From the trees to the seas: multi-species perspectives on long-term climatic and ecological variability

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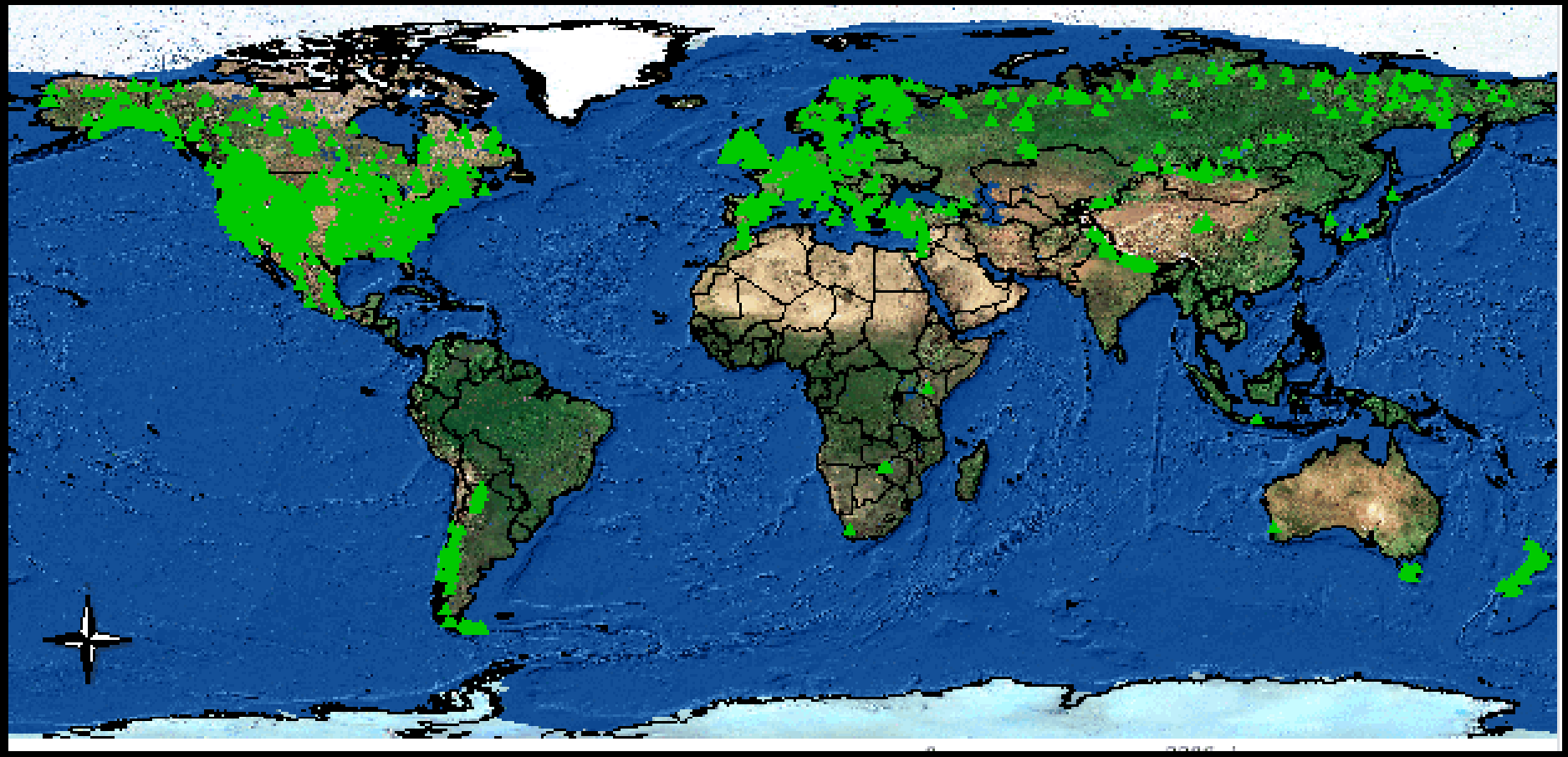
International tree-ring databank



Many animals form increments…

…and can be quite old!

Pacific rockfish

100 yr + yelloweye rockfish

Freshwater drum

70 yr +

***Margaritifera* freshwater mussels**

100 yr +

Pacific geoduck

150 +

Arctica islandica

405-410; world's oldest animal!

U. Wales, Bangor

Tropical corals

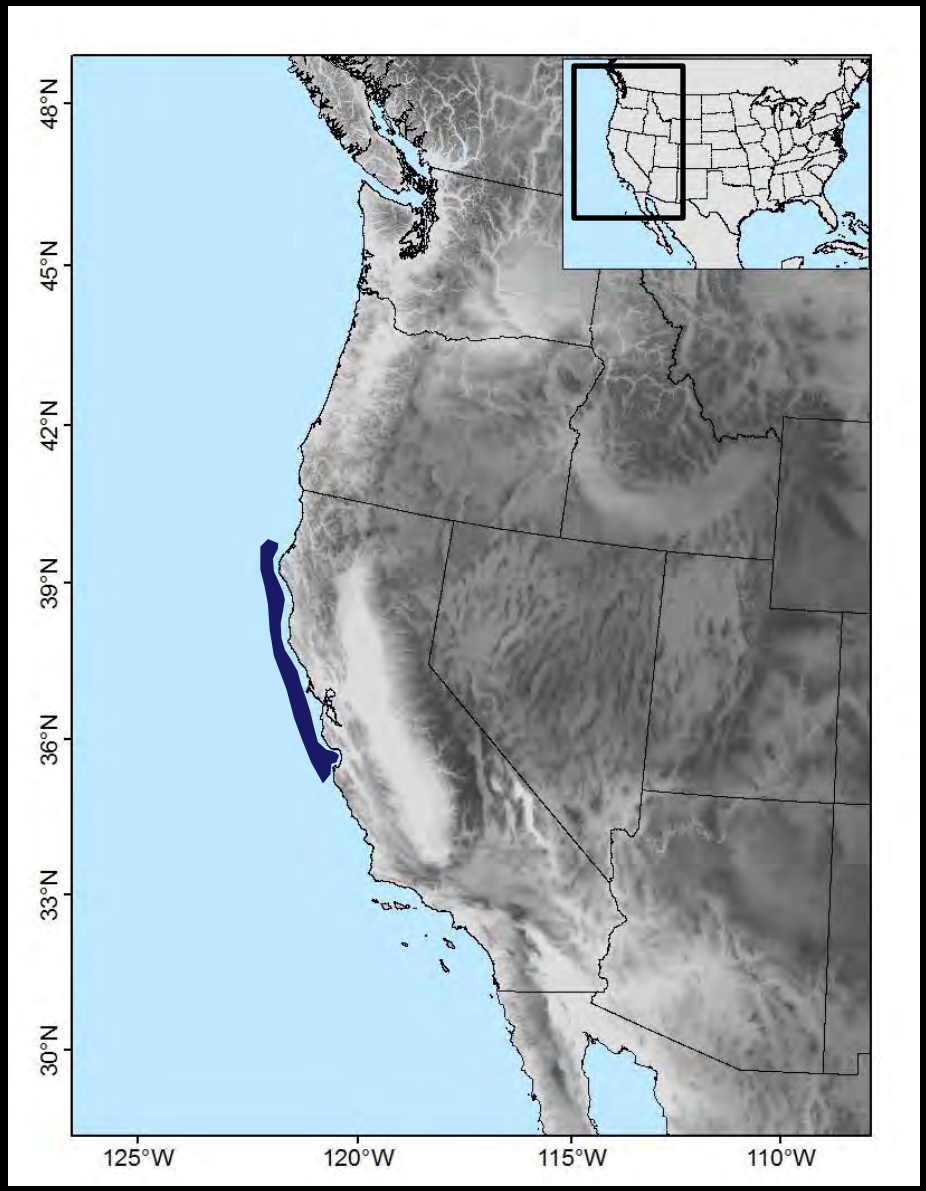
300 yrs +

Splitnose rockfish (*Sebastes diploproa*)

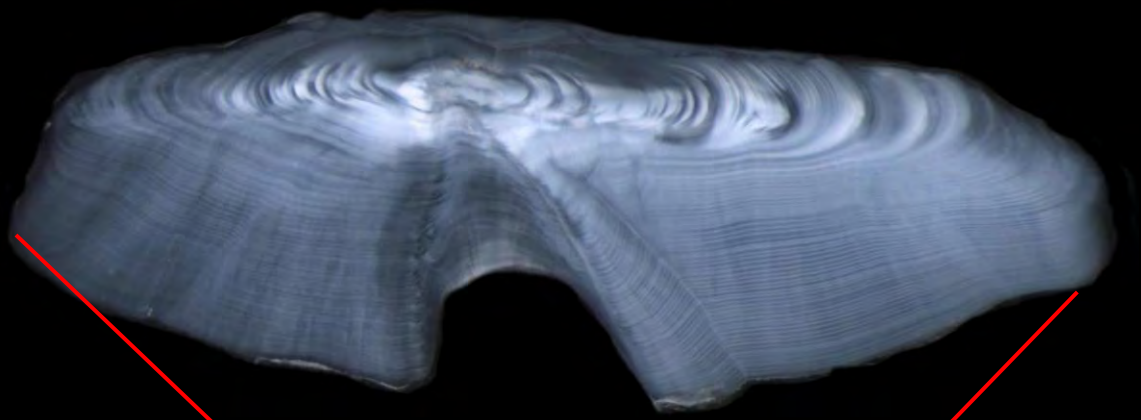
80+ yrs old
300 m depth
Live-collected 1980 - 2008

***Sebastes diploproa*, splitnose rockfish**

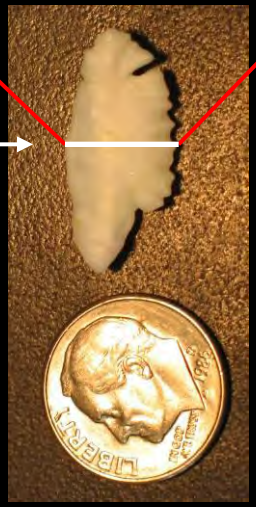
Photo credit:Lifted from M. Love's webpage



Otolith thin sectioning

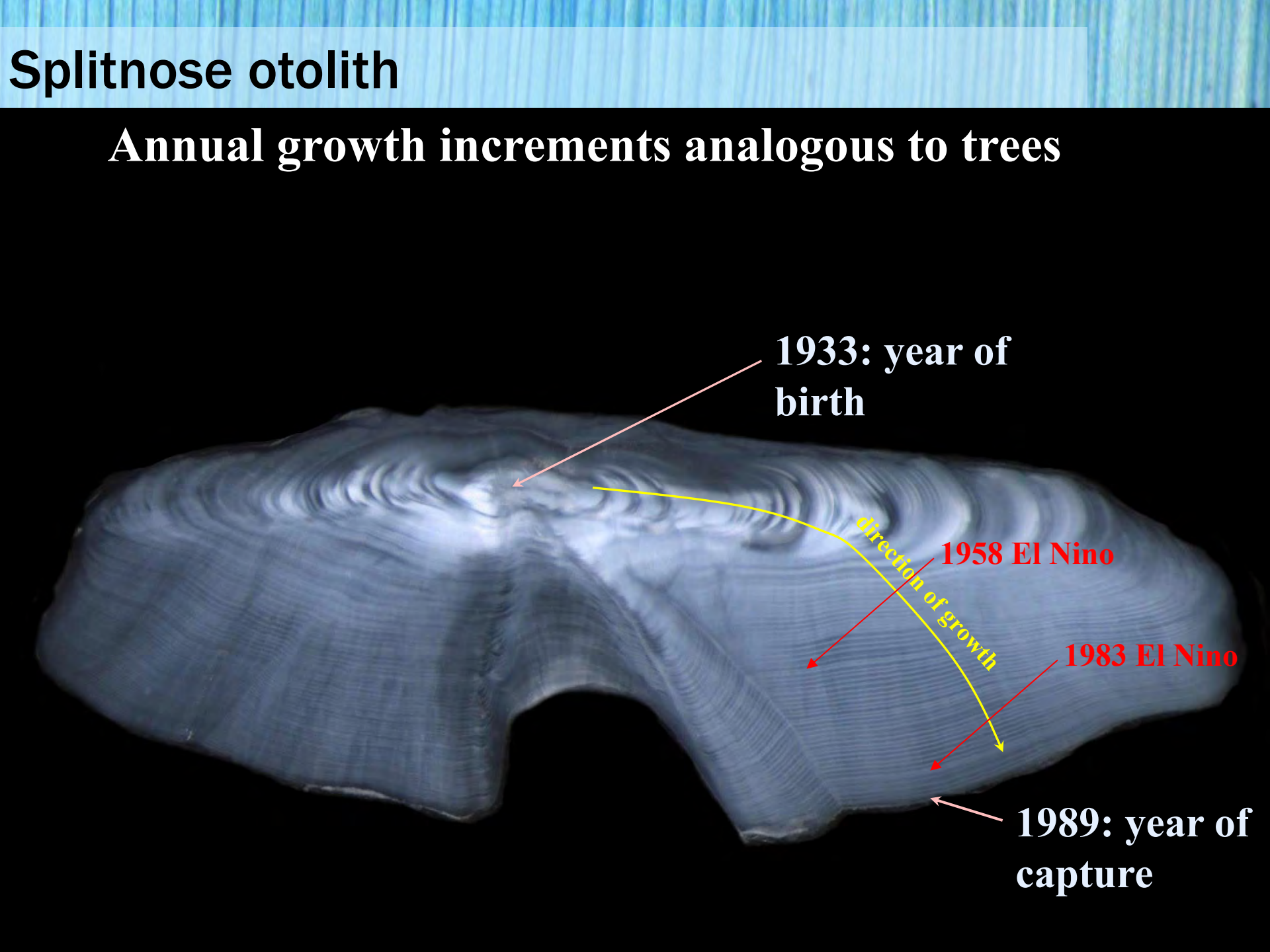


cut here

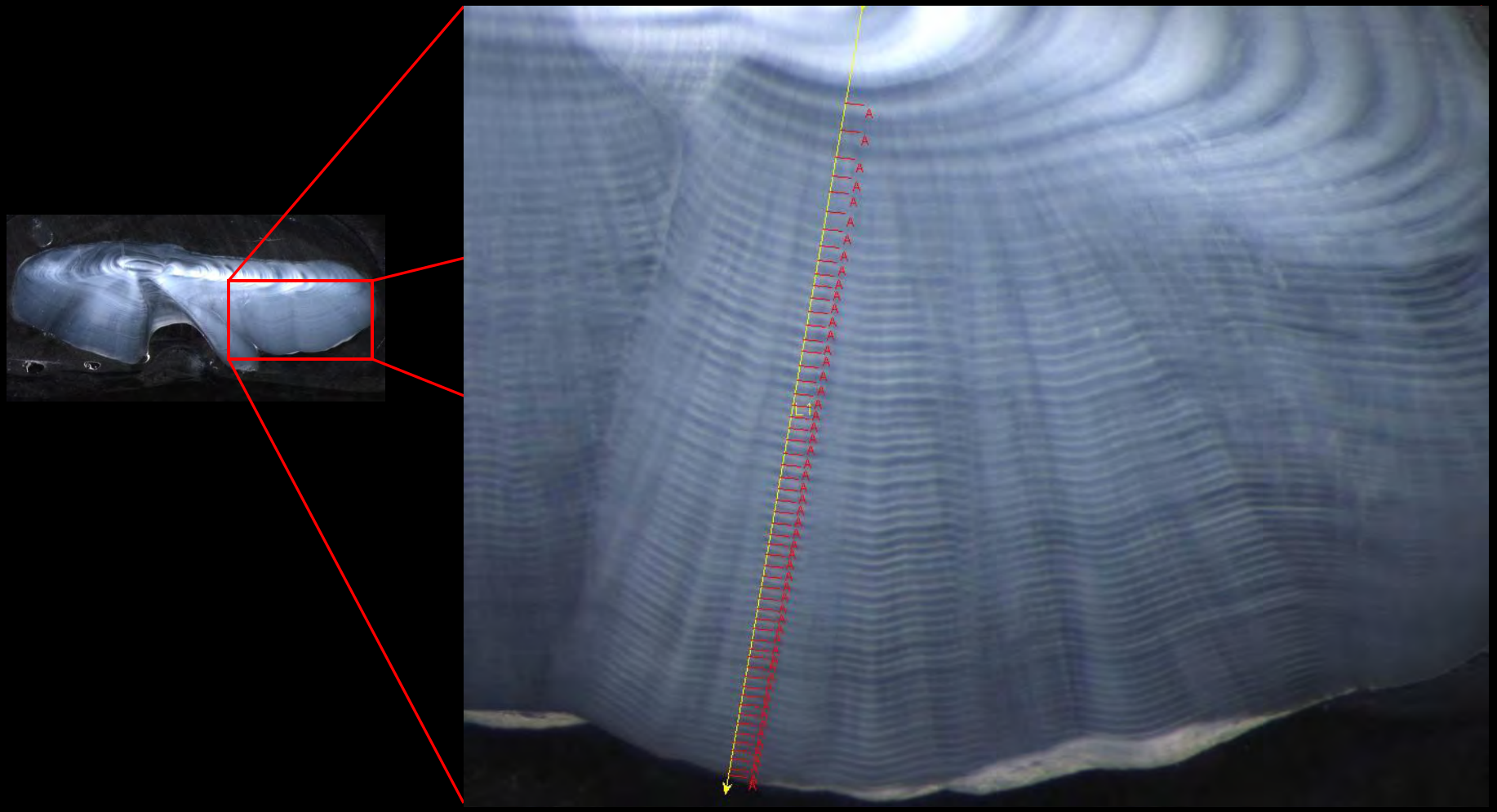


Splitnose otolith

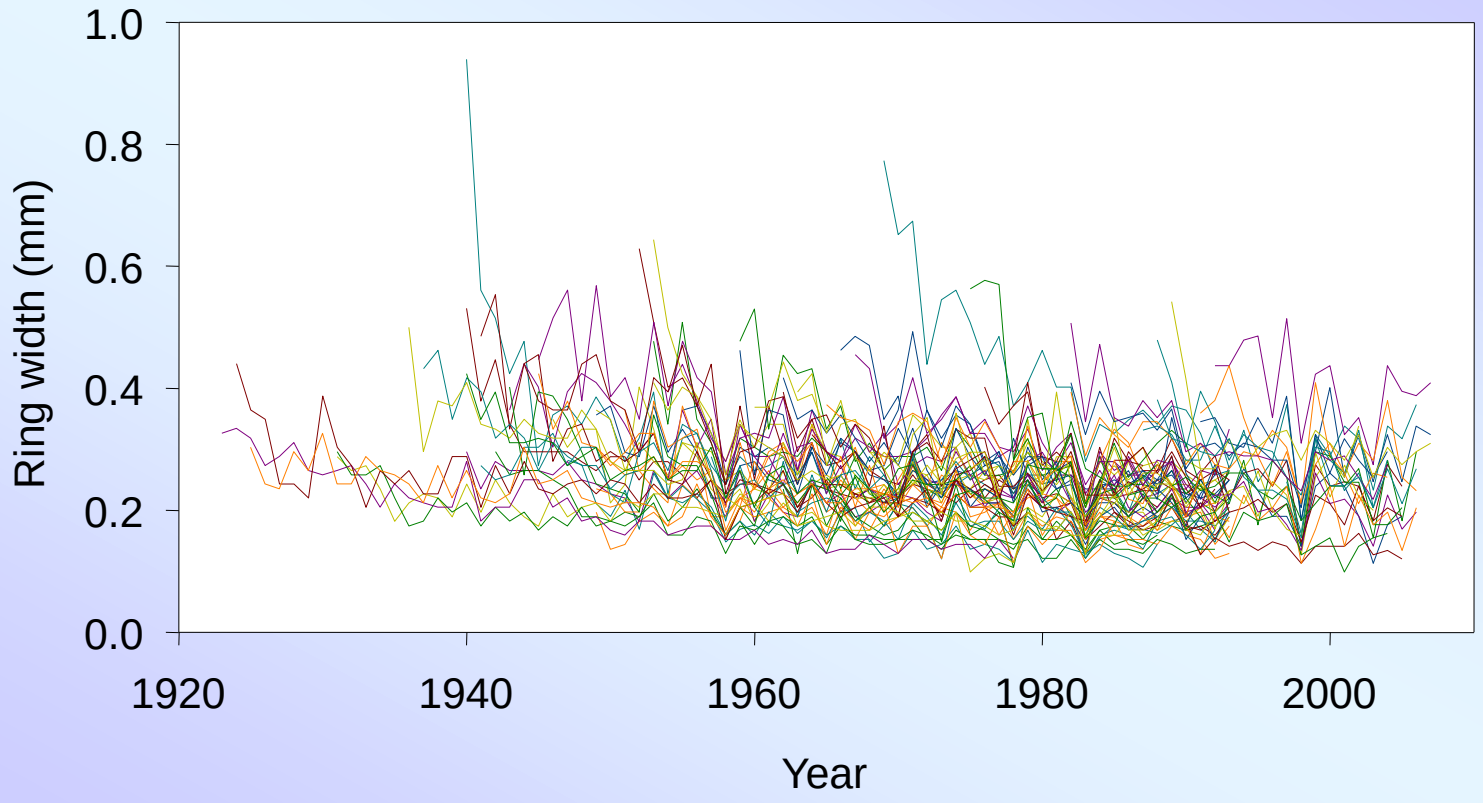
Annual growth increments analogous to trees



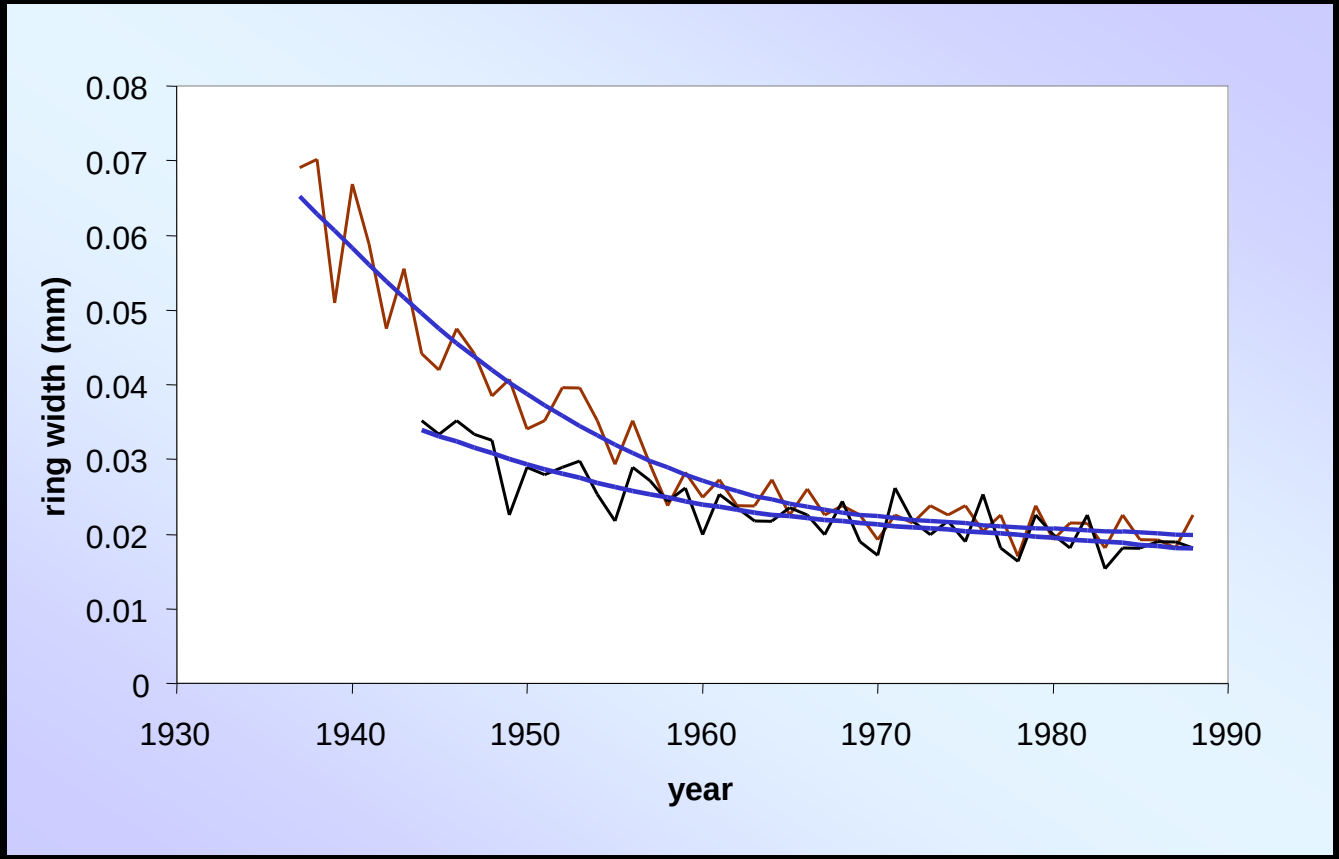
Axis of measurements



Measurements



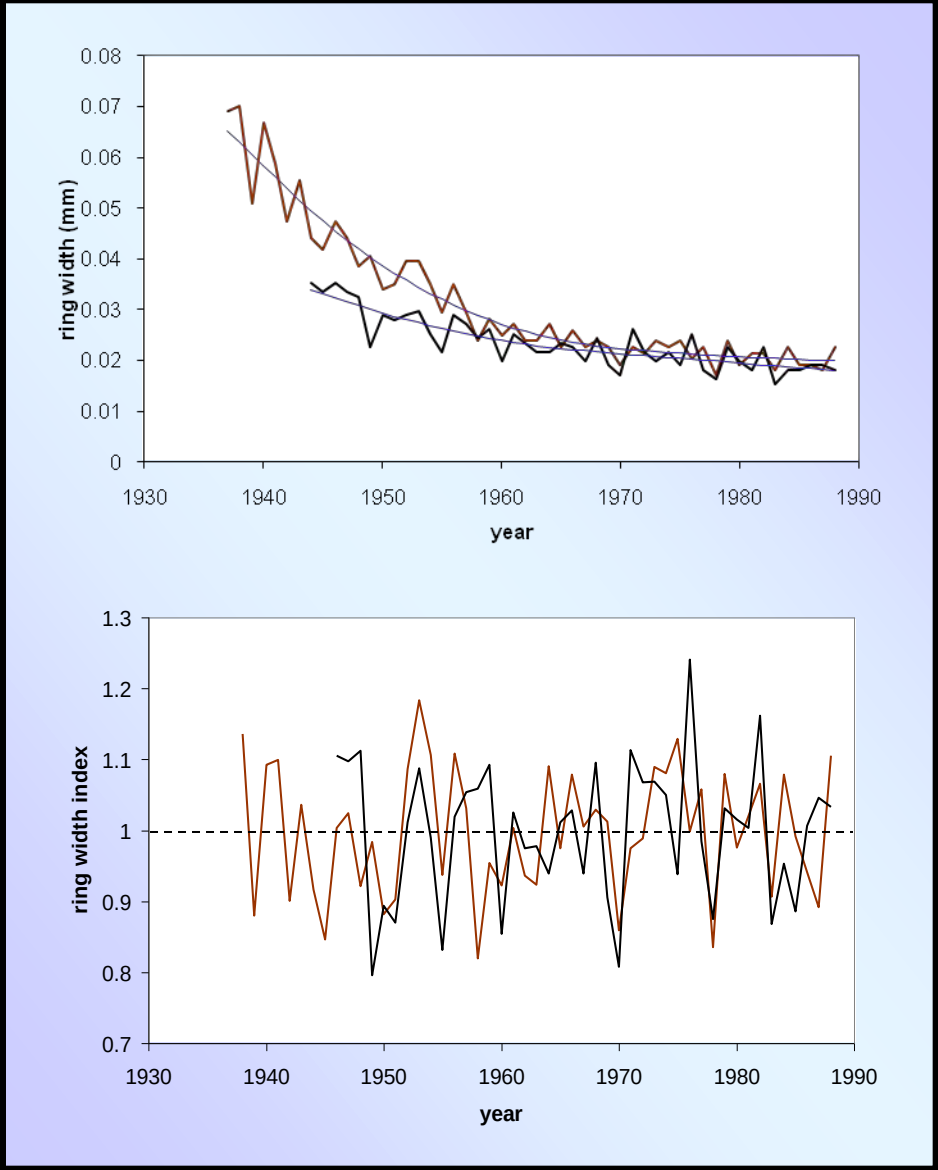
Detrending


0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
ring width (mm)
1930
1940
1950
1960
1970
1980
1990
year

Detrending

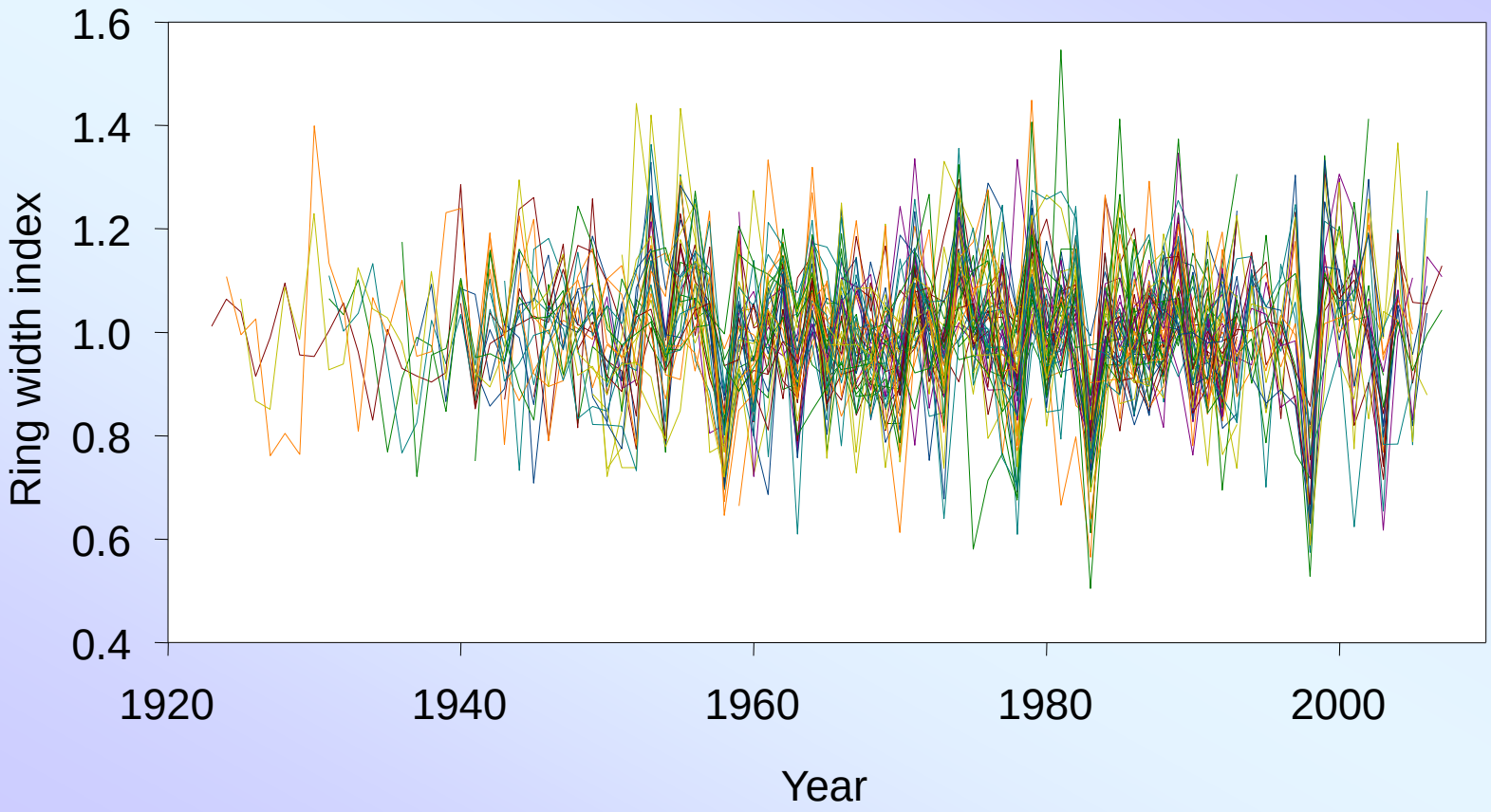
ring width measurements, best-fit curves

detrended, mean = 1



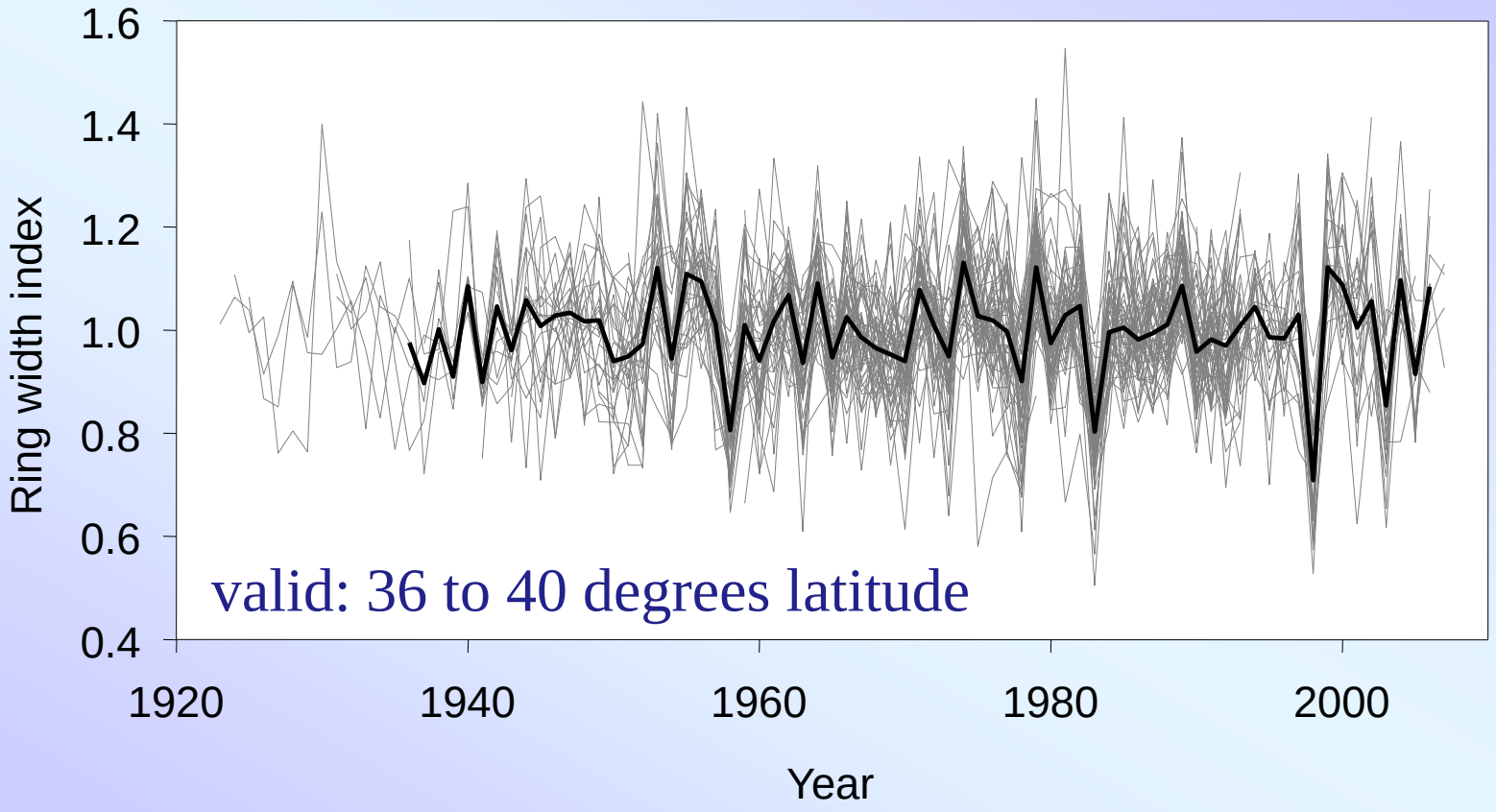
Detrended measurements

detrended splitnose otolith measurements



Splitnose chronology: 72 otoliths

Master chronology



Upwelling index

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

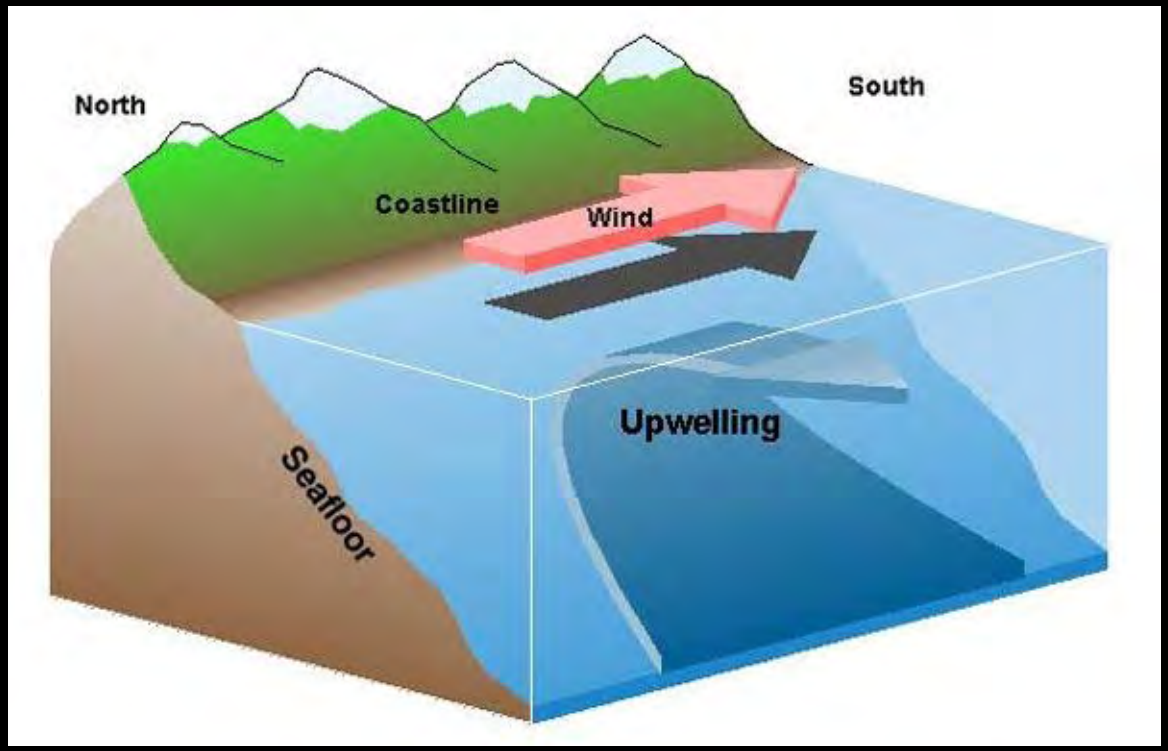
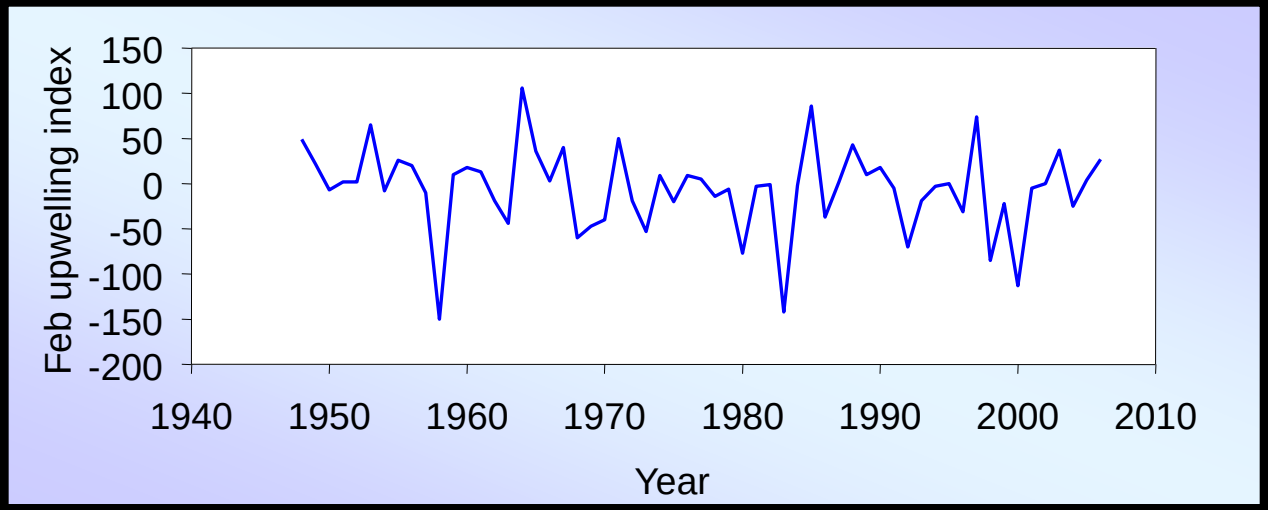
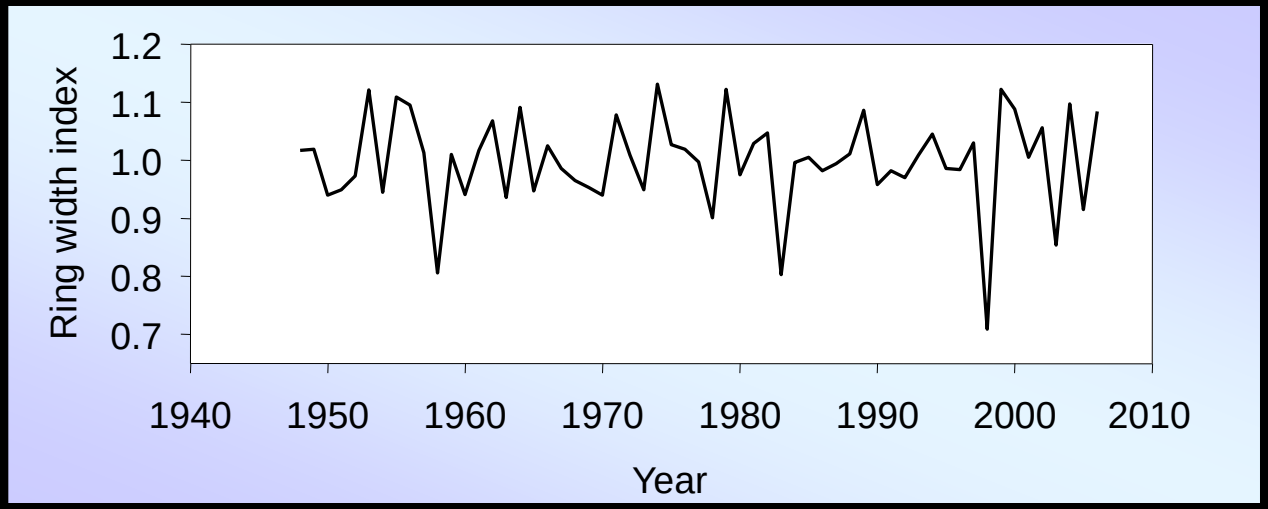


Figure credit: D. Reed and Pacific Marine Environmental Lab

Correlations with upwelling

February upwelling





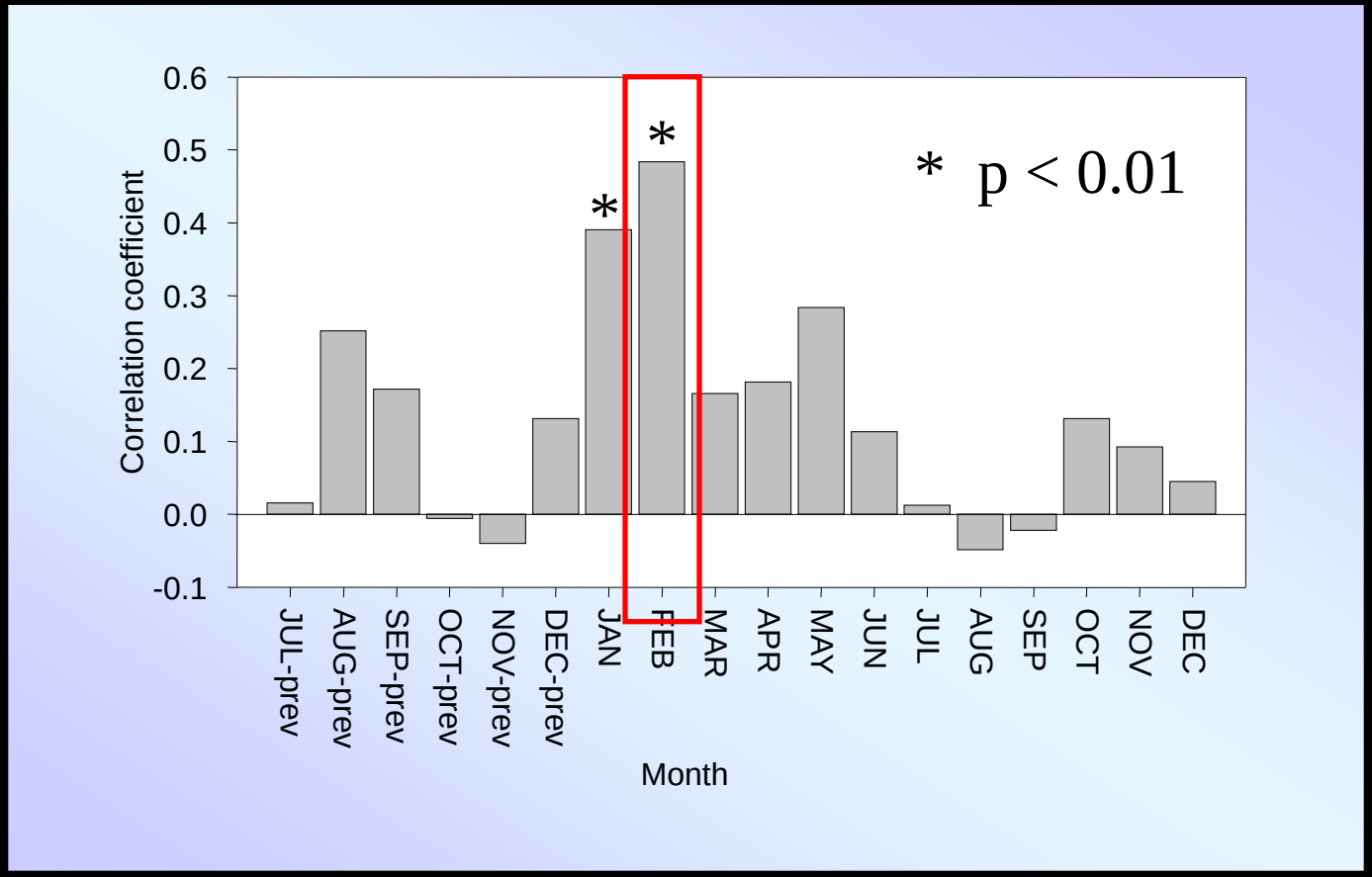
r = 0.54

p < 0.01

splitnose chronology

Correlations with upwelling

Splitnose rockfish chronology and monthly upwelling (51 yr overlap)



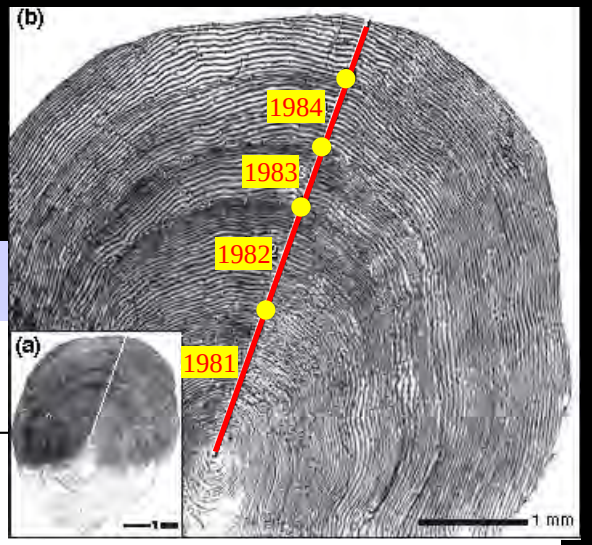
Growth-increment chronologies

splitnose rockfish
planktivorous

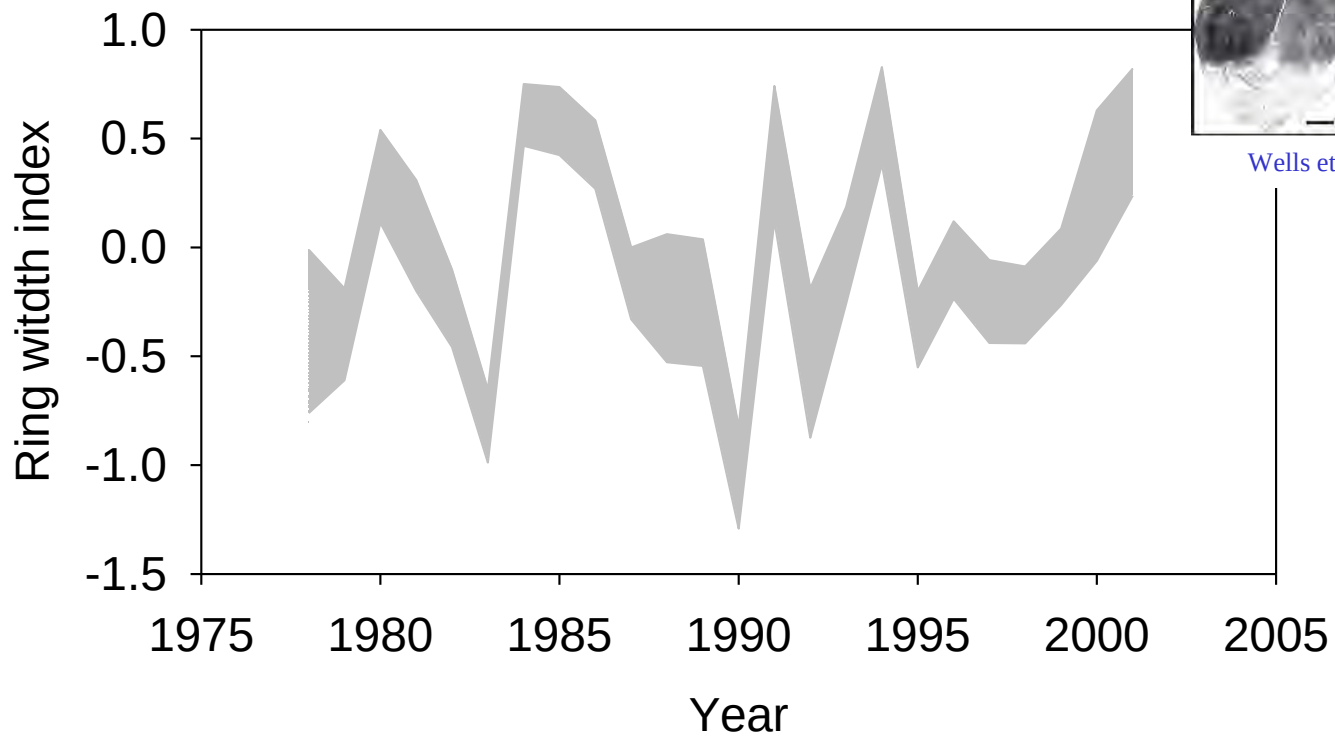
yelloweye rockfish
piscivorous

Chinook salmon
piscivorous

Salmon chronology: 613 fish (scales)



Wells et al. 2007 Fish Oceanog 16:363-382



Seven time series

yelloweye rockfish
piscivorous

splitnose rockfish
planktivorous

growth-increment chronology

Chinook salmon
piscivorous

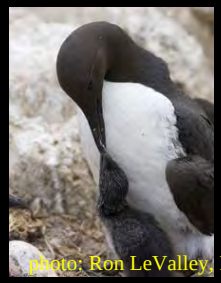


photo: Ron LeValley, PRBO

common murre
piscivorous

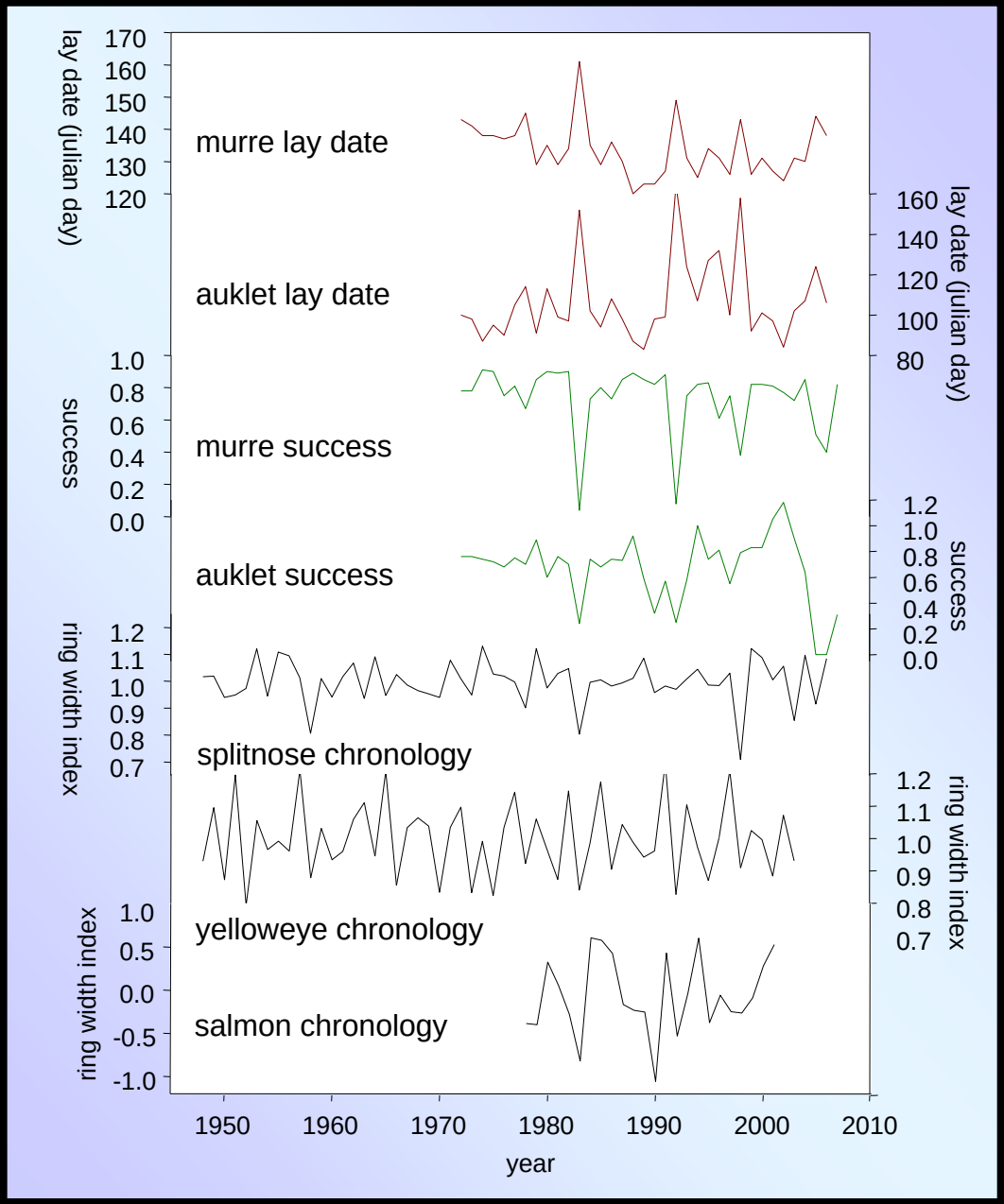
egg lay date

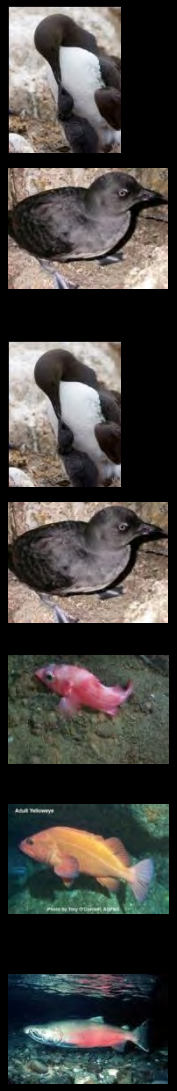
and

Cassin's auklet
planktivorous

fledgling success

Biological time series



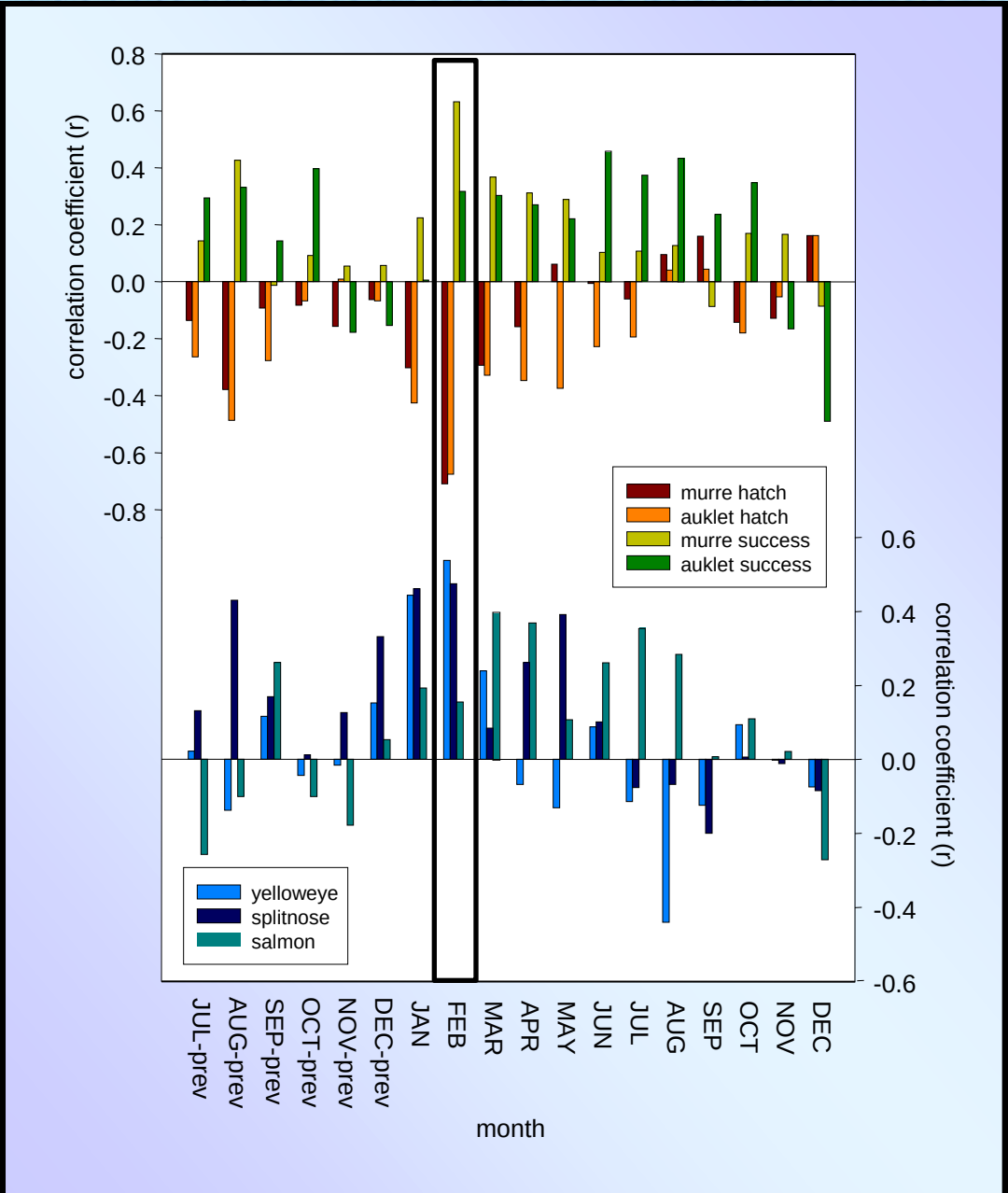


lay date

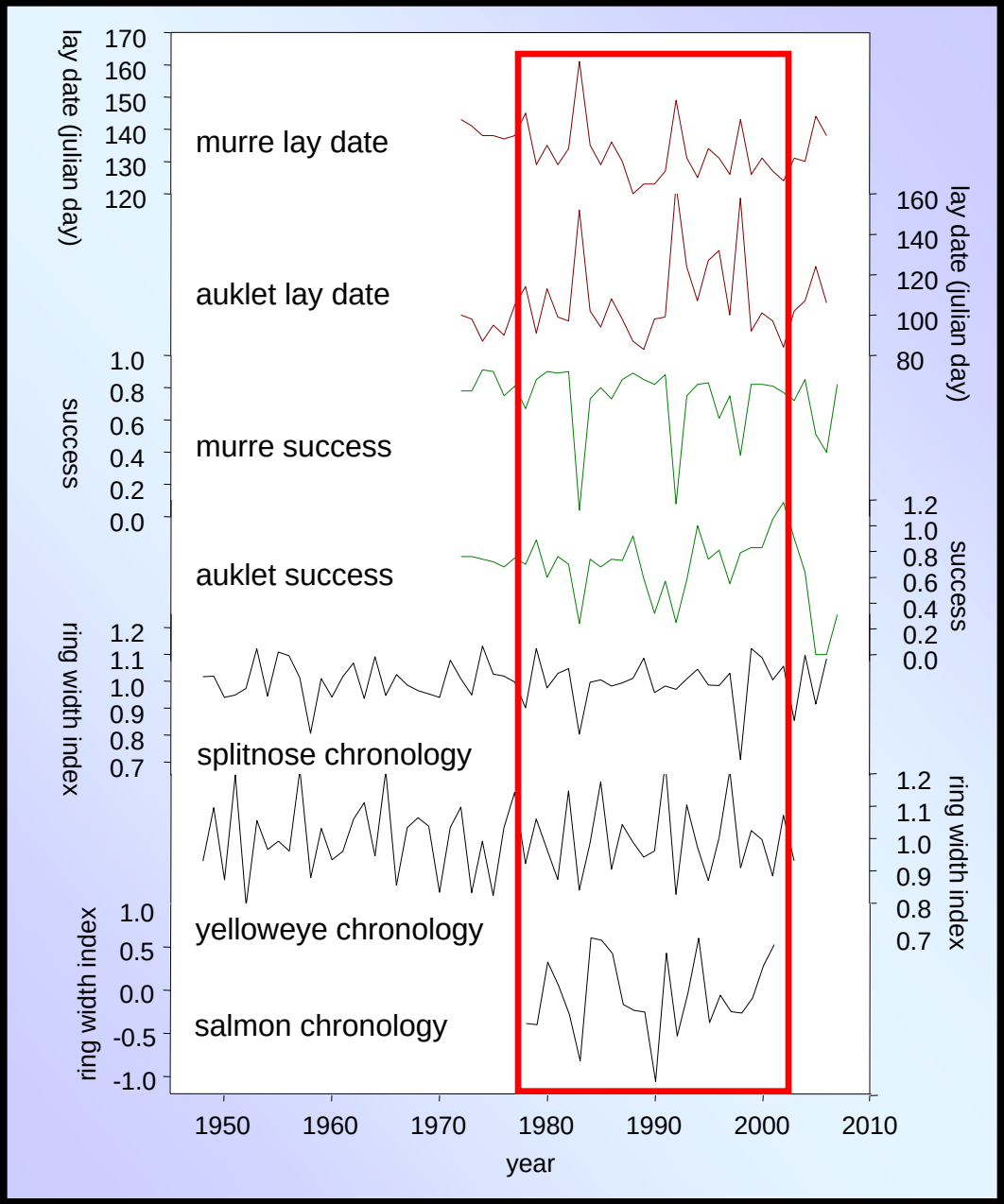
fledgling success

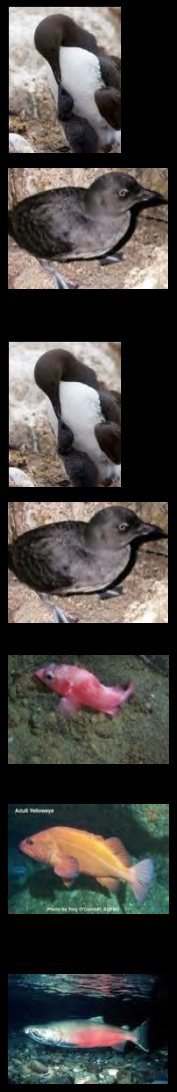
growth-increment chronology

Biological time series: Feb UW correlations



Biological time series



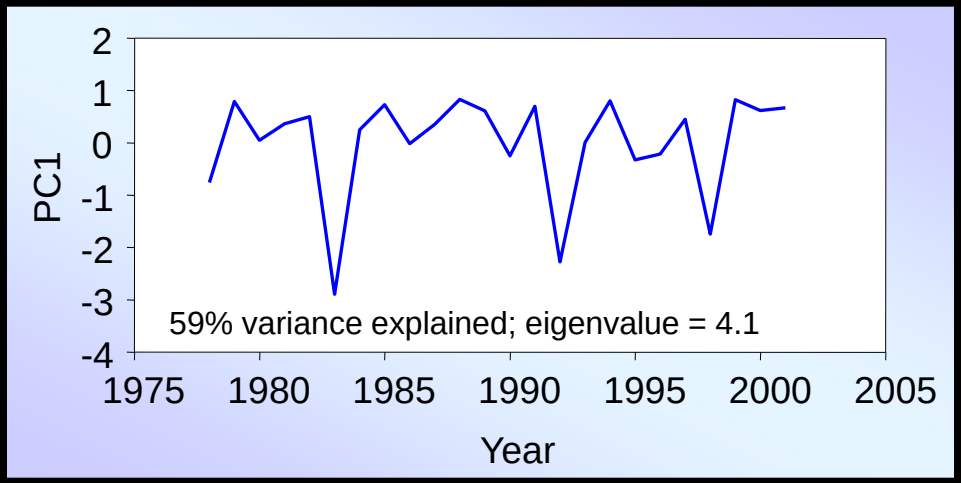


lay date

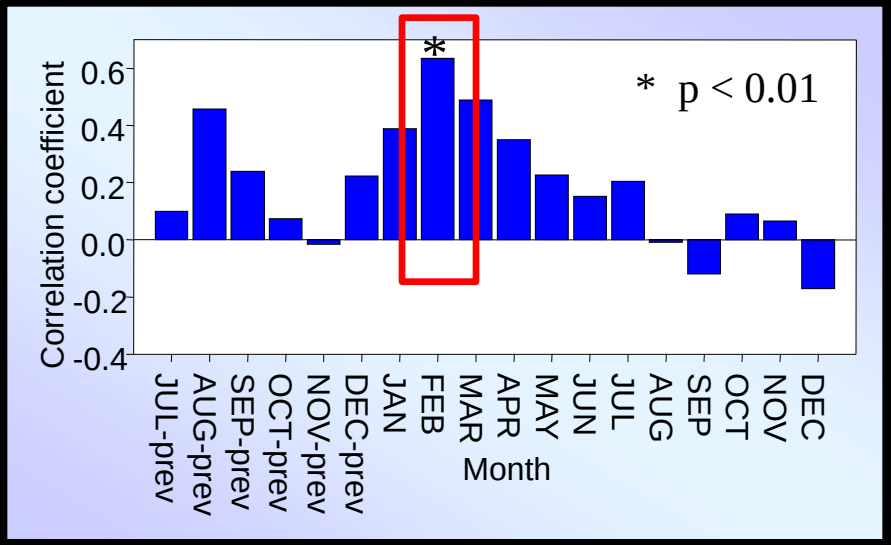
fledgling success

growth-increment chronology

PC1 for fish and bird time series

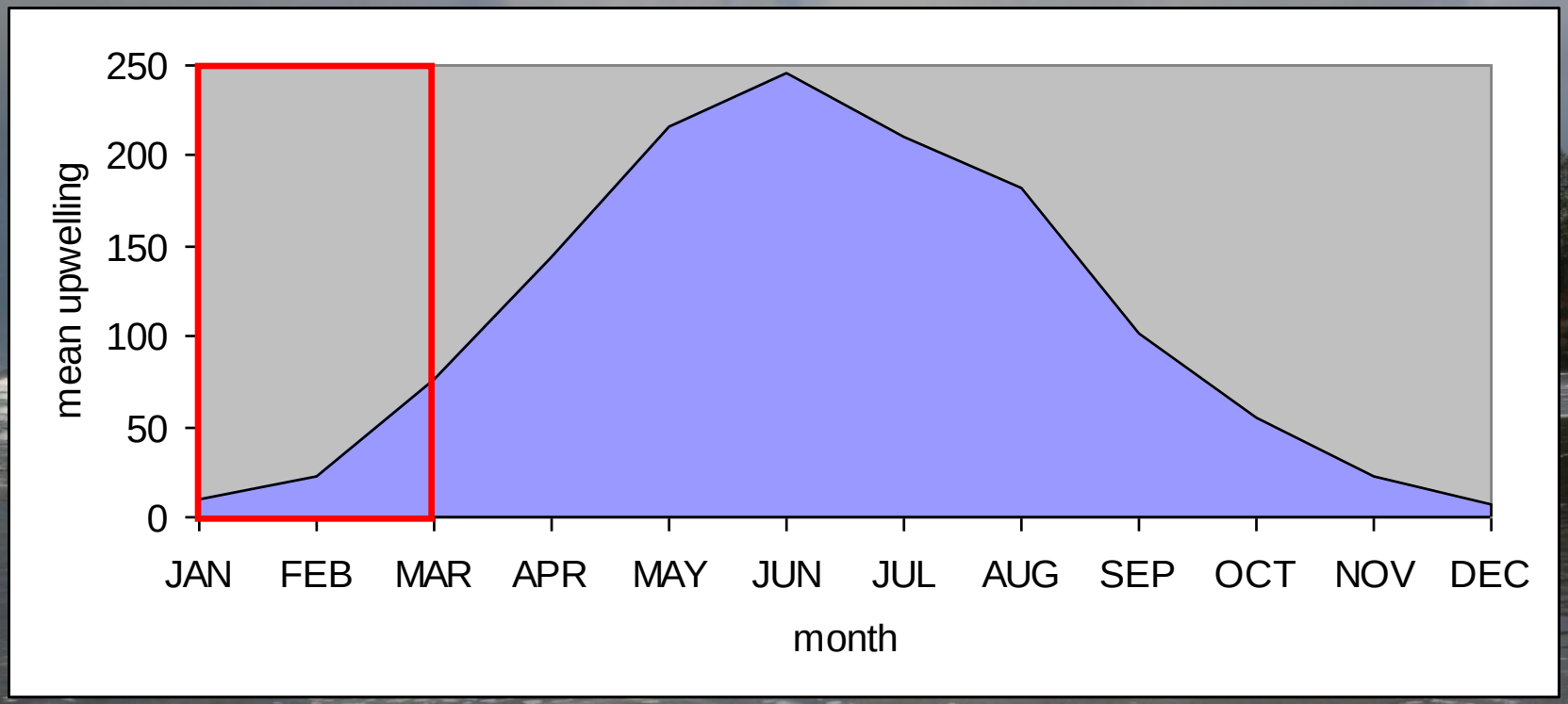


Leading principal component for 7 bird and fish time series



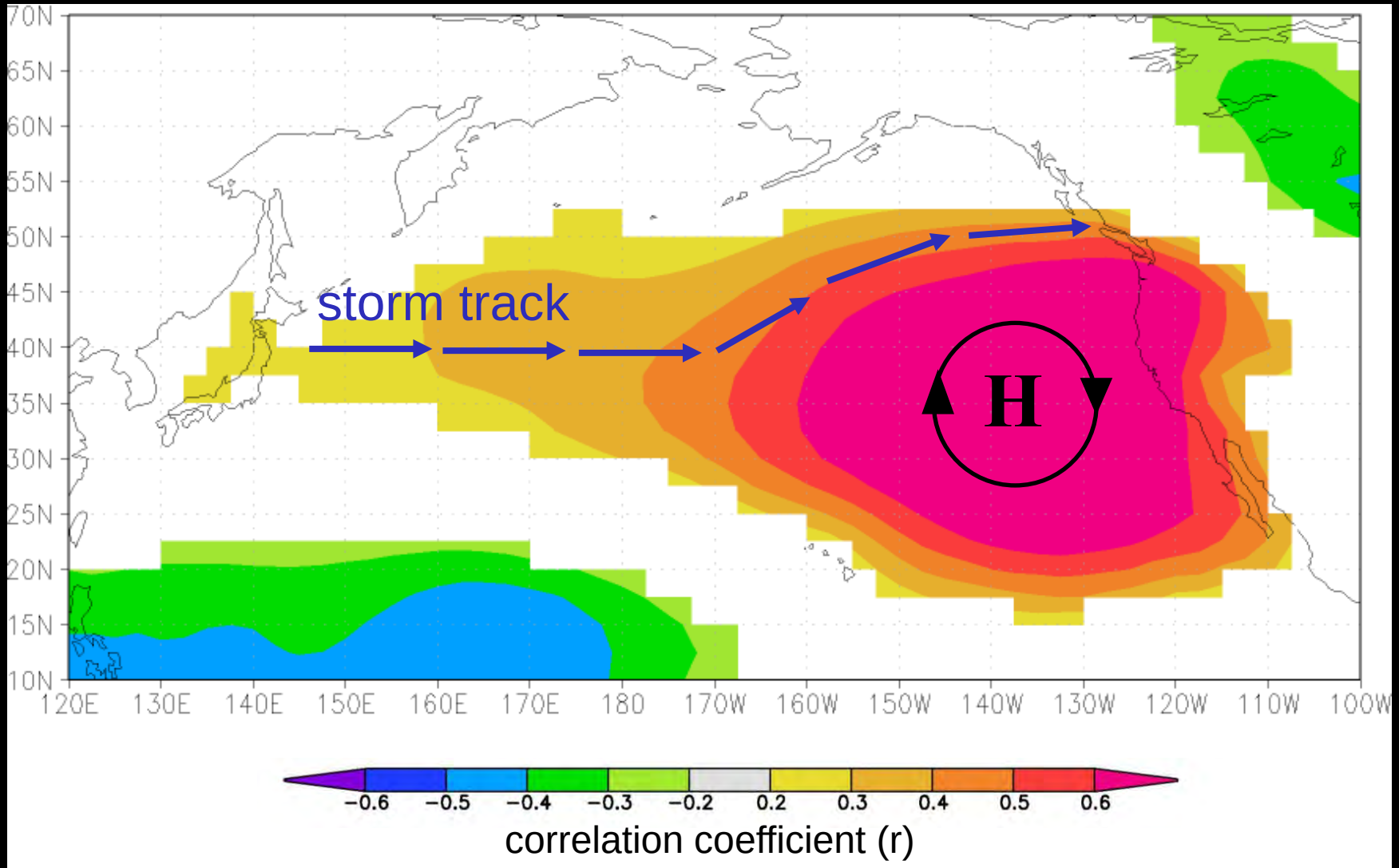
Correlation with upwelling

Winter upwelling

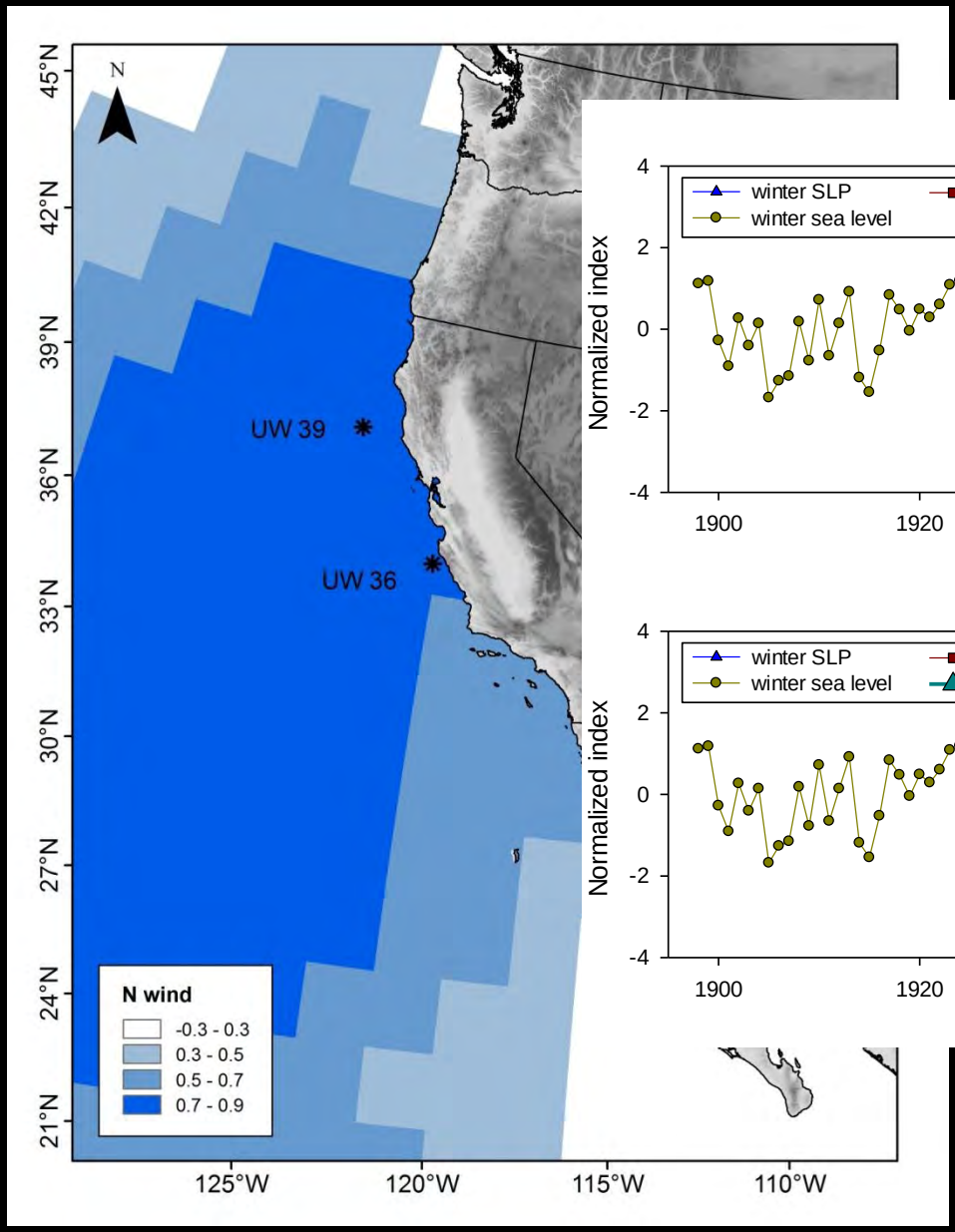


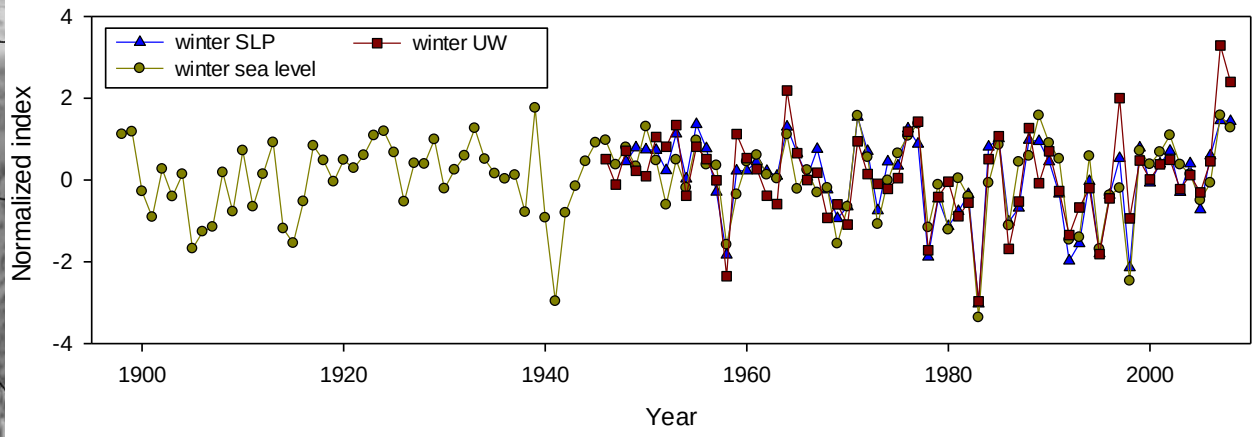
Winter blocking high

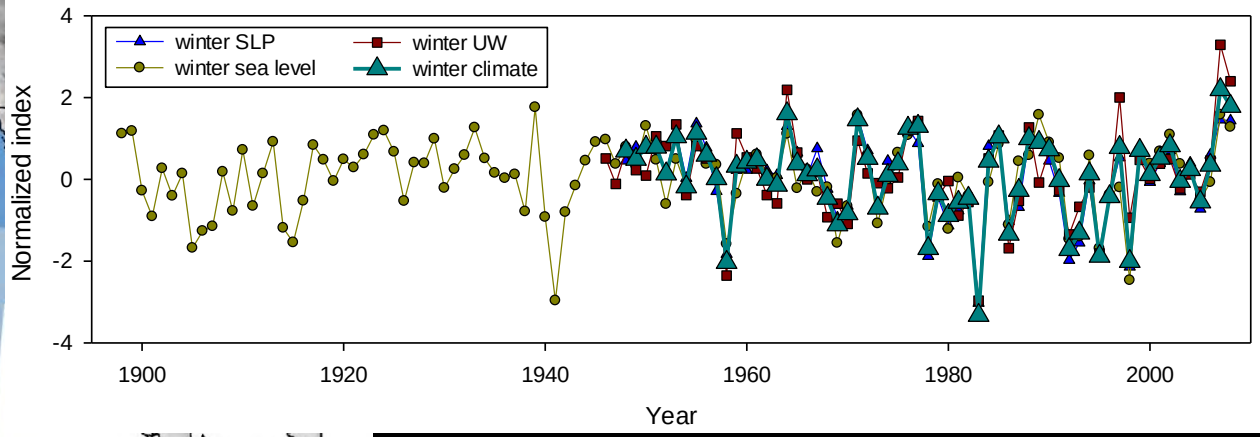
Correlation between upwelling and winter sea level pressure



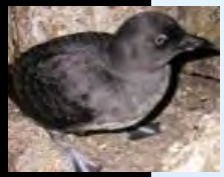
Correlation with N winds

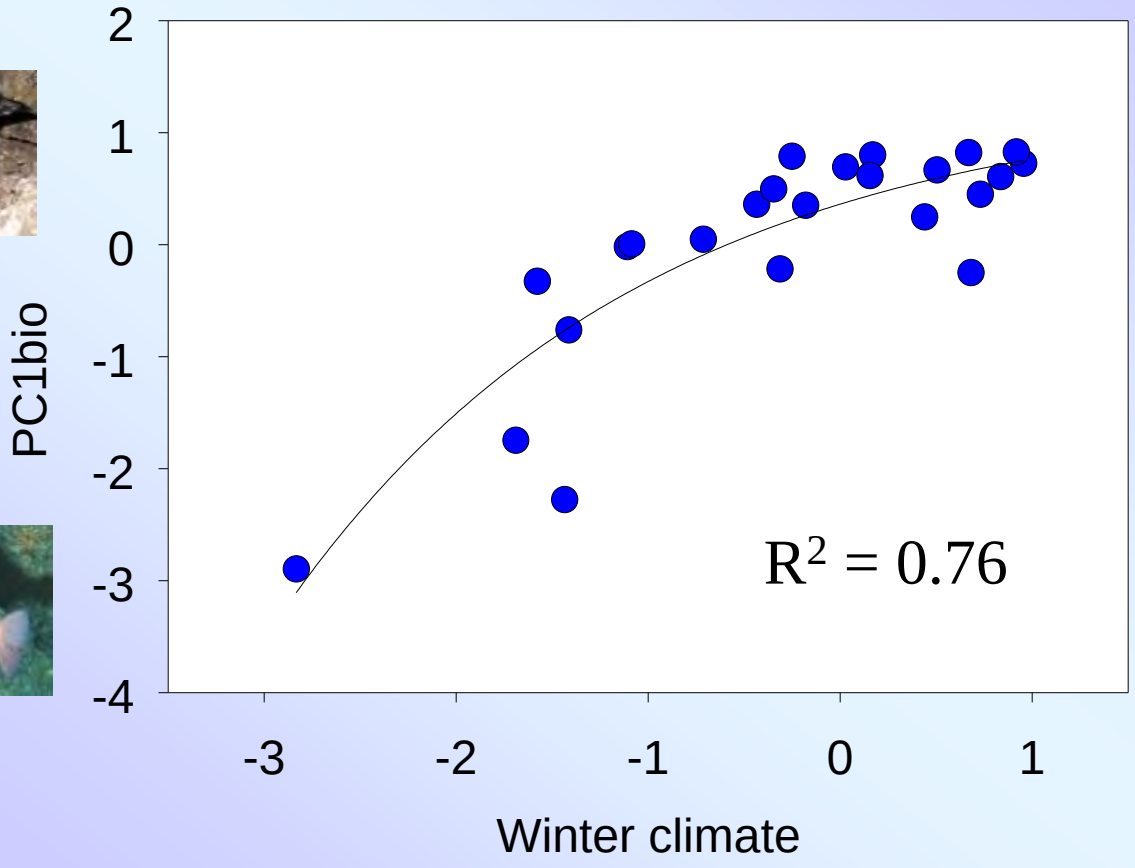




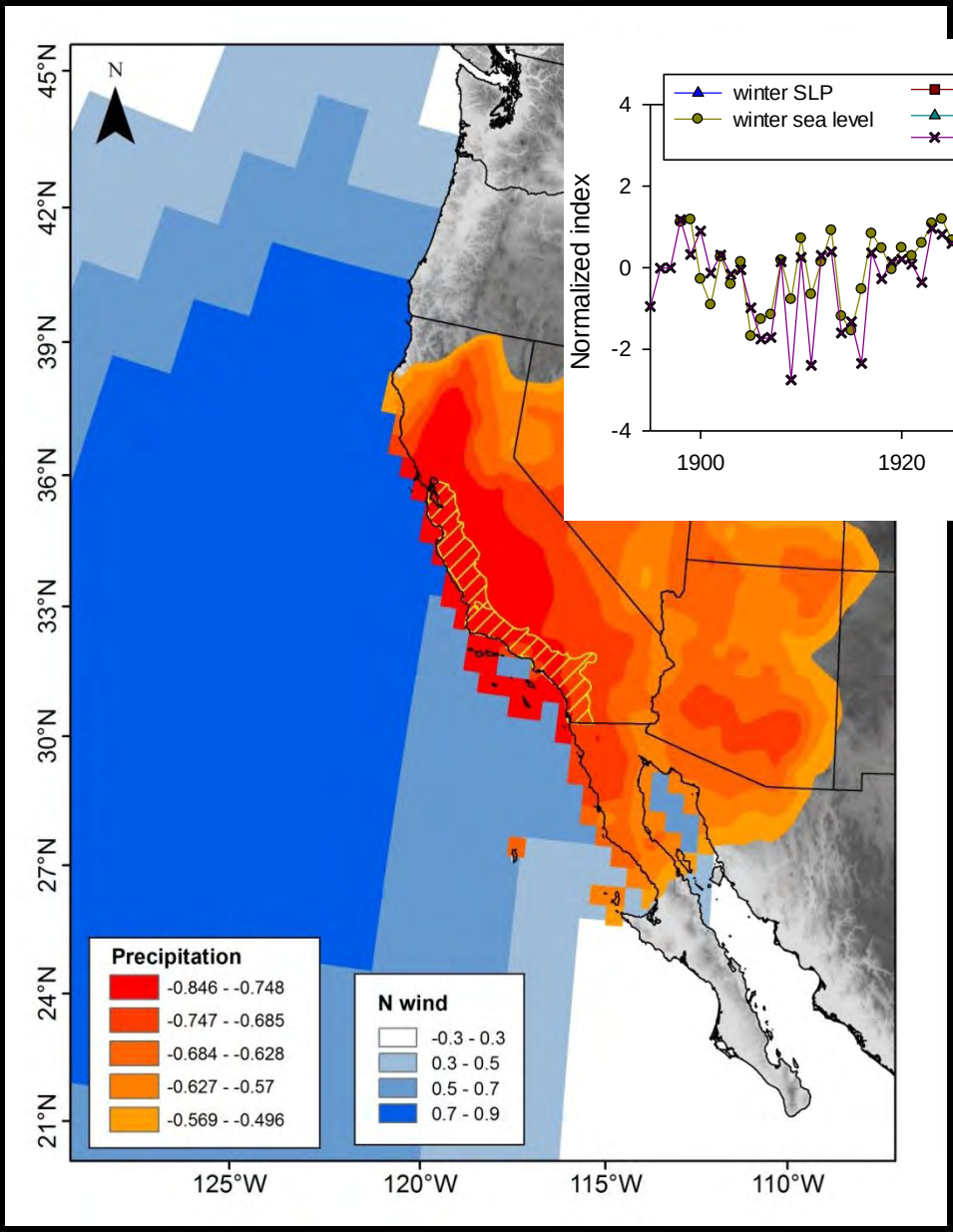


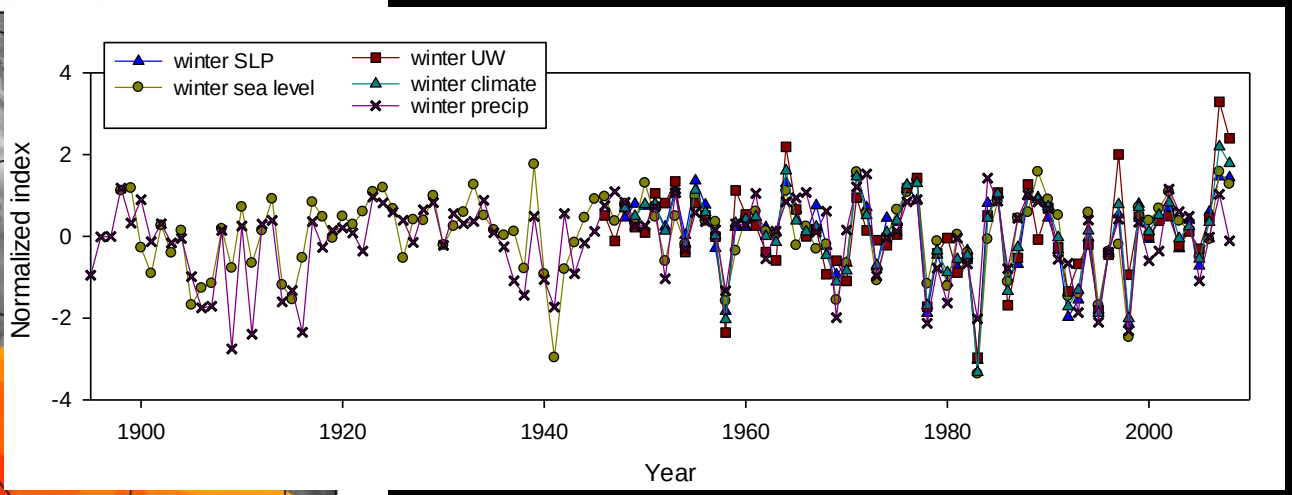
Winter climate and biological response



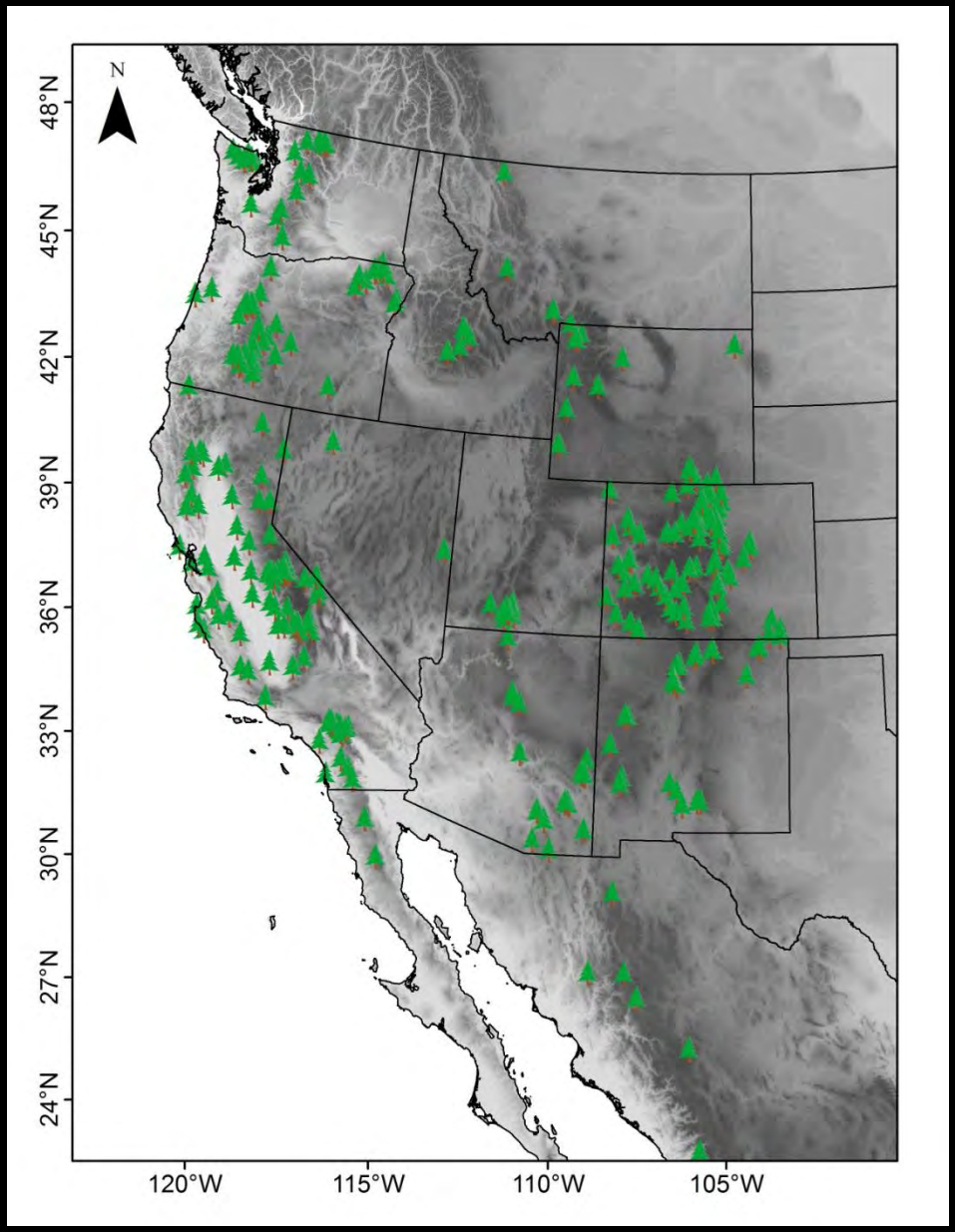


Correlation with N winds, precip

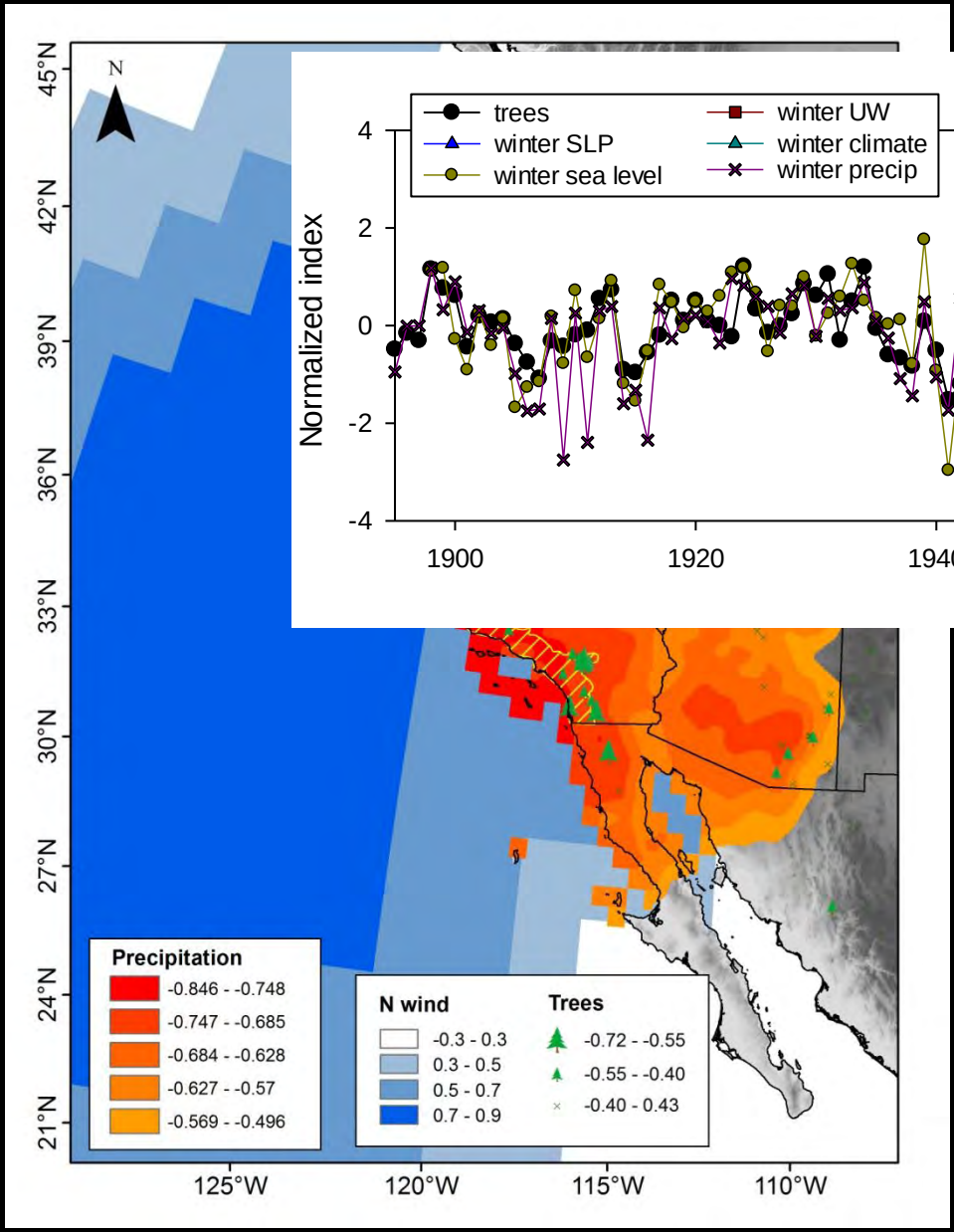


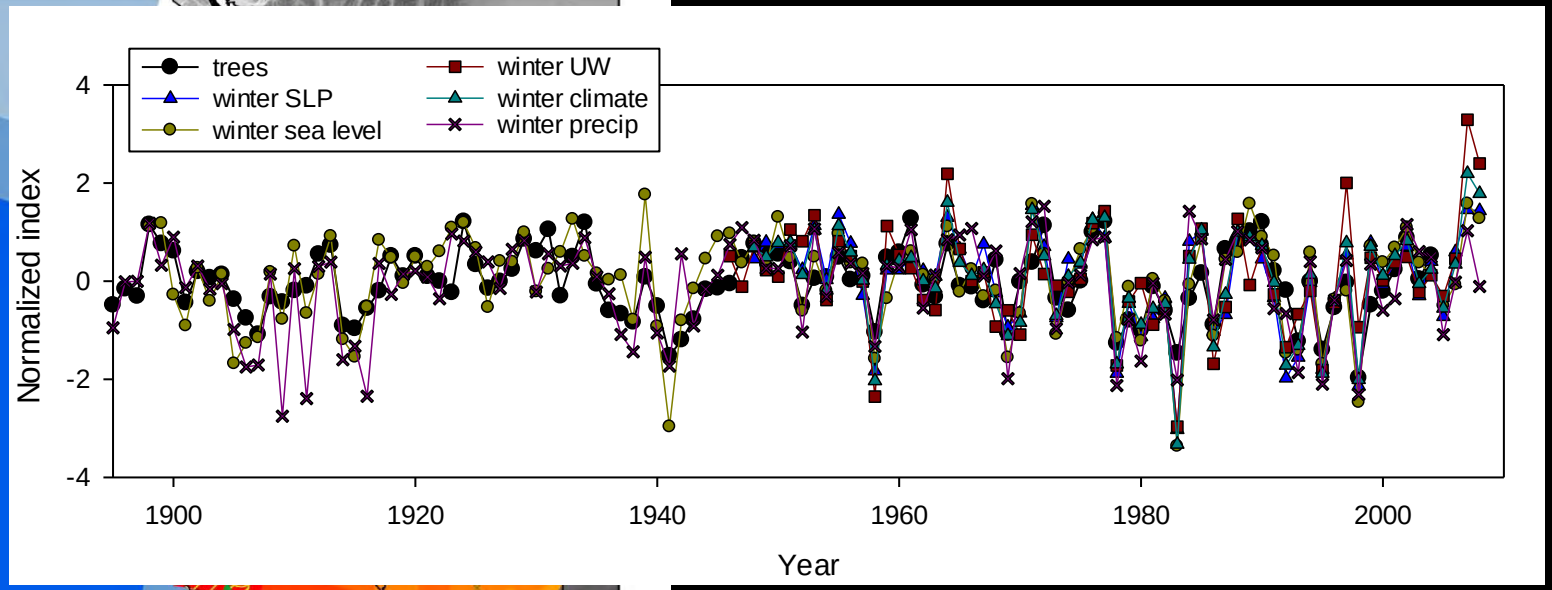


Tree-ring chronology locations

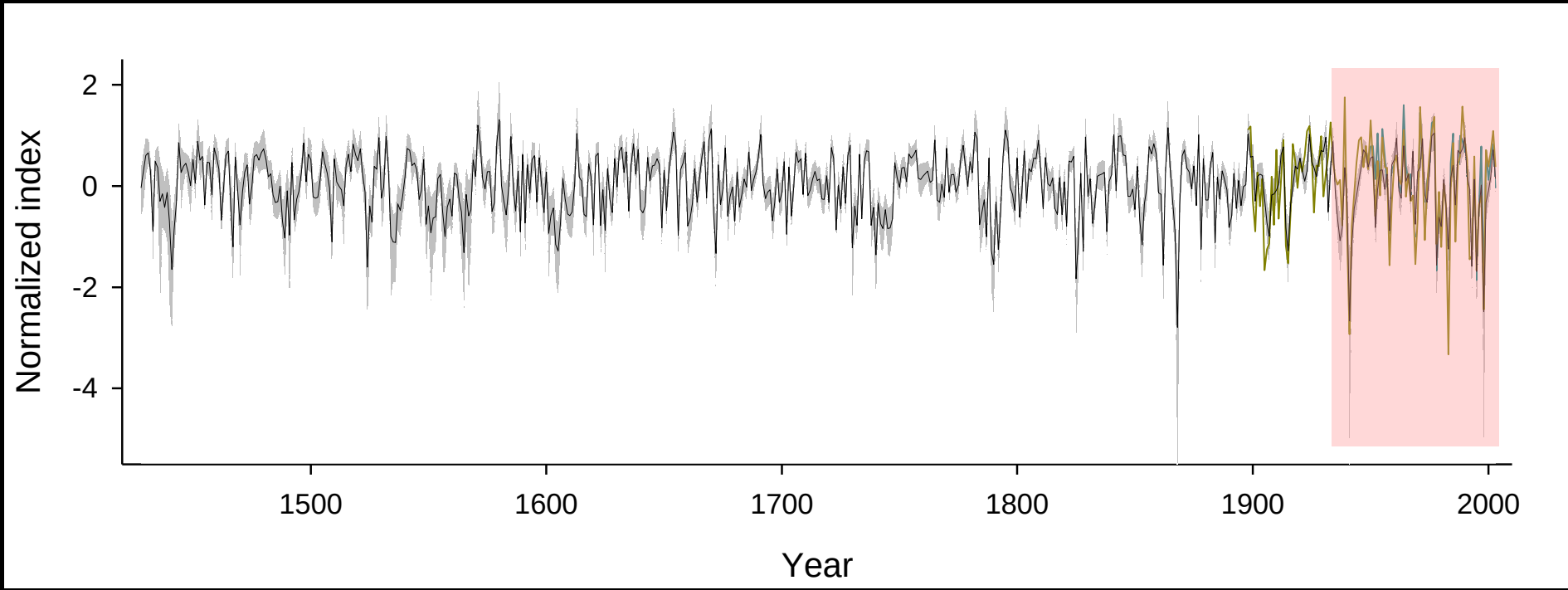


Marine and terrestrial linkages





CC winter climate reconstruction



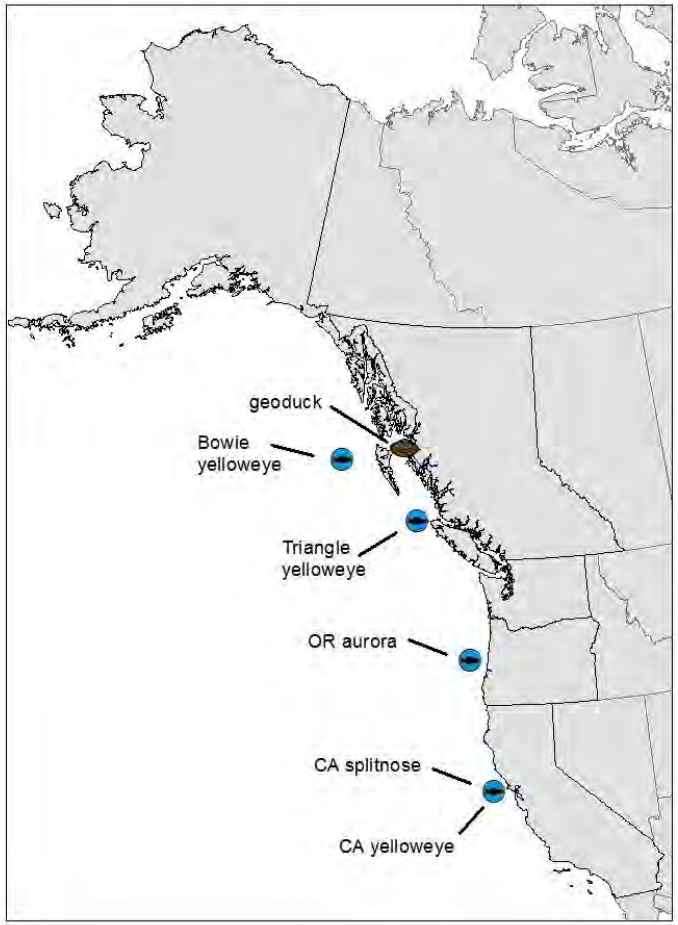
Comparisons across ocean domains

Rockfish and bivalve growth

***Sebastes ruberrimus*, yelloweye rockfish**

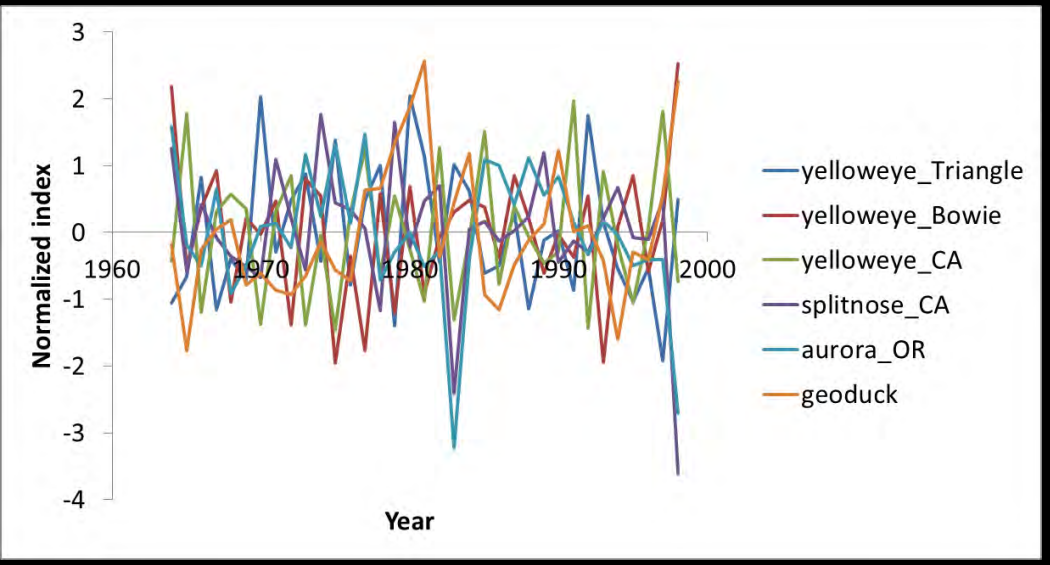
***Sebastes diploproa*, splitnose rockfish**

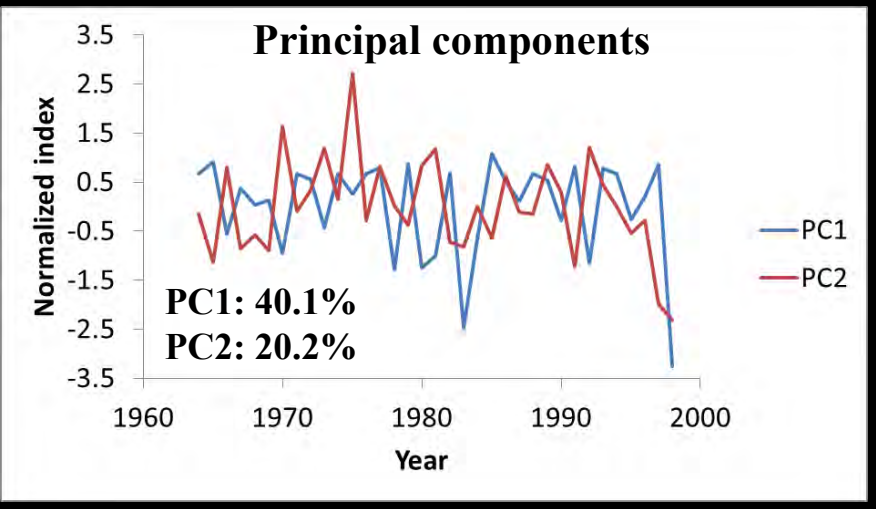
***Panopea generosa*, Pacific geoduck**

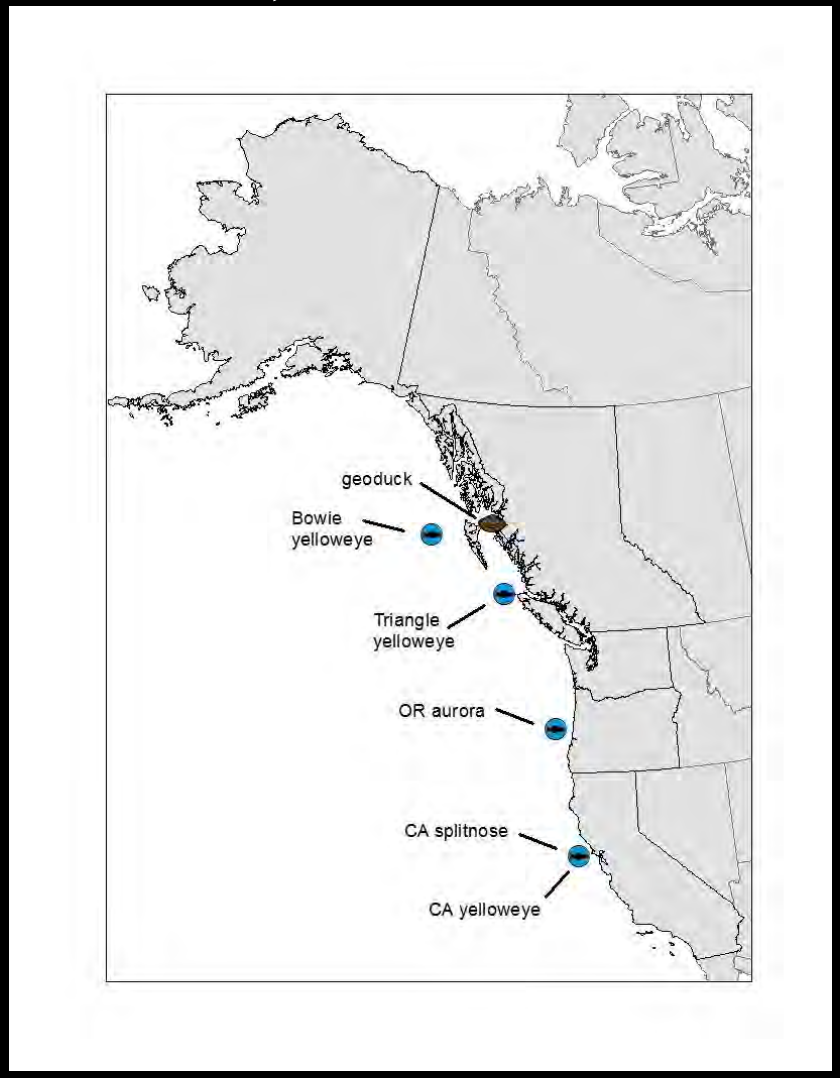


Comparisons across ocean domains

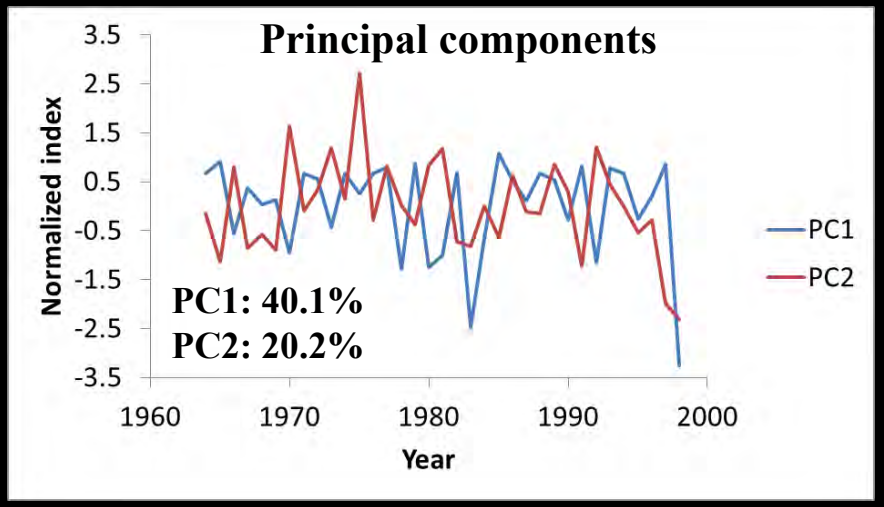
Rockfish and bivalve growth (1964-1998)

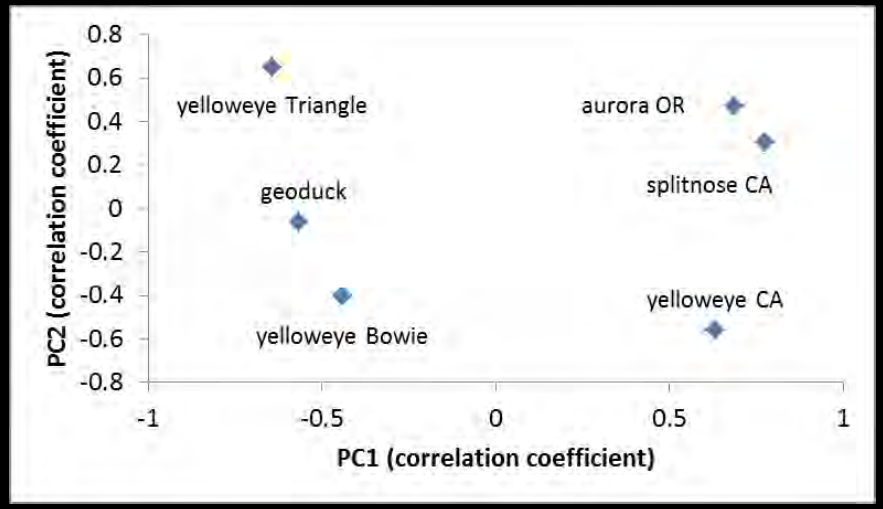


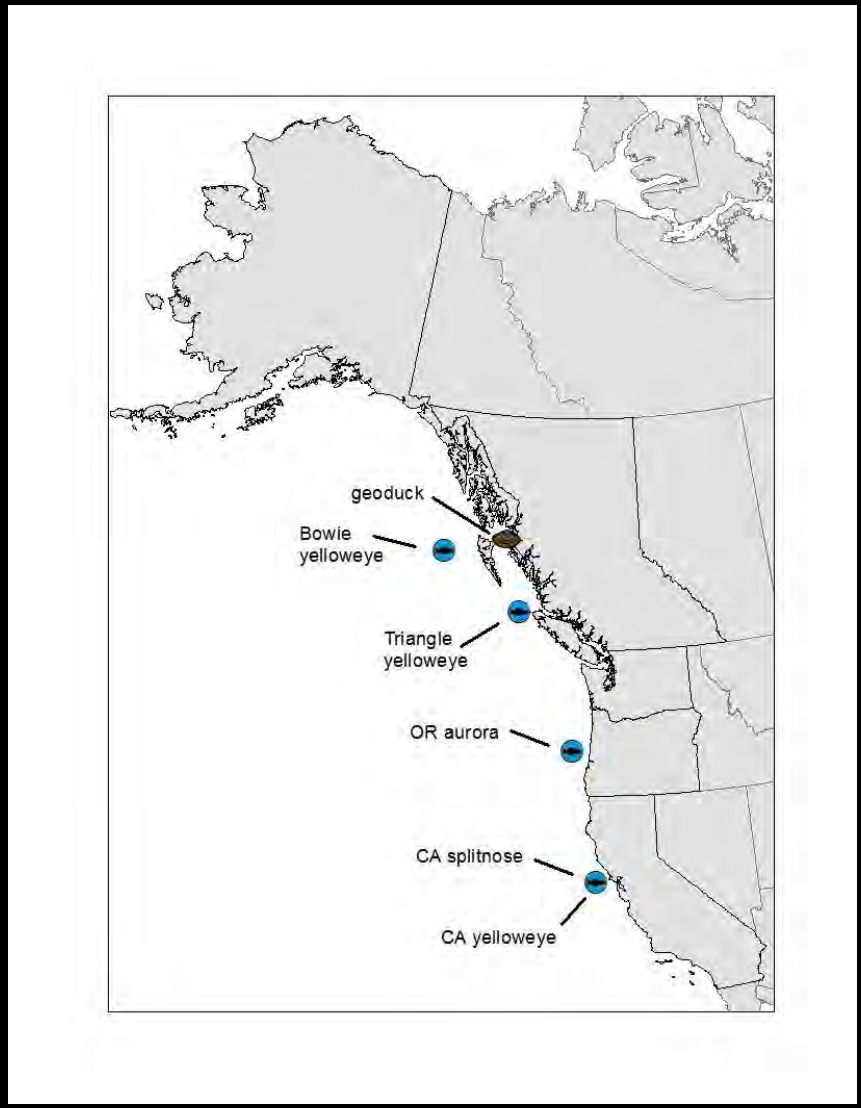




Comparisons across ocean domains

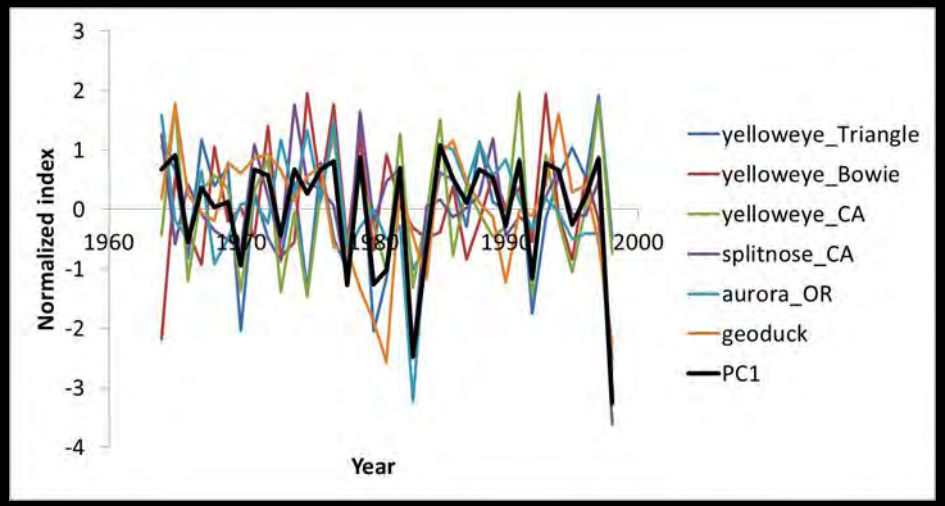




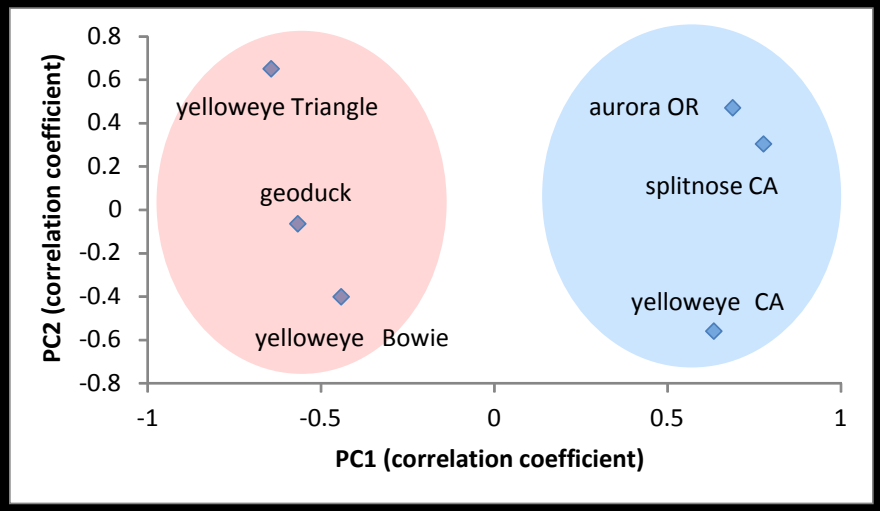


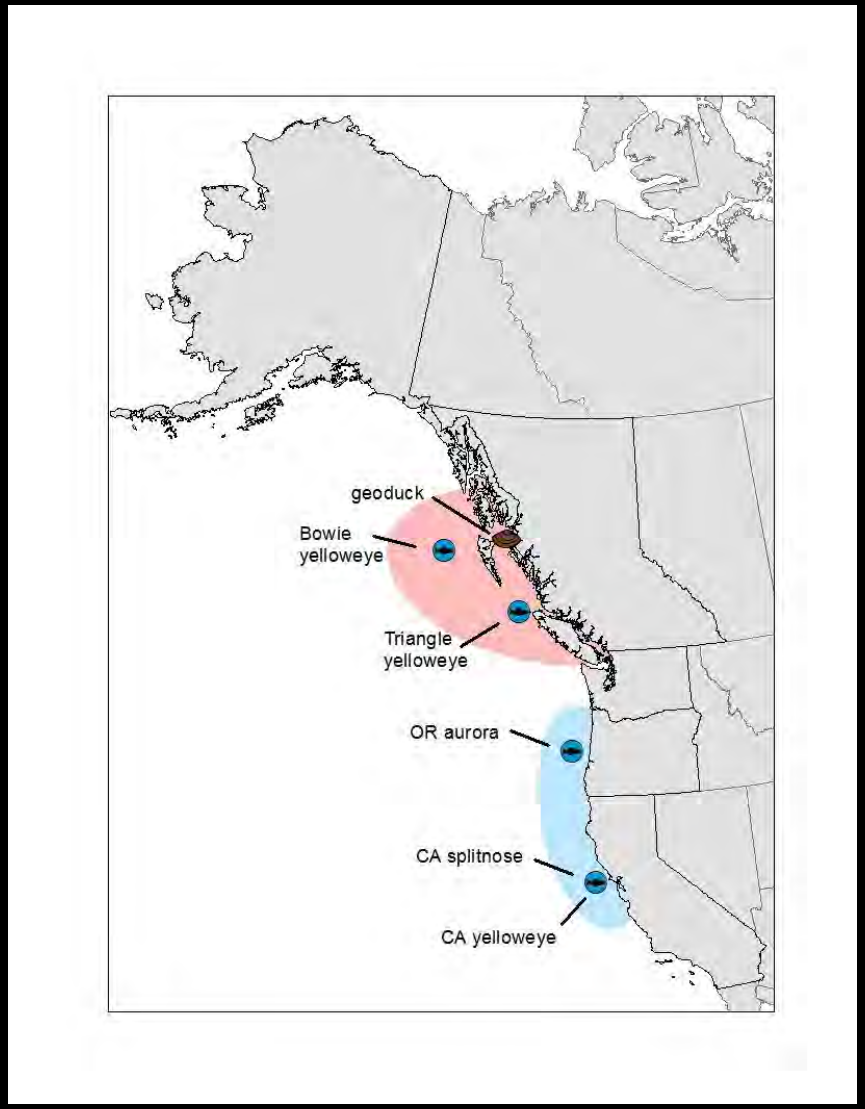
Comparisons across ocean domains

Northern 3 crns inverted



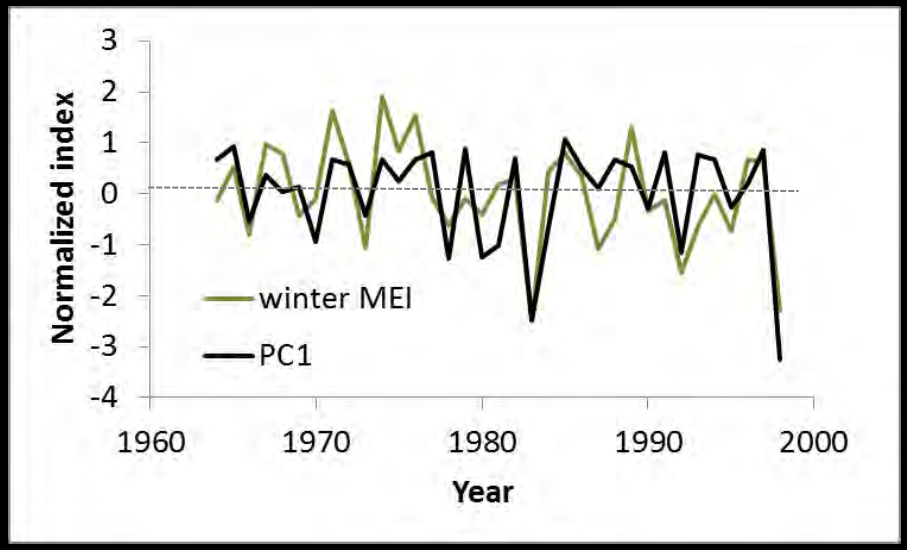
north south

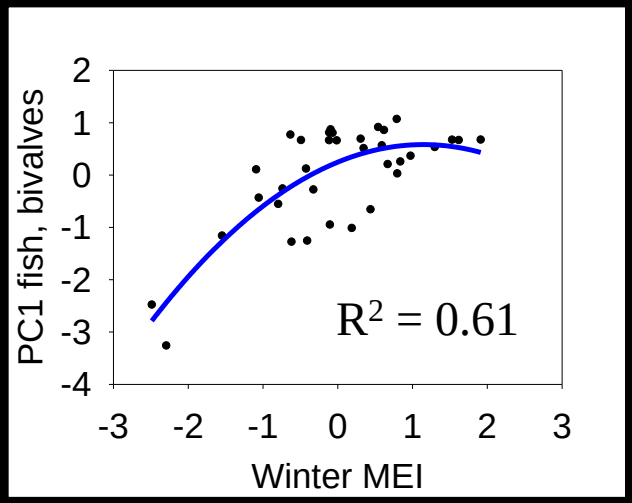




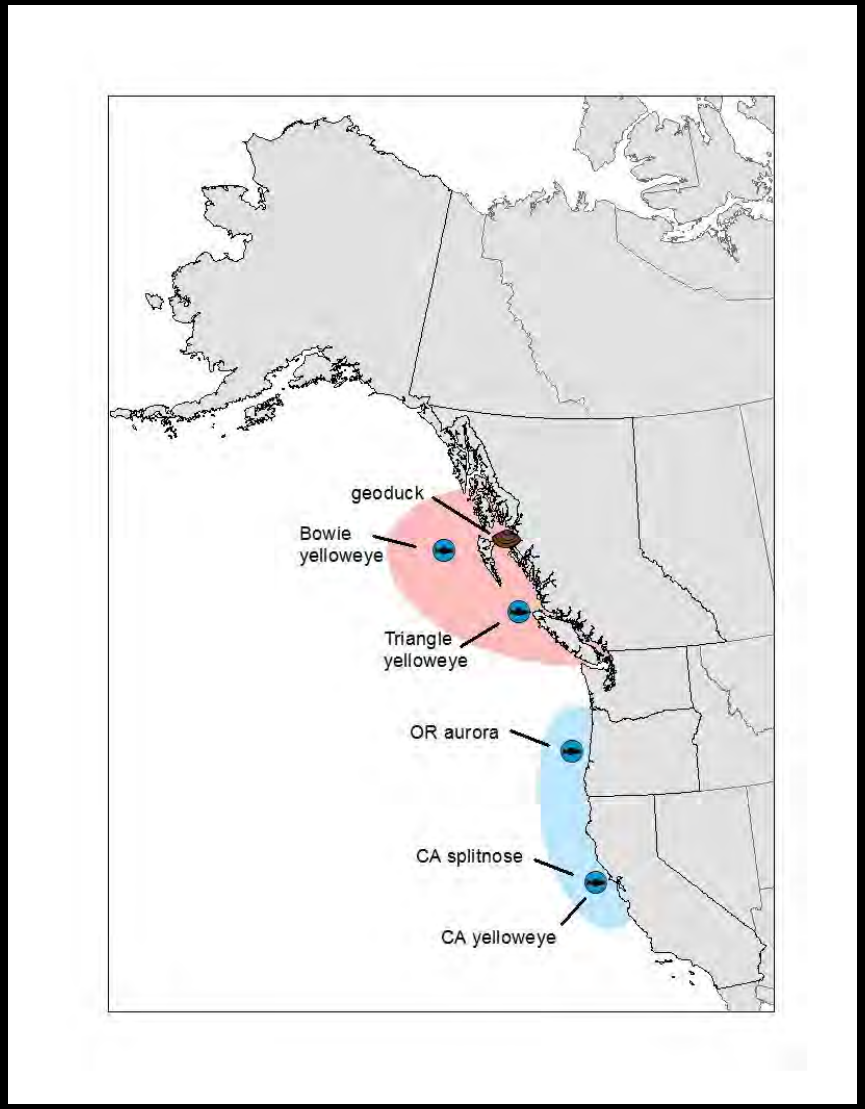
Comparisons across ocean domains

Winter ENSO (MEI)



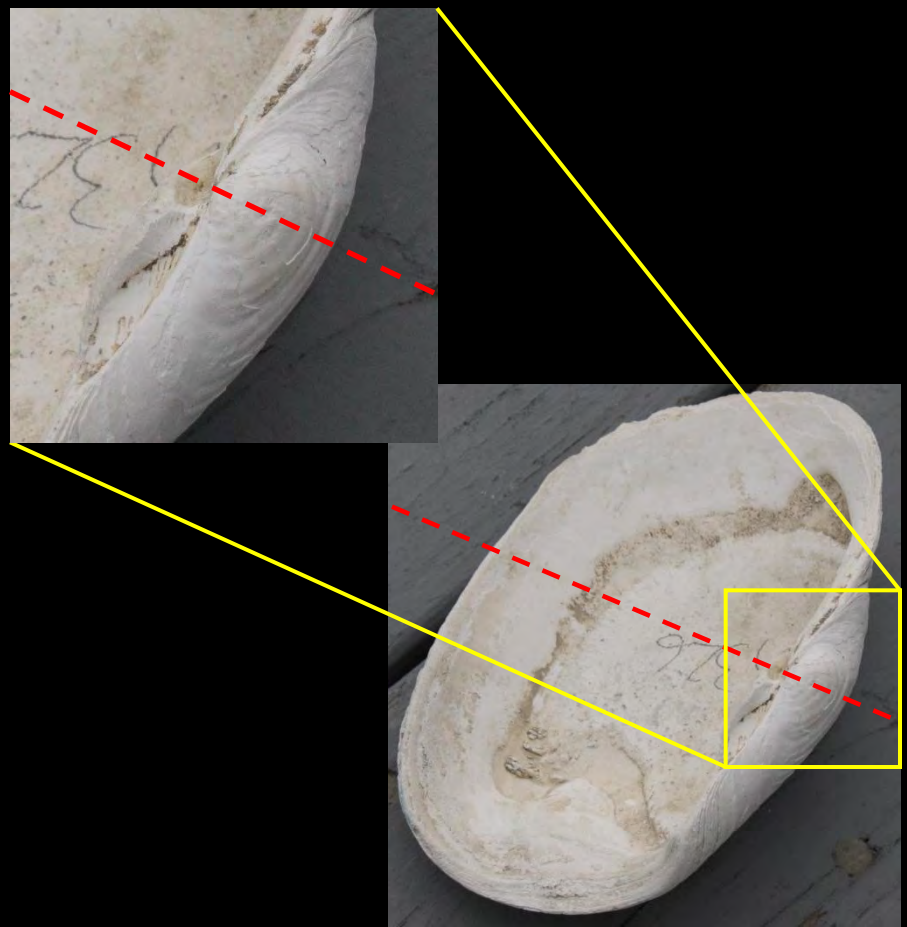


$PC1 = 0.248 + 0.5847*MEI - 0.2552*MEI^2$

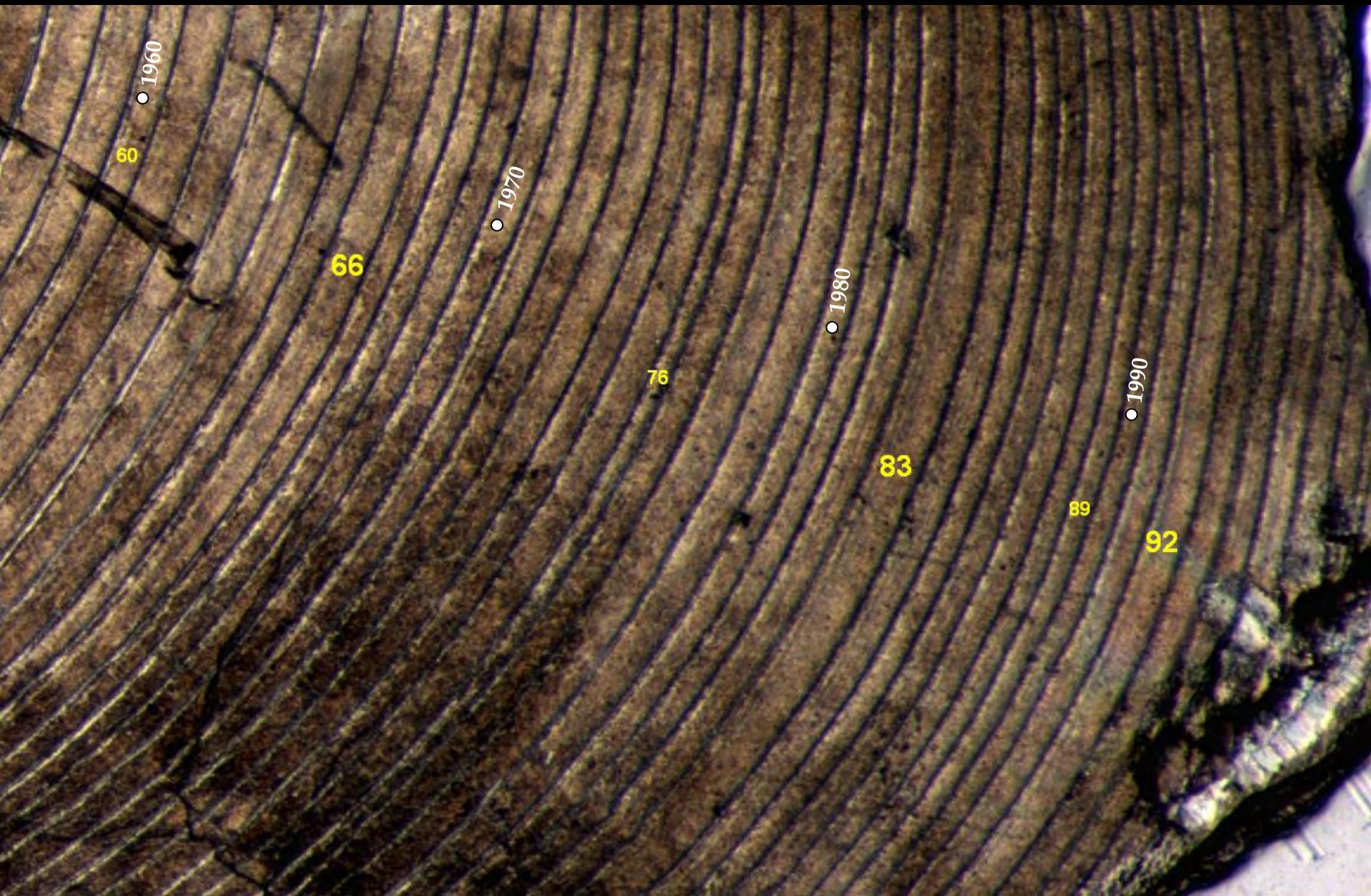


Pacific Geoduck

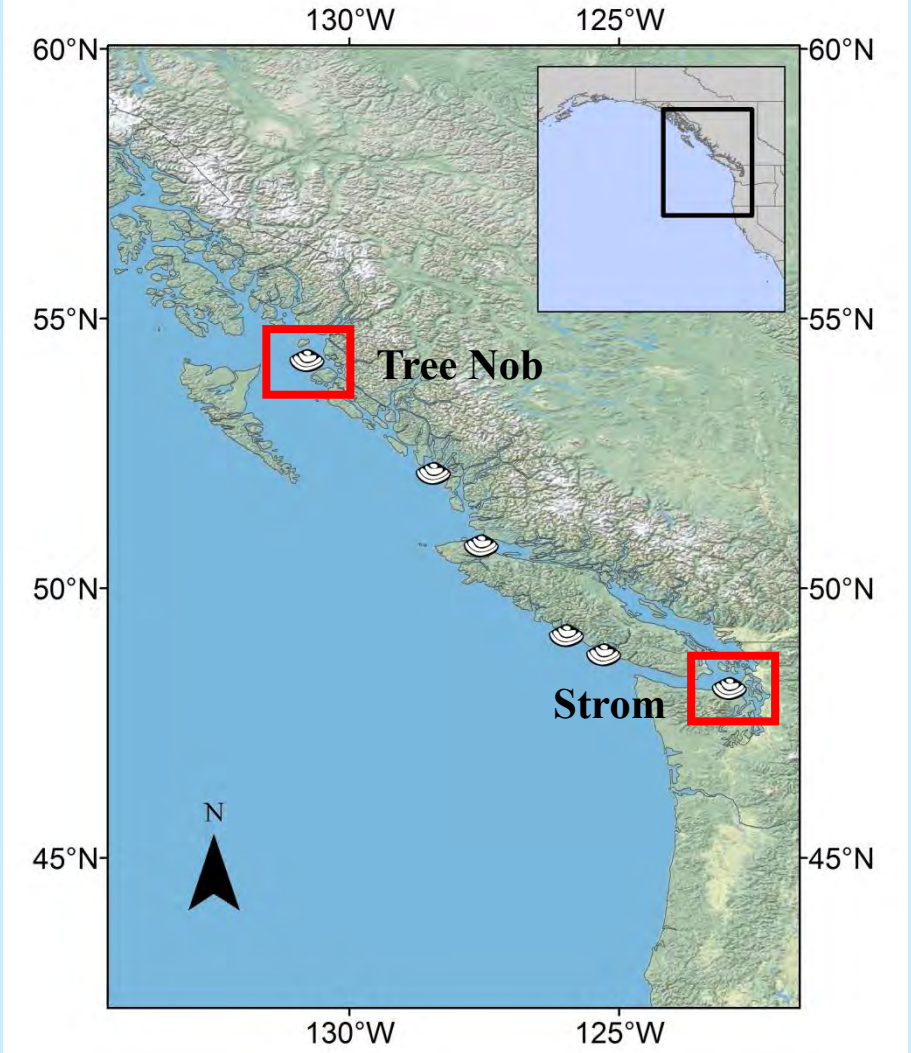
Puget Sound to Kodiak, AK
nearshore
150 yrs old!



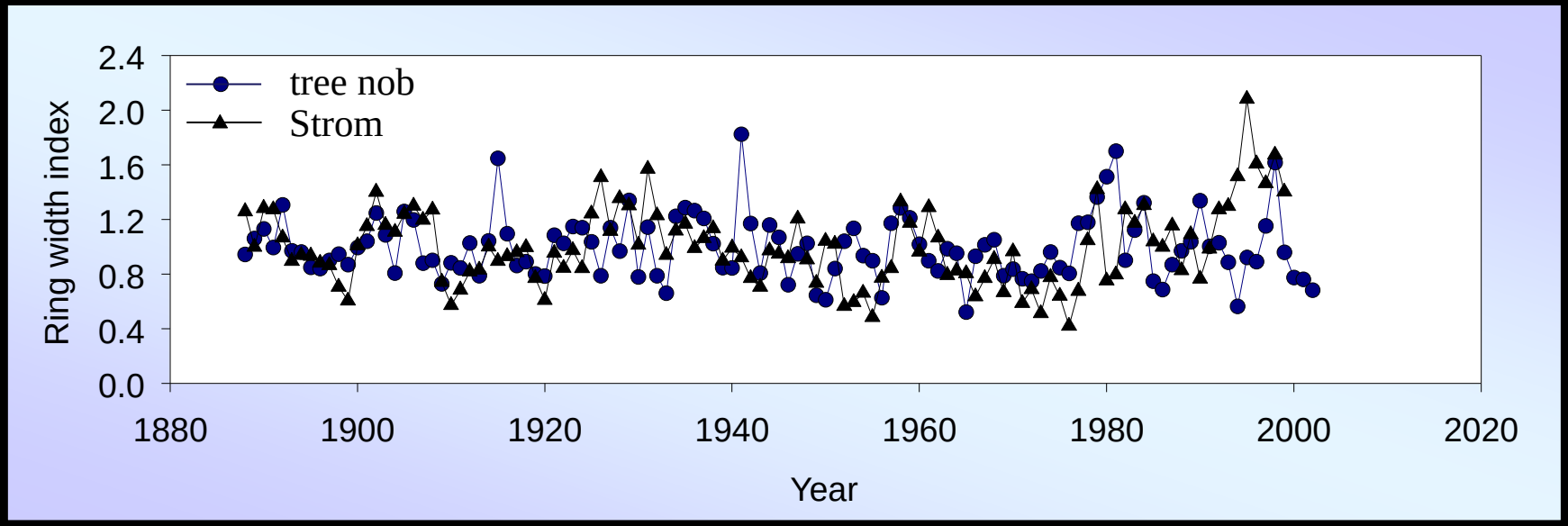
Geoduck growth increments



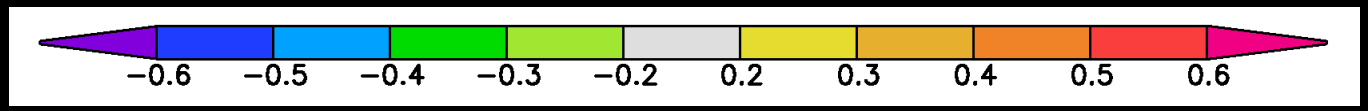
Geoduck chronologies



Geoduck chronologies



Geoduck and sea surface temperatures



\- correlation coefficient +

Pacific Decadal Oscillation

Typical wintertime sea surface temperature anomalies (colors), sea level pressure (contours) and surface wind stress (arrows)

warm phase ***cool phase***

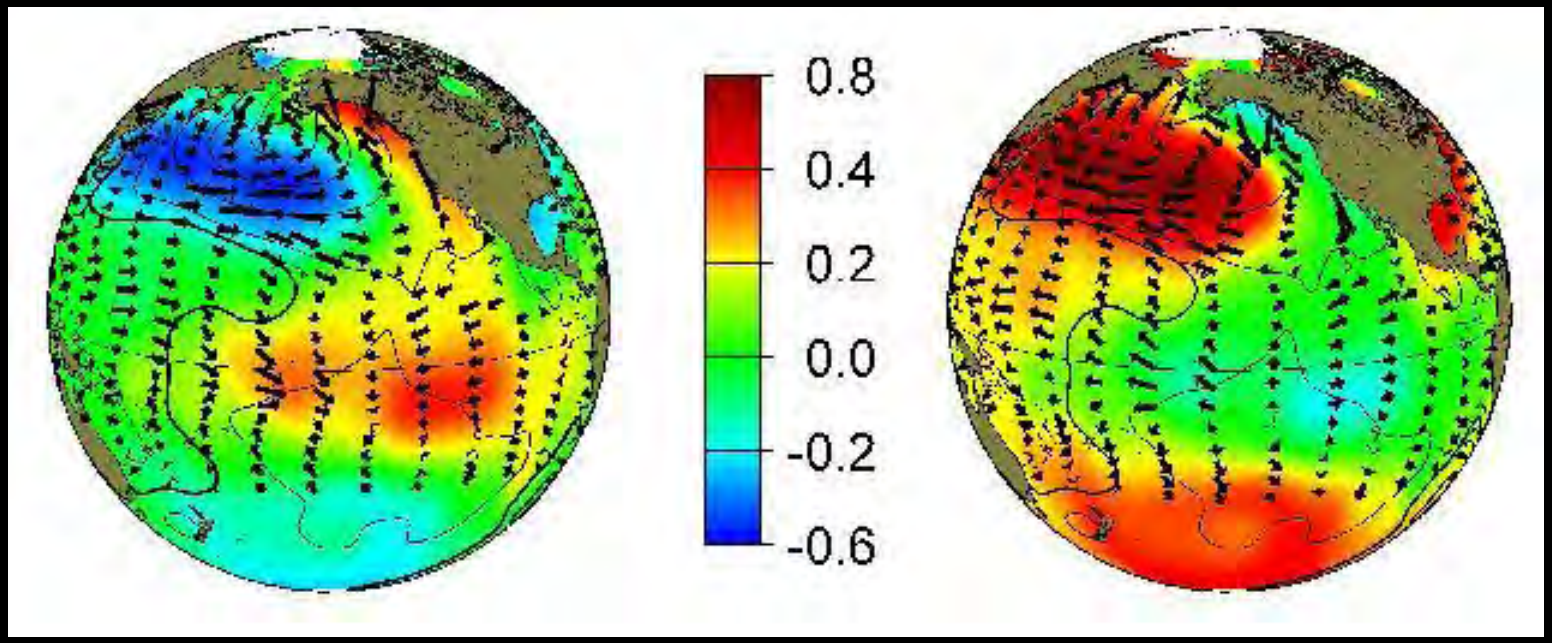
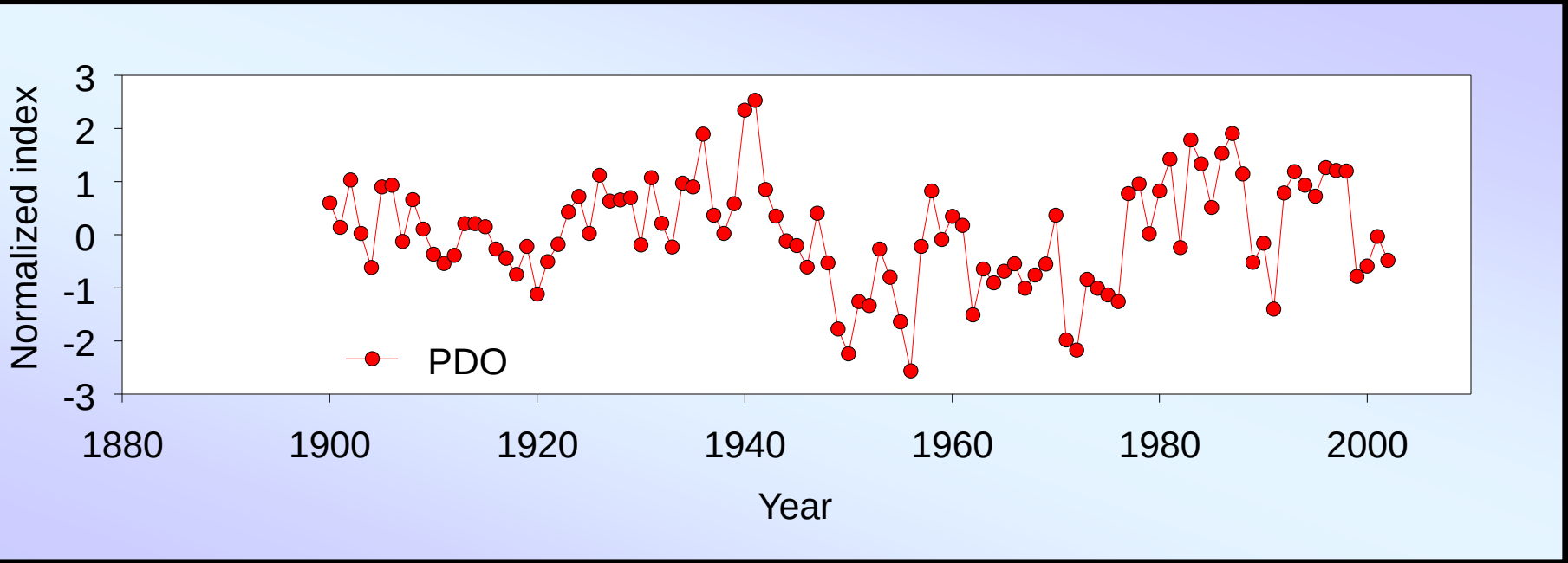
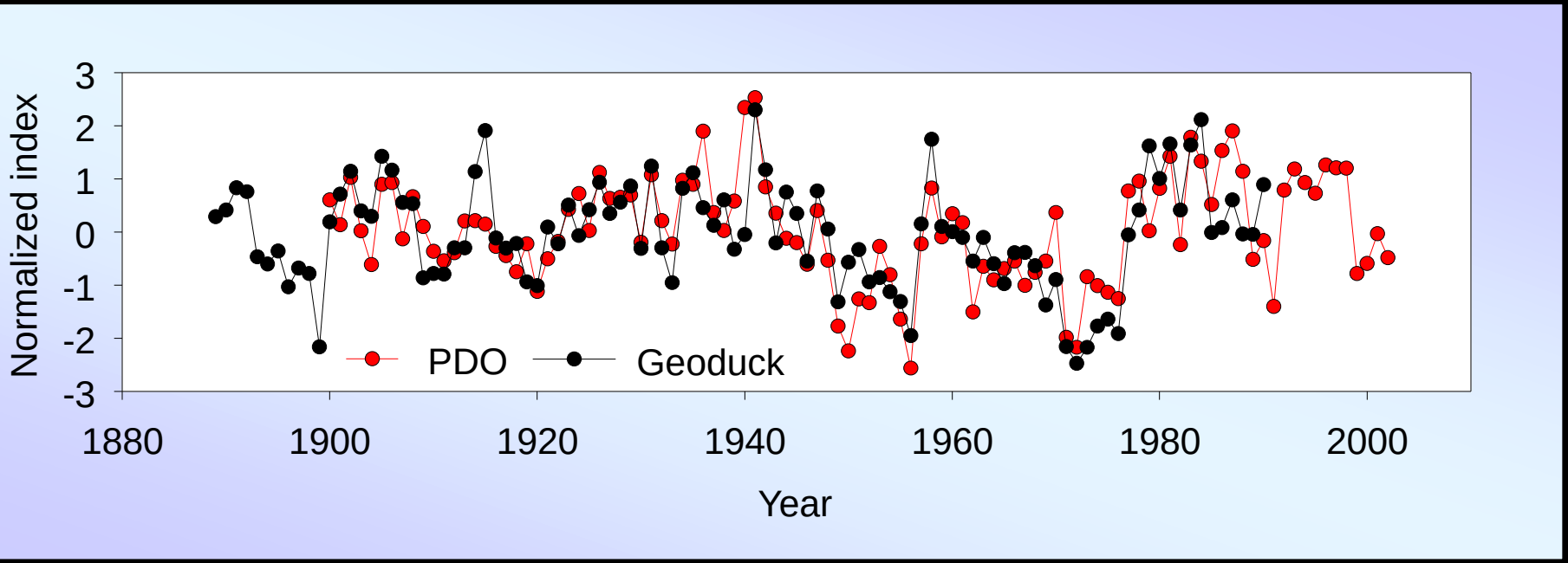


Figure credit: Joint Institute for the Study of the Atmosphere and Ocean: U. Washington

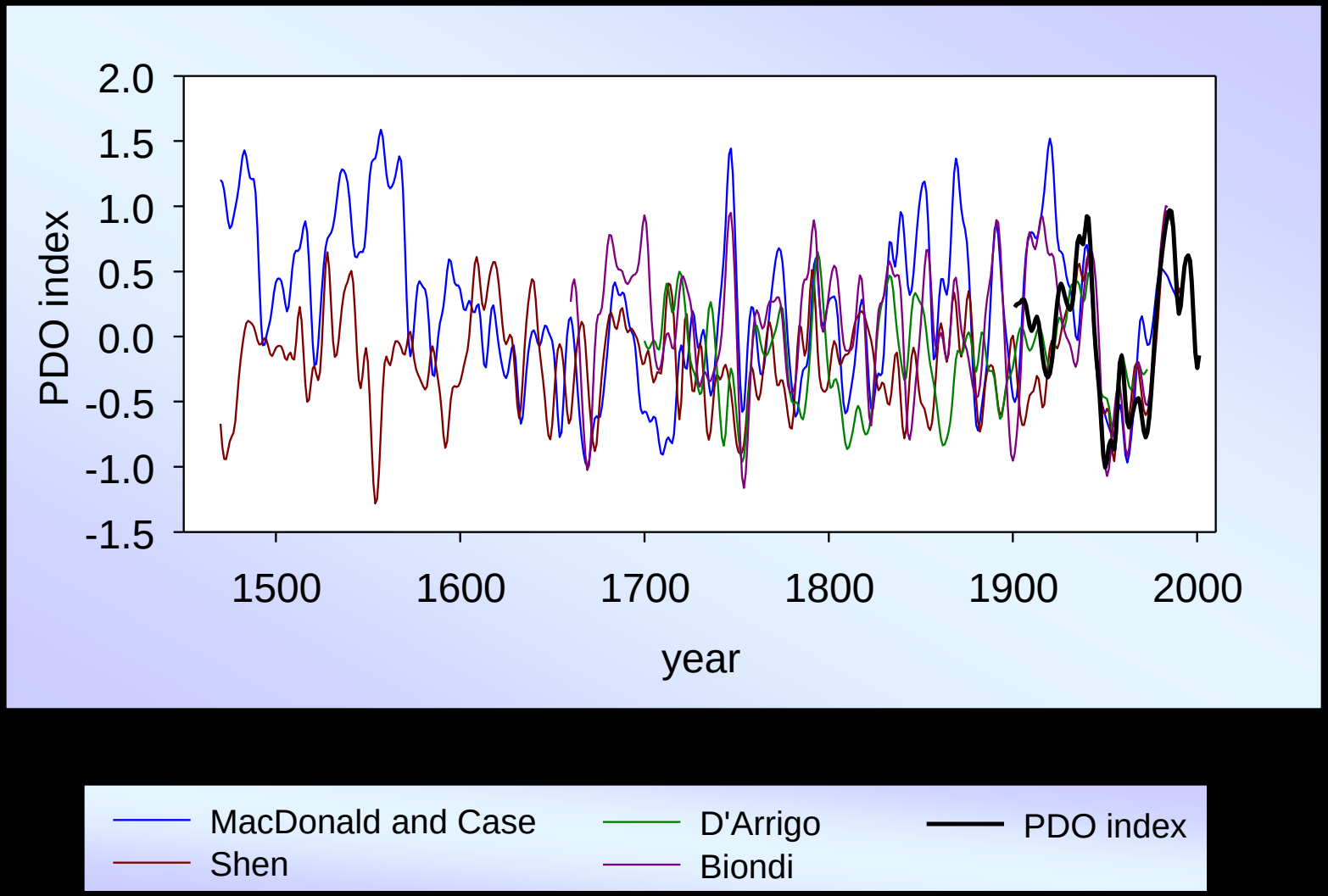
Geoduck chronologies



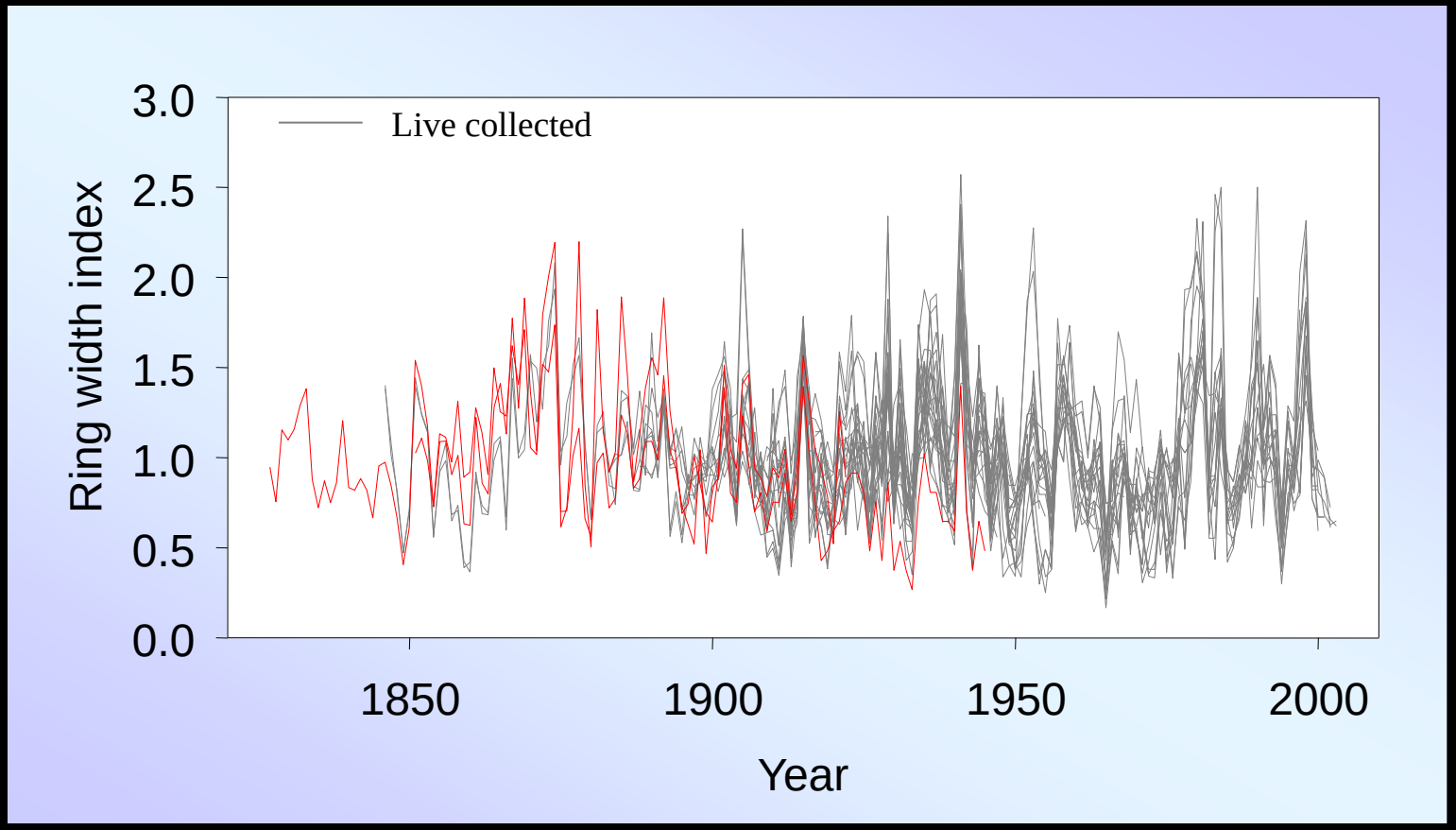
Geoduck chronologies



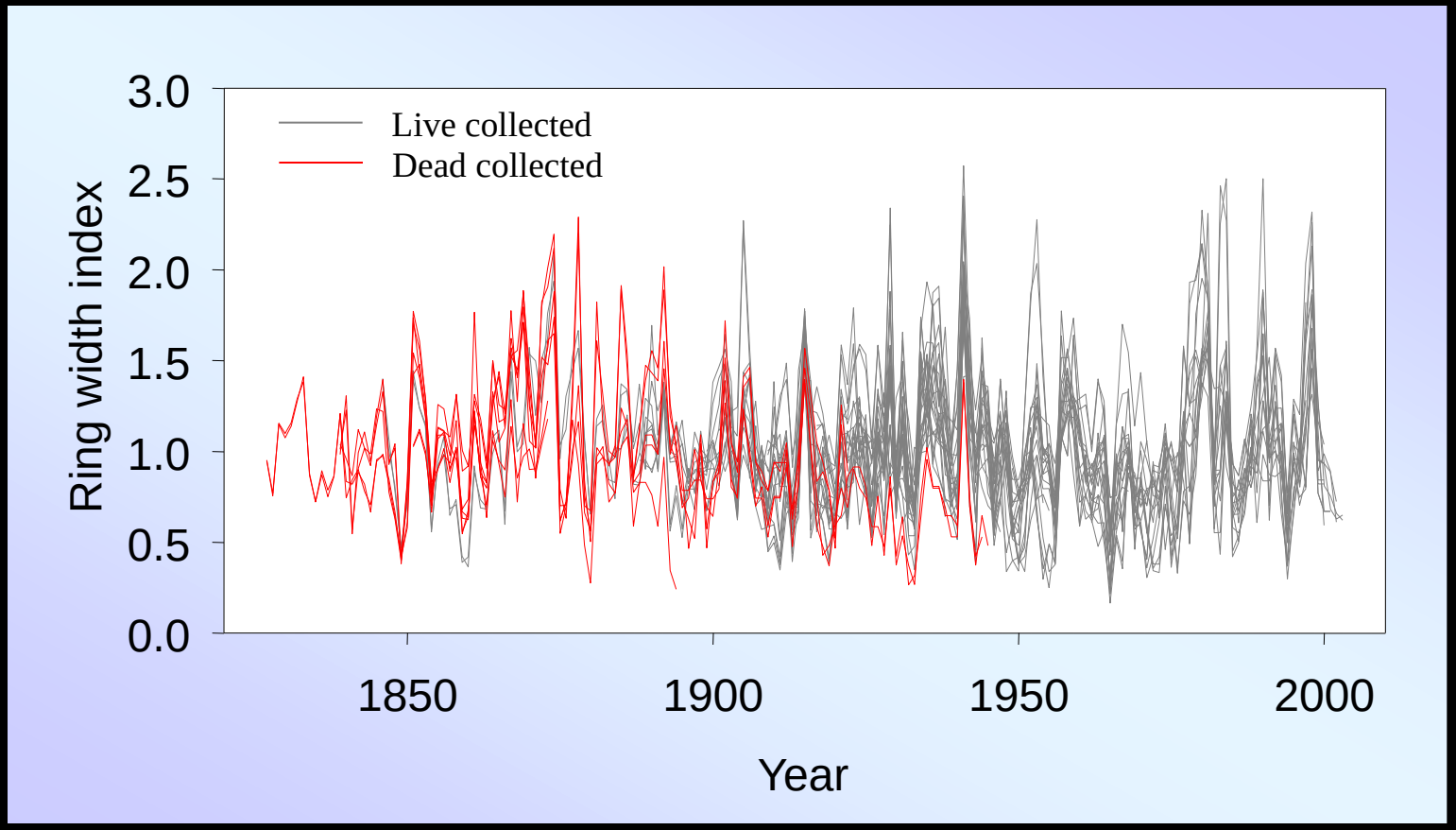
Pacific Decadal Oscillation



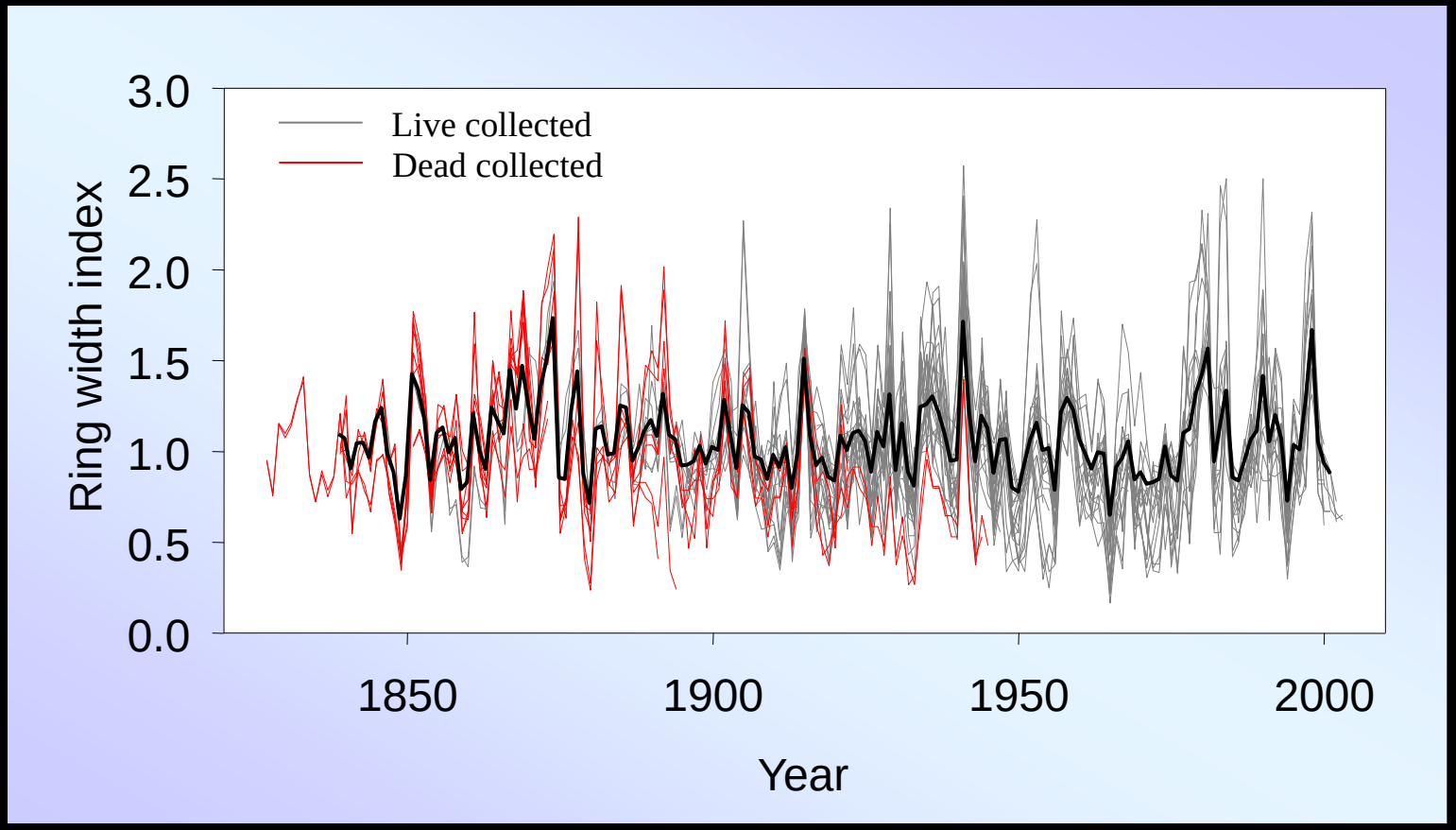
Dead-collected individuals



Dead-collected individuals



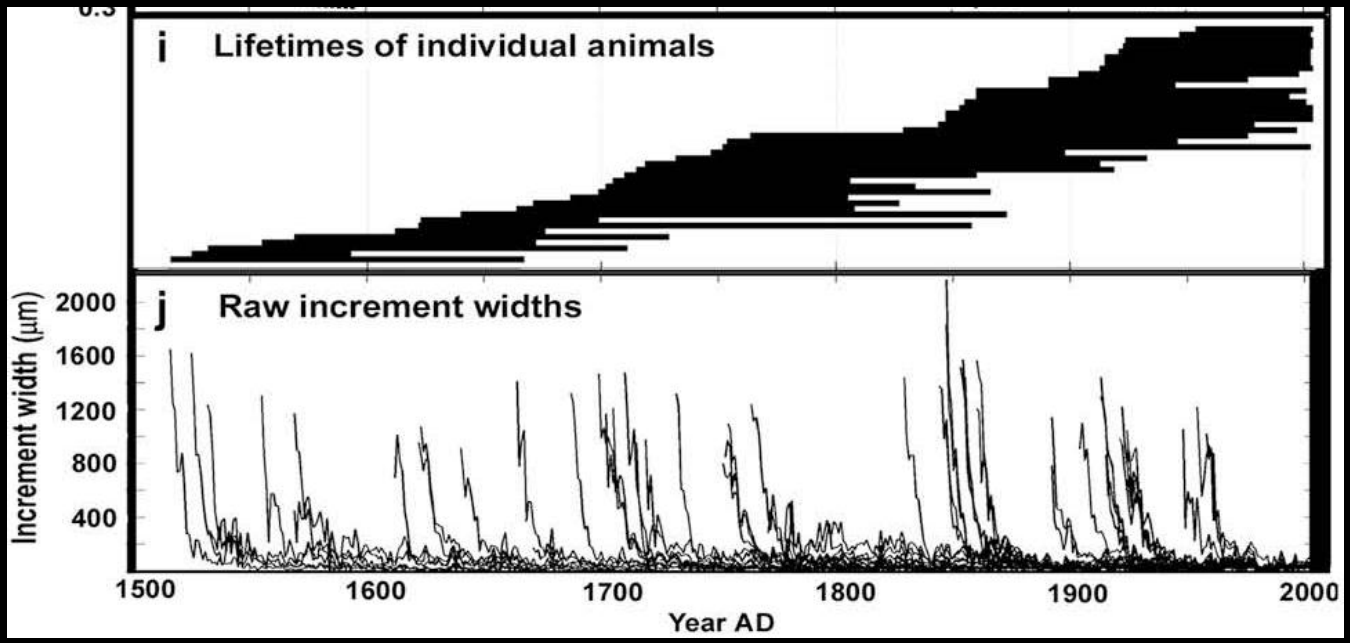
Dead-collected individuals



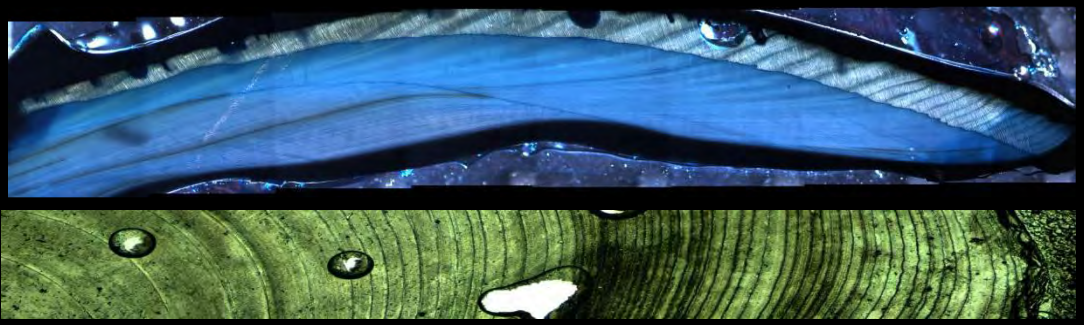
Supra-long chronologies

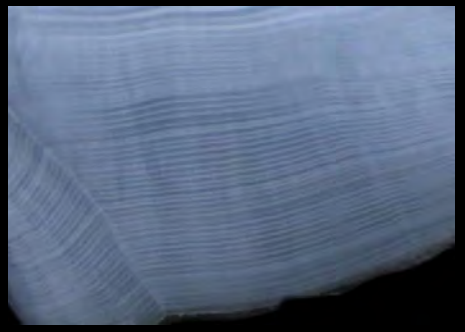
***Arctica islandica* marine bivalve**

Butler et al. 2010 *Quaternary Science Reviews*



Ecosystem linkages



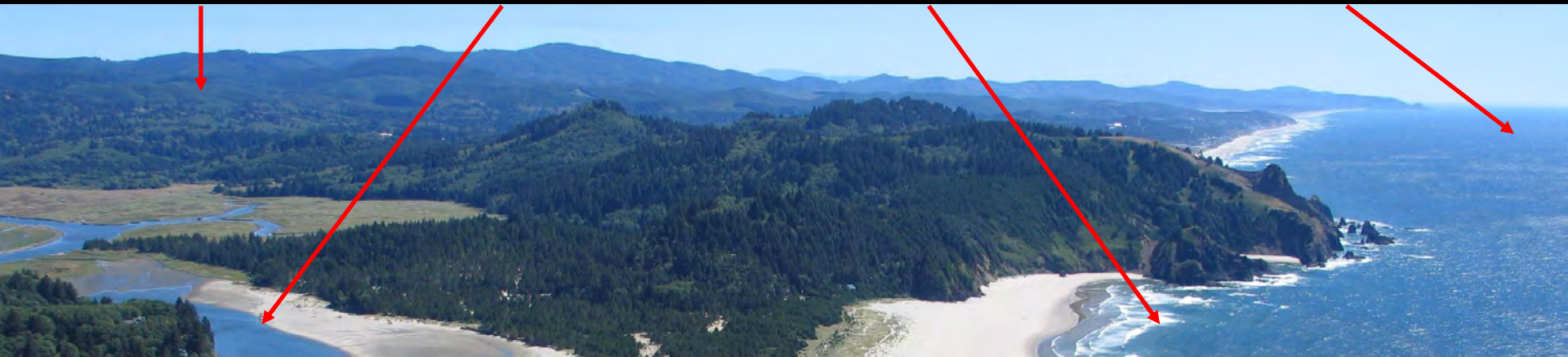


trees
forests

mussels
rivers

geoduck
nearshore

rockfish
continental shelf



Present, past, future

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