The Management Strategy Evaluation Approach and the Gulf of Alaska walleye pollock fishery

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Overview

- What is the Management Strategy Evaluation approach?
- Components of the MSE
- Initial results
- Preliminary conclusions
- Next steps

What is Management Strategy Evaluation?

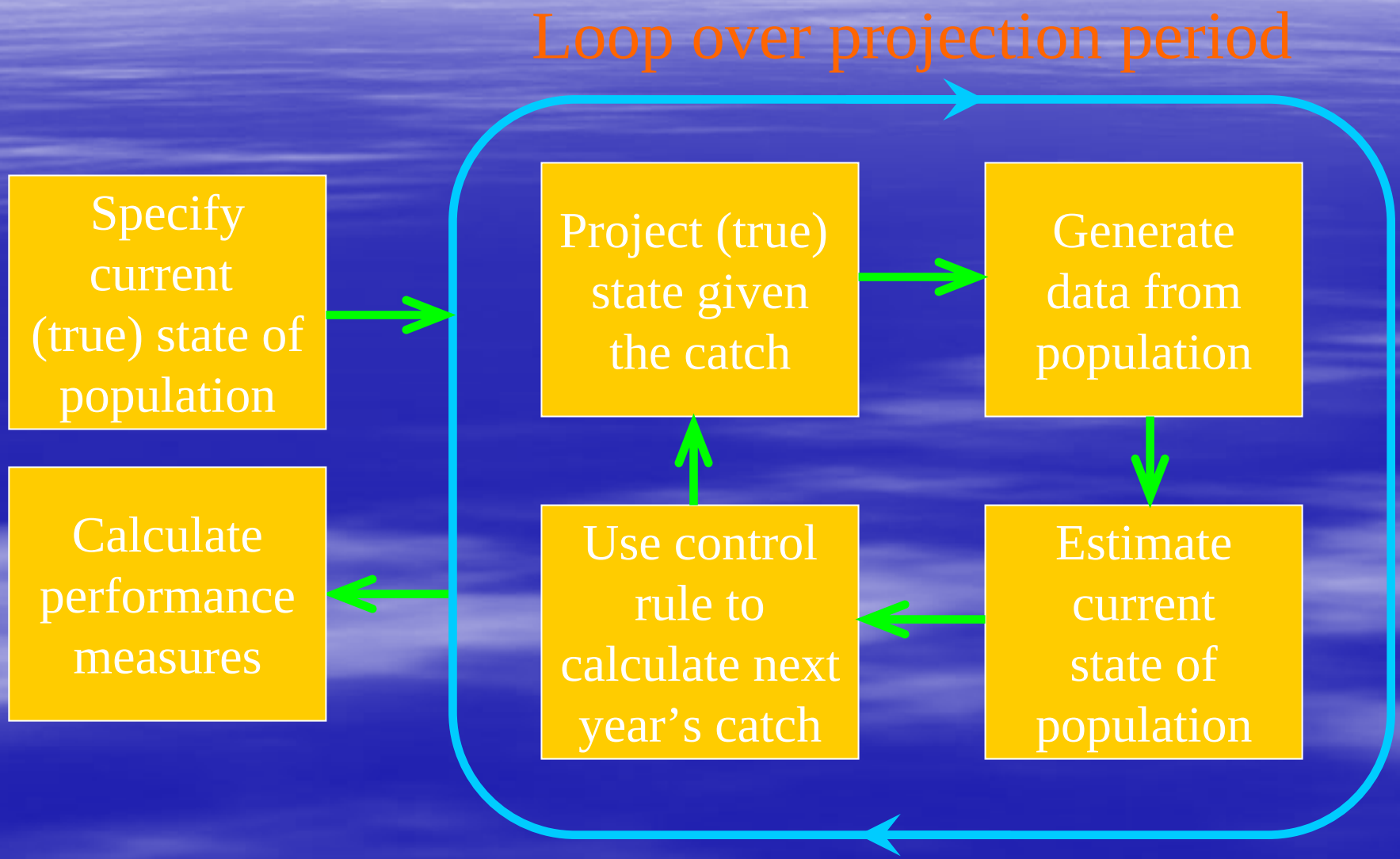
- Simulation testing of the complete management system:
  - data collection systems;
  - assessment methods; and
  - catch control rules

  evaluation using metrics defined in terms of the management goals and objectives
- Why perform an MSE?
  - Assess the impact of error and uncertainty on the ability to achieve management goals

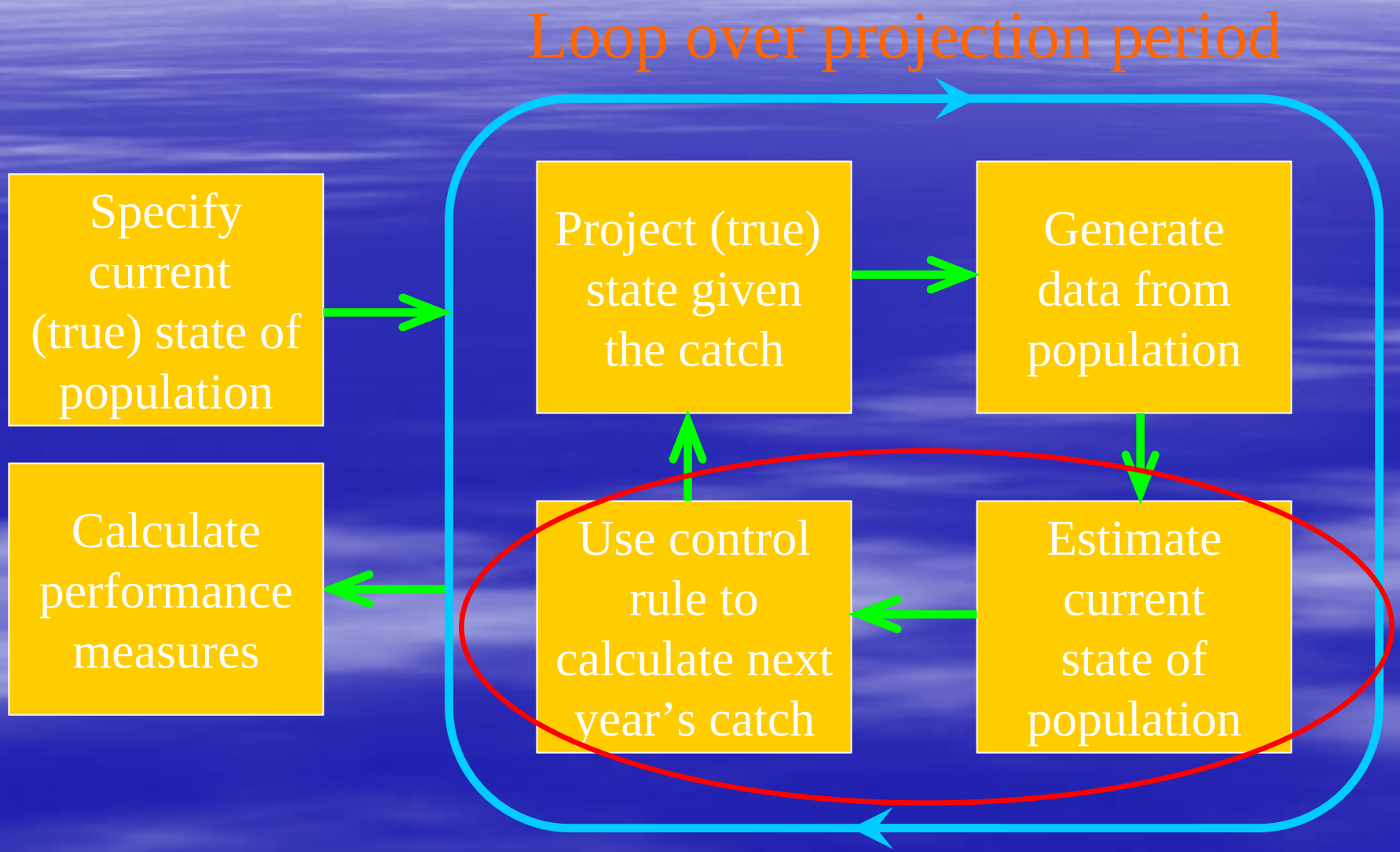
The Management Strategy Evaluation components

- The operating model:
  - simulates the “true” state of nature
  - generates the data used for management purposes
  - applies management decisions to the “true” population
- The stock assessment model:
  - defines the “perceived” state of the system
  - estimates stock status and biological reference points
- The catch control rule:
  - determines management decisions based on the results of the assessment
- The performance measures:
  - statistics that quantify management goals and objectives

The MSE Approach



The MSE Approach



Uncertainties

Key Types

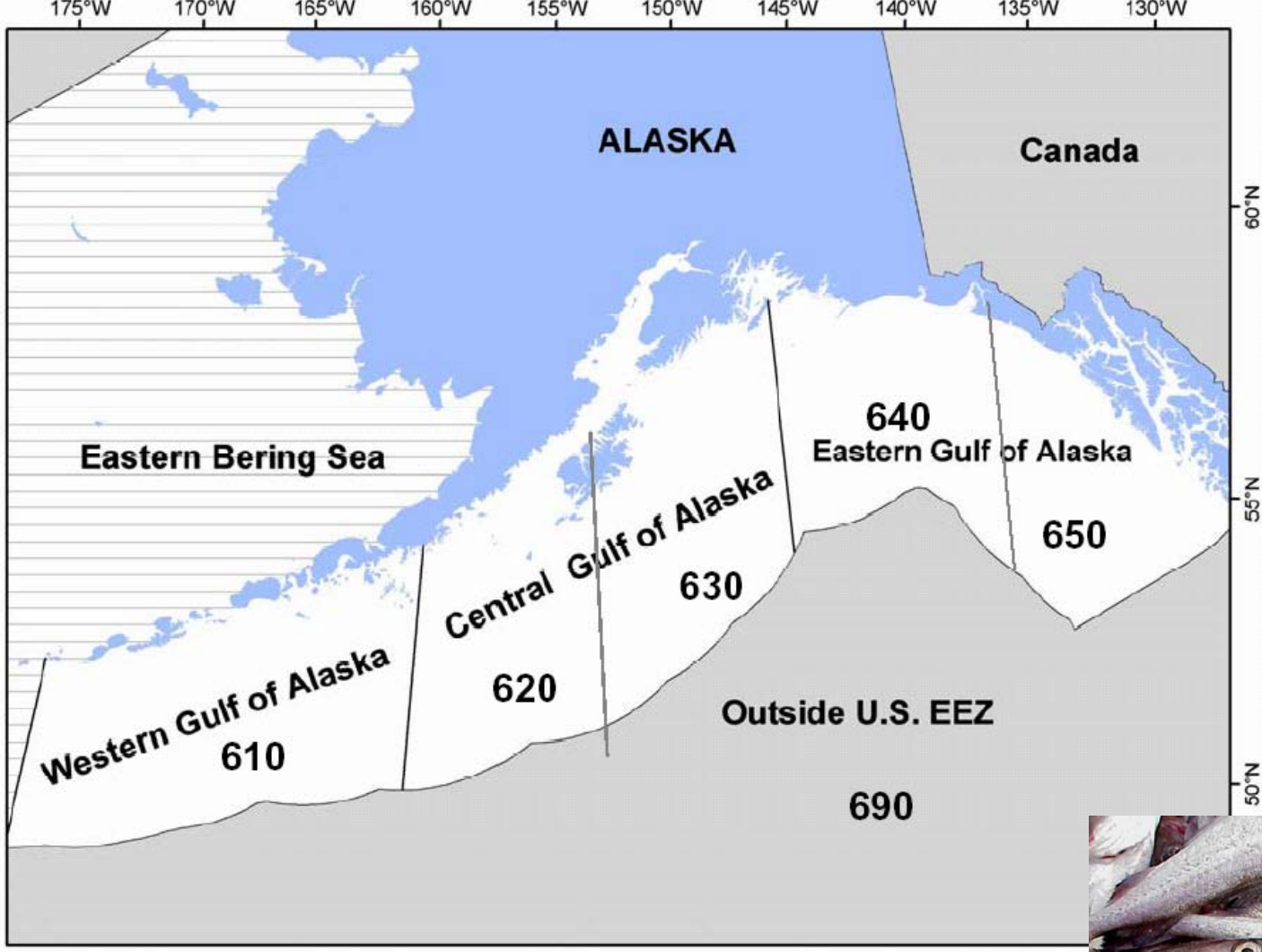
- Process error
- Observation error
- Model error
- Implementation error

Examples in MSE

- Recruitment variation; predation impacts on *M*
- Fishery, survey and ageing errors
- Form of the stock-recruitment relationship; alternative hypotheses (e.g., effects of climate)
- Are catch levels implemented as expected

Key Questions For The Gulf of Alaska Pollock Fishery

- Is the current management system robust to:
  - process and observation error;
  - changes over time in the ecosystem composition and multi-species interactions; and
  - the influence of climate variability and regime shifts?
- Can the current management system be modified to perform better given these uncertainties?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55°N
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ALASKA
Canada
Eastern Bering Sea
640
Eastern Gulf of Alaska
650
Central Gulf of Alaska
630
620
Western Gulf of Alaska
610
Outside U.S. EEZ
690

The Operating Model

Currently

- Age-structured model similar to the stock assessment model
- Projection parameter values based on fits to actual data (MCMC)
- Generates projection fishery and survey data
- Applies catch control rule

In Development

- Natural mortality focused by predator interactions (Ecosim model linked to an age-structured model for pollock)
- Recruitment influenced by climate variability (regime shifts / slow changes in parameters)

The Management Strategy

Stock Assessment

- Age-structured model
- Average level of recruitment
- Fits to fishery, survey, and age/length-composition data
- Calculates biological reference points

Catch Control Rule

- Uses biological reference points $F_{40\%}$ and $SB_{40\%}$
- Sets an acceptable biological fishing mortality and catch level based on the estimate of spawning biomass

The Performance Measures

- Estimation measures:
  - how well does the assessment method estimate the true spawning biomass and fishing mortality?
- Management measures:
  - How well does the management strategy satisfy the management goals:
    - probability that the spawning biomass is below $SB_{20\%;}$
    - probability that the fishing mortality is exceeding the overfishing threshold;
    - status of the stock relative to the target level; and
    - average, total, and interannual variation in catch

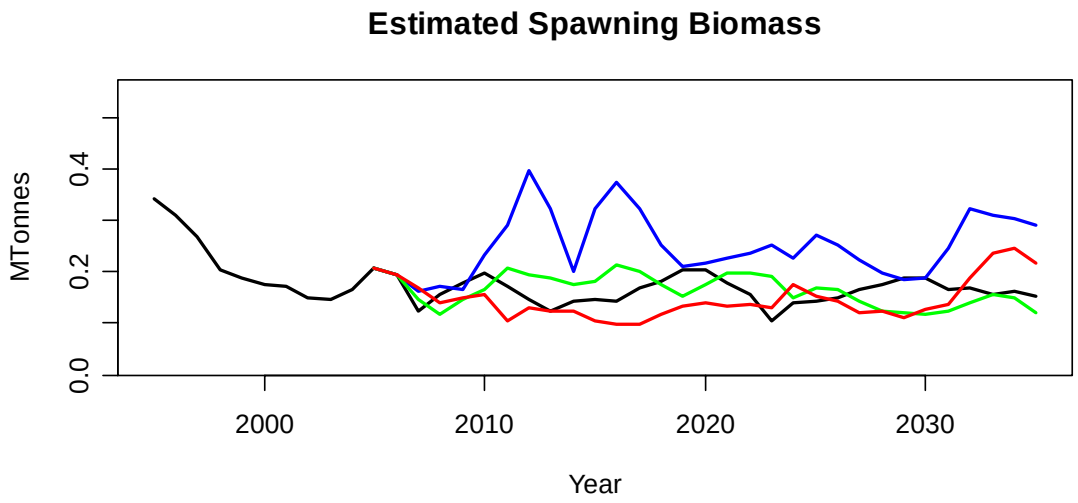
Initial Simulations and Results

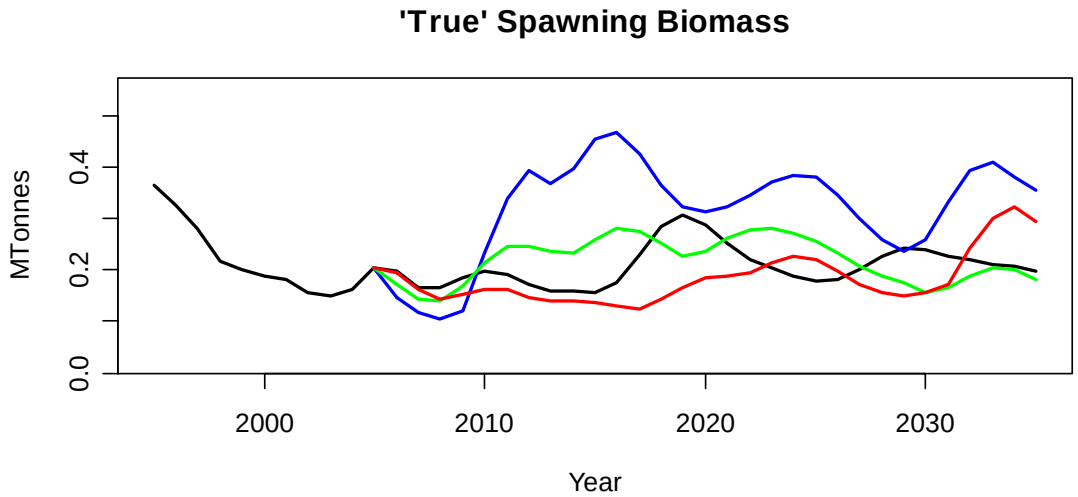
Does The Management Strategy Work Under Ideal Conditions?

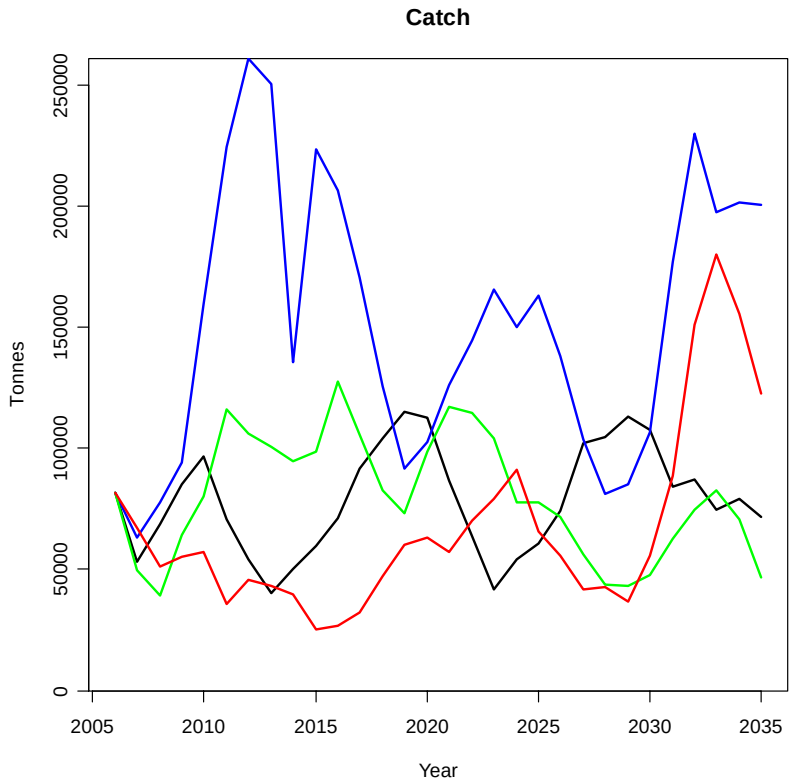
- The operating model and assessment models are very similar in structure
- Process error is applied to recruitment
- Observation error is applied to the generated fishery and survey data
- No implementation error is applied

If the management strategy fails this test, there is little point considering more complicated operating models.

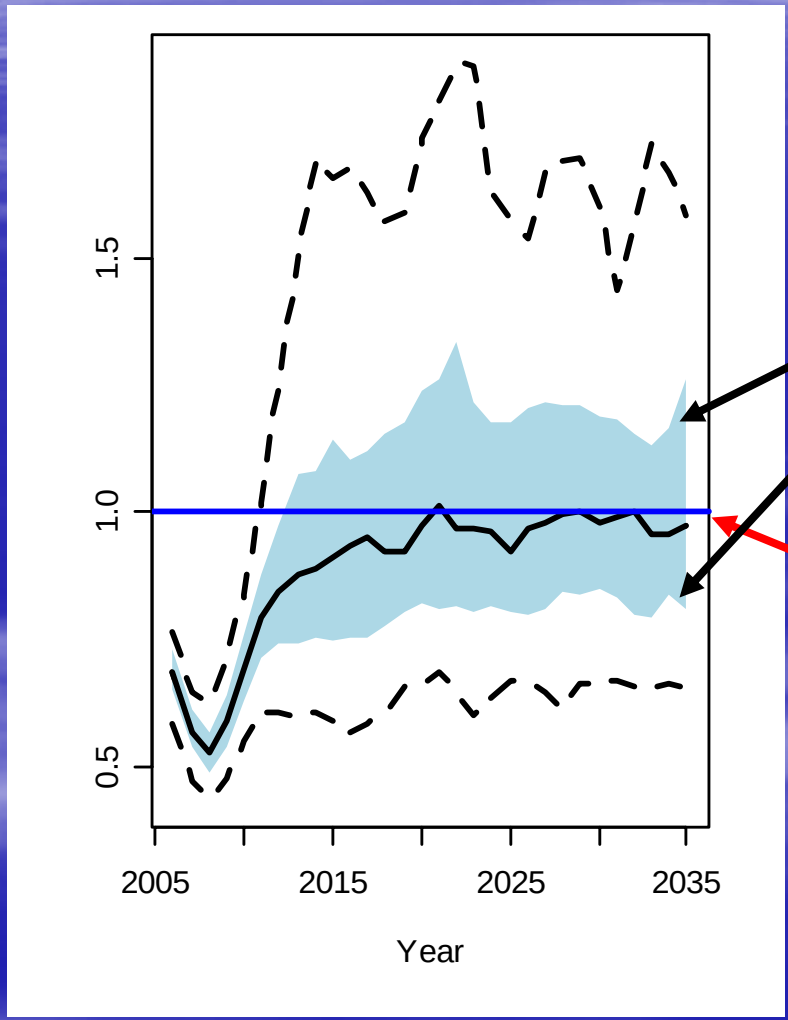
Simulation trajectories







Management Performance
(Is the spawning stock near the target level?)

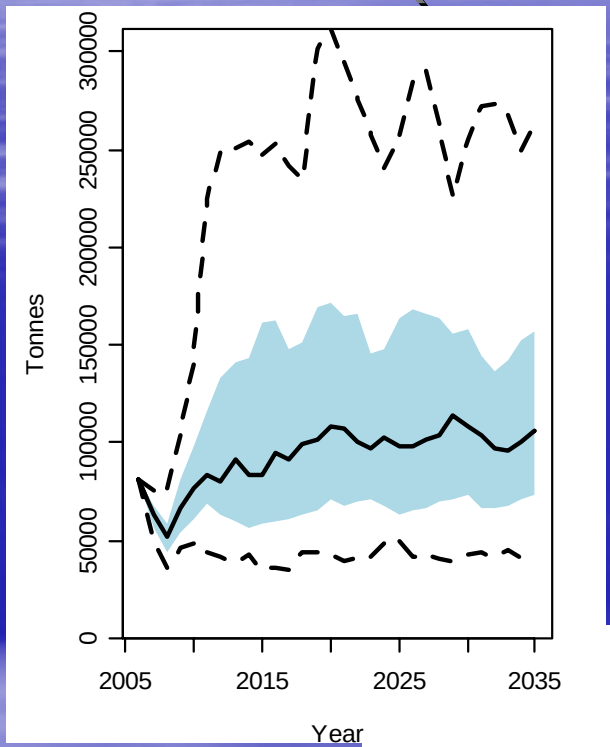


Inter-simulation quantiles

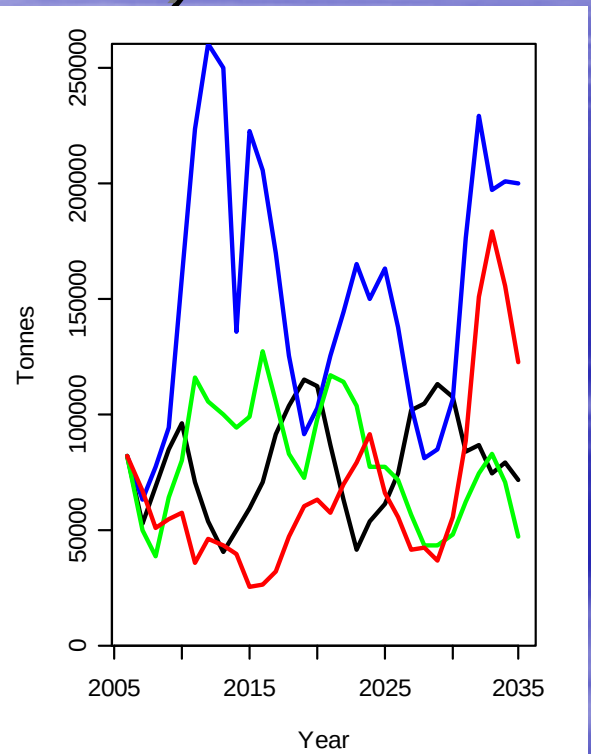
Target level

The stock is close to the target level on average

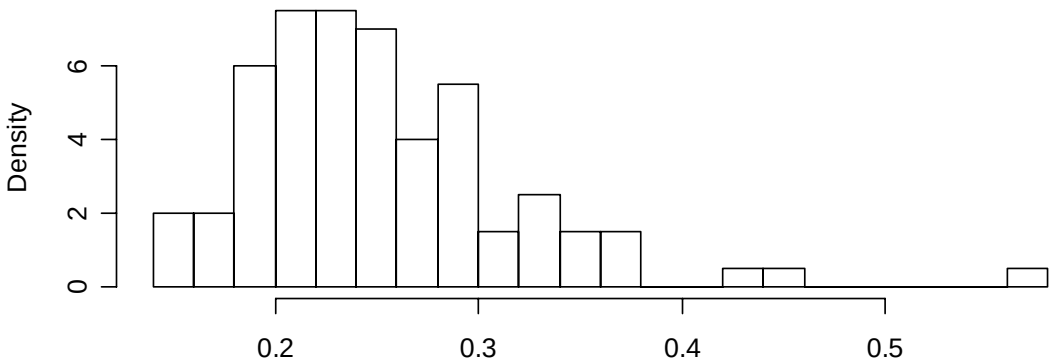
Management Performance
(Catches and catch variation)



Catches vary considerably from one simulation to the next

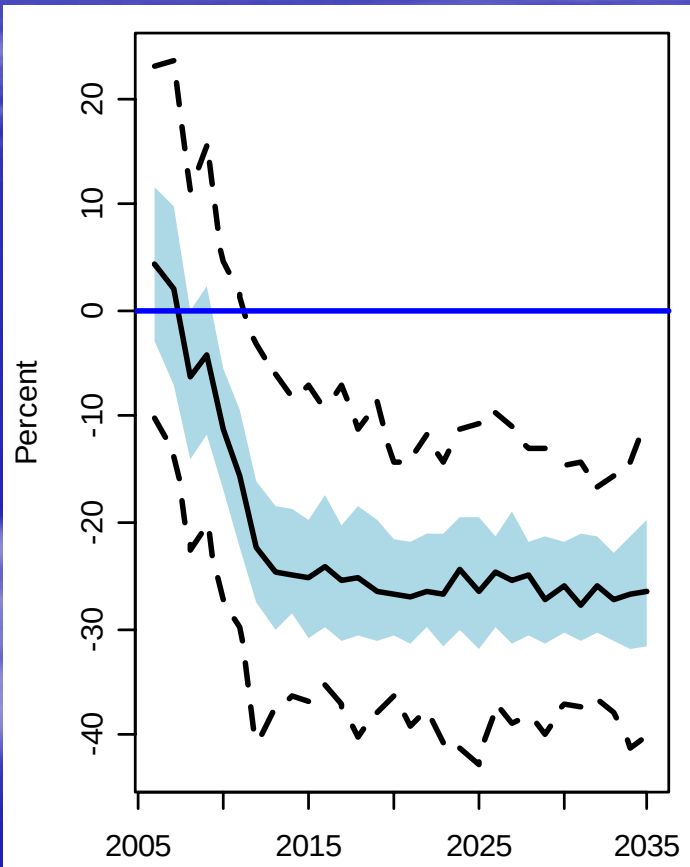


Distribution of interannual variation of catch

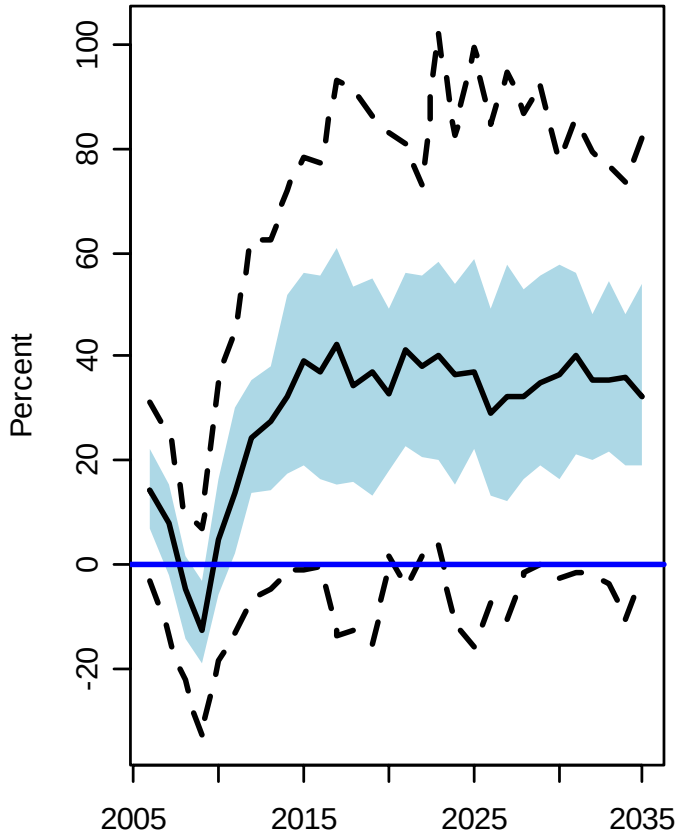


Estimation Performance
(Spawning biomass and fishing mortality)

Spawning biomass



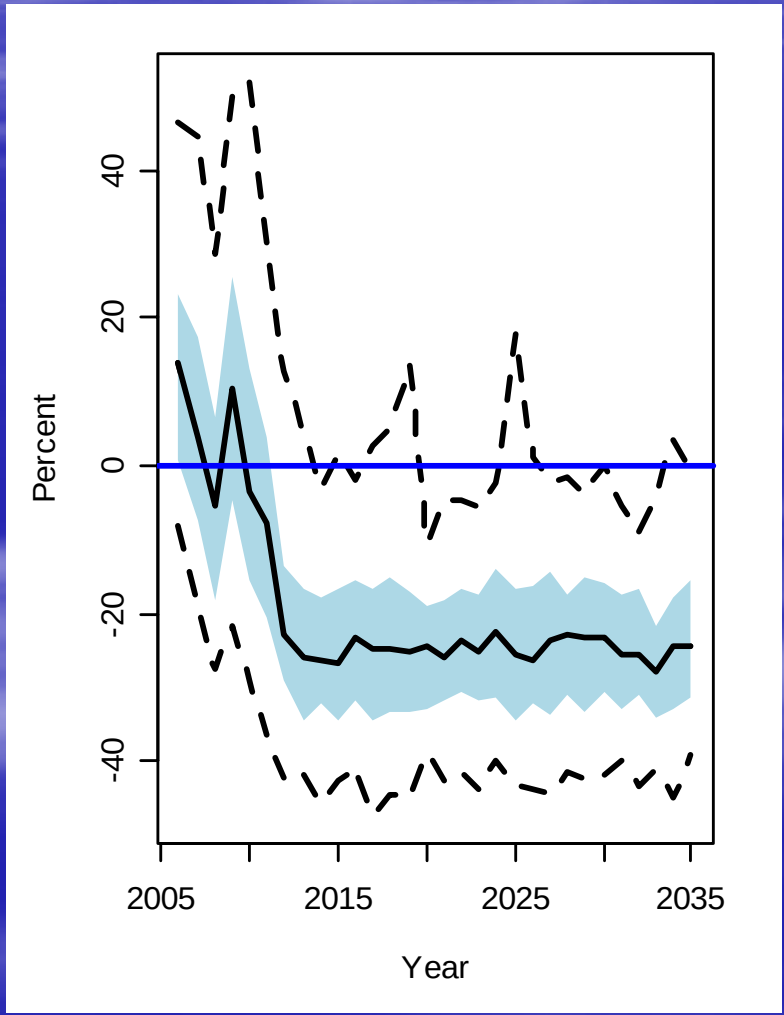
Fishing mortality



$$Error_y = 100(Est_y - True_y)/True_y$$

Estimation Performance

Acceptable Biological Catch



Annual management decision based on assessment results and catch control rule

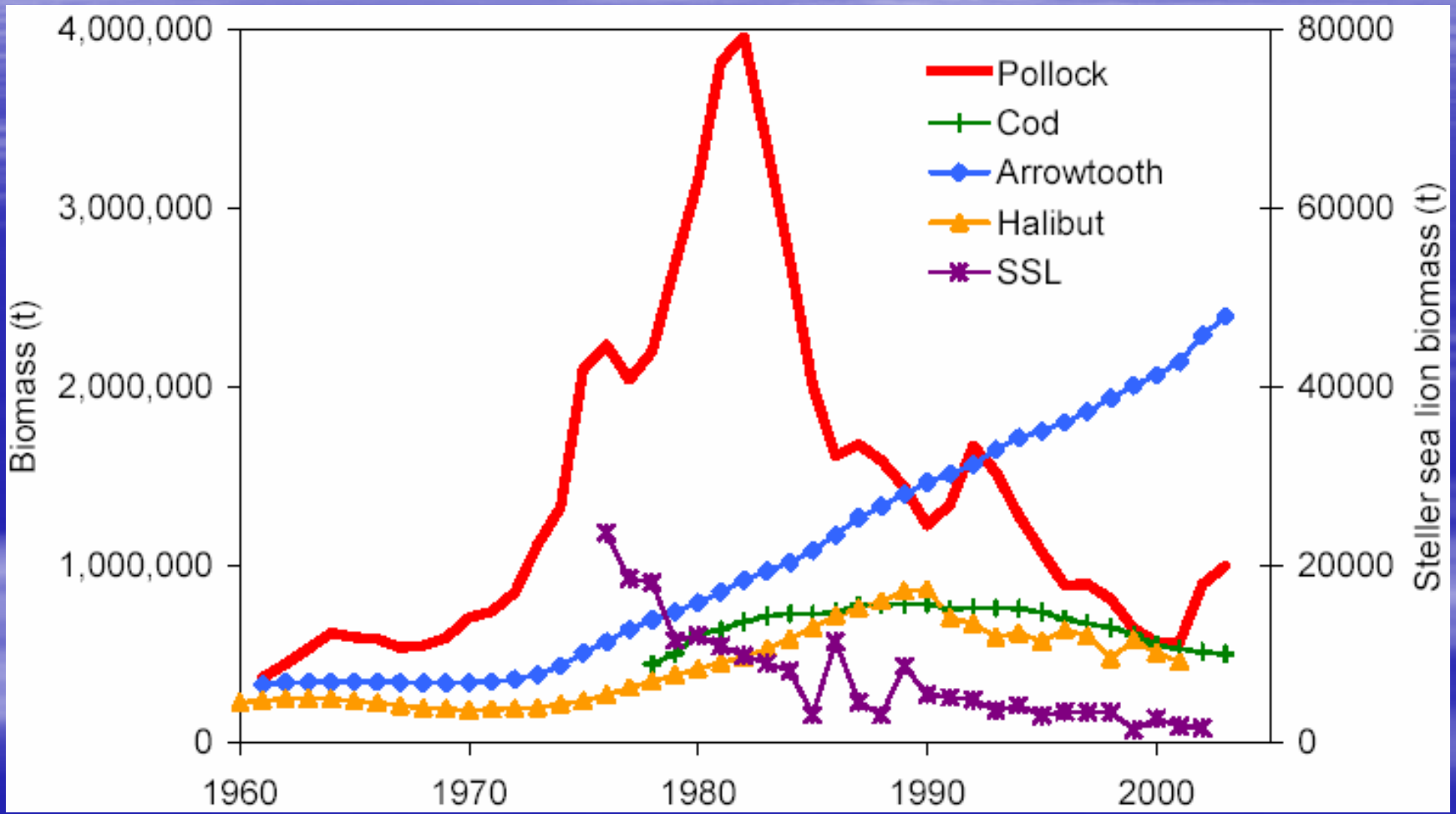
$$Error_y = 100(Est_y - True_y)/True_y$$

Current Conclusions

- The spawning stock is left close to the target level
- Future catches vary considerably from one year to the next
- The assessment is biased
  - why?

Next Steps

Including Trophodynamics



Including Trophodynamics

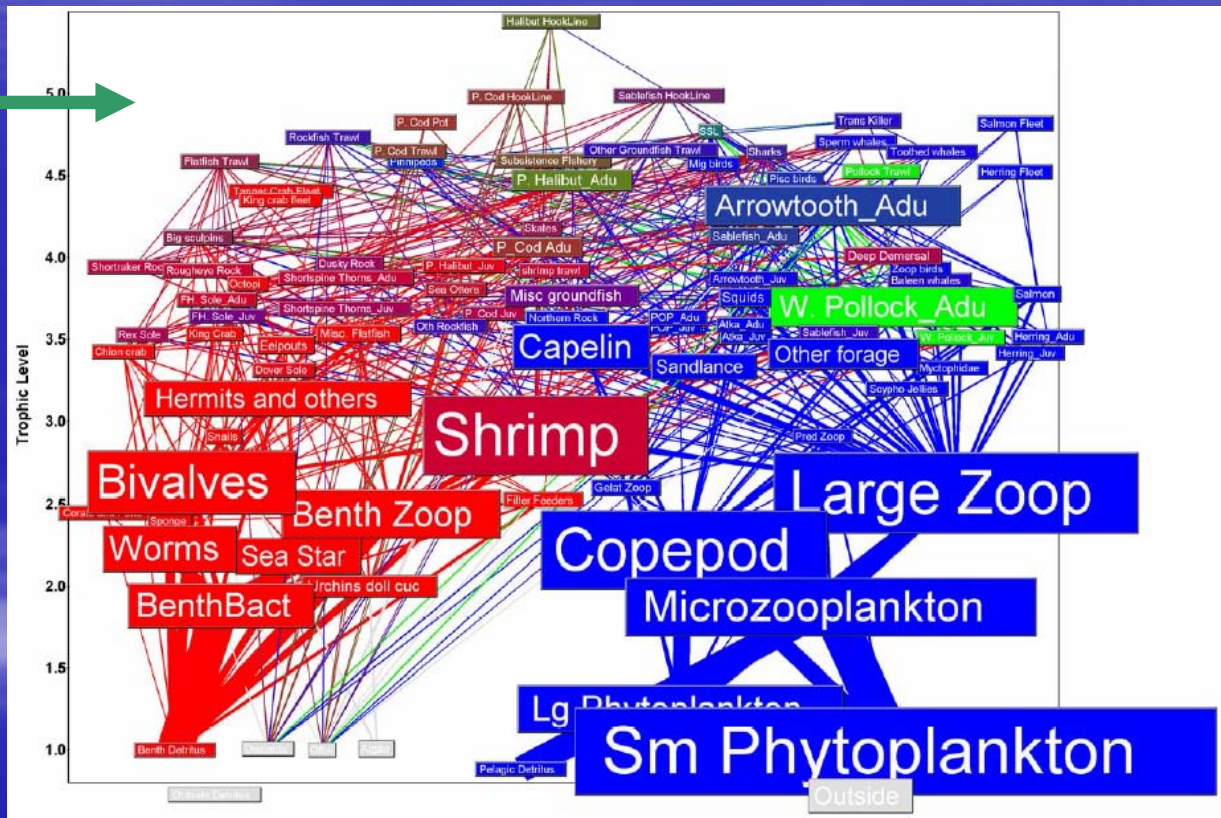
Predation

Age-structured operating model

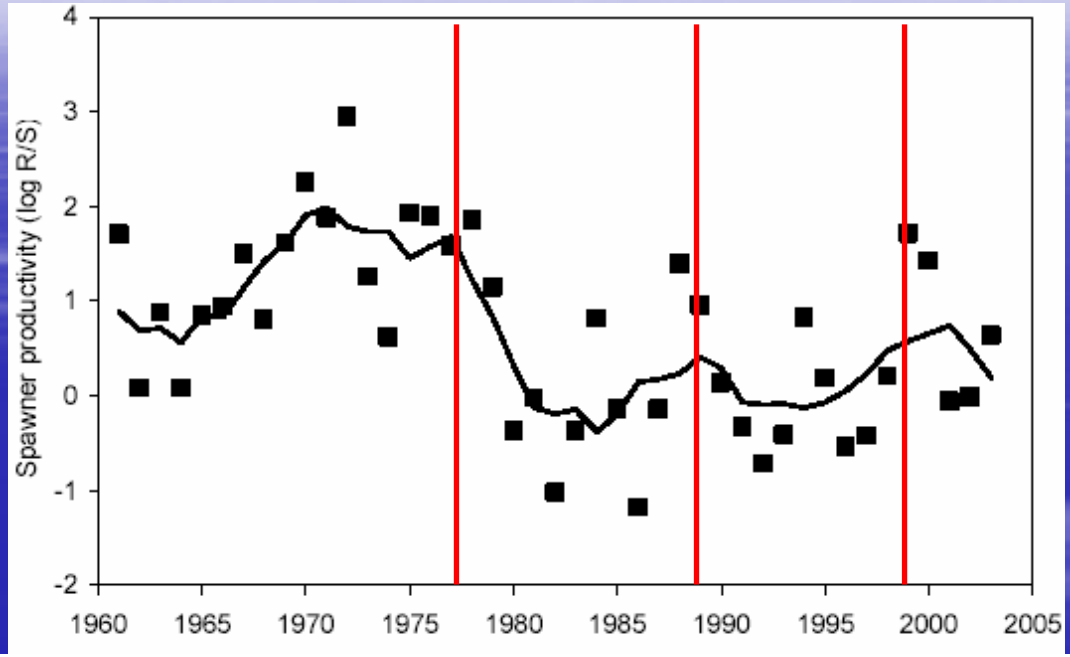
Data

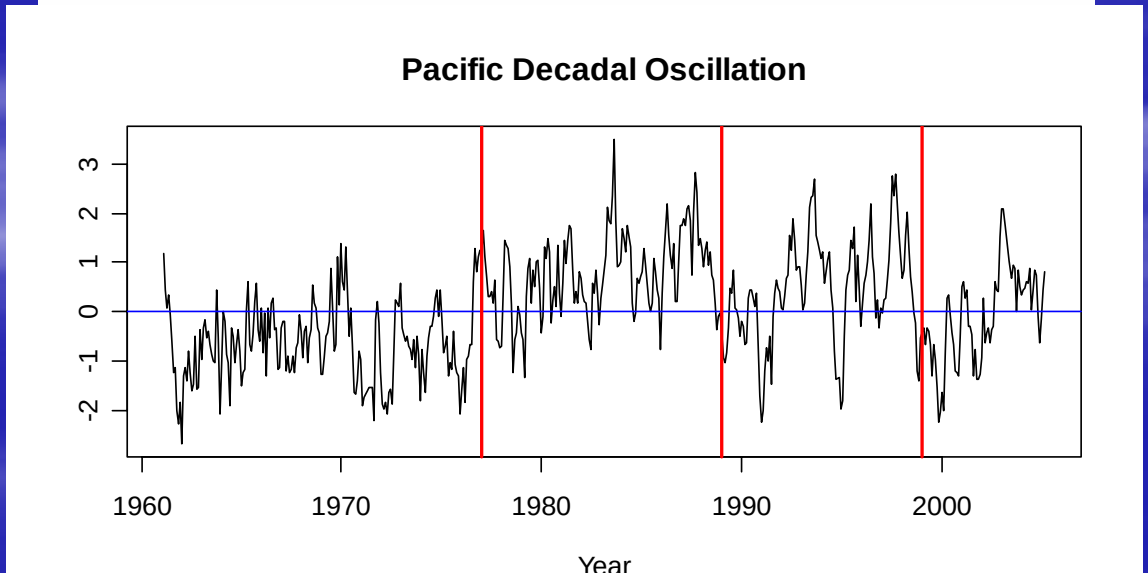
TAC

Management Strategy



Climate Impacts on Productivity

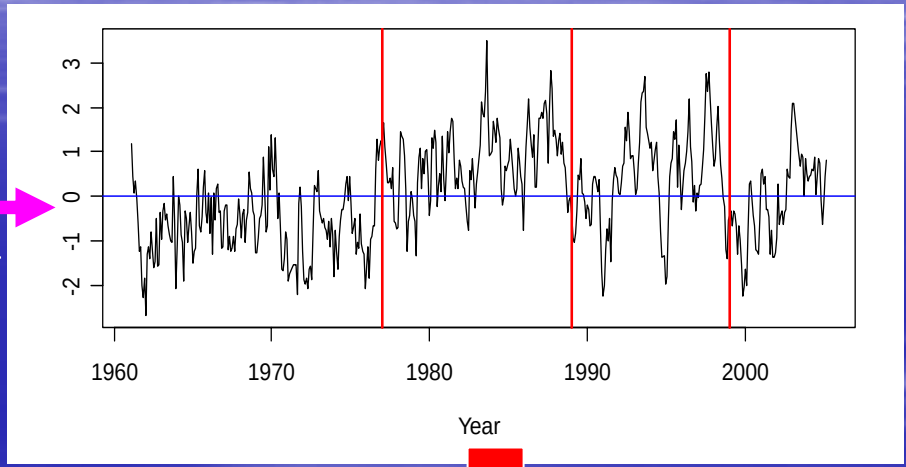




Climate Impacts on Productivity

Age-structured operating model

Link to recruitment



Data

TAC

Climate data

Management Strategy

Years for defining the current regime

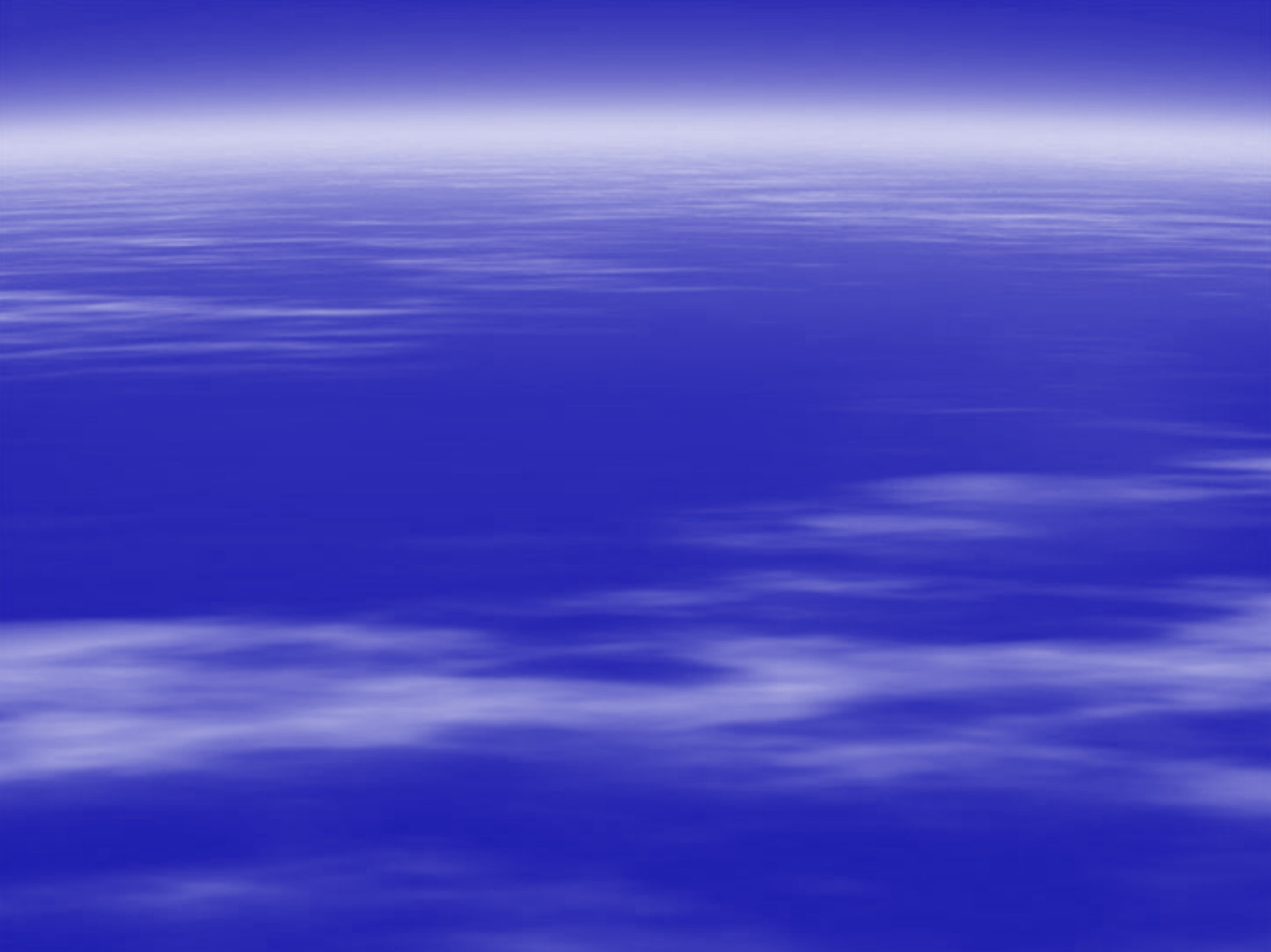
Climate Decision rule

Acknowledgements

- Funding through NOAA Fisheries

- Ray Hilborn, Dan Huppert, Lurdes Inoue, Jim Ianelli and Anne Hollowed

- The Punt Lab at UW



Catch Control Rule