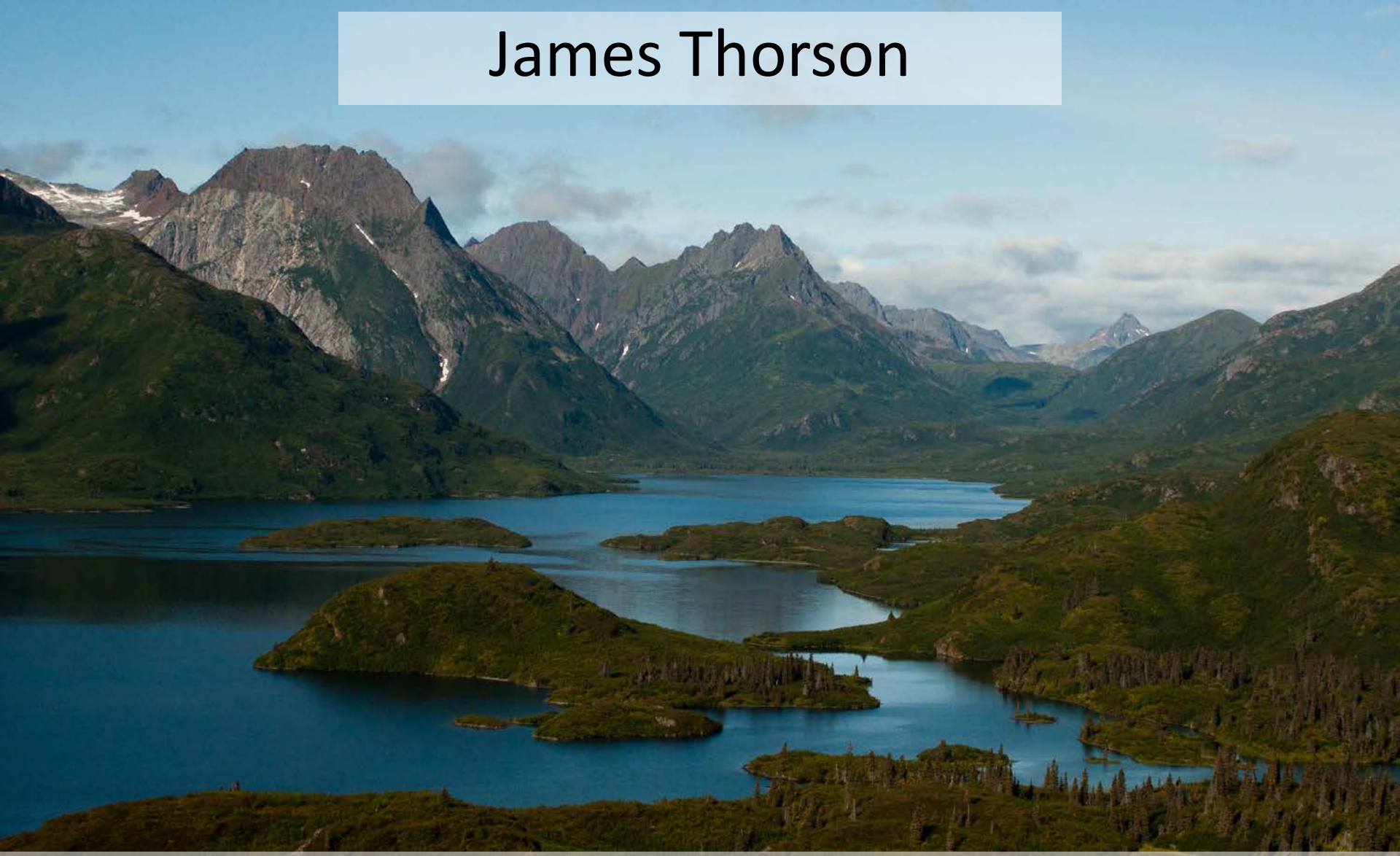
James Thorson

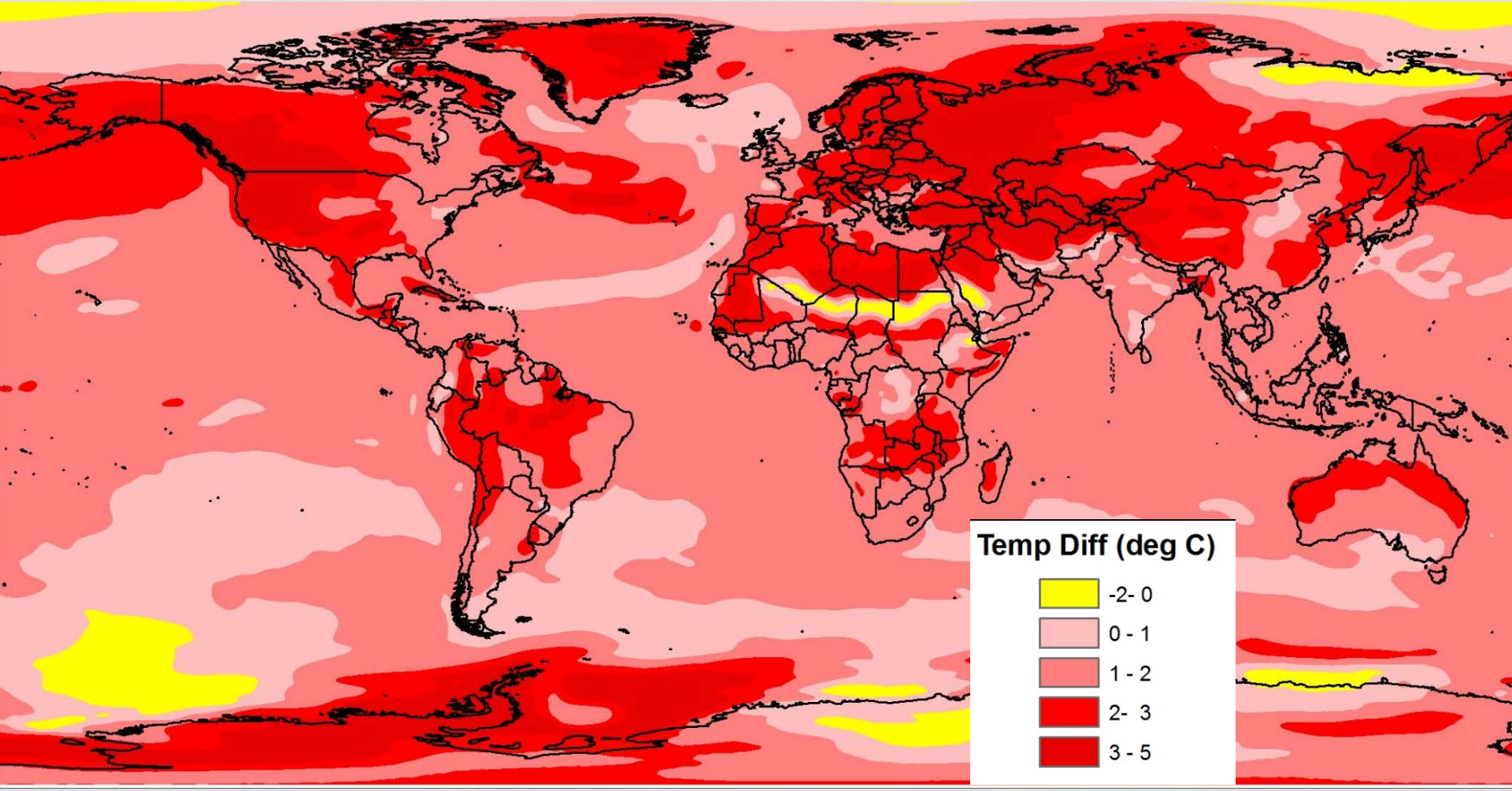


Time-varying processes in stock assessment: A bridge to ecosystem-based reference points

Why use stock assessments for ecosystem reference points?

1. Compare ecosystem advice with advice with existing assessment methods
2. Stock assessments…
   - … are ubiquitous worldwide
   - … have strong link to management
   - … have existing capabilities to

Sensitivity to time-varying process



Thorson, Monnahan, Cope, J.M., 2015. The potential impact of time-variation in vital rates on fisheries management targets for marine fishes. Fish. Res. 169, 8–17.

Sensitivity to time-varying process

Questions

1. How sensitive are management targets to changing productivity?
2. What process has the greatest impact?

Approach

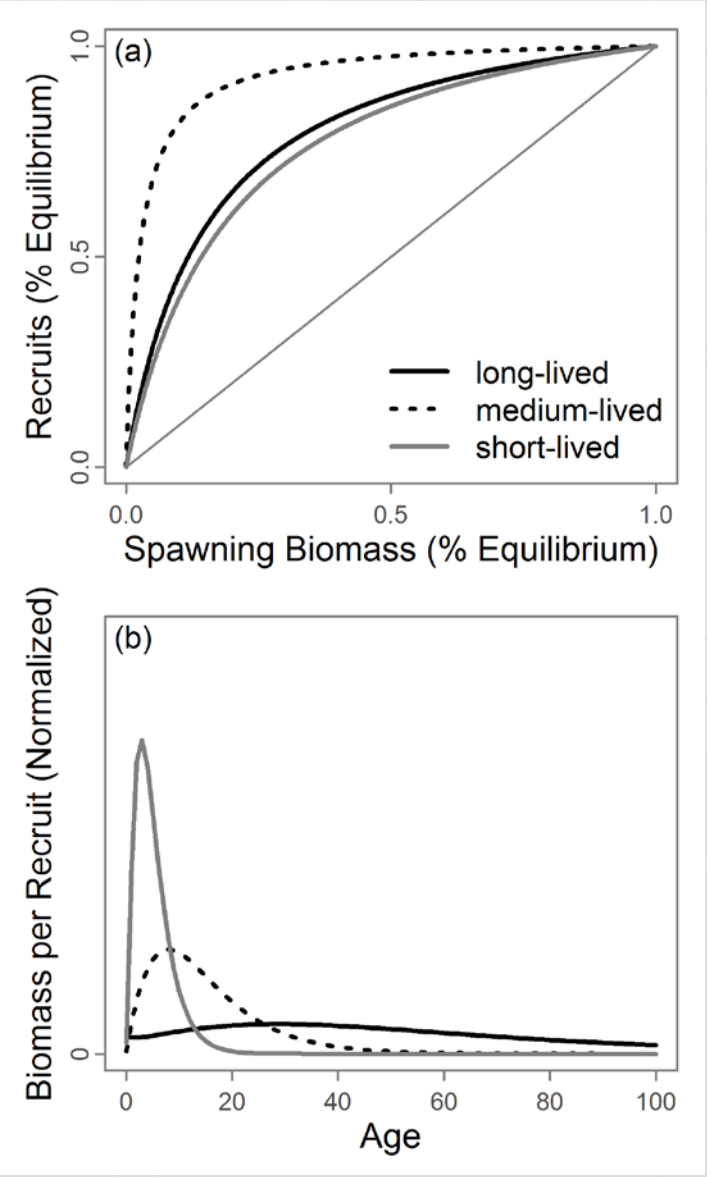
1. Simulate population given life-history theory
2. Change parameters and record impact on management targets

Sensitivity to time-varying process

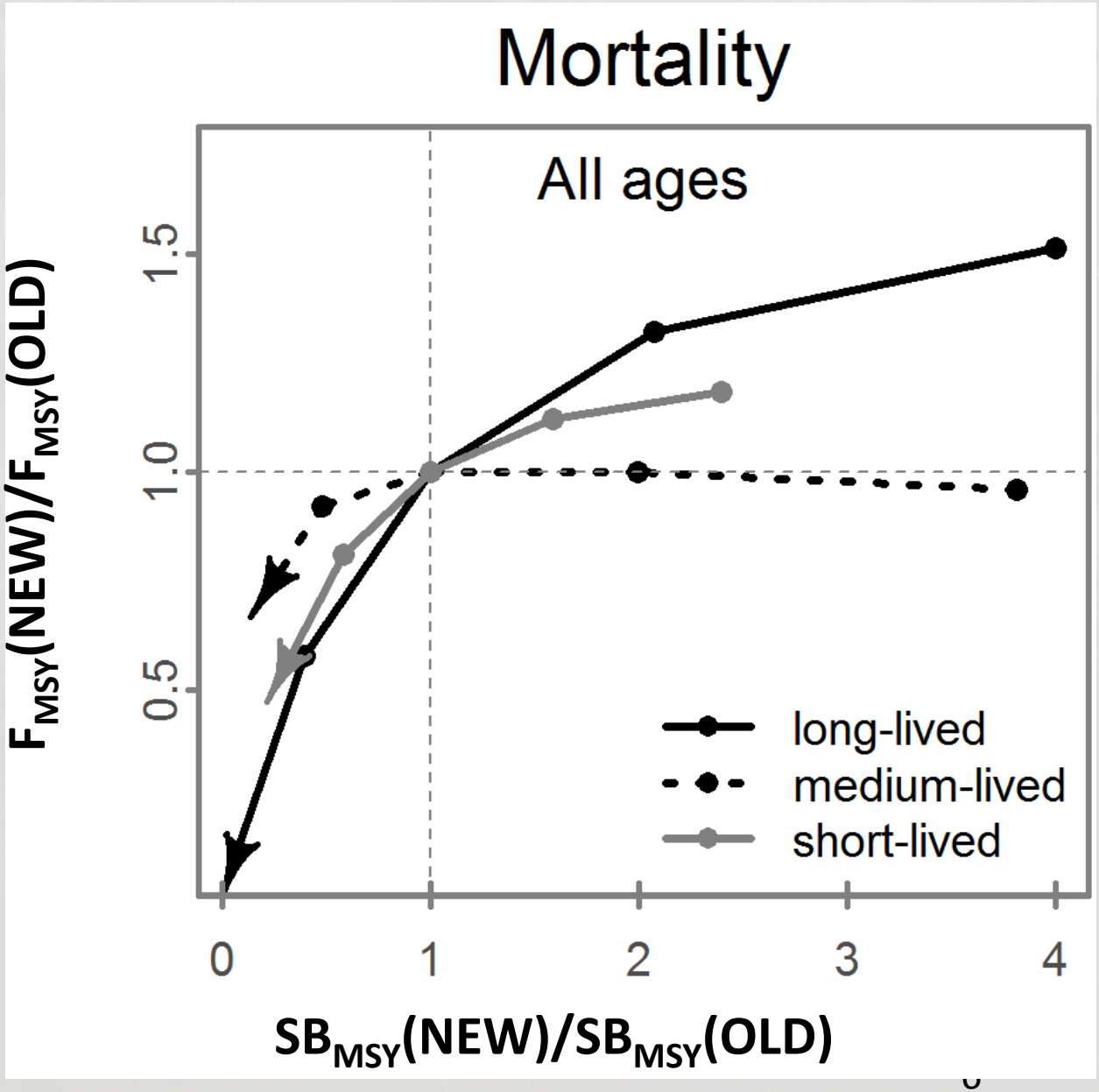
Life history model

- Input parameters
  - Natural mortality rate (M)
  - Recruitment compensation

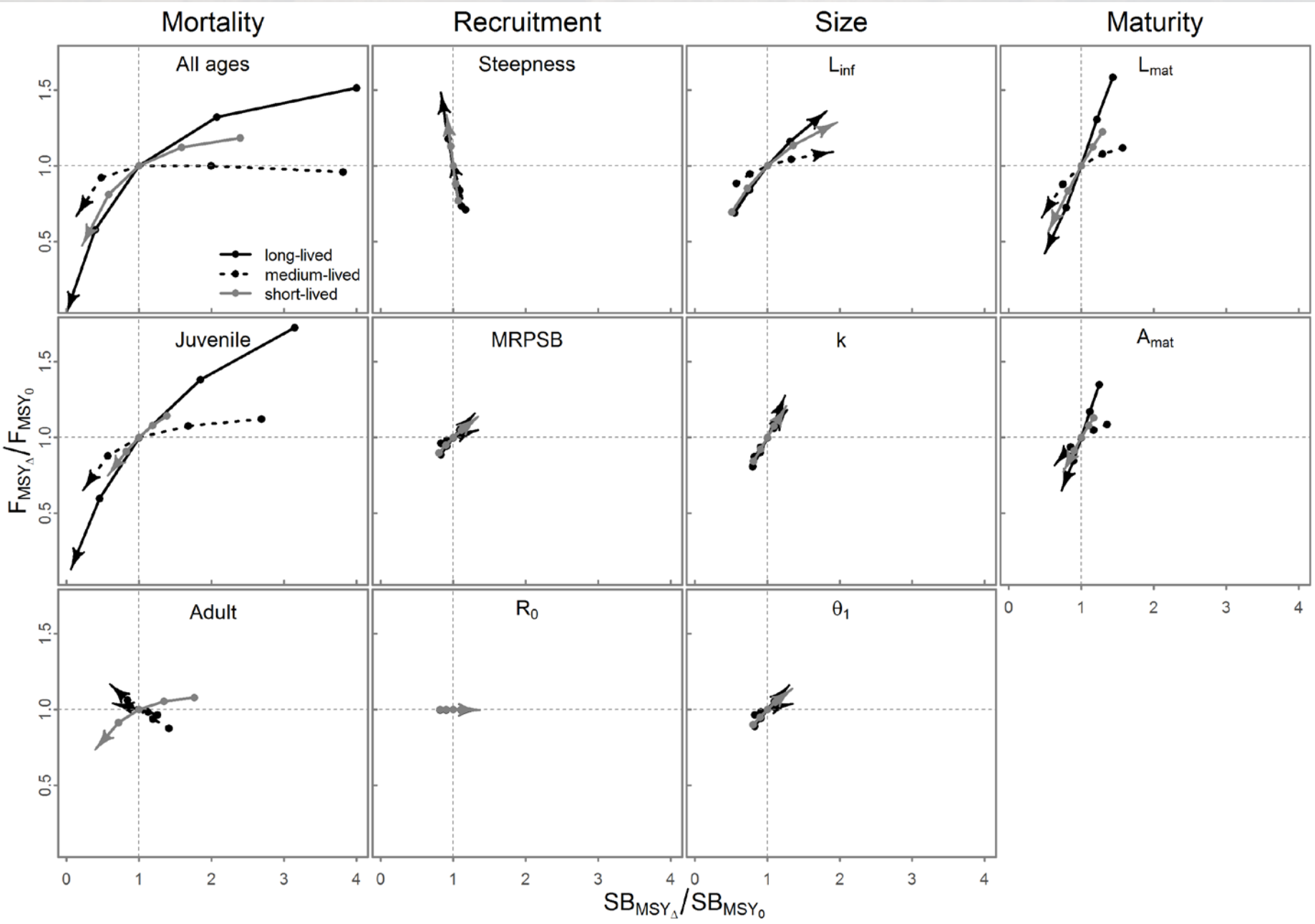
    (max. recruits per recruit)
- Life history invariants
  - M → a_{mat}
  - M → k
  - MRPR → steepness



Sensitivity to time-varying process



Sensitivity to time-varying process



Sensitivity to time-varying process

Questions

1. How sensitive are management targets to changing productivity?
2. What process has the greatest impact?

Conclusions

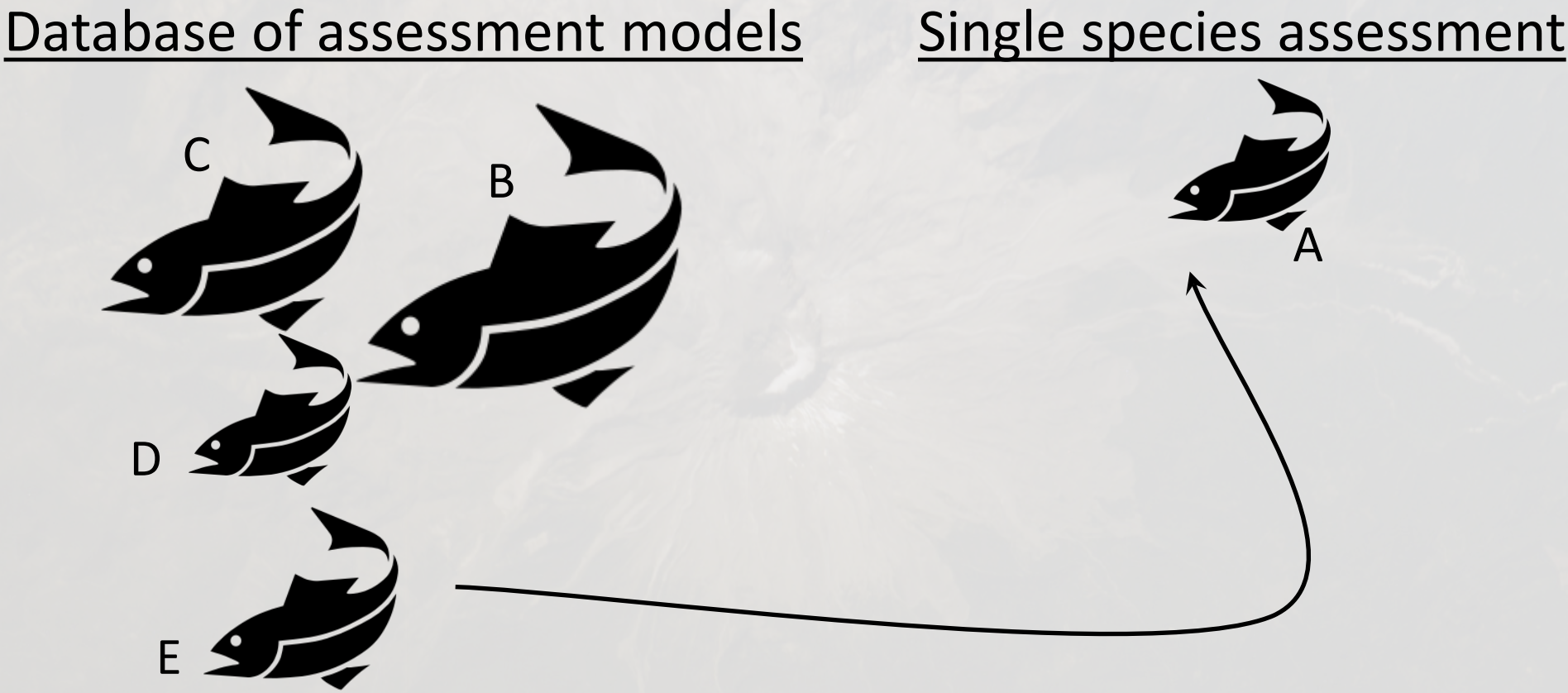
1. Most parameters can cause a greater-than-proportional change on targets
2. Mortality has the greatest impact!

Meta-analysis and time-variation

Thorson, Stewart, Taylor, Punt. 2013. Using a recruitment-linked multispecies stockassessment model to estimate common trends in recruitment for US West Coast groundfishes. *Mar. Ecol. Prog. Ser.* 483: 245–256.

Meta-analysis and time-variation

Proposal: Use existing single-species models for meta-analysis

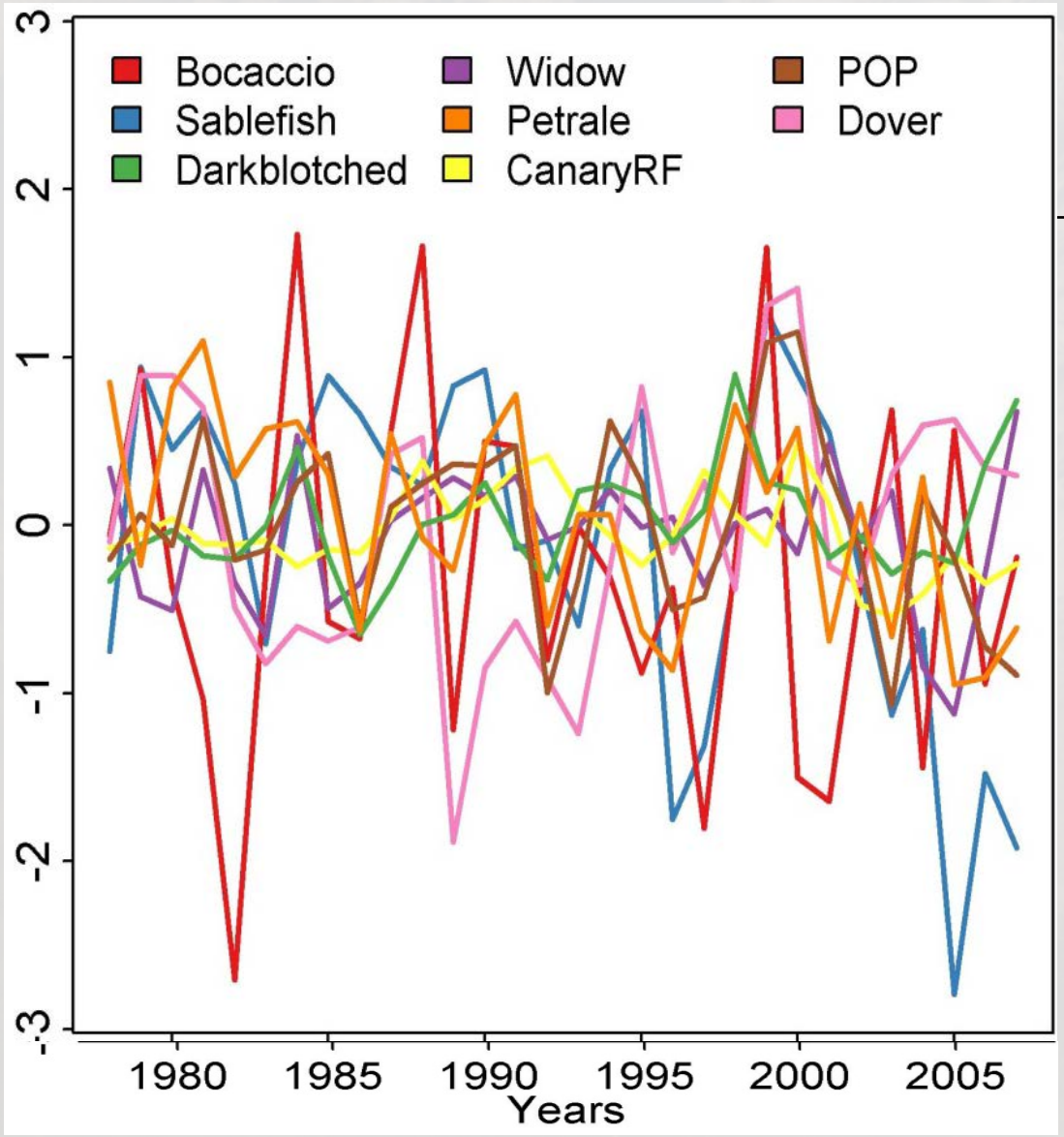


Meta-analysis and time-variation

Process

1. Assemble comparable stock assessments
2. Link using shared recruitment deviations
3. Estimate parameters for all models simultaneously
4. Explore impact for data-poor stocks

Meta-analysis and time-variation



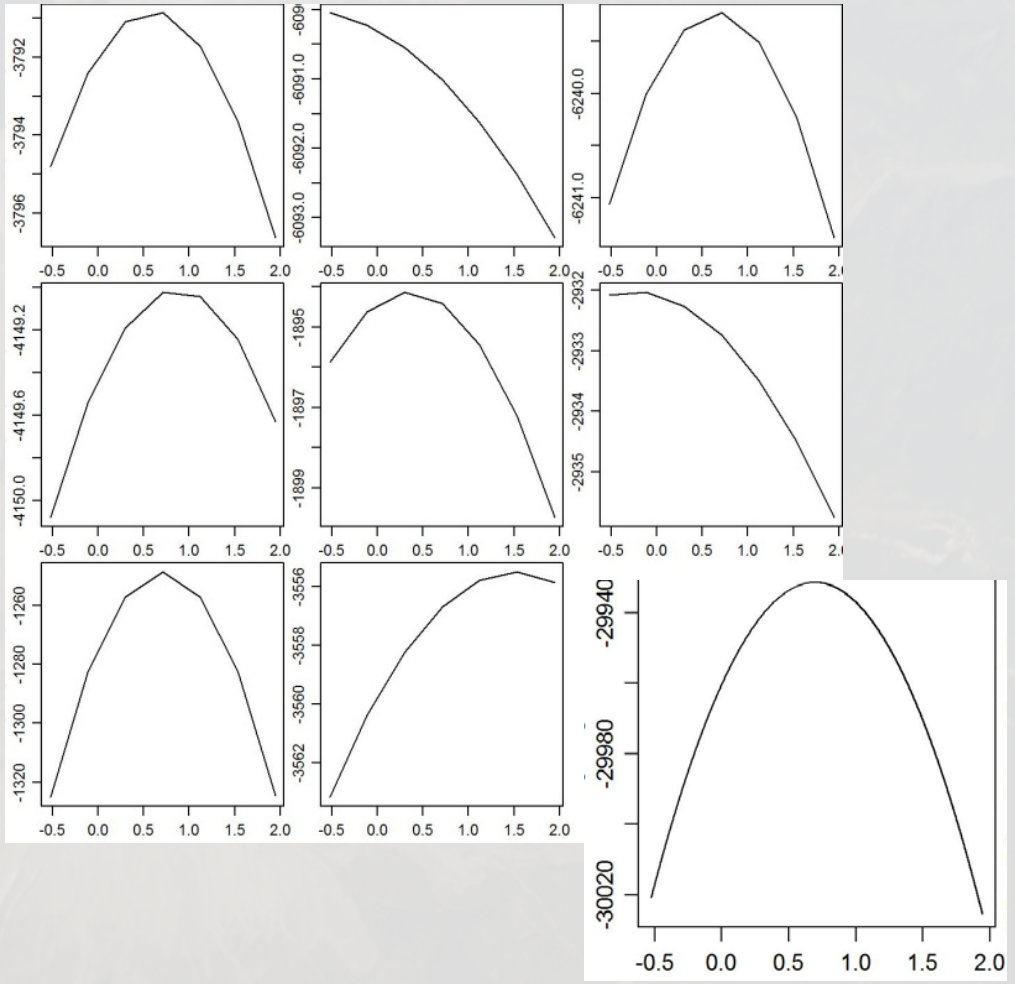
Common name	Years
Sablefish	1965-2010
Bocaccio	1954-2010
Canary rockfish	1960-2010
Darkblotched	1975-2009
Dover sole	1960-2009
Petrale sole	1959-2007
Pacific ocean perch	1952-2008
Widow	1978-2009

Meta-analysis and time-variation

Optimize each single-species model :

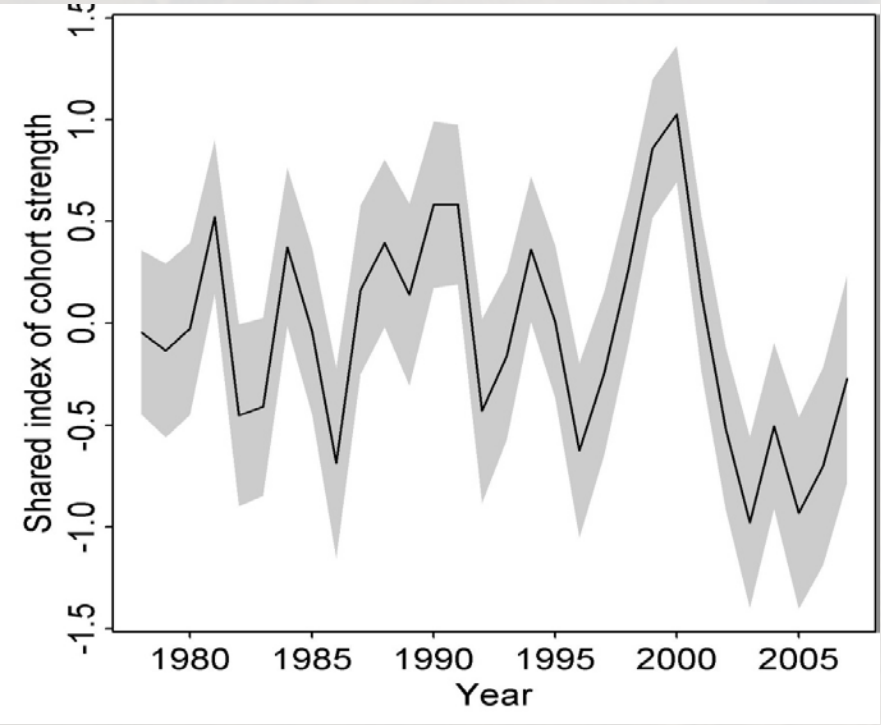
1. Sablefish
2. Bocaccio
3. Canary rockfish
4. Darkblotched
5. Dover sole
6. Petrale sole
7. Pacific ocean perch
8. Widow

Optimize each shared recruitment dev:

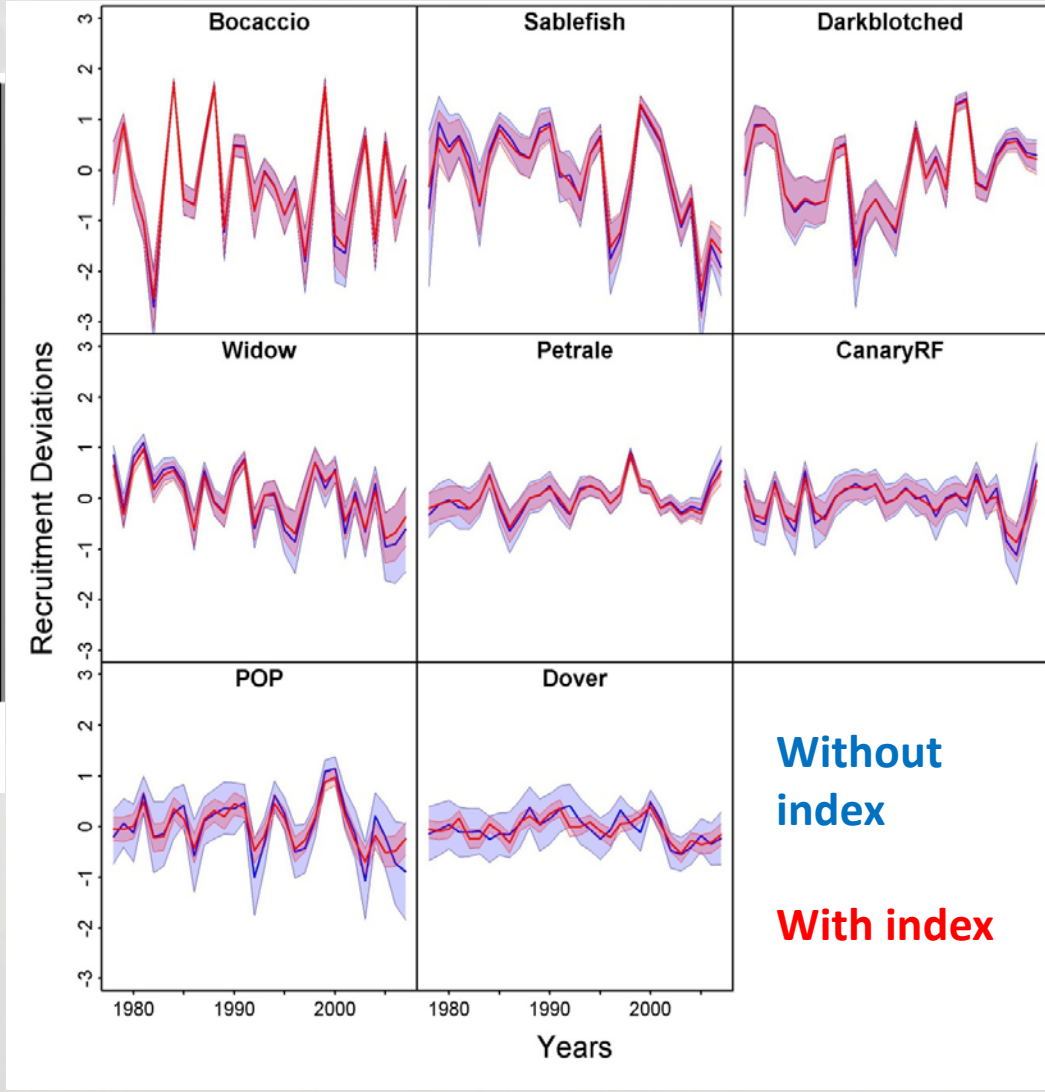


Meta-analysis and time-variation

Shared index

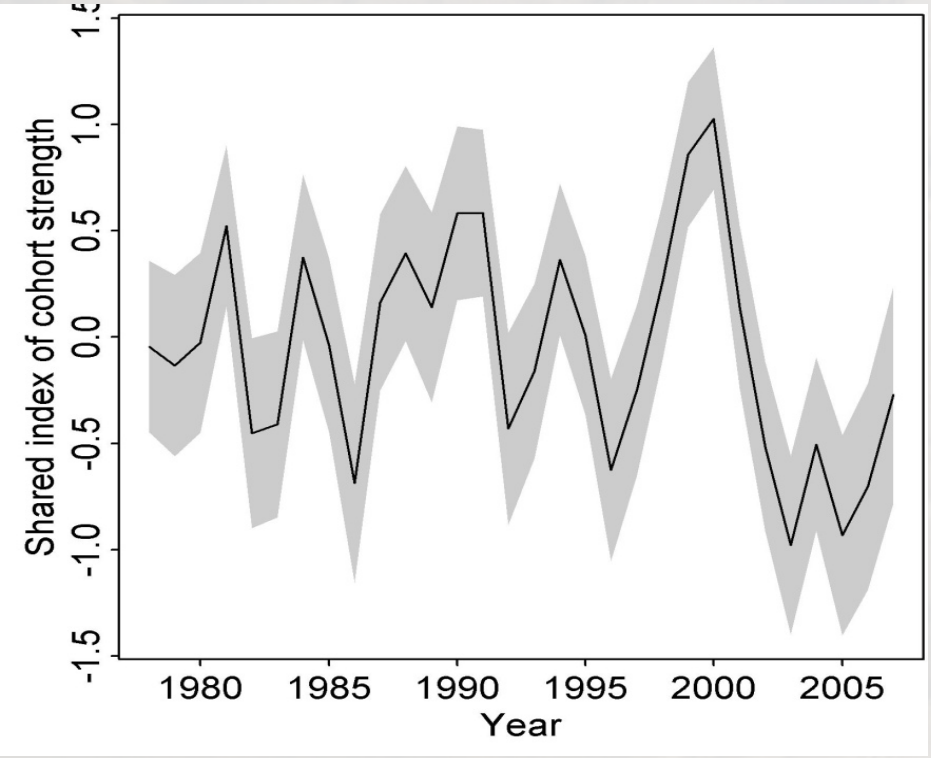


Fit to species in model

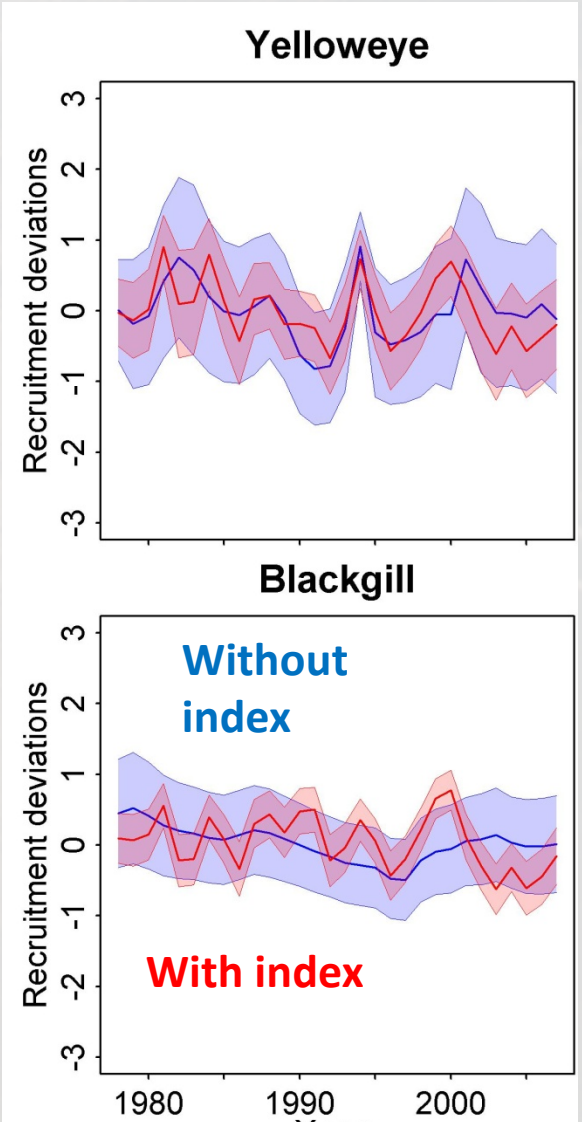


Meta-analysis and time-variation

Shared index



Fit to new data-poor species



Meta-analysis and time-variation

Conclusion

1. Can use stock assessment database for ecosystem analysis

Next steps

1. Applying to other processes
2. Using index in stock assessments to account for ecosystem-level processes

How do time-varying parameters relate to ecosystem reference points?

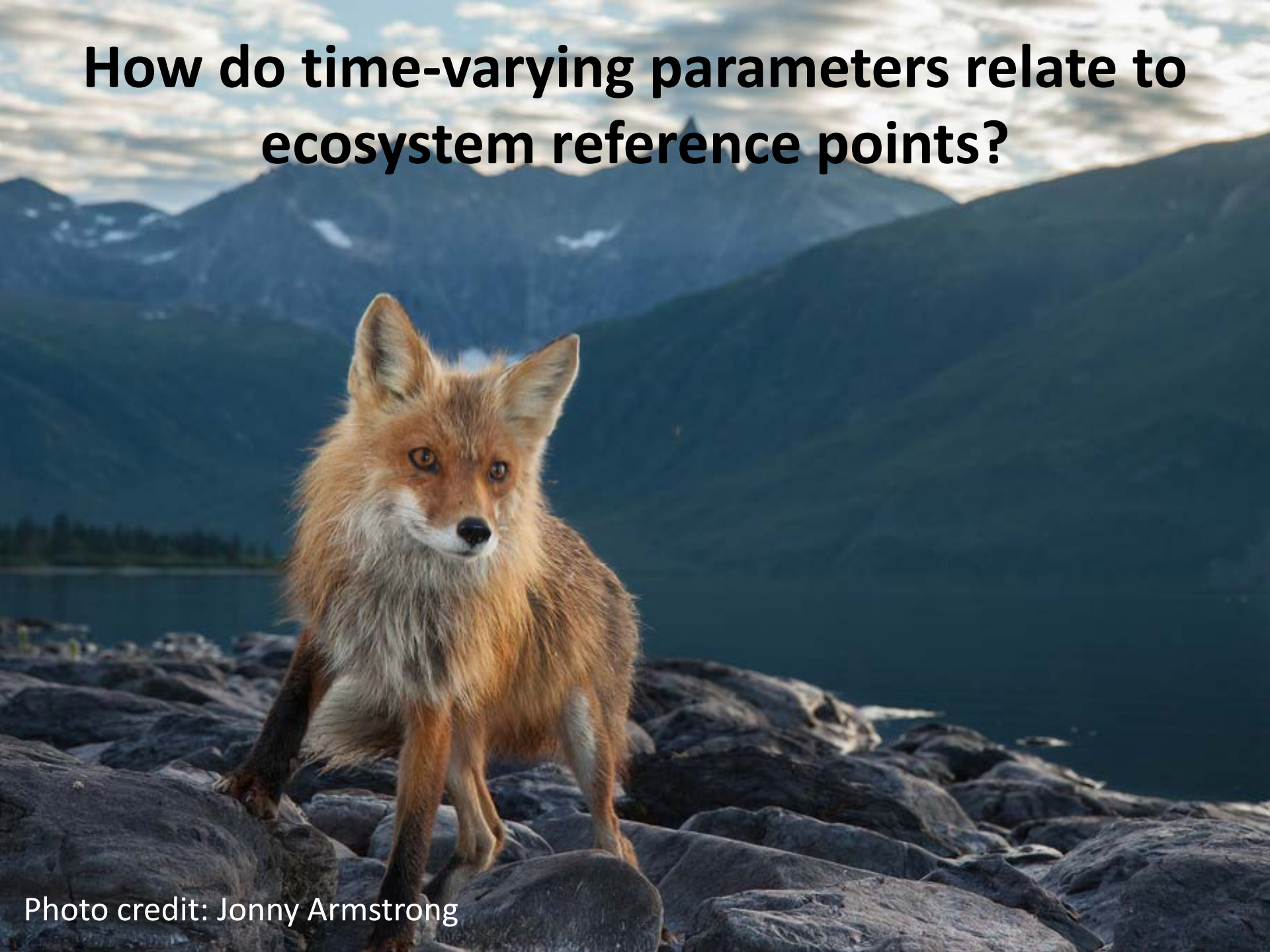


Photo credit: Jonny Armstrong

How do time-varying parameters relate to ecosystem reference points?

Ecosystem reference points

- Needed to account for relationships excluded from single-species rules

Responses:

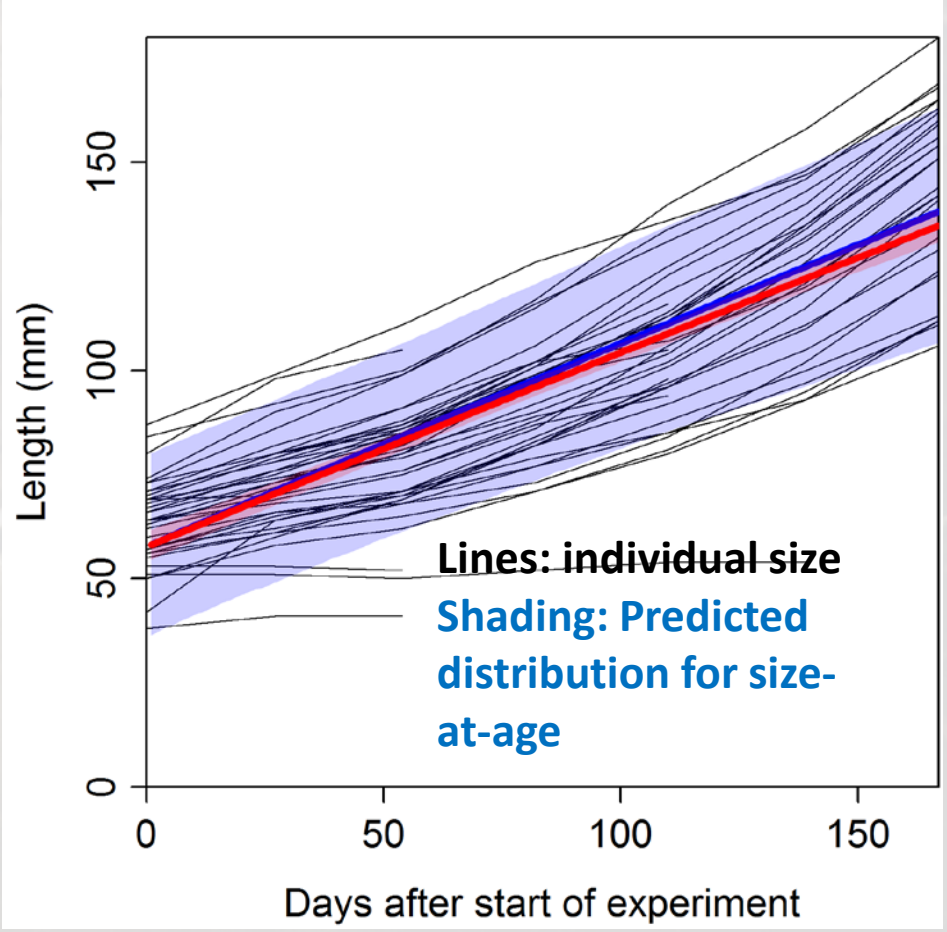
1. Develop new models
   - Ecosystem models
   - Pressure/response analysis
2. Adapt existing models
   - Account for interactions

How do time-varying parameters relate to ecosystem reference points?

#1: Mixed-effects modelling

- Can account for residual variation in ecological processes
- Calculate "Variance explained" by covariates

Variation in growth among individuals

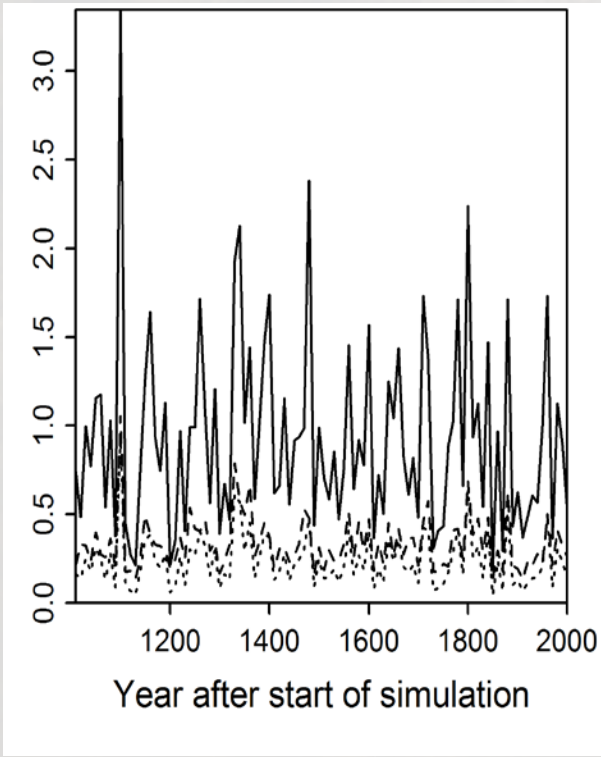


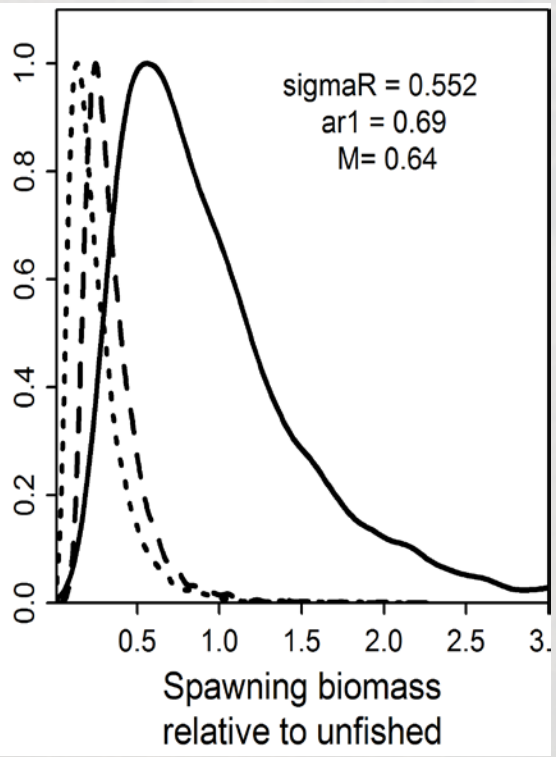
Thorson and Minto. 2015. Mixed effects: a unifying framework for statistical modelling in fisheries biology. ICES J. Mar. Sci. J. Cons. 72, 1245–1256.

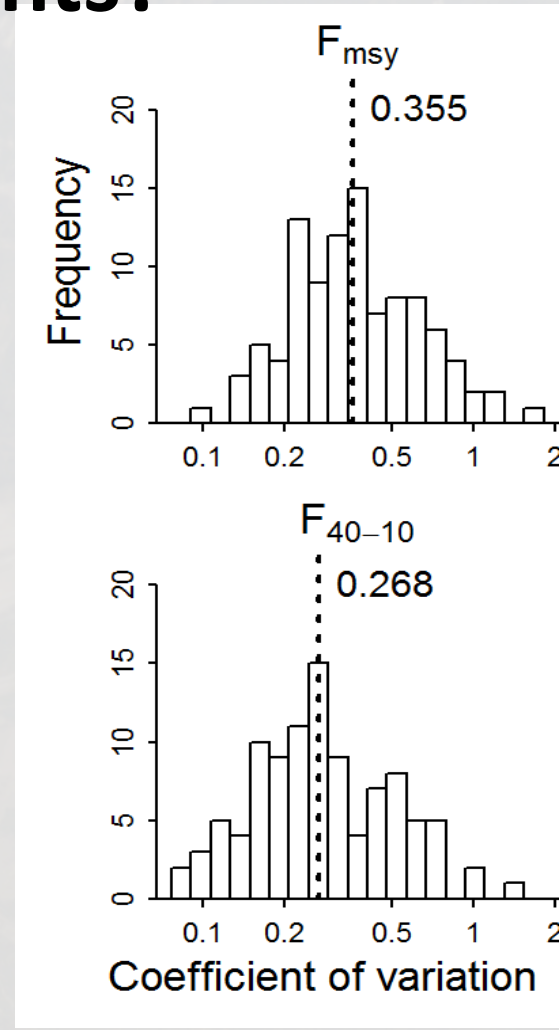
How do time-varying parameters relate to ecosystem reference points?

#2: Managing for variability

- Equilibrium is a stationary distribution!







Thorson, Jensen, Hilborn, 2015. Probability of stochastic depletion: an easily interpreted diagnostic for stock assessment modelling and fisheries management. ICES J. Mar. Sci. J. Cons. 72, 428–435.

Acknowledgements

Content:

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