

NORTH-SOUTH LOCATION OF THE NORTH PACIFIC CURRENT AND ITS INFLUENCE ON TEMPORAL VARIATION IN RECRUITS PER SPAWNER OF NORTHEASTERN PACIFIC SALMON (*ONCORHYNCHUS*) POPULATIONS

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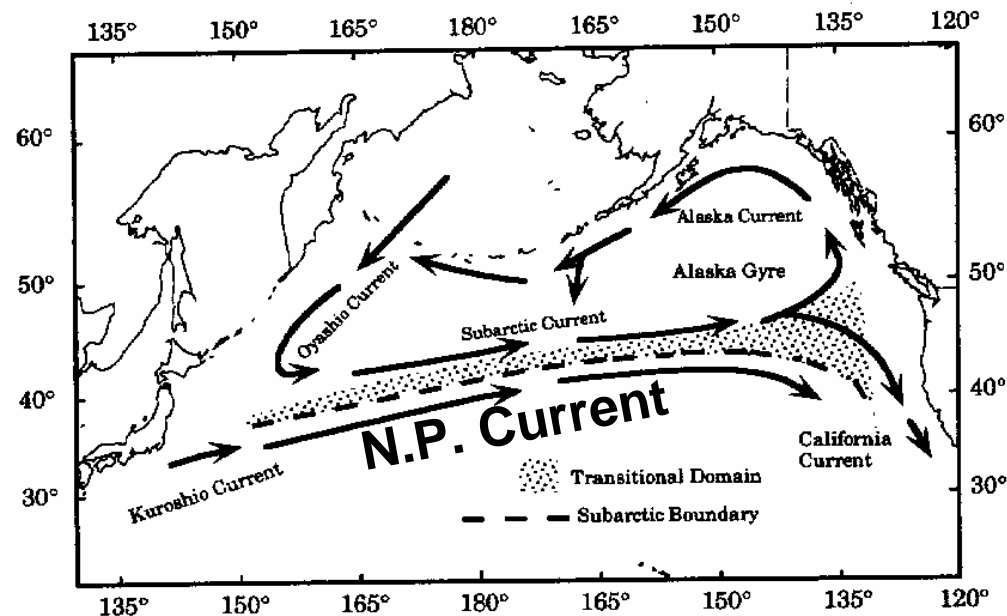
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Southwest Fisheries Science Center, Pacific Grove, CA

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Goal & objectives

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- Understanding causes of temporal variability in productivity of Pacific salmon (*Oncorhynchus spp.*)
 - Does salmon productivity vary with the location of the North Pacific Current (NPC)?
 - Does this increase our understanding of variability in salmon productivity?



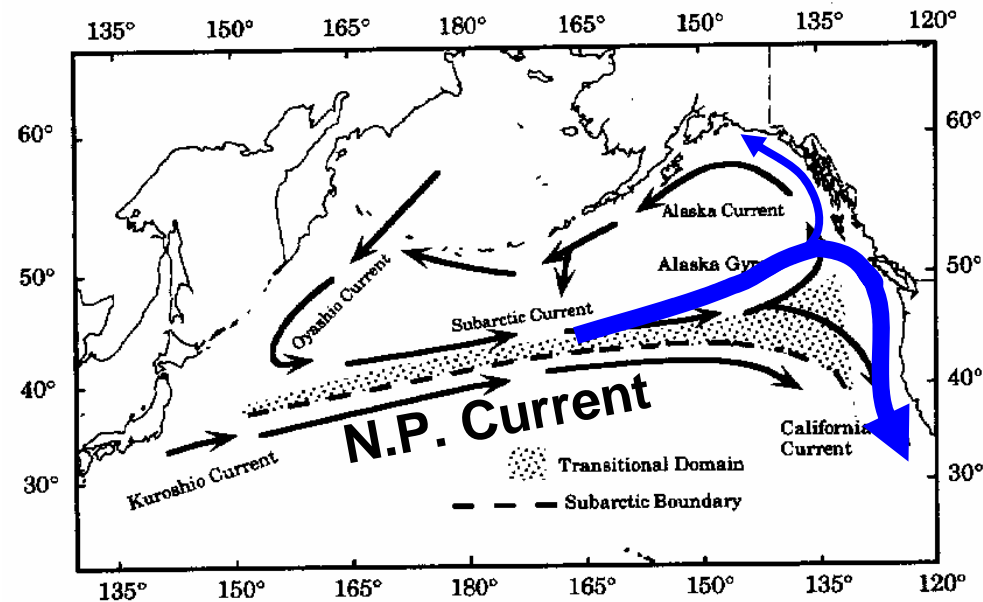
Favorite et al. 1976

Effects of variability in location of North Pacific Current

Effects of northerly bifurcation on southern region:

- Stronger southward flow along BC coast
- Cooler SST along BC coast
- Increased upwelling
- Fewer predators from southern water?
- More food for salmon?

➔ **Increased survival
of southern stocks?**

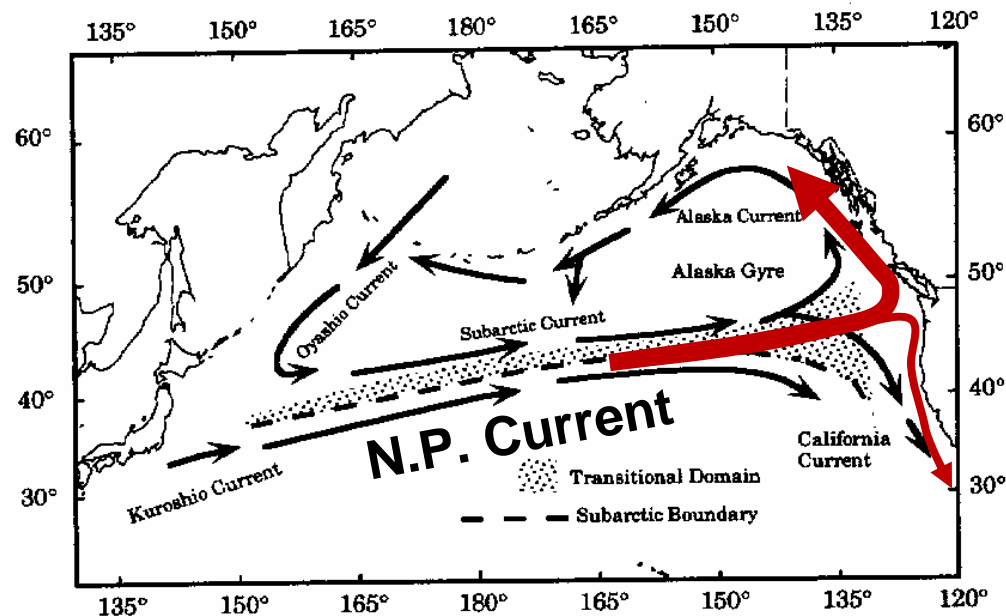


Effects of variability in location of North Pacific Current

Effects of southerly bifurcation on northern region:

- Stronger northward flow in Alaska Coastal Current
- Stronger onshore Ekman transport
- Increased primary production?
- Increased early-spring zooplankton bloom?

→ **Increased survival of northern stocks?**



Expected effects on salmon



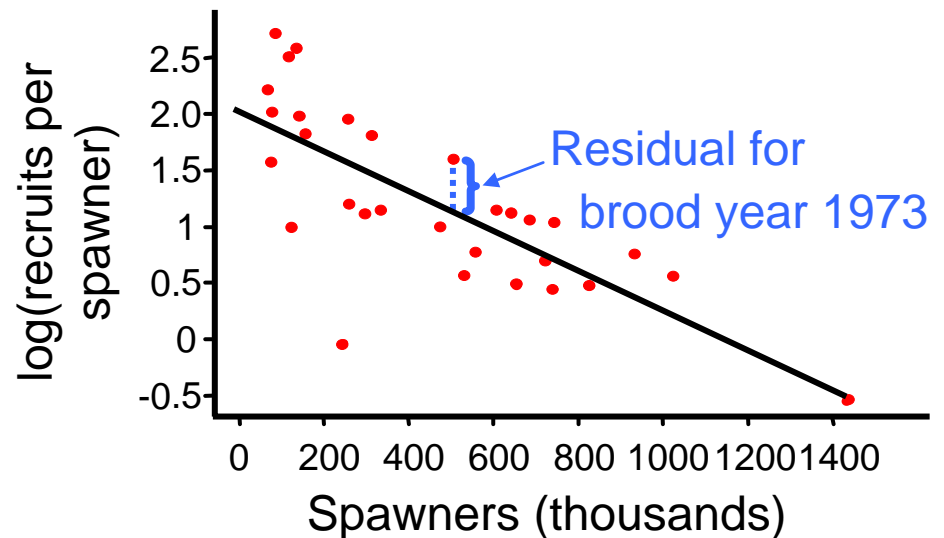
More northern location of bifurcation:

- Increased productivity in the south
- Decreased productivity in the northern Gulf of AK
- Little or no effect on western AK stocks ?

Data

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- Productivity of salmon stocks
 - ▣ Measured as stock-recruit **residuals** to remove **within-population** density-dependence:

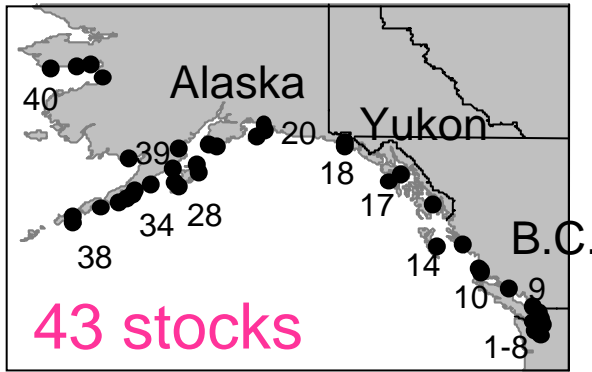


- Coastal SST by region
- Bifurcation index:
 - ▣ relative North-South location of North Pacific Current

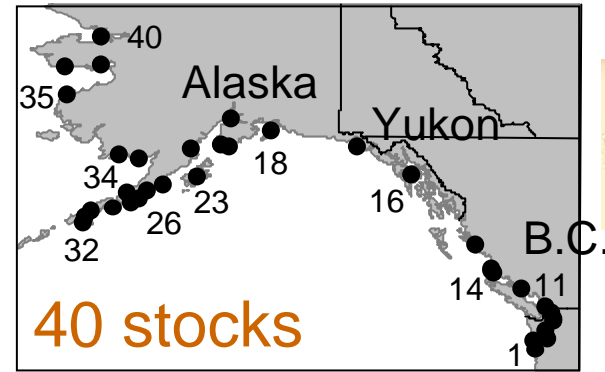
Salmon data: 120 stocks, 3 species averaging 31 years of S-R data

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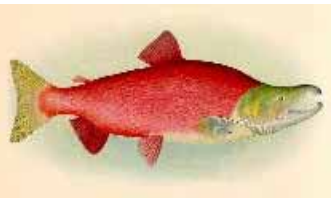
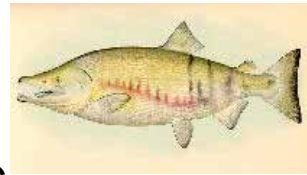
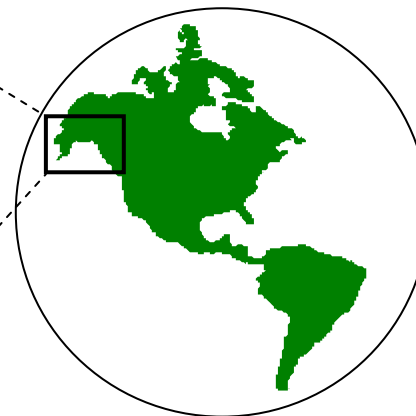
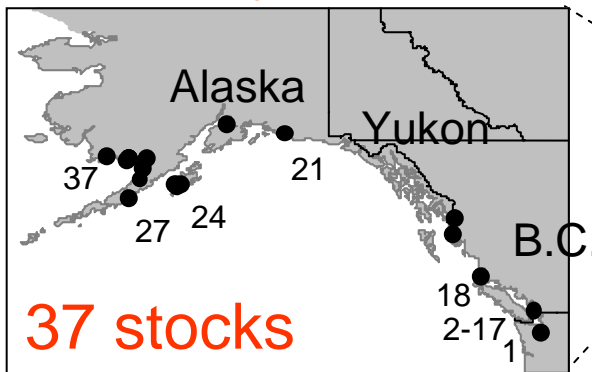
Pink salmon



Chum salmon



Sockeye salmon

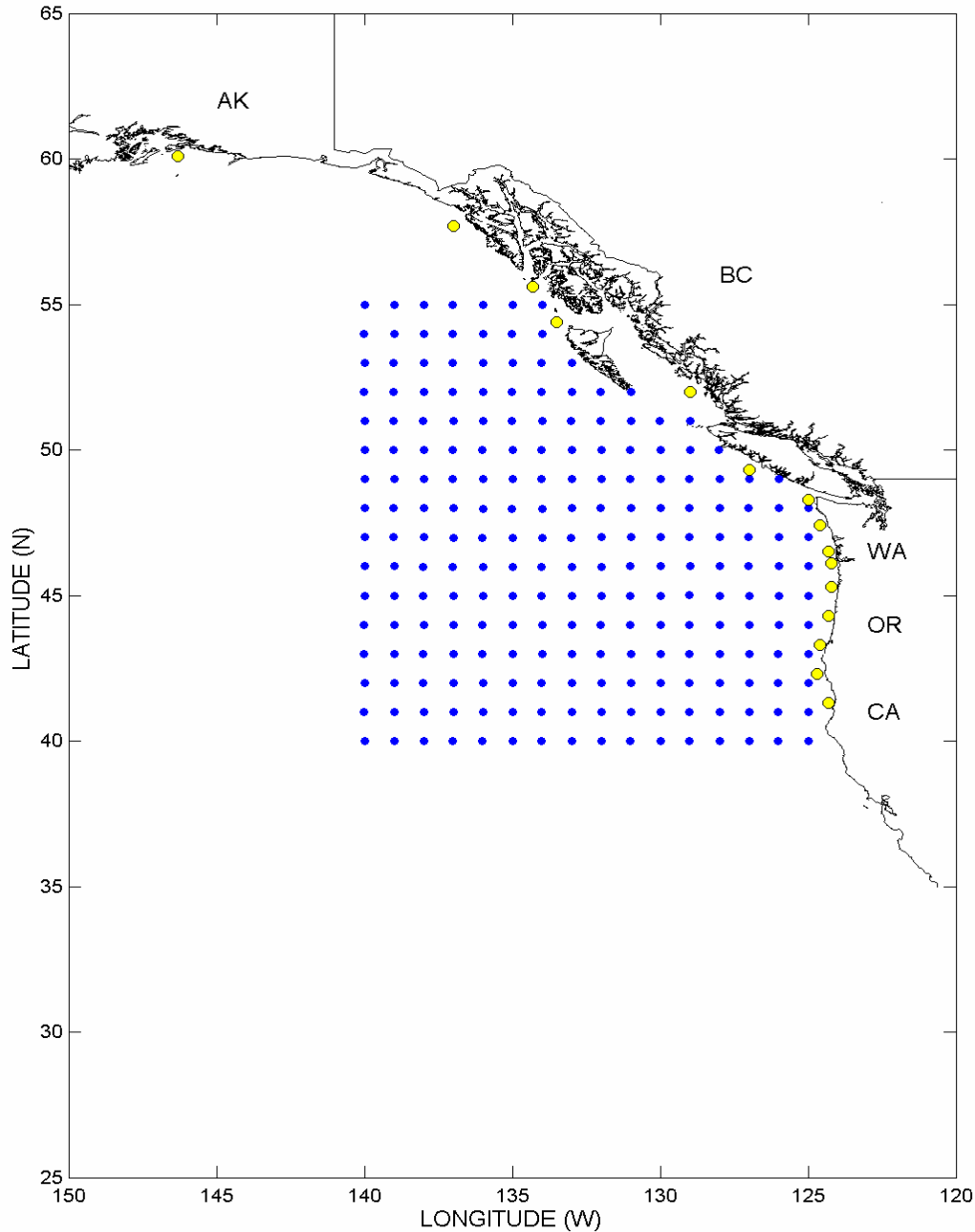


Bifurcation index

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- Index based on Watters and Bessey (in press)
- OSCURS model (Ingraham, 1997): uses historical wind records to simulate trajectories of drifters
- Quantify and visualize bifurcation using a grid of simulated drifter release sites

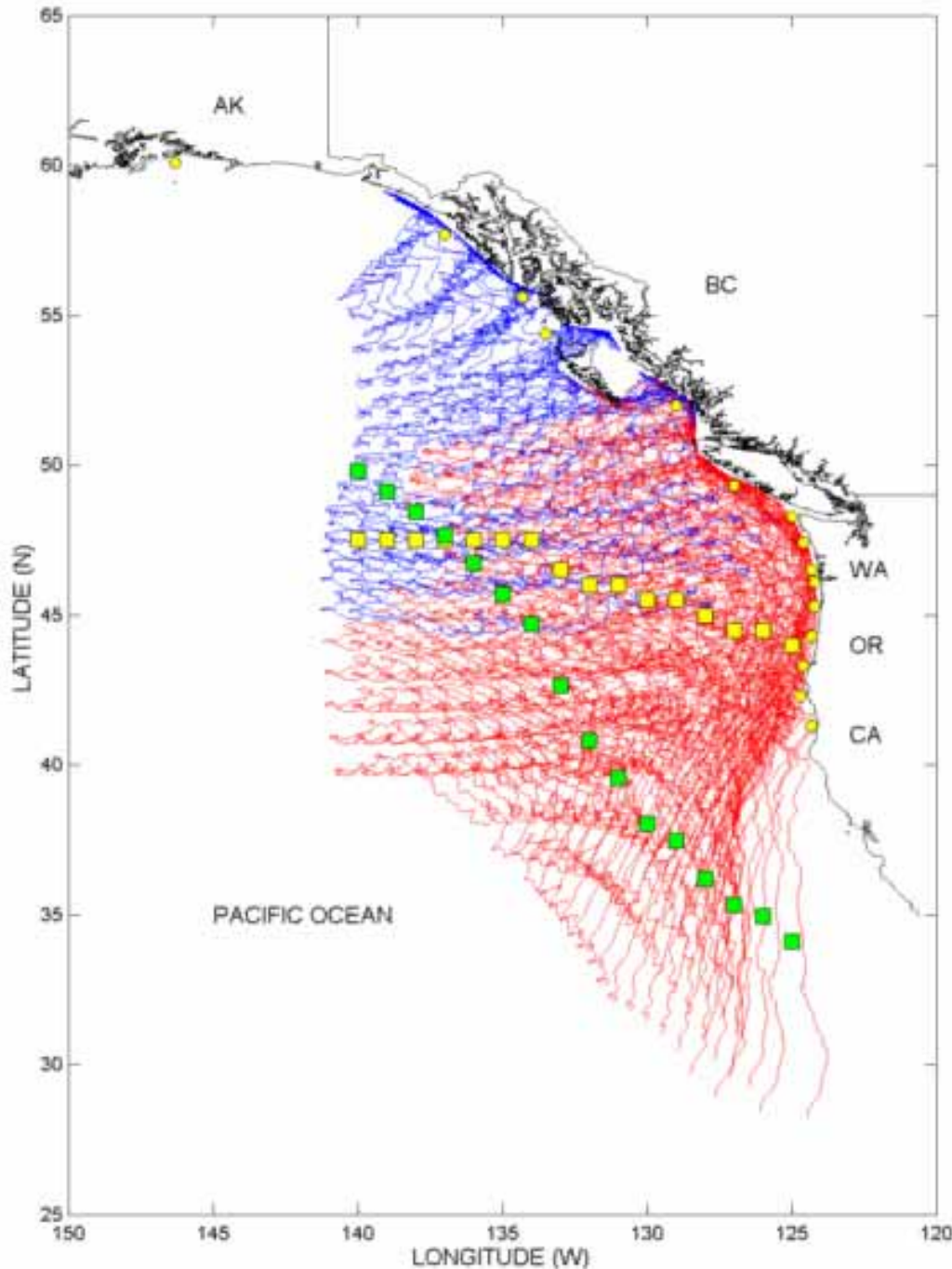
STARTING POSITIONS FOR OSCURS MODEL RUNS



216 starting points on a one degree grid

Run from Feb.1 to June 30 each year, 1973 – 1999

1973



Bifurcation index:

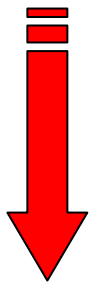
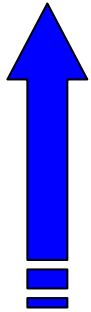
For each column of drifters,
track median latitude of
starting and stopping
locations

$$\sum(\text{latitude of yellow sq.} - \text{latitude of green sq.})$$

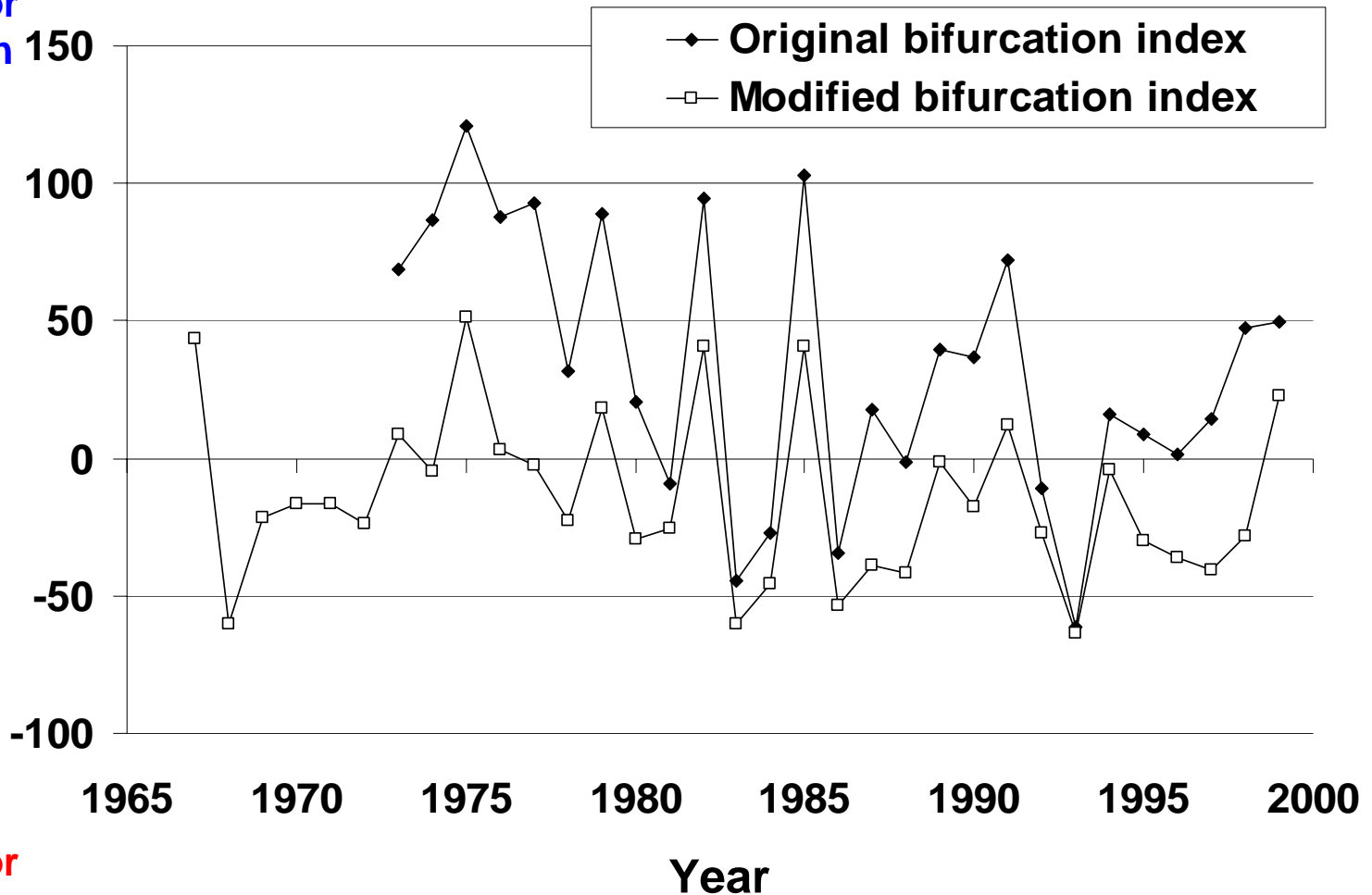
From Watters & Bessey (in press)

Bifurcation index, 1967-1999

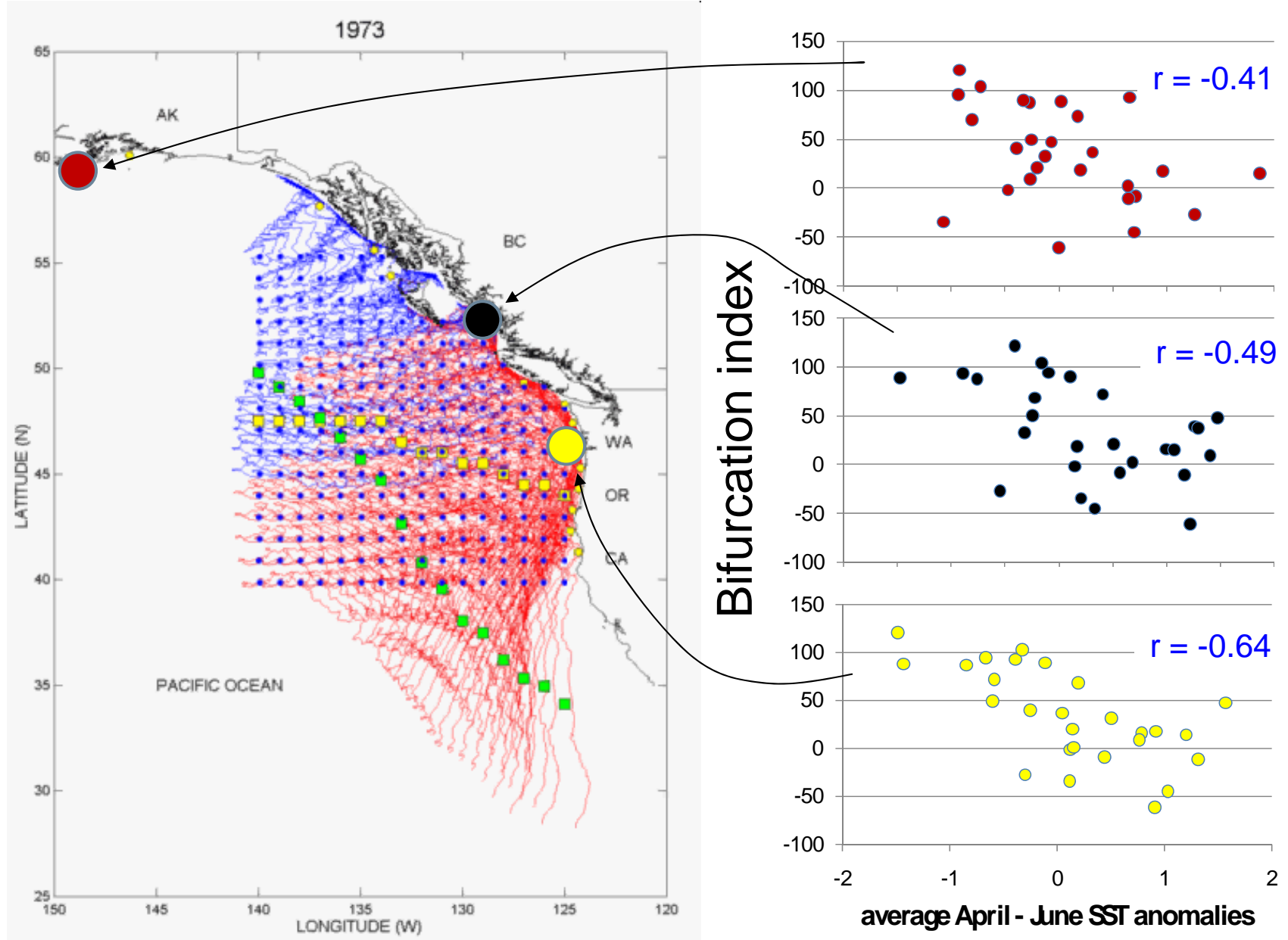
Northern
location for
bifurcation



Southern
location for
bifurcation

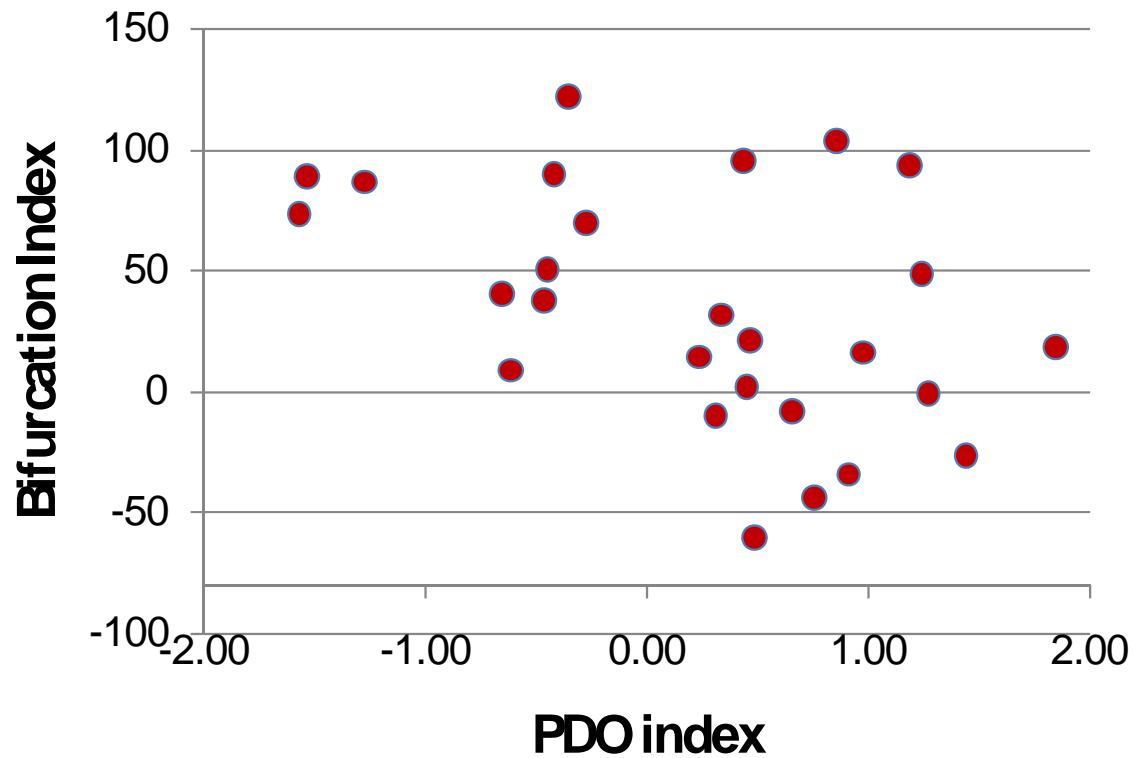


Bifurcation and SST



PDO and bifurcation index

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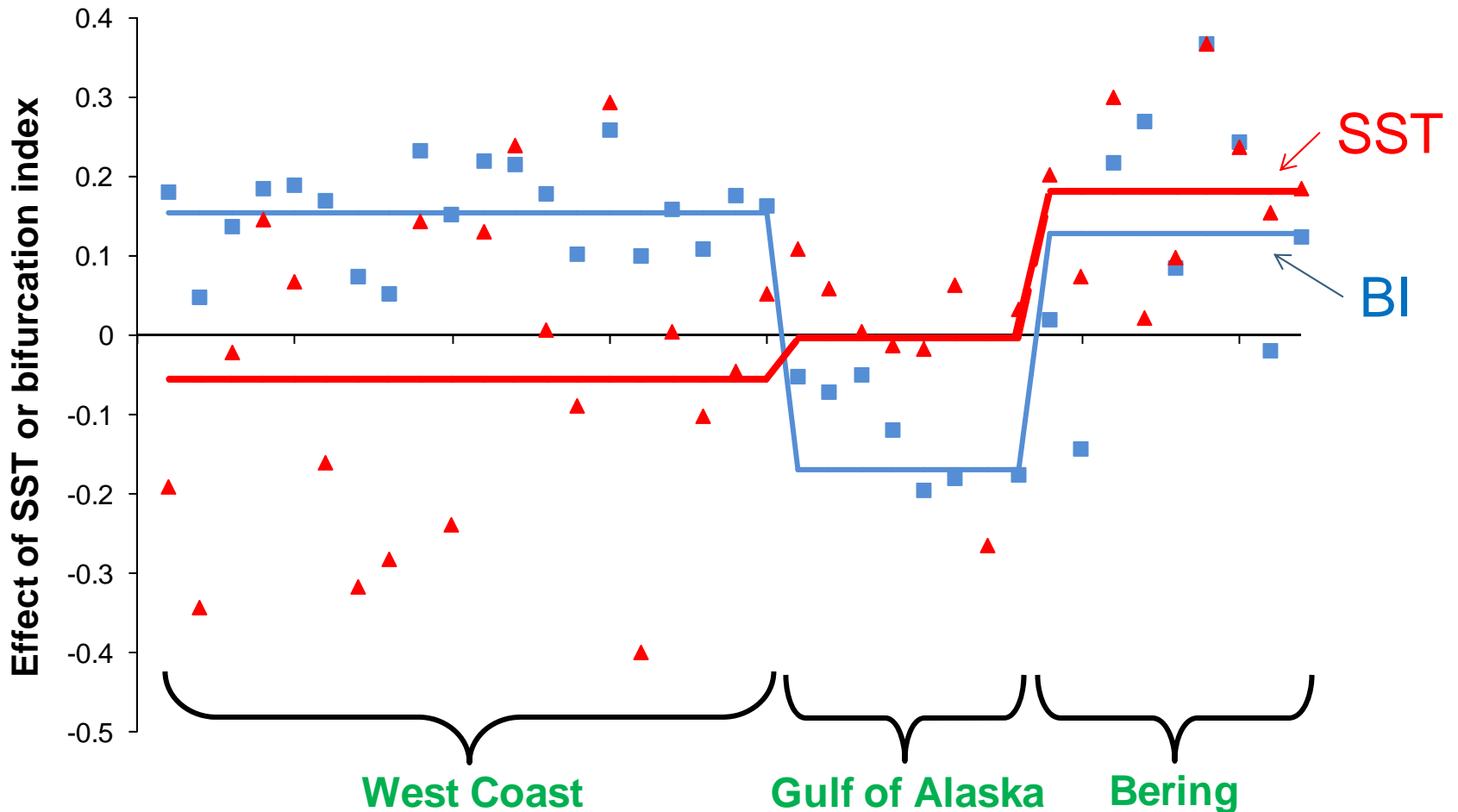


$r = -0.44$

37 Sockeye salmon populations:

Effects of **SST** and **bifurcation** on variability in survival rates by stock

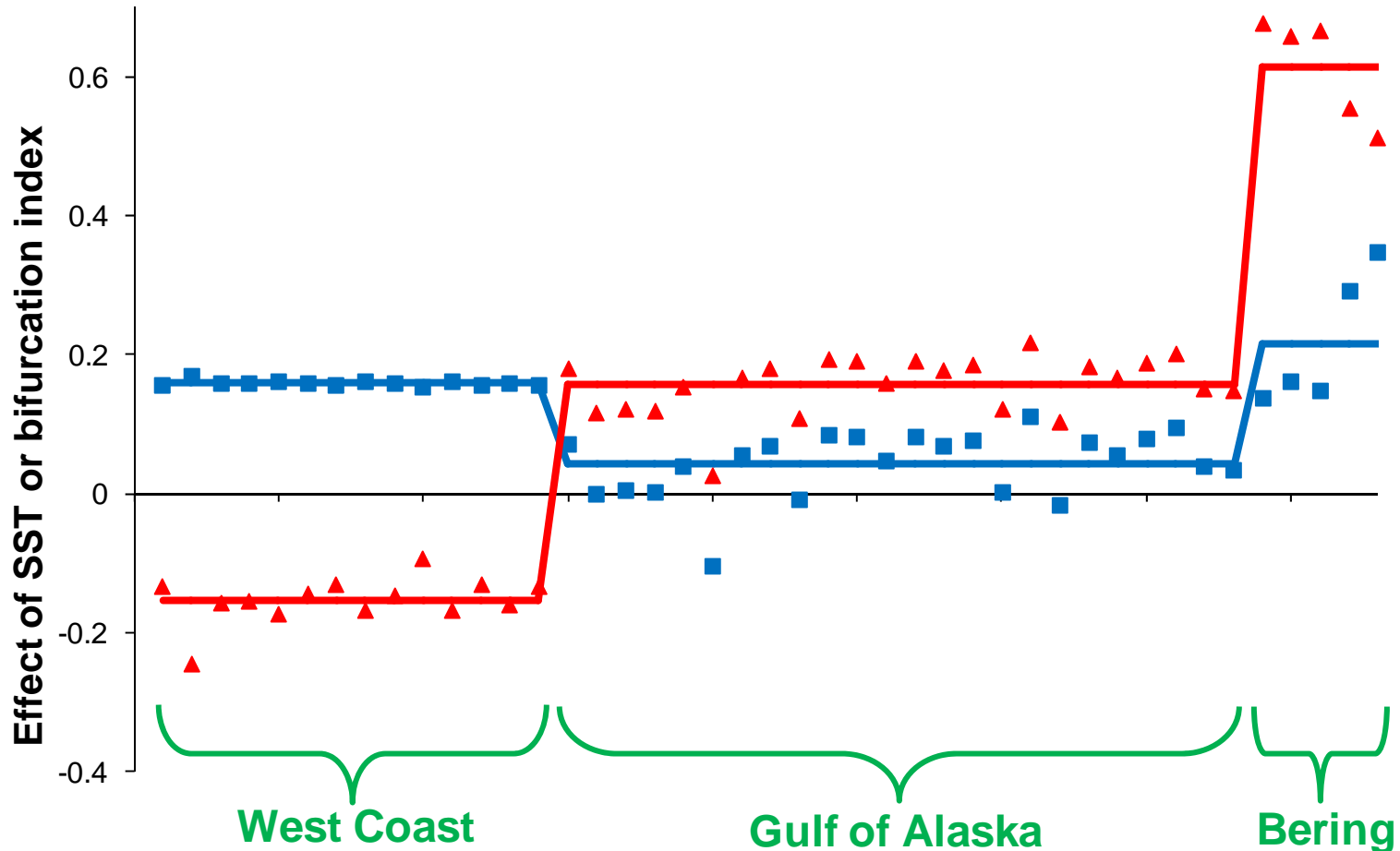
14



43 Pink salmon populations:

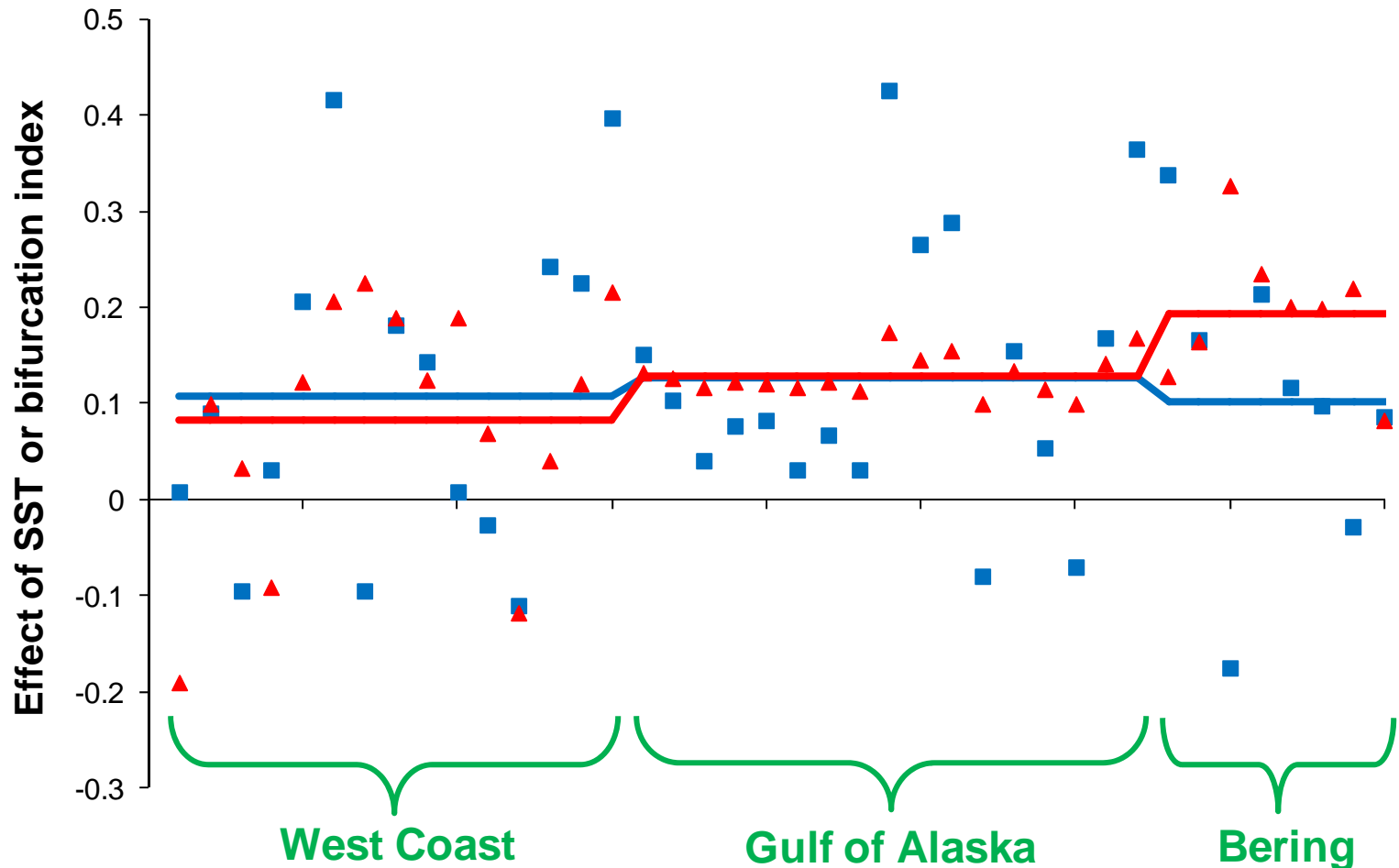
Effects of **SST** and **bifurcation** on variability in survival rates by stock

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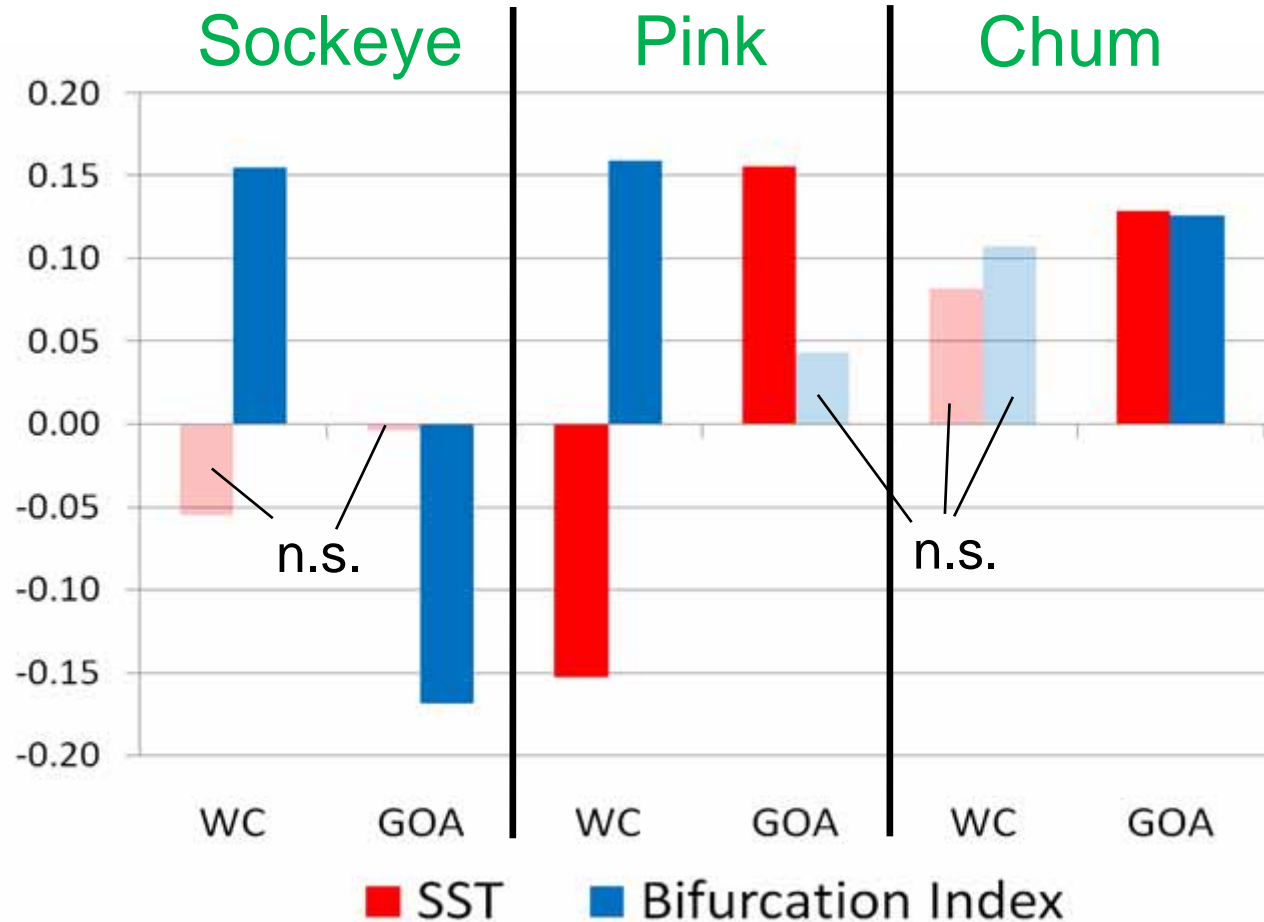
40 Chum salmon populations:

Effects of SST and bifurcation on variability in survival rates by stock



Correlations between average S-R residuals and SST / Bifurcation

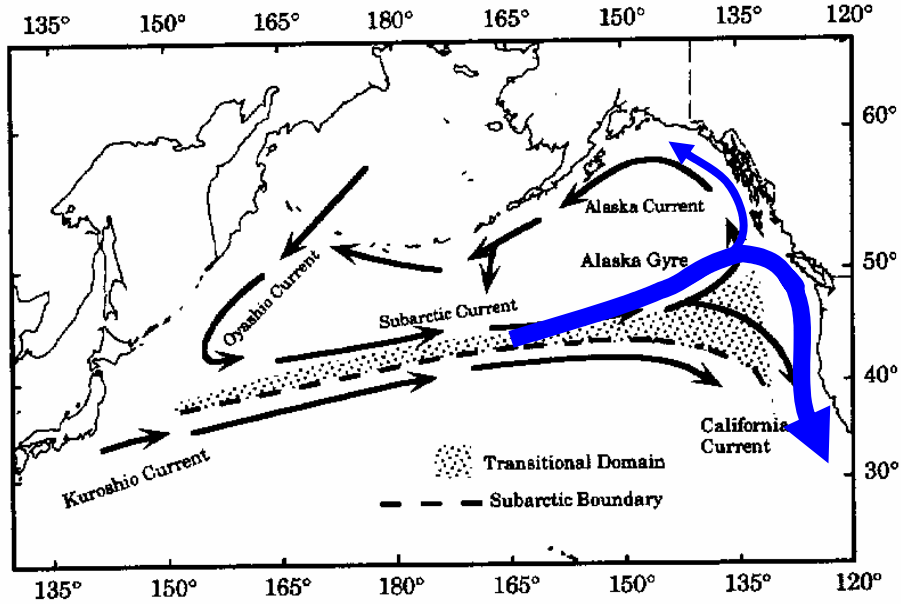
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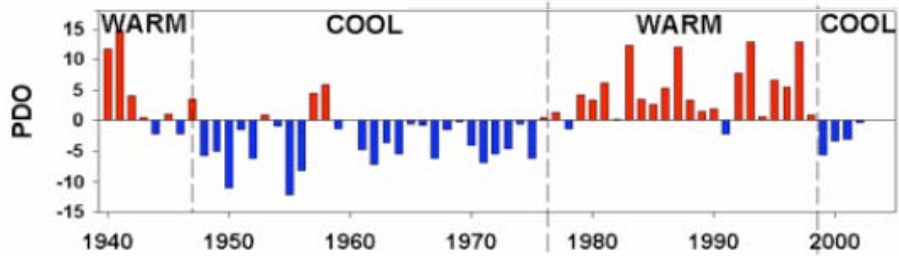
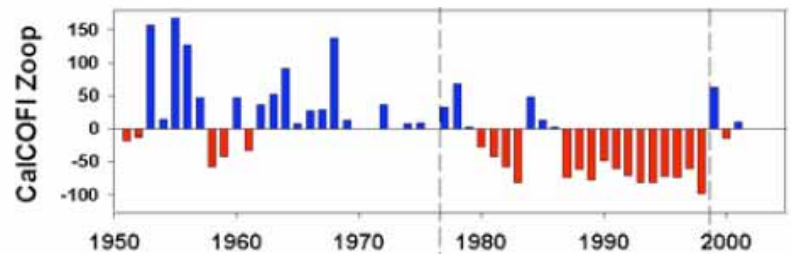
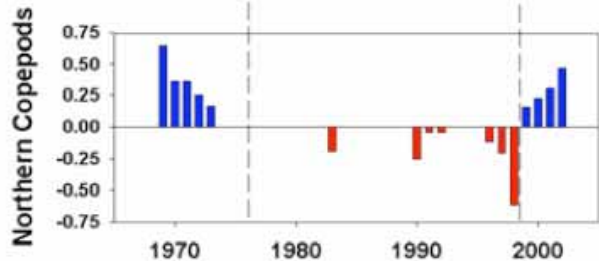
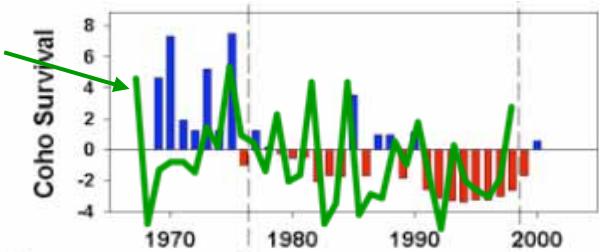
Standardized effect
of SST or BI

Potential mechanism for southern stocks: bottom-up effect?

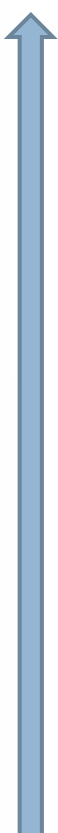
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Bifurcation index

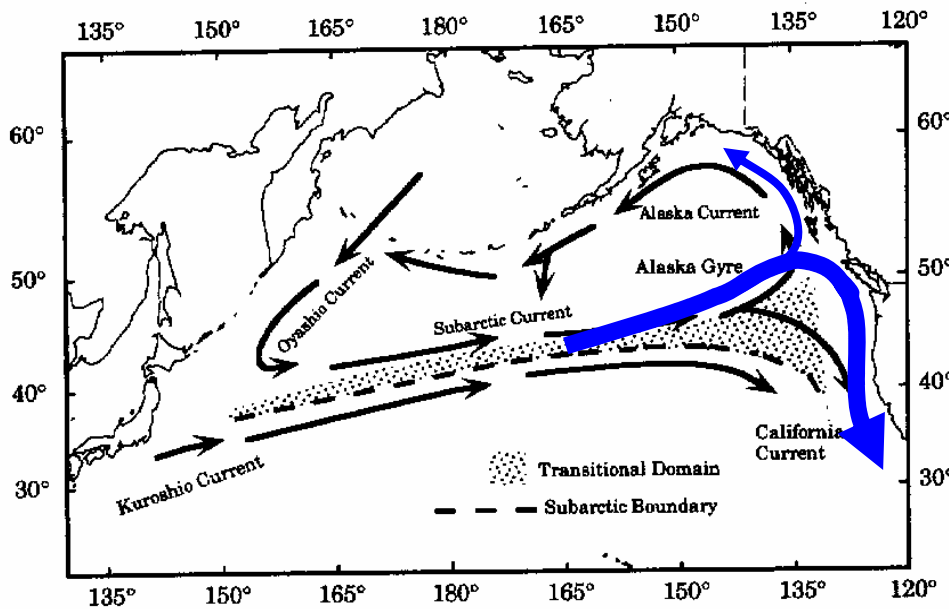


Sources: Petersen et al ??
CalCOFI??, JISAO website



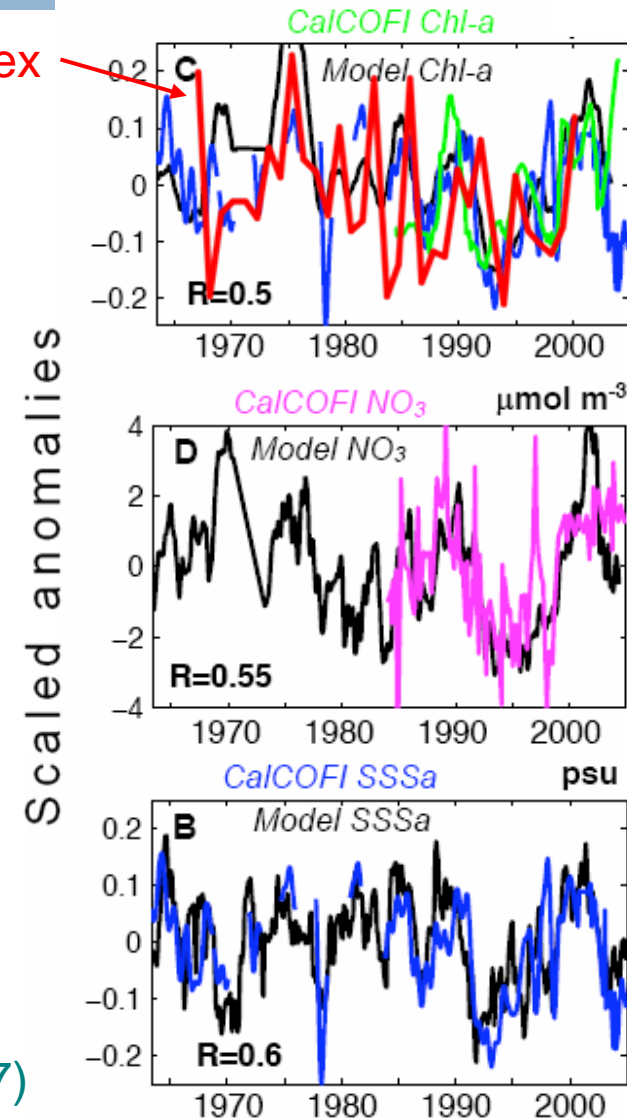
Potential mechanism for southern stocks: bottom-up effect?

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Bifurcation index

From: Di Lorenzo et al. (2007)



Summary and Conclusions

- Anomalies in the location of the North Pacific Current are correlated with salmon survival rates in the California Current region, but not (or weakly) in the Alaska Coastal Current region
- Northward displacement of North Pacific Current is associated with enhanced salmon survival in southern stocks, possibly as a consequence of enhanced nutrient supply
- The bifurcation index provides a useful predictor of salmon survival for southern stocks in addition to (and distinct from) SST

Achnowledgements

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