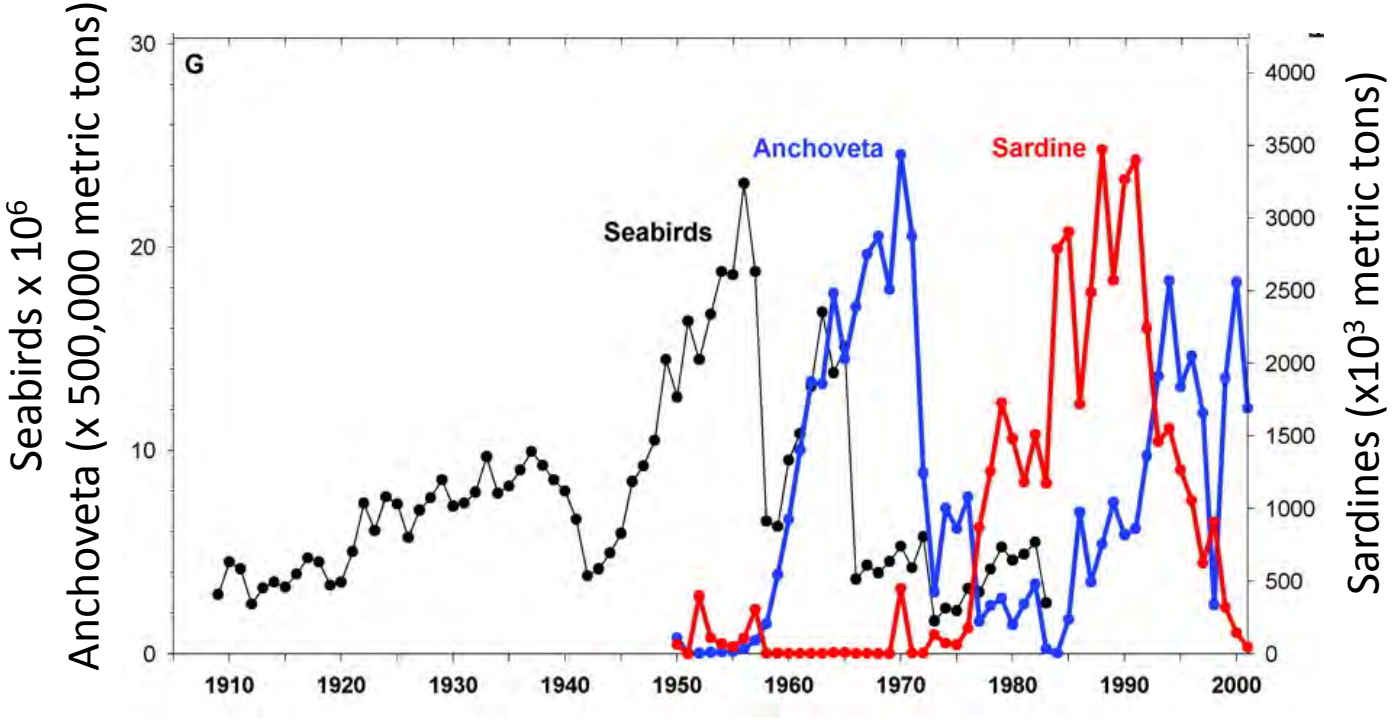
Forage Fish Harvest Control Rules from a Seabird Perspective

Laura E. Koehn

Timothy E. Essington, Margaret Siple, and Andre Punt

Forage Fish and Ecosystem-Based Fisheries Management



Chavez et al. 2003 *Science*

Call for more conservative harvest control rules

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Ecology

Stop-loss order for forage fish fisheries

Ellen K. Pikitch[1]

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REPORT

Global Seabird Response to Forage Fish Depletion—One-Third for the Birds

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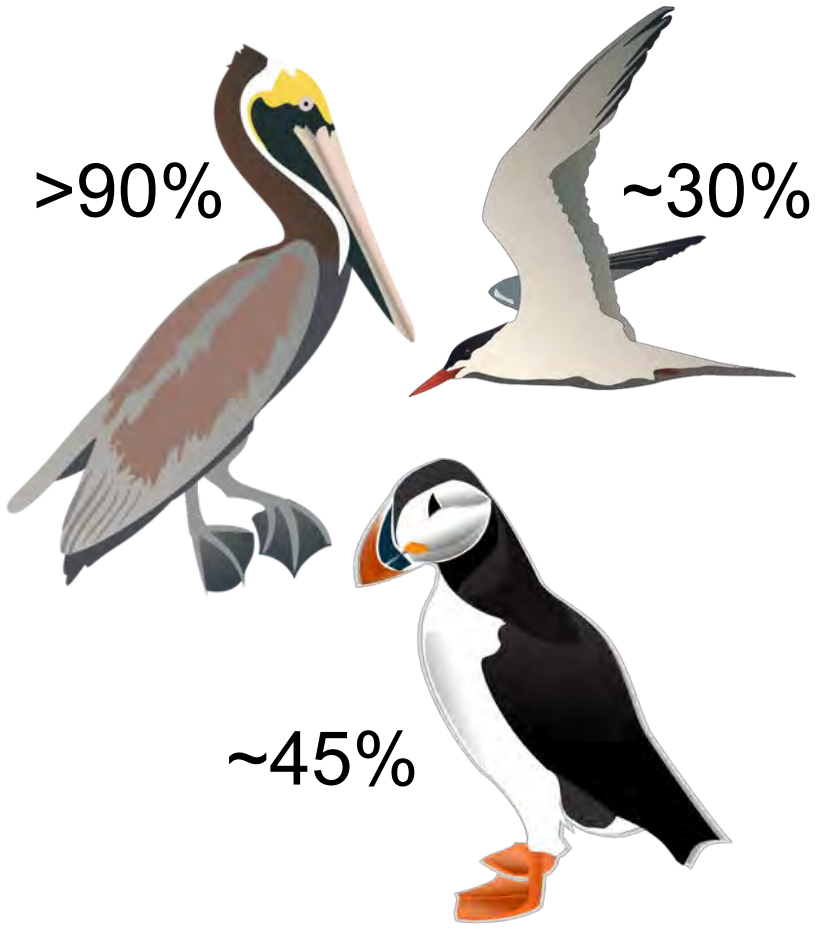
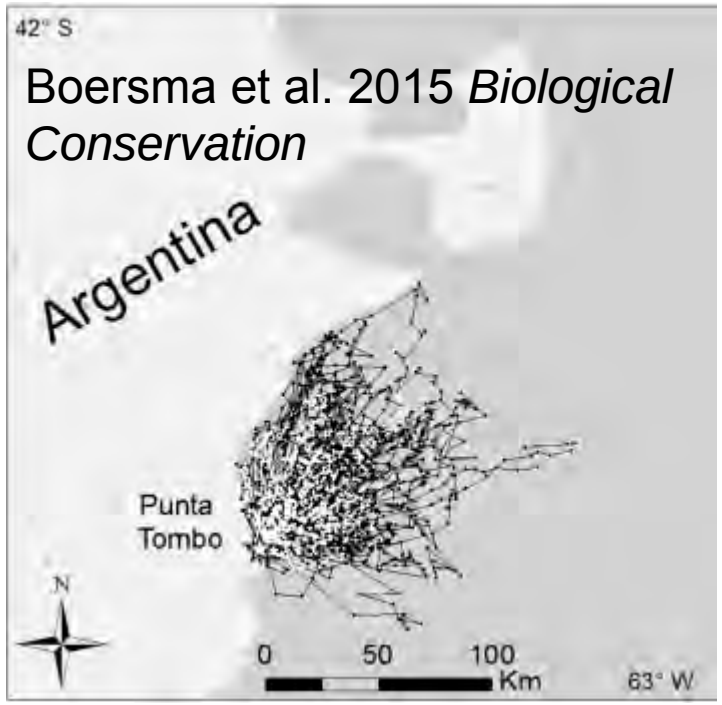
Conservative Forage Fish Control Rules Espcially for Seabird Conservation?

1. Diet on Forage Fish

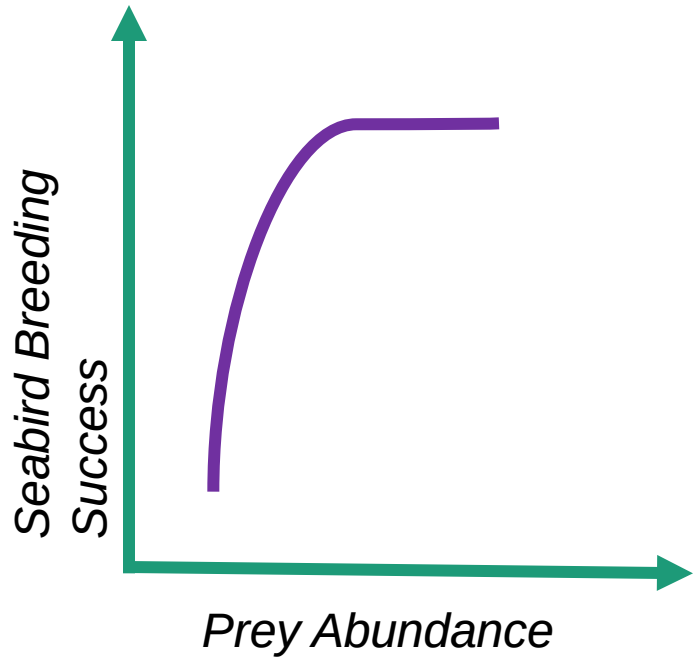


Values from Koehn et al. 2016

2. Central-Place Foraging

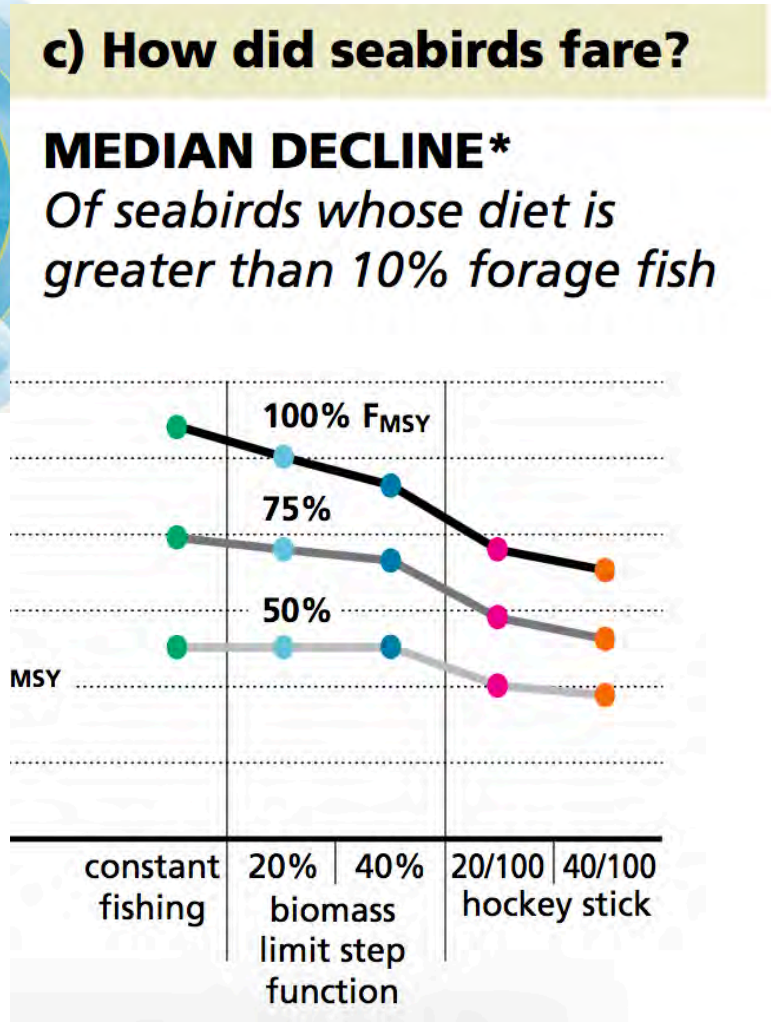


3. Link to prey availability ”1/3 for the birds” Cury et al. 2011



How well do these harvest control rules perform for seabirds?

Pikitch et al. 2012
Lenfest Forage Fish Task Force



Protective fishing rules led to less decline for predators

LIMITATIONS

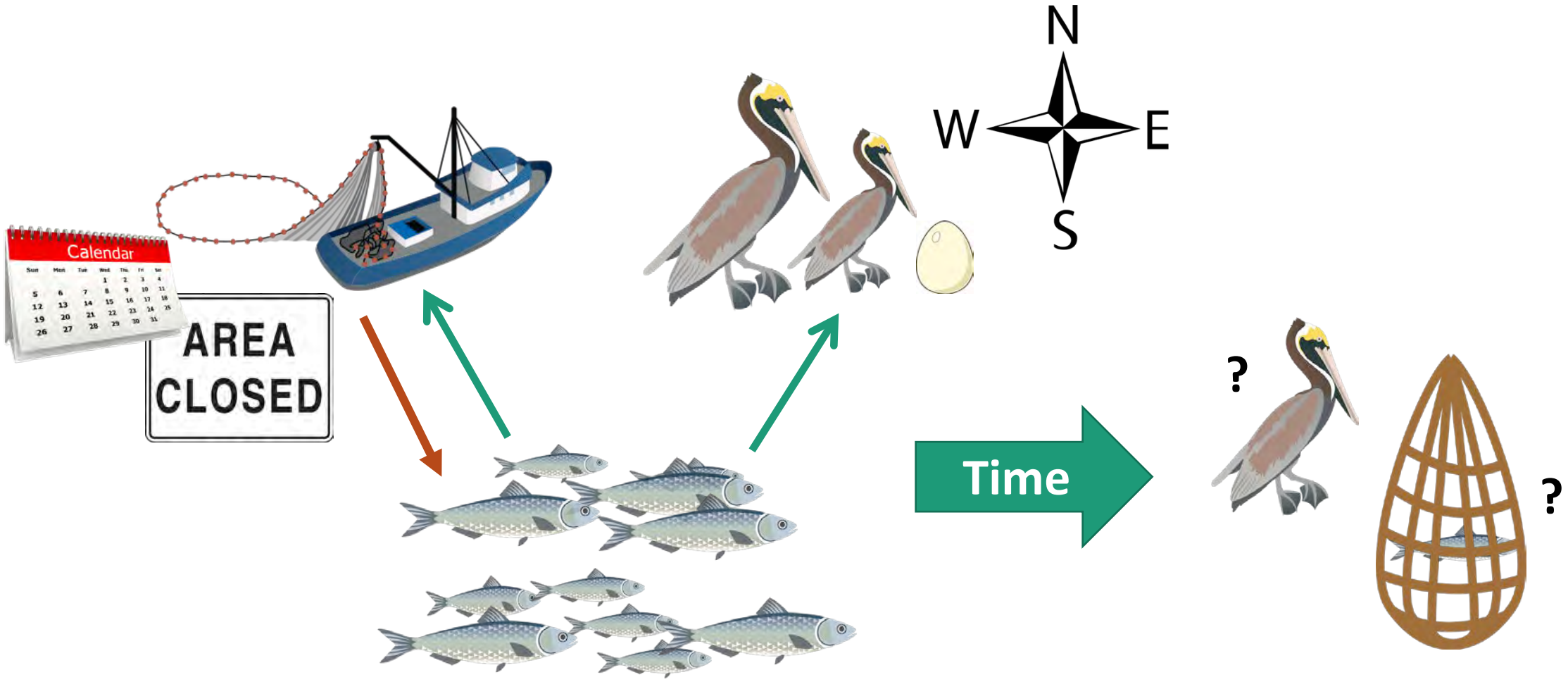
- Limited harvest control rules tests
- Only based on biomass (EwE models)
- No spatial representation
- Aggregate broad “seabird” functional groups

QUESTIONS

With continued harvest, which forage fish harvest control rule(s) optimize seabird conservation?

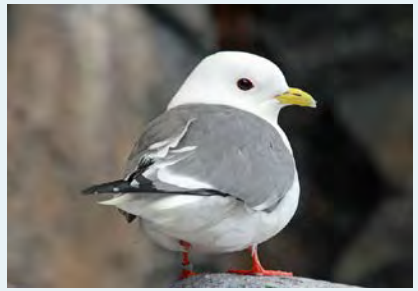
- **How does this vary across seabird life histories?**

Forage Fish – Seabird Management Strategy Evaluation-like Simulation Analysis



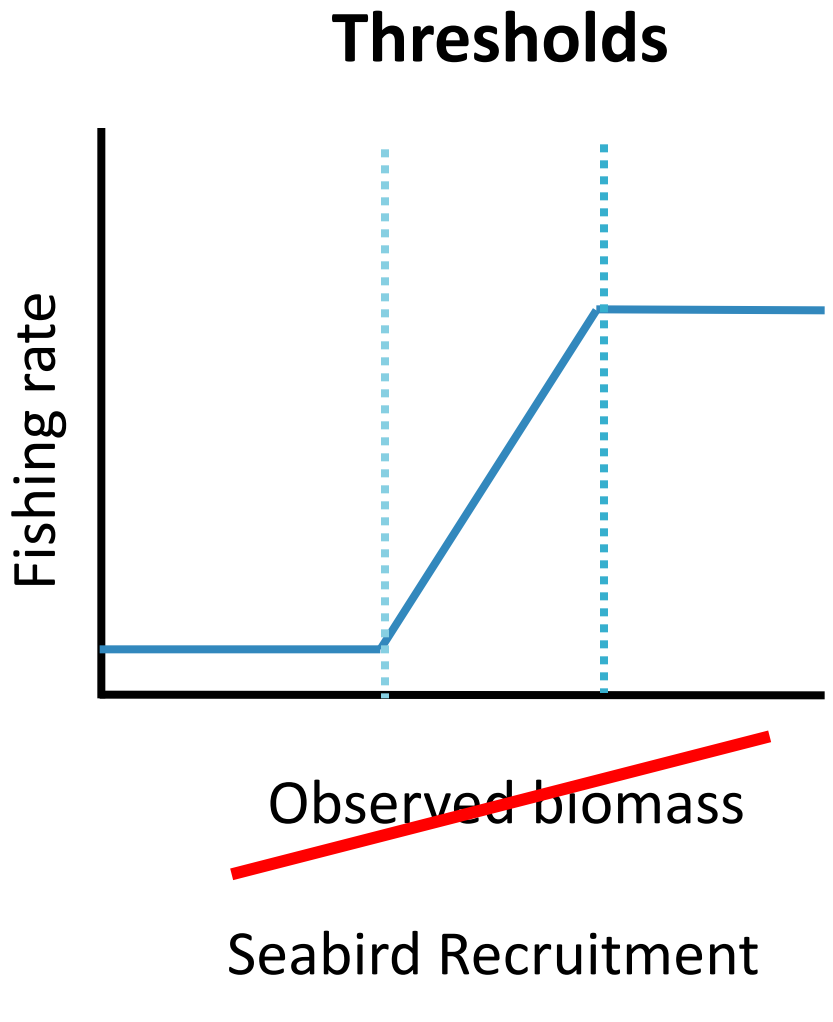
Answer may vary across seabird species/types

Seabird Life History

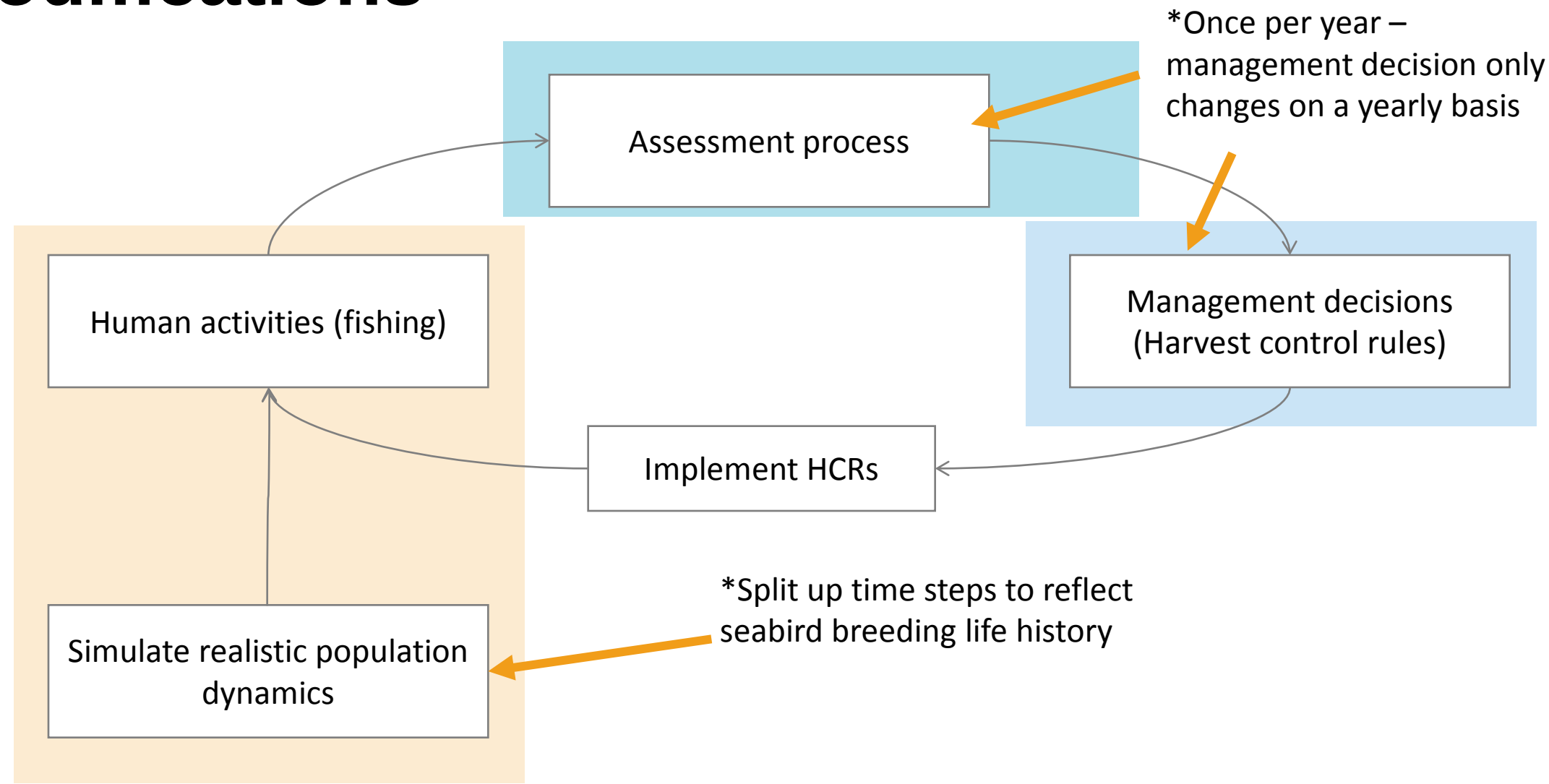
Diet Dependence	Low 	High 	Biomass thresholds?
Foraging Distance	Near 	Far 	MPA?
Diving Type (Foraging Strategy)	Shallow 	All depths 	Temporal closures?

Harvest Control Rules

- Constant fishing
- Biomass threshold / cut-off rules
- Spatial closures (no fishing, 50% constant F)
- Temporal closures (breeding season)
- Move-on rules
- Top-down indicator



Forage Fish Model Overview and Modifications



Slide from Megsie Siple

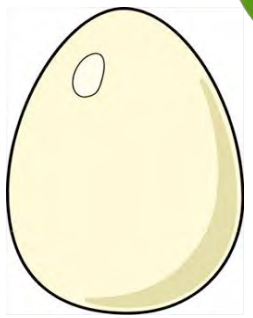
Toy example – Penguin Case Study

Based on information on Magellanic Penguins in Argentina and work Dr. P. Dee Boersma

Breeding

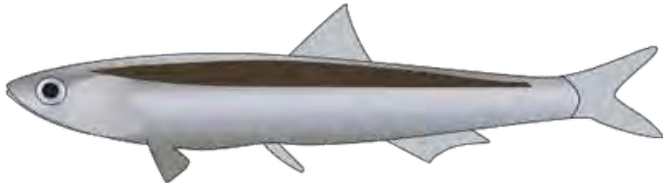
Ages 4-30

Non-breeding: 6months- Age 3



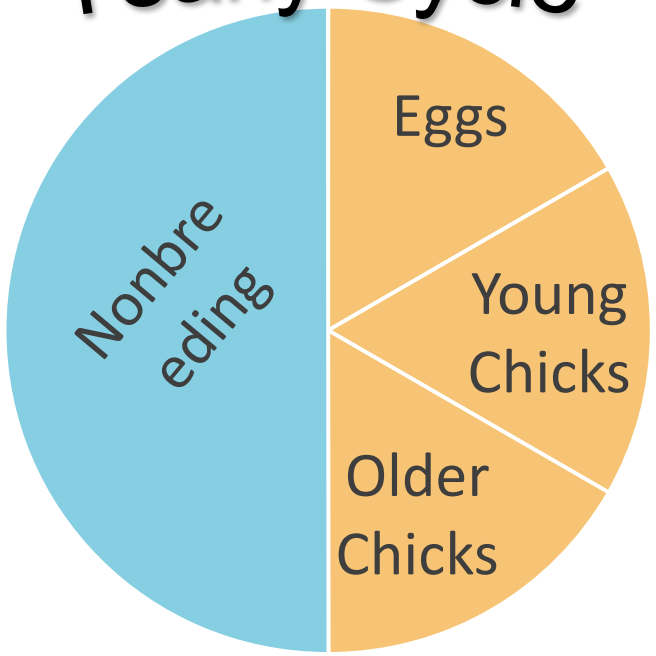
0 to 6 months

Stochastic survival



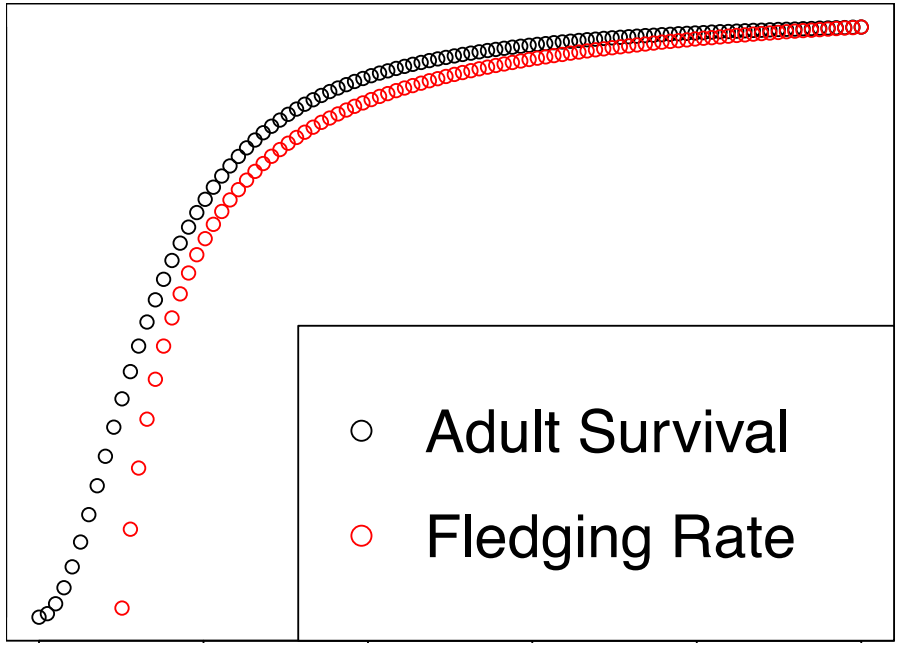
50% of diet

Yearly Cycle



Photos from P. Dee Boersma and Laura Koehn

Seabird reproduction and survival are dependent on prey availability

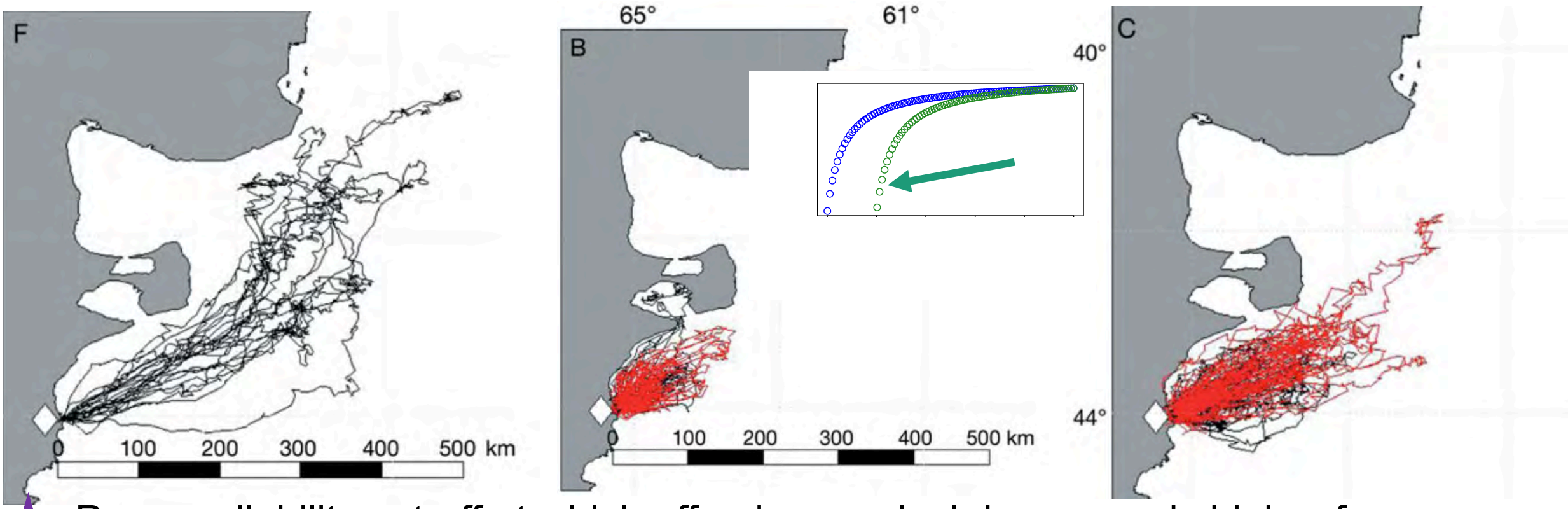


- Similar curves for:
  - Egg survival
  - Young chick survival
  - Juvenile survival

Prey availability near the colony is most important when chicks are young

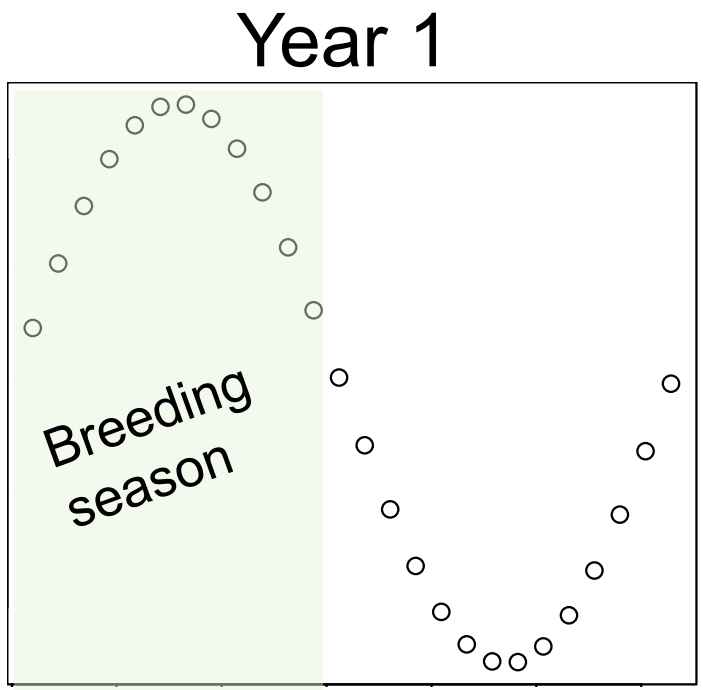
From Boersma and Rebstock 2009 *MEPS* :

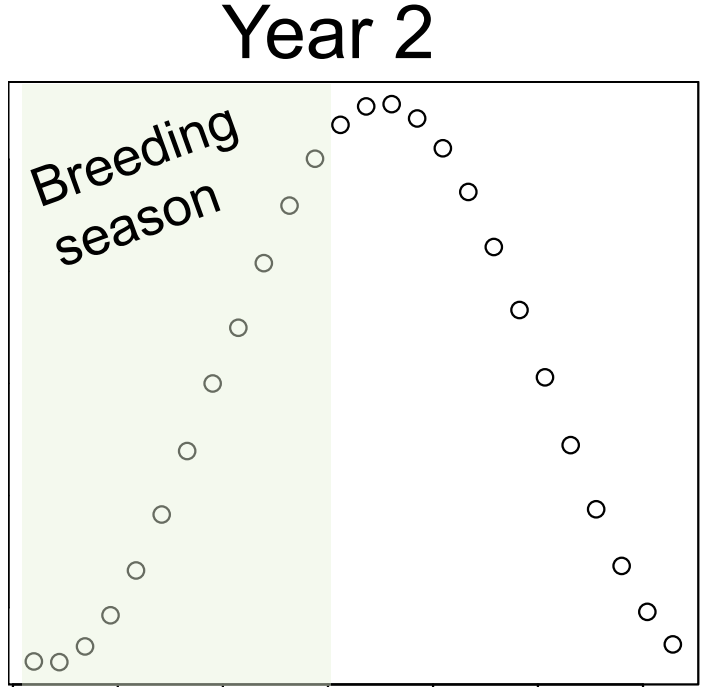
Egg Incubation | Young Chicks | Older chicks



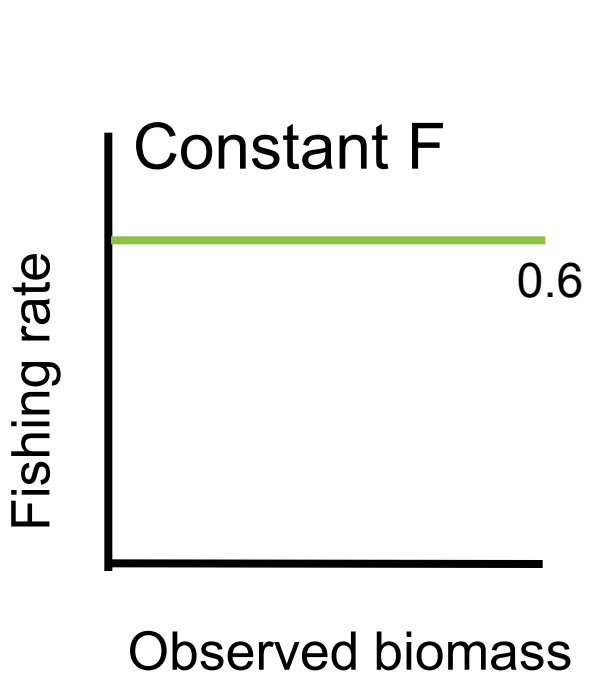
★ Prey availability cut-off at which offspring survival decreases is higher for young chicks

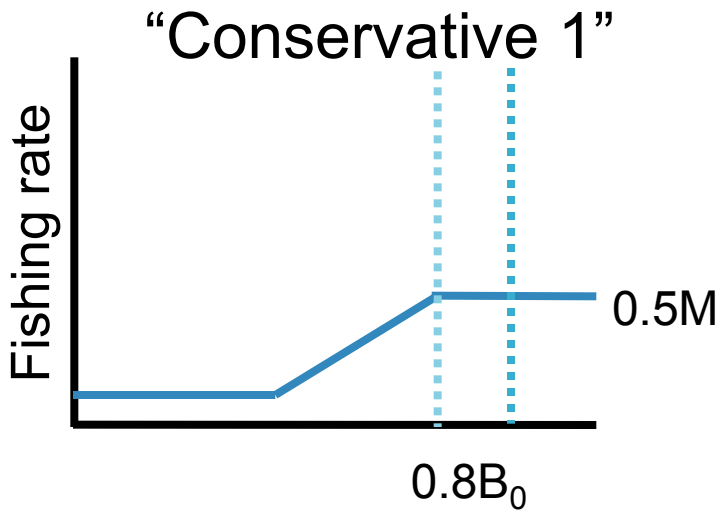
Proportion of prey near colony varies from year to year

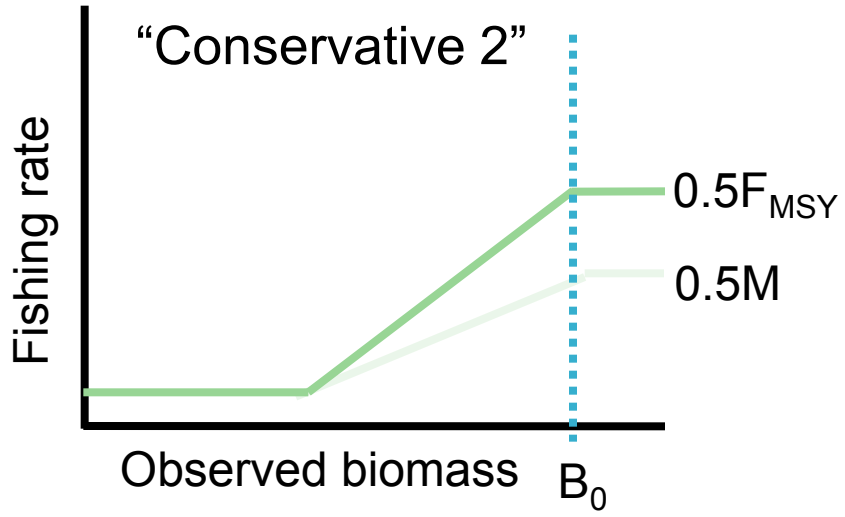


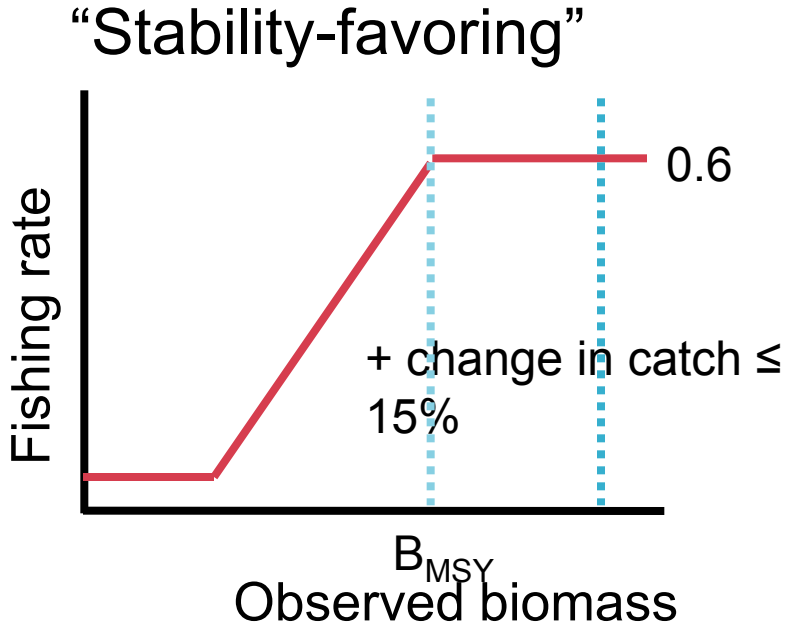


Test Harvest control rules (based on forage fish model)

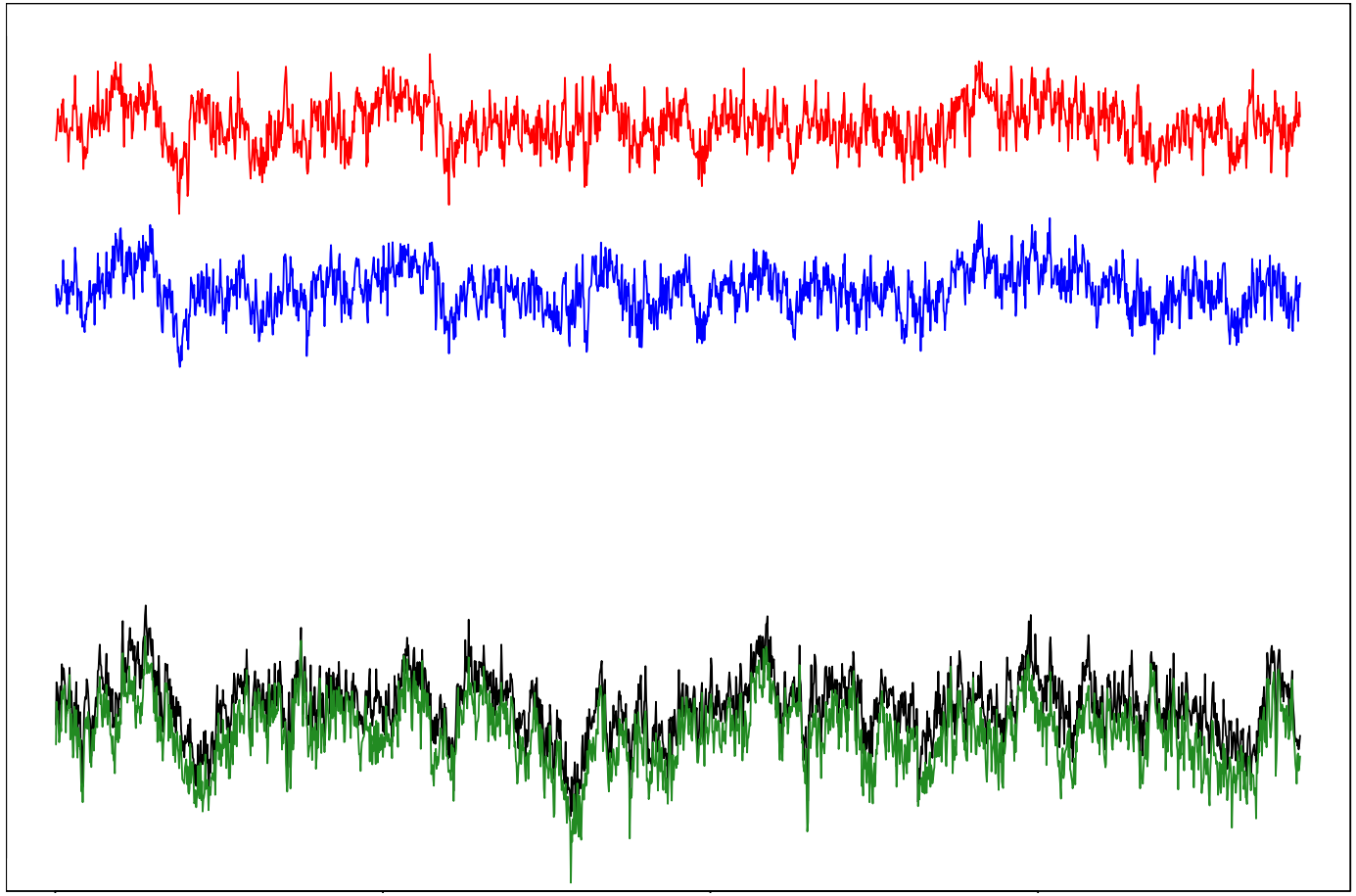








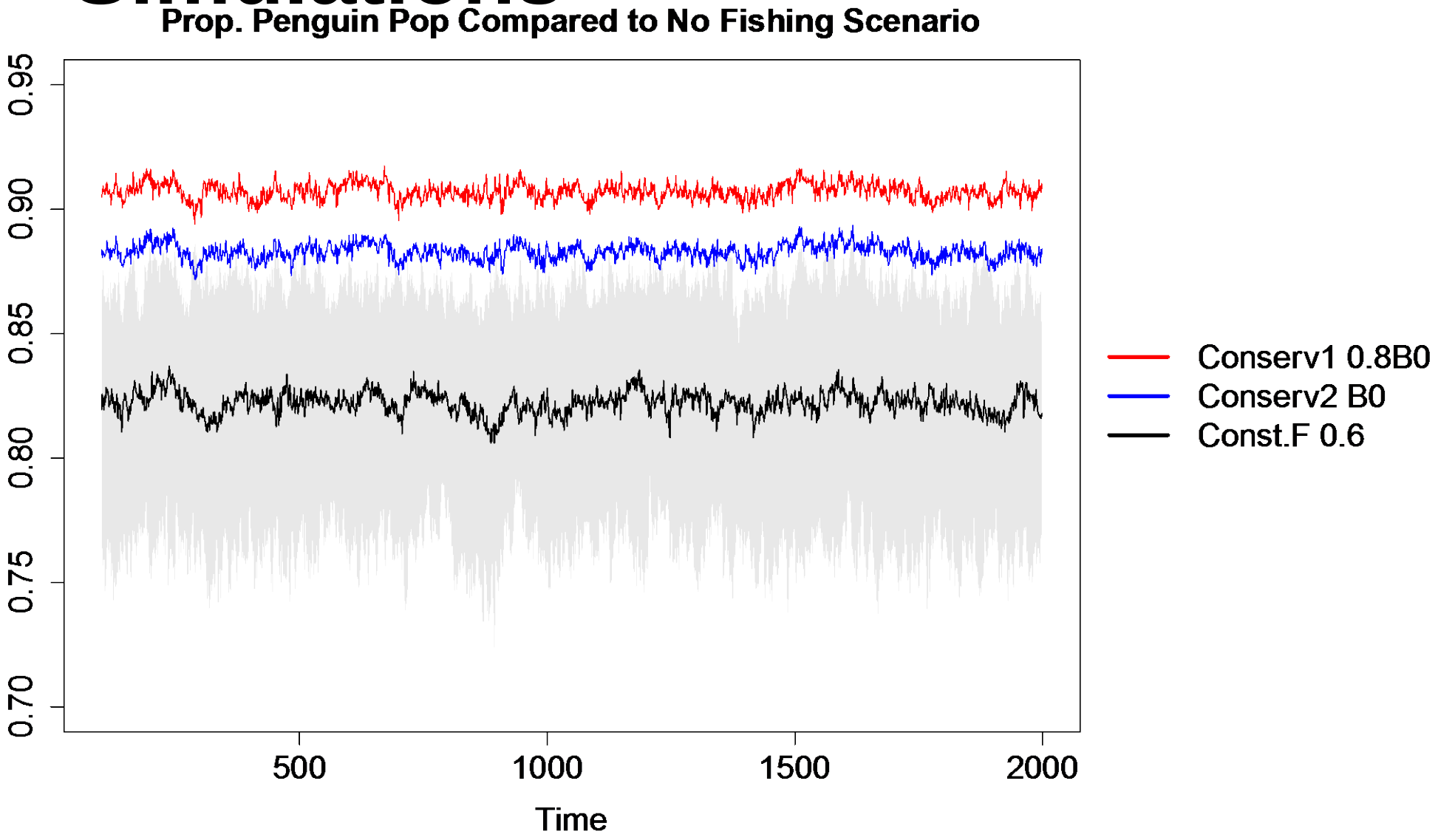
Preliminary Results



nst.F 0.6
Stability

Consistent with previous analyses to test impacts of forage fish control rules on seabirds

Preliminary Results Across 100 Simulations



Some overlap between conservative control rules and constant fishing BUT only one anchovy scenario

NEED MORE SCENARIOS!!!!

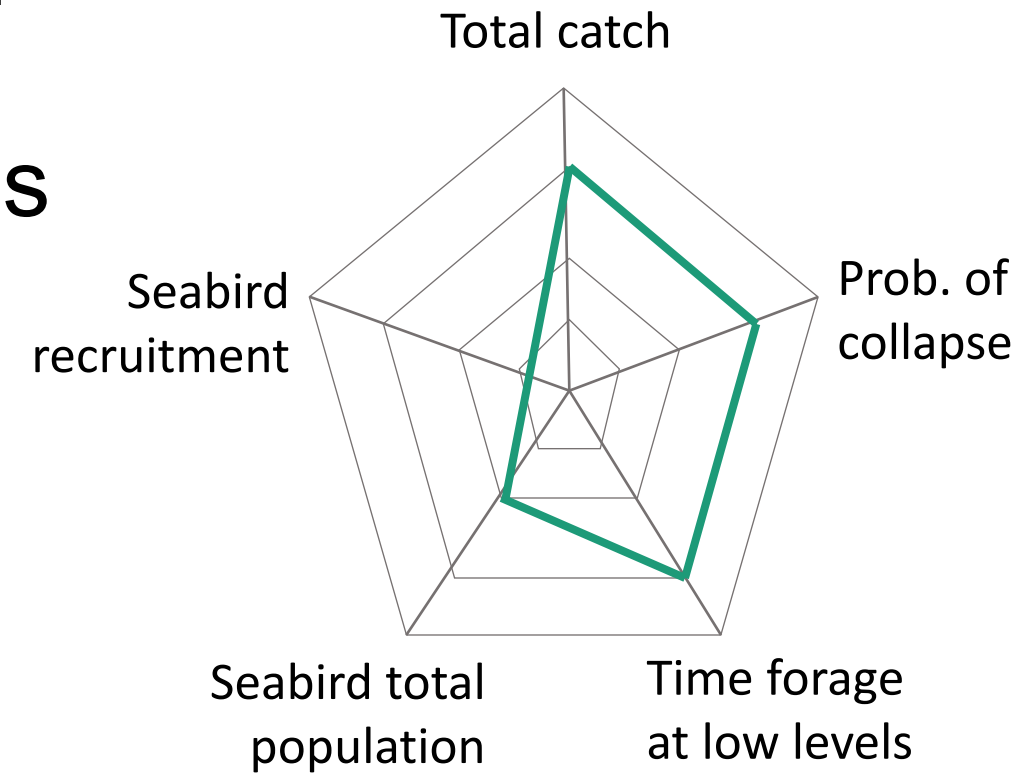
But...not all great for catch…

Harvest Control Rule	Years with 0 Catch	Long-term Mean Catch (Mil. Metric Tonnes)
Stability-Favoring	0	3.160186
Constant F (0.6)	0	3.13537
Conservative 1	23	2.166532
Conservative 2	2	2.494449

Need to test the additional harvest control rules that may equally benefit seabird conservation but have some increased benefits for fisheries

Next Steps – test everything!

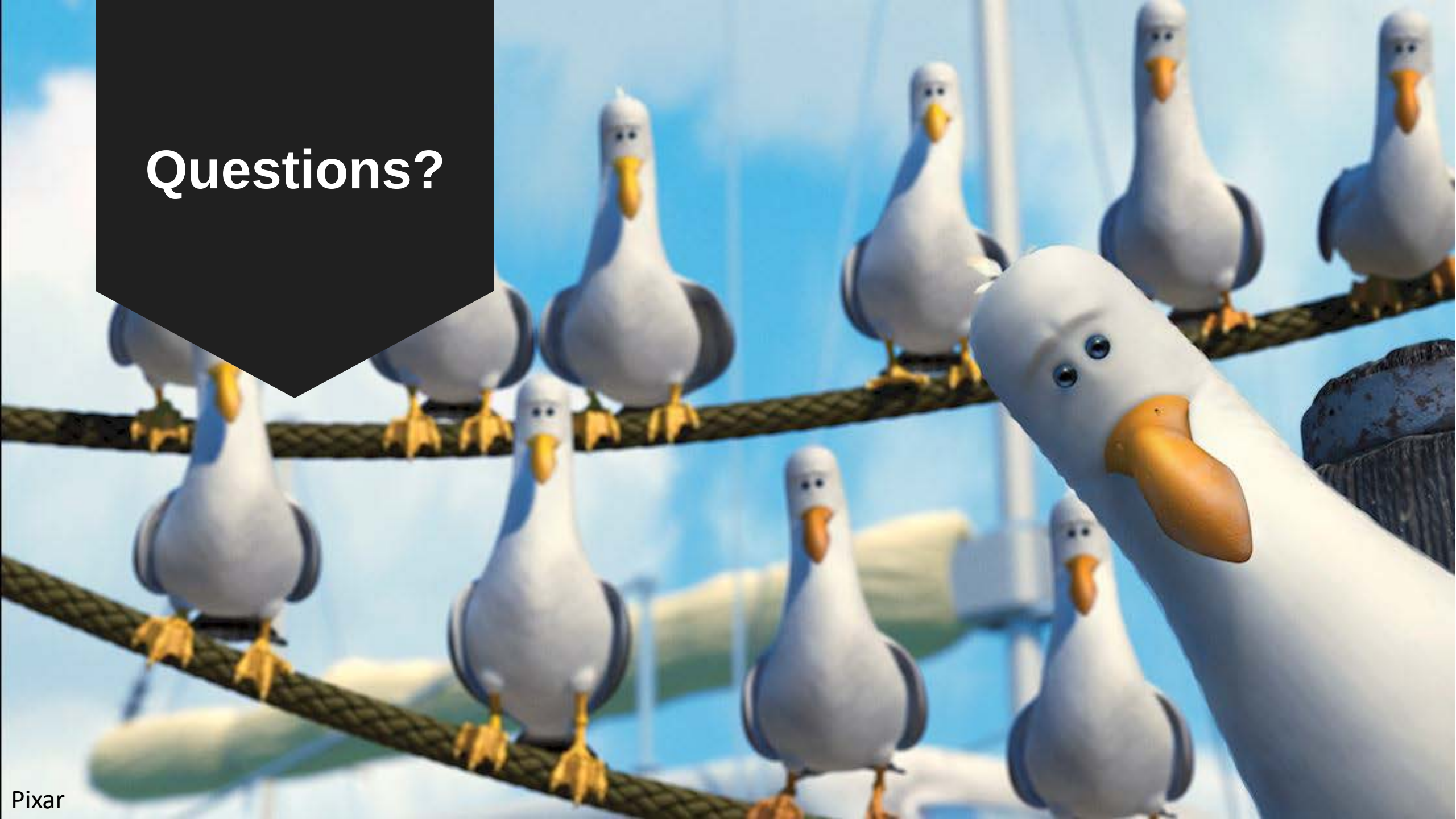
- Full simulation models for four seabird life history types
- Additional harvest control rules
- Variation in functional responses
- Variation in forage fish parameters
- Suggestions???



Thank you!

- UW School of Aquatic and Fishery Sciences
- Essington Lab
- PICES for travel funding

Questions?



Pixar