

# The evolution of the Blob in the North Pacific: Oct 2013-April 2015

Bill Peterson  
Senior Scientist  
NOAA-Northwest Fisheries Science Center  
Hatfield Marine Science Center  
Newport OR

If you read the newspapers, magazines, watch TV or follow internet blogs, you know that 2014 was a wild and crazy year throughout the North Pacific Ocean

- Anomalous winds
- Anomalously warm water
- Northward shifts of > 1000 km in zooplankton, krill, turtles, fishes and some marine mammals

**2015 IS SHAPING UP TO BE EVEN CRAZIER**

# A normal year

- Two seasons: stormy winters and pleasant summers.
  - WINTER: Low pressure and cyclonic winds over the Gulf of Alaska (blowing counter-clockwise) mix the water column to depths of 100s of meters, cooling water column. We get lots of rain, with heaviest during the “pineapple express”.
  - SUMMER: High pressure develops over much of the north Pacific with clockwise winds which off Oregon are from the north, creating upwelling and high productivity.

# Seasonal changes in winds and current structure affect ecosystem structure in the Oregon upwelling zone:

## • Winter:

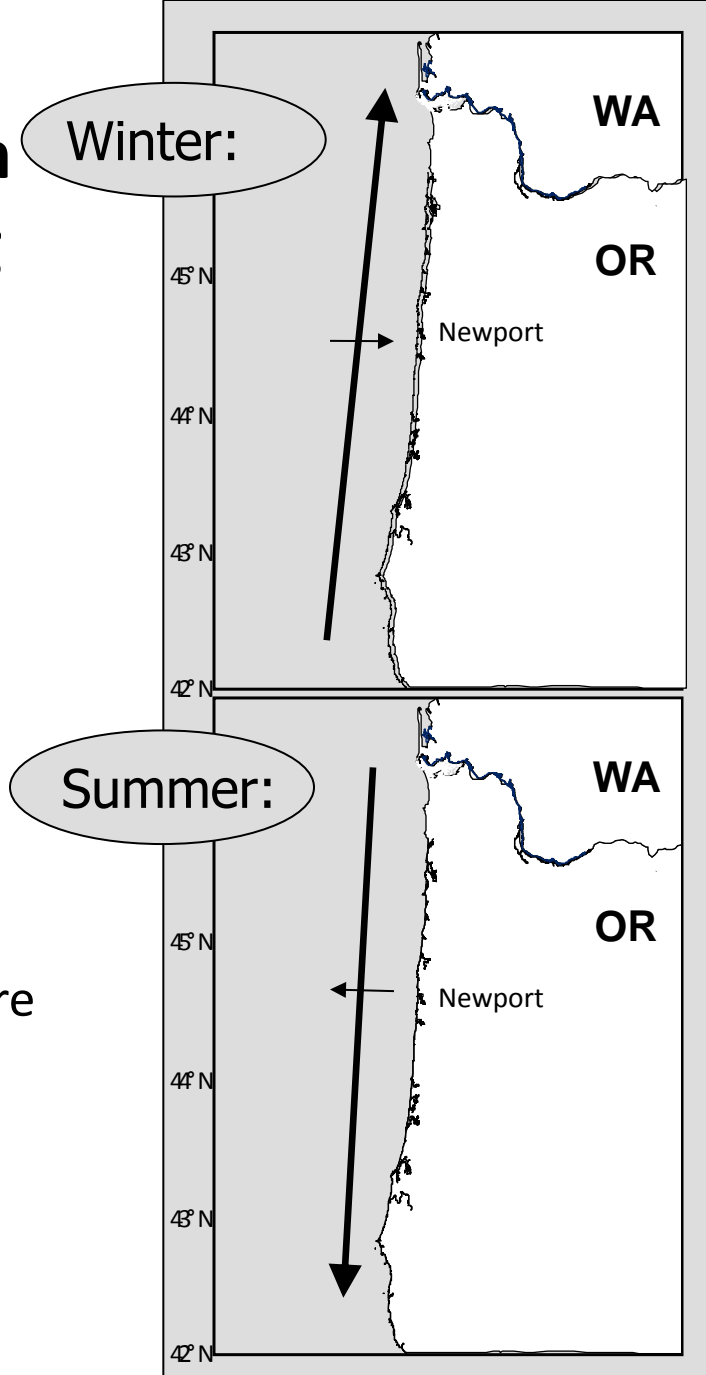
- Winds from the South pushes water onshore
- Poleward-flowing Davidson Current
- Subtropical and **southern species** transported northward & onshore

## • Spring Transition in April (usually)

## • Summer:

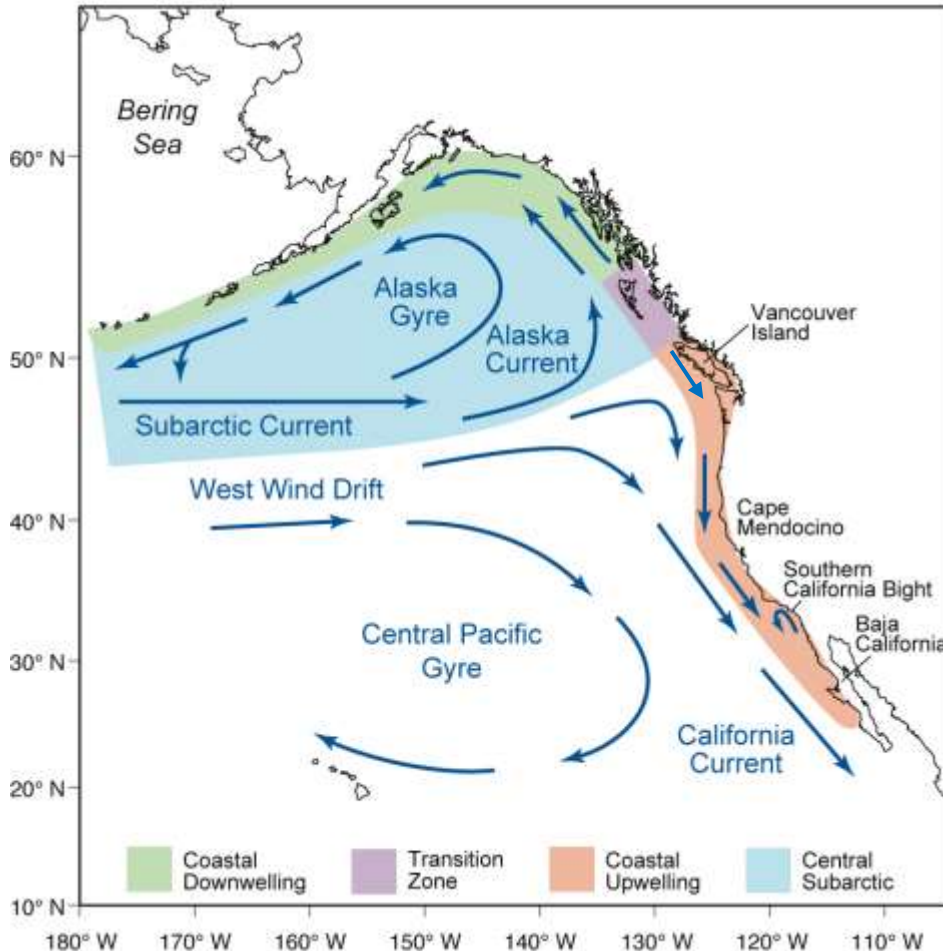
- Strong winds from the north cause coastal upwelling, pushing surface water offshore
- Equatorward alongshore transport
- **Northern species** transported southward

## • Fall Transition in October (usually)



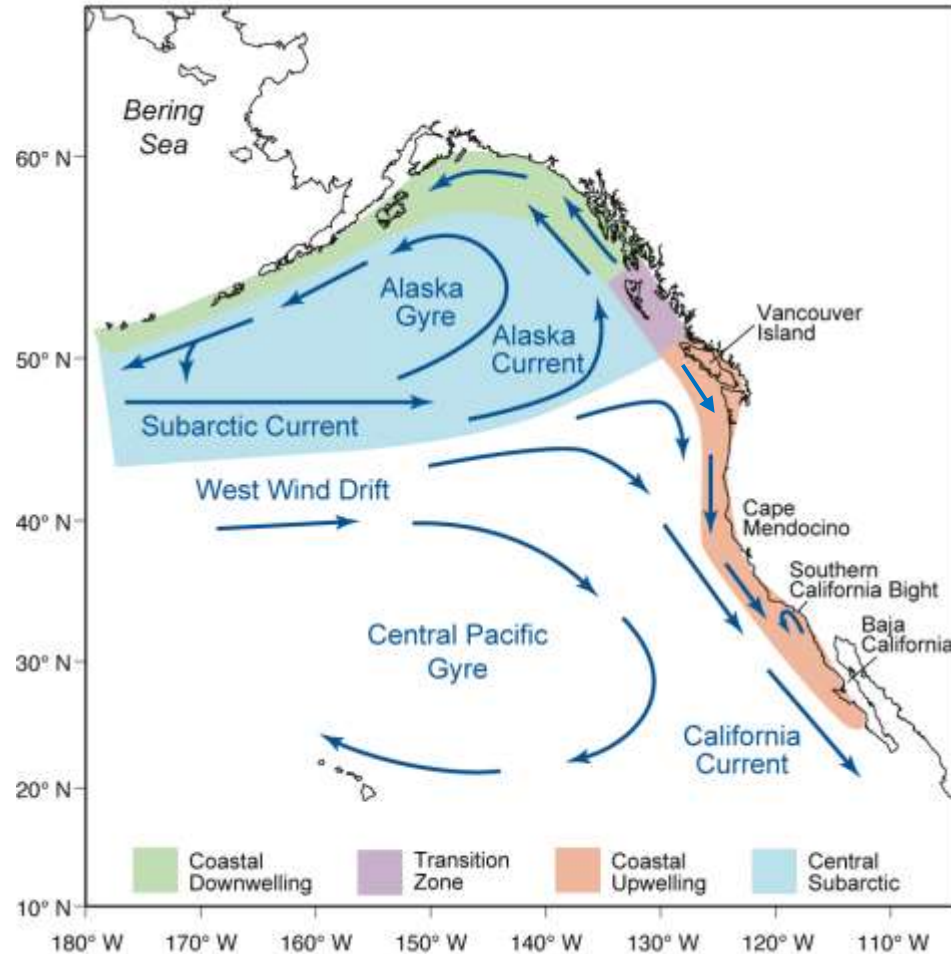
# Circulation patterns in the Northeast Pacific

Transport is a key aspect of pelagic ecosystem structure, for three reasons:



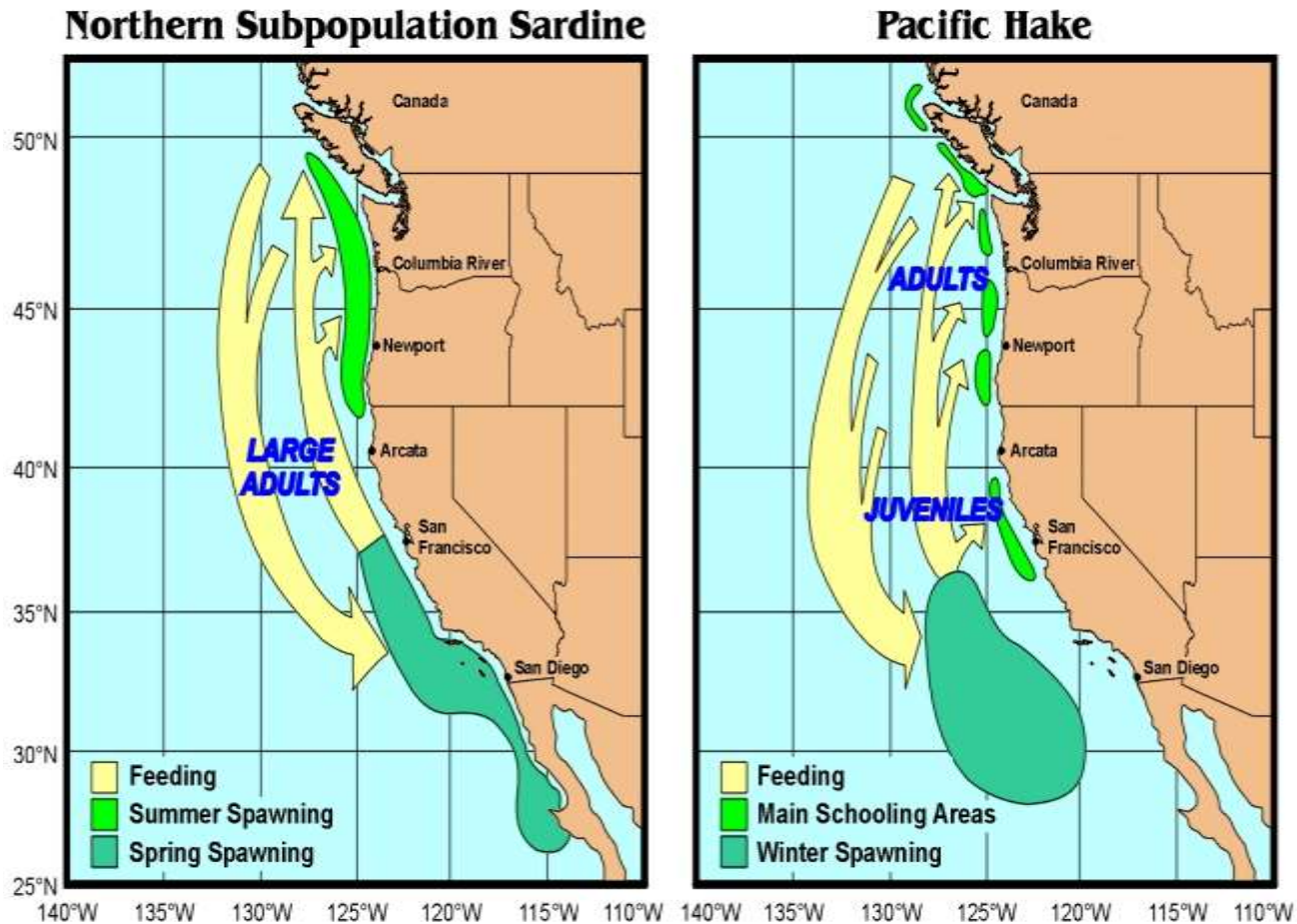
1. Subarctic Coastal Currents bring cold water and **"northern"** (fatty) copepods to the N. California Current during spring and summer
2. The West Wind Drift and reversals in coastal currents during winter and during El Niño events bring subtropical water and **"southern"** (non-fat) copepod species to the NCC.
3. Therefore, the bioenergetic and fat content of the food chain is affected by the source waters which feed the CC.

# Circulation off the Pacific Northwest



- The offshore boundary between the subarctic gyre (blue colored region) and the central Pacific gyre can shift north or south as well
- Such shifts also affect the types of water that feed the California Current.

During a “normal year”, sardines and hake migrate to Oregon in spring to take advantage of the bountiful harvest during summer; salmon of course migrate to the ocean at the same time (April/May) for the same reasons





# We also get some long distance migrants including:



- Sooty shearwaters from New Zealand
- Black Footed and Laysan Albatross from Hawaii
- Gray Whales from Mexico
- Humpback whales from Peru
- The occasional leatherback turtle from New Guinea





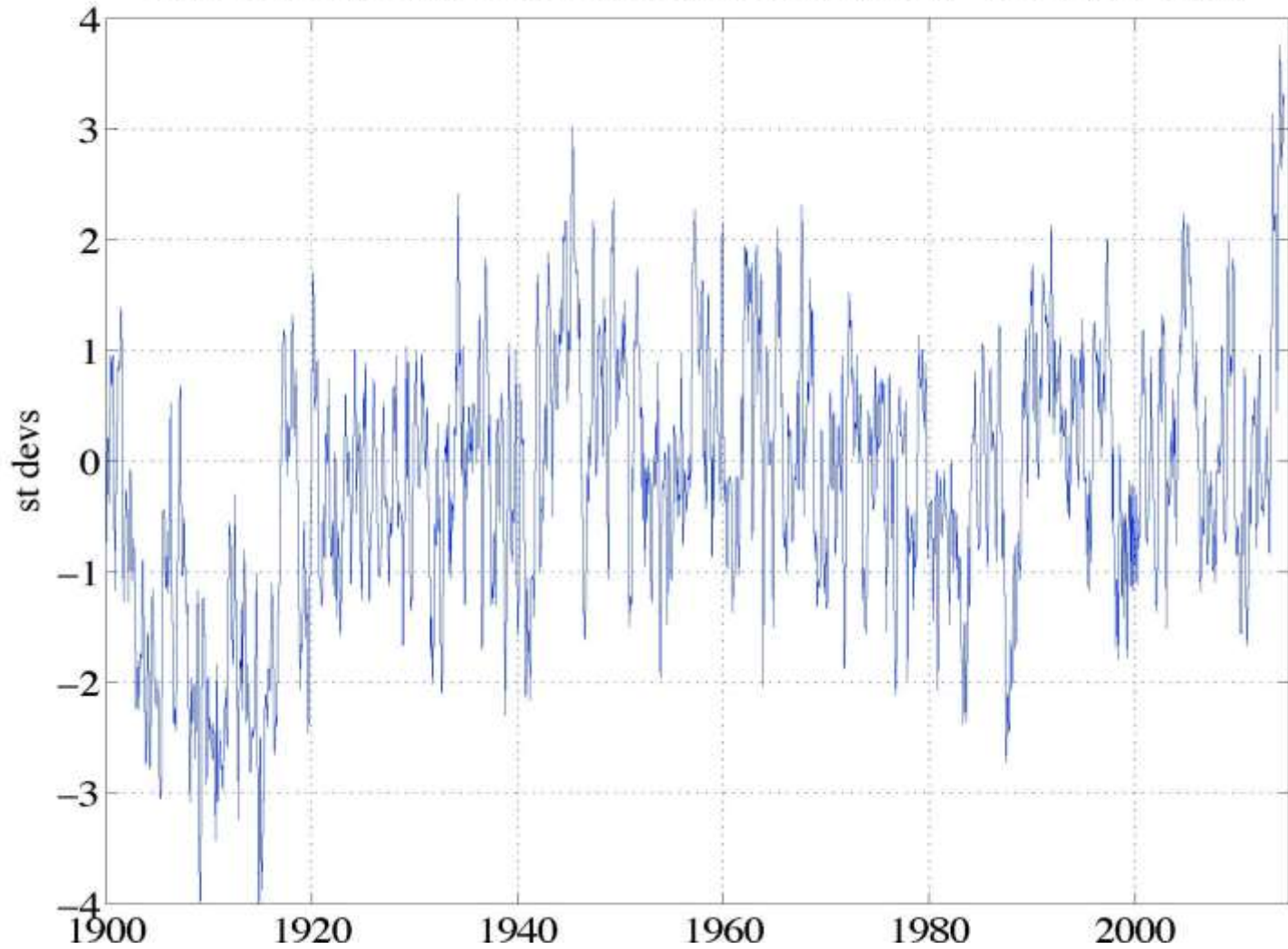
But, the years 2014 and 2015 were anything but normal!

- No climate models predicted this “thing”
- The anomalies in ocean conditions and the biological responses were beyond anything ever observed to date, thus we lack experiential knowledge that we might ordinarily use to provide some idea of expectations for the outcomes in 2015 and beyond.
- And is there a double-whammy on the horizon (is there or is there not, an El Niño on the way)?

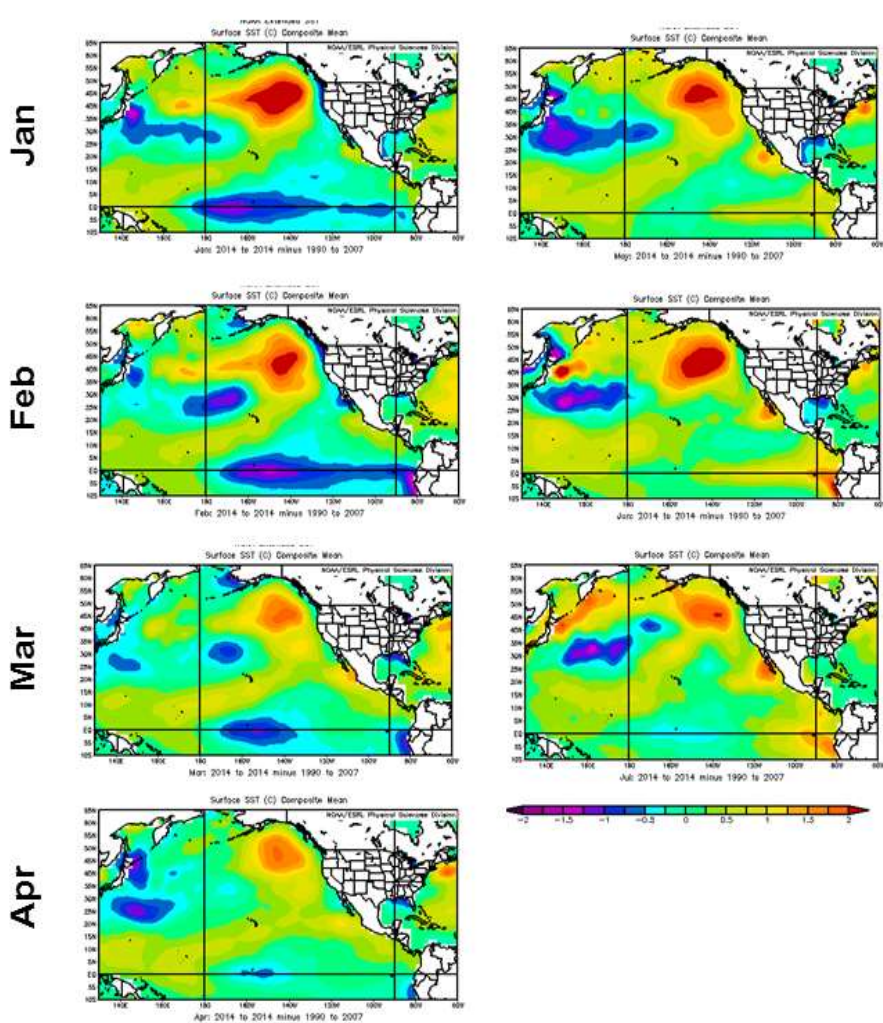
# Development of the warm blob

- November 2013, Aleutian Low fails to develop
  - Surface waters of GOA did not cool due to lack of strong winds and subsequent deep mixing; by summer SST anomalies of  $3.5^{\circ}\text{C}$  were observed which were  $1.5^{\circ}\text{C}$  greater than any year since at least 1948.
  - SST anomalies persisted through summer 2014
  - Weak westerly winds along  $40^{\circ}\text{N}$  (weakest zonal winds on record ( $1.6 \text{ m s}^{-1}$  vs  $4.5 \text{ m s}^{-1}$ ) affected the Transition Zone
  - No SW winds along west coast of US during winter 13/14 (or 14/15 for that matter).

Gulf of Alaska normalized SST anomalies (160W–130W, 30–50N)



Courtesy of Nate Mantua, NMFS-Southwest Fisheries Science Center; Santa Cruz



← The SST “Blob” in the Gulf of Alaska in 2014

May

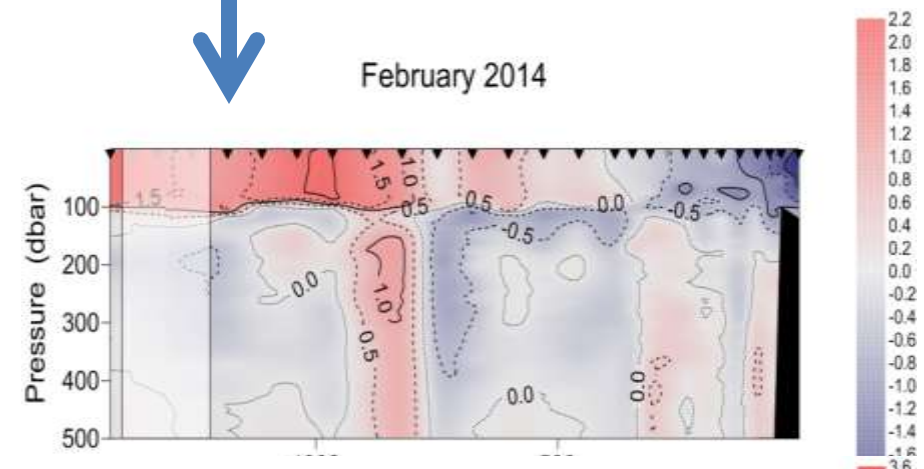
Temperature vs depth from a transect line from Vancouver Island into the Blob

Jun

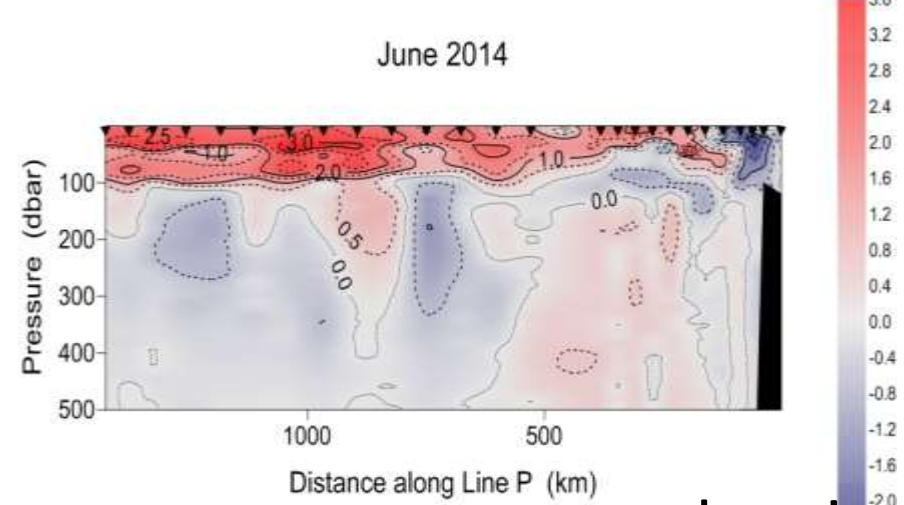


February 2014

Jul



June 2014



**RED** is warmer than normal

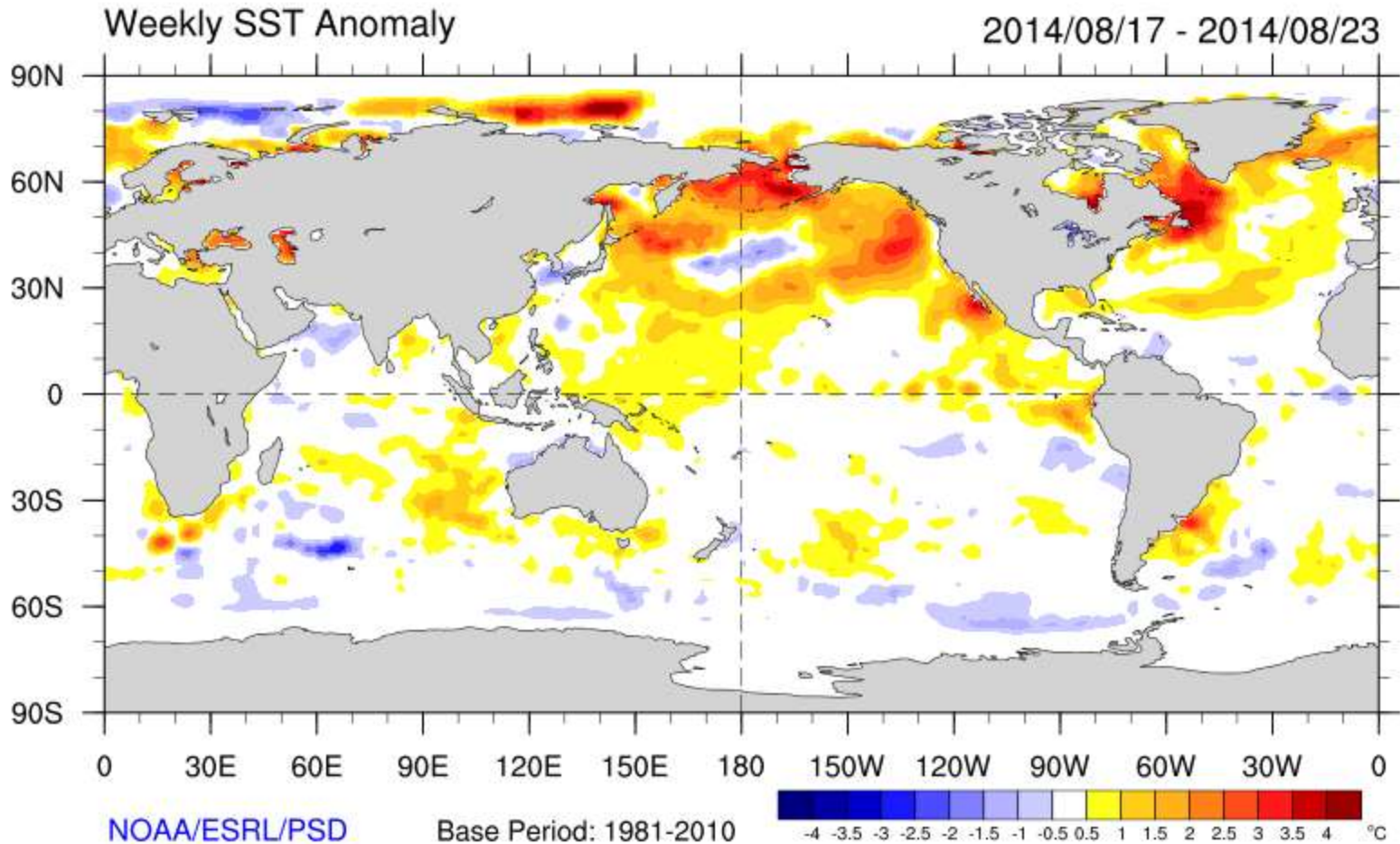
**BLUE** is colder than normal

Note also: SST in waters at the equator are not anomalous!



# 17-23 August 2014: SST Anomaly

Note: (1) Cooler waters off our coast due to coastal upwelling; (2) Lack of SST anomaly at the equator; (3) Two separate blobs (off OR and off S. Cal and Baja)

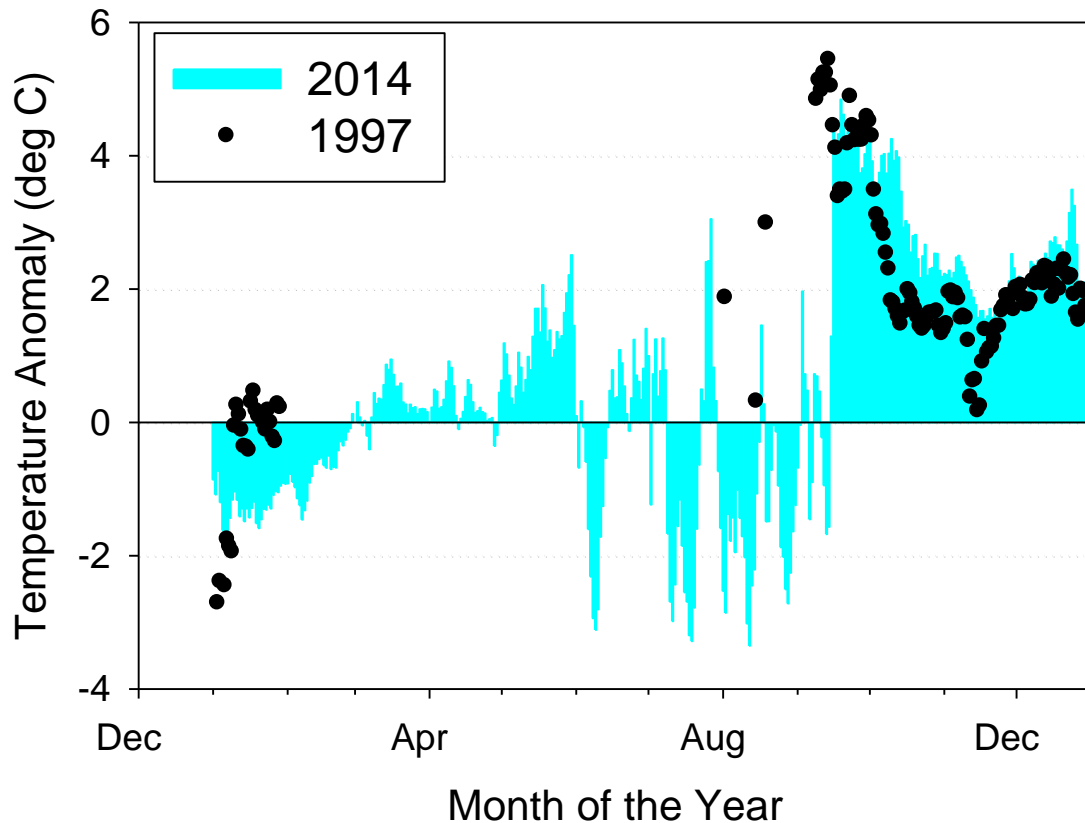


# Upwelling at Newport

- Start of upwelling delayed until late June (nearly matched 2005)
- As soon as the northerly winds (such as they were) ceased to blow, the warm blob began moving eastward
- Upwelling season ended in mid September making this the **shortest** upwelling season that we have seen since we began sampling NH in 1996!

# SST at NOAA Buoy 46050 Stonewall Bank off Newport

SST at NOAA Buoy 46050  
(Stonewall Bank)

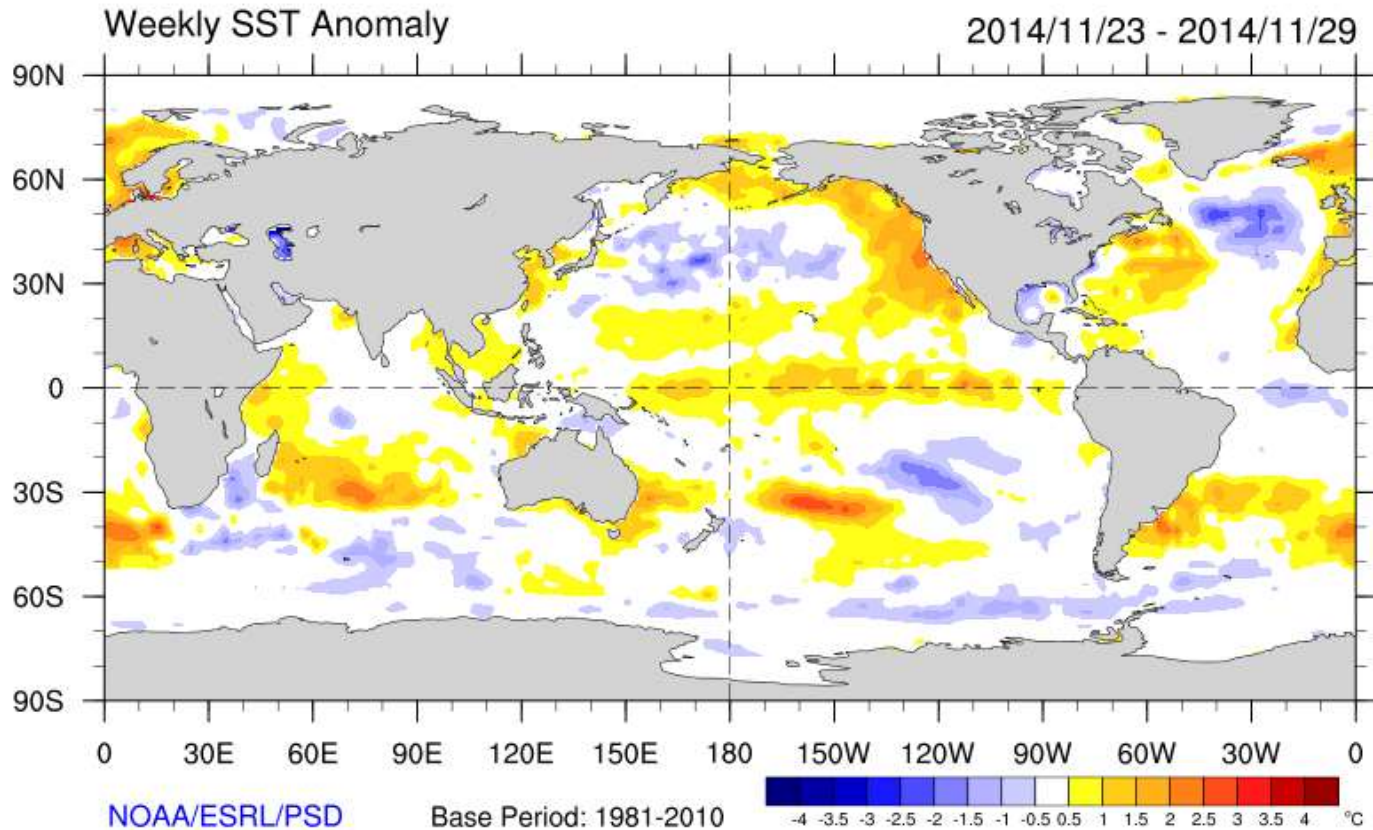


The “Blob” came onshore on 14 Sep 2014 at 10 pm with a peak temperature of 19.4°C

SST in 2014 (teal blue) compares very well to the 1997 El Niño (black dots). (Buoy was not working for most of 1997, hence no black dots.)



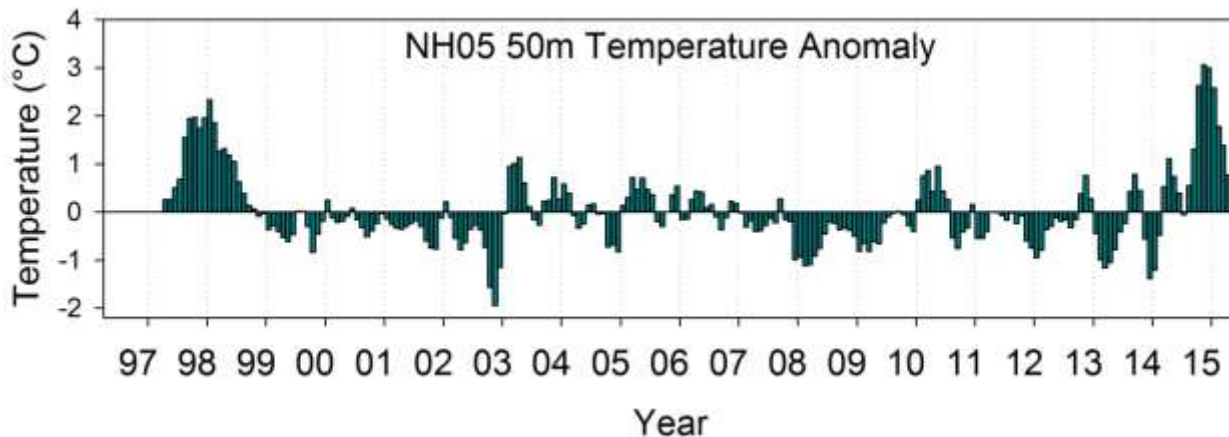
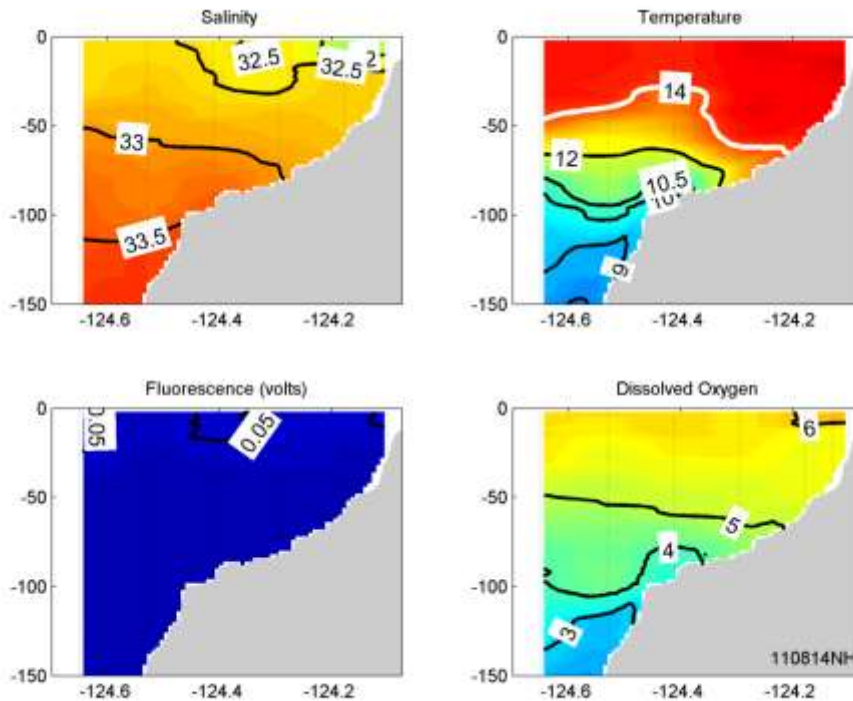
# 23 -29 November 2014



By late November, we see that the blob has moved eastward and occupies pretty much the entire California Current and eastern GOA.

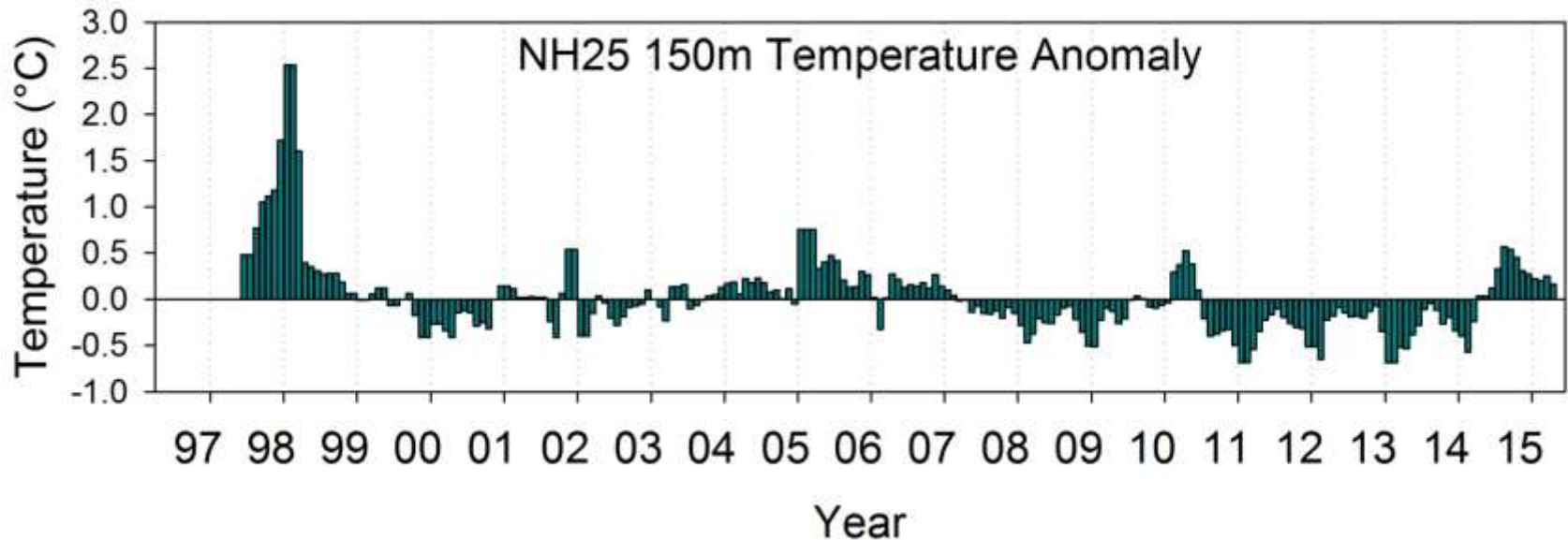
# 8 Nov 2014 Newport Line

We see that the waters over the continental shelf, to depths of 50-80 m, are excessively warm. Cruises in Jan-March 2015 show the same patterns.



In fact at 50 m, temperatures were **3°C above** 'normal' and the warmest in our 19 year time series.

# NH 25 temperature at 150 m (California Undercurrent)



- The deep waters (below 100 m) were not unusual in any way, being only slightly warmer than climatology.
- Note difference in temperature during the 1997/98 El Niño

# Why is the Blob so different from an El Niño?

- Even though SSTs were similar between the Blob and a big El Niño event, there was no El Niño at the equator, thus there was no transport of tropical water north along the coast of California and Oregon.
- Instead, the Transition Zone shifted northward, bringing offshore tropical waters near to our coast, and this is the water that came onshore.
- Therefore, it was eastward transport of subtropical warm water, not northward of subtropical water that has given us all of this interesting “biology” and the potential for an ecological nightmare this year.

# El Niño or not?

- Yes, but consensus seems to be that it is a weak one. However, even the weak ones affect our weather through atmospheric teleconnections.
- Too soon to know what might happen.

**Final Comment:** When someone tells you that on average, this or that will change at such and such a rate by the year 2050, tell them you don't care!

Your worry should be increased 'climate variability' and 'climate surprises', not slow chronic climate change!

How many more surprises are on the horizon? Remember the result of delayed upwelling in 2005?

The End



# Consequences of a warm North Pacific: all kinds of tropical fish and birds have shifted north in 2014

- Gulf of Alaska and Prince William Sound
  - Pomfret, skipjack tuna, thresher shark, ocean sunfish common everywhere
- Bering Sea
  - Warm year; big coccolithophore bloom; unusual 'fish'
- Oregon/Washington
  - Green turtle, Florence and Greys Harbor, in Sep
  - Olive Ridleys turtle off WA in December
  - Ocean sunfish common everywhere
  - Sardines and anchovy spawning off central Oregon in February and March 2016
  - Sardine fishery closed in March 2016
- Newport Hydrographic Line
  - Deep water temperatures on continental shelf **2°C** warmer than we have ever seen in 19 years of sampling!
  - Copepod species present on shelf that are usually seen only during strong El Niño events, or in far offshore waters. A total of 17 species new to the Oregon coast have been identified.
- California
  - Opah (moonfish) landed in San Diego
  - *Velella* (by-the-wind sailors) seen commonly everywhere (off Oregon as well)
  - Green turtle off San Francisco
  - Mahi mahi caught here and there
  - 335 lb yellowfin tuna caught at Cabo (a record)
  - 50 lb wahoo caught off Dana Point (first record for CA)
  - Market squid fishery shifted north from Monterey Bay to Eureka
- Salmon
  - Fraser River sockeye all returned through Johnstone Strait (Canadian Waters), none through Strait of Juan de Fuca, thus no sockeye for US.



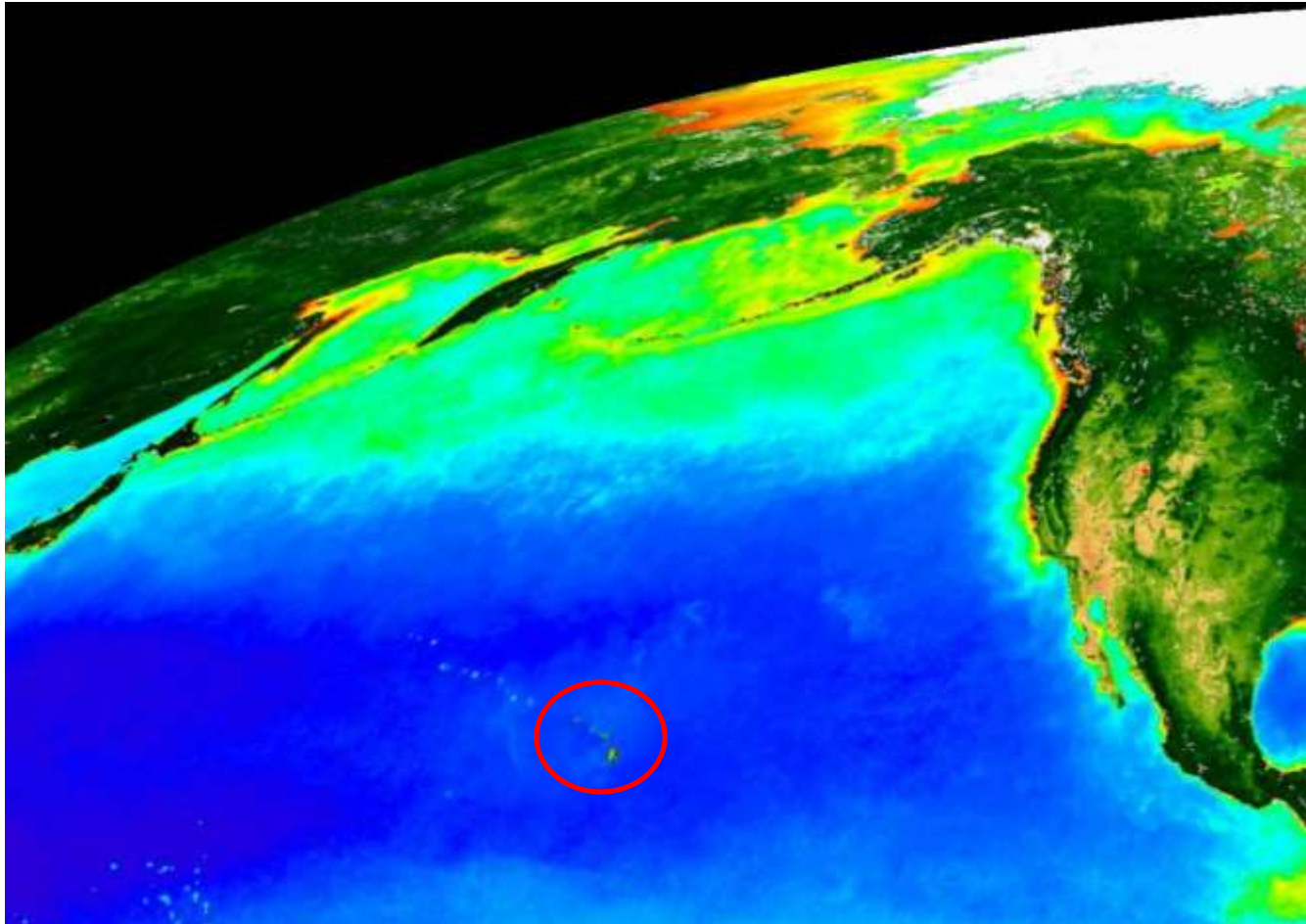
An Opah

# Notable seabird issues

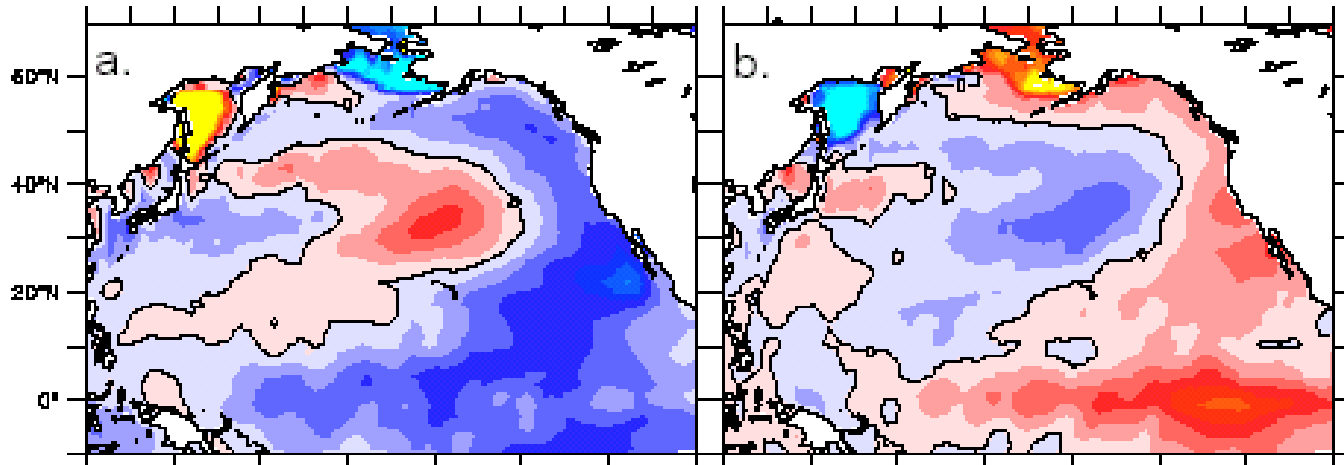
- Unusual (tropical) seabirds seen off OR during the tri-annual west coast mammal survey
  - Band-rumped storm petrel, black storm petrel, brown booby
- Two major mortality events of Cassin's auklets
  - 16 Nov 2014, Marin County
  - 22 Dec 2014, Seaside OR
- Big story appeared in Audubon magazine in March/April on the auklet mortality events, featuring Peterson and Mantua.
- Record-high nesting success of albatross in the Hawaiian Islands due to productive Transition Zone Chl-a Front.

**EXTRA SLIDES**

# Transition Zone Chlorophyll Front (phytoplankton, where blue meets green)



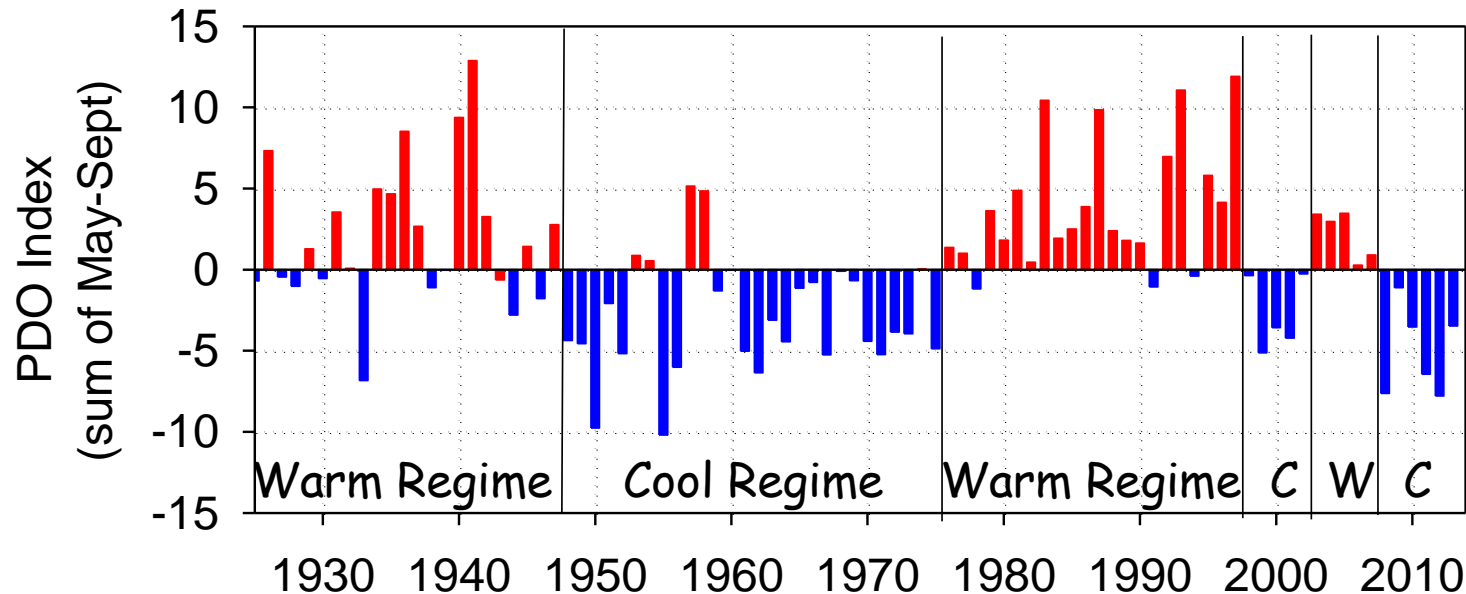
Winds over the North Pacific in winter are a big driver of ocean variability: e.g., the Pacific Decadal Oscillation)



Blue is anomalously cold; Red is anomalously warm  
La Niña at the equator    El Niño at the equator

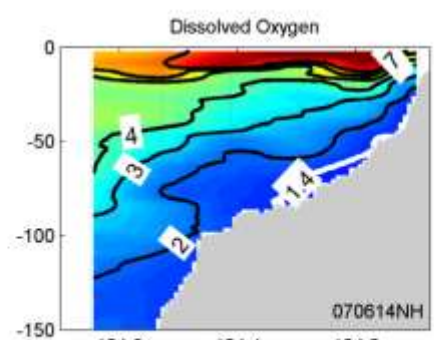
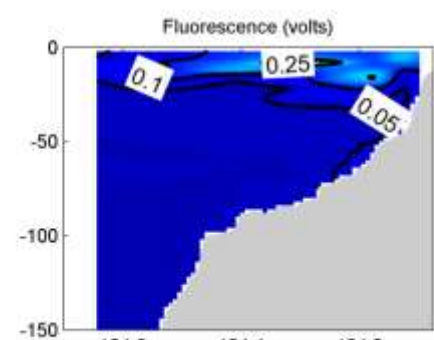
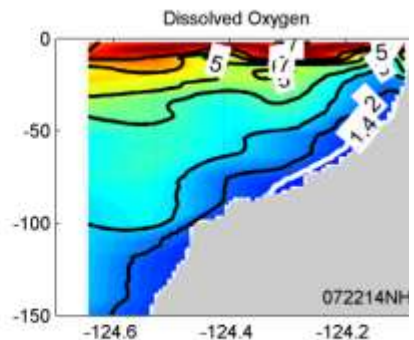
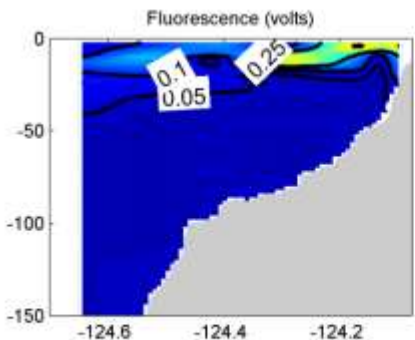
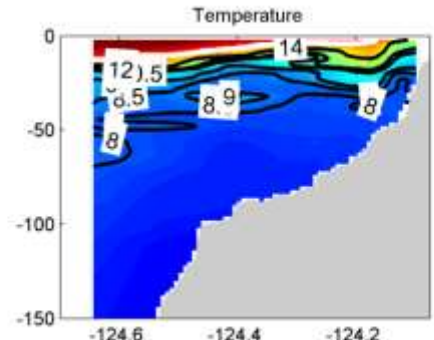
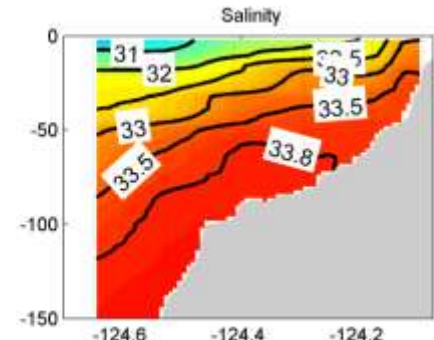
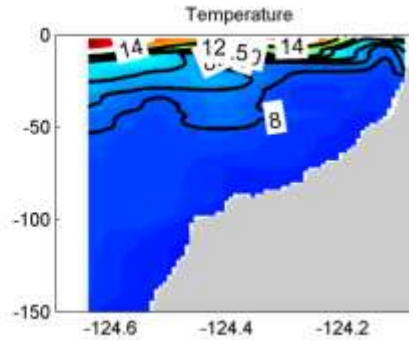
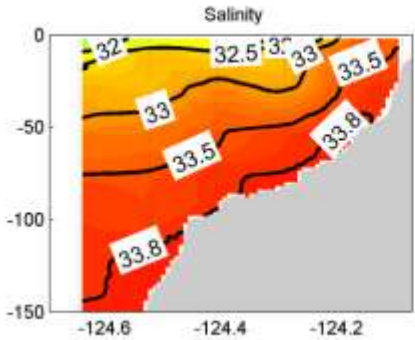
SST anomaly patterns result from basin scale winds: W'ly and NW'ly [negative phase= cool regime] and SW'ly [positive phase=warm regime].

# PDO: May-Sep Average, 1925-2013



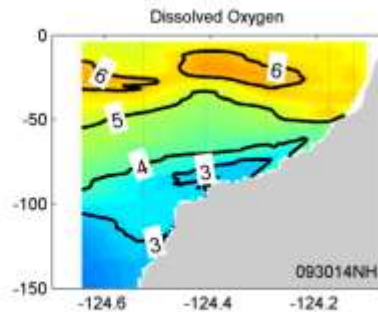
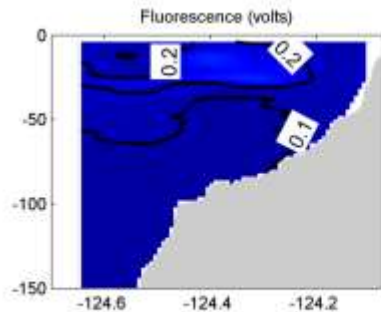
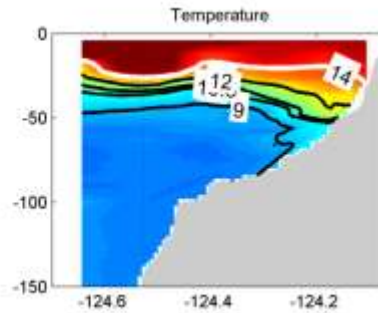
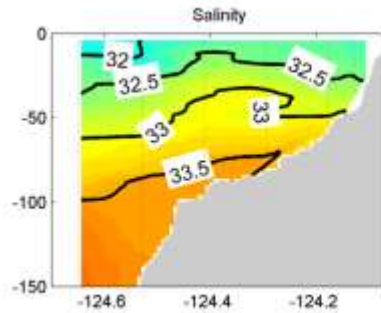
- From 1925-1998, PDO shifted every 20-30 years. Some refer to these as "salmon" regimes (cool) and "sardine" regimes (warm).
- However, we have had three shifts of 5-6 years duration recently: 1998-2002, 2003-2007, and 2008-2013, thus we have a natural experiment to examine the affects of PDO on marine food chains.

# 16 & 24 July 2014, Newport Line

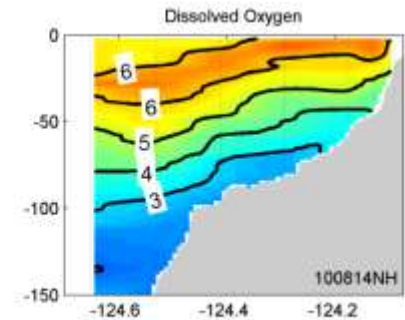
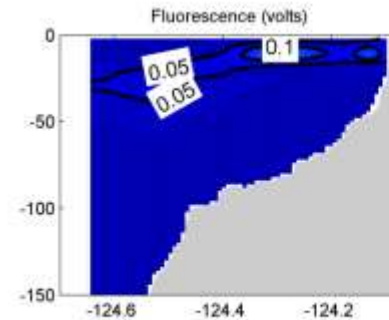
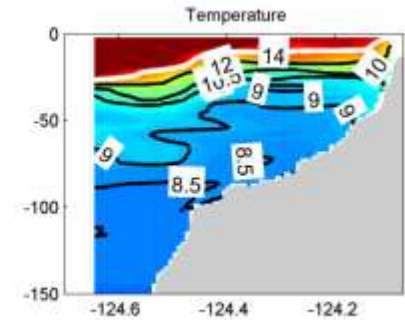
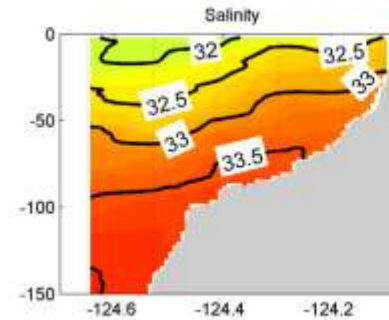




# 25 September 2014 Newport Line

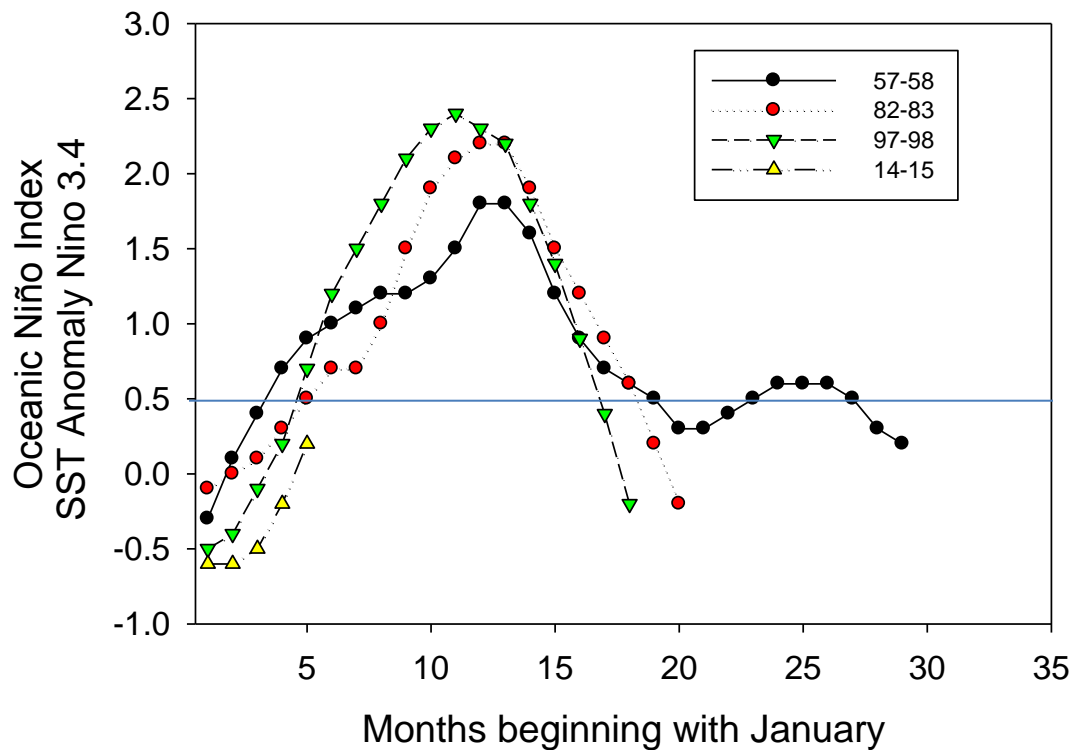


# 8 October 2014 Newport Line



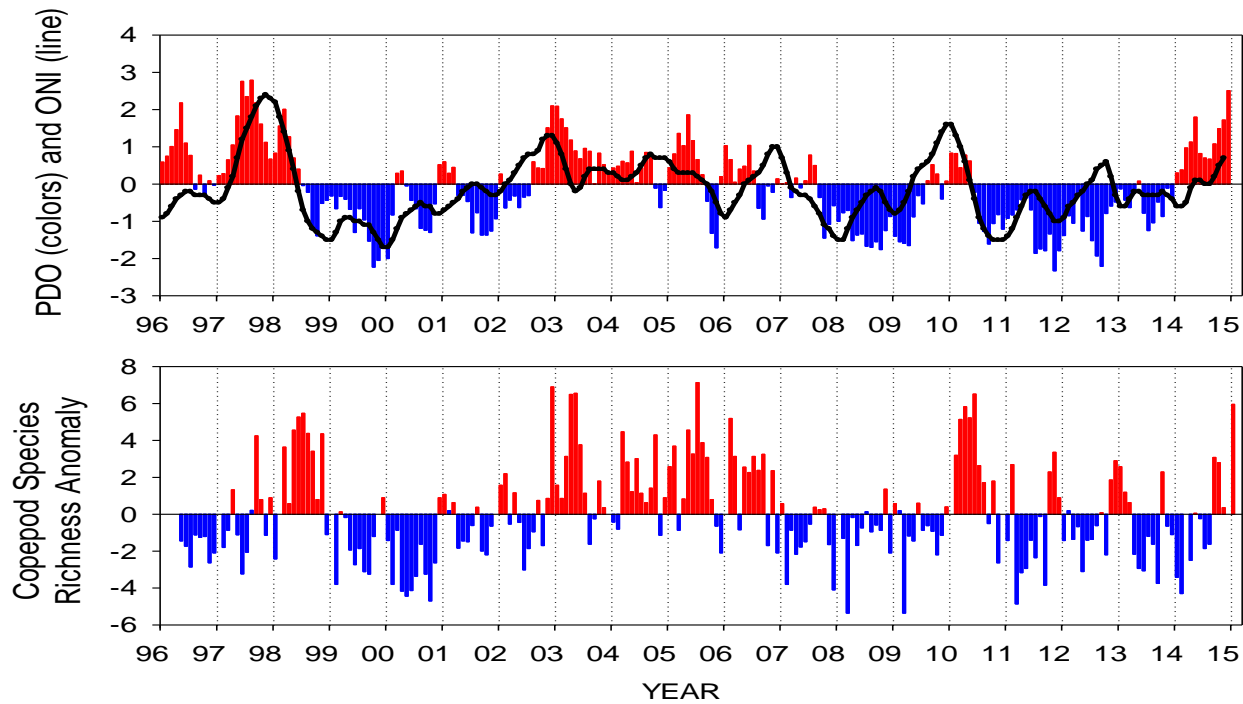
On both cruises, only the upper 20-30 m was excessively warm

# SST Anomaly at Equator for the past three really big events



- The three big past events exceeded the 0.5 °C threshold by March or April;
- The 14-15 event has not (and won't).

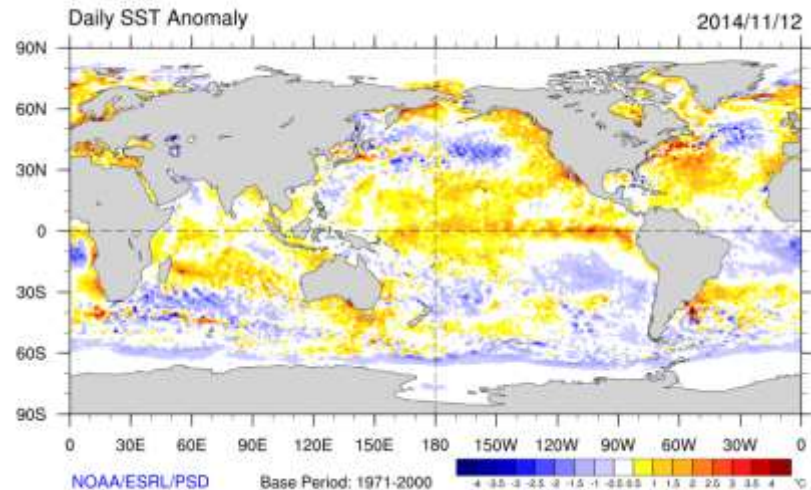
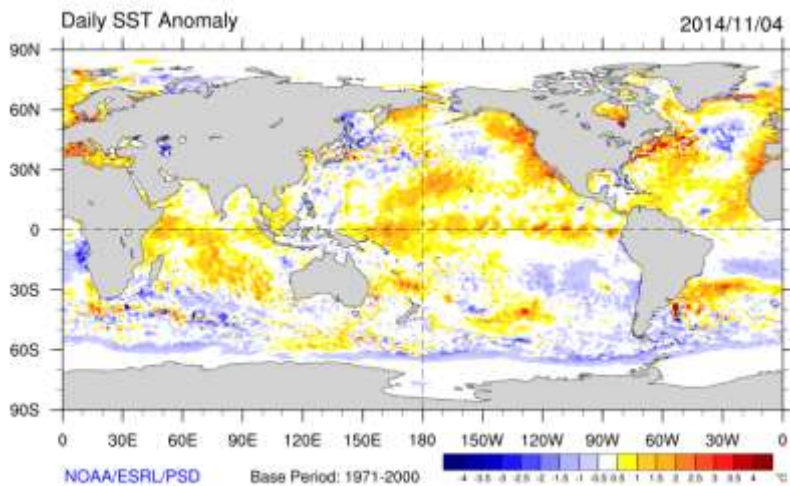
# Copepod Species Richness



## Some unusual bugs seen since Nov 2014

- *Rhincalanus nasutus*
- *Eucalanus hyalinus*
- *Eucalanus subcrassus* (Lifer)
- *Clausocalanus farrani*
- *Clausocalanus furcatus* (Lifer)
- *Calocalanus pavo*
- *Penilia* spp (Lifer)

# 4 and 11 November 2014



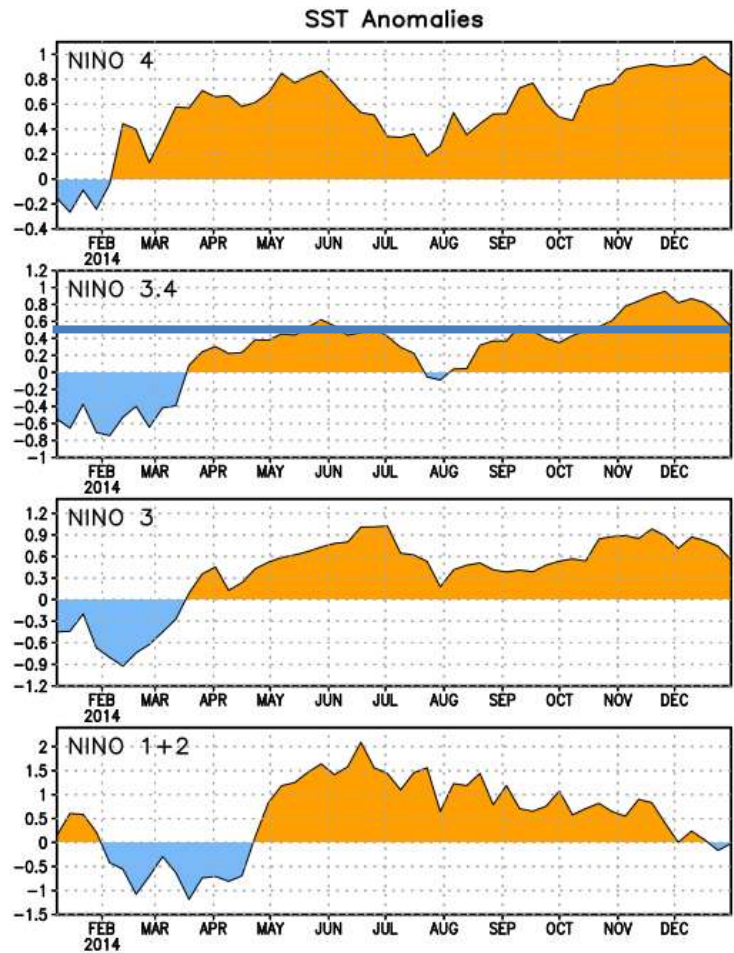
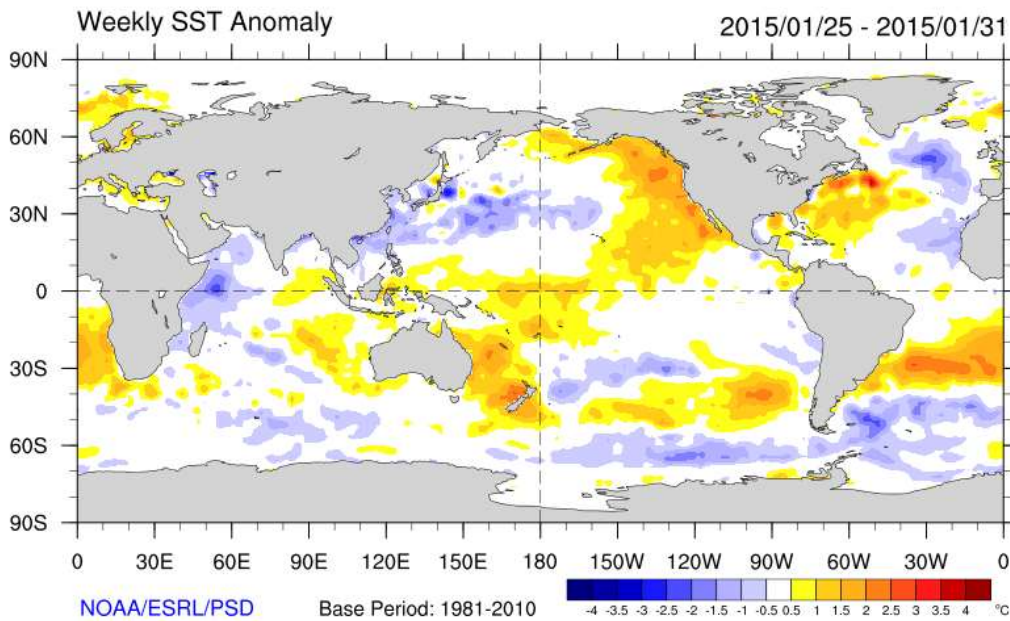
Noteworthy features are:

- (1) the California Current is still very warm
- (2) Equator is warming, slowly but surely
- (3) SST pattern in North Pacific is looking more like the familiar pattern of a positive PDO.

# SST Anomalies

## Nino 1+2, 3, 3.4 and 4

### 25-31 January 2015





# Niño Region SST Departures (°C) Recent Evolution

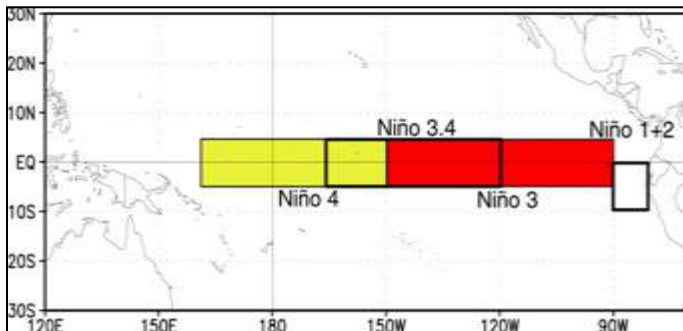
The latest weekly SST departures are:

Niño 4

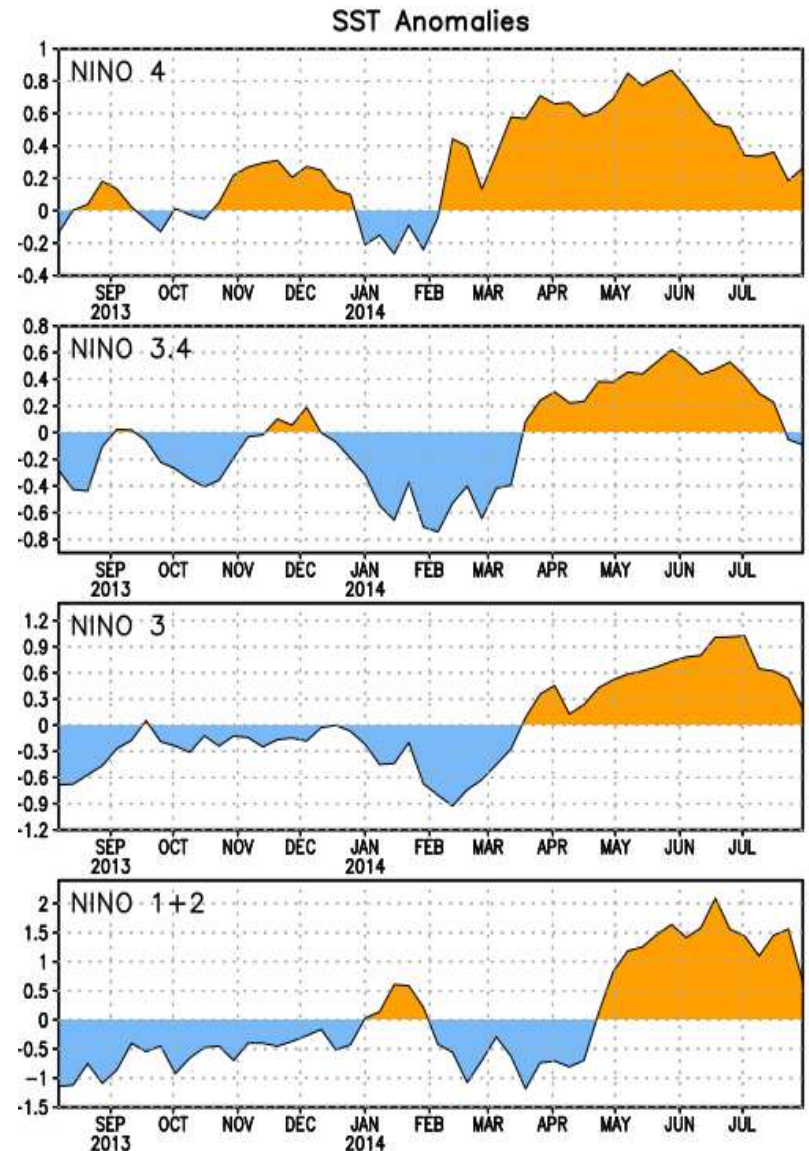
0.2°C

0.3°C

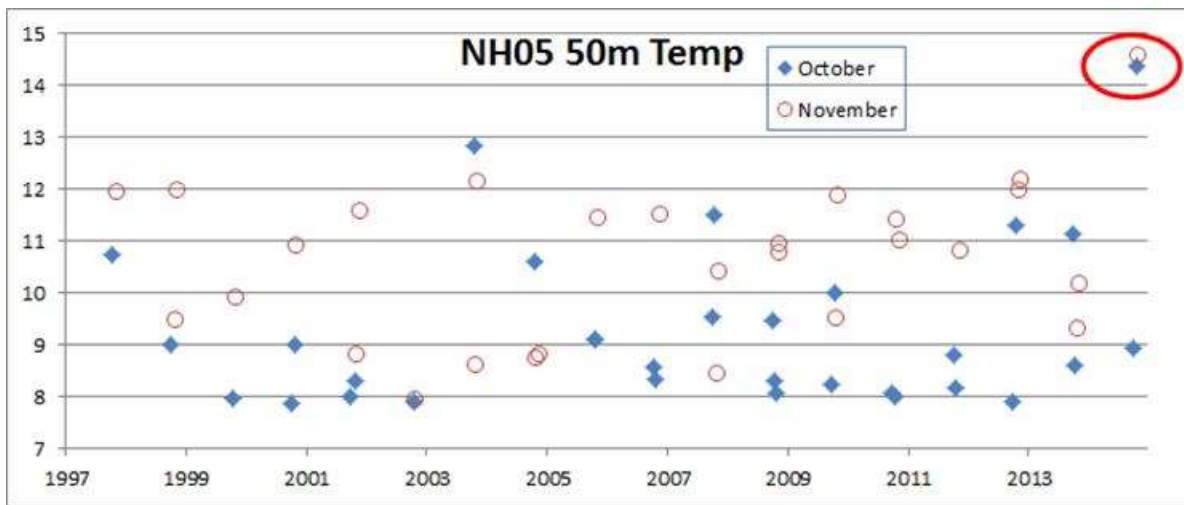
0.1°C

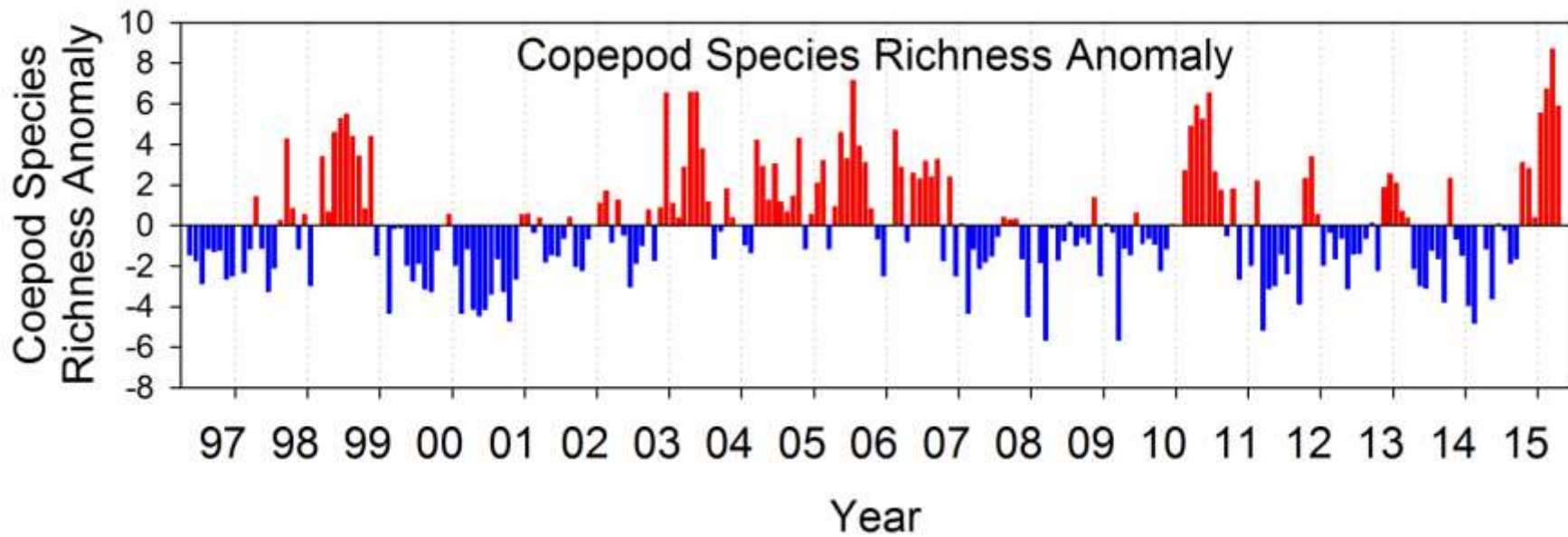


[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/enso\\_advisory/](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/)

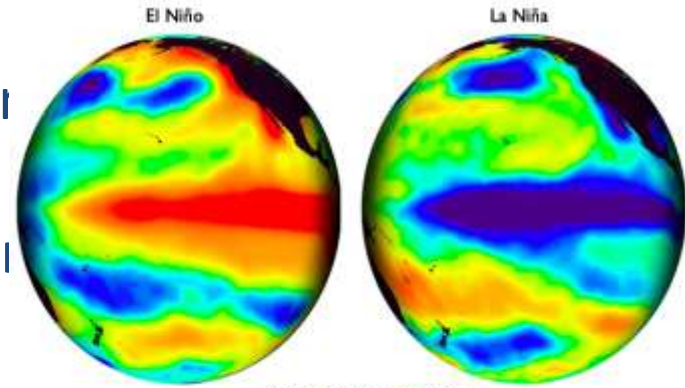








Since 1950, there have been six “strong” and “moderate” *El Niños* and five “strong” and “moderate” *La Niñas*. We are over-due for “strong *El Niño*”.



## Oceanic Niño Index (ONI)

[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensostuff/ensoyears.shtml](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml)

