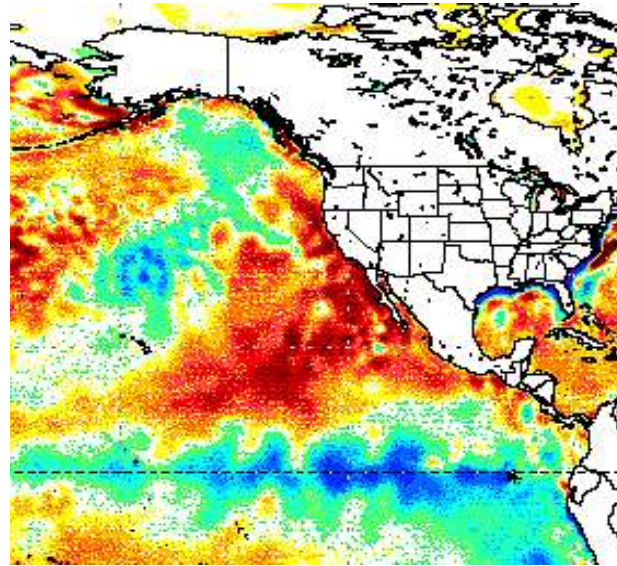


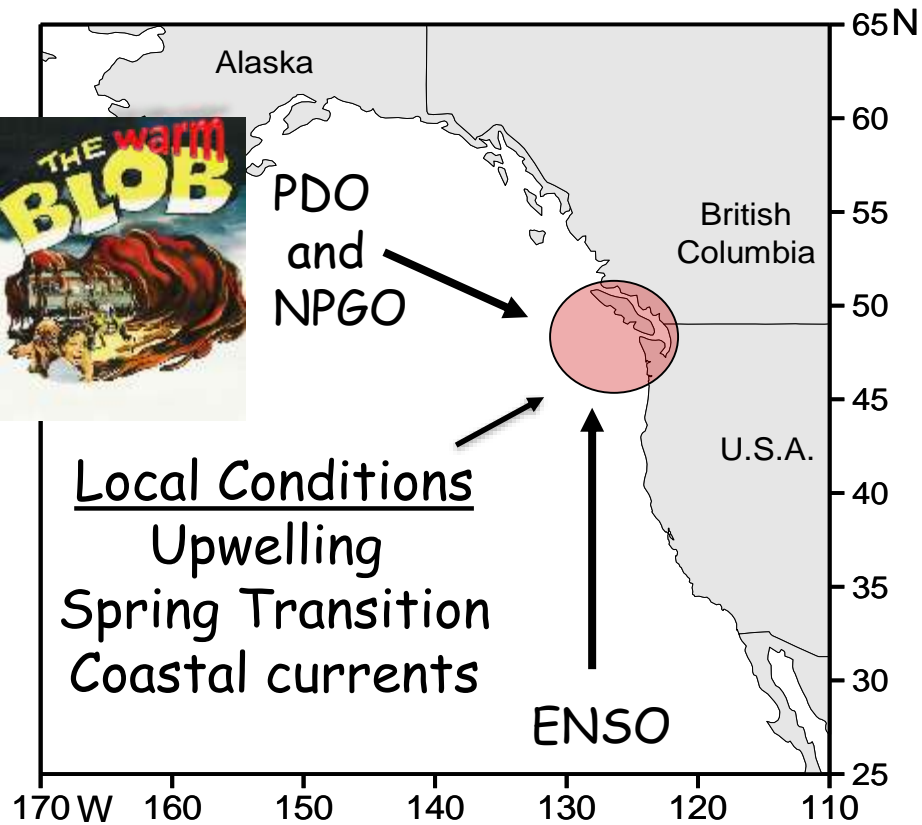
The Blob, El Niño, La Niñas, and North Pacific marine ecosystems



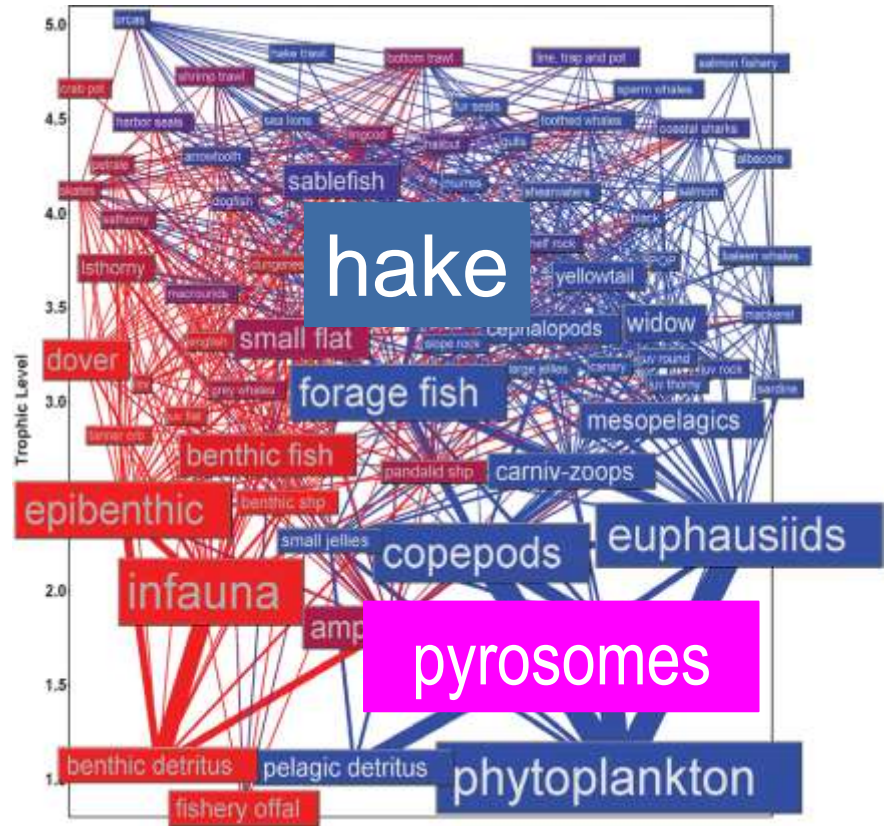
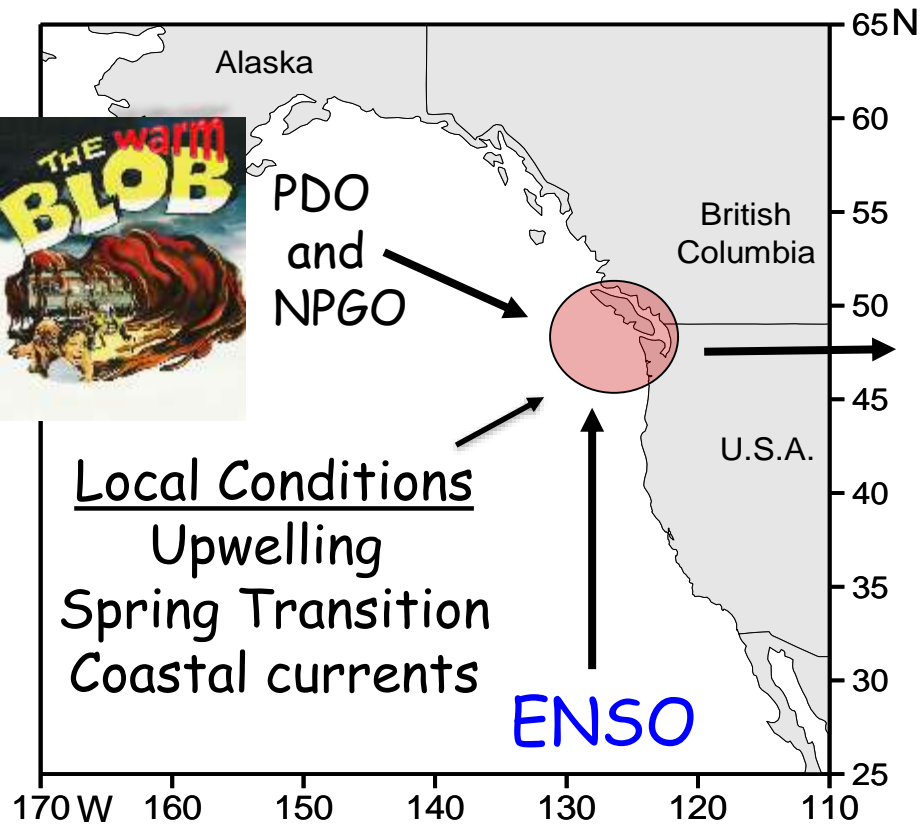
Laurie Weitkamp
Northwest Fisheries Science Center
Newport Field Station
NOAA Fisheries
Laurie.weitkamp@noaa.gov



Bill Peterson's Big Picture: Large scale forces and local scale processes affect local biological process



Bill Peterson's Big Picture: Large scale forces and local scale processes affect local biological process



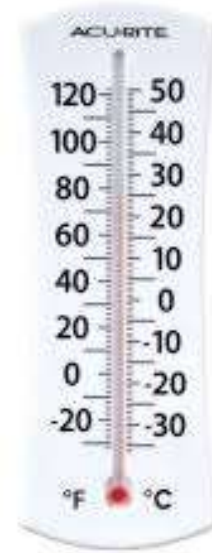
Today's talk

1. Physical conditions across the North Pacific
2. Biological response to physical conditions
3. Forecasts



1. Physical conditions across the North Pacific

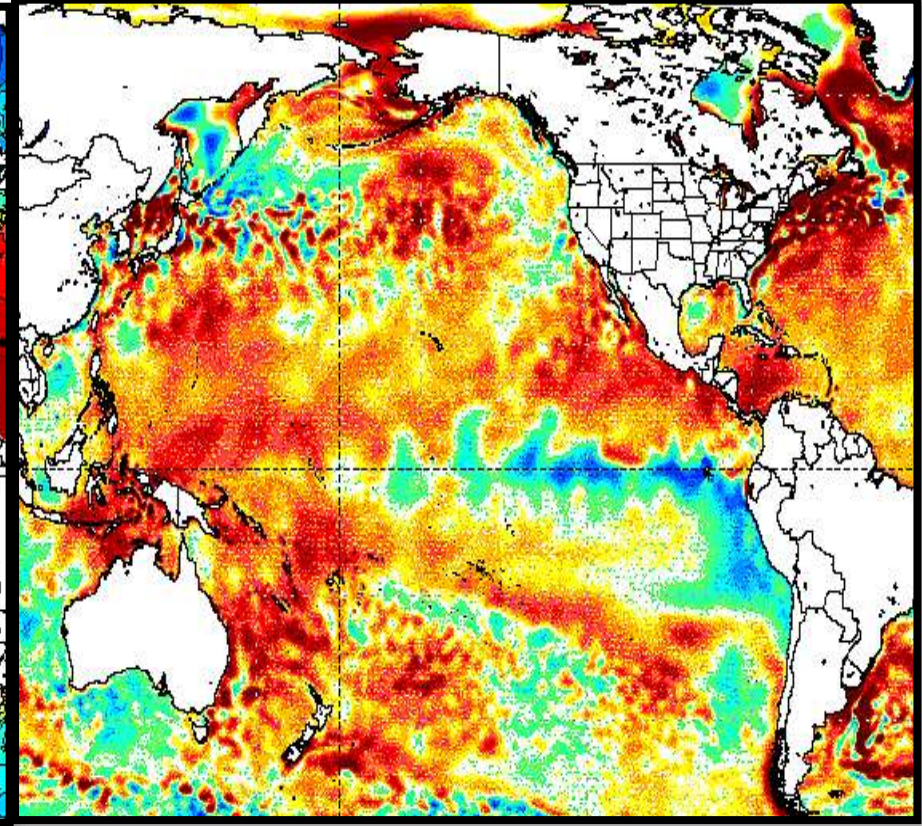
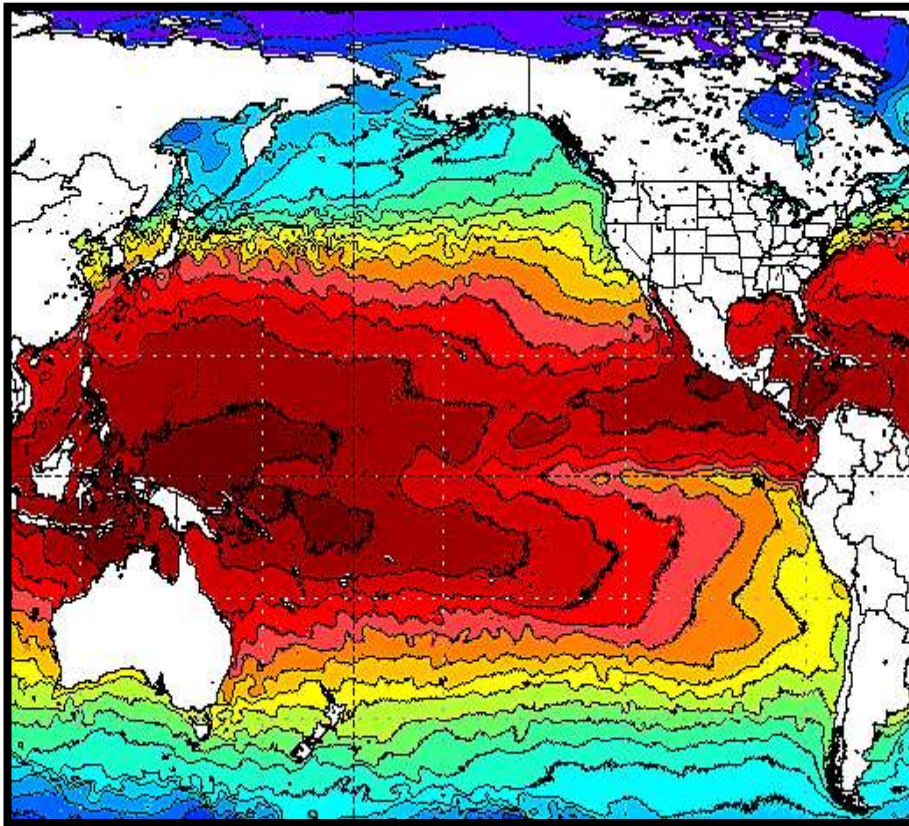
- Why the blob formed
- El Niños/La Niñas
- Recent sea surface temperature (SST) anomalies



Terminology: Anomaly

Actual sea surface
temperature (SST)

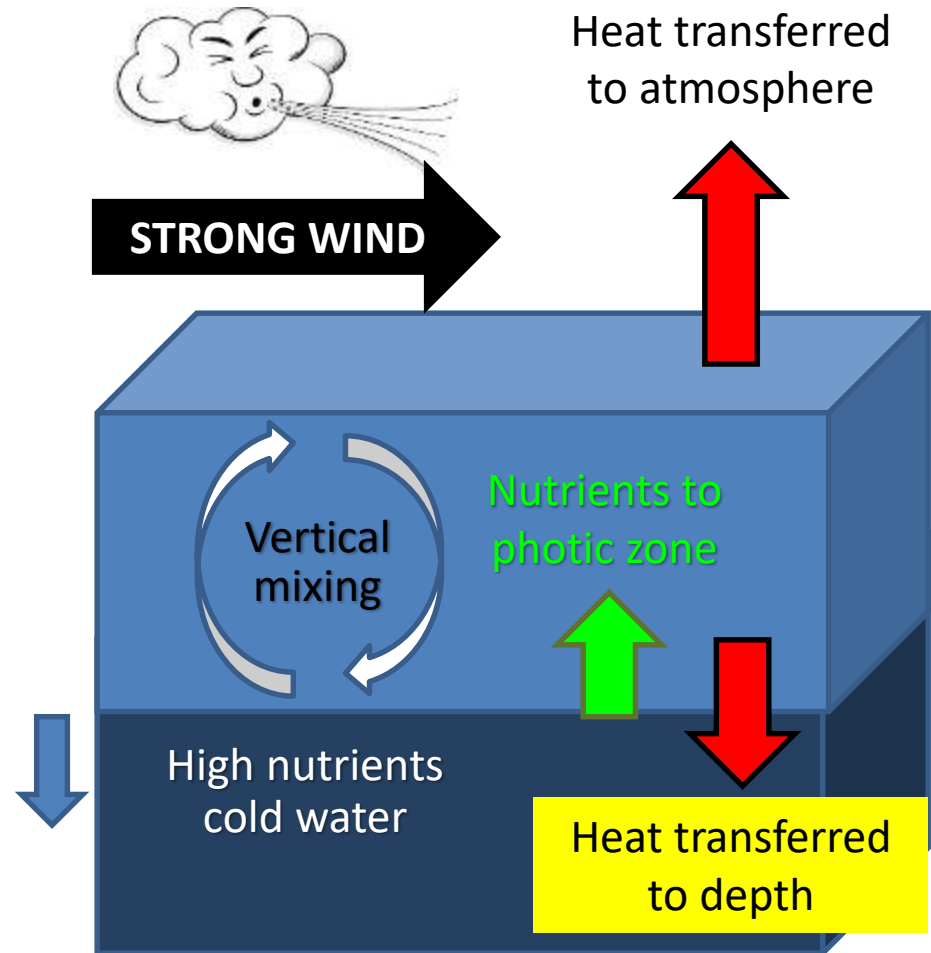
SST anomalies



<http://polar.ncep.noaa.gov/sst/phi/>

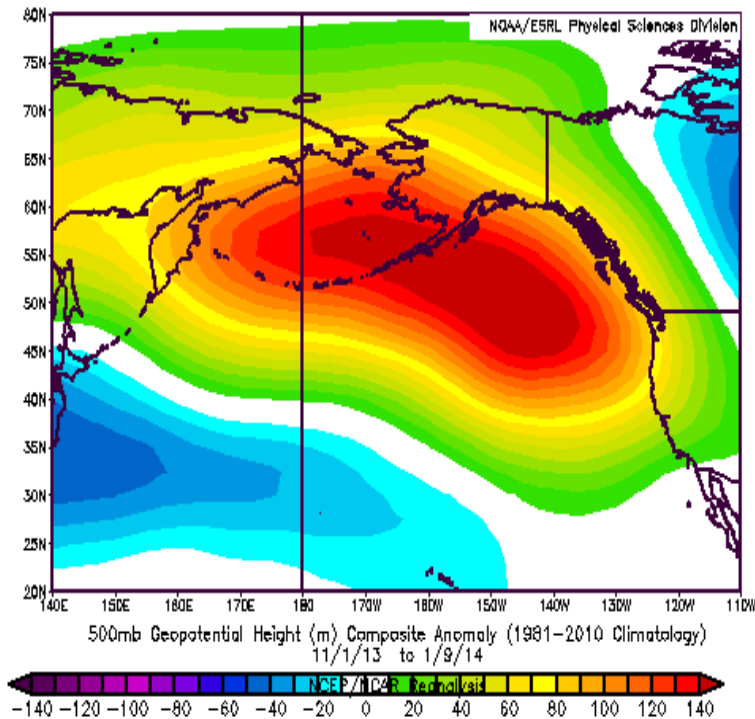
How the blob formed

Winter storms mix and cool the ocean

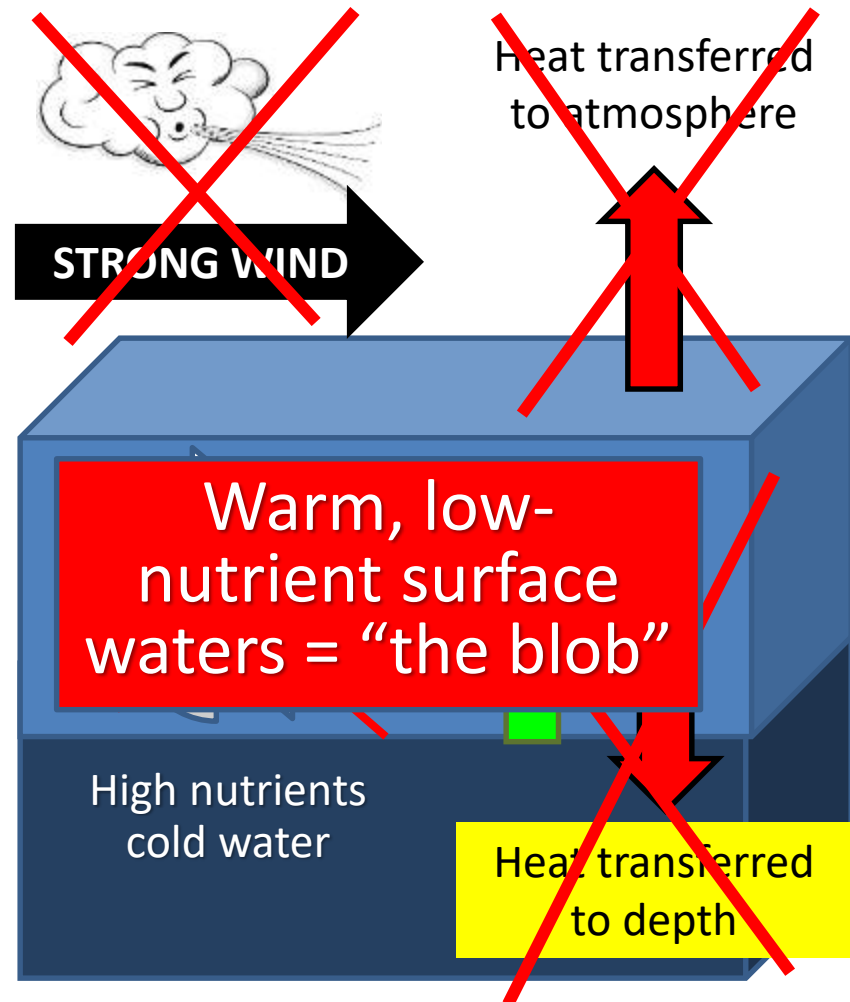


Formation of the warm blob (Winter 2013/14): Unusually stationary high pressure over the North Pacific blocked storms, which limited vertical mixing

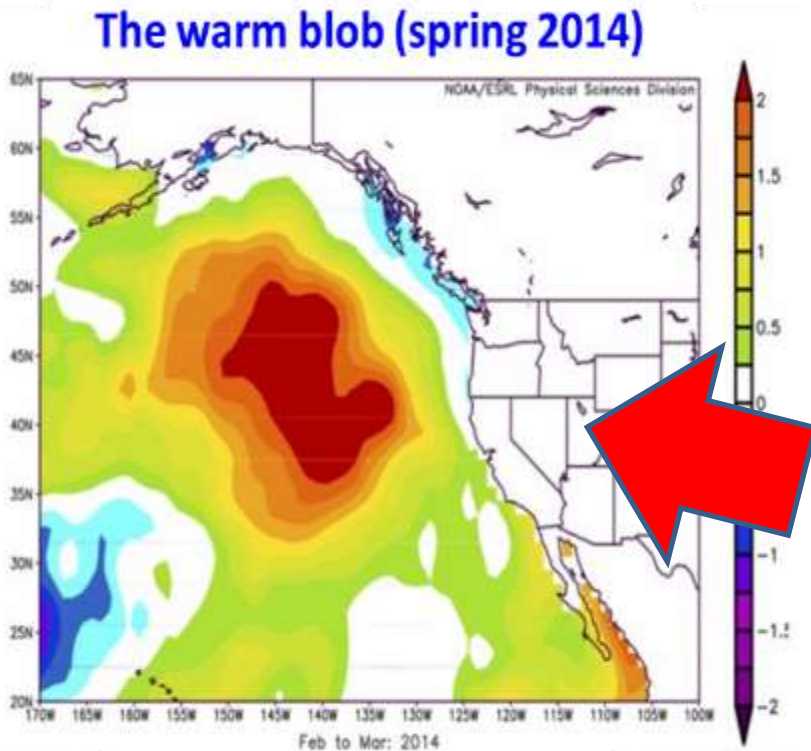
Ridiculously resilient ridge



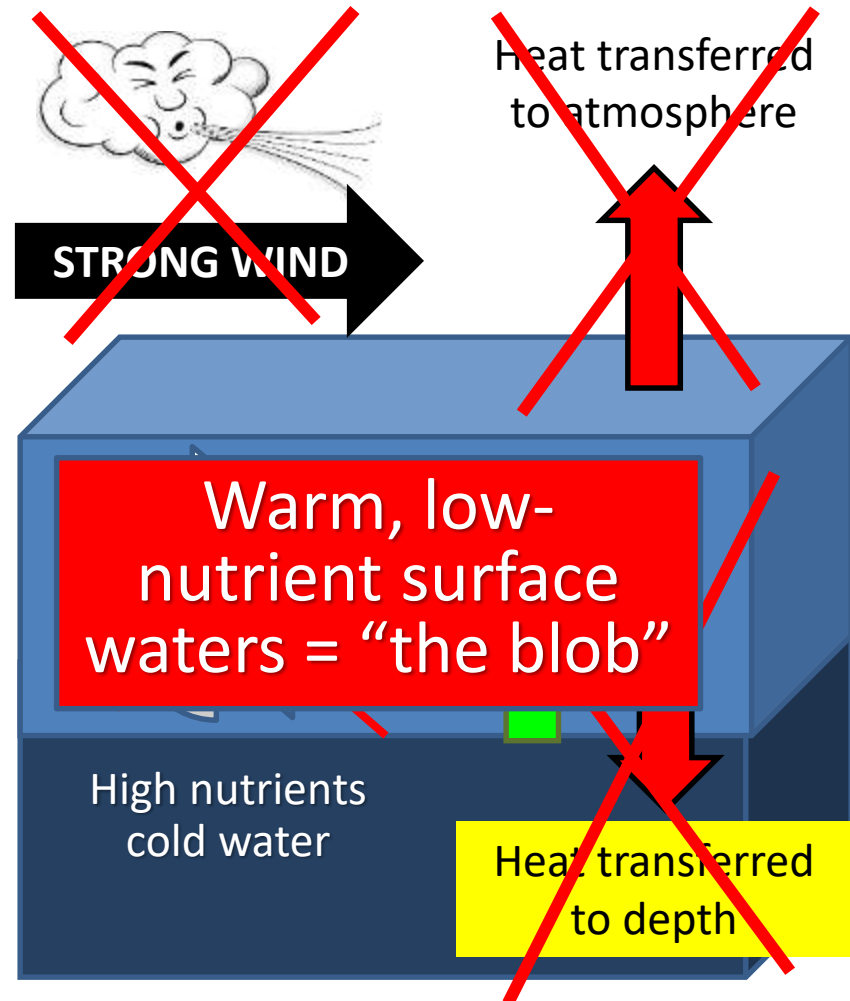
Atmospheric pressure anomalies,
Nov 1, 2013-Jan 9, 2014



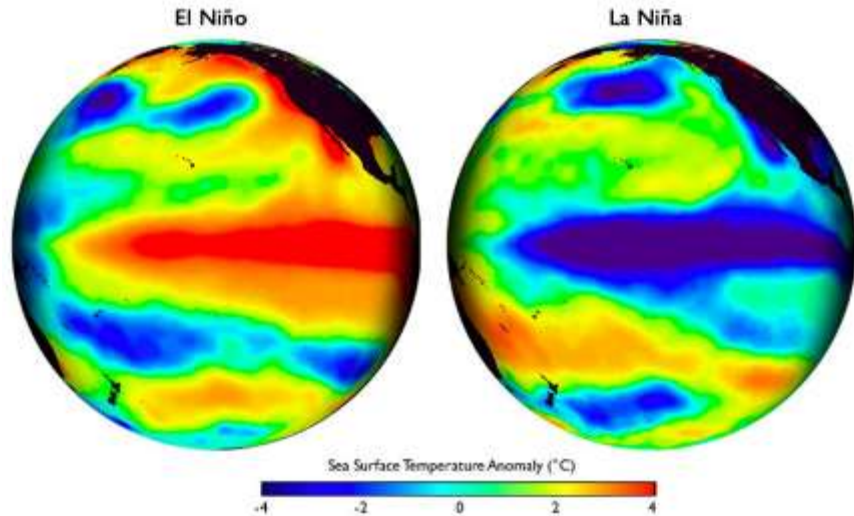
Formation of the warm blob (Winter 2013/14):
Unusually stationary high pressure over the North Pacific blocked storms, which limited vertical mixing



Sea surface temperature (SST) anomalies



El Niños and La Niñas: Tropical phenomena that impact global weather



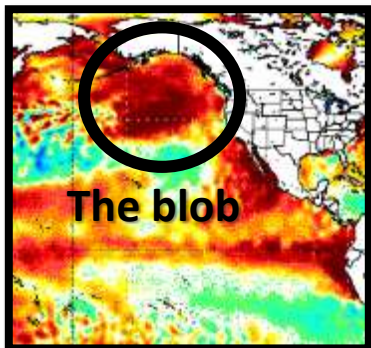
Typical Pacific Northwest Impacts
El Niños: Warm winters (low snow)
La Niñas: Cold & wet winters

Recent Events

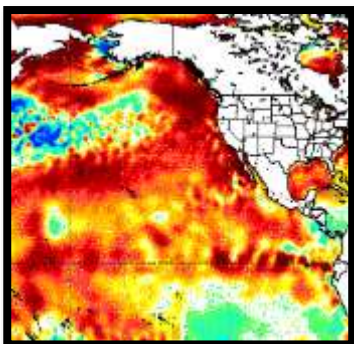
- 2015/2016 **El Niño** was one of the largest on record but oceanic teleconnections to our area were weak
- 2016/2017 **La Niña** was weak and short lived
- 2017/2018 **La Niña** is slightly stronger but rapidly fading

North Pacific surface temperature anomalies

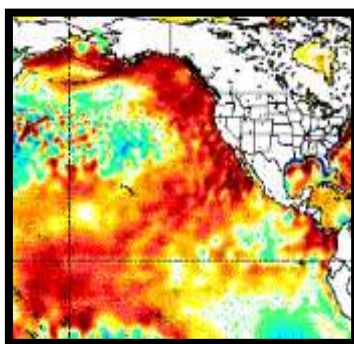
Jul '14



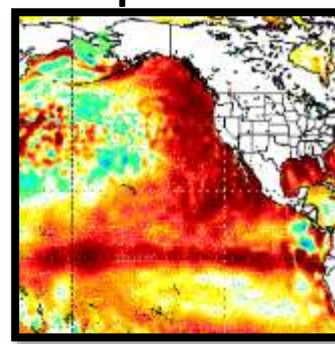
Oct '14



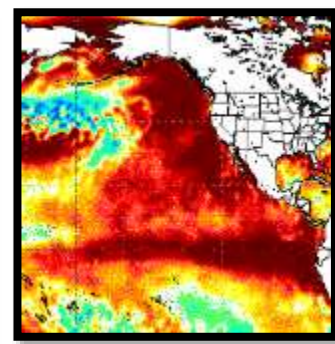
Jan '15



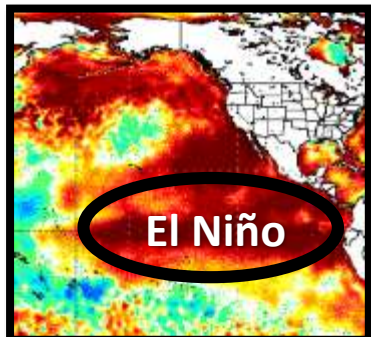
Apr '15



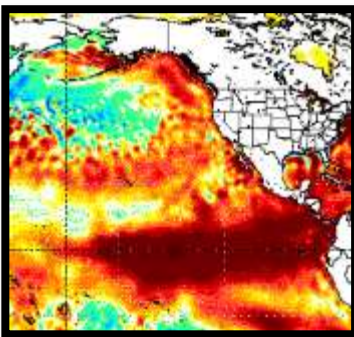
Jul '15



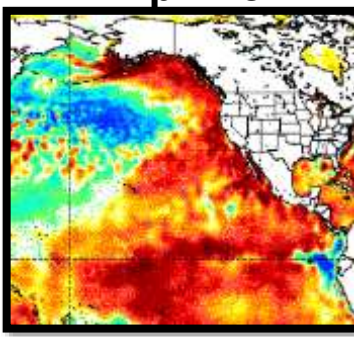
Oct '15



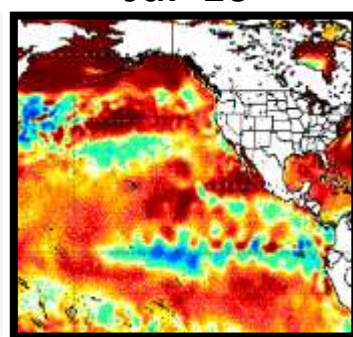
Jan '16



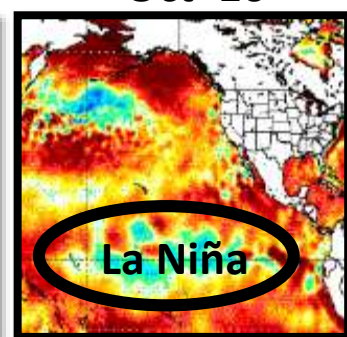
Apr '16



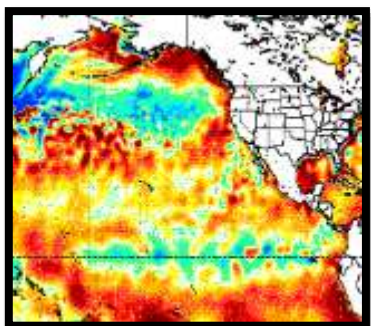
Jul '16



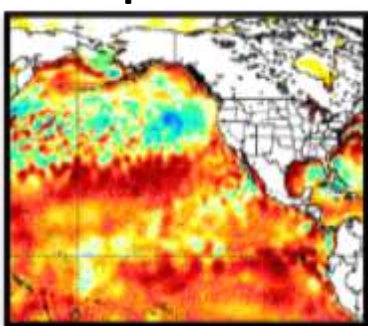
Oct '16



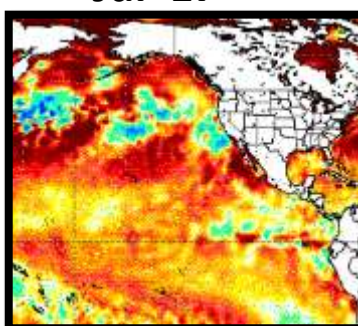
Jan '17



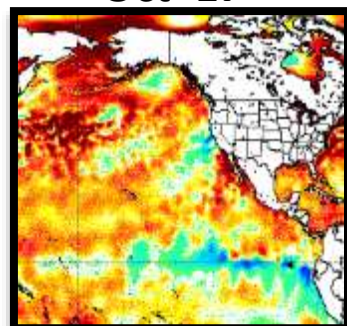
Apr '17



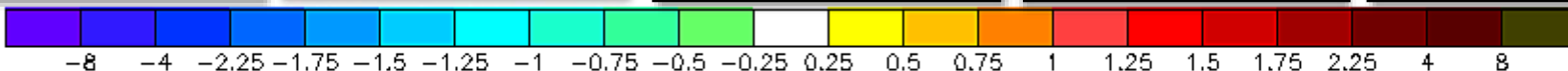
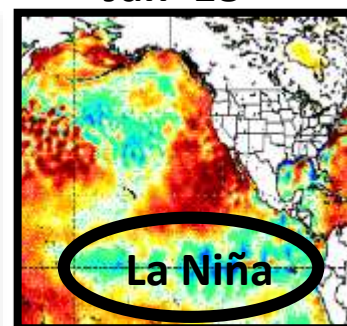
Jul '17



Oct '17



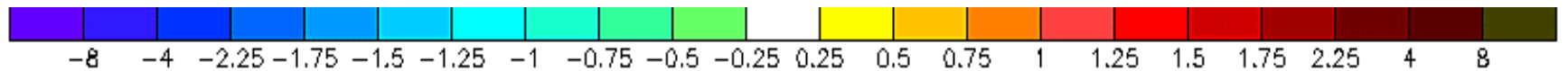
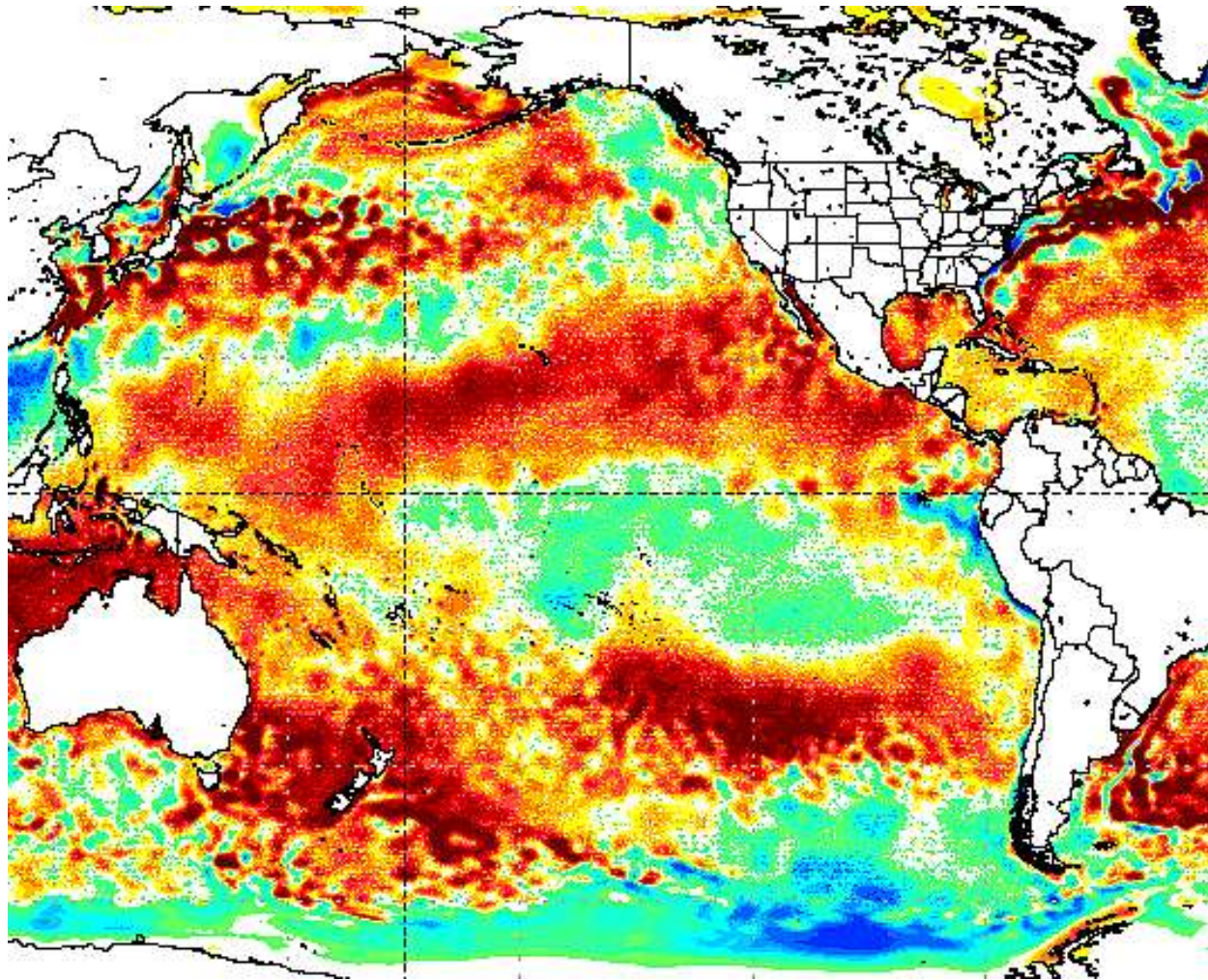
Jan '18



degrees C

<http://polar.ncep.noaa.gov/sst/ophi/>

SST anomalies, 8 April 2018



degrees C

<http://polar.ncep.noaa.gov/sst/ophi/>

2. Biological response to physical conditions



Highlights

- Extremes across the N Pacific
- Observations from local waters
- Adult salmon returns, AK to CA

Bottom line: Huge response across N Pacific from diatoms to marine mammals; effects still continue

Joe Orsi (AFSC) with ocean sunfish in SE Alaska, June 2015

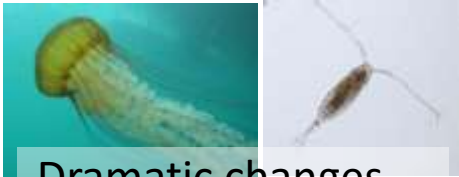
Biological response to warm oceans

2015

Tropicals
In Oregon

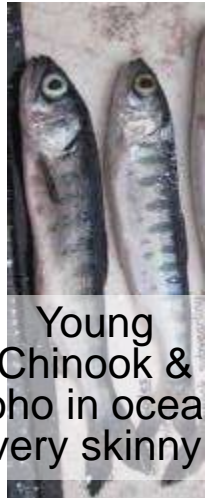


Species
range
extensions
from CA to
AK



Dramatic changes
to food webs

Domoic acid closes
crab and clam
fisheries AK-CA



Young
Chinook &
coho in ocean
very skinny

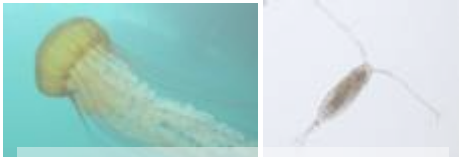
Biological response to warm oceans

2015

Tropicals
In Oregon



Species
range
extensions
from CA to
AK



Dramatic changes
to food webs

Domoic acid closes
crab and clam
fisheries AK-CA



Young
Chinook &
coho in ocean
very skinny

2016

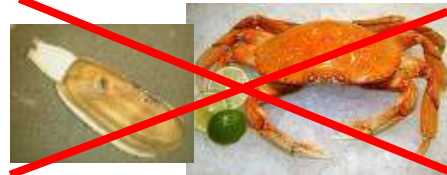
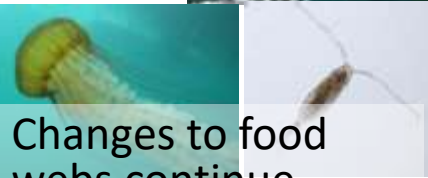


Red pelagic
crabs in
Oregon!

Anchovies
invade the
Salish Sea



Changes to food
webs continue



Crab and clam
fishery closures

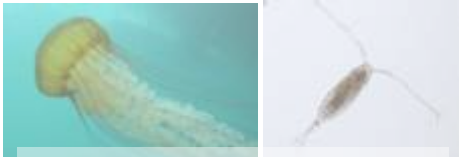
Biological response to warm oceans

Tropicals
In Oregon

2015



Species
range
extensions
from CA to
AK



Dramatic changes
to food webs

Domoic acid closes
crab and clam
fisheries AK-CA



Young
Chinook &
coho in ocean
very skinny

2016



Red pelagic
crabs in
Oregon!

Anchovies
invade the
Salish Sea



Changes to food
webs continue



Crab and clam
fishery closures

2017



High Pacific
lamprey counts at
Bonneville Dam

Pyrosomes
explode
AK-CA



Swordfish off
Vancouver
Island

Extremely low
Pacific cod
abundance in
Gulf of Alaska



Crab and clam
fishery closures

Biological response to warm oceans (cont)

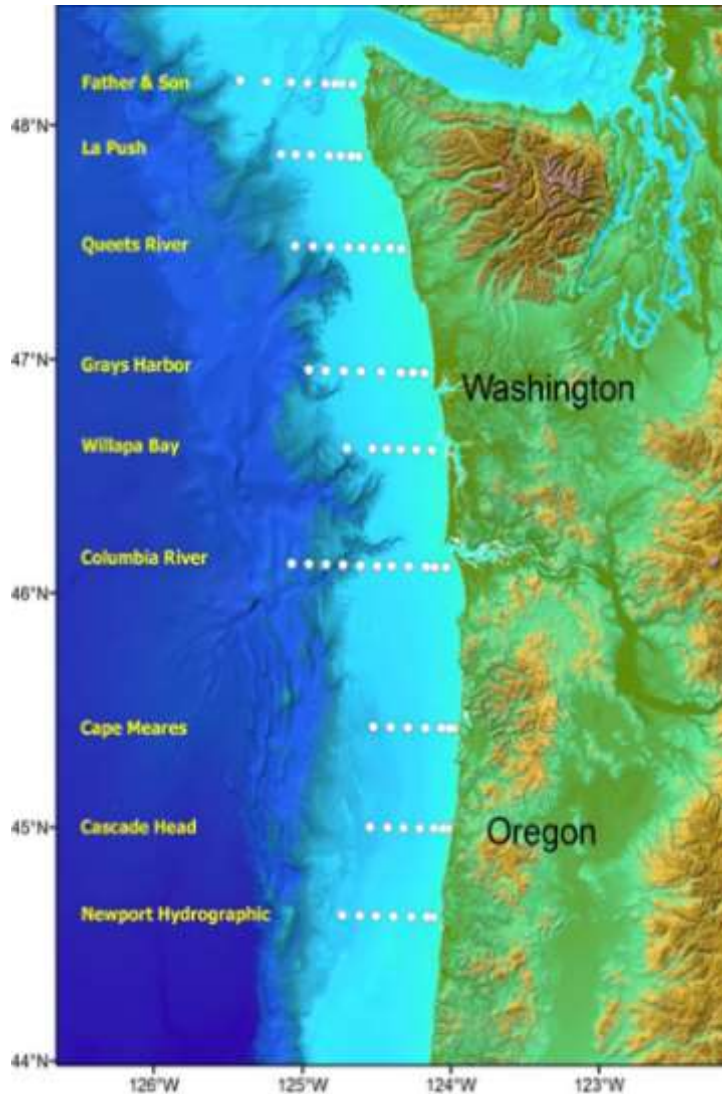
2018

Pyrosomes still here!



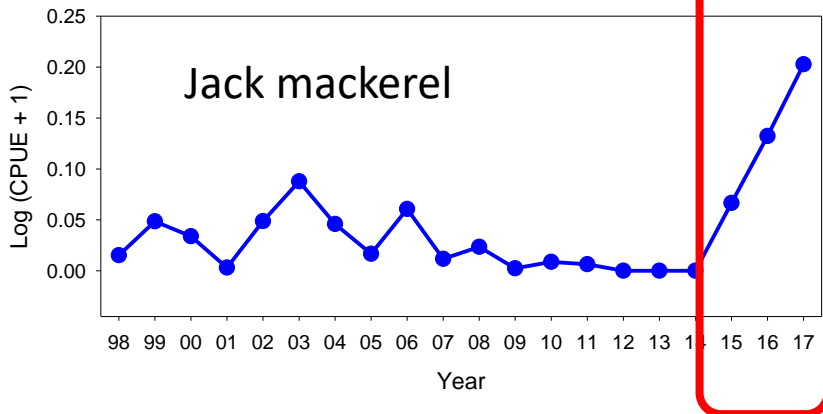
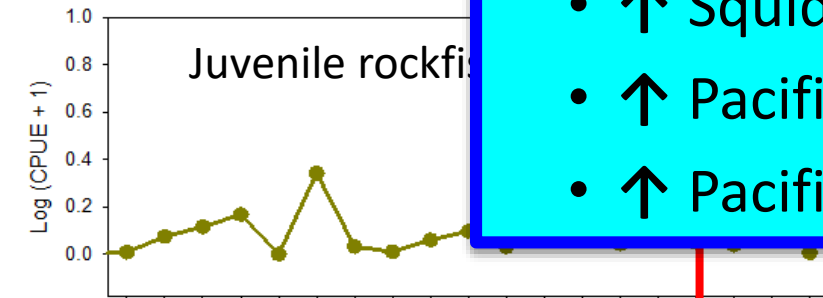
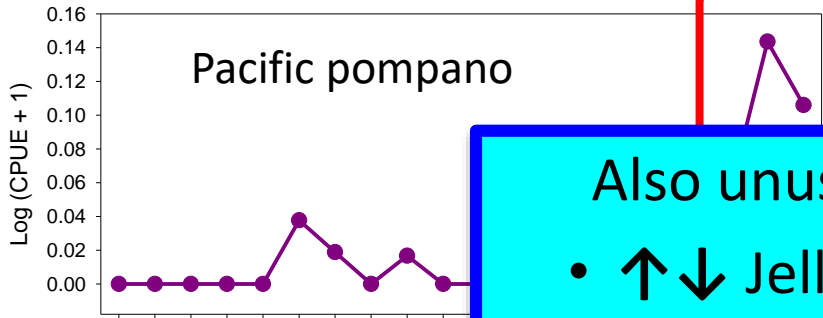
S OR/N CA crab and razor clam fisheries closures due to domoic acid continue

Unusual abundances of many fishes in NWFSC Salmon Surveys



Surveys in May & June
1998-present

Unusual abundances of many fishes in NWFSC Salmon Surveys



Also unusual abundances of:

- ↑↓ Jellyfish
- ↑ Squid
- ↑ Pacific mackerel
- ↑ Pacific hake



Age 0 fish = Salmon **prey**



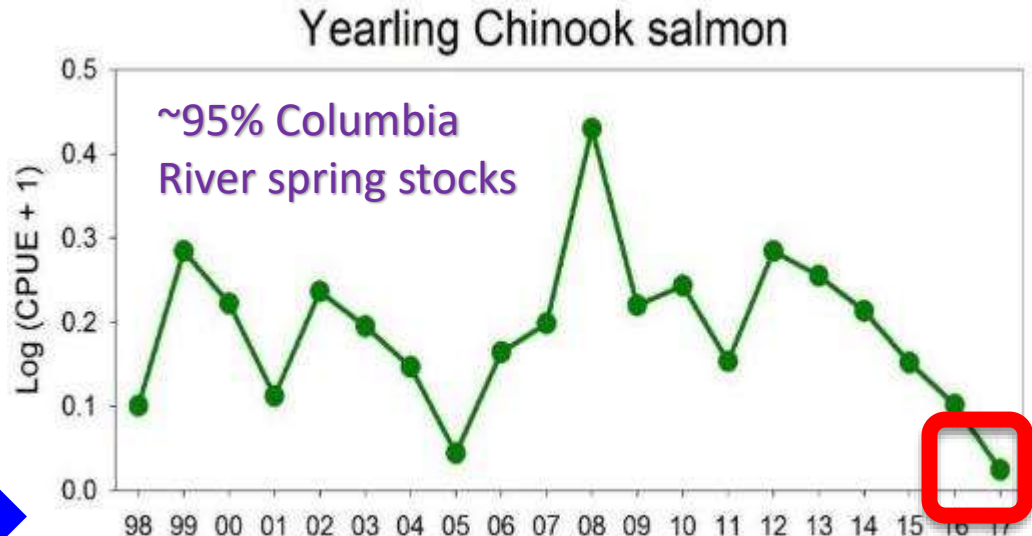
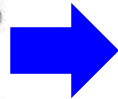
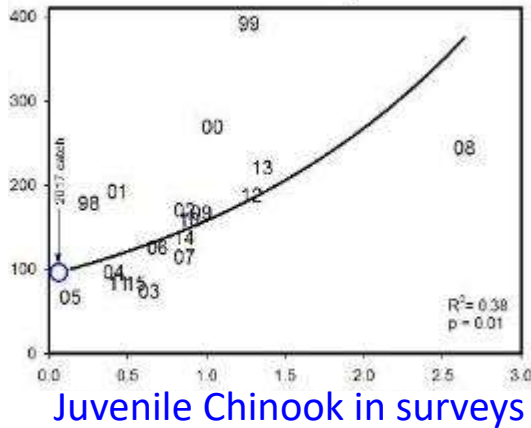
Age 1-2 fish = Salmon **competitors**

Age 3+ fish = Salmon **predators**

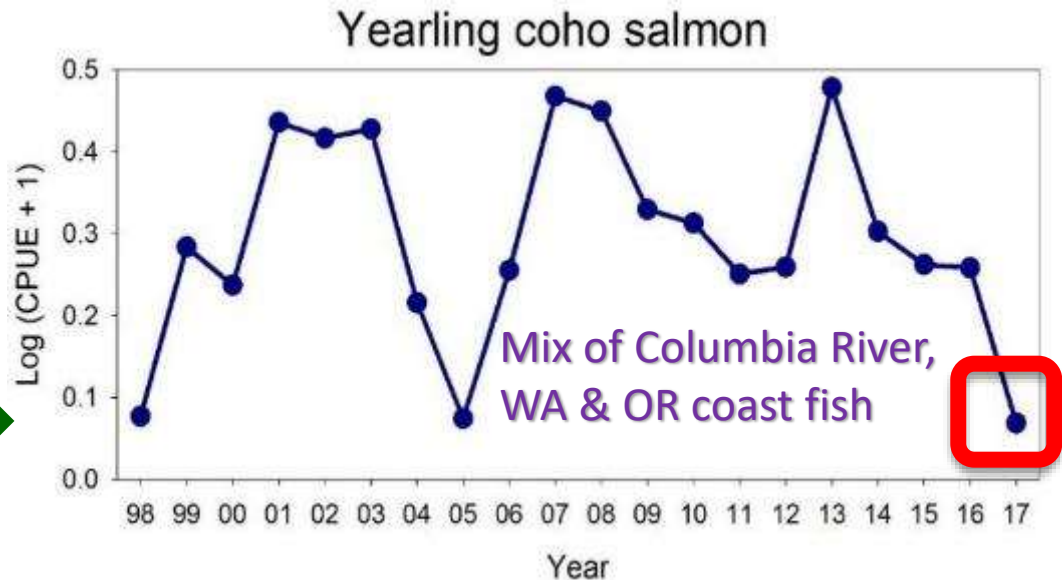
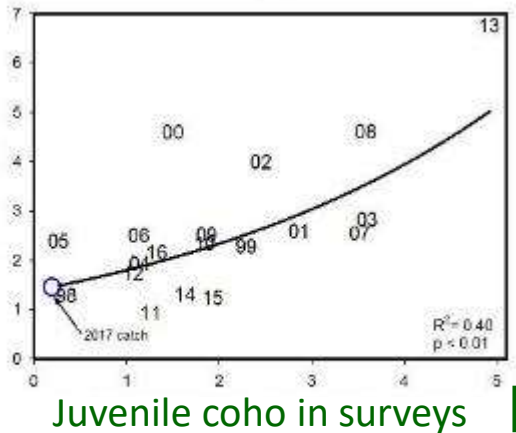
Morgan et al. in prep.

Extremely low juvenile salmon abundances in 2017 will likely result in poor adult returns in 2018 & 2019

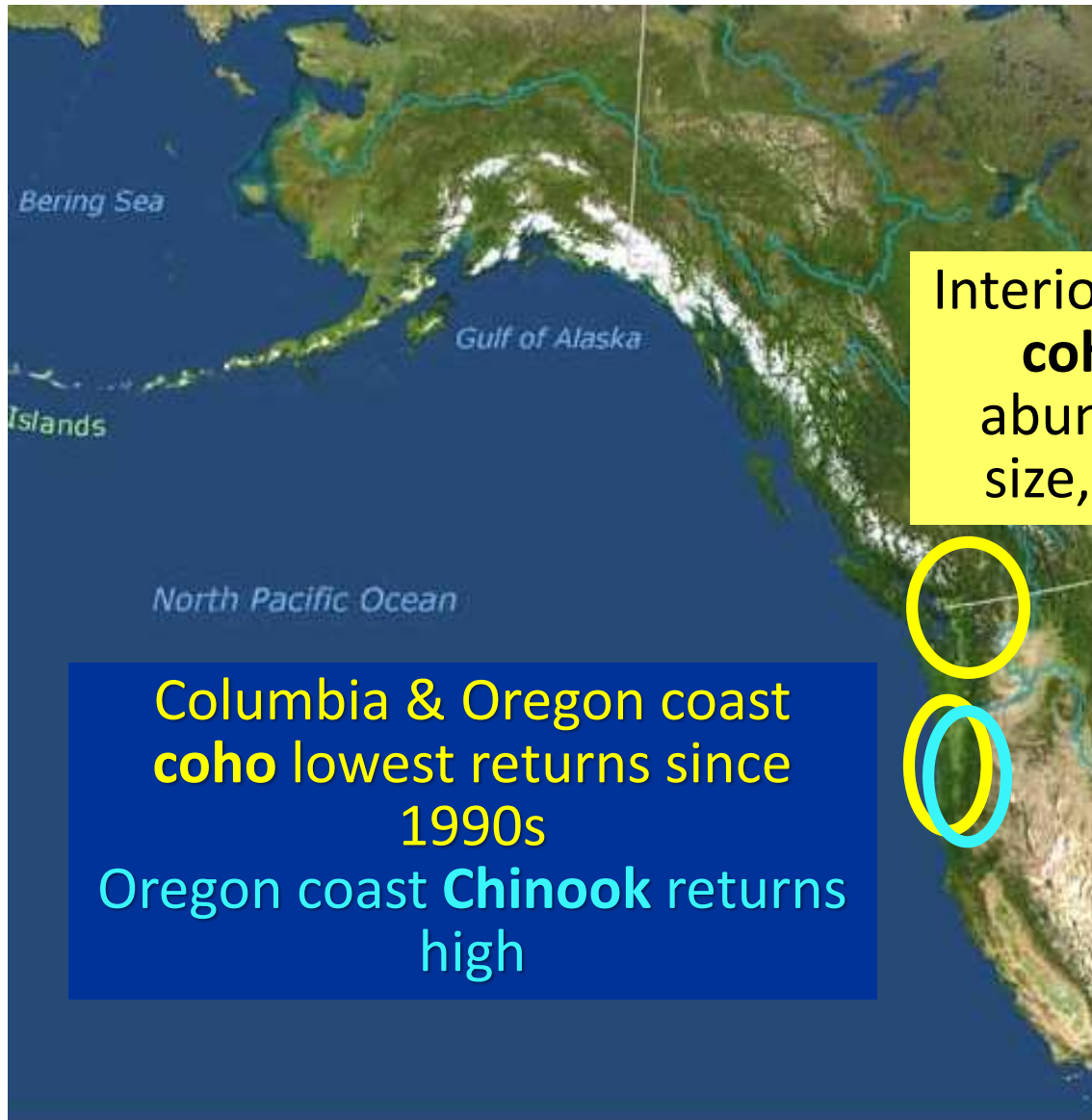
Spring Chinook counts at BON 2 yrs later



Coho survival (OPI) 1 year later



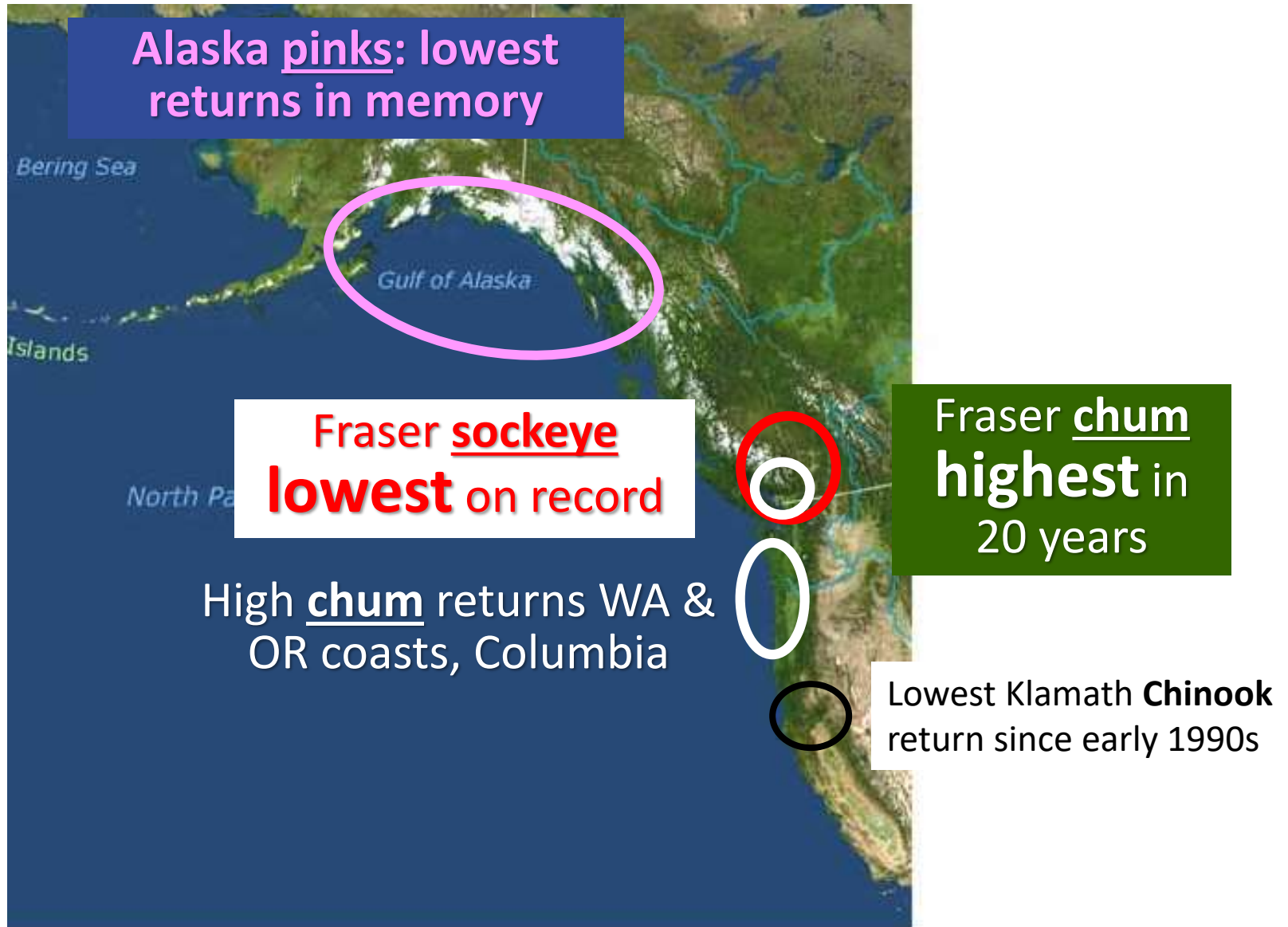
Unusual adult salmon observations in 2015



Interior Fraser & Salish Sea
coho extremely low
abundance, small body
size, and low fecundity

Columbia & Oregon coast
coho lowest returns since
1990s
Oregon coast **Chinook** returns
high

Unusual adult salmon observations in **2016**



Unusual salmon observations in **2017**

Alaska: Highest chum harvest ever, high **pink & sockeye** returns (best in W AK)
Lowest SE AK Chinook ever

Fishery closure for **Chinook**
from BC, WA, OR

2nd lowest Fraser
sockeye on record

2nd lowest Fraser
pink return ever

Lowest **steelhead** returns
to OR Coast ever

Fishery closure for Klamath **Chinook**

Lowest Central Valley
wild fall **Chinook** return
ever



Sea bird die-offs

Cassin's Auklets off WA/OR coasts,
Winter 2014



Common murre, N. California
to Alaska, summer 2015



Fulmars and shearwaters,
Bering Sea, summer 2017



Bad conditions elsewhere can affect our area: California sea lions left S. California for the Columbia



Source: Bryan Wright, ODFW

Changing behavior? Humpback whales entering large coastal estuaries

2015

Humpback whales in Columbia estuary



2016

Humpback whales in the Columbia estuary & San Francisco Bay



2017

Humpback whales in San Francisco Bay & Columbia River again!



Increased entanglements in crab gear in 2015 & 2016



4. Forecasts

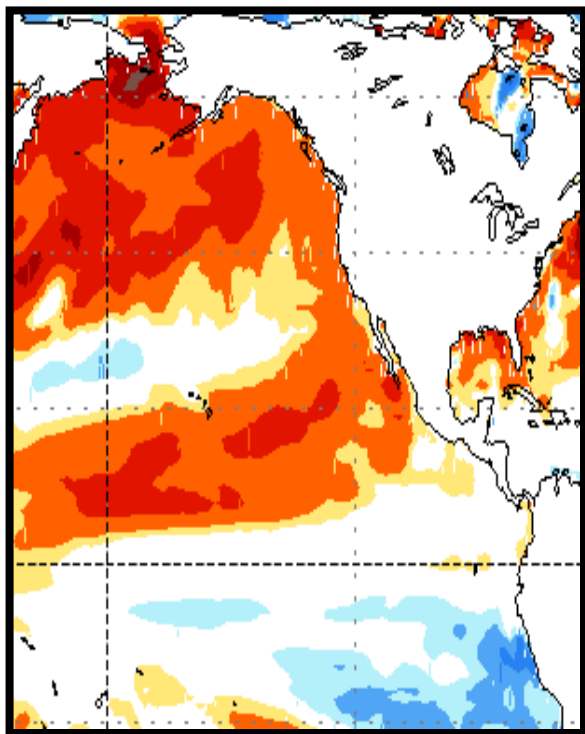
- Spring 2018 SST forecasts



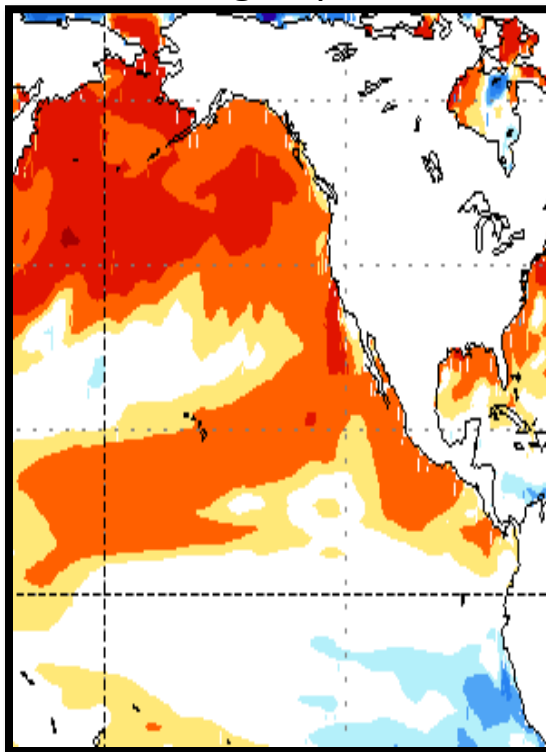
Forecast SST anomalies

NOAA Climate prediction Center coupled forecast model 2

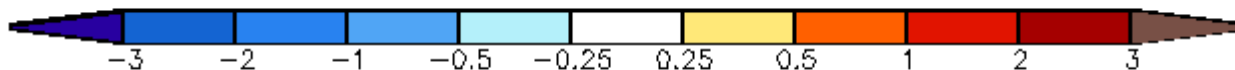
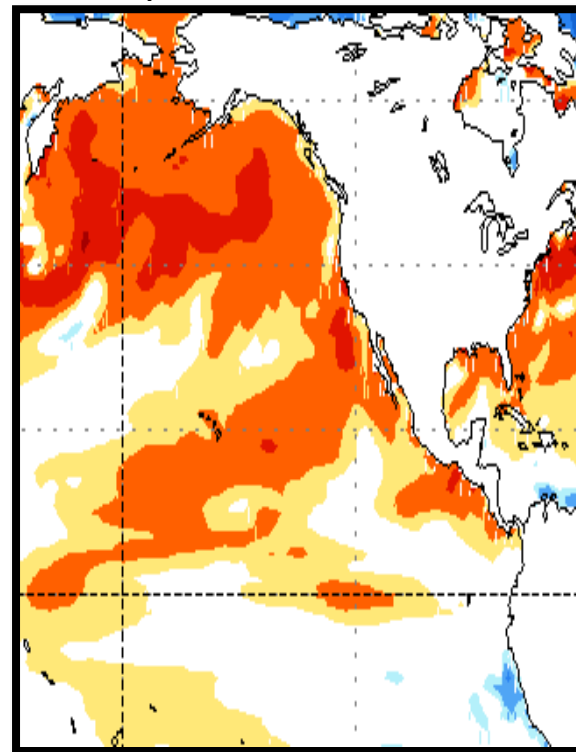
May-Jun-Jul 2018



Jul-Aug-Sep 2018



Sep-Oct-Nov 2018



<http://www.cpc.ncep.noaa.gov/products/CFSv2/CFSv2seasonal.shtml>

Summary

- Warm ocean waters present since 2014 still continue across large parts of the North Pacific Ocean
- Biological response to warm ocean has been huge
 - Effects observed at all levels of marine ecosystem
- Expect biological effects of warm ocean conditions to continue for several years
 - Big concern for 2018 coho and 2019 Chinook returns because of low 2017 juvenile abundances
 - Big recruitment of hake & mackerel off WA/OR—will they stay?
 - Residual effects on other species (e.g., crab, groundfish) uncertain
- Forecast for warm coastal waters in summer 2018 won't be good for cold water species (salmon, crab) but should benefit warm water species (tuna, sardines, squid).

Questions?



Sea lions in Astoria, Oregon