

# Interactions between marine mammals and chinook salmon in a Strait of Georgia ecosystem model

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# Outline

- The Strait of Georgia Ecopath/Ecosim model
- Simulations of the past
- Model results
- Future work

# Model Components

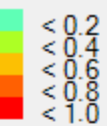
- Mass Balance

- Biomass
- Mortality
- Consumption Rate
- Diet Composition
- Fishing

- Dynamic

- Driver time series
- Reference time series
- Top-down dynamics
- Bottom-up dynamics

Diet



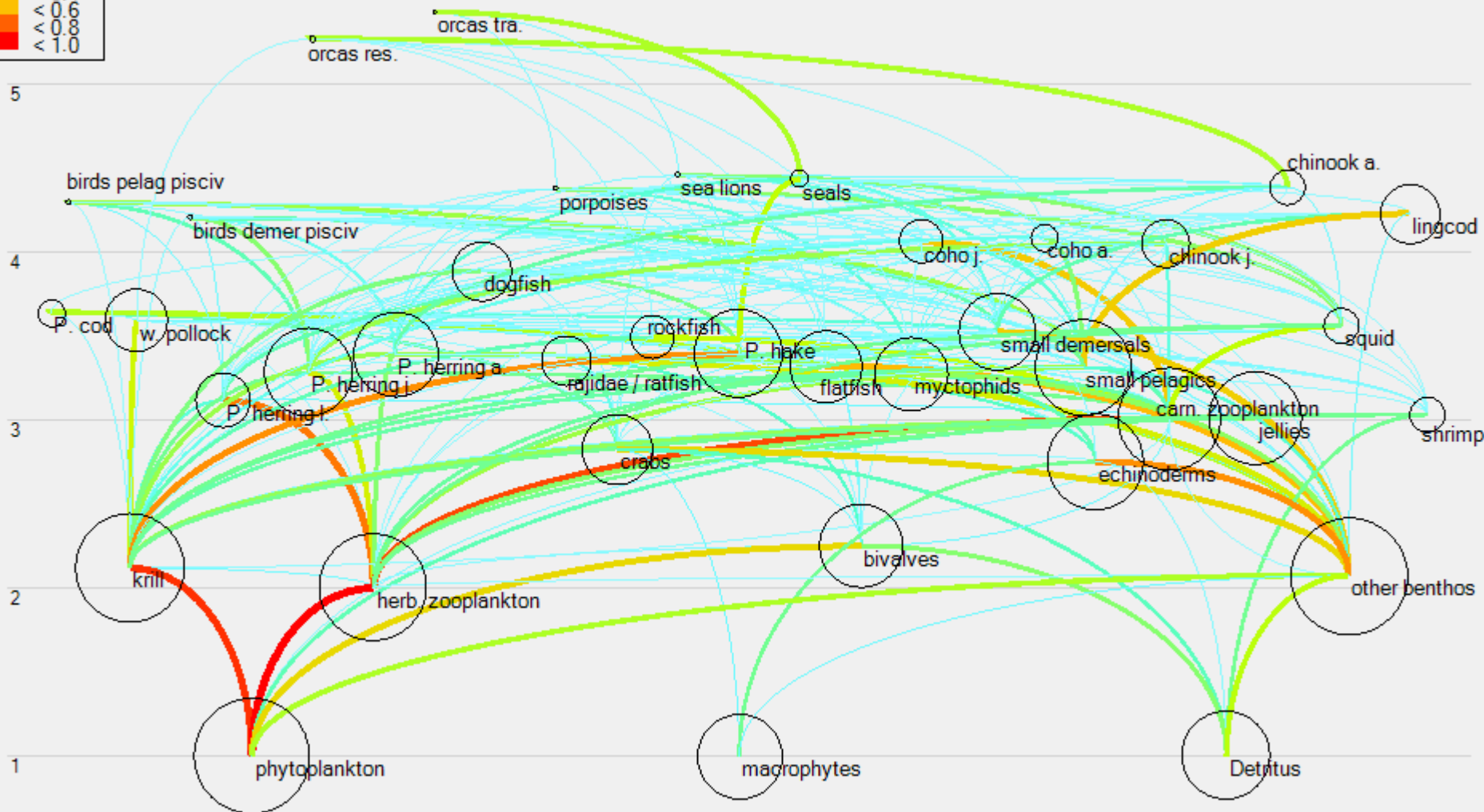
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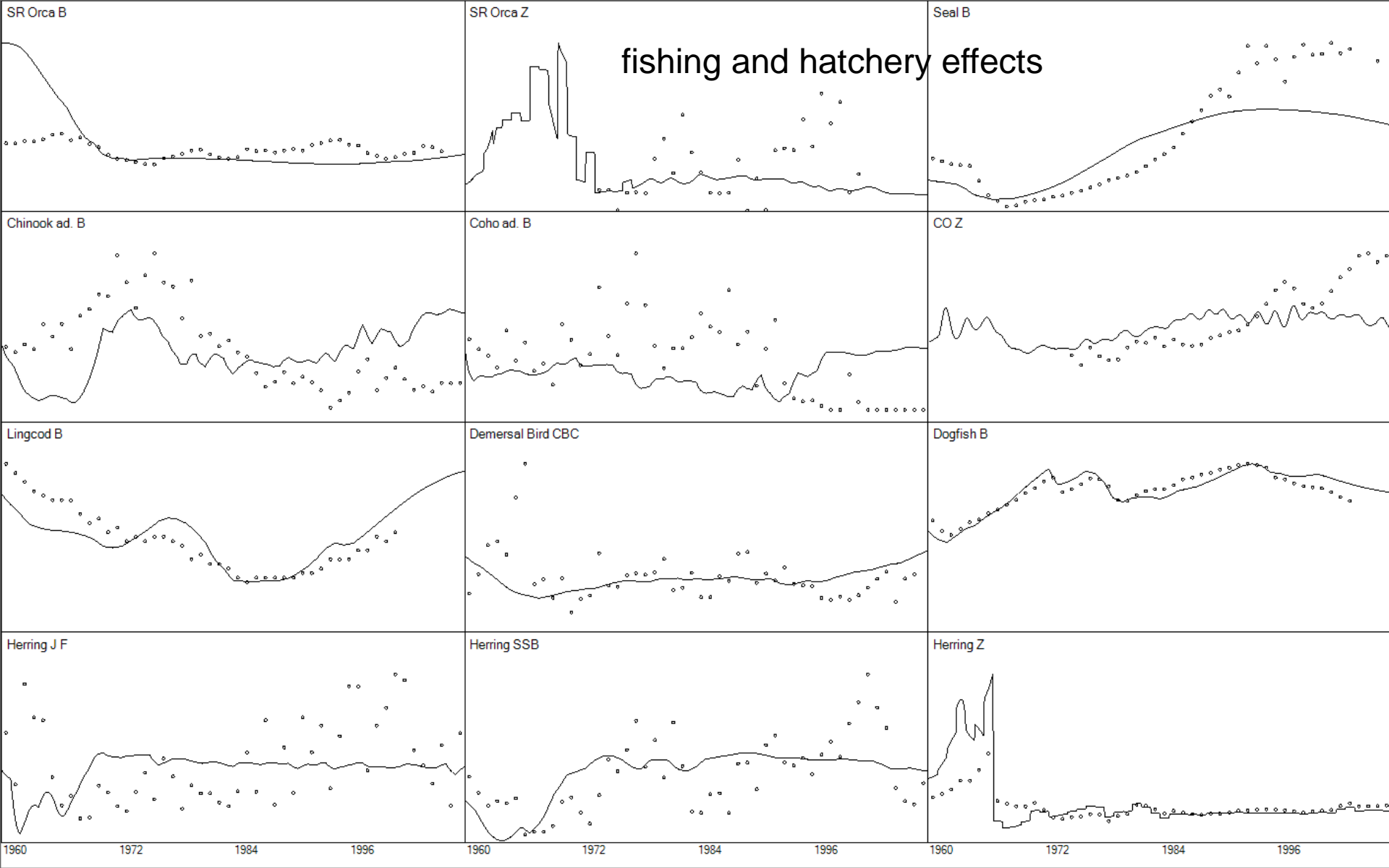
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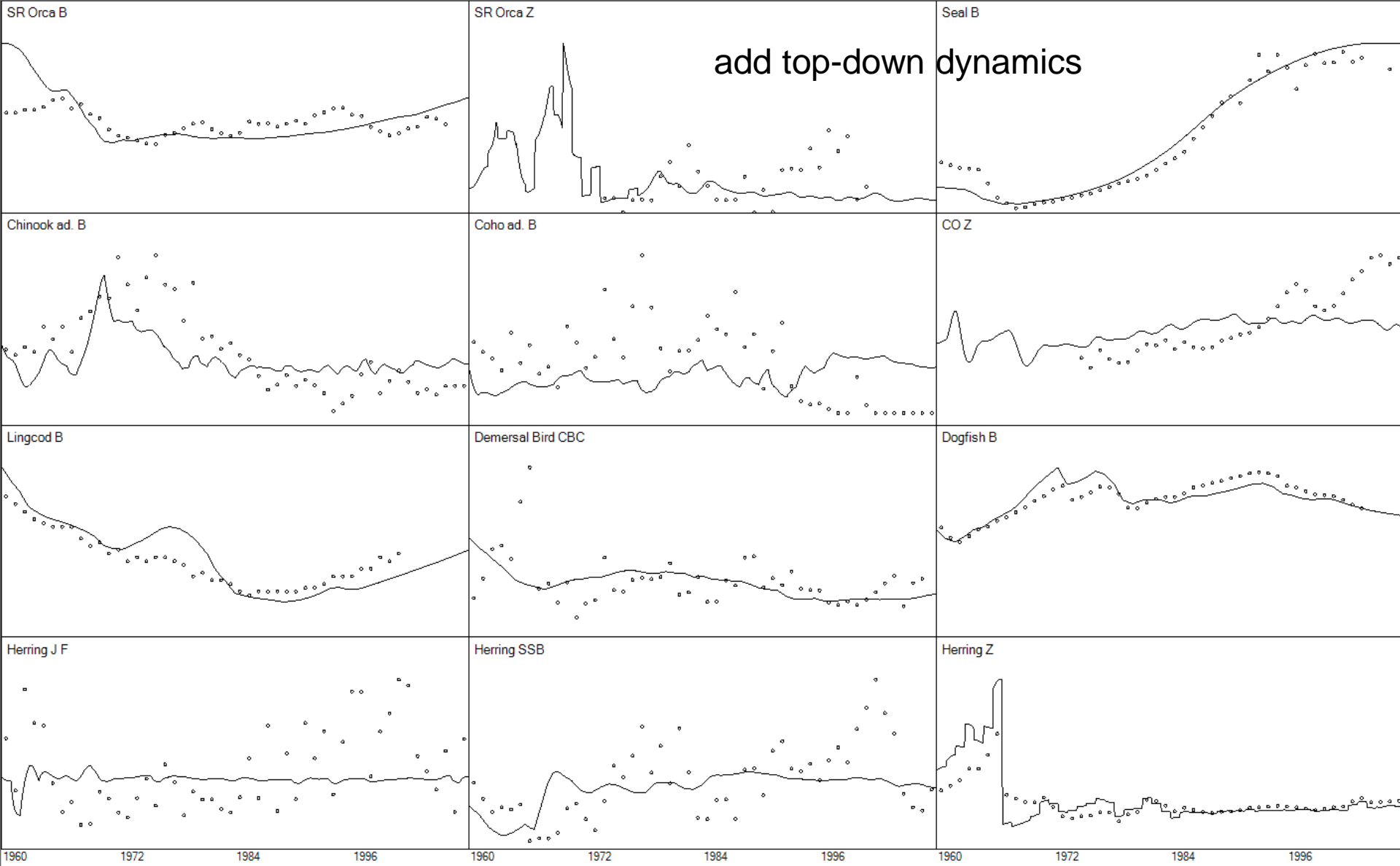
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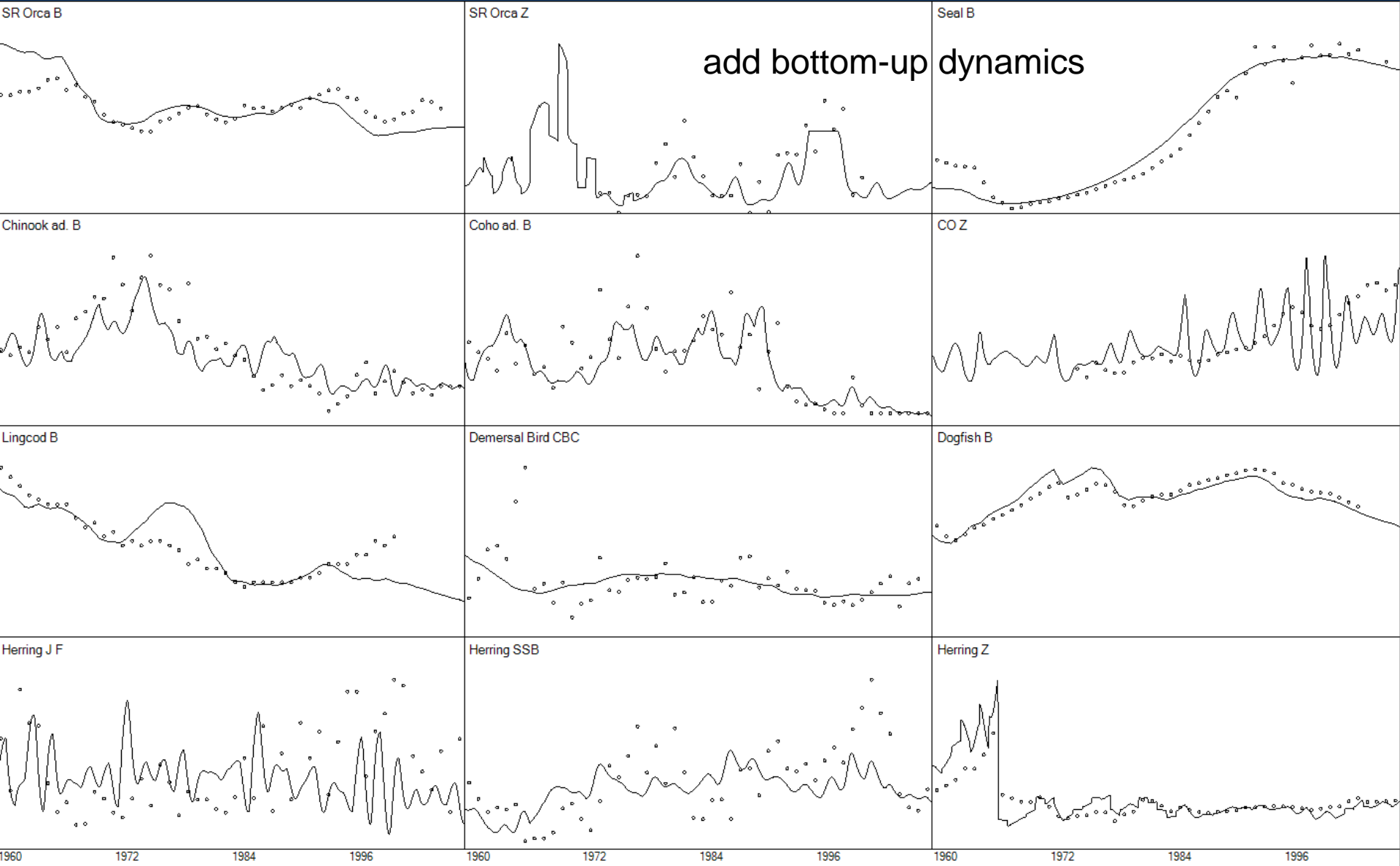


# Simulating Dynamic Changes

- Initialise simulation with 1960 model
- Run with hatchery and fishery effects.
- Add predation effects on mortality changes in prey species
- Add climate effects by estimating annual anomalies in primary production
- The following figures show reference time series as dots and tuned Ecosim hindcast as lines

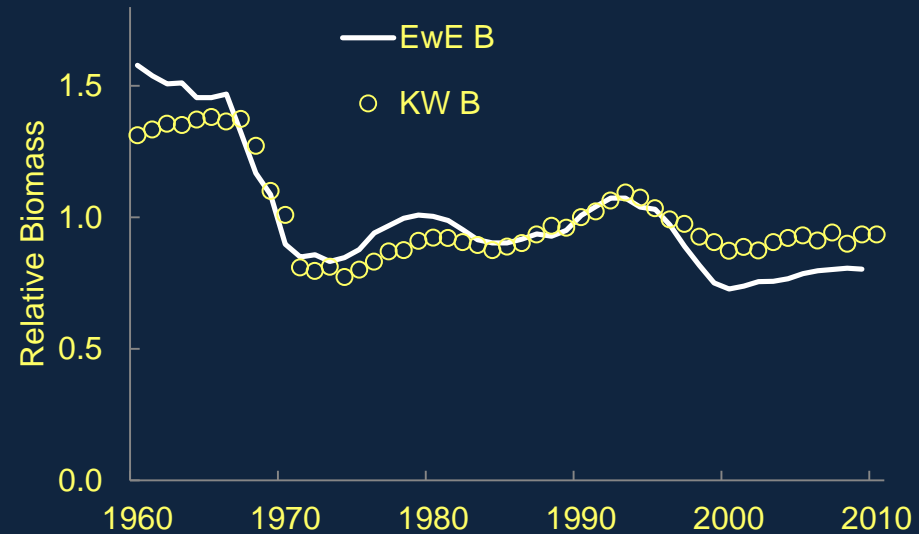
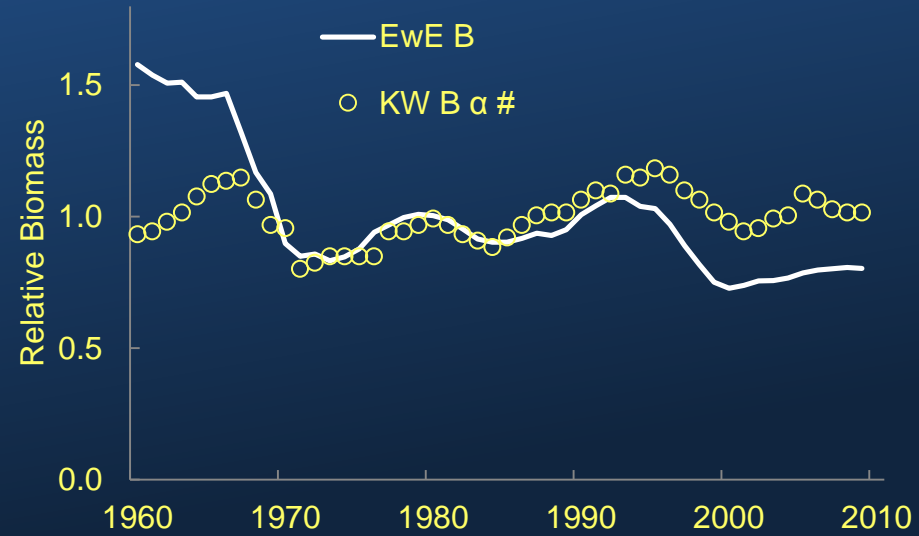




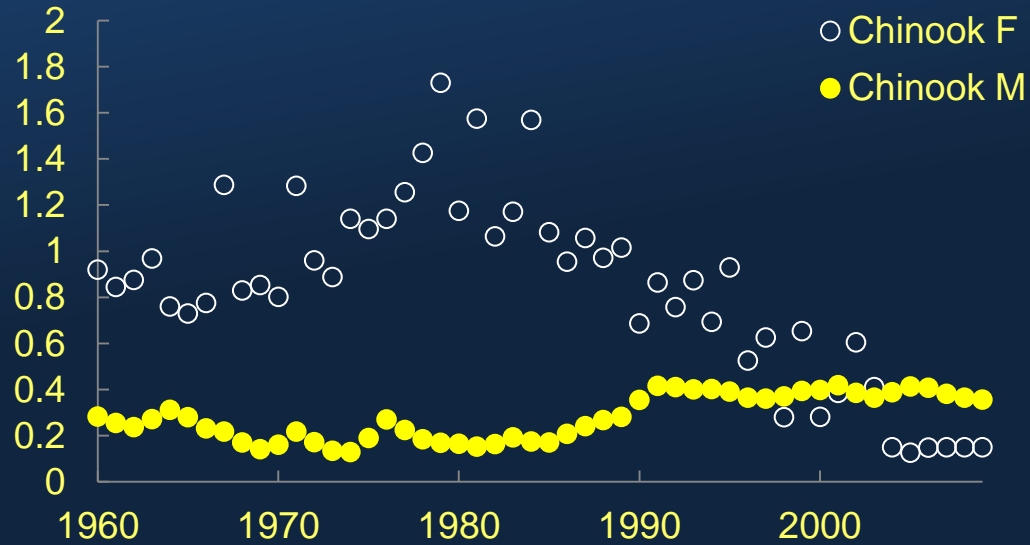




# New Killer Whale Biomass Estimate

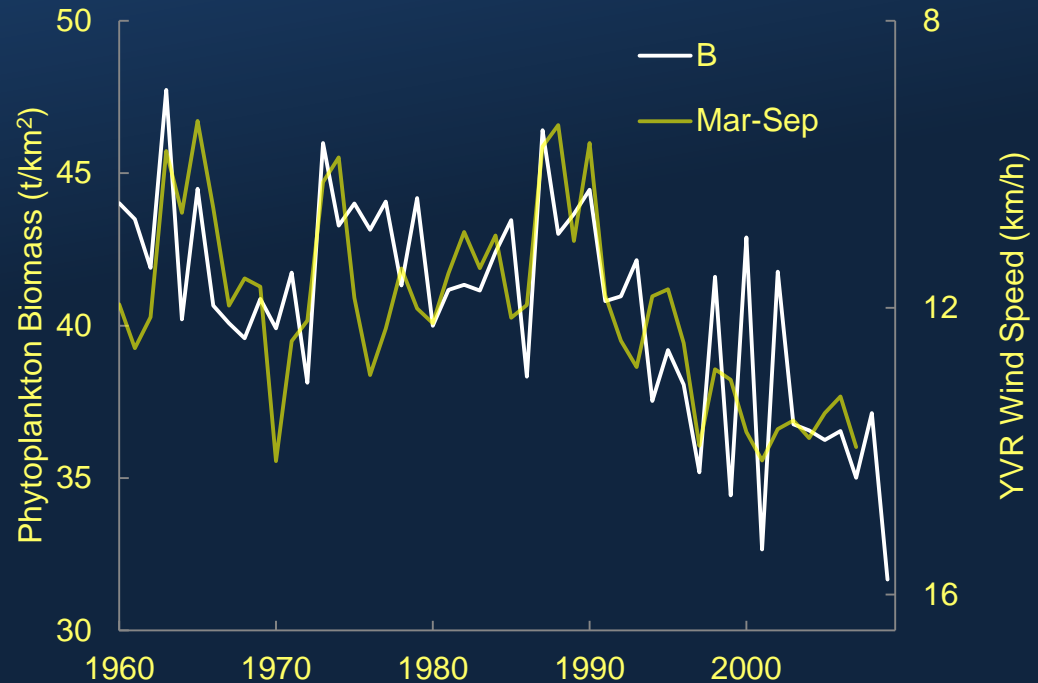


# Changes in Fishing vs Natural Mortality



# A Potential Link to Climate

- Ecosim primary production anomaly is negatively correlated to wind in all months
- Correlations strongest in March to September, when averaged over all seven ( $R^2 = 0.43$ )
- Dramatic decline in modelled phytoplankton biomass after 1989 and change to higher summer wind velocity



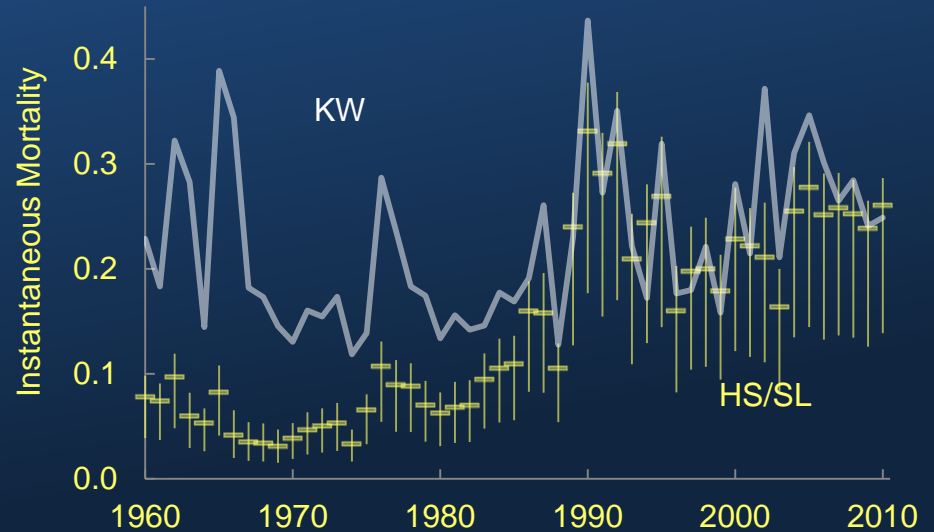
# Mean trophic level of predators changes in the Strait of Georgia simulation

- Stable until early 1990s
- Steady decline from 1990 to 2009



# Three scenarios of seal and sea lion effect on chinook mortality

- Low: CK 1% of HS+SL diet
- Medium: CK 2% of HS+SL diet
- High: CK 2% of HS diet and 5% of SL diet



White line: Simulated chinook mortality caused by killer whale predation

Yellow lines: Low to high range of chinook mortality from varying seal/sea lion diet composition, yellow dash is the medium scenario

# Potential for the Future

- Most important links to Killer Whales can be parameterised quite accurately
- Developing what if scenarios to explore the influence of future production regimes on salmon and marine mammal production
- Improve resolution in modelling Northern Resident KWs, Transient KWs, and sea lions
- Expand scale to include the whole geographic range of SR KWs
- Develop a strategic gaming tool to explore policy options