The changing North Pacific ecosystem and potential impacts to steelhead

Elizabeth A. Daly[1], Hillary L. Thalmann[2], and Richard D. Brodeur[3]

[1]Oregon State University, CIMRS, Newport, OR

[2]NOAA, Ernest F. Hollings Scholarship Program, Silver Spring, MD

[3]NOAA, Northwest Fisheries Science Center Newport Branch

What do we know about Columbia River steelhead salmon in the marine environment?

14th PSMFC Steelhead Management meeting

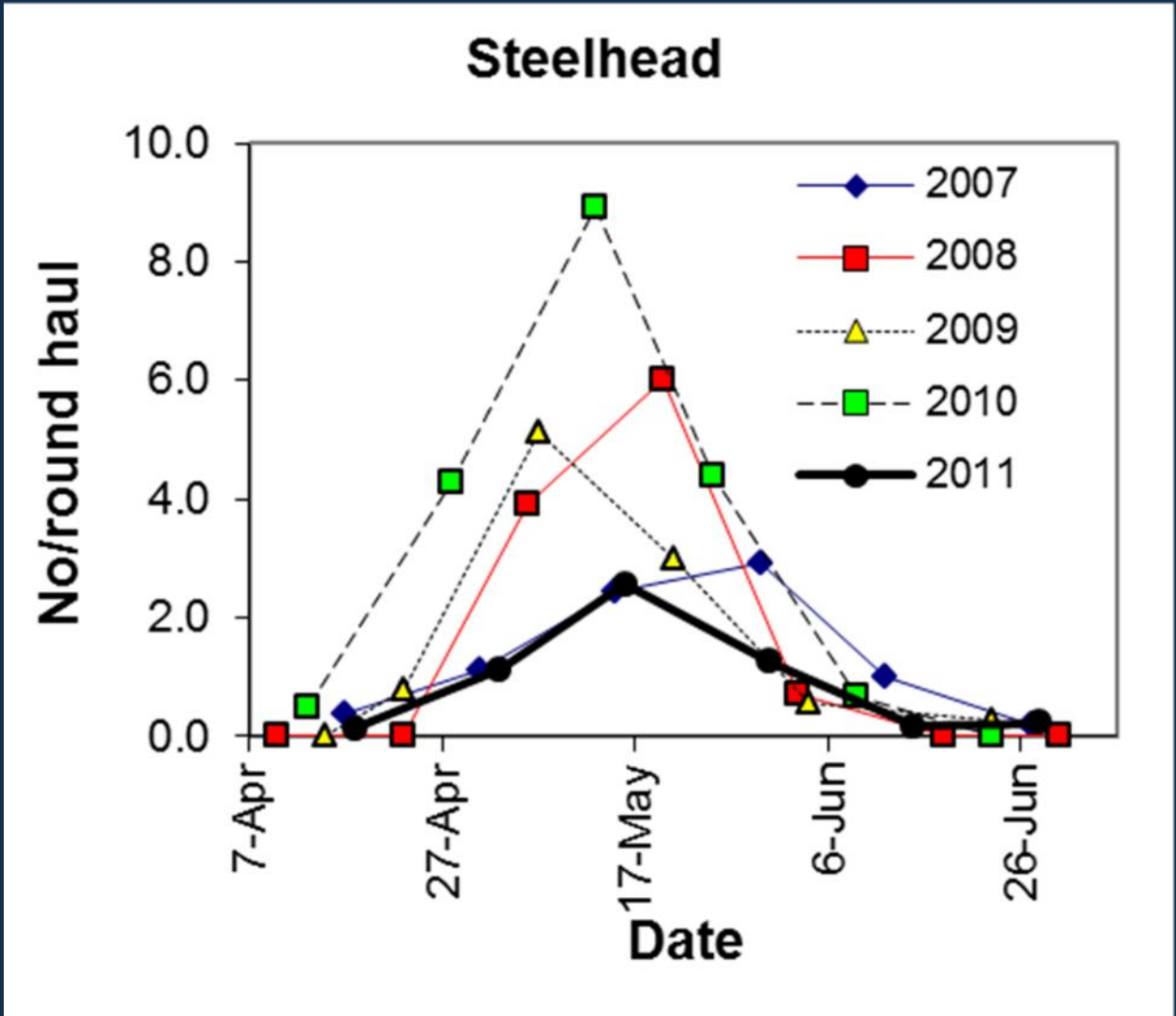
An Overview of Juvenile Steelhead Ecology and Survival When They First Enter the Ocean

Richard Brodeur (NWFSC)

with help from:
Elizabeth Daly (OSU)
Julie Scheurer (ARO)
Laurie Weitkamp (NWFSC)
Jessica Miller (OSU)
Brian Beckman (NWFSC)

Next few slides are a review based on Ric's 2014 talk

Timing of juvenile Columbia River steelhead ocean migration

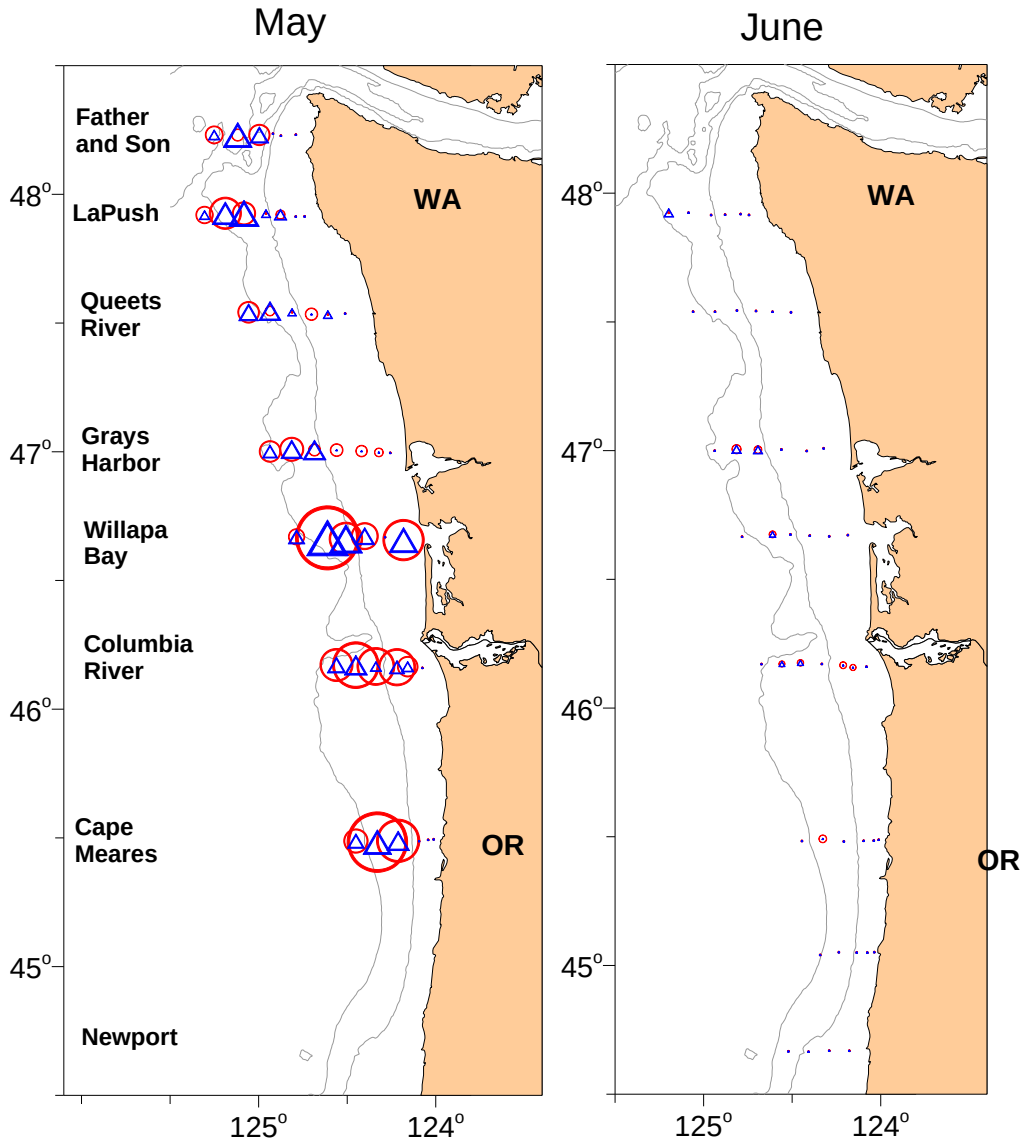


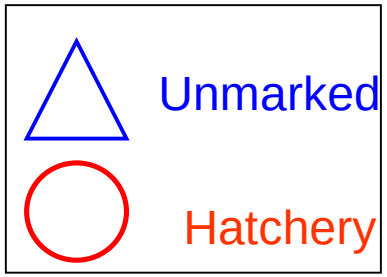
- Updated figure from Laurie Weitkamp Columbia River estuary purse seine sampling
- Peak timing is early to mid-May

Seasonal and interannual variation in juvenile salmonids and associated fish assemblage in open waters of the lower Columbia River estuary

Laurie A. Weitkamp (contact author)[1]
Paul J. Bentley[2]
Marisa N. C. Litz[3]

Juvenile steelhead salmon are caught off coastal OR/WA in May and are offshore by June





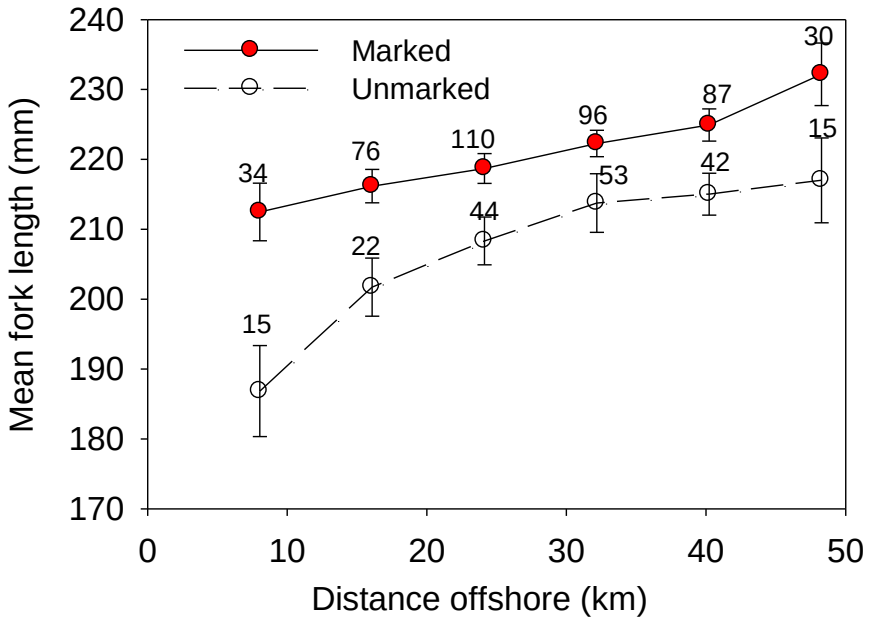
Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/umcf20

Juvenile Steelhead Distribution, Migration, Feeding, and Growth in the Columbia River Estuary, Plume, and Coastal Waters

Elizabeth A. Daly[a], Julie A. Scheurer[be], Richard D. Brodeur[b], Laurie A. Weitkamp[b], Brian R. Beckman[c] & Jessica A. Miller[d]

Juvenile steelhead salmon quickly grow and move offshore, spending less than 10 days in our ocean sampling area- based on otoliths

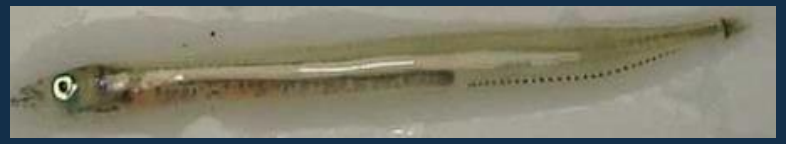


Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/umcf20

Juvenile Steelhead Distribution, Migration, Feeding, and Growth in the Columbia River Estuary, Plume, and Coastal Waters

Elizabeth A. Daly[a], Julie A. Scheurer[bc], Richard D. Brodeur[b], Laurie A. Weitkamp[b], Brian R. Beckman[c] & Jessica A. Miller[d]

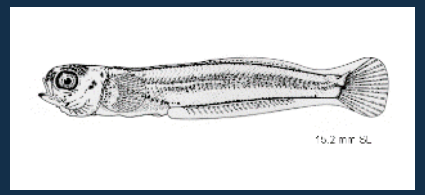
In the ocean, juvenile steelhead feed on a variety of near-surface prey items



Sandlance

Rockfish

Greenlings



Crab Larvae

Insects

Krill

More steelhead return as adults (2 years latter) when juveniles are fatter (heavier for their length) when caught in the ocean in May

New data

- Steelhead spend 1-4 years in the ocean
- For this talk we assume 2 years (CRITFC reports)

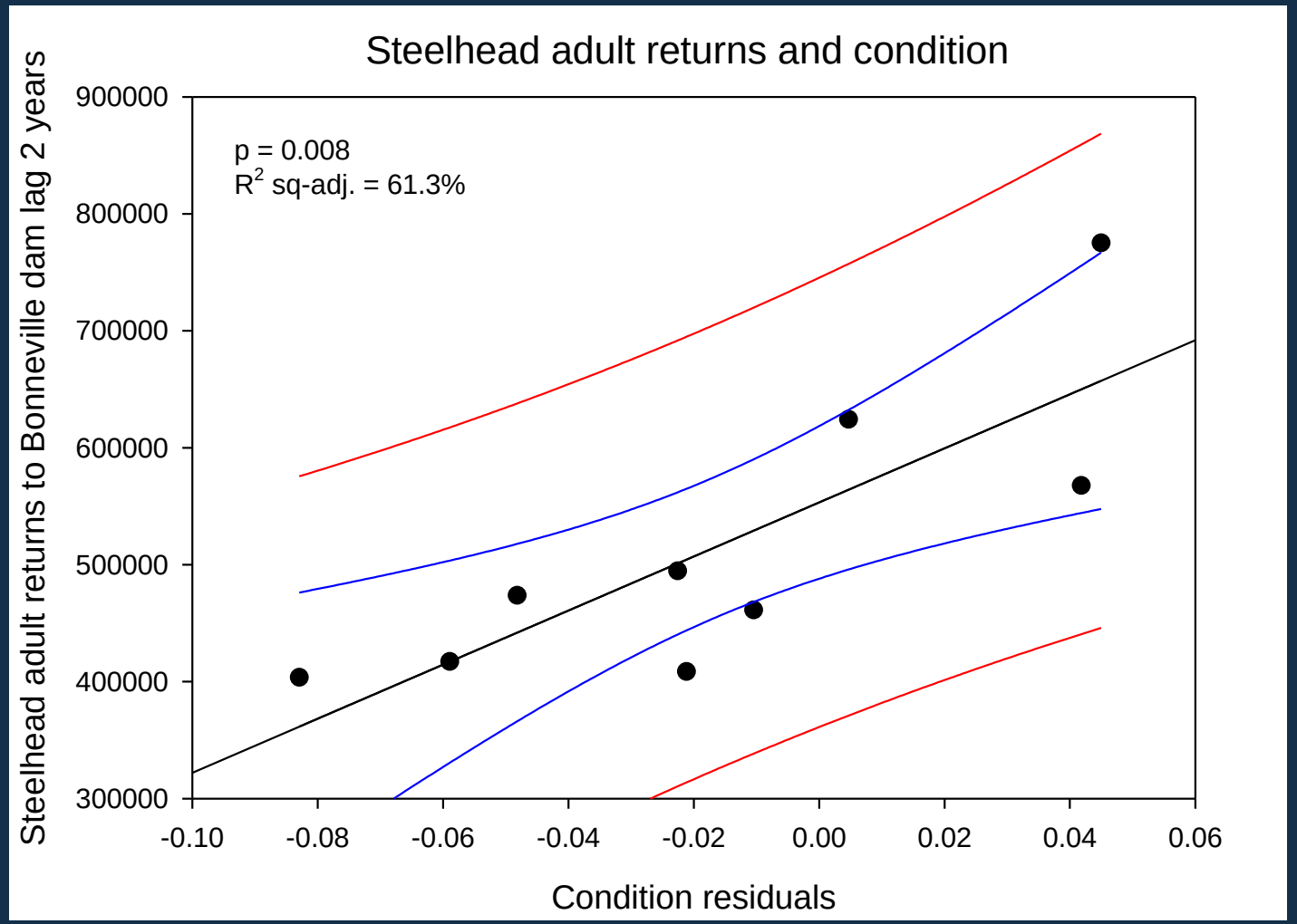
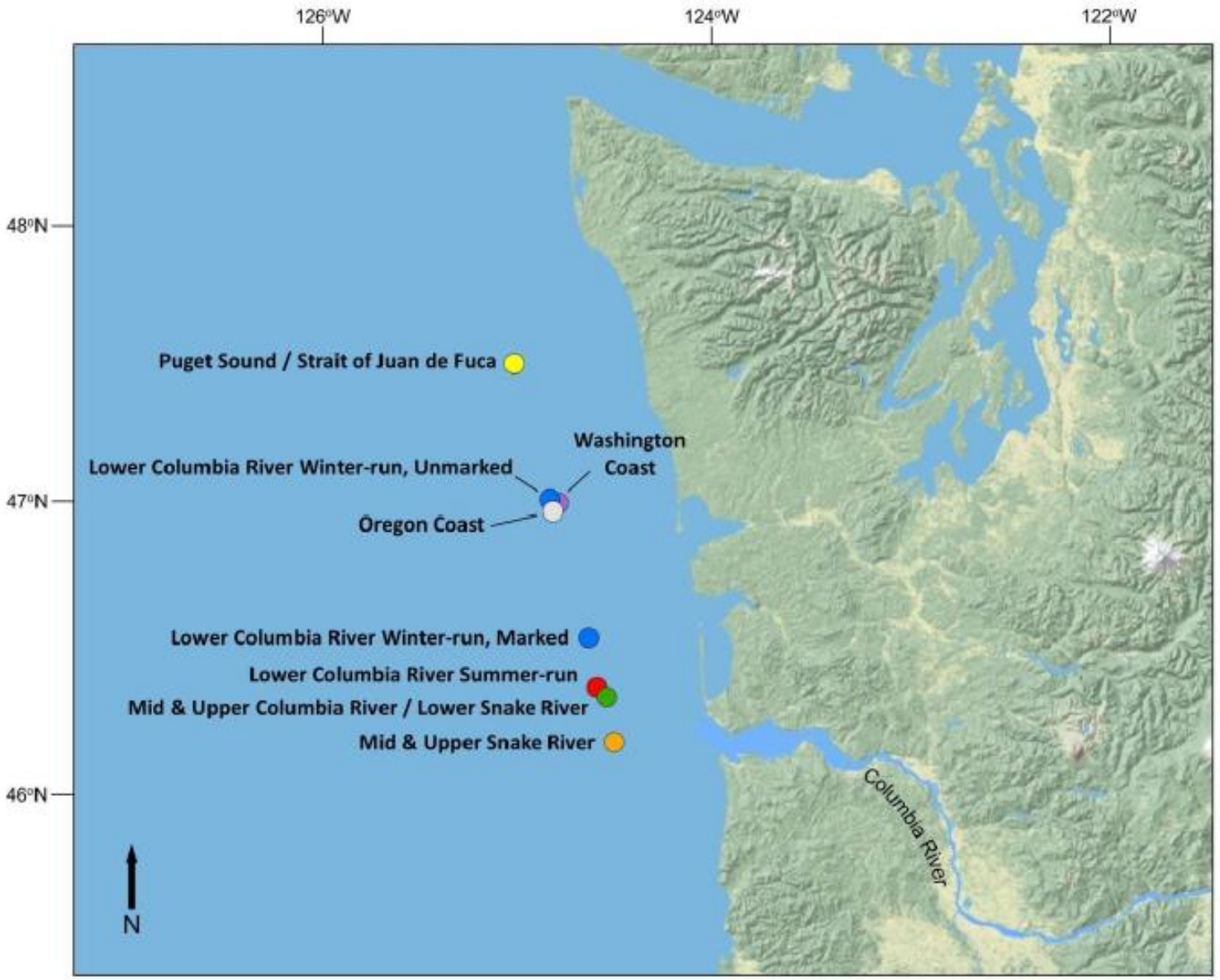


Figure 4. Average latitude and distance from shore, summed over all years, where juvenile steelhead from each genetic stock group were caught.



New research: Genetic information of ocean caught juvenile steelhead from OR/WA coastal survey 2006-2012

Van Doornick et al *In Prep*

- 78% from Columbia River

Genetic Analysis Provides Insights into Stock Specific, Early Ocean Migration Behaviors of Juvenile Columbia River Steelhead

In Prep

Donald M. Van Doornik[1], David R. Kuligowski[1], Cheryl A. Morgan [2], Todd R. Seamons[3]

Over the past three decades, Columbia River steelhead stocks have been in decline.

1275

NRC Research Press

ARTICLE

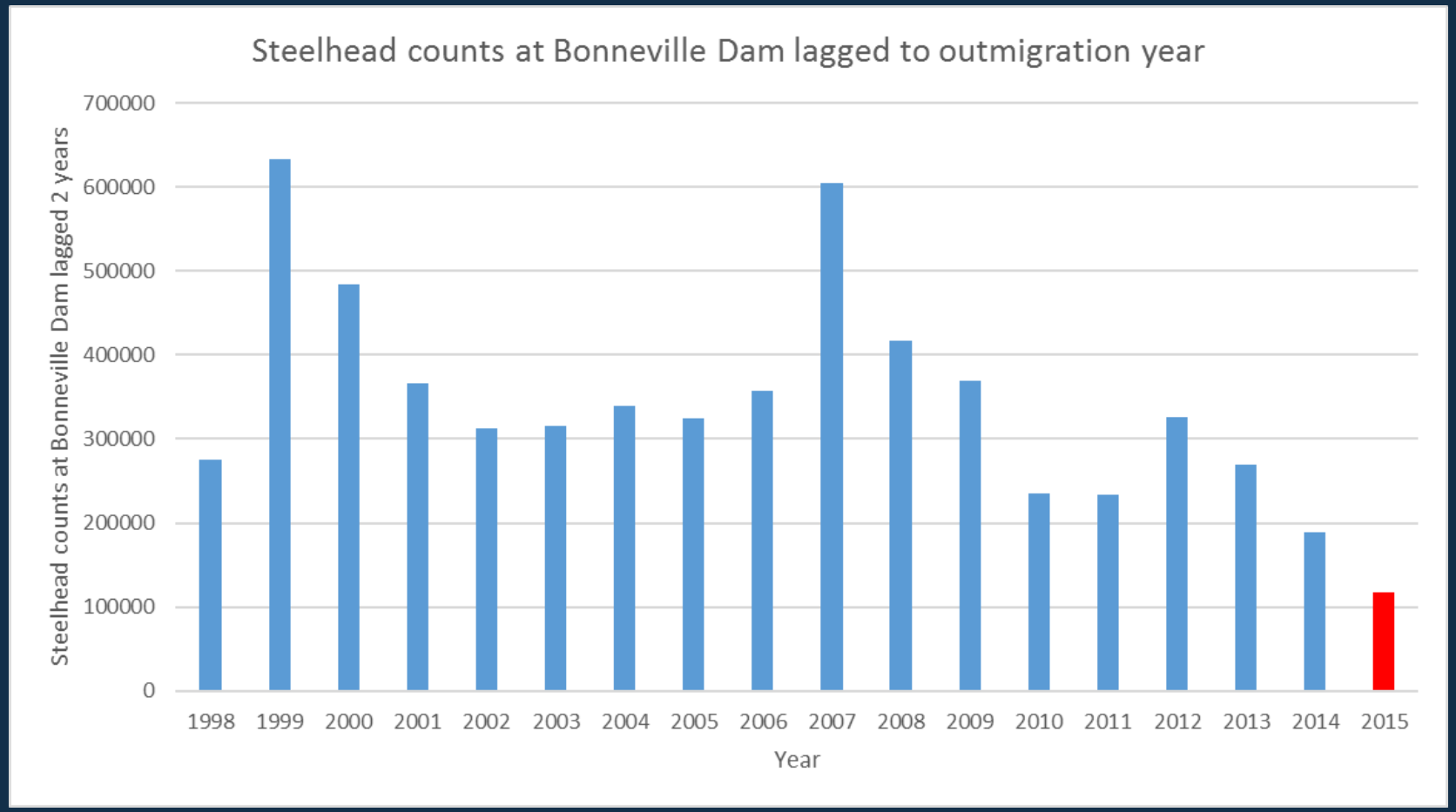
Declining patterns of Pacific Northwest steelhead trout (*Oncorhynchus mykiss*) adult abundance and smolt survival in the ocean

Neala W. Kendall, Gary W. Marston, and Matthew M. Klungle

Kendall et al. 2017

Abstract: Examination of population abundance and survival trends over space and time can guide management and conservation actions with information about the spatial and temporal scale of factors affecting them. Here, we analyzed steelhead trout (anadromous *Oncorhynchus mykiss*) adult abundance time series from 35 coastal British Columbia and Washington populations along with smolt-to-adult return (smolt survival) time series from 48 populations from Washington, Oregon, and the Keogh River in British Columbia. Over 80% of the populations have declined in abundance since 1980. A multivariate autoregressive state-space model revealed smolt survival four groupings: Washington and Oregon coast, lower Columbia River, Strait of Juan de Fuca, and Puget Sound – Keogh River populations. Declines in smolt survival rates were seen for three of the four groupings. Puget Sound and Keogh River populations have experienced low rates since the early 1990s. Correlations between population pairs' time series and distance apart illustrated that smolt survival rates were more positively correlated for proximate populations, suggesting that important processes, including those related to ocean survival, occur early in the marine life of steelhead.

Columbia River steelhead adult returns for last 18 years; 2015 lowest in time series



Low adult returns in 2017 of 2015 salmon out-migrants most likely temperature (warm blob) related and ocean catches are still different

The Columbia Basin Fish &Wildlife News Bulletin

Latest CBB News | Archives | About Us | Free Newsletter

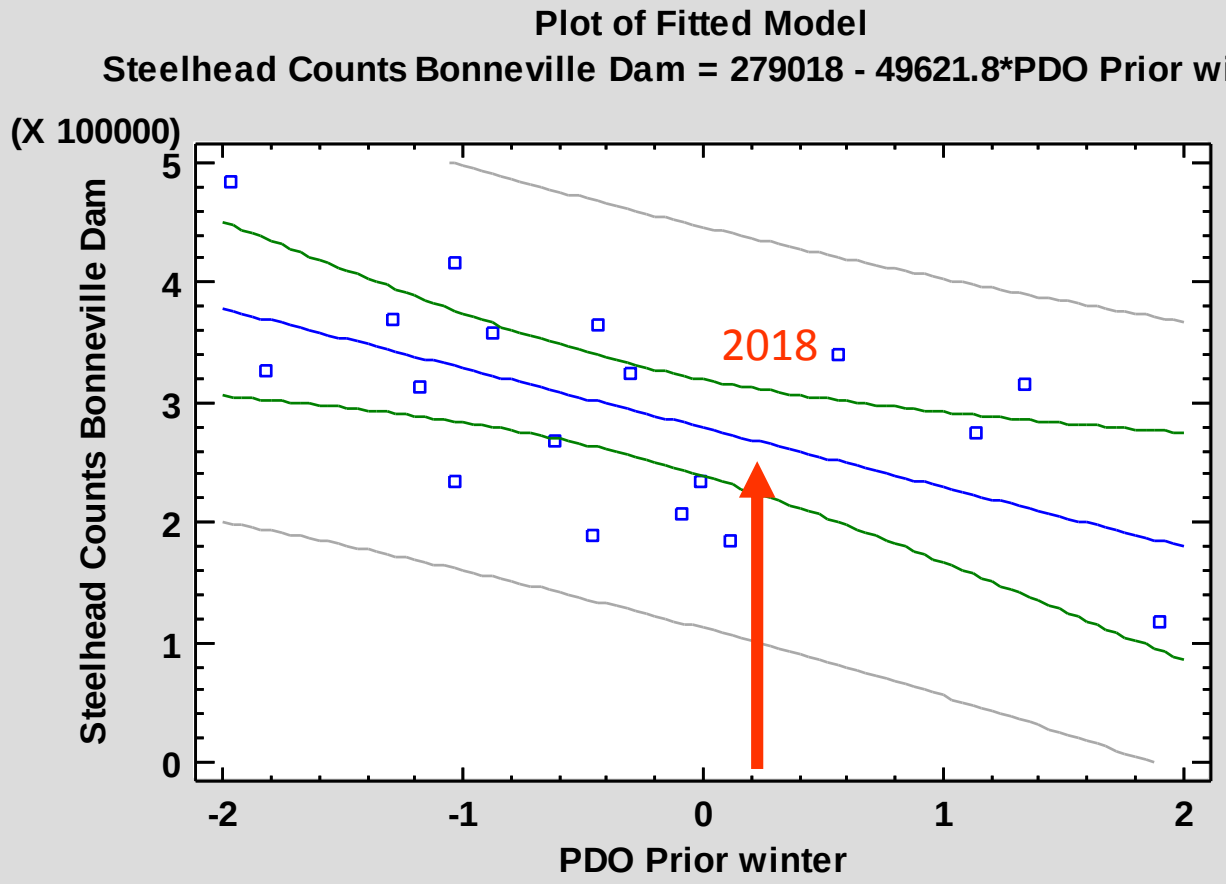
Latest CBB News

Print this Story Email this Story

With Some Of Lowest Steelhead Returns On Record, ODFW Asks Anglers To Give Fish A Helping Hand

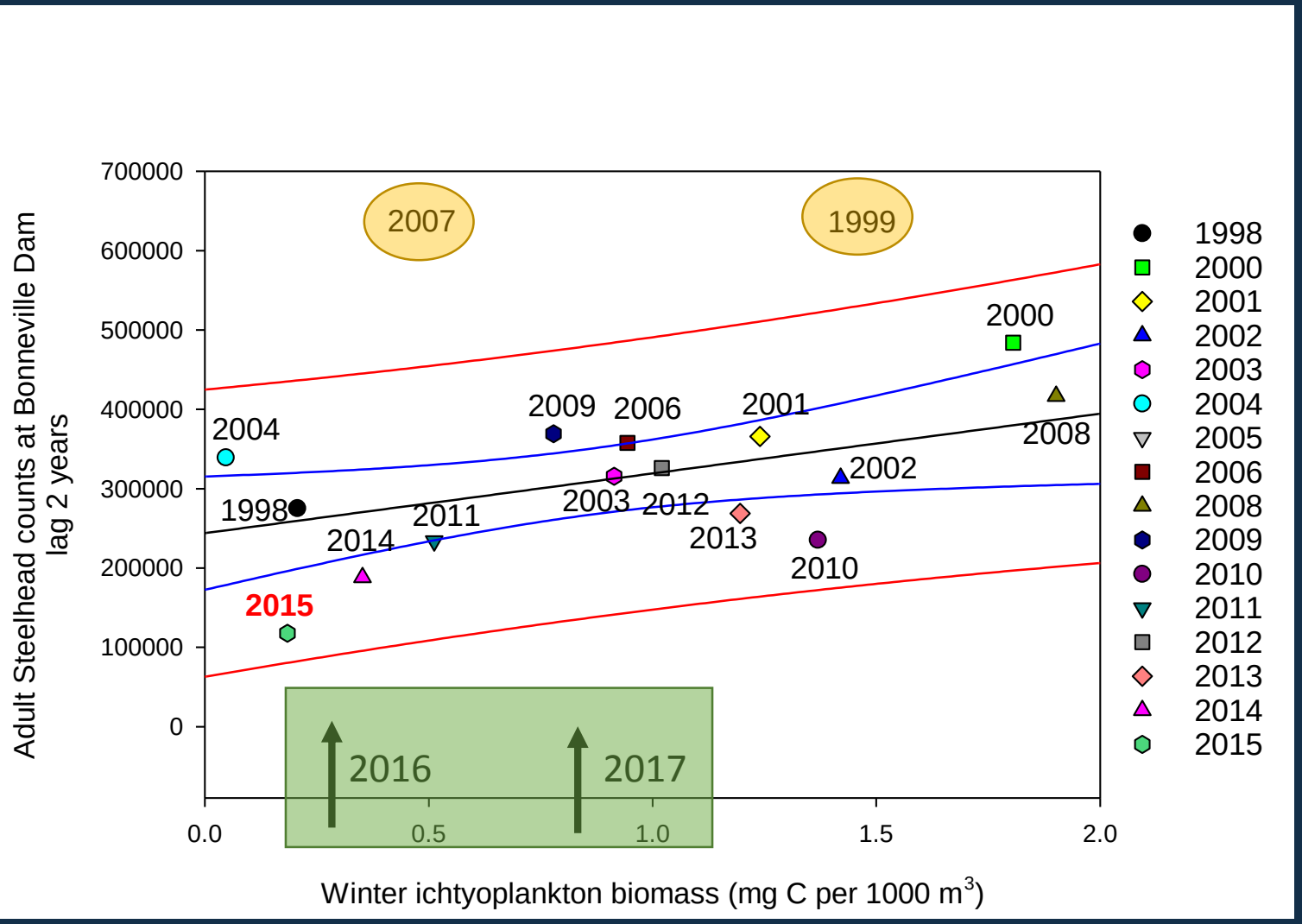
Posted on Friday, July 14, 2017 (PST)

Steelhead adult returns (2 ocean years) relate to winter ocean temperatures prior to outmigration: A pre-condition period for their prey



P = 0.012; R-sq 33.4%

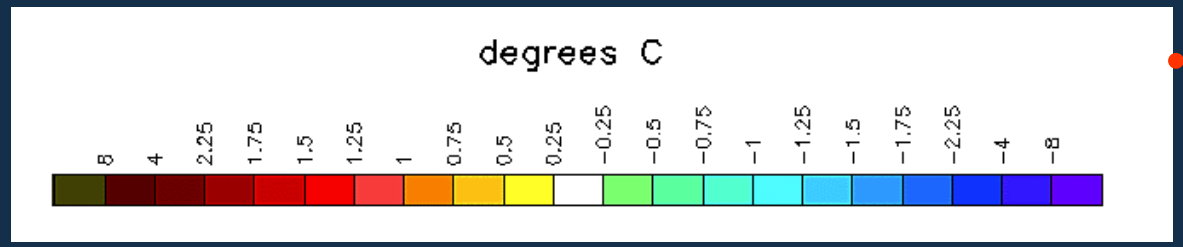
Steelhead adult returns relative to winter Ichthyoplankton biomass as an index of outmigration food availability



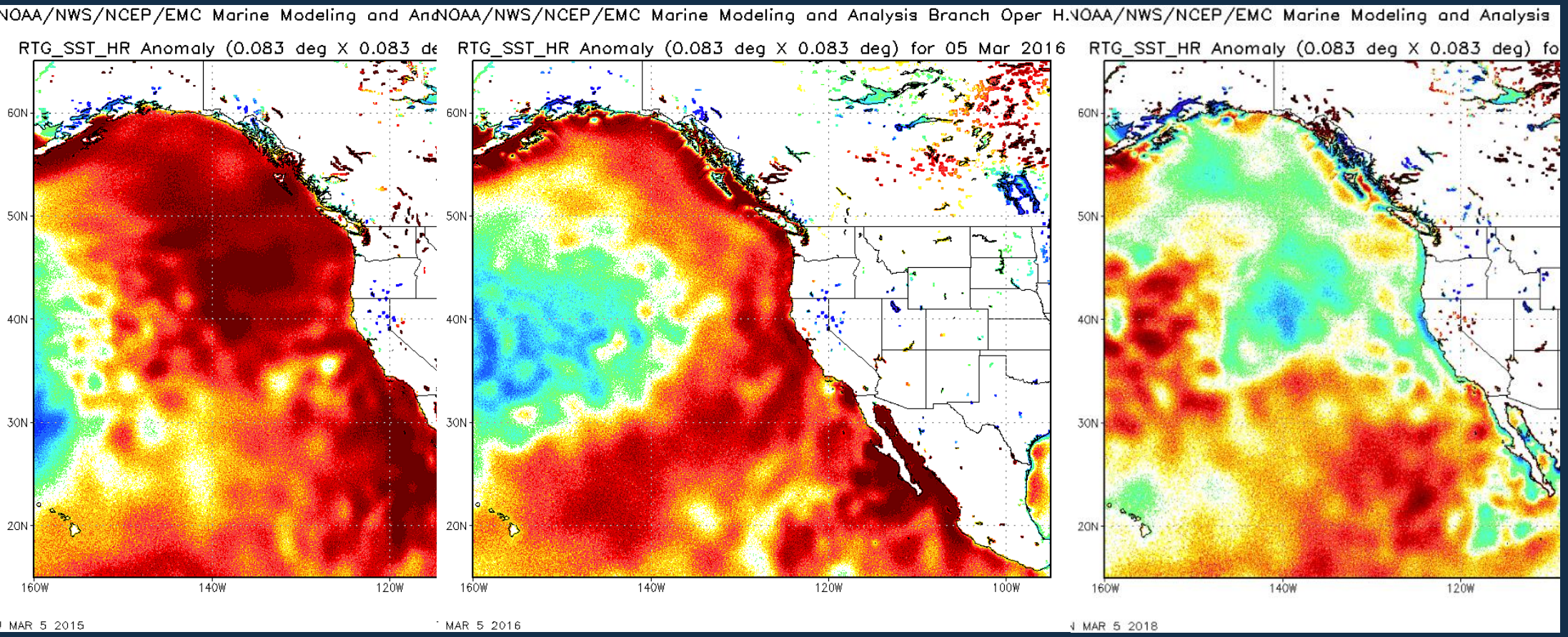
- Higher returns of adult Steelhead when there are more fish larvae in winter prior to their outmigration as juveniles
- 2 outlier years 1999 and 2007
- Predictions for adult returns in 2018 are slightly higher than 2017
- Predictions for adult returns in 2019 are slightly below average

SST anomalies March 05

- NE Pacific biological responses to extreme warm ocean conditions in 2014-2016 still occurring
- Poor salmon returns from outmigration year 2015 (Spring Chinook, coho, and steelhead) and 2016 (coho)

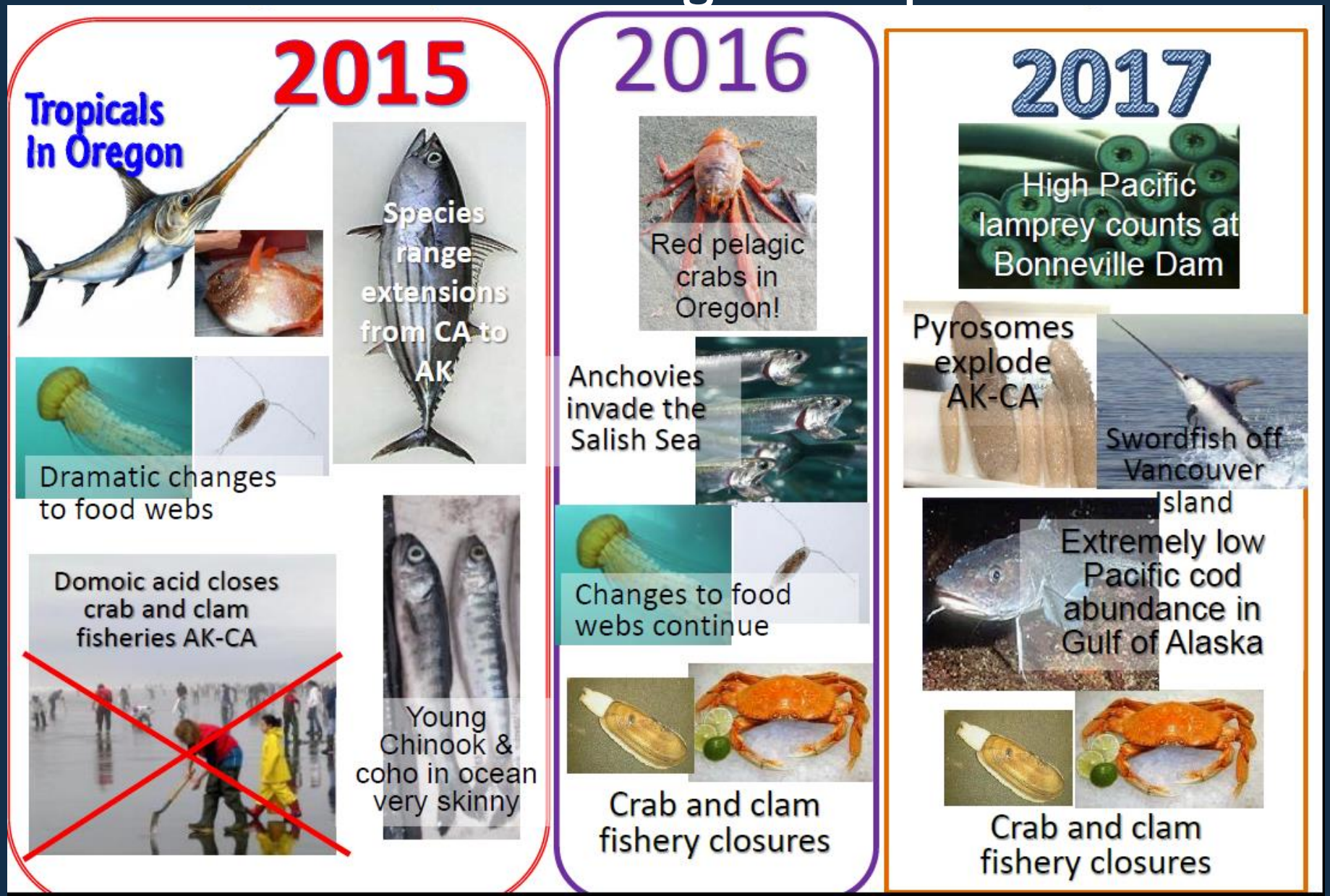


2015 "The Blob" 2016 El Nino 2017



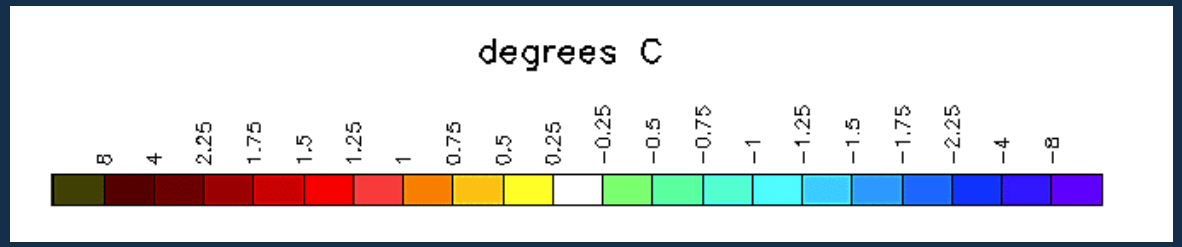
http://polar.ncep.noaa.gov/sst/ophi/

Three years… of warm ocean conditions in the NE Pacific and the biological response

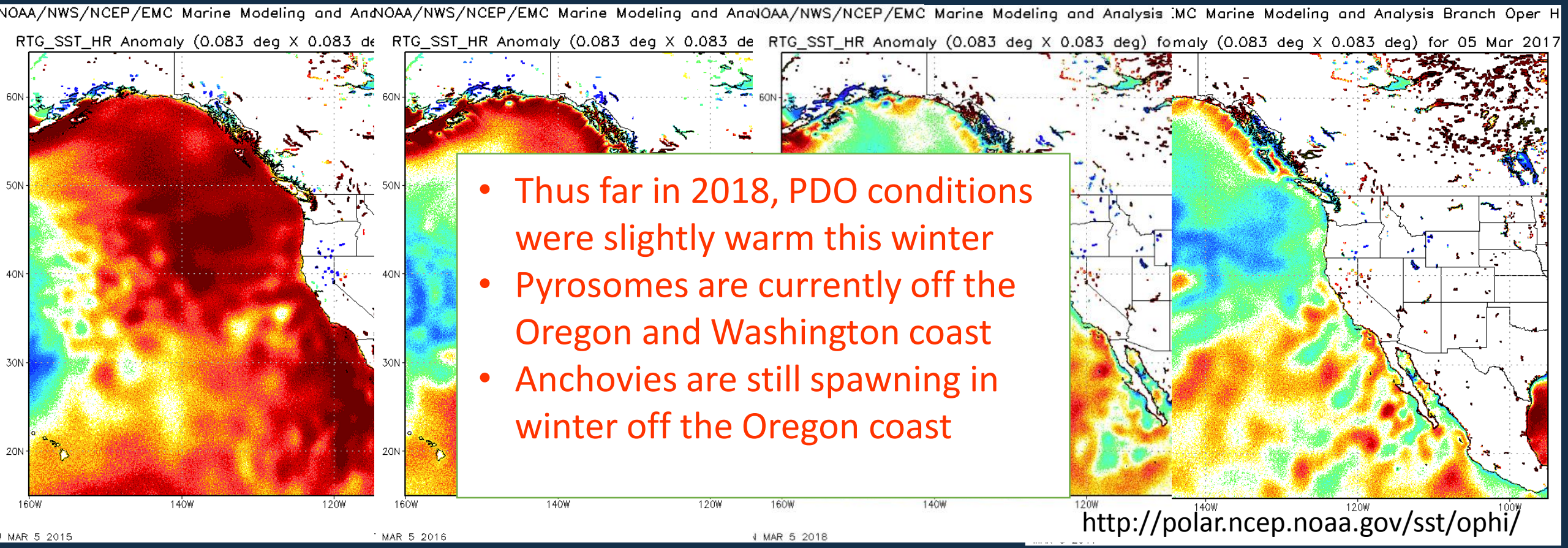


Slide from Laurie Weitkamp

SST anomalies March 05 for the last 4 years



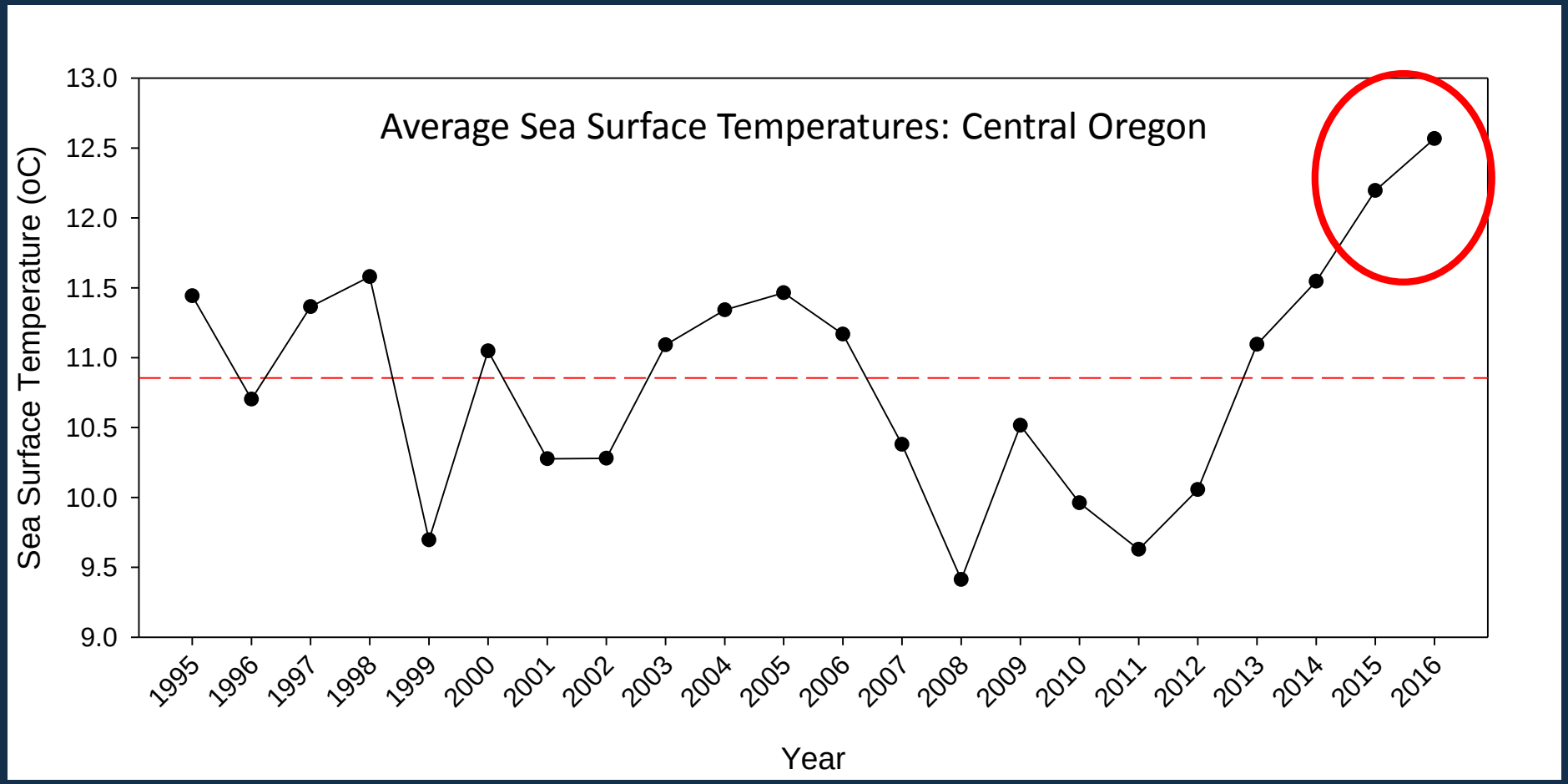
2015 "The Blob" 2016 El Nino 2017 2018



- Thus far in 2018, PDO conditions were slightly warm this winter
- Pyrosomes are currently off the Oregon and Washington coast
- Anchovies are still spawning in winter off the Oregon coast

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

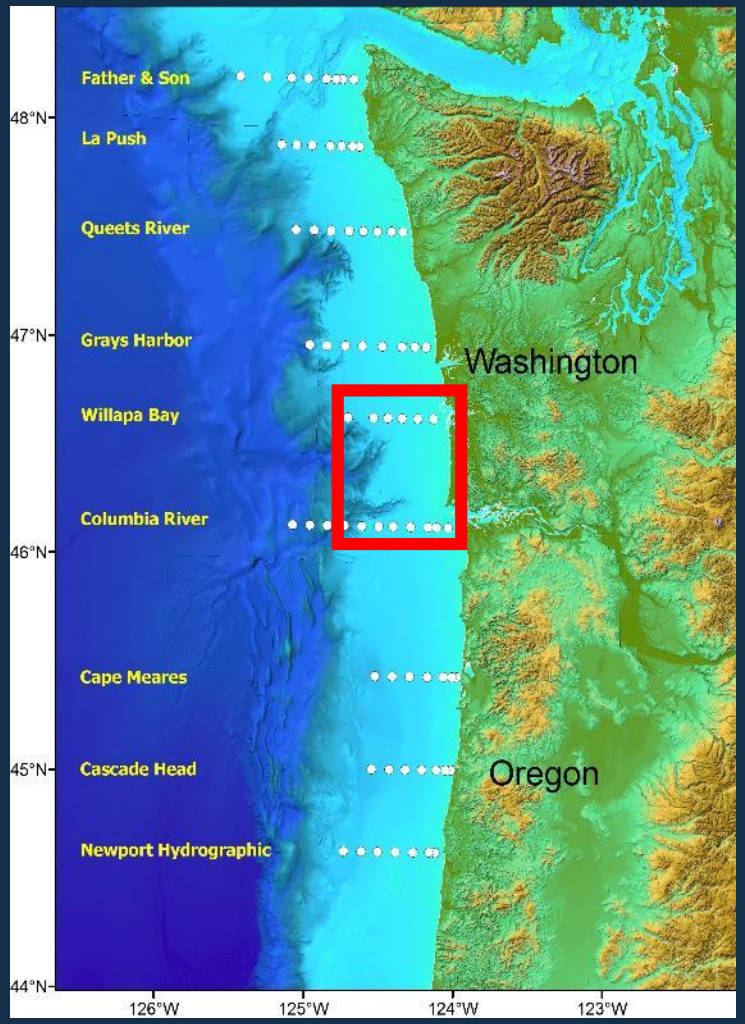
In 2015 and 2016, anomalous ocean conditions were present in the northern California Current, increasing ocean temperature by >2.5°C.

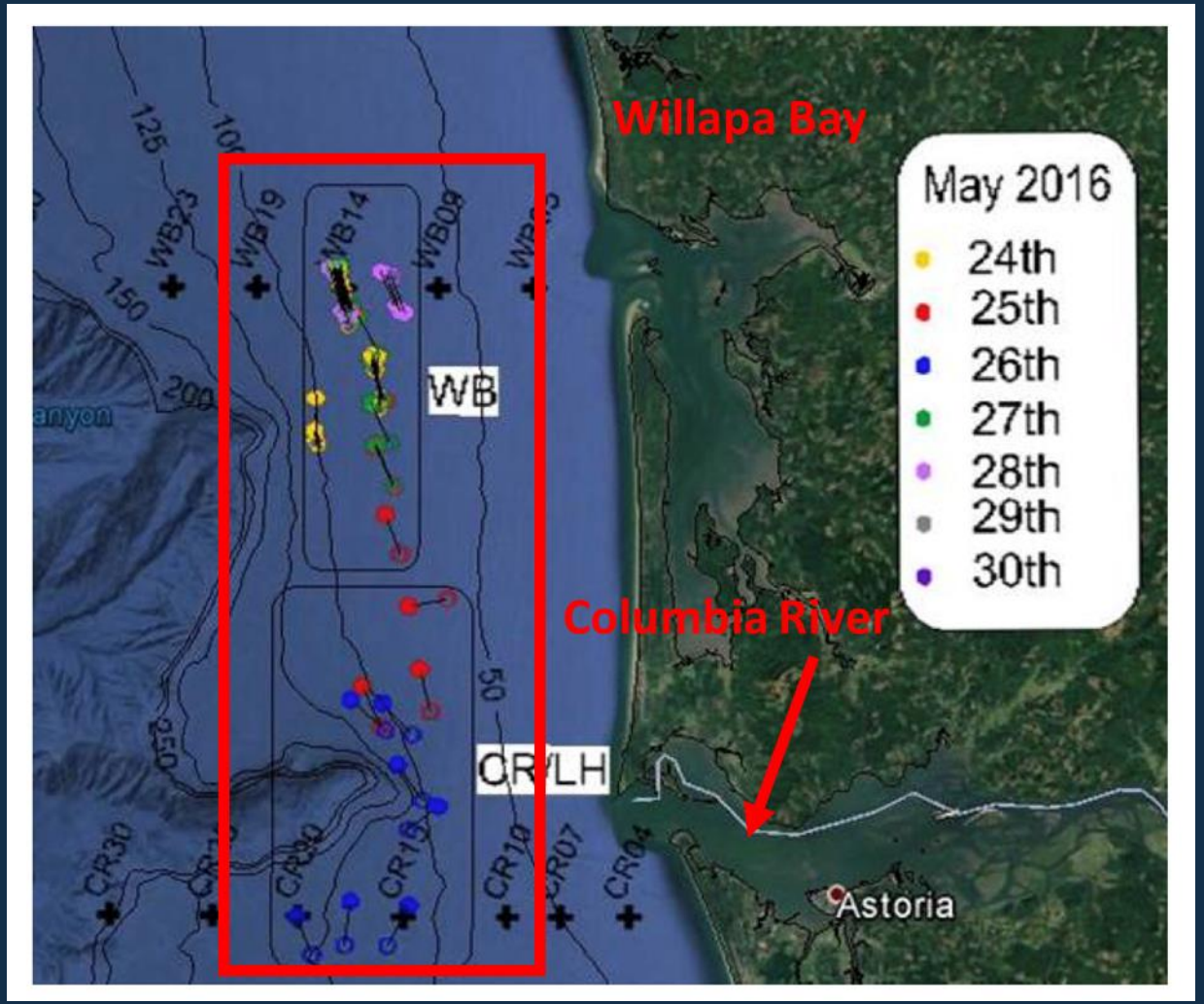


NOAA ESRL

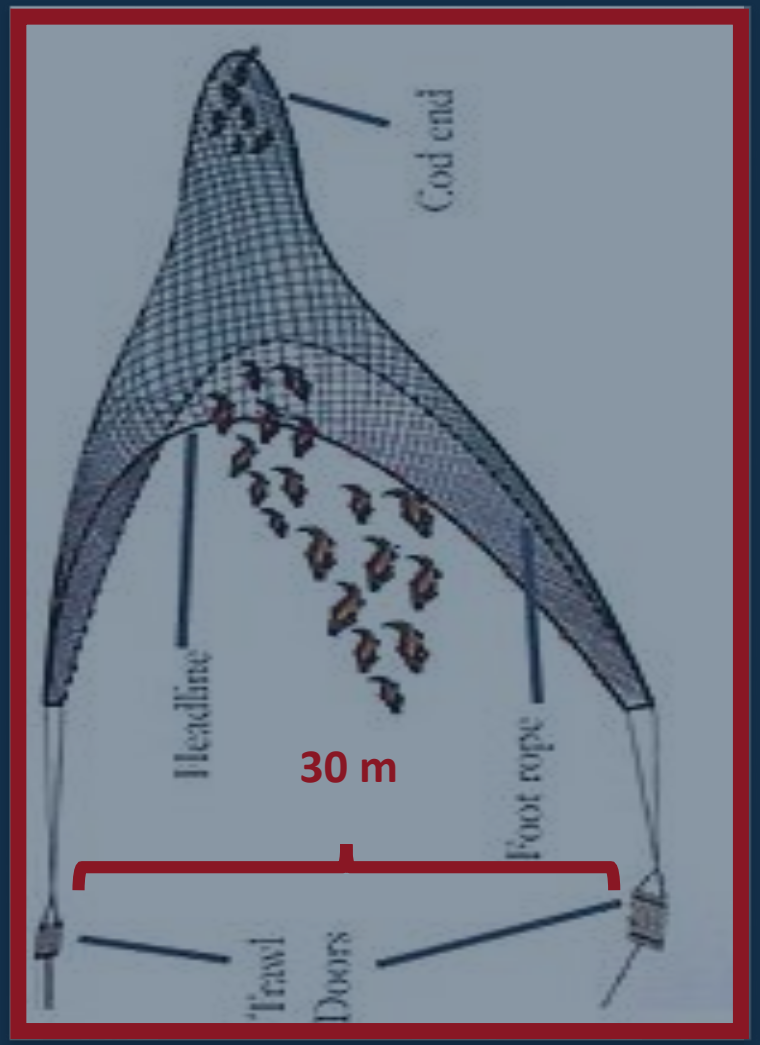
Our objective for this research was to determine how anomalous ocean temperature conditions impact juvenile steelhead diet composition, morphology, and ocean survival.

Sampling station used for updated time series on Steelhead salmon trophic habits

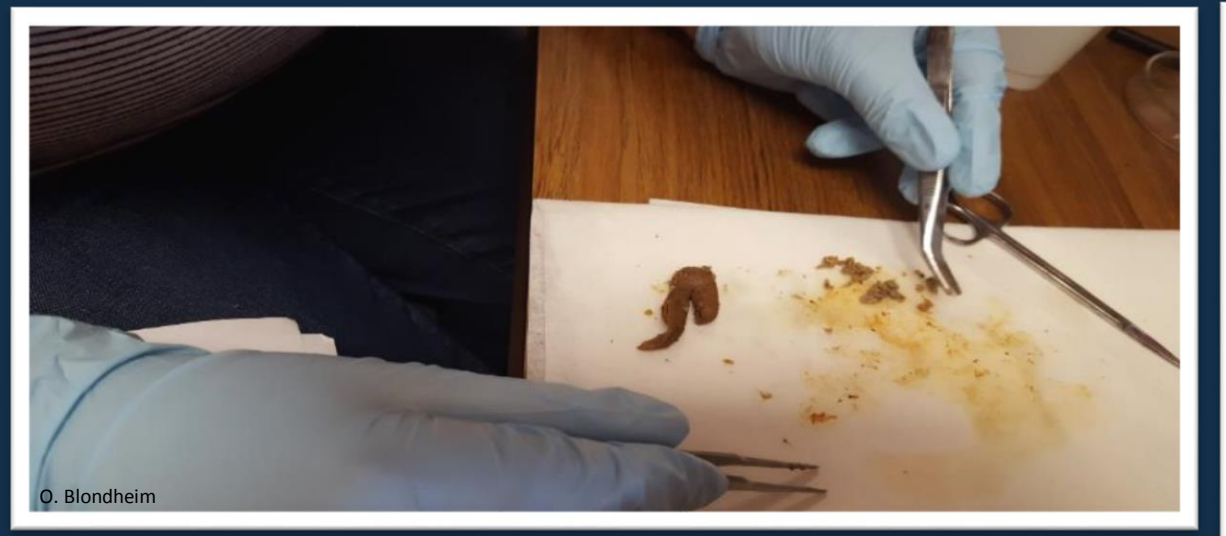




Steelhead were collected and analyzed from sites near the Columbia River from 2001 to 2016.

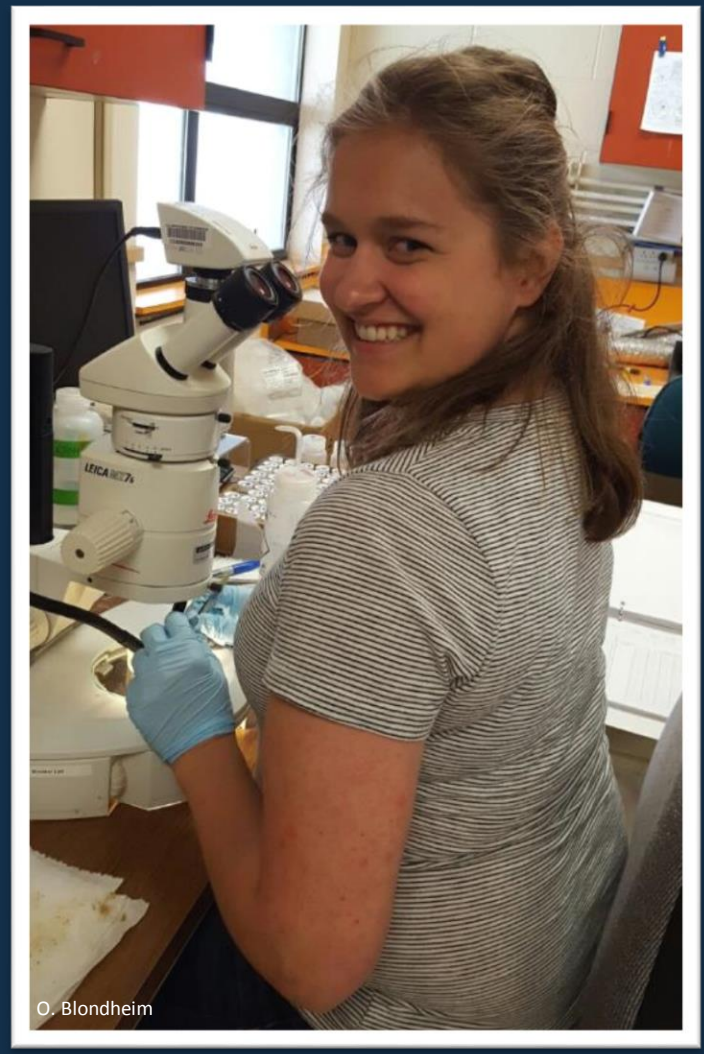


Steelhead stomachs were dissected to determine the amount and type of prey consumed.

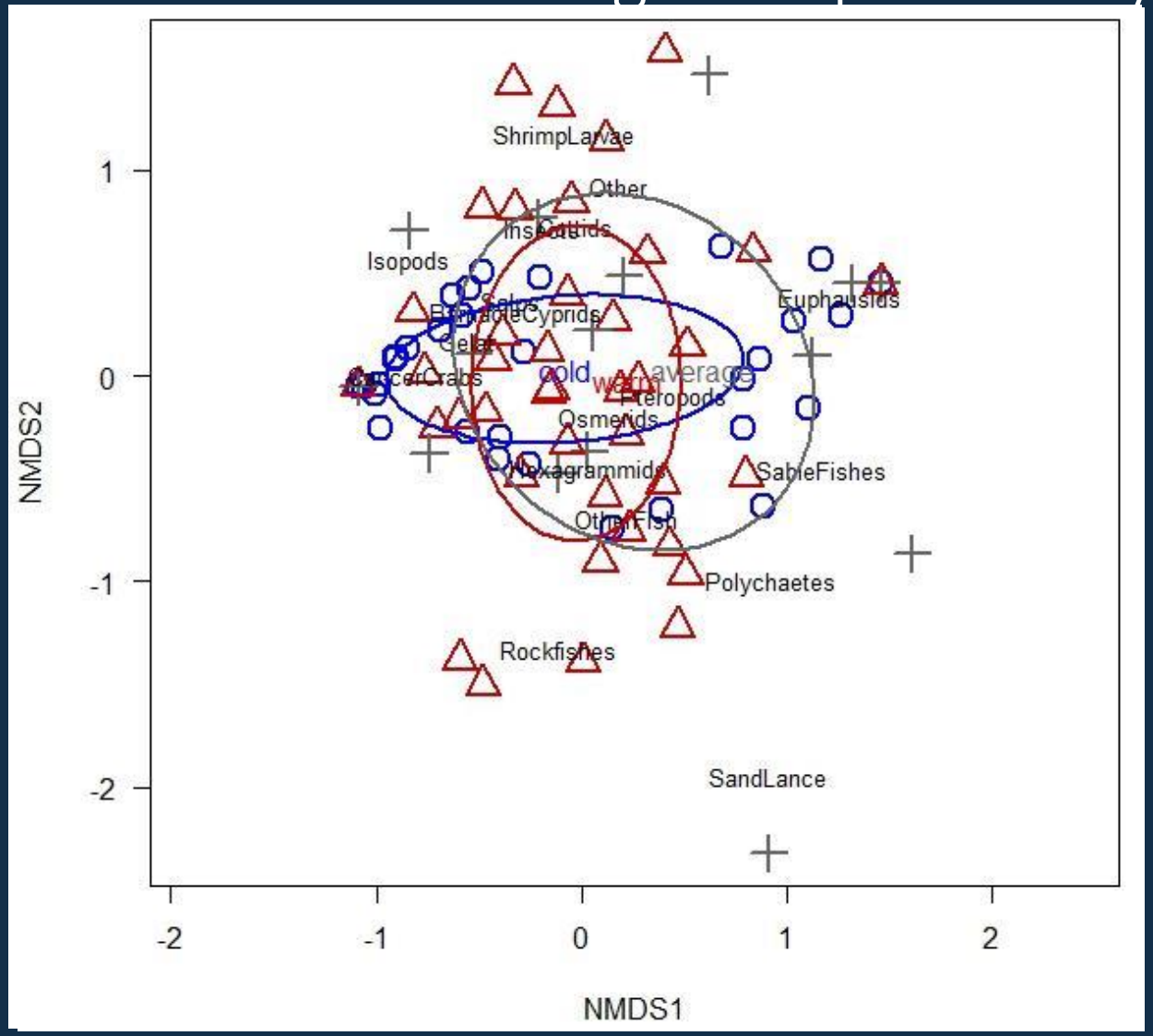

O. Blondheim


H. Thalmann


H. Thalmann

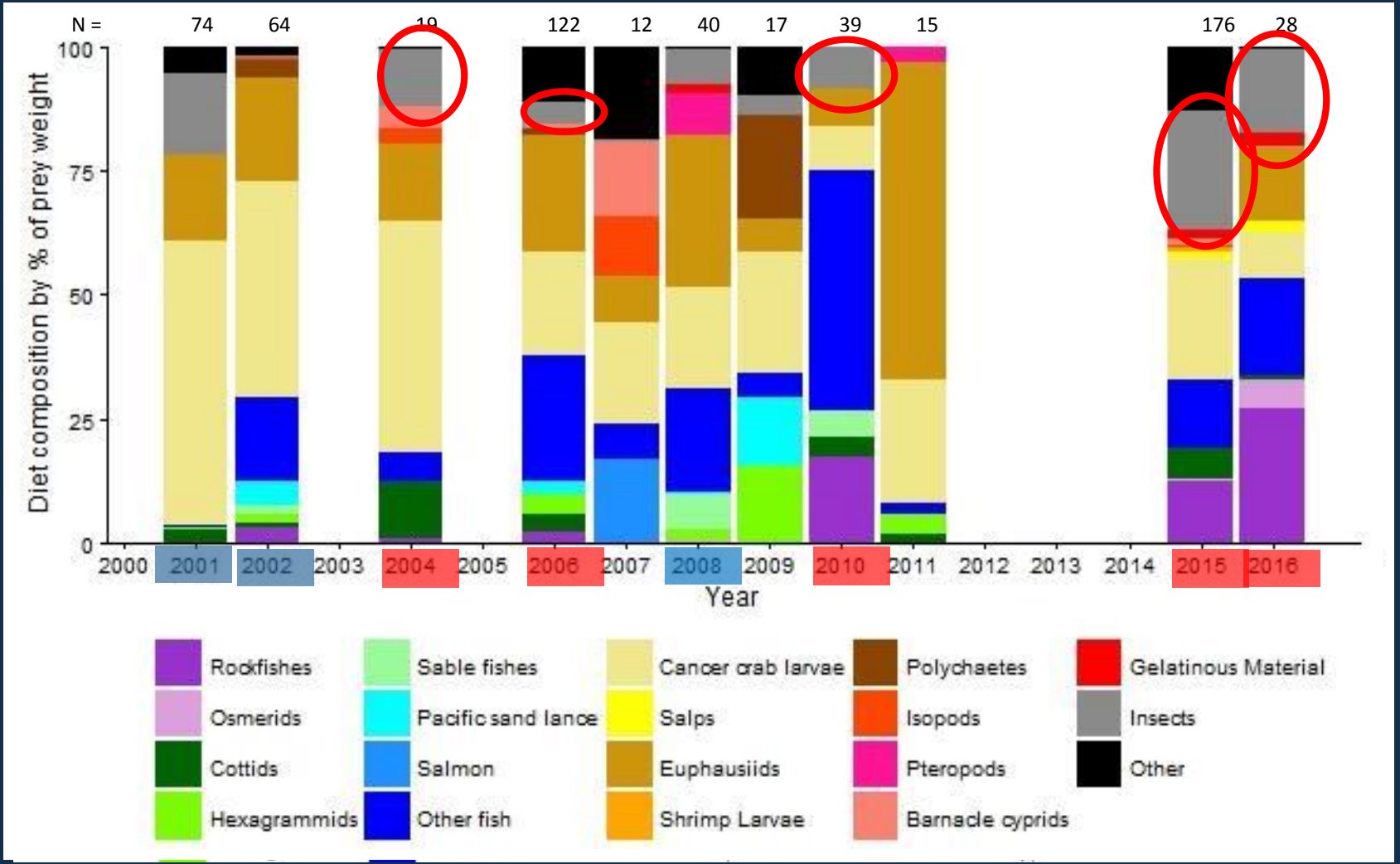

O. Blondheim

Steelhead diet varied between warm and cold years and between warm and average temperature years.



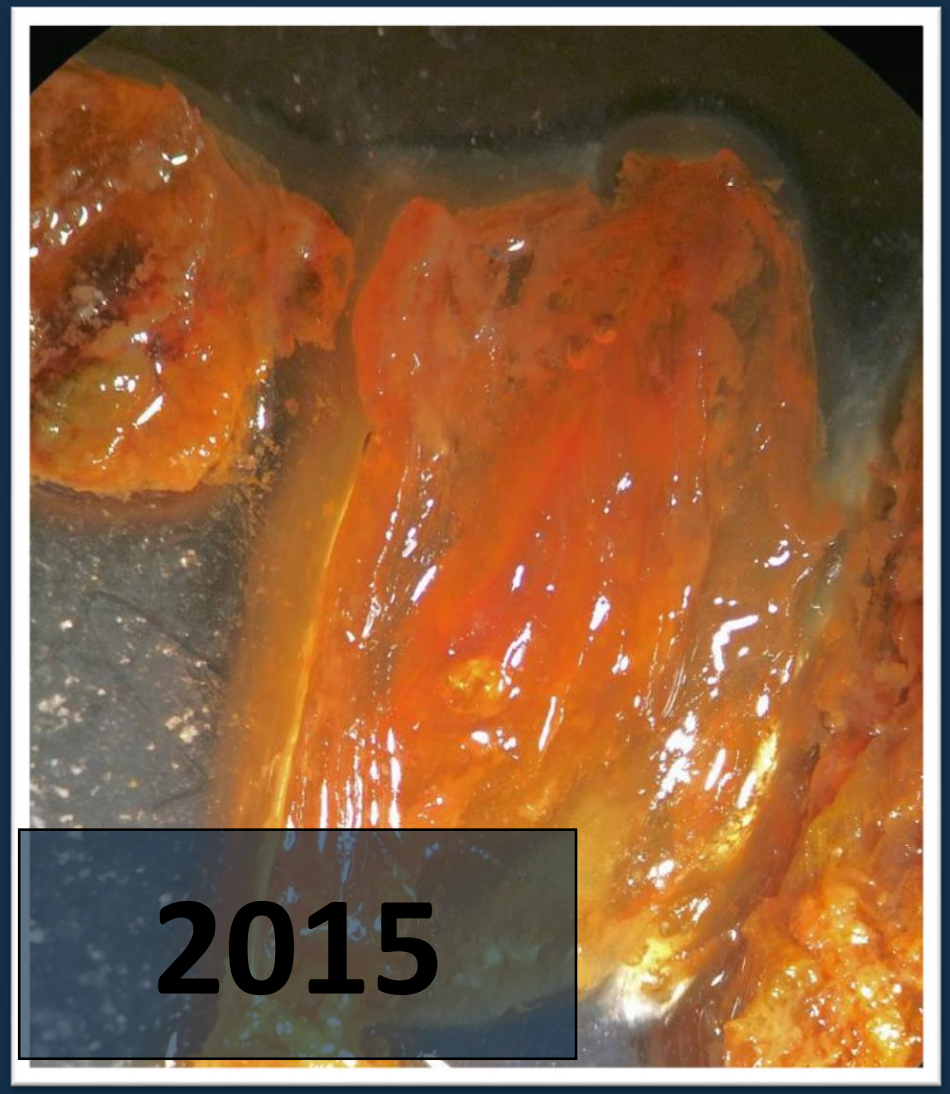
(MRPP, comparison of warm vs. cold years, p = 0.0004, comparison of warm vs. average years, p = 0.0023)

Steelhead consumed more rockfish, unidentified fish, and insects in warm years.

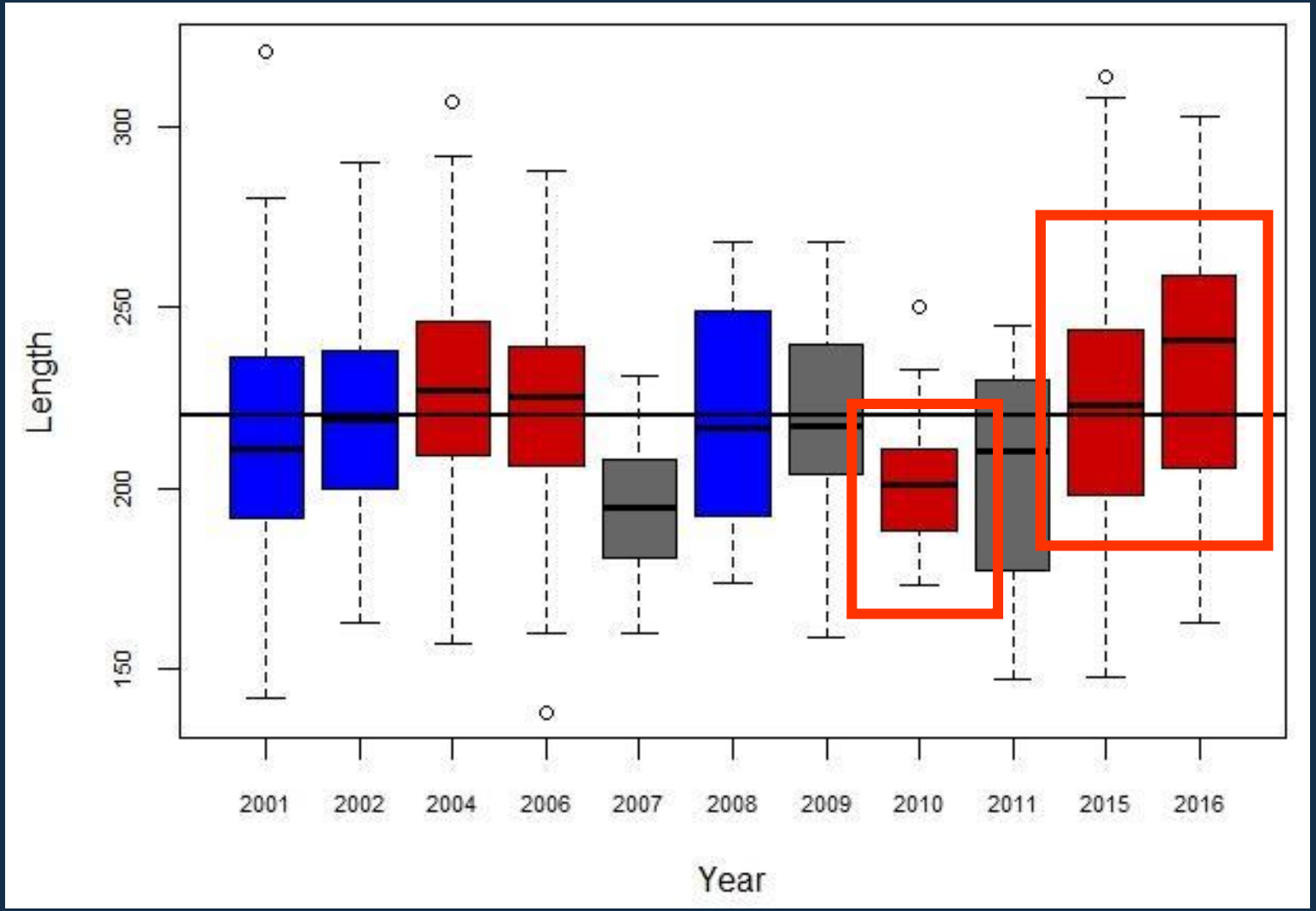


(Indicator Species Analysis, effect of rockfish, p = 0.0008, effect of unidentified fish, p = 0.0228, effect of insects, p = 0.0250)

Unusual taxa such as salps and smelt were consumed during Blob-influenced years.

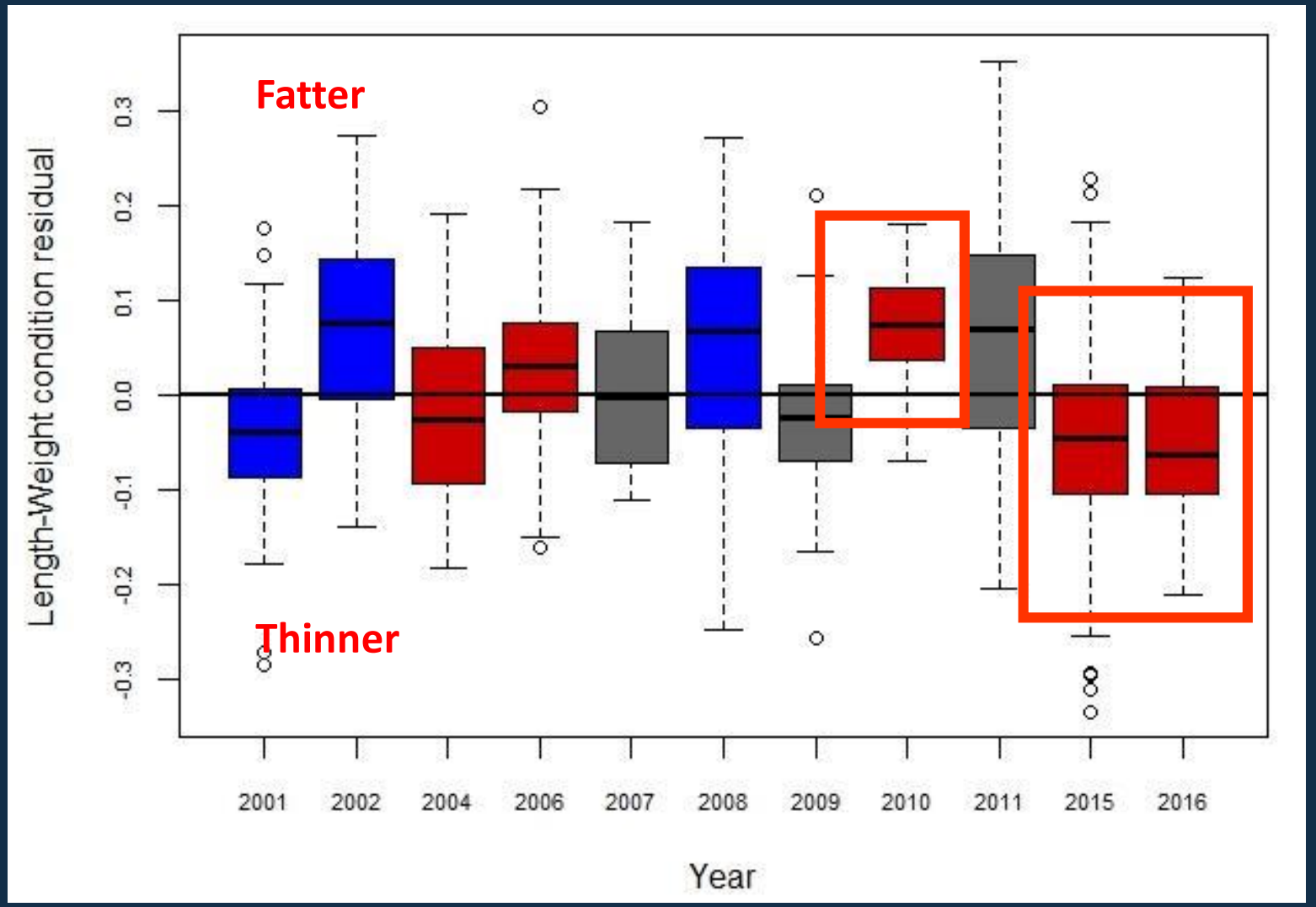


Steelhead tended to be larger in Blob-influenced years, but this pattern was not consistent across all warm years.



(Bars represent 25th and 75th percentiles, Kruskal-Wallis Non Parametric Test, p = < 0.0001)

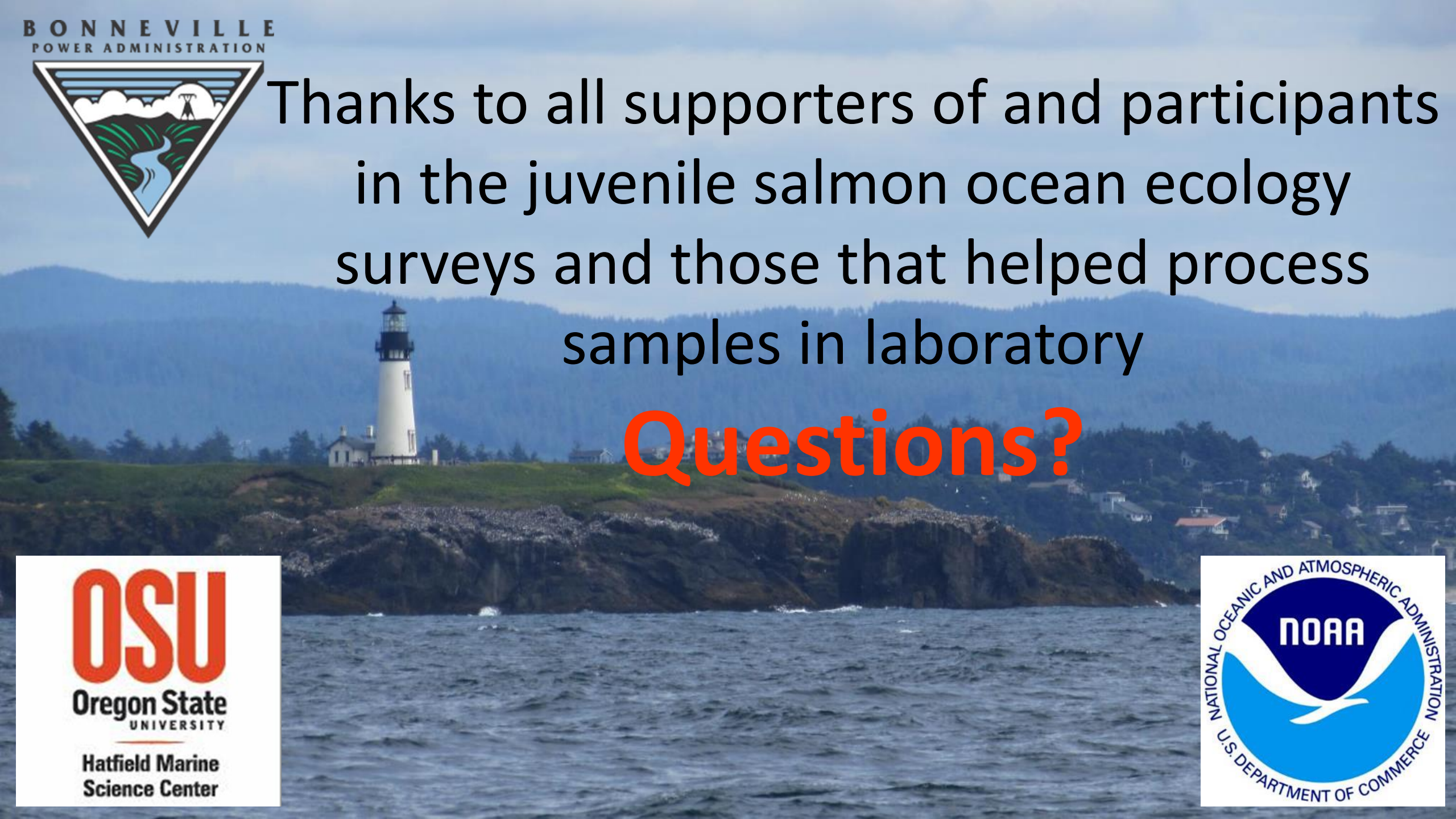
Steelhead body condition was low during Blob-influenced years, but this pattern was not consistent across all warm years.



(Bars represent 25th and 75th percentiles, Kruskal-Wallis Non Parametric Test, p = < 0.0001)

Conclusions

- Anomalous biological conditions continue to ripple through the NE Pacific
- Conditions for 2018 outmigrants do not look much different from 2017
- Steelhead diet composition shifts in warm ocean years
- Steelhead consume more rockfish, insects, and unidentified fish in warm ocean years
- In Blob-influenced years, steelhead size increases, (size dependent mortality?) but are thinner
- Steelhead return in lower numbers as adults if they entered the ocean as juveniles during a warm year


BONNEVILLE
POWER ADMINISTRATION
Thanks to all supporters of and participants in the juvenile salmon ocean ecology surveys and those that helped process samples in laboratory
Questions?
OSU
Oregon State
UNIVERSITY
Hatfield Marine
Science Center
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE