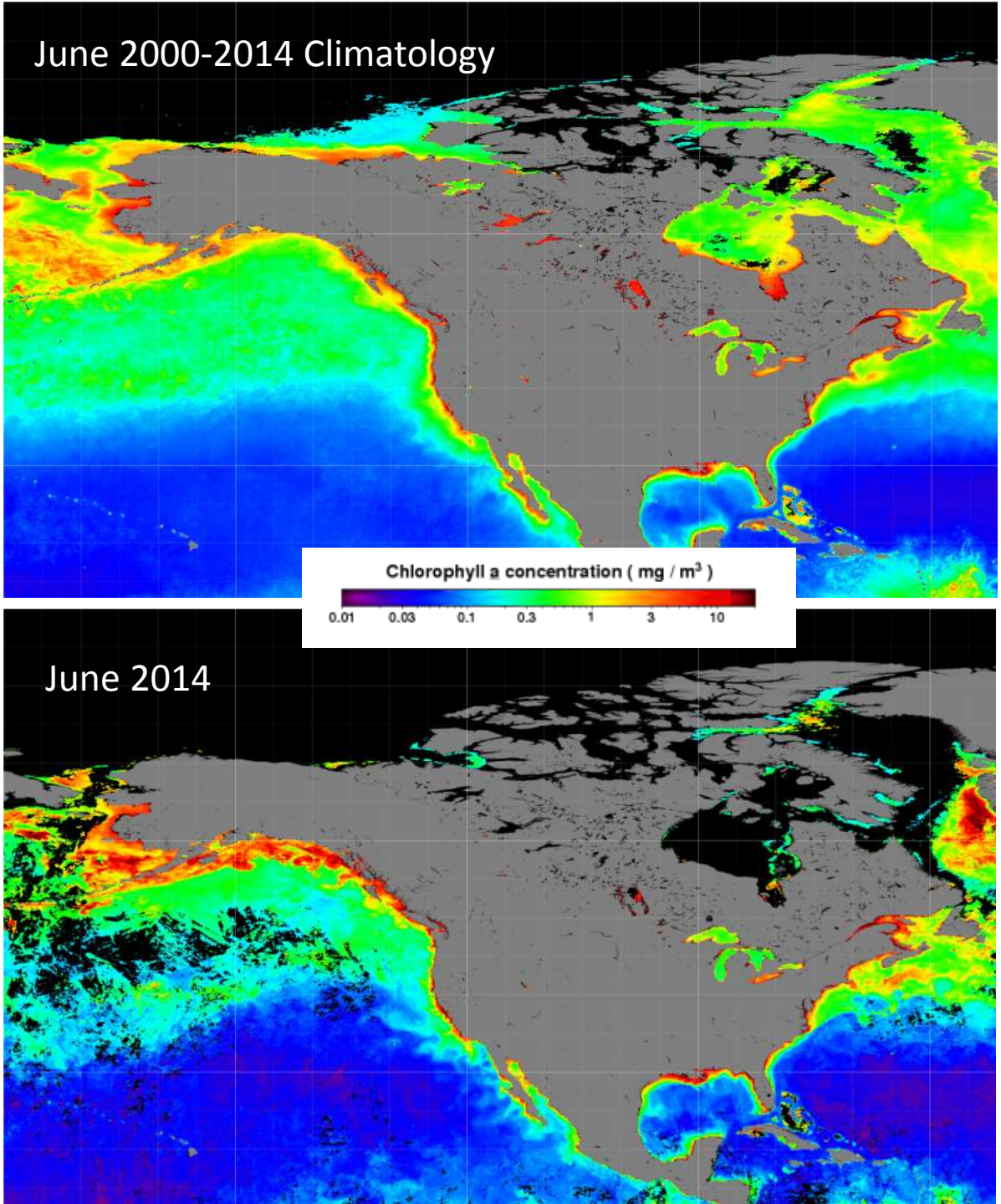

June 20 - July 23, 2013
3m Chlorophyll *a*



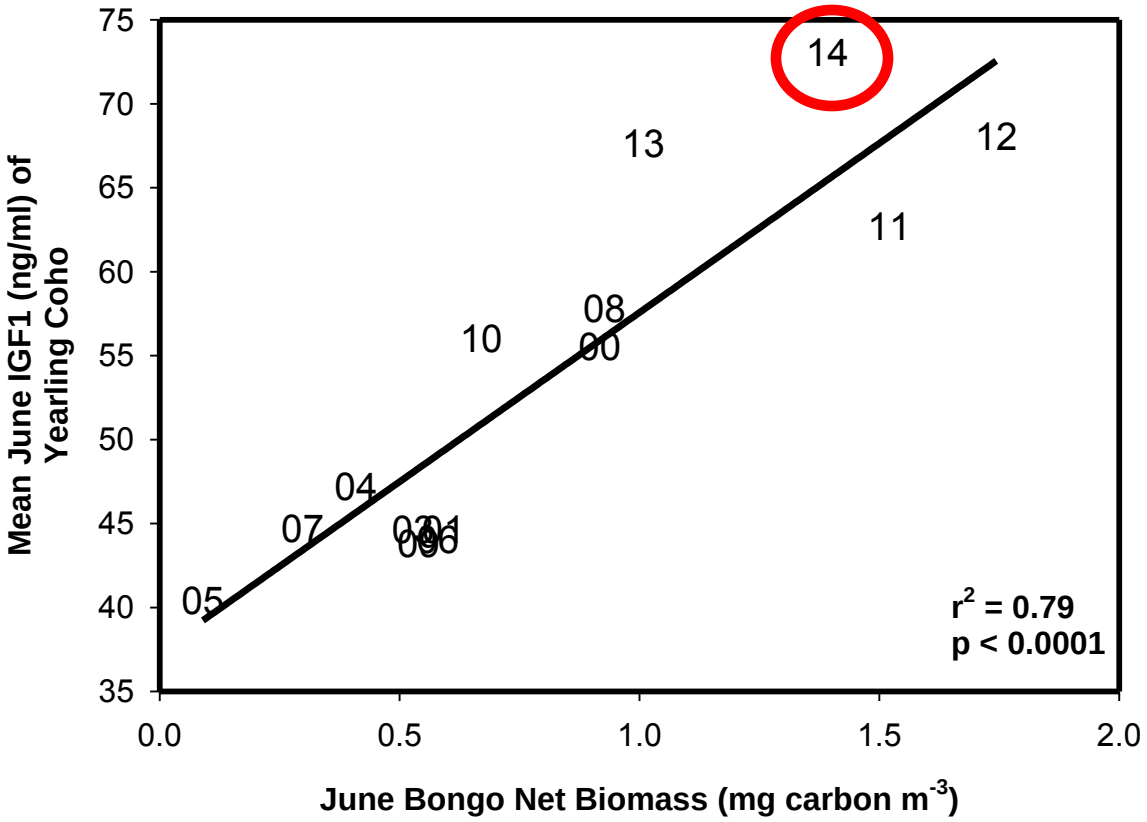

June 20 - July 22, 2014
3m Chlorophyll *a*



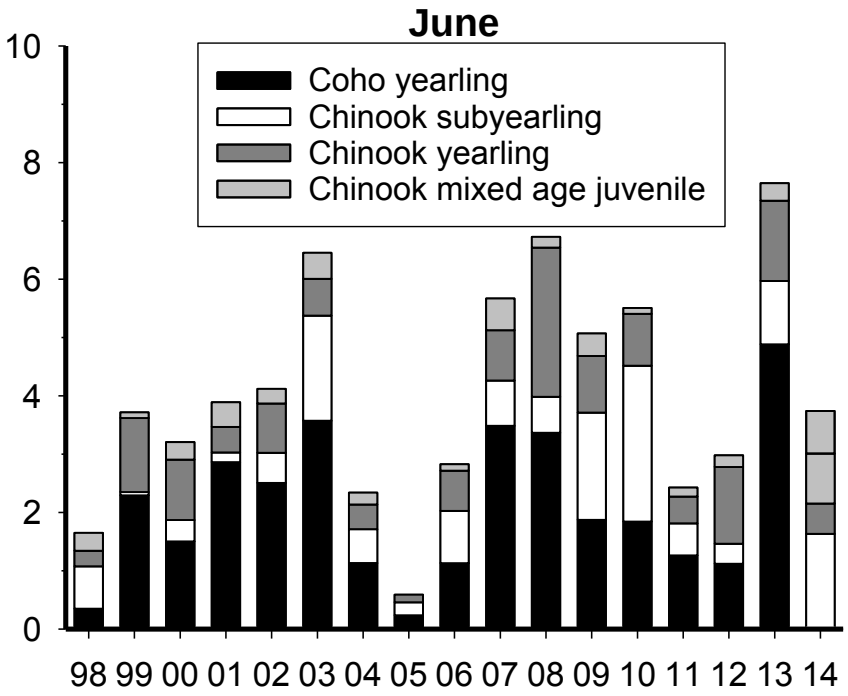

June 2014
http://oceancolor.gsfc.nasa.gov/cgi/l3


June 2000-2014 Climatology
Chlorophyll a concentration ( mg / m3 )
0.01
0.03
0.1
0.3
1
3
10
June 2014

# Salmon growth was high!



## Salmon Catch per Unit Effort



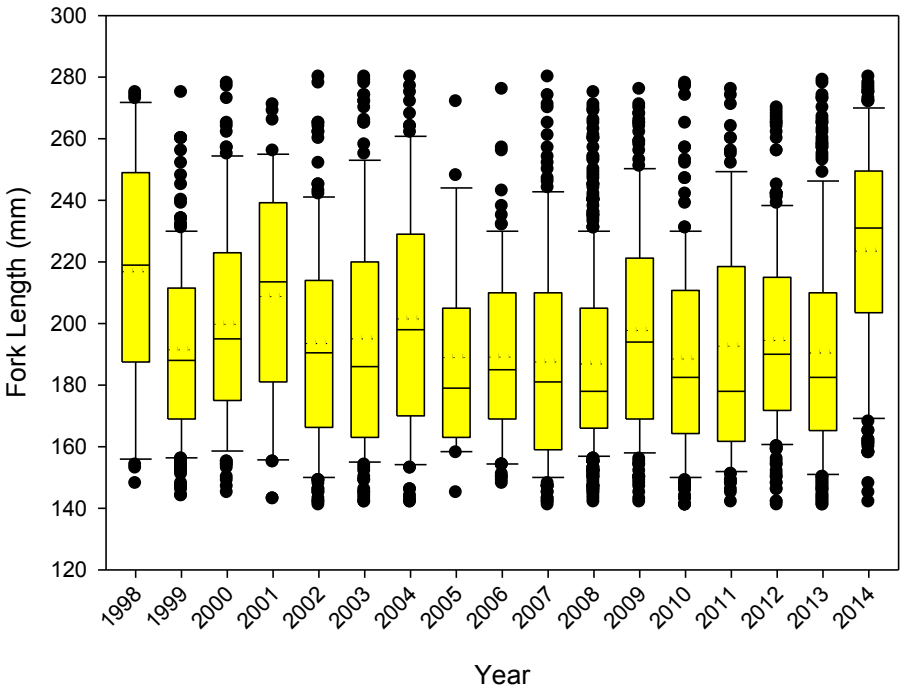

17 June Cruises

Coho yearling –10th

Chinook subyearling – 11th

Chinook yearling – 9th

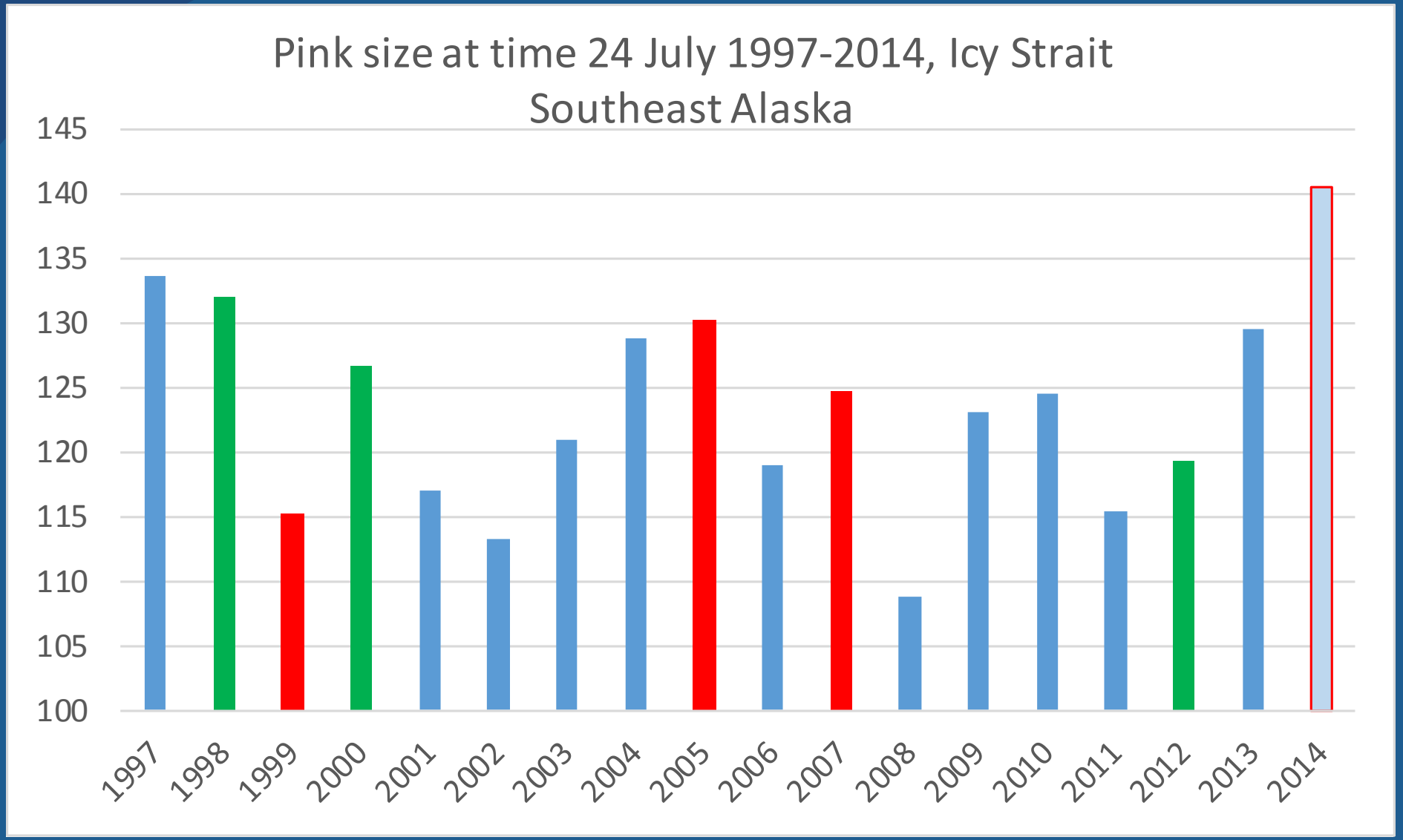
## Yearling Chinook Salmon Size



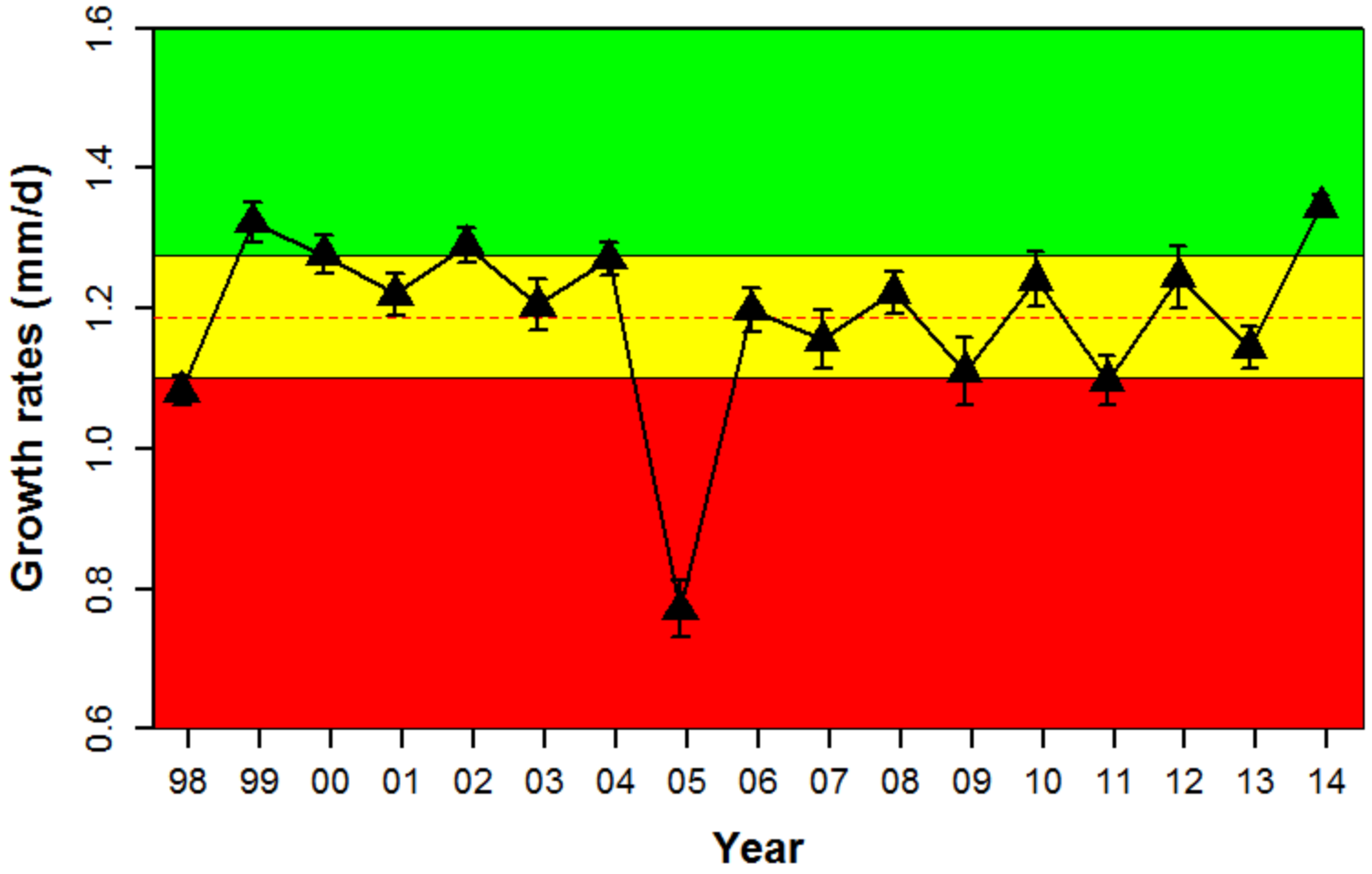

2014: Largest in time series

(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)

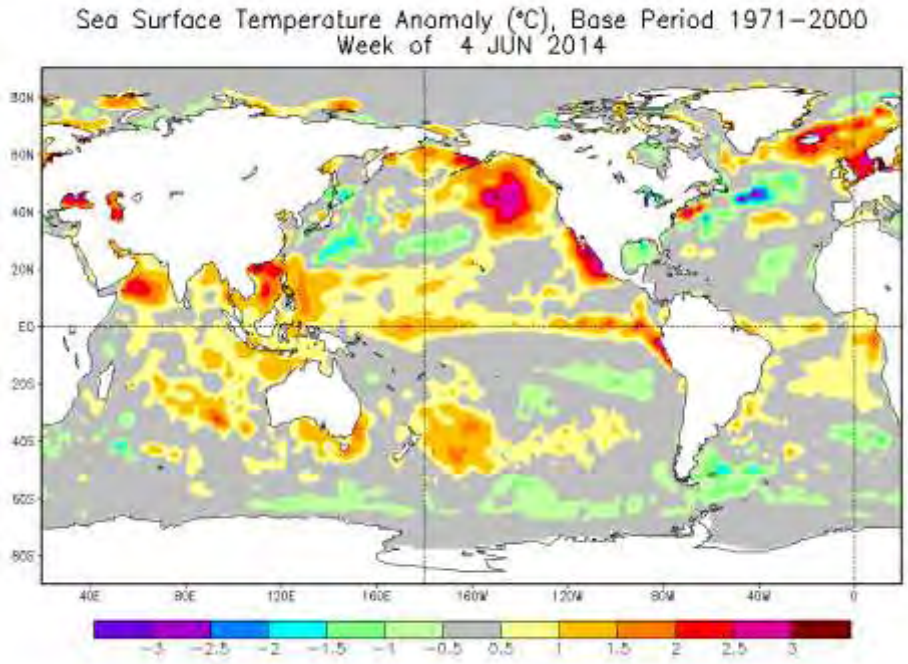


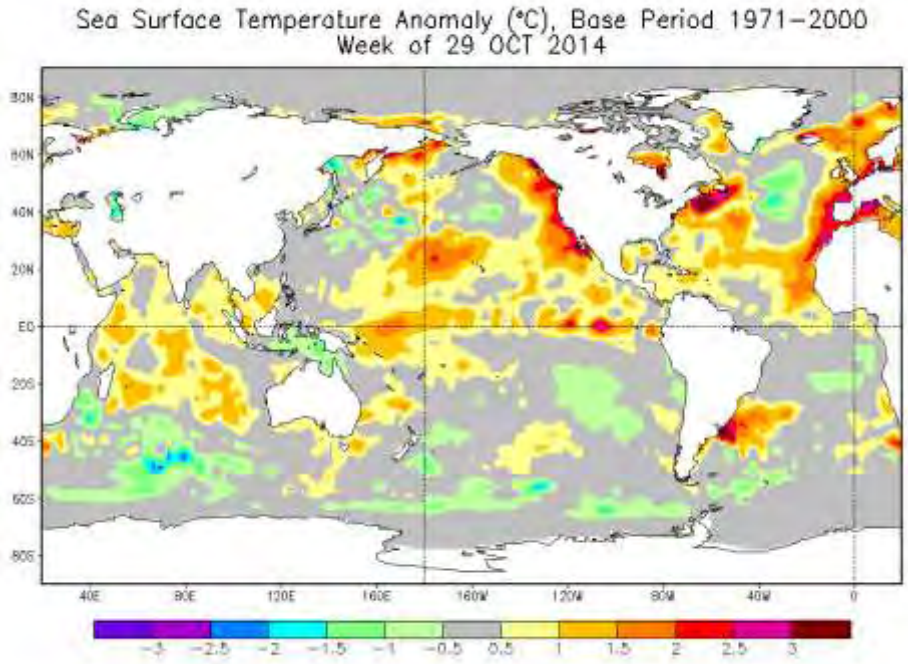
# Best growth on record off the west coast of Vancouver Island in 2014 for juvenile Coho Salmon



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

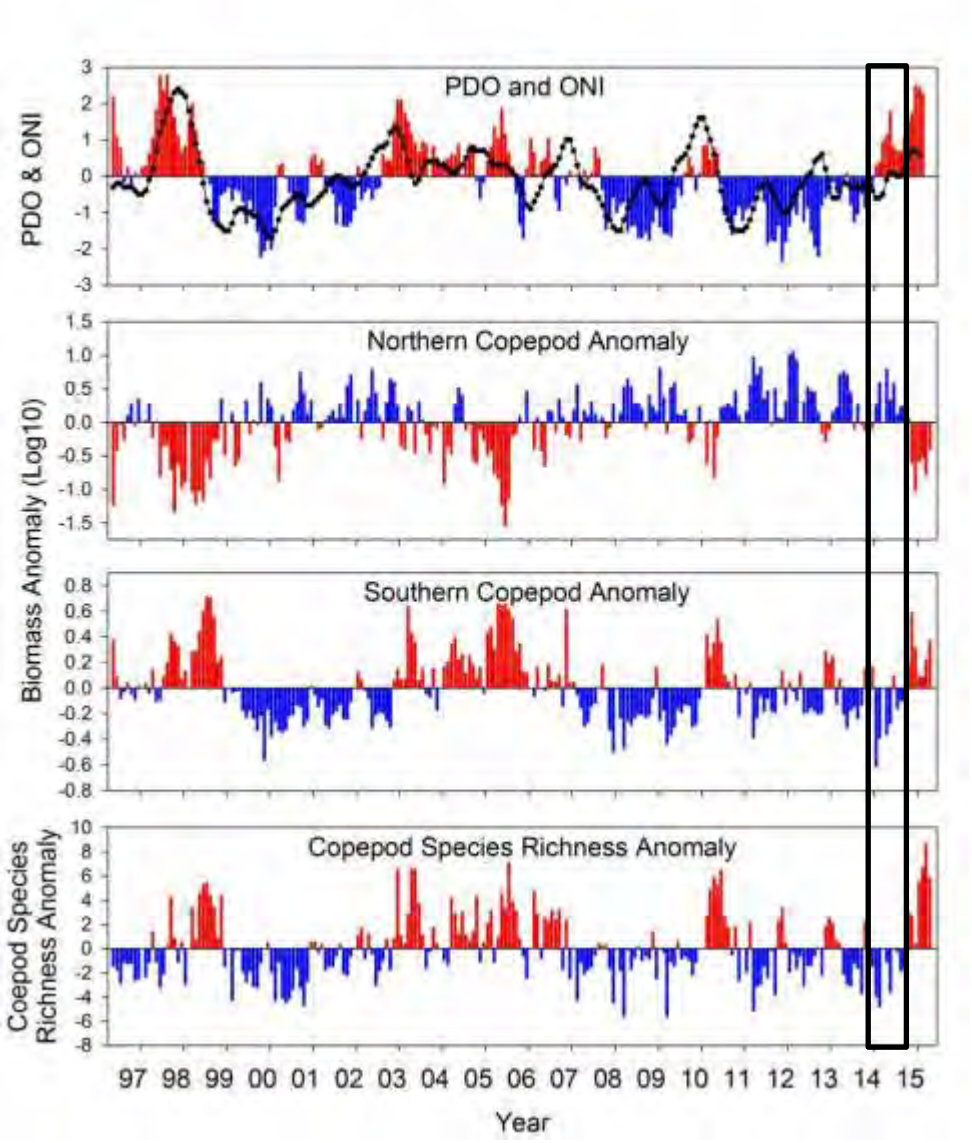
# But things changed…




*So what?*

# Zooplankton



# In Alaska…

pomfret

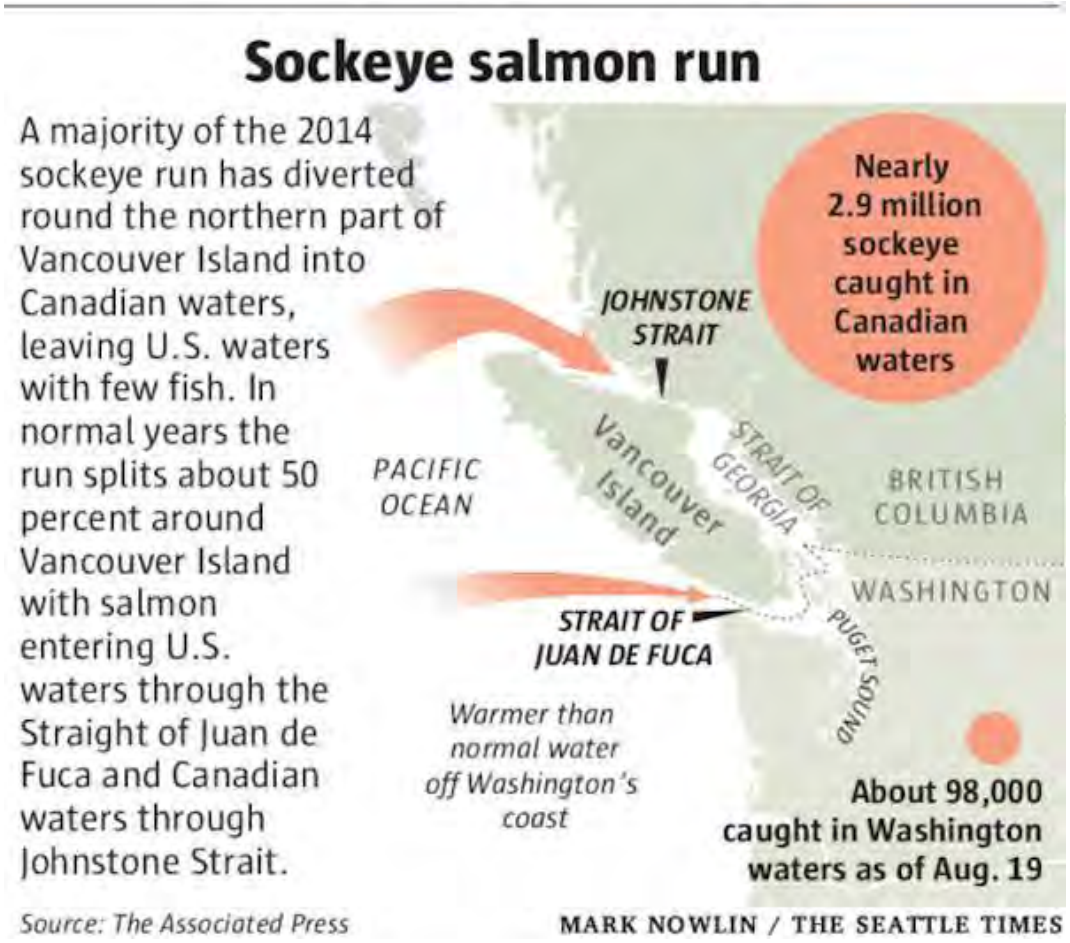
salmon shark

Mola mola

sablefish

thresher shark

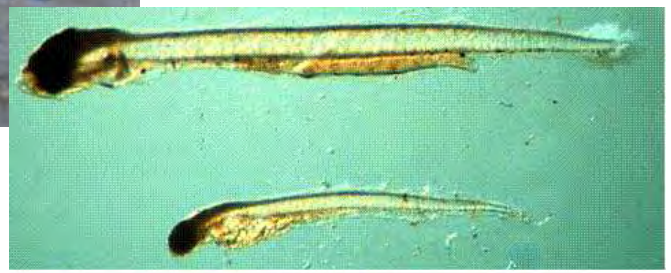
# In British Columbia…

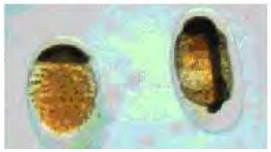


# In Washington/Oregon…

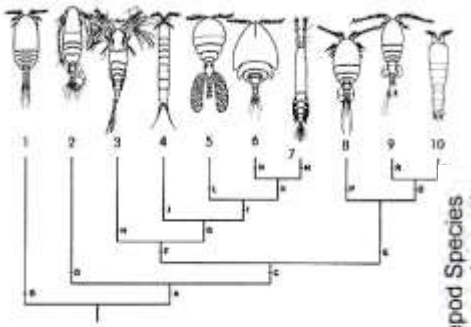
Vellela vellela



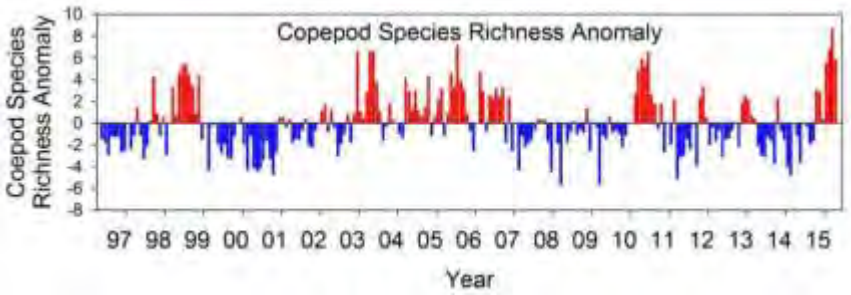




larval sardine and anchovies



copepods



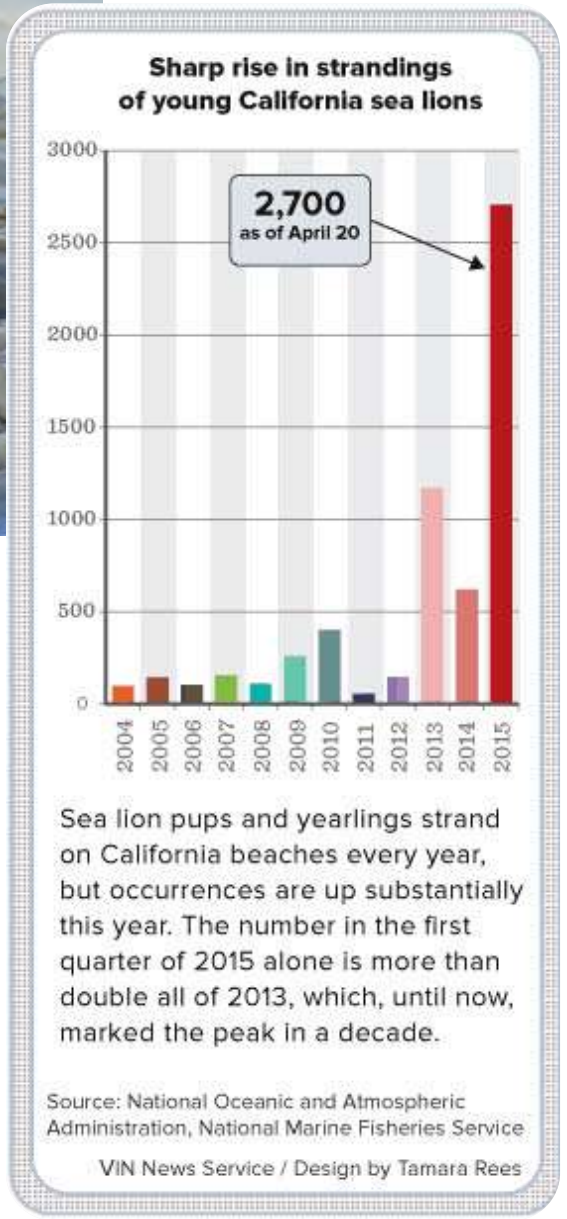

# In California…

wahoo

tuna

moonfish

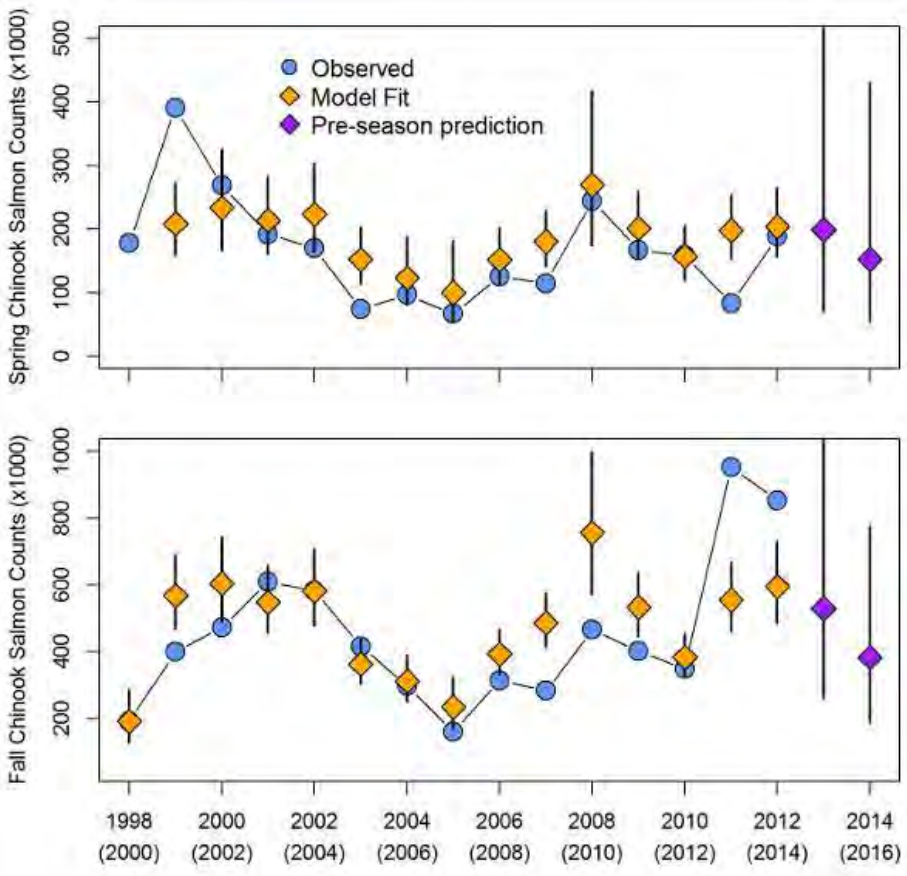
California sea lions

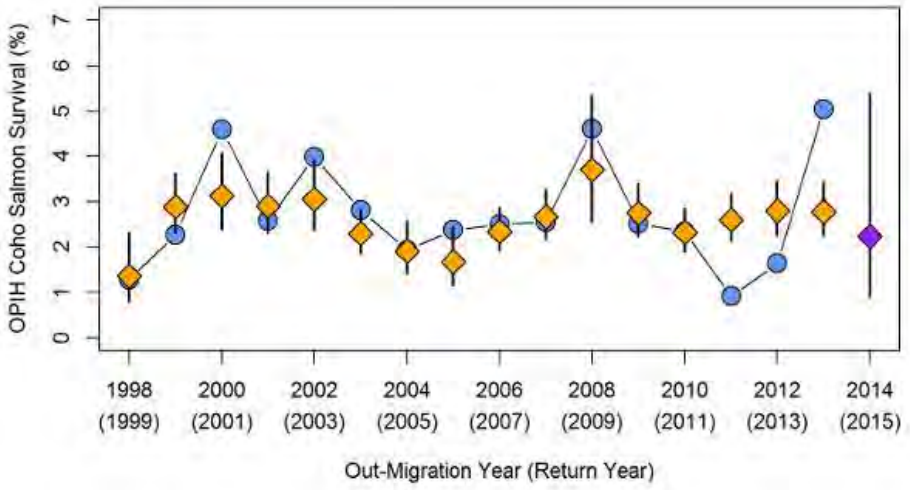


# Coast-wide…

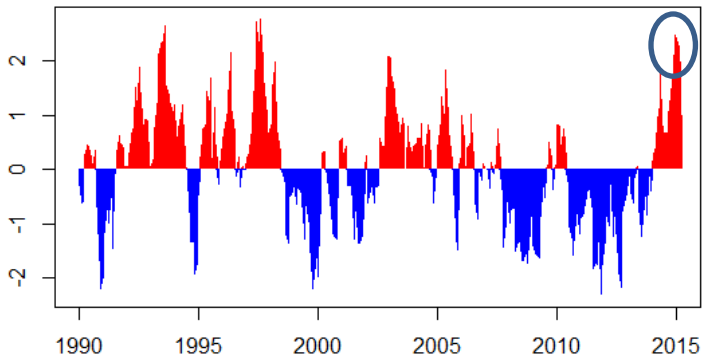

Cassin's auklet

# Salmon Forecasts

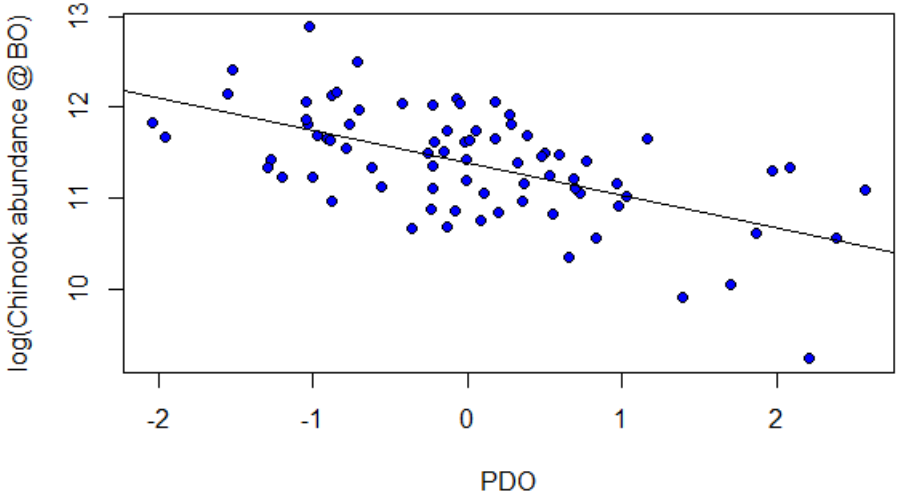


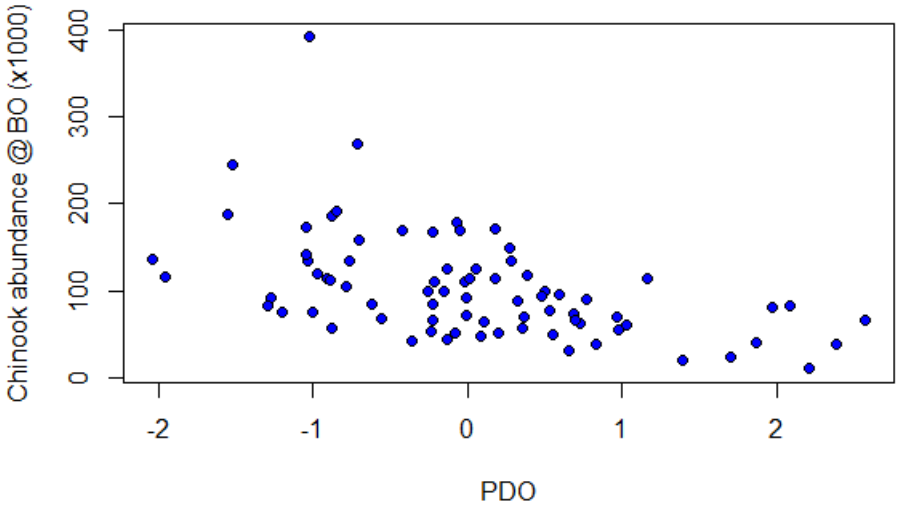



# PDO

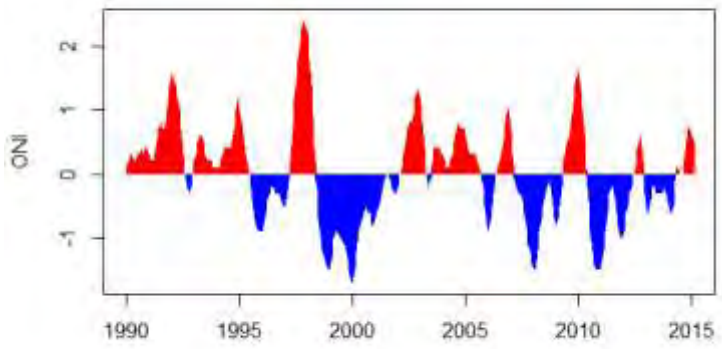



PDO (May-Sept) and
spring Chinook counts at Bonneville
1936-2012

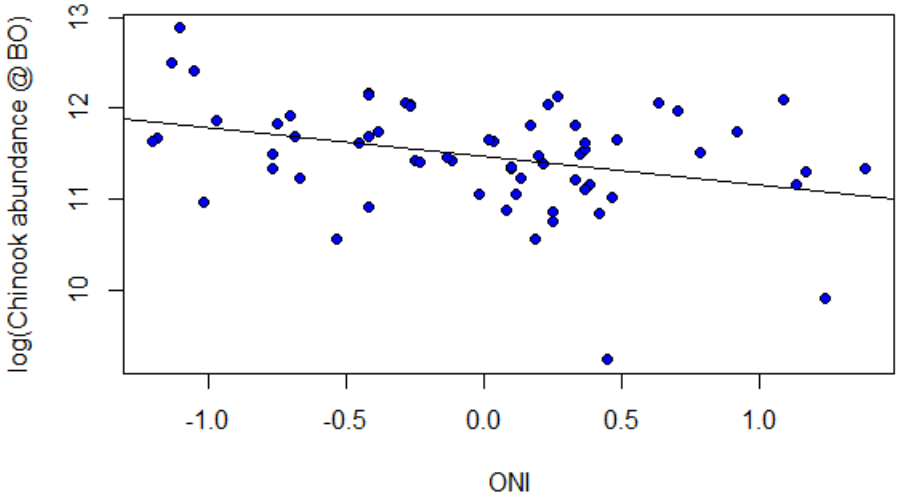


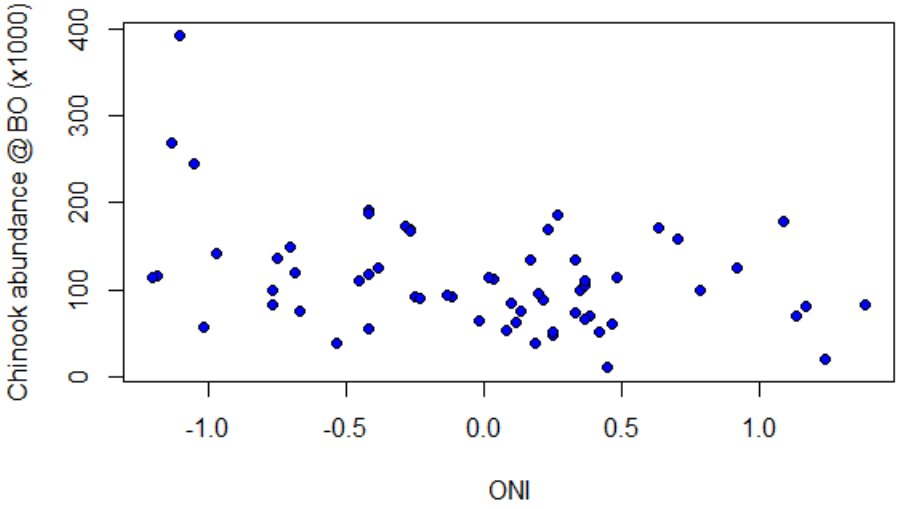



# ONI

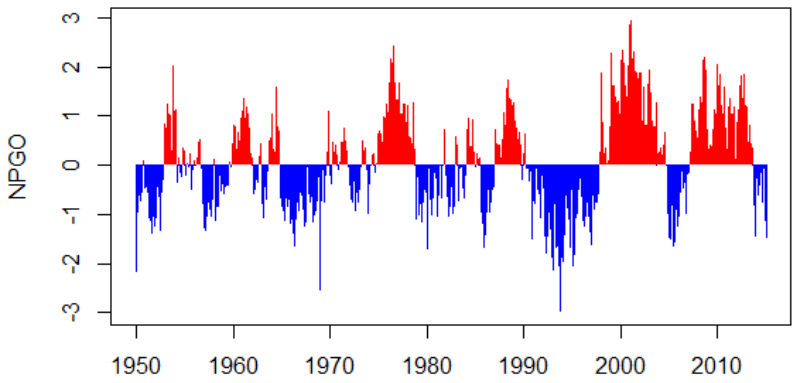


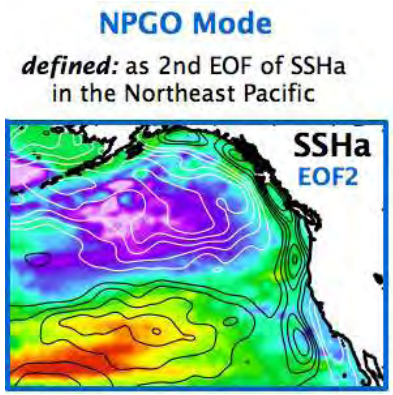

ONI (Jan-June) and
spring Chinook counts at Bonneville
1950-2012



# NPGO




NPGO (May-Sept) and
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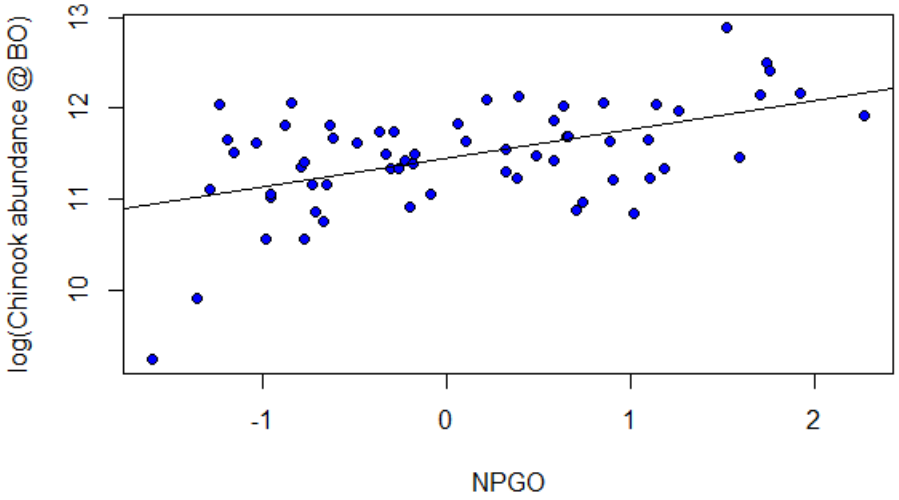
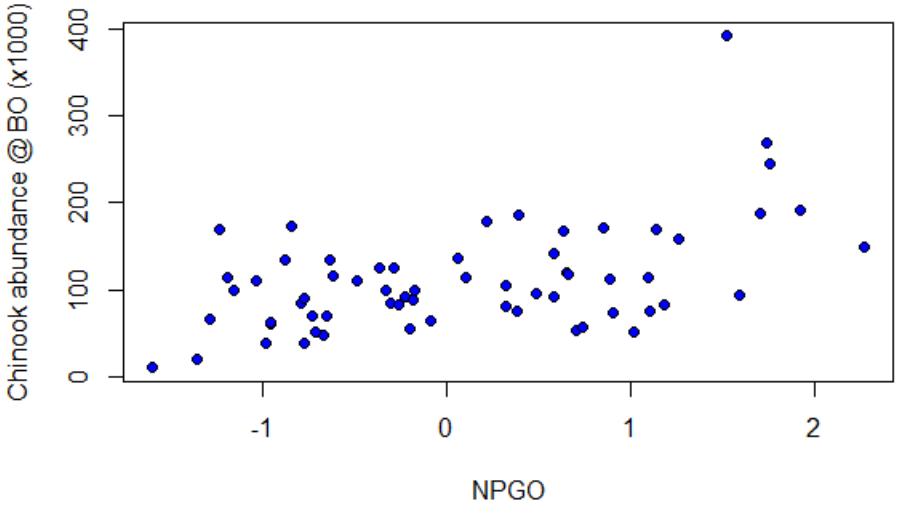
1950-2012



# 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?