Climate Change and Subarctic Fisheries

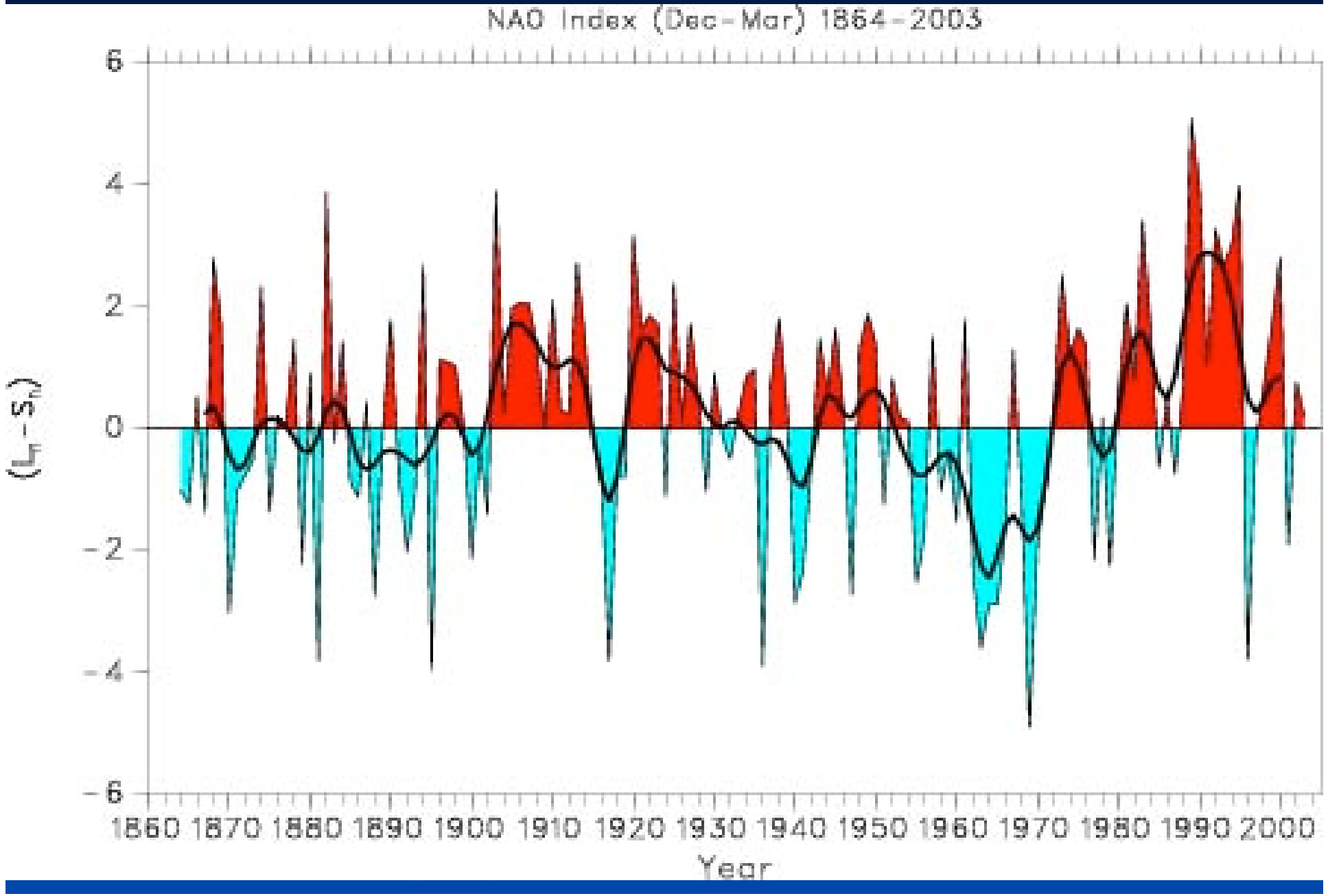
L. Hamilton

ARCSS Synthesis Retreat, 2004

"Climate variability, fish and fisheries" draft 6/2004

- "The close link between climate and fisheries is best illustrated by the effect of 'unexpected' events – i.e. non-seasonal and sometimes catastrophic…."
- Due to "the complex nature of biological systems and their ability to evolve with their changing environment…non-stationarity seems to be the rule, and this will prevent simple linear empirical models from being used as predictive tools"

NAO: North Atlantic Oscillation



North Atlantic Cod

world's most-studied fish

- **North Sea:** _NAO/warm … unfavorable (increase metabolic rates, decrease food).
- **Barents Sea:** _NAO/warm … favorable (higher primary production, zooplankton influx, more food, higher growth).
- **Newfoundland_Labrador:** _NAO/cold … unfavorable (slow growth, low food).

Atlanto-Scandian herring

- Abundance increased during warm periods, or low ice around Iceland, at the extreme north of their range. Decreased in –NAO/icy periods.
- +NAO/warm periods in NE Atlantic favorable (opposite for North Sea herring and others towards southern limit of range).

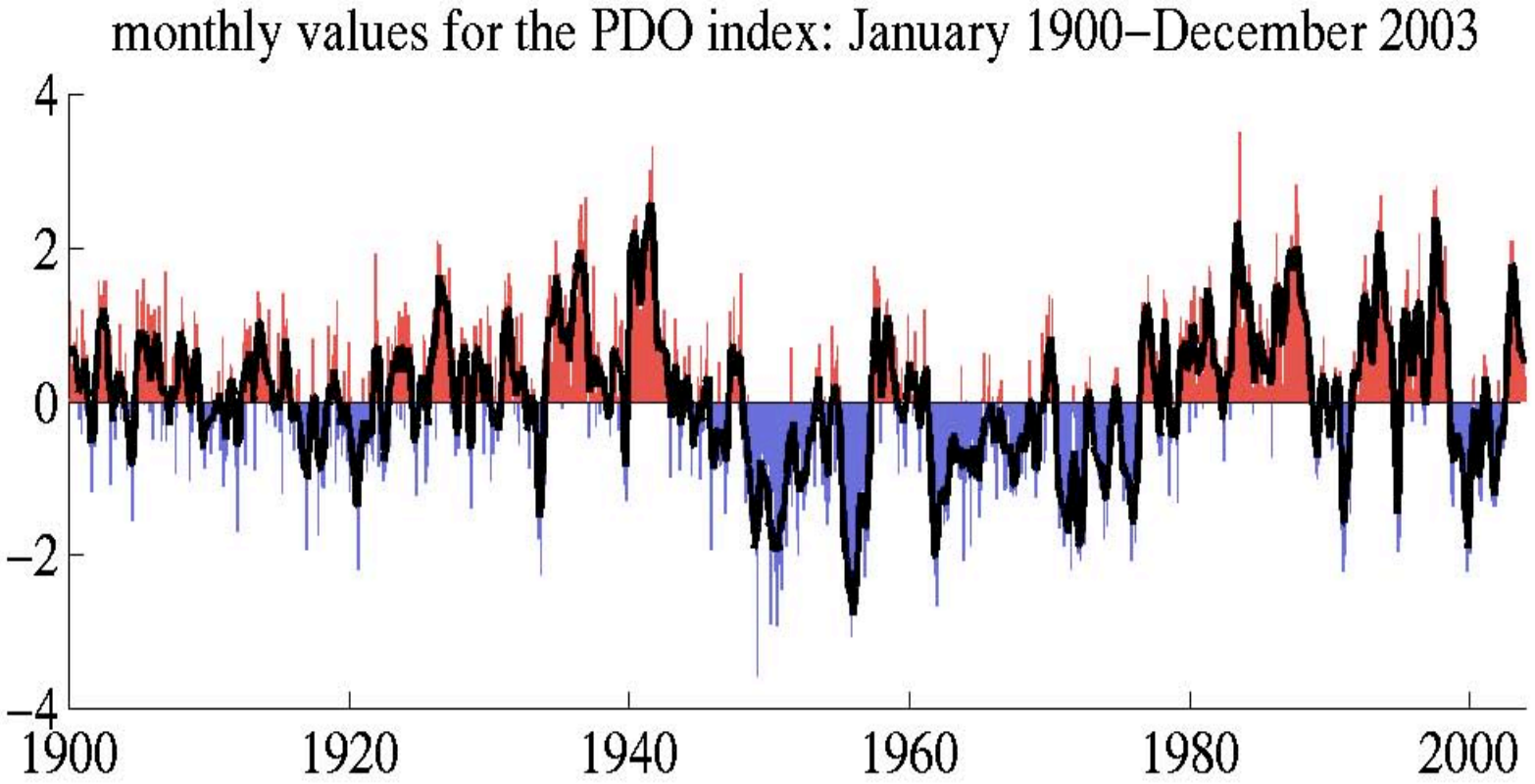
Generalizations from N. Atlantic

- Warmer conditions tend to benefit fish populations at the northern extreme of the species' range, harm populations at the southern extreme; colder conditions have opposite effect.
- But, "warm" or "cold" conditions typically involve other changes besides temperature, some of which might be more important – e.g., stratification, primary production, larval drift, storminess, hatching of prey species.

Evolutionary aspects

- Small pelagic species w/short lifespans (e.g. herring, capelin, shrimp) tend to be immediately sensitive to ocean climate.
- Longer-lived species (e.g. cod) adapted by "integrating" across decadal-scale variations; older individuals are reproductively robust.
- Fisheries remove large and old fish first, eliminating this climatic adaptation.

PDO: Pacific Decadal Oscillation

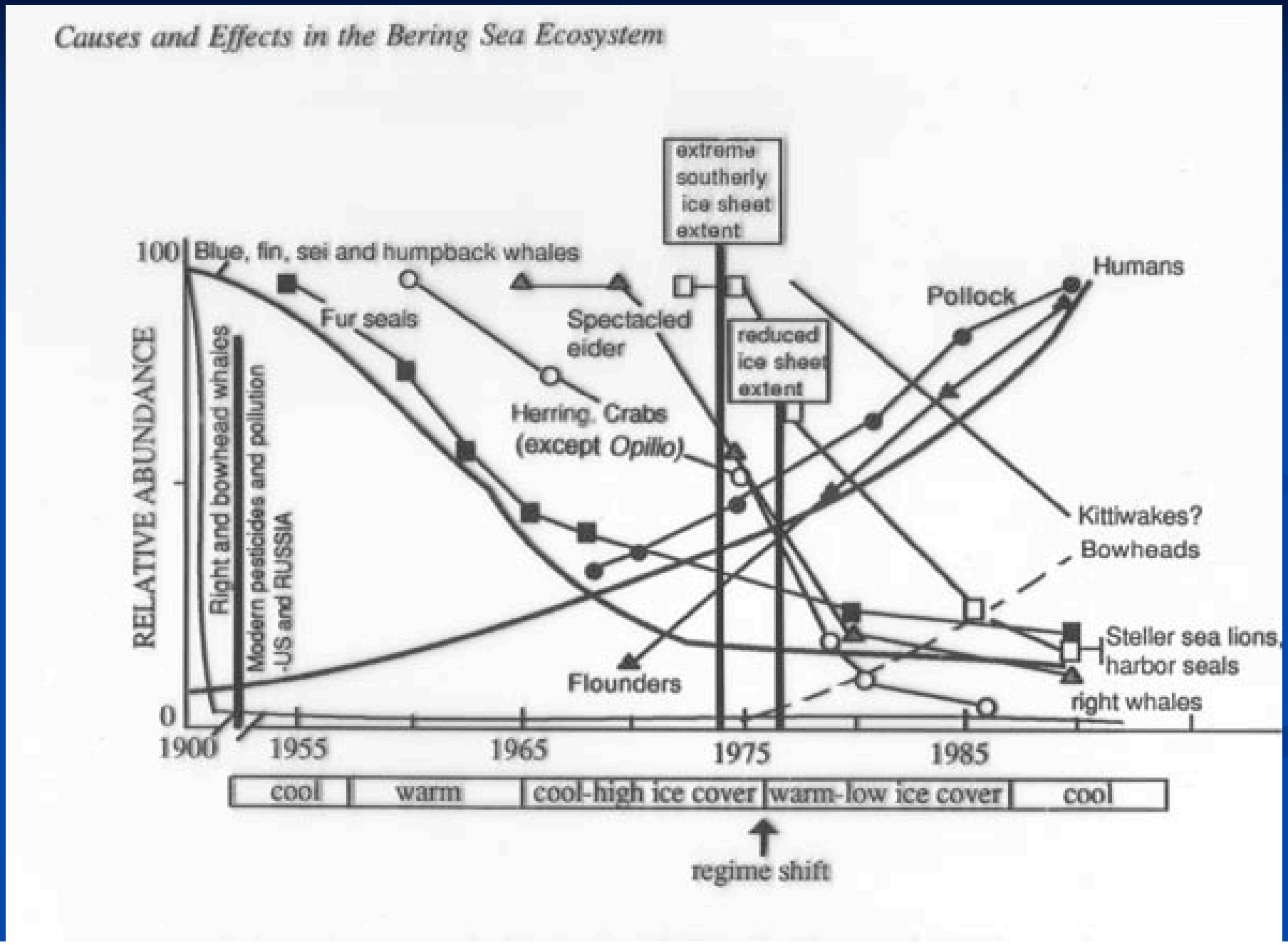


Northern Pacific fisheries

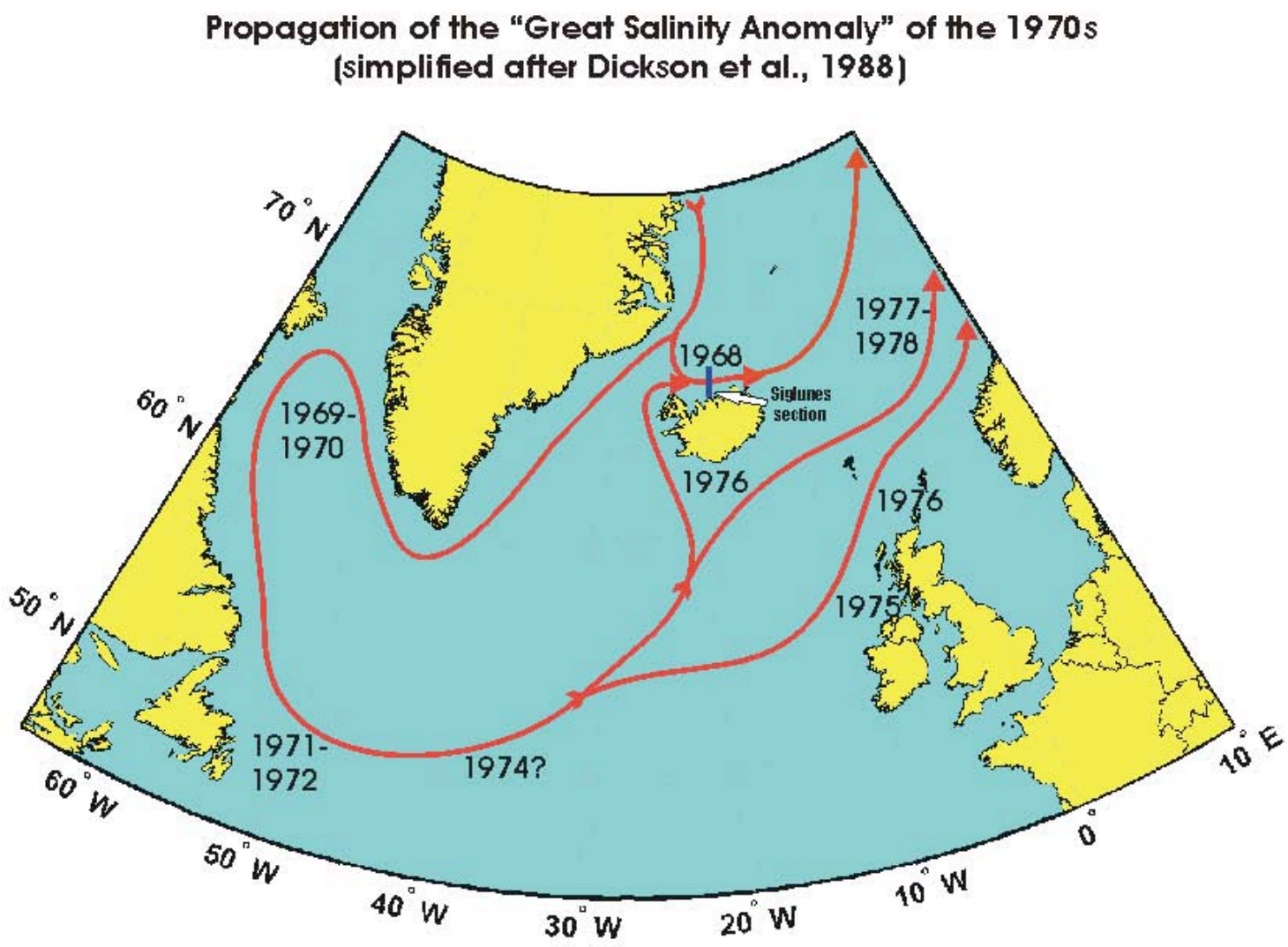
"regime shift," _PDO to +PDO, 1976-77

- **Alaska salmon**: +PDO/wet NE Pacific … favorable to abundance (water column vertically stable, more biological productivity, more food) but not size.
- **Groundfish**: (~50% US fisheries value) +PDO … favorable to some species' abundance, but not all (increased productivity). Again, abundance might be negatively related to size-at-age.
- Zooplankton timing favors some species over others.
- Intra- and inter-species interactions filter climate impacts.

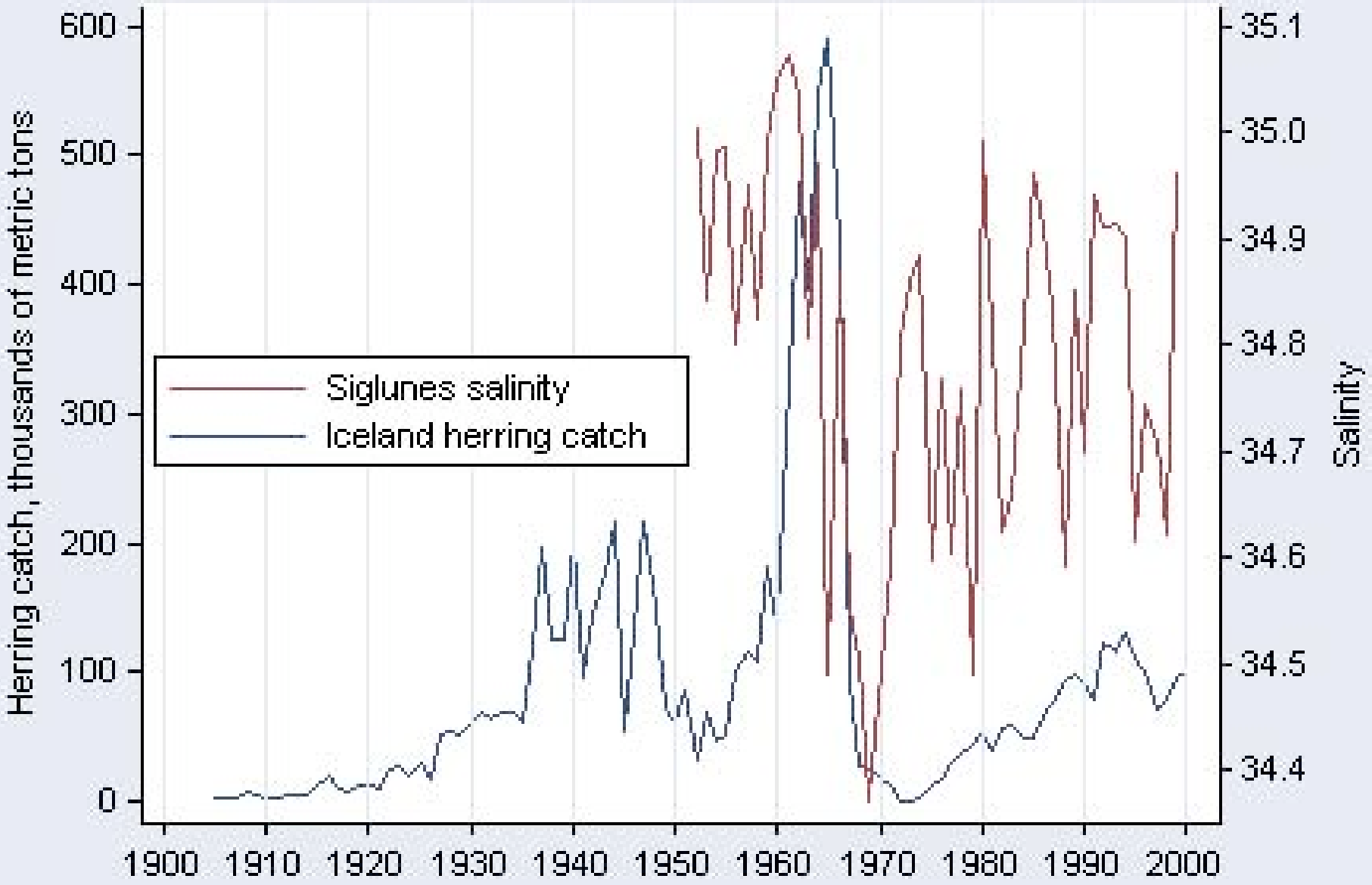
Regime change in the Bering Sea (Policansky 2004)



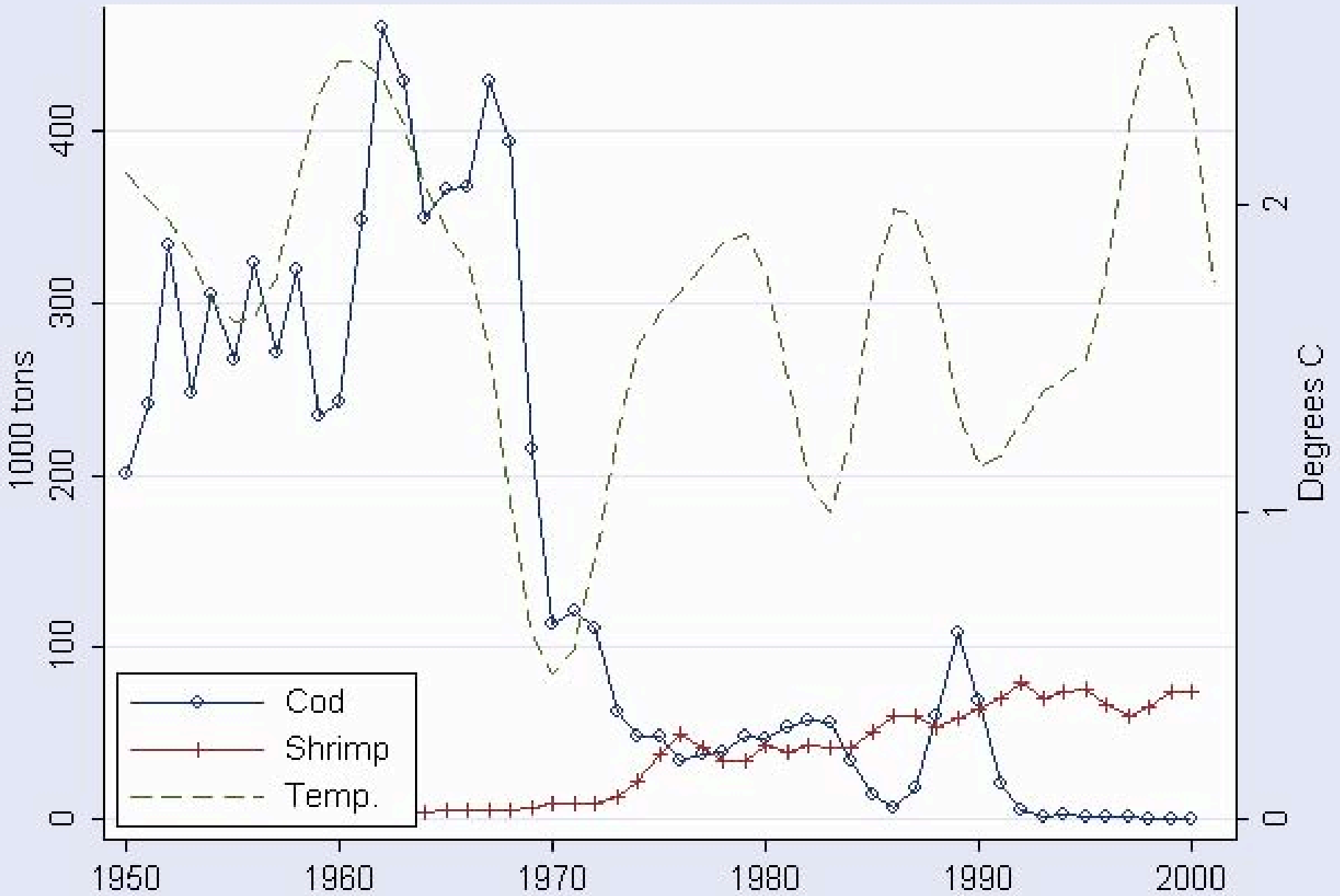
Great ice/salinity anomaly of 1966-78



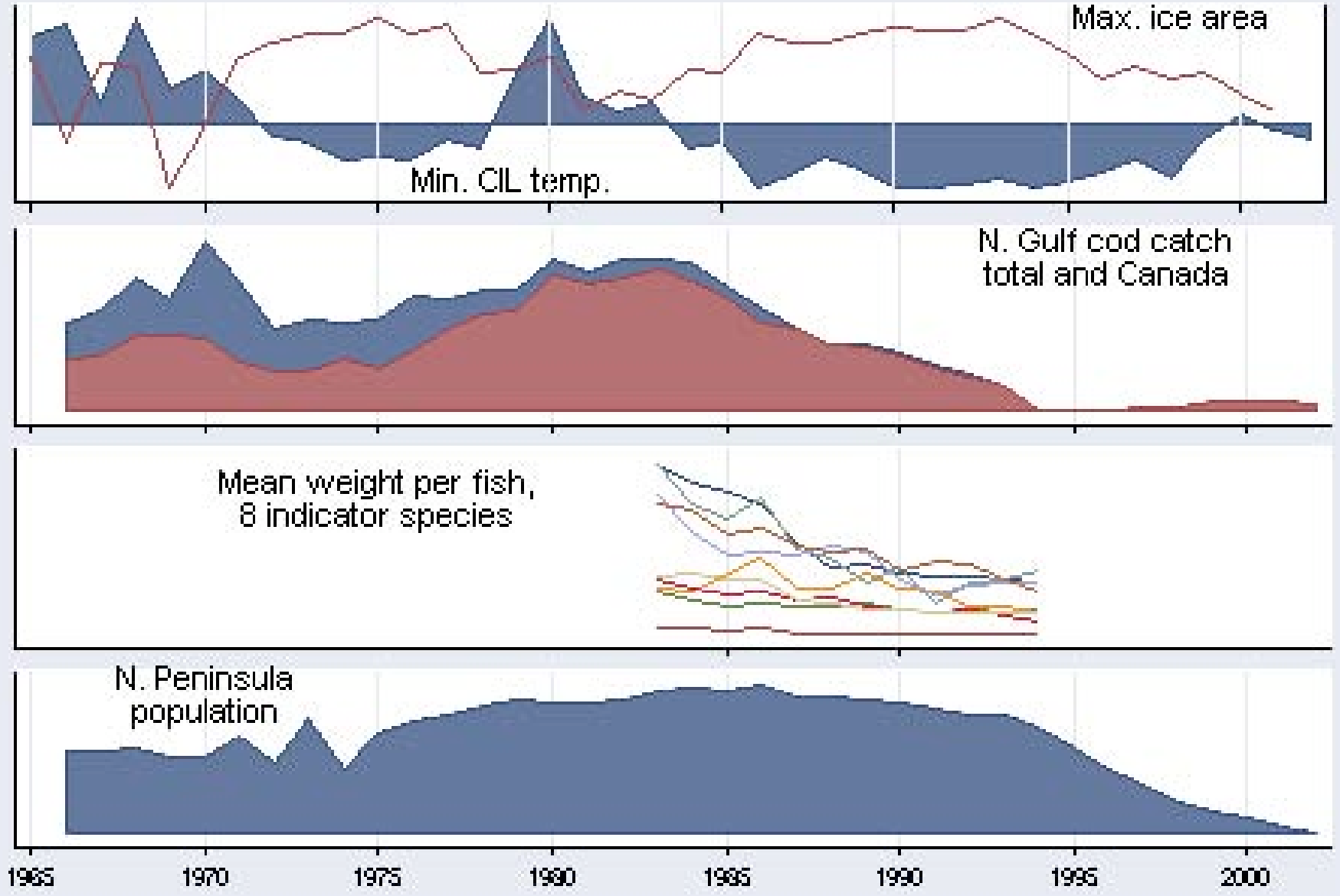
Iceland herring catch and salinity



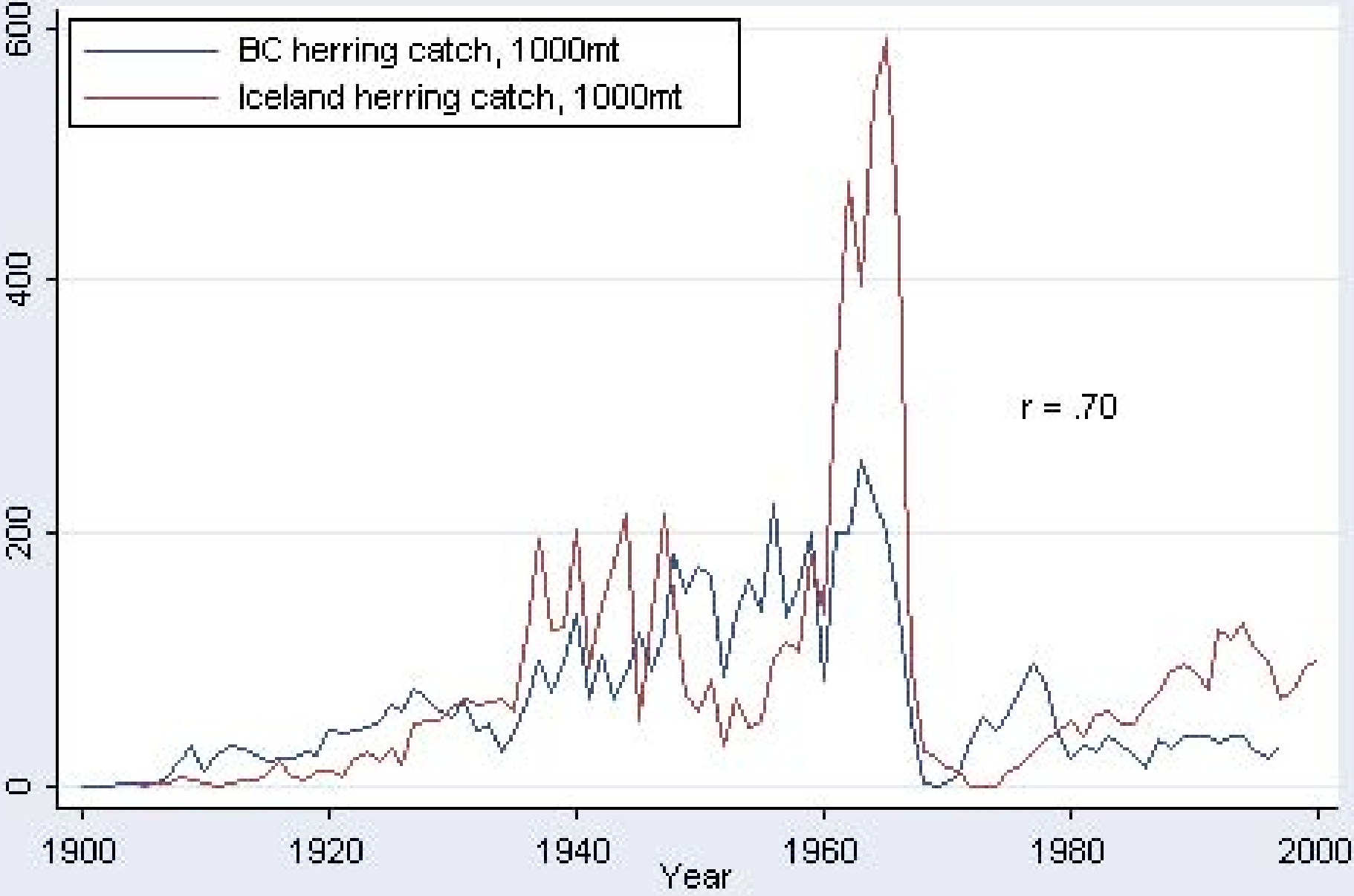
Greenland cod catch, shrimp catch, sea temperature



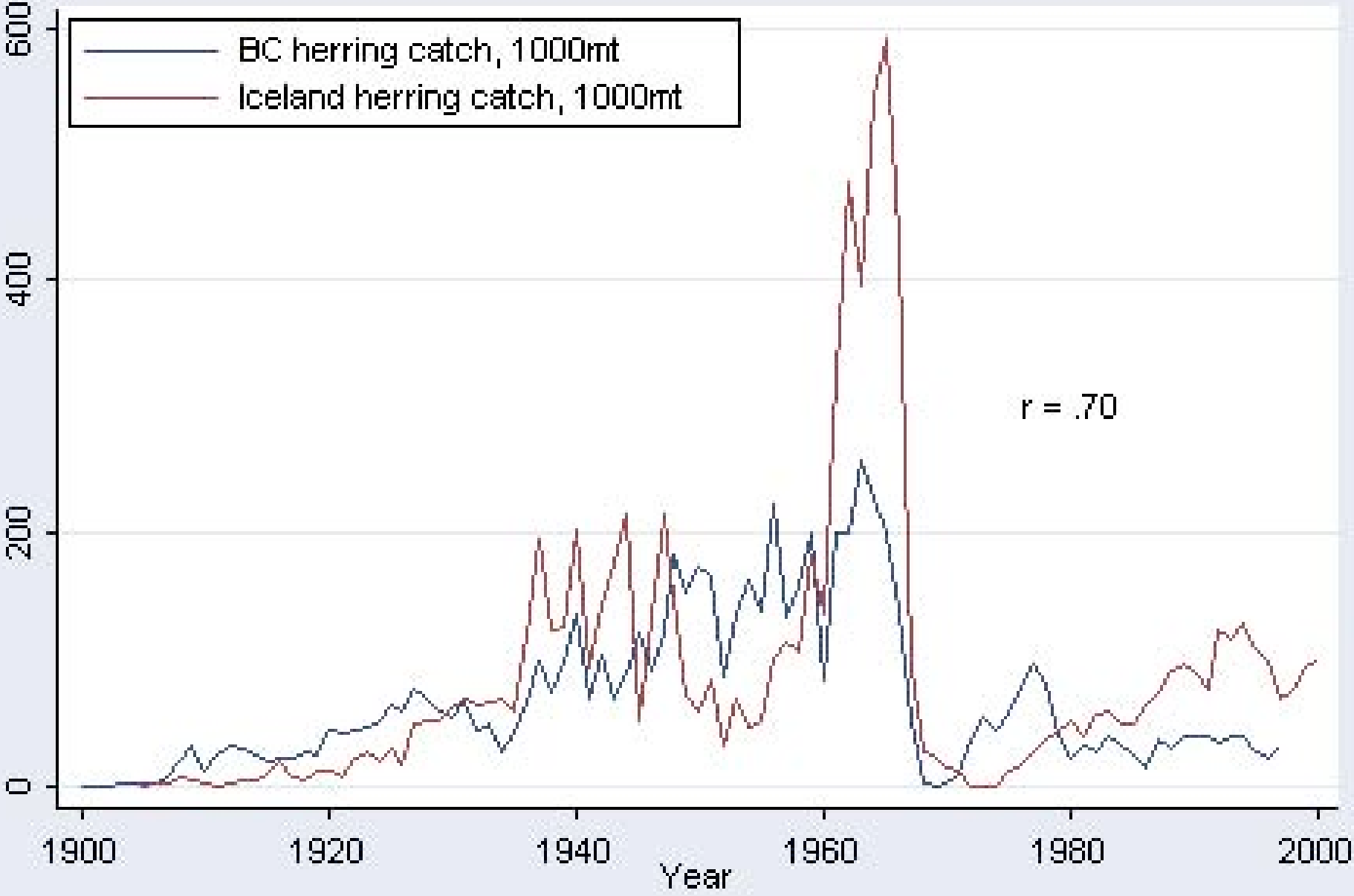
Integrating time series across disciplines: Newfoundland's Northern Peninsula and the northern Gulf of St. Lawrence



The "other" teleconnection … Humans



The "other" teleconnection … Humans



Regime change in the Bering Sea – a second look