

# Growth-increment chronologies reflect ecosystem responses to climate variability in the northeast Pacific

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# Many animals form increments...

**...and can be quite old!**

**Pacific geoduck**  
**150 +**



**Pacific rockfish**  
**100 yr + yelloweye rockfish**



***Margaritifera* freshwater mussels**  
**100 yr +**



**Freshwater drum**  
**70 yr +**

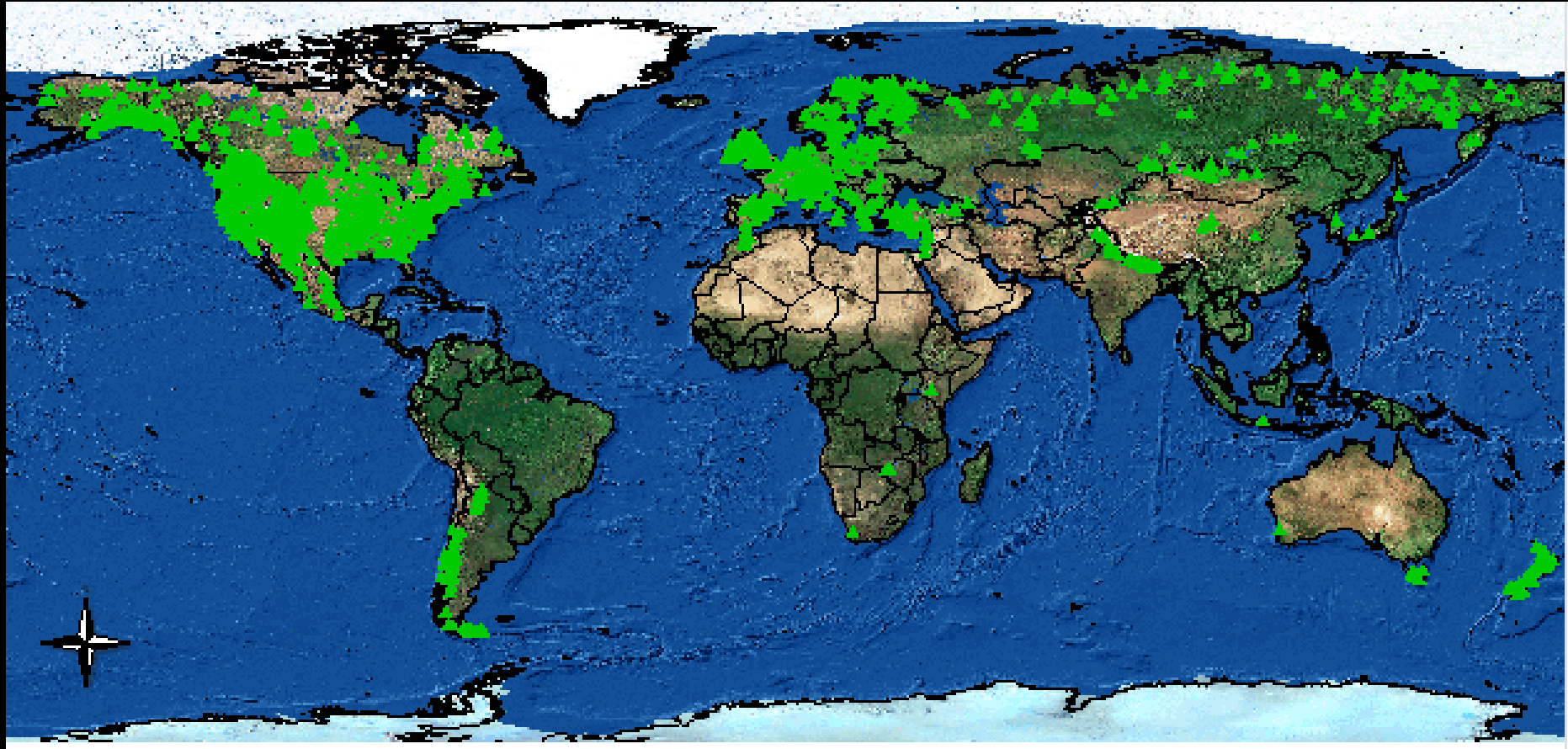


**Tropical corals**  
**300 yrs +**



# Crossdating

Matching growth “bar codes”





# Dendrochronology applied to animals

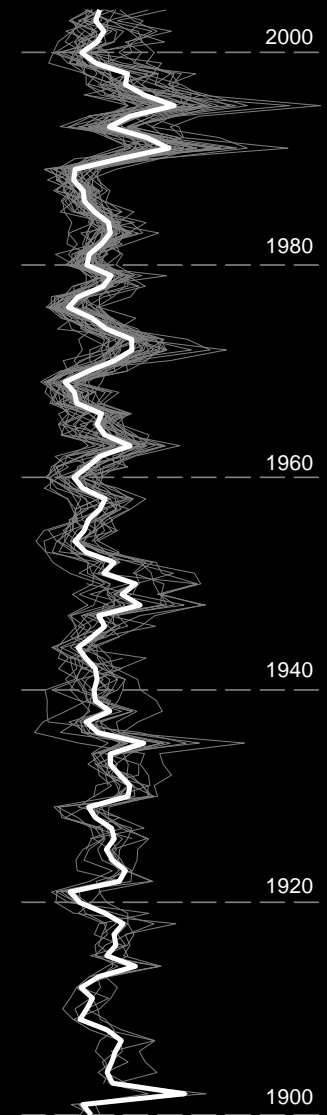
**With well-dated chronologies.....**

**Climate-growth relationships**

**Comparisons among diverse species**

**Ecosystem indicators**

**Climate reconstructions**



# Splitnose rockfish

**Splitnose rockfish (*Sebastes diploproa*)**

**80+ yrs old**

**300 m depth; live on shelf floor**

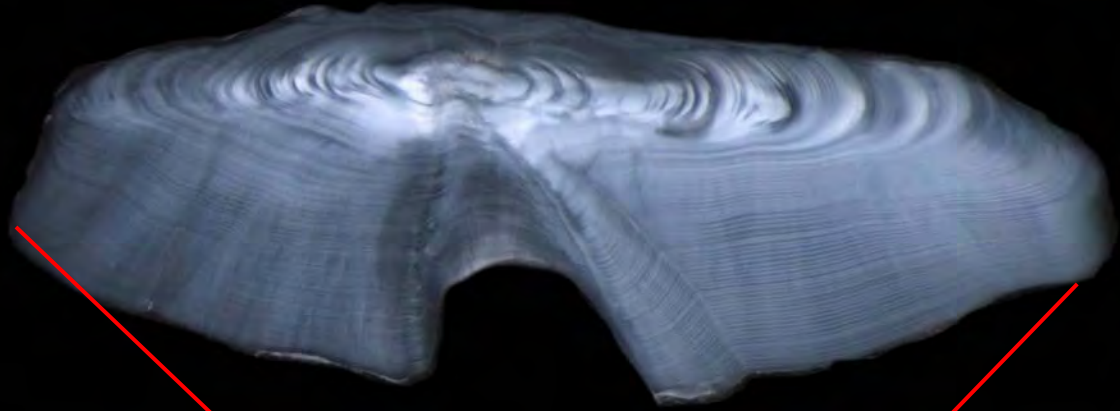
**collected 1989, 1995**



Photo credit:Lifted from M. Love's webpage



# Otolith thin sectioning



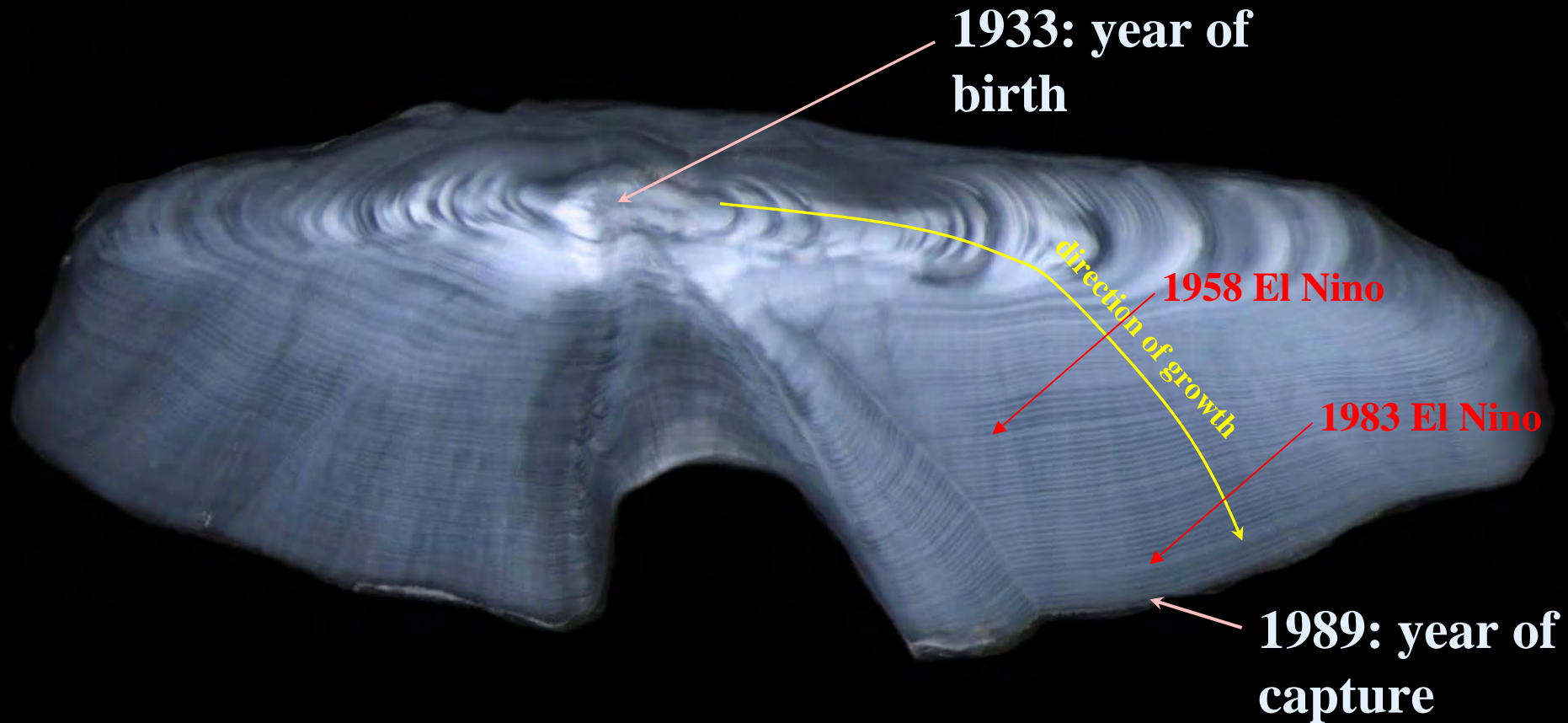
cut here





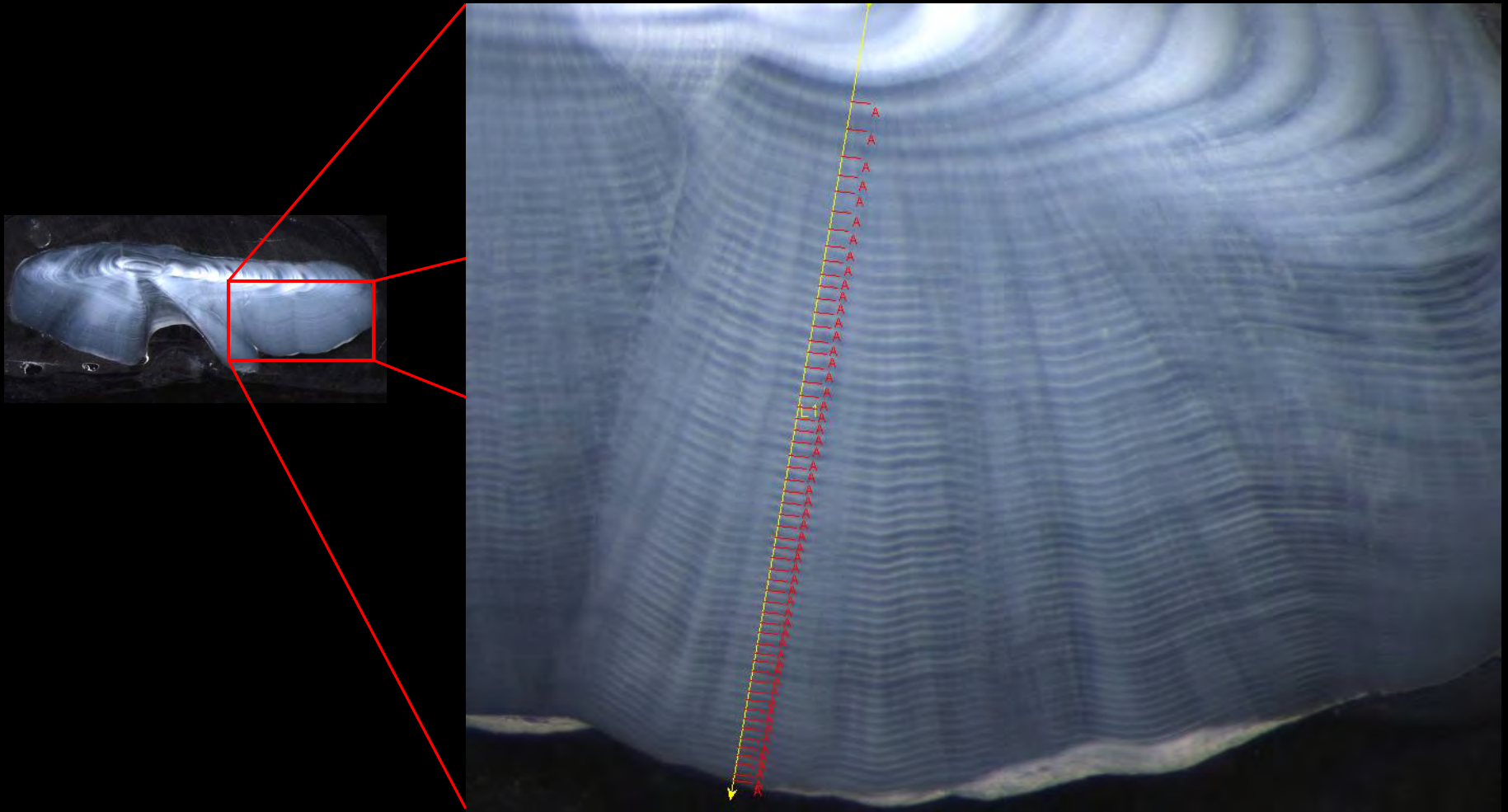
# Splitnose otolith

Annual growth increments analogous to trees

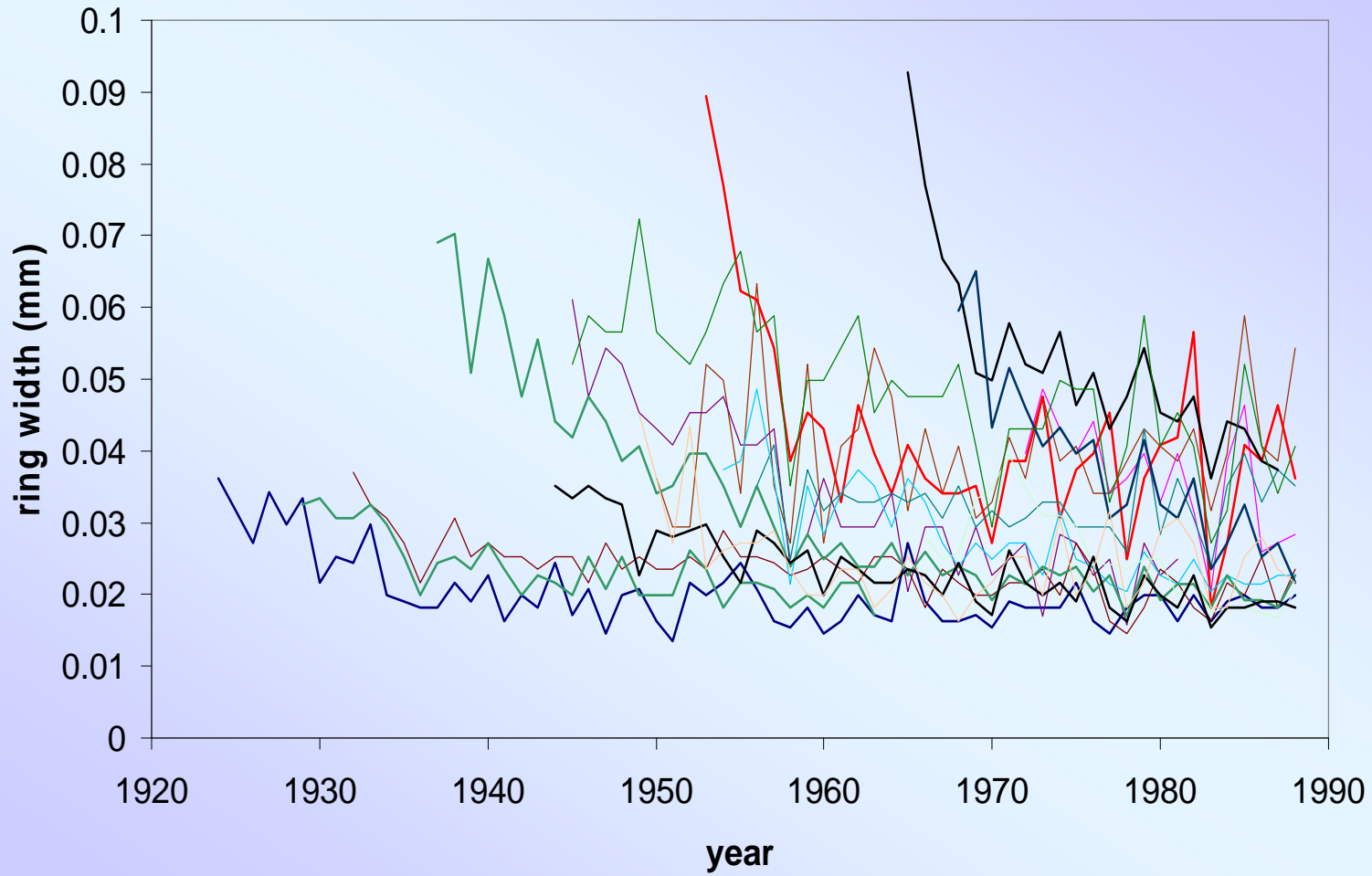




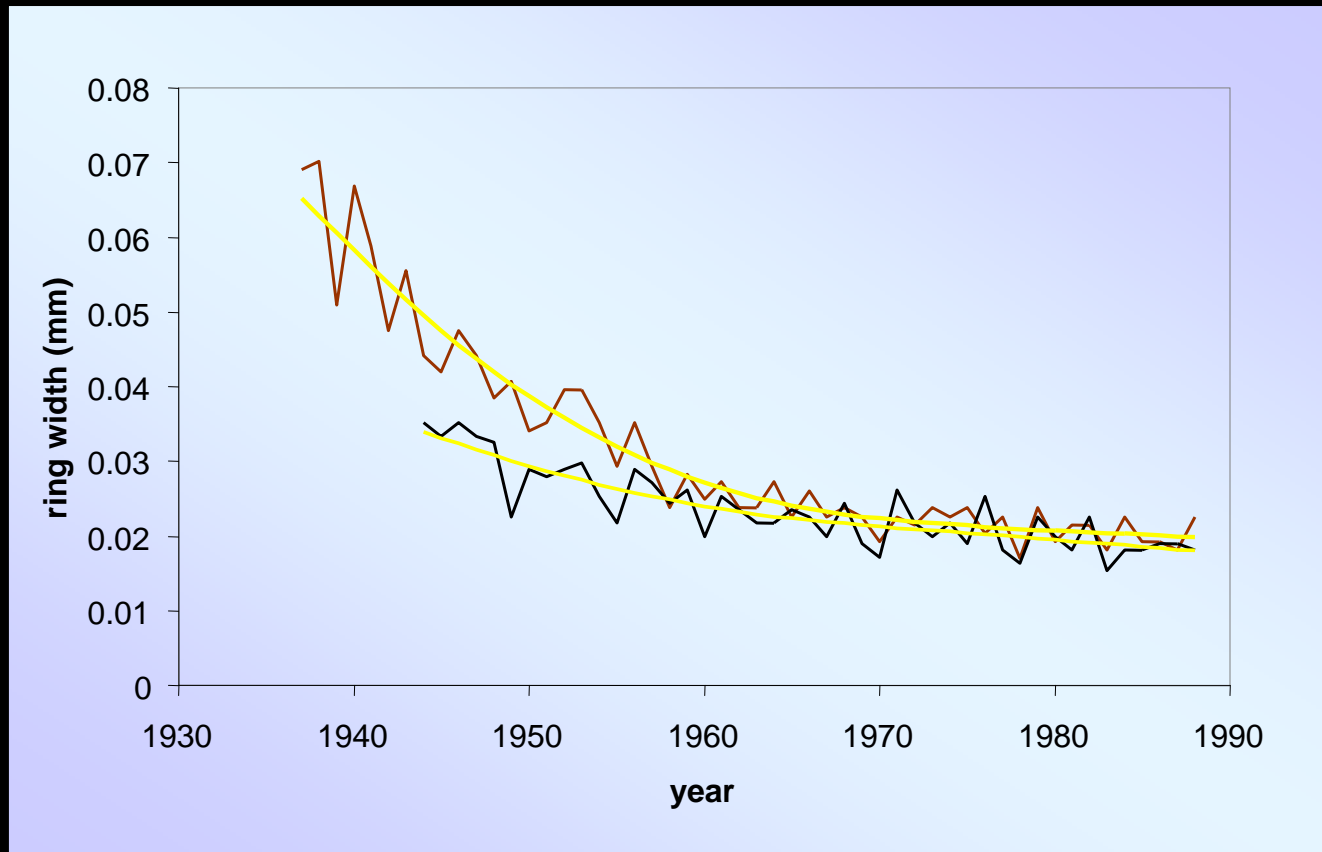
# Axis of measurements



# Measurements



# Detrending

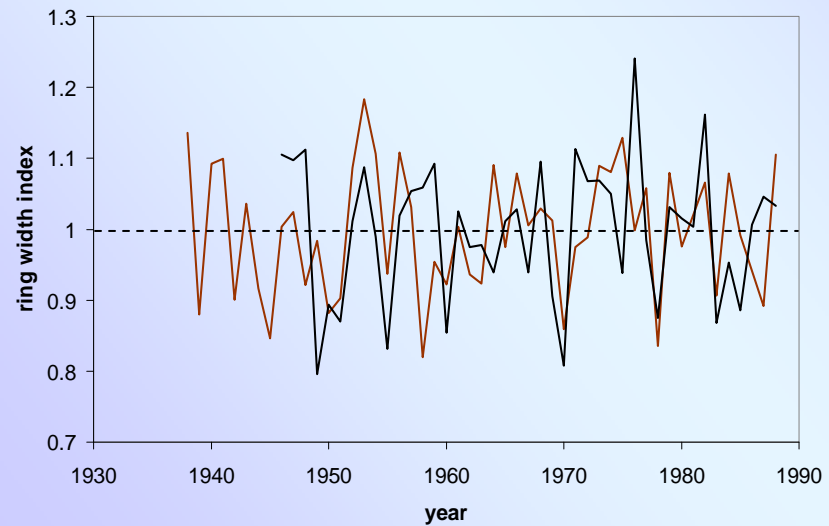
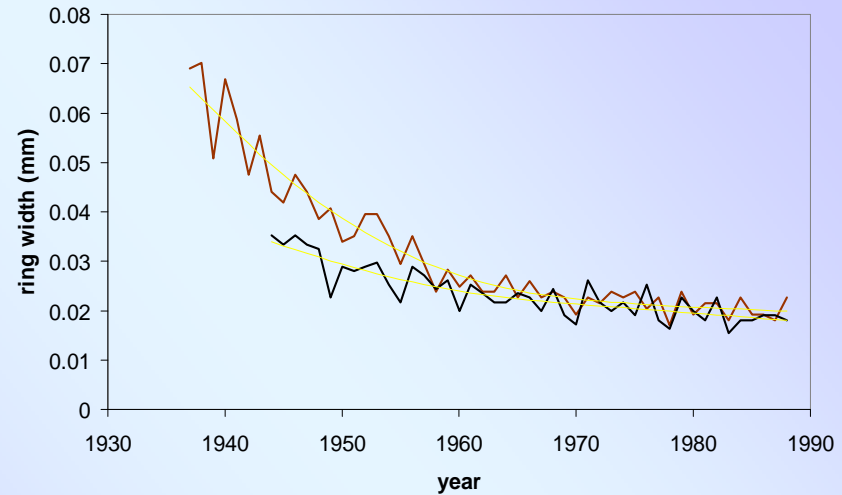




# Detrending

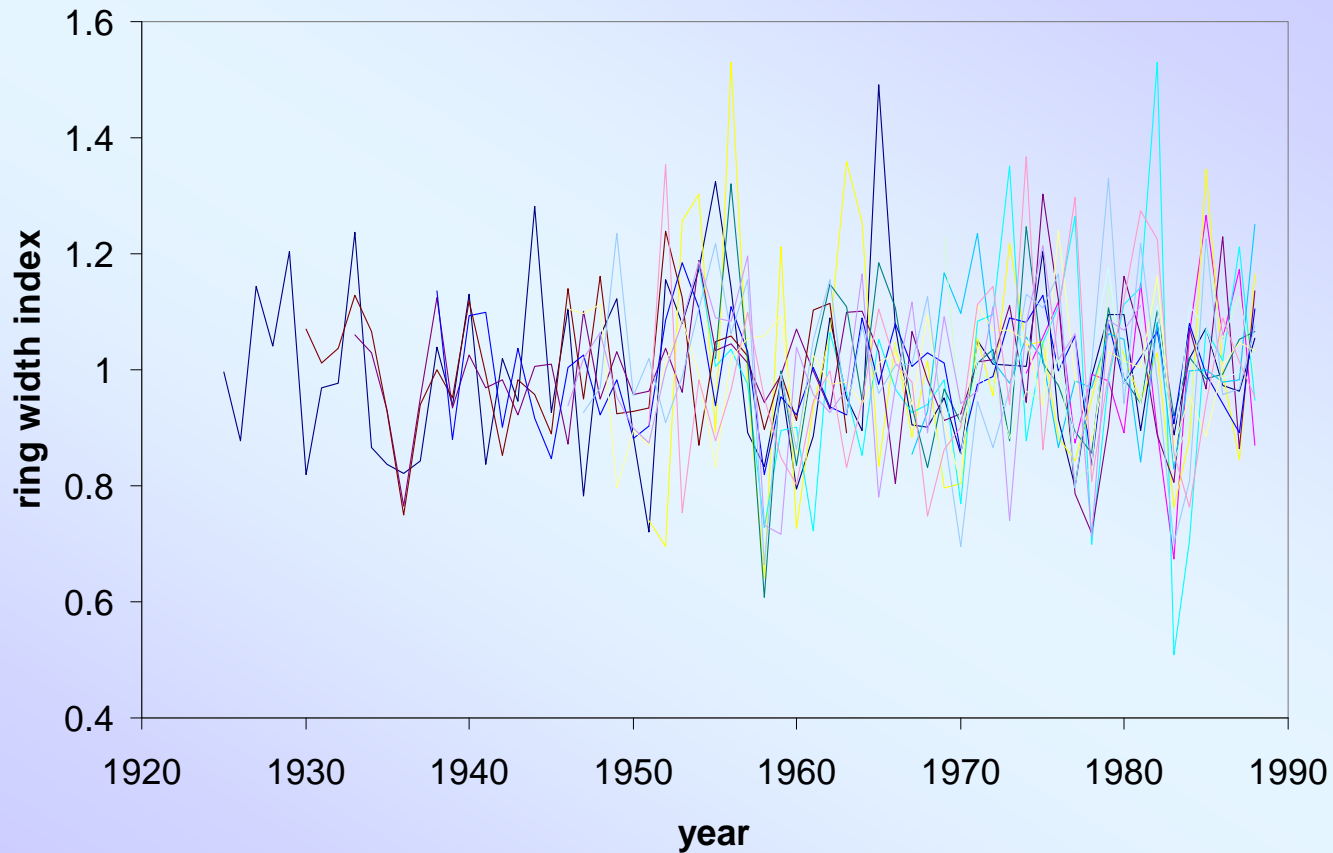
ring width  
measurements,  
best-fit curves

detrended,  
mean = 1



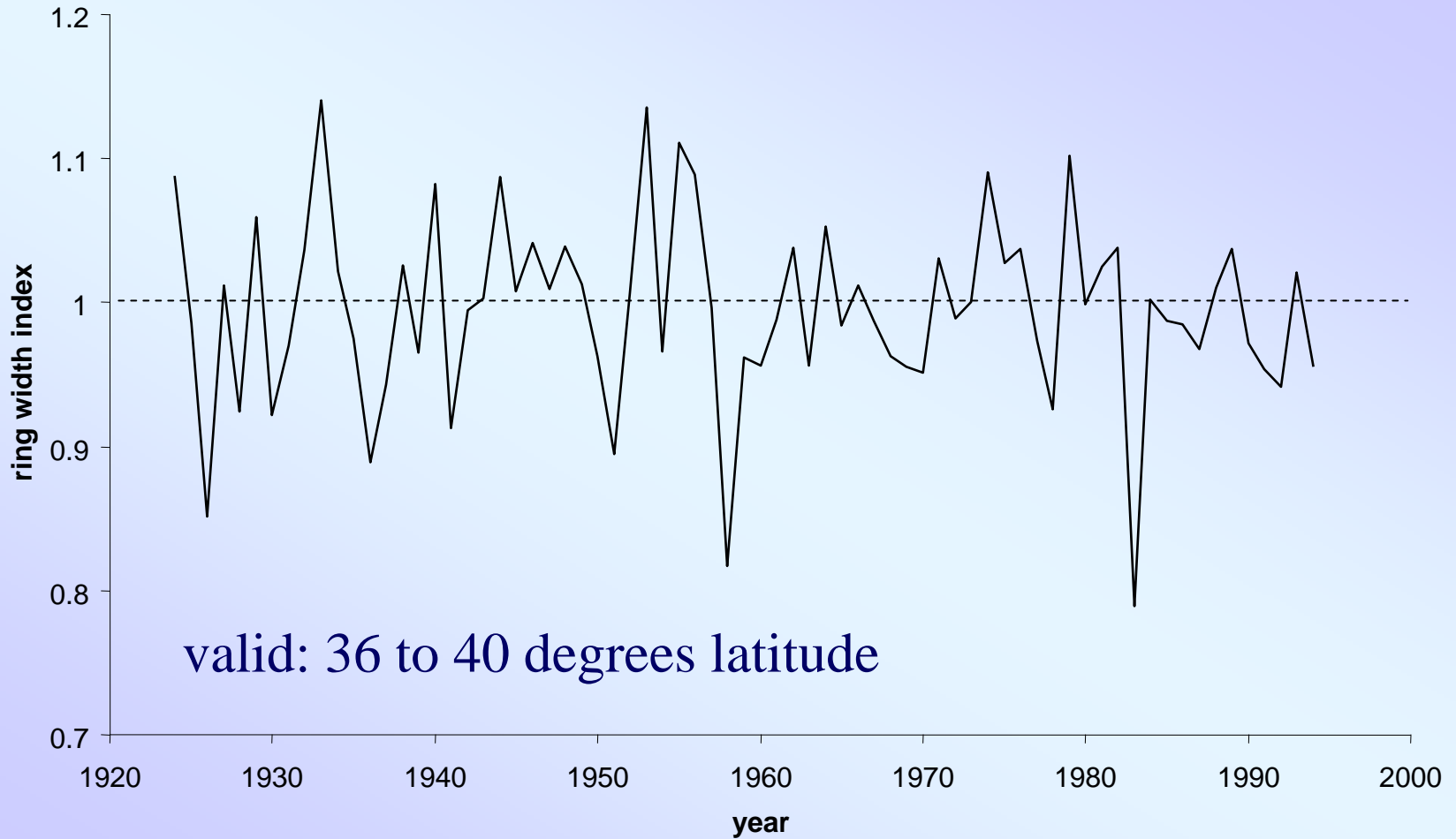
# Detrending

## 15 detrended splitnose otoliths



# Splitnose chronology: 48 otoliths

## Negative exponential detrending





# Climate indices

## Sea Surface Temperatures

**Upwelling: deep, cold, nutrient-rich water  
very productive!**

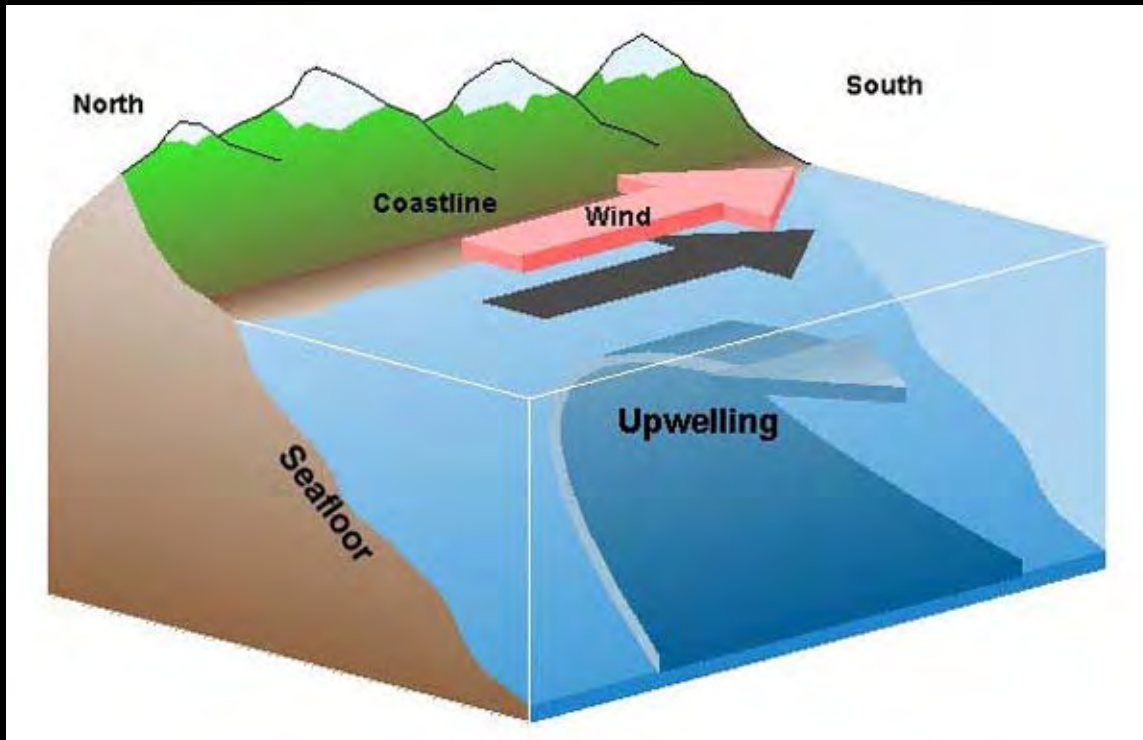
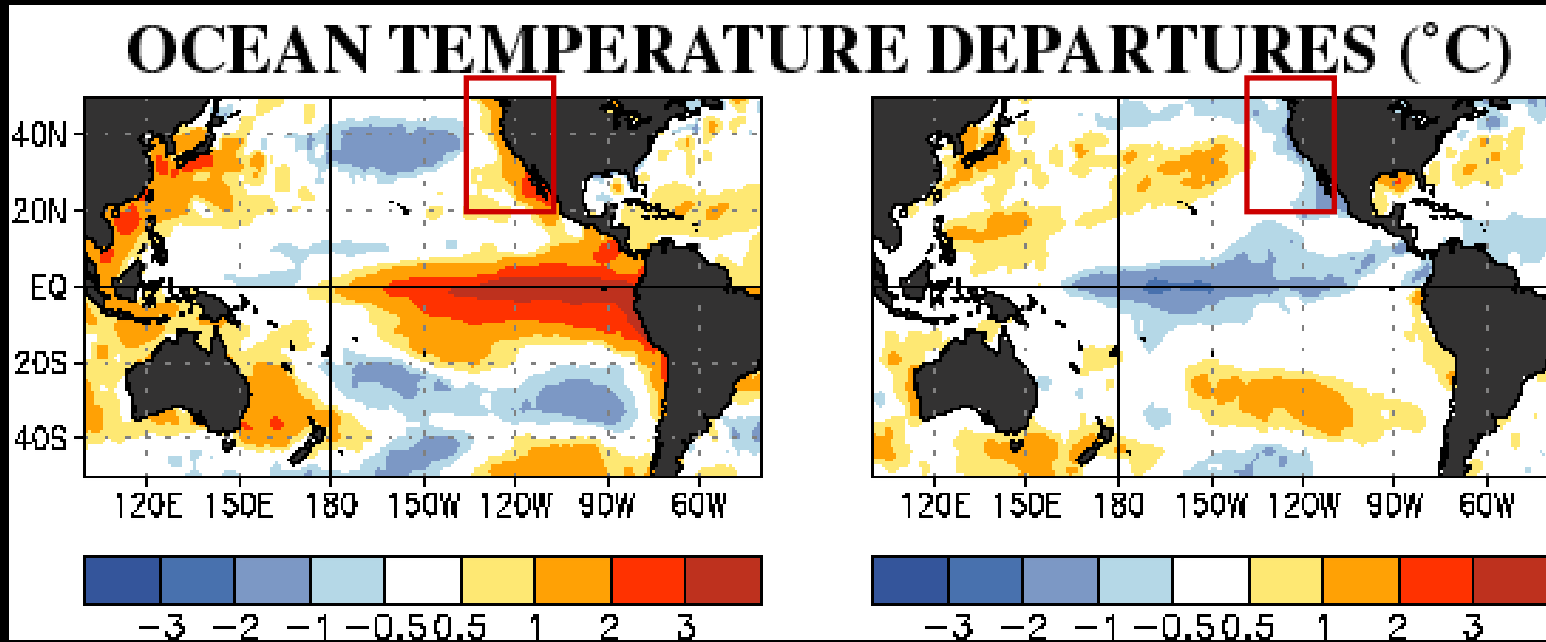


Figure credit: D. Reed and Pacific Marine Environmental Lab

# El Niño / La Niña

## Departures from normal....



**El Niño (warm)**

**La Niña (cool)**

# Climate indices

**High values = COOL waters**

**Upwelling Index**

**Northern Oscillation Index (measure of El Niño)**

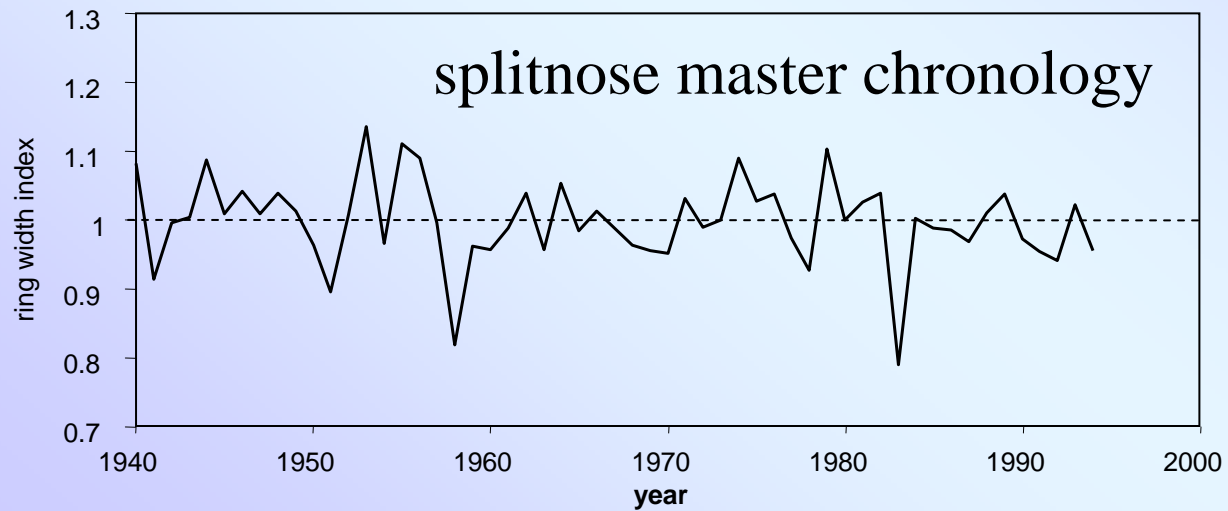
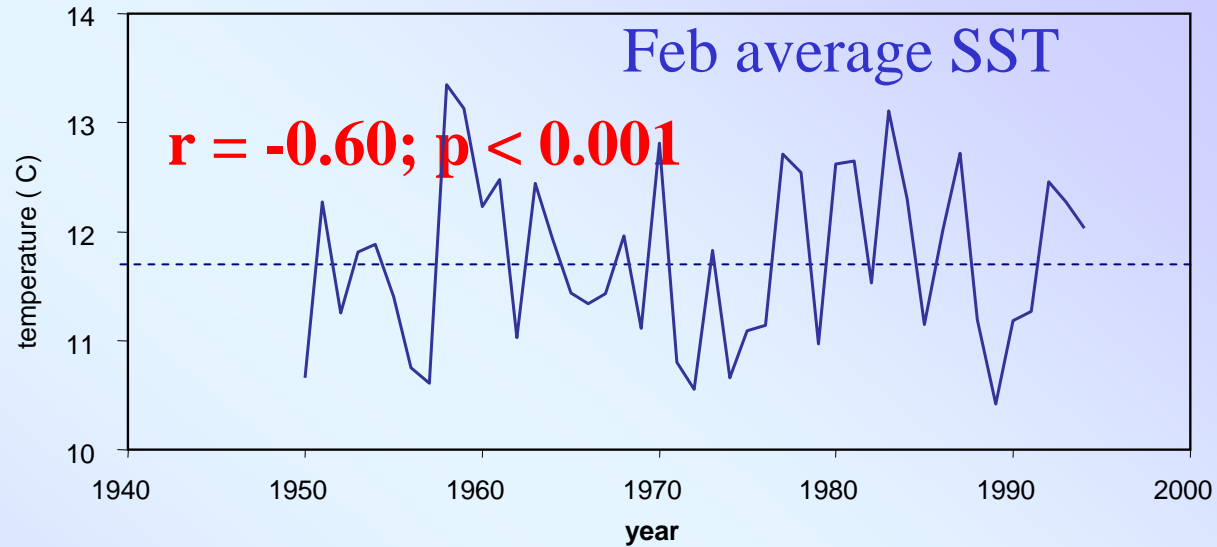
**High values = WARM waters**

**Sea Surface Temperatures**

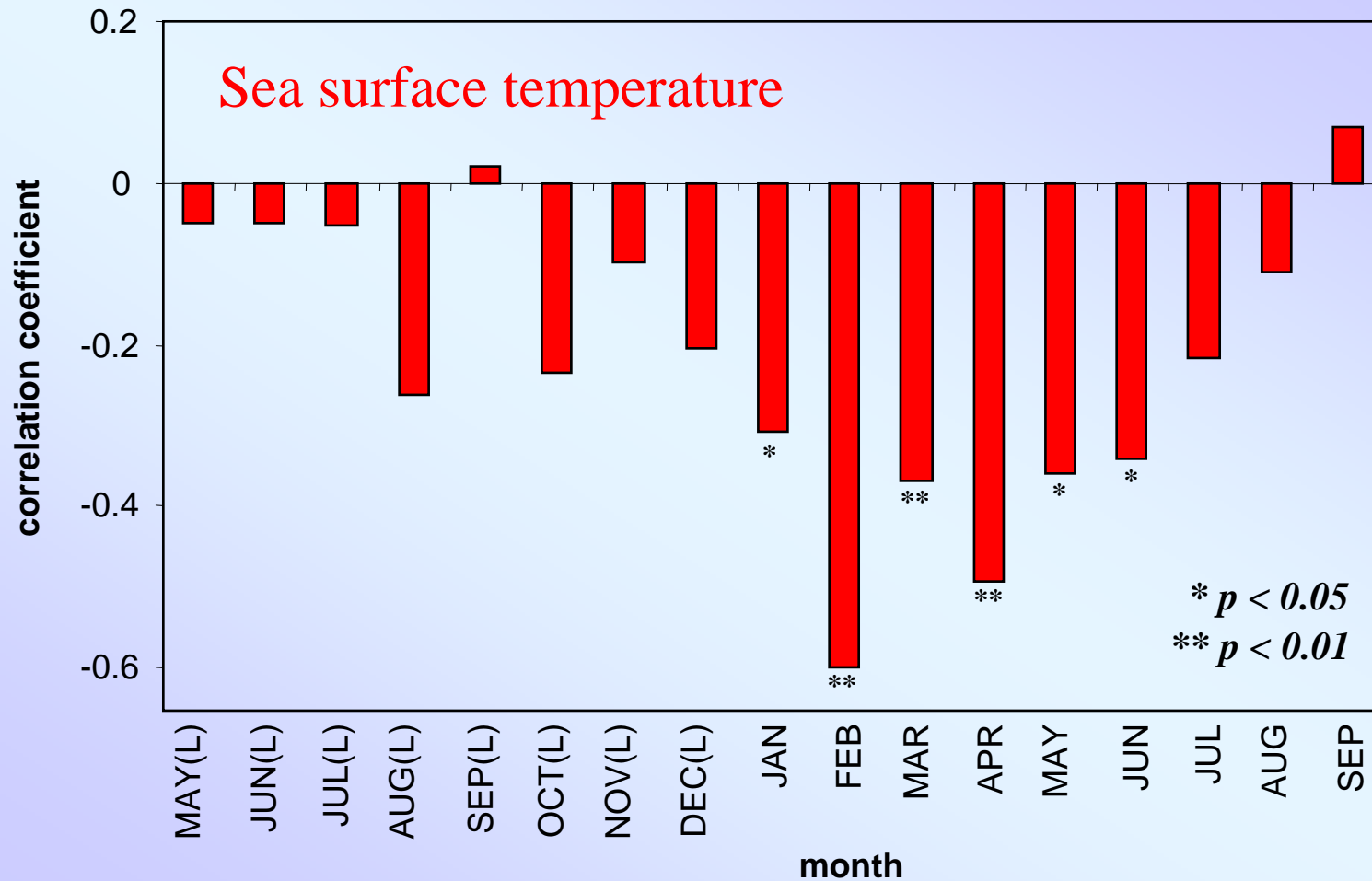
**USE MONTHLY AVERAGES**



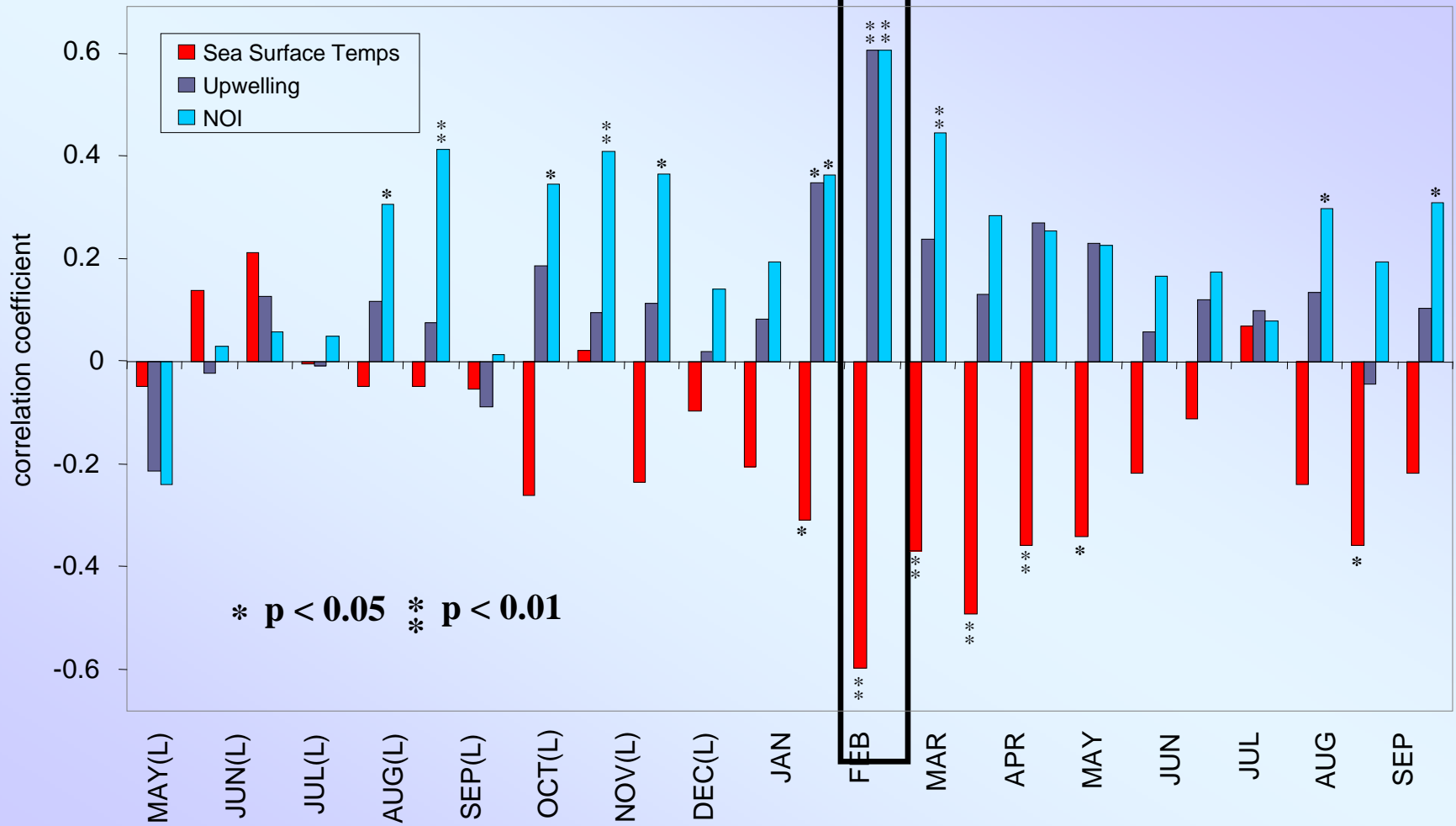
# Effects of climate: sea surface temps



# Effects of climate: sea surface temps



# Climate response





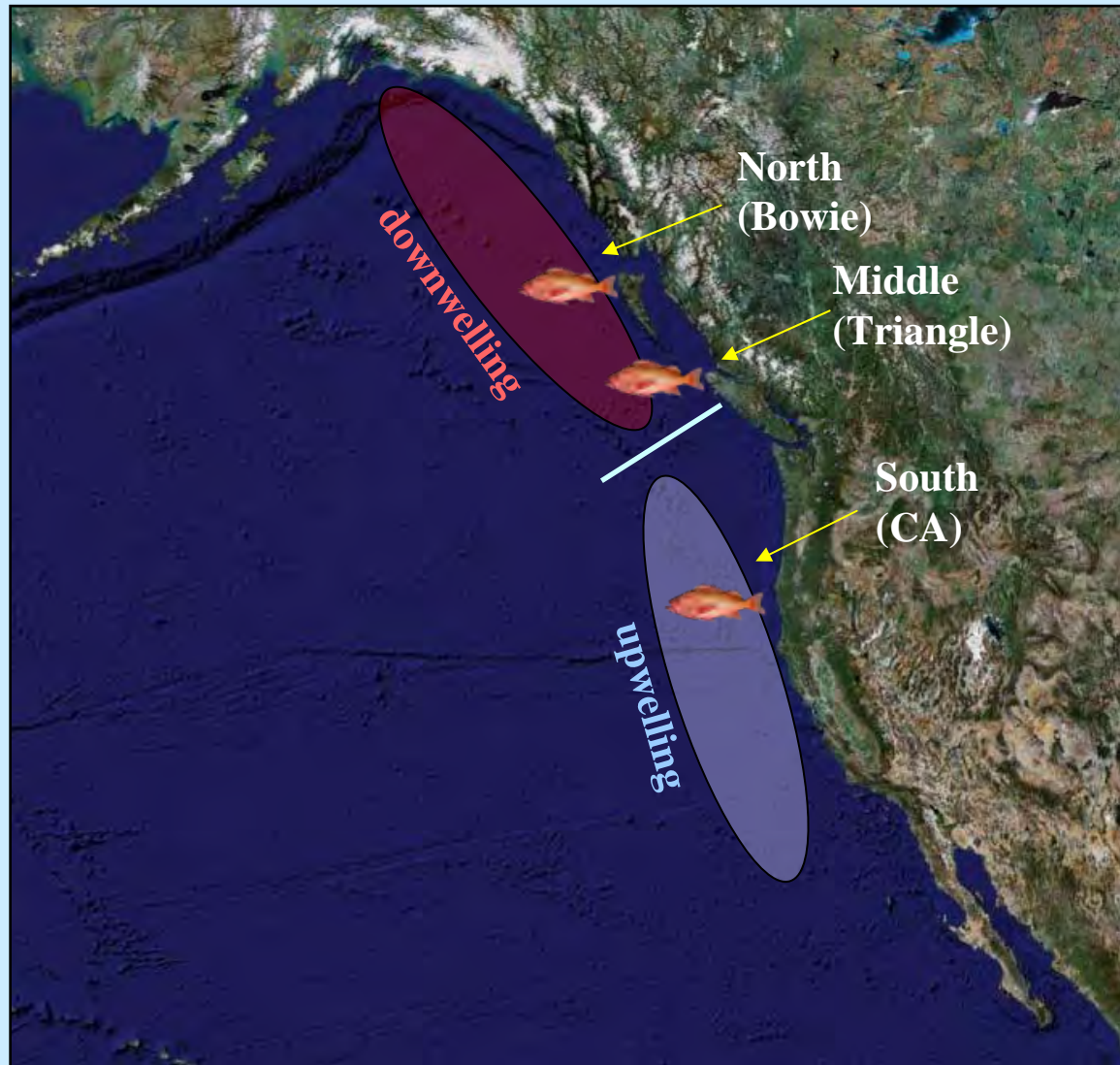
# Yelloweye rockfish

**three sampling locations:  
-spatial differences in growth**

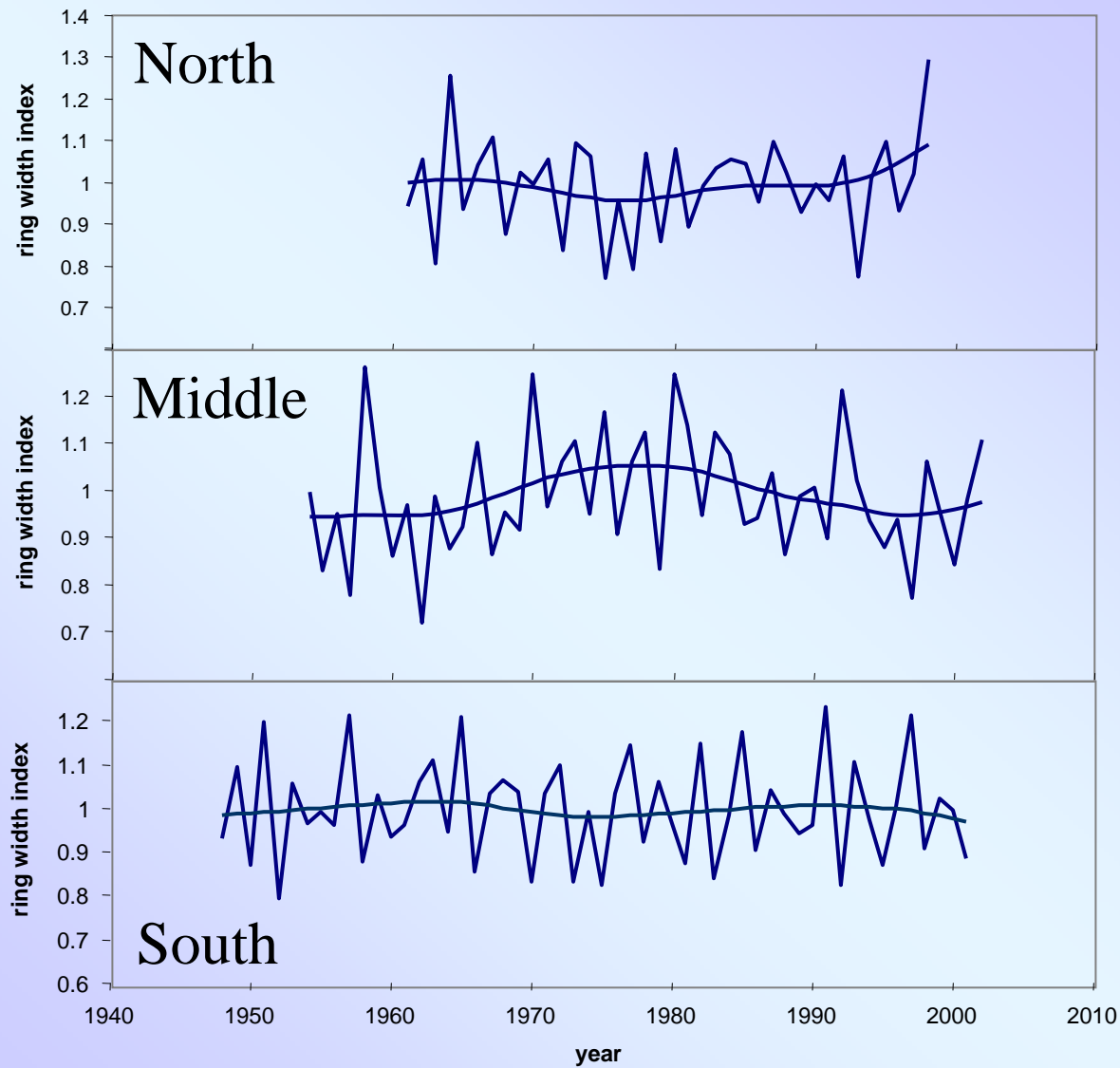


*Sebastes ruberrimus*,  
yelloweye rockfish

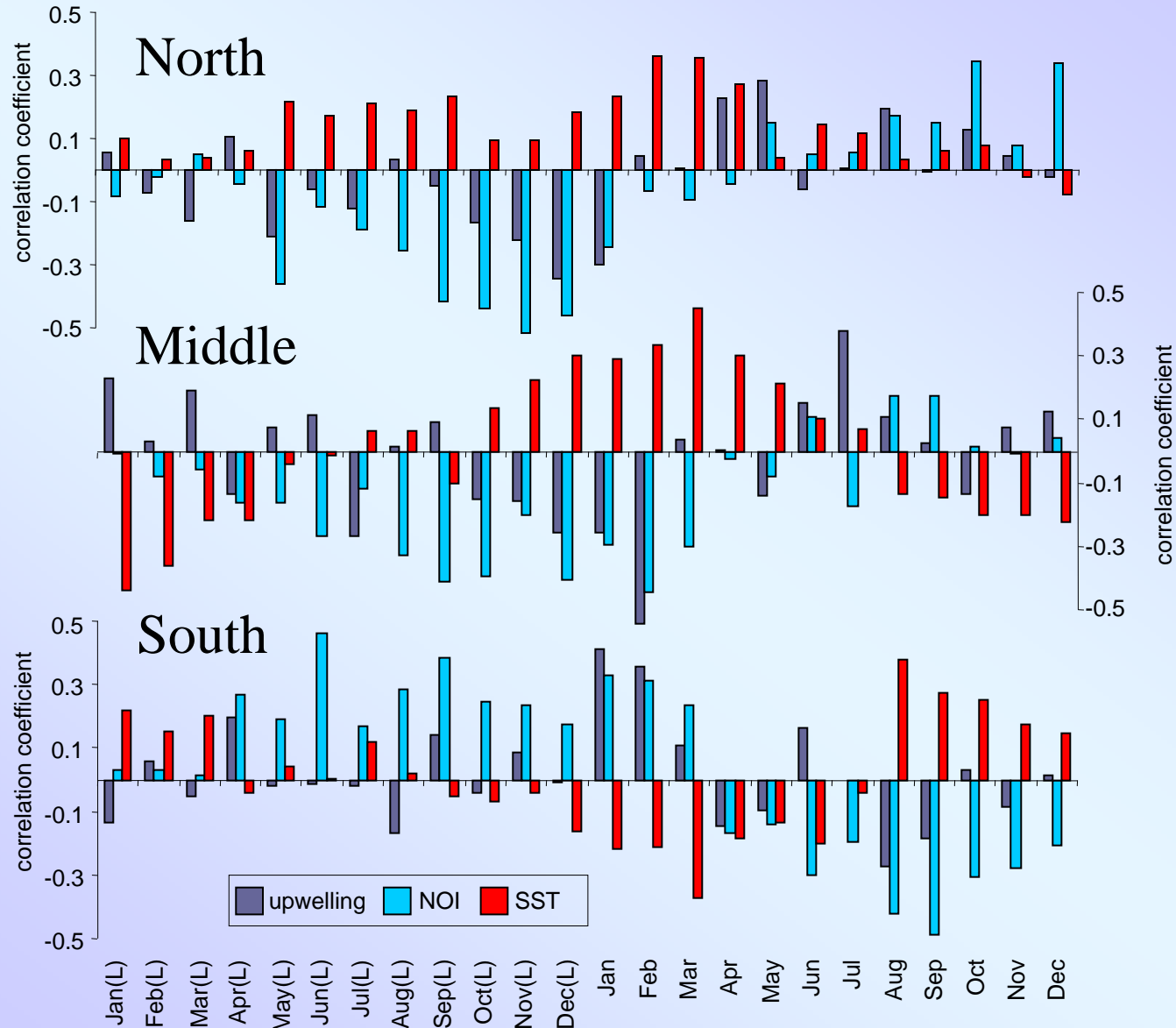
# Yelloweye rockfish sites



# Yelloweye chronologies



# Yelloweye climate-growth relationships



downwelling

upwelling



# Pacific Geoduck

**Puget Sound to Kodiak, AK  
nearshore  
150 yrs old!**

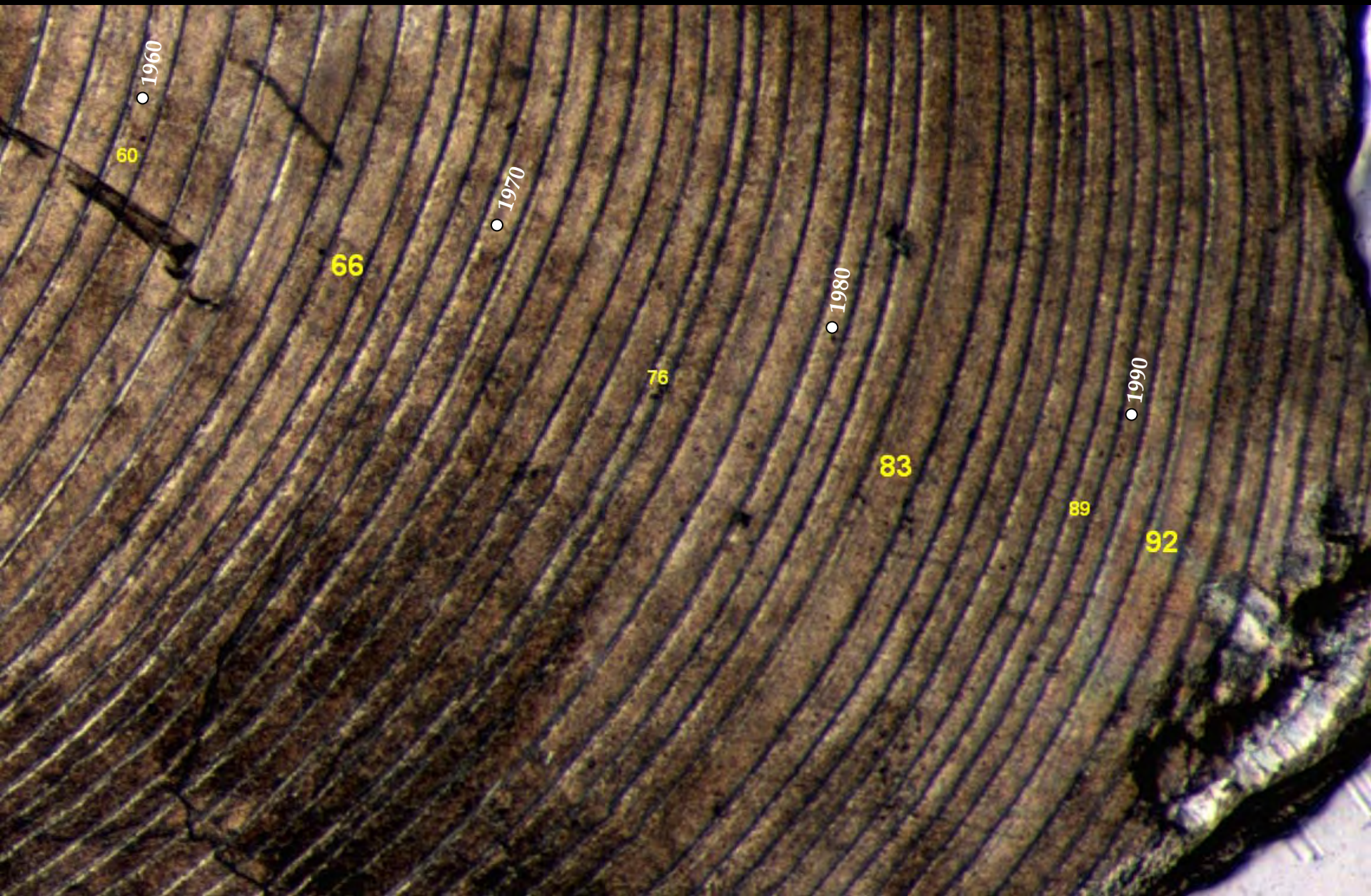


**growth increments in  
hinge plate**

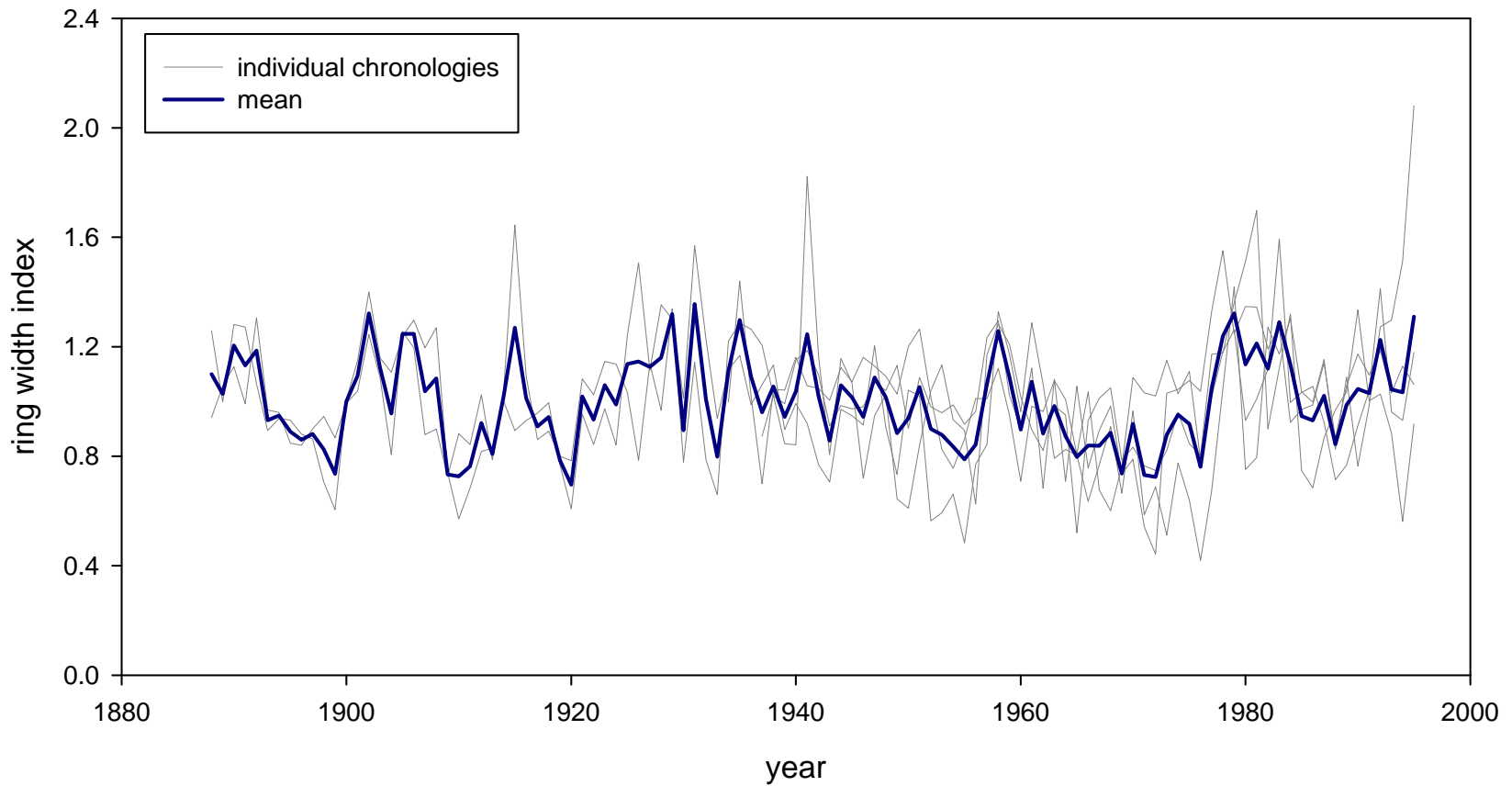




# Geoduck growth increments

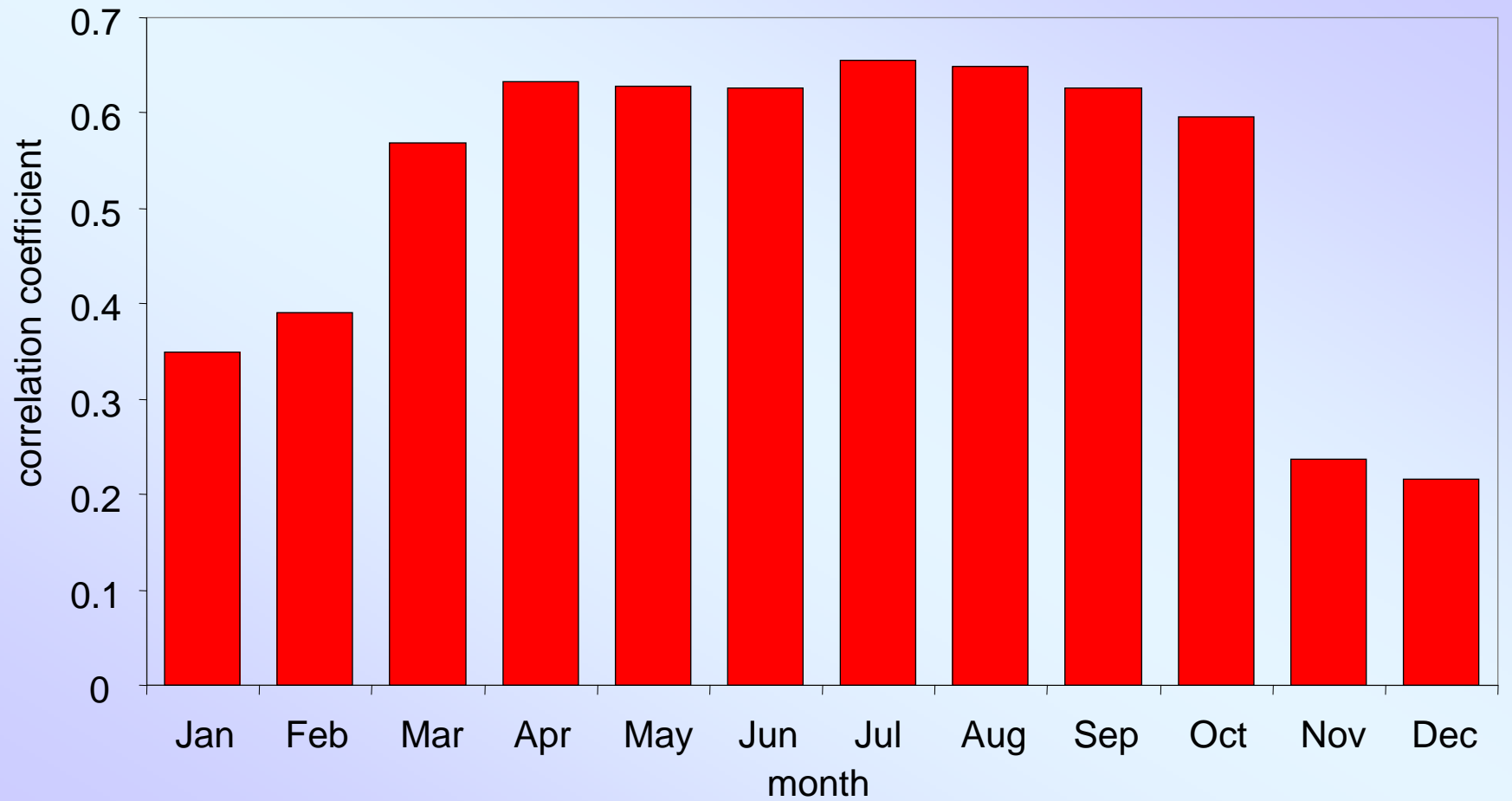


# Geoduck chronologies



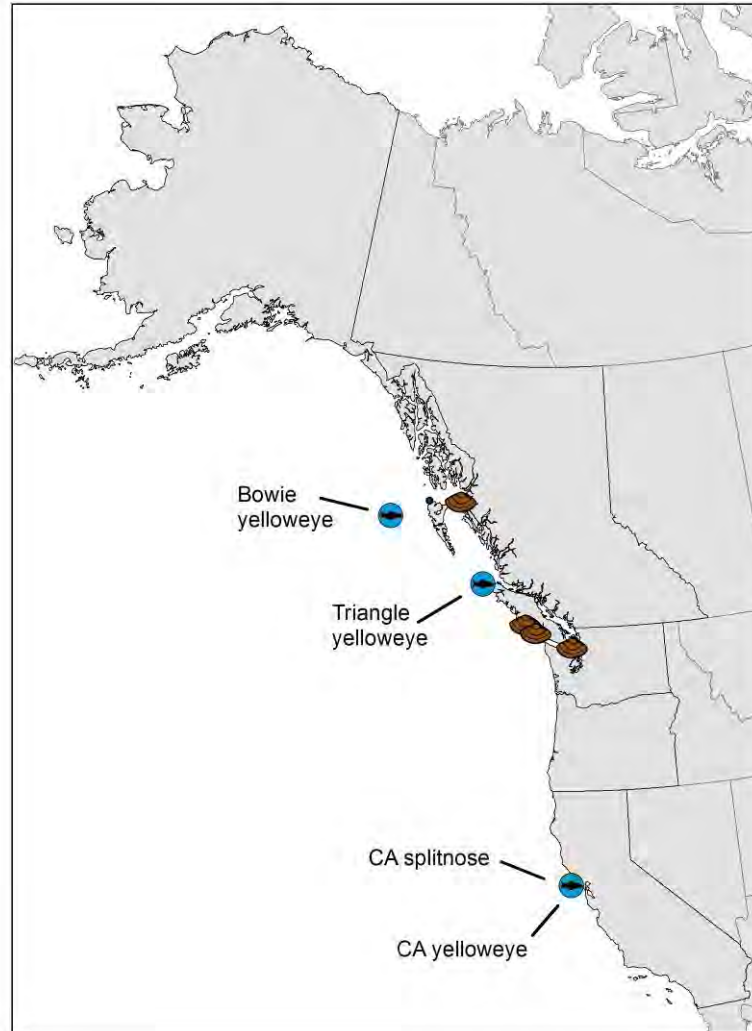


# Correlation with SST

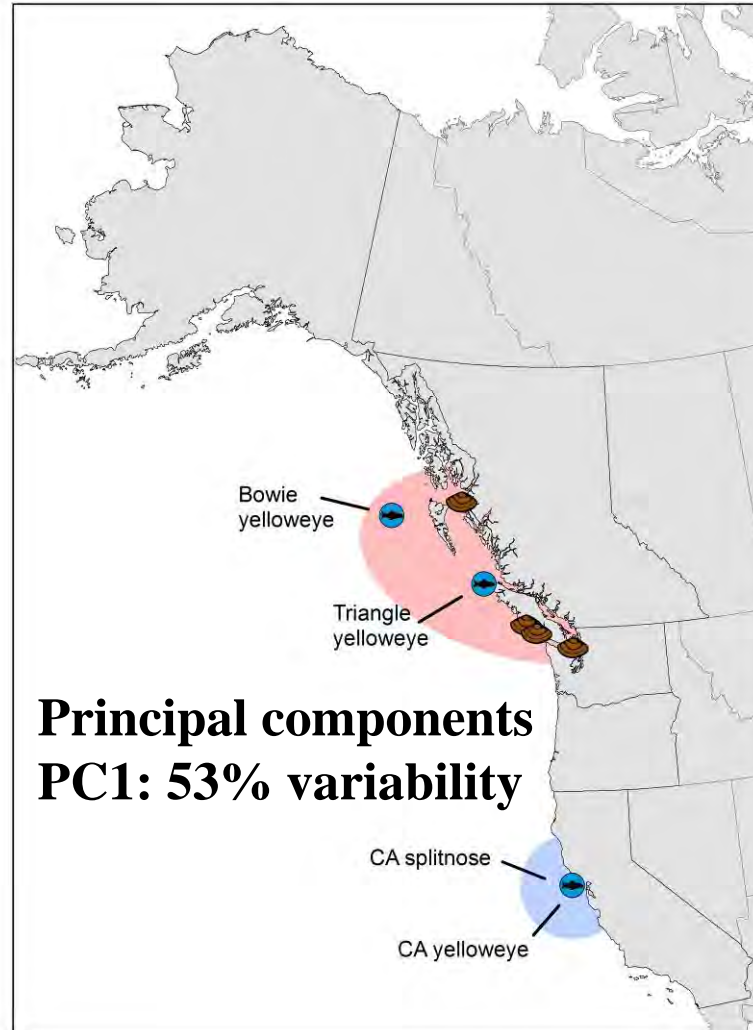




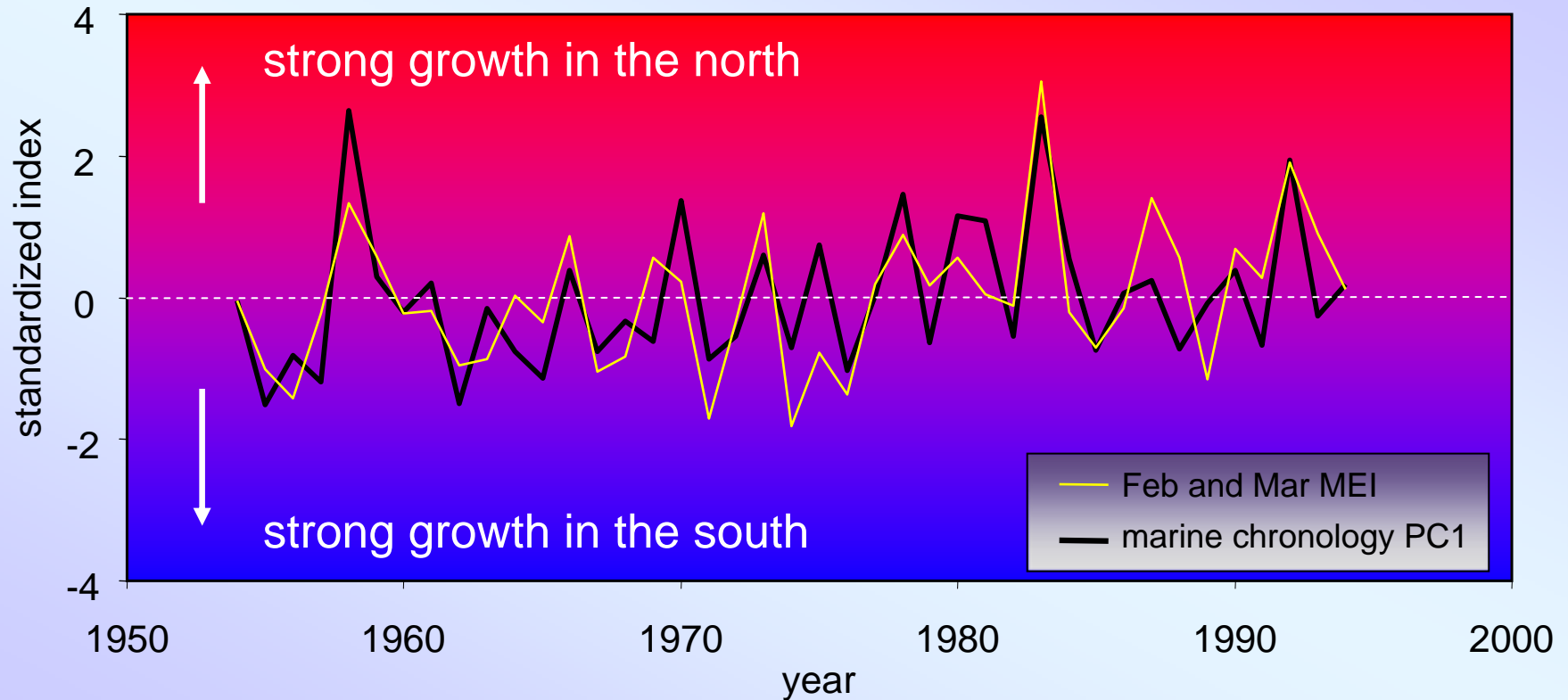
# Rockfish and geoduck chronologies



# Rockfish and geoduck chronologies

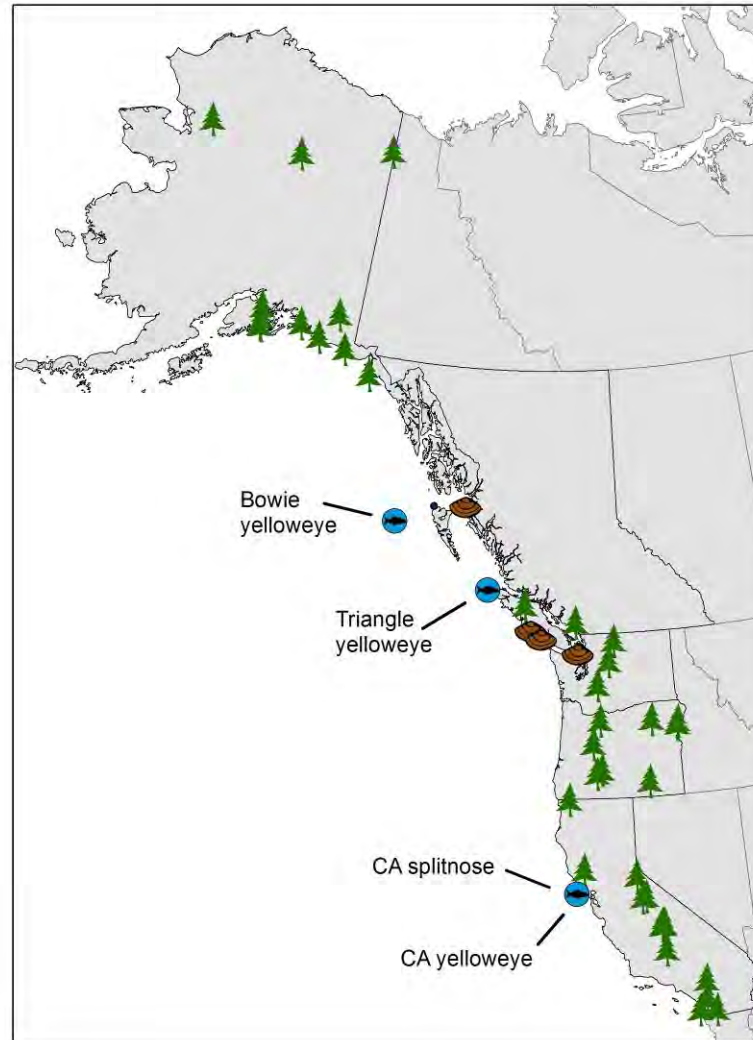


# Marine chronology PC1



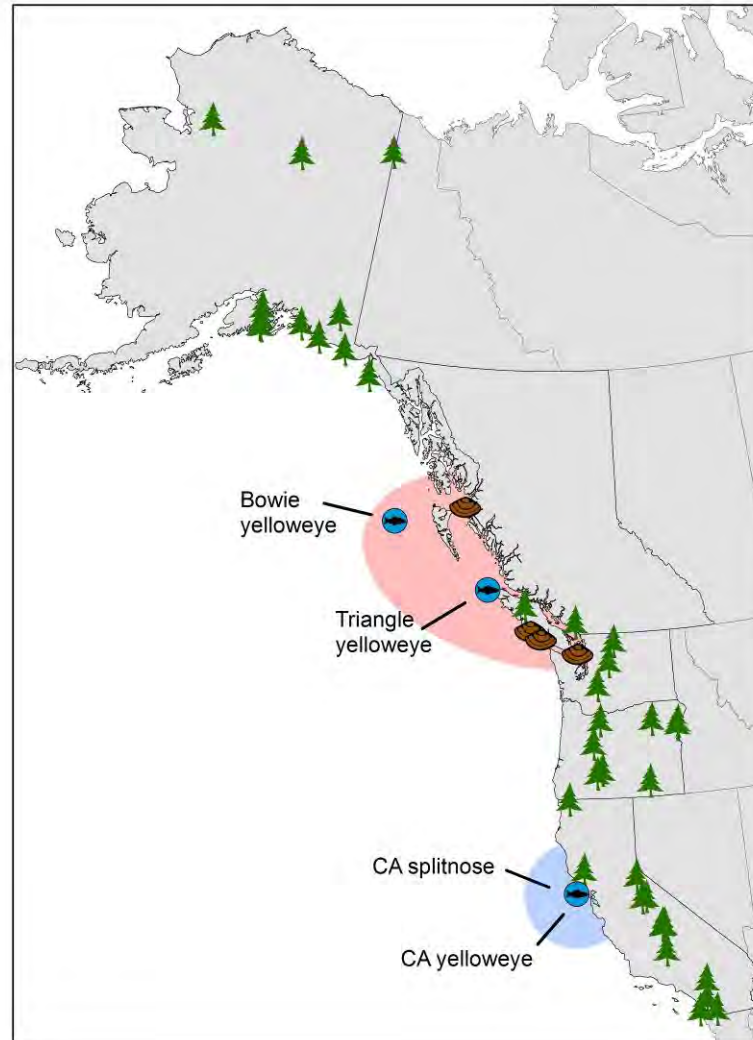
**MEI = Multivariate ENSO Index**

# Rockfish, geoduck, and tree rings

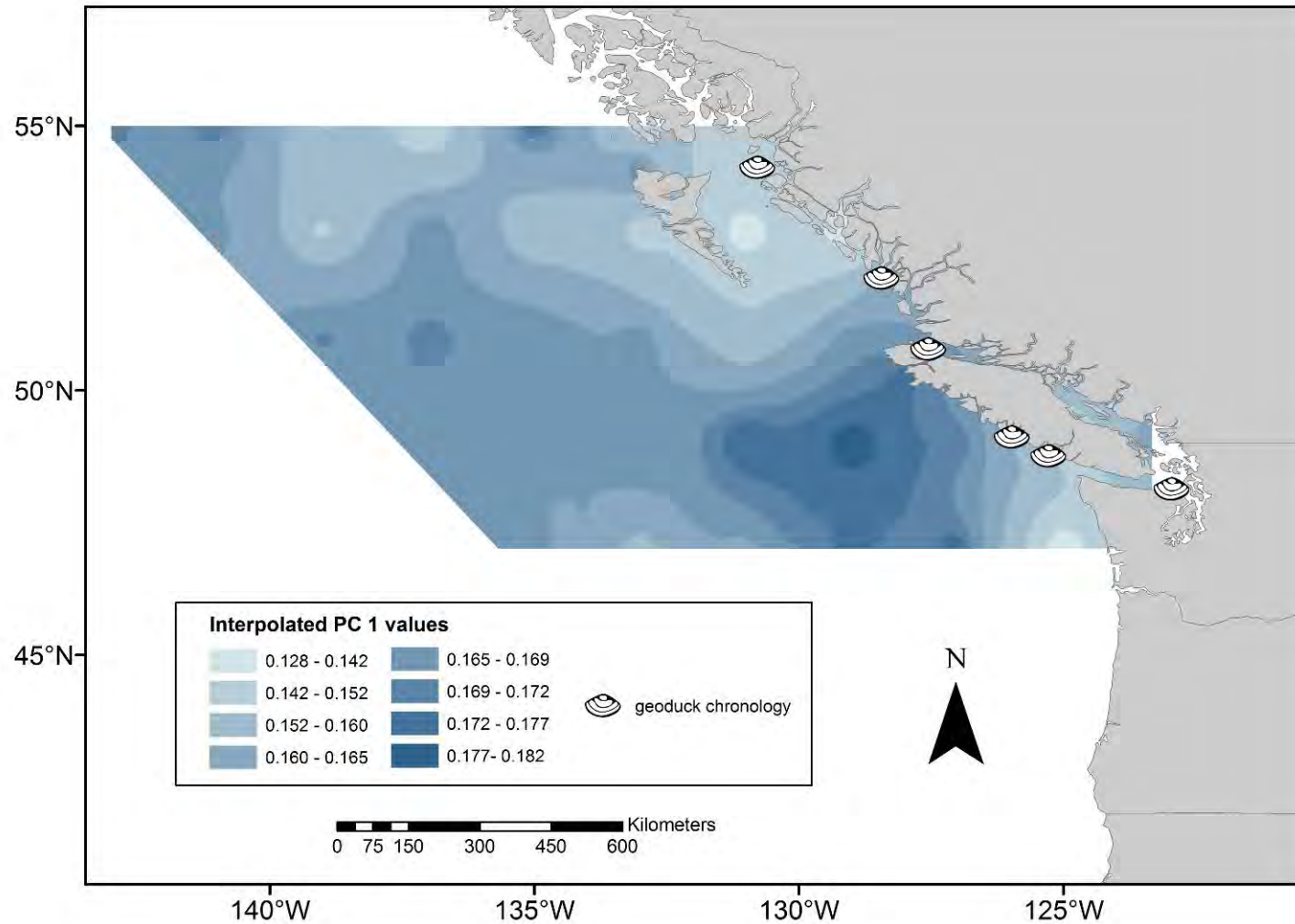




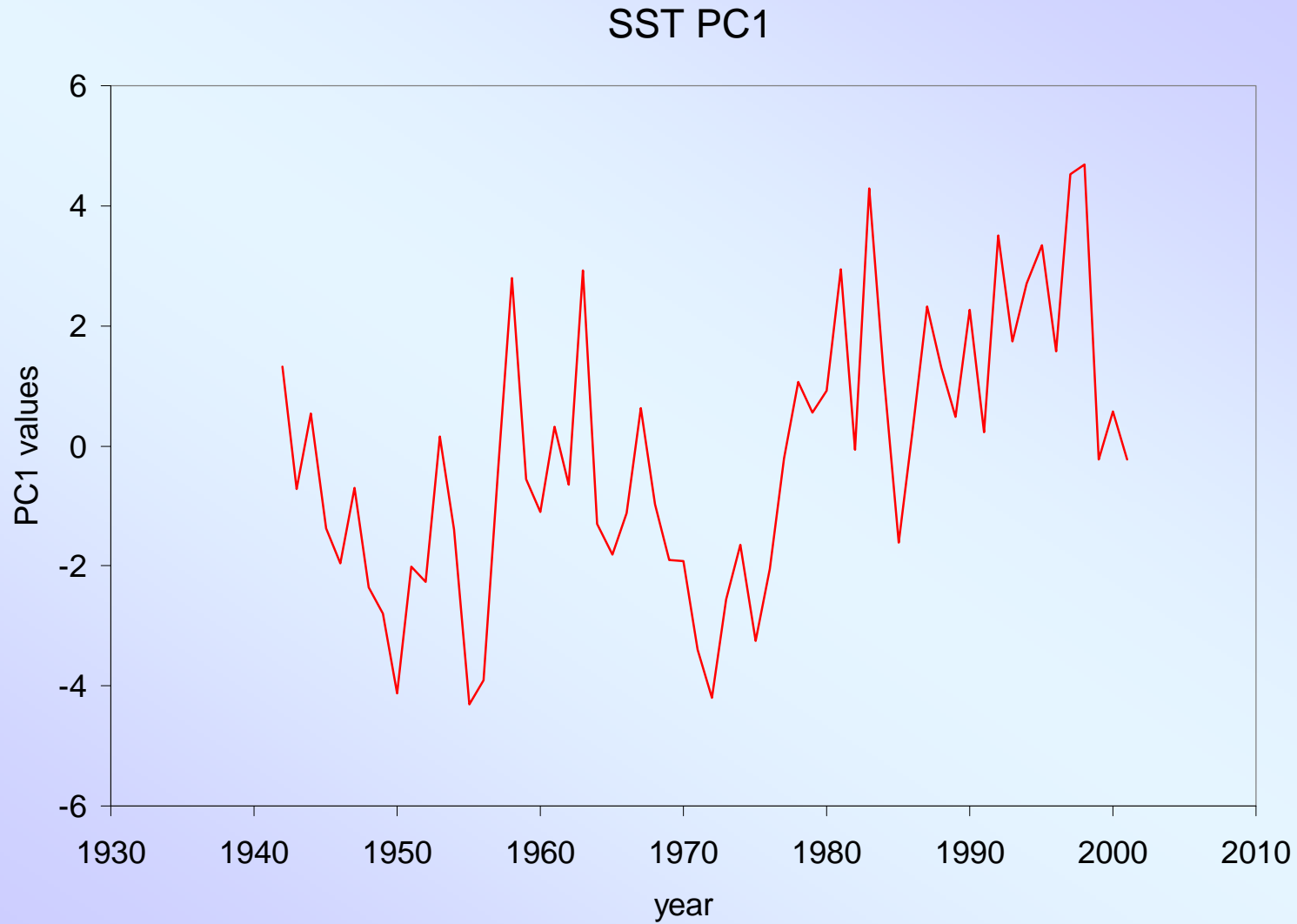
# Rockfish, geoduck, and tree rings



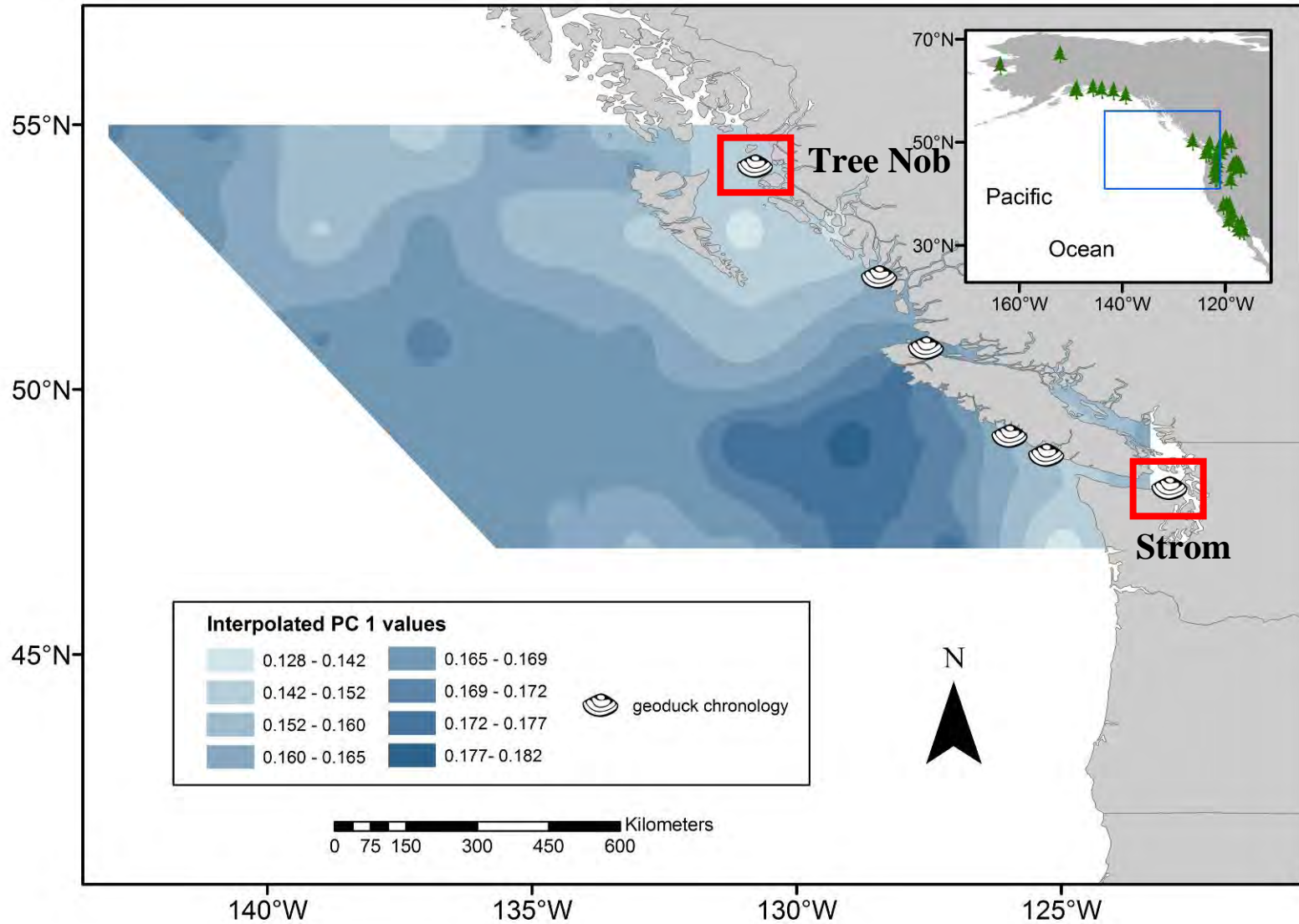
# SST data points



# Temperature reconstruction



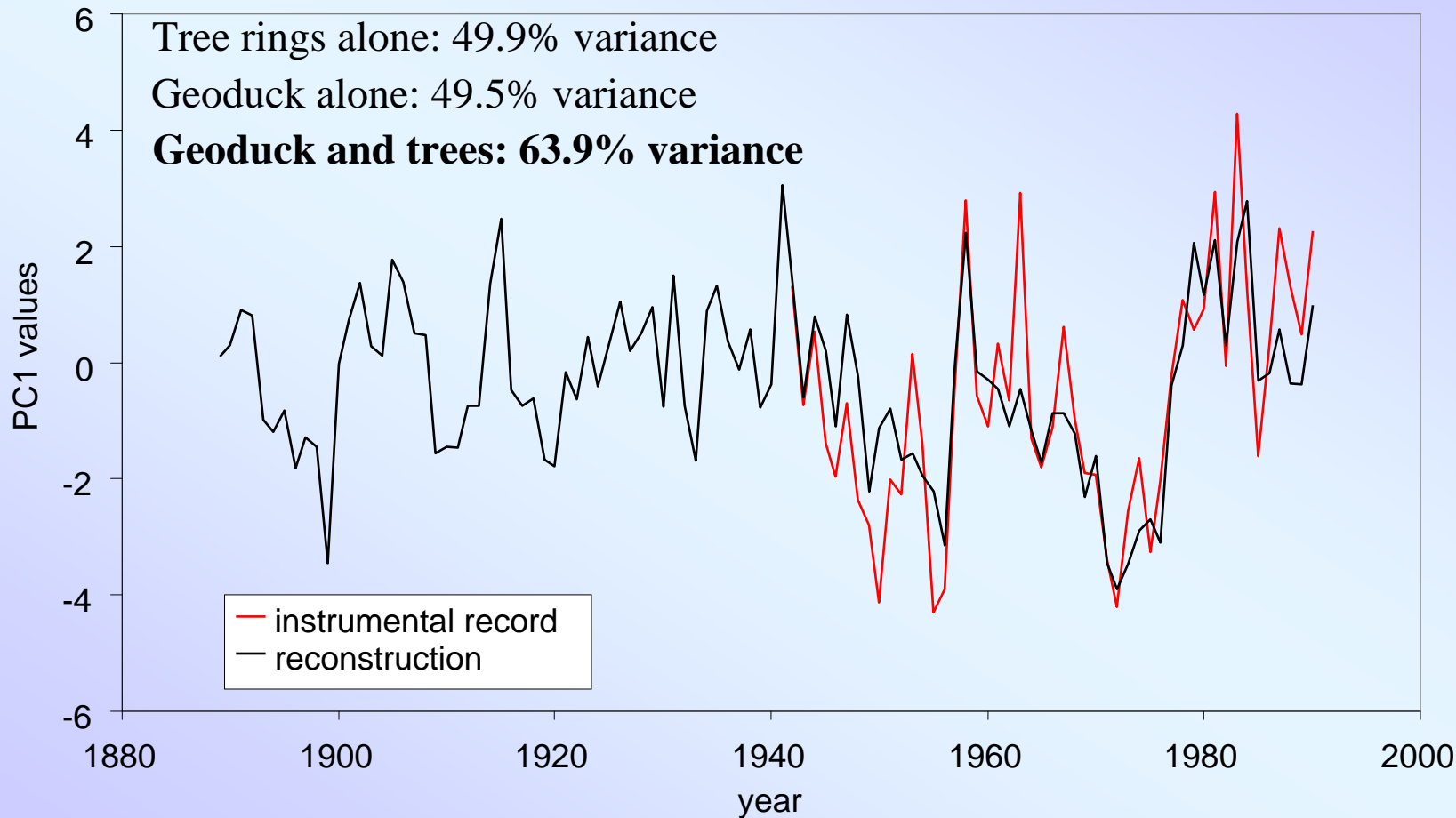
# SST data points





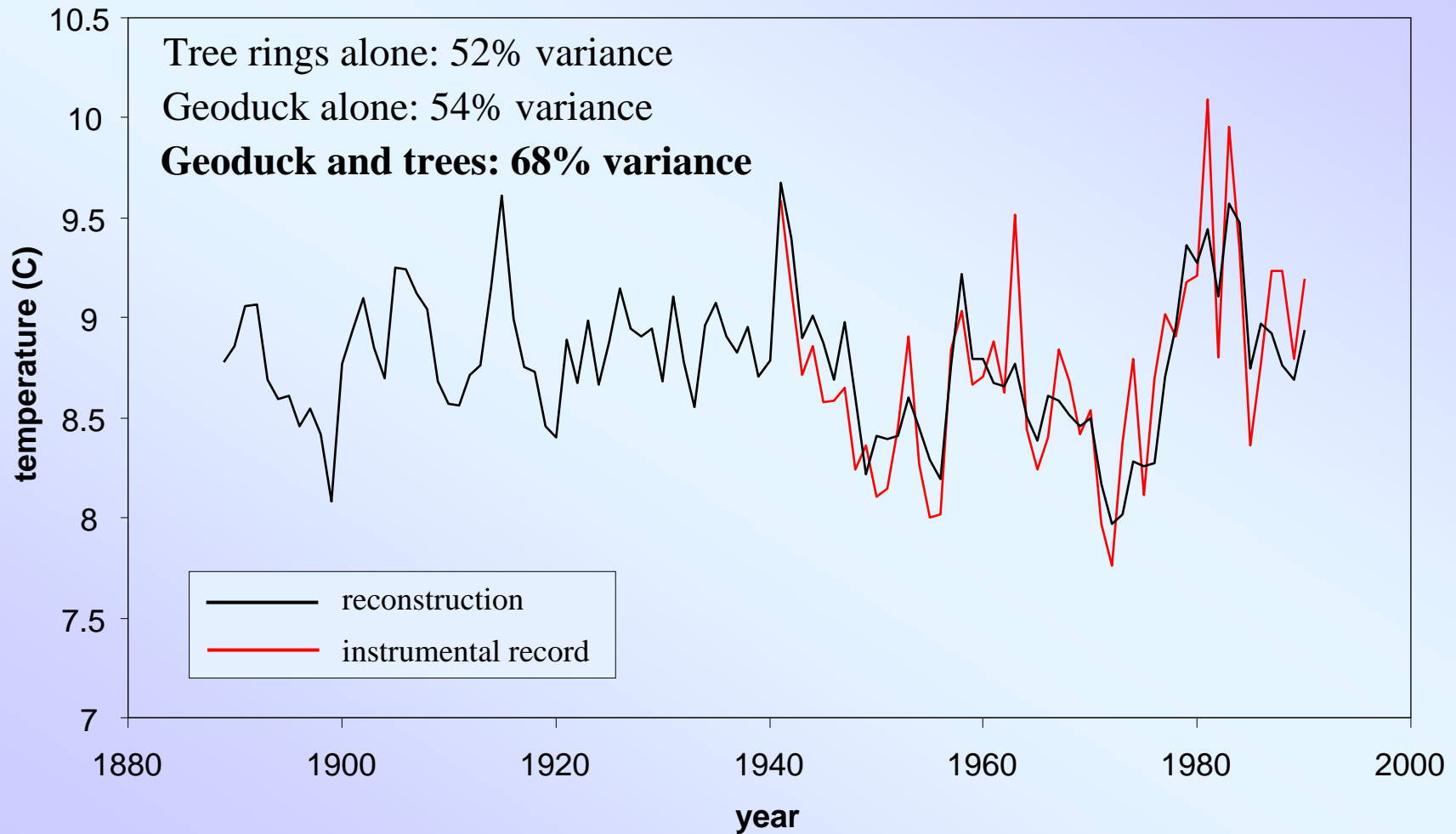
# Temperature reconstruction

SST PC1 reconstruction

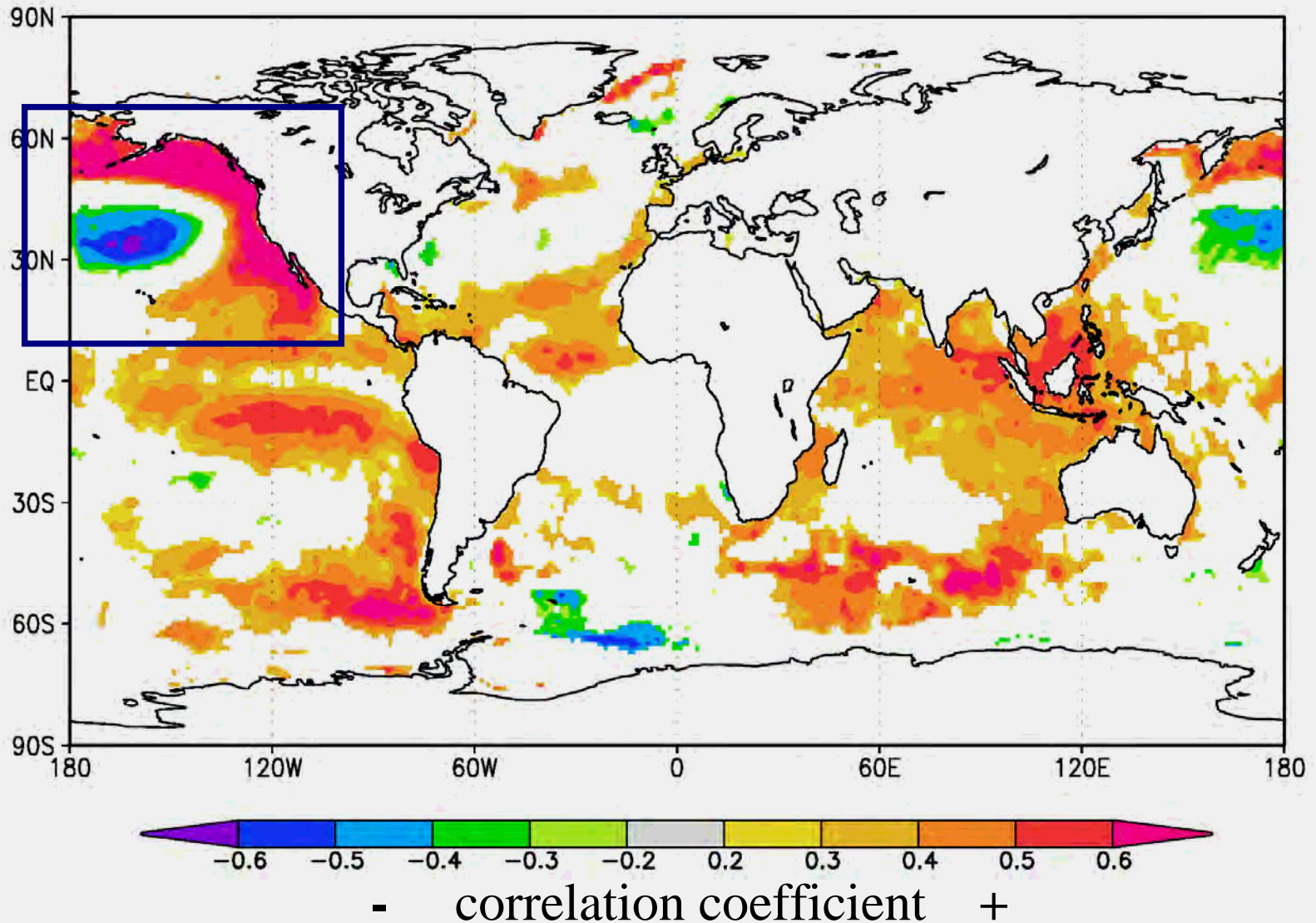


# Temperature reconstruction

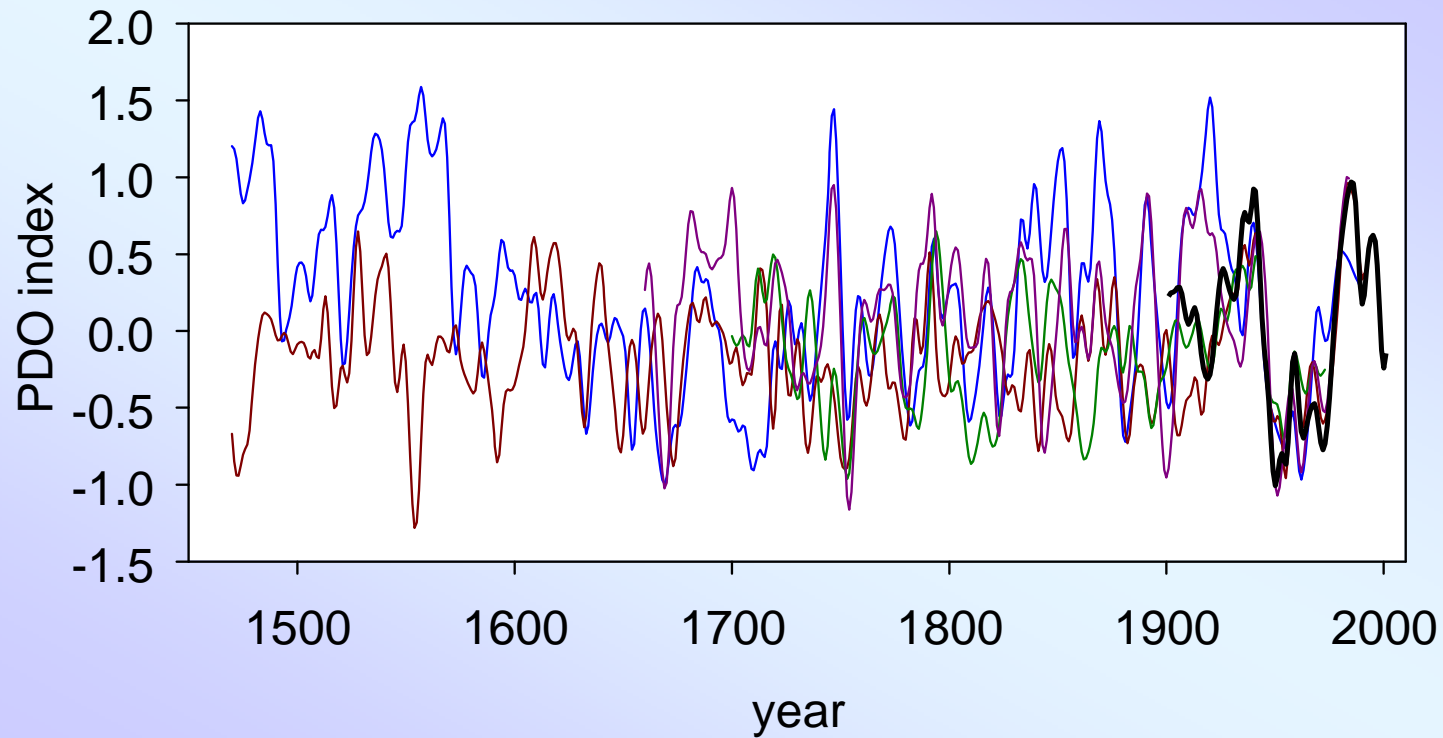
SST reconstruction at Langara Lighthouse



# Correlations with global SST



# Pacific Decadal Oscillation



— MacDonal and Case

— Shen

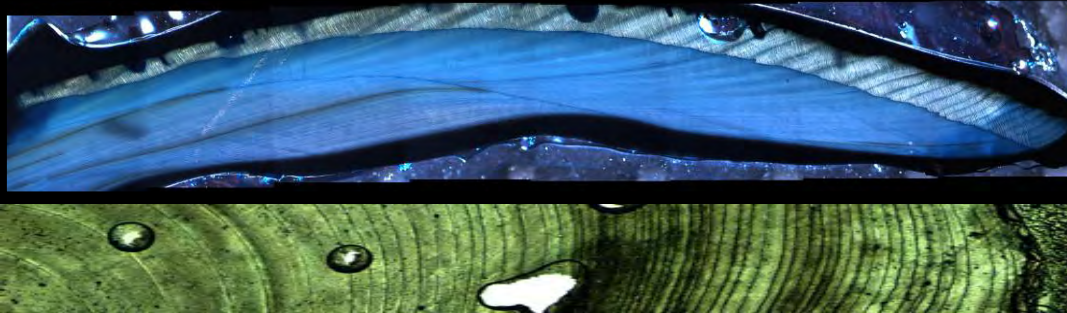
— D'Arrigo

— Biondi

— PDO index



# Ecosystem linkages

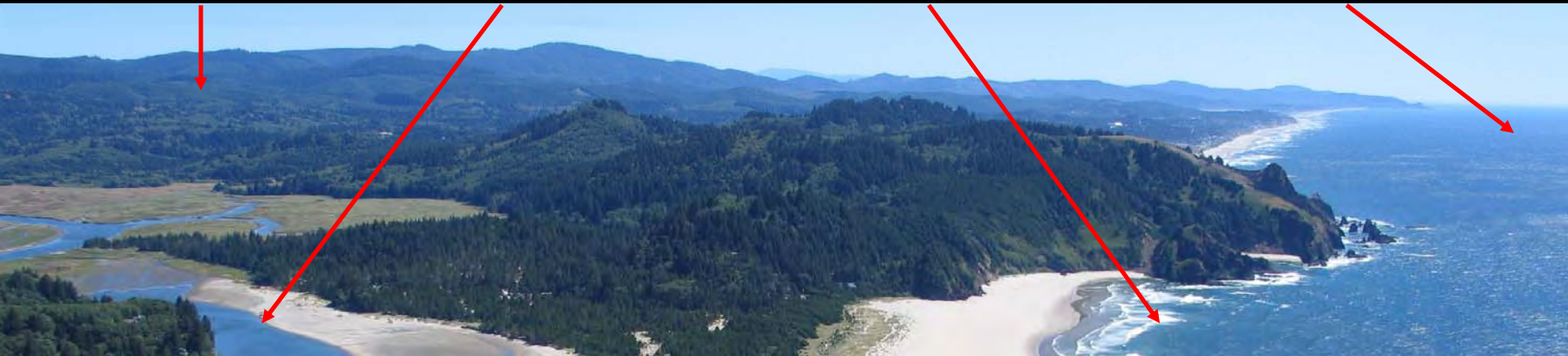


*trees*  
**forests**

*mussels*  
**rivers**

*geoduck*  
**nearshore**

*rockfish*  
**continental shelf**



# Acknowledgements

George Boehlert: OSU

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