In the Path of the Polar Front

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Introduction

Year-class strength or recruitment is a primary driver of fluctuations in fish stock size. Reliable estimation is often hindered by lack of data on early life history stages and limited knowledge of the underlying processes influencing survival through these stages.

These limitations often result in high uncertainty in recruitment estimates. Solution → develop regional indices that represent a hypothesized influence on a species' survival and integrate the index within a population model.

Case Study & Objectives

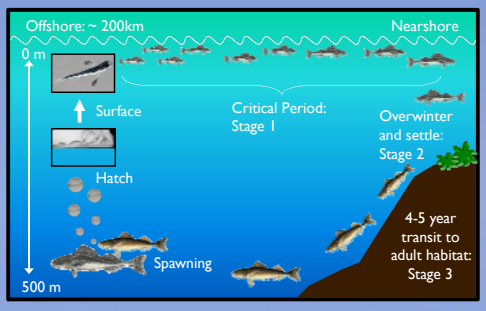
Species Focus: *Anoplopoma fimbria*, Alaska sablefish, a valuable commercial groundfish that lives in deep depths on the slope and has variable recruitment.

Hypothesis: Advection along the North Pacific Polar Front and associated currents plays a key role in shaping the climate of Alaska waters and the environment that sablefish encounter during their critical early life stages.

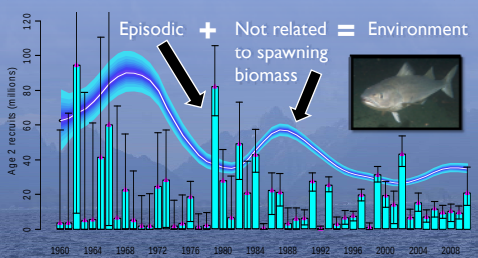
Primary Objectives:

1) Develop time series of sea surface temperature (SST) along Polar Front
2) Integrate series into sablefish model and test for reduction in uncertainty

Early Life of Sablefish:



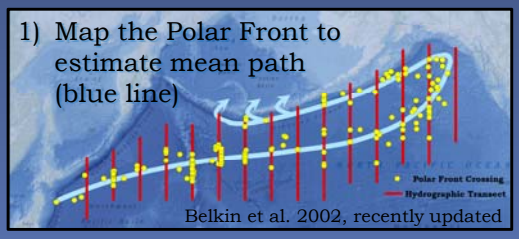
Recruitment & Spawning Biomass:



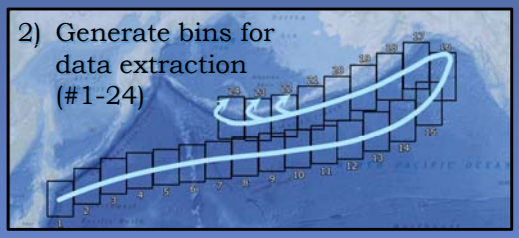
Methods

North Pacific Polar Front is associated with the dominant current systems in Alaska: North Pacific Current, Alaska Current, and Alaskan Stream.

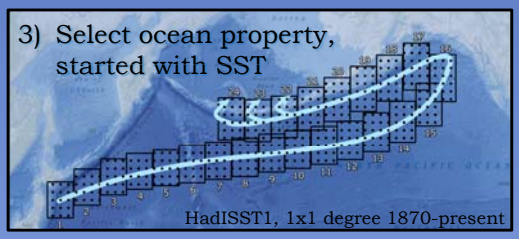
1) Map the Polar Front to estimate mean path (blue line)



2) Generate bins for data extraction (#1-24)

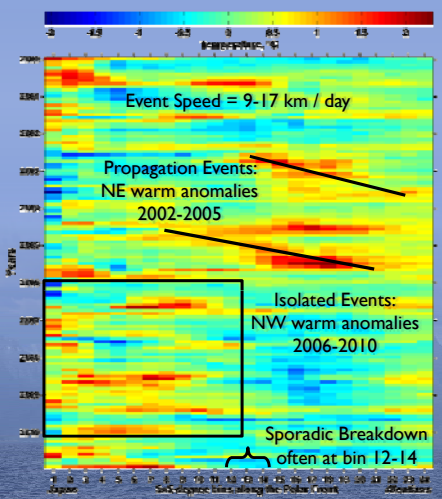


3) Select ocean property, started with SST



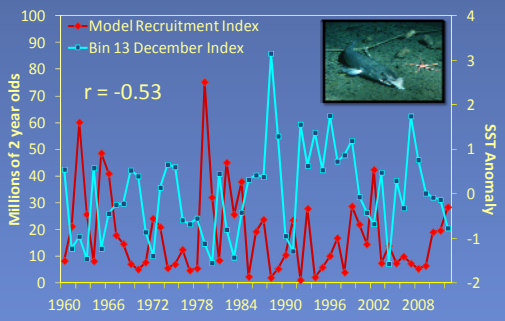
4) Extract time series by bin and month and calculate anomalies
5) Integrate time series into model (Maunder and Watters 2003)
6) Use multistage hypothesis testing to select best model and evaluate model impact (Deriso et al. 2008)

Results – Time Series SST



Results – Modeling

1) Monthly time series = +/- 1 year lags, pre-spawn to settlement
2) Multistage testing yielded five significant time series
   - Winter SST, bins 12-14, negative
   - Bin 13 December = best model
3) 17% reduction in unexplained variability from mean recruitment
4) Increased future projections of female spawning biomass in the medium term



Discussion

Our best model suggested that colder than average winter SST in the central North Pacific (CNP) represent oceanic conditions that create positive recruitment events for sablefish. The cold pool in the CNP is a hallmark of a strengthening Aleutian Low. Based on this result, we developed a conceptual model of sablefish recruitment that combined three staged mechanisms:

Ocean Domain Dynamic Synergy (What are the ODDS?)

1) Cold productive water advected to slope domain aids sablefish larvae
2) Increased eddy activity enhances condition of entrained sablefish
3) Highly stratified coastal waters sustain food for juvenile sablefish

Future research includes developing other proxy time series that support this conceptual model, investigating variability of the Polar Front path, and identifying impact of the path on other ocean features (e.g. Alaskan Stream).

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