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# Effects of climate change on the northern Benguela ecosystem

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FISCES Workshop 2/3

Gijón, Spain

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# Objectives

Linking global climate model output to:

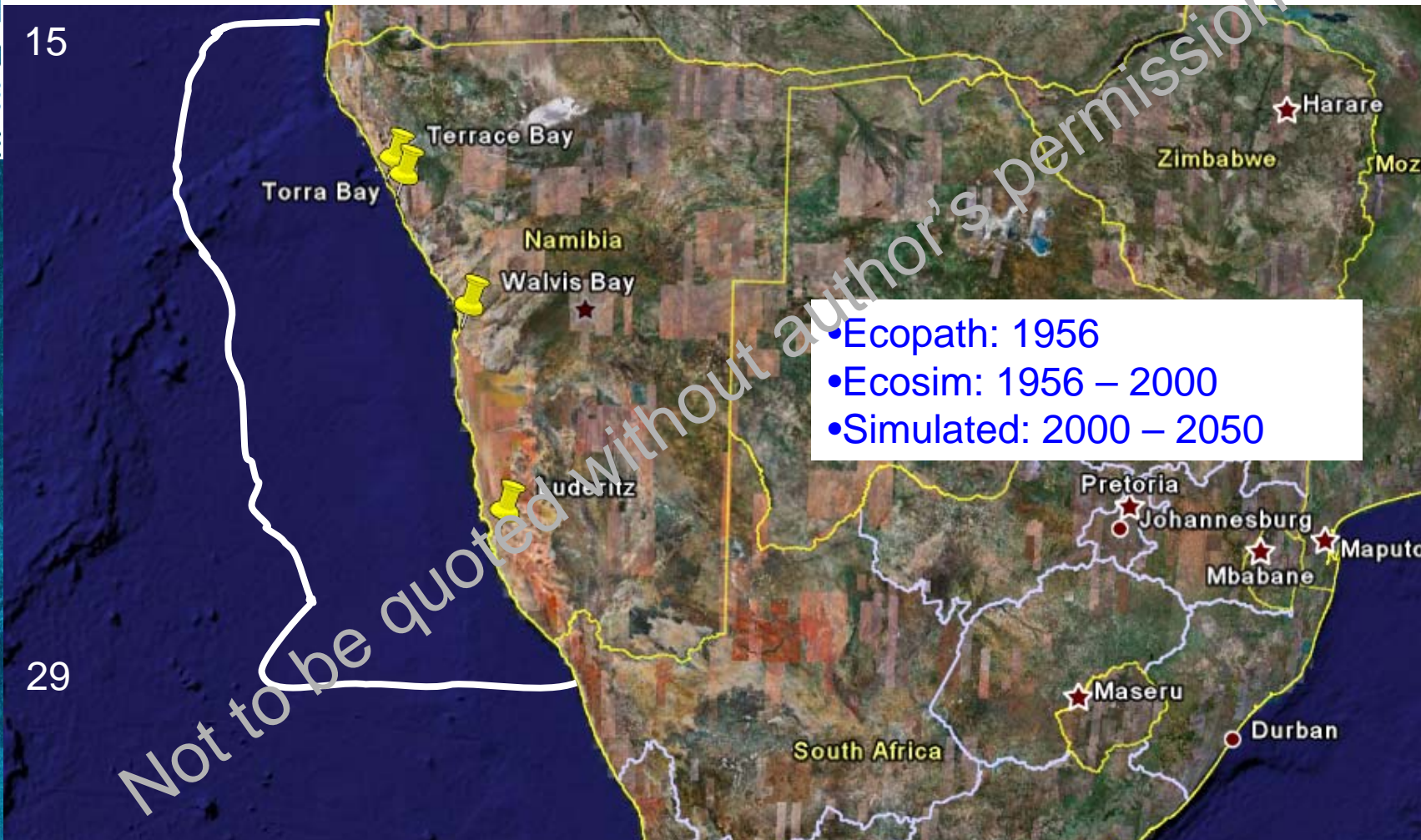
1. trends in commercial species productivity
2. Changes in broader biological communities

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# Northern Benguela ecosystem

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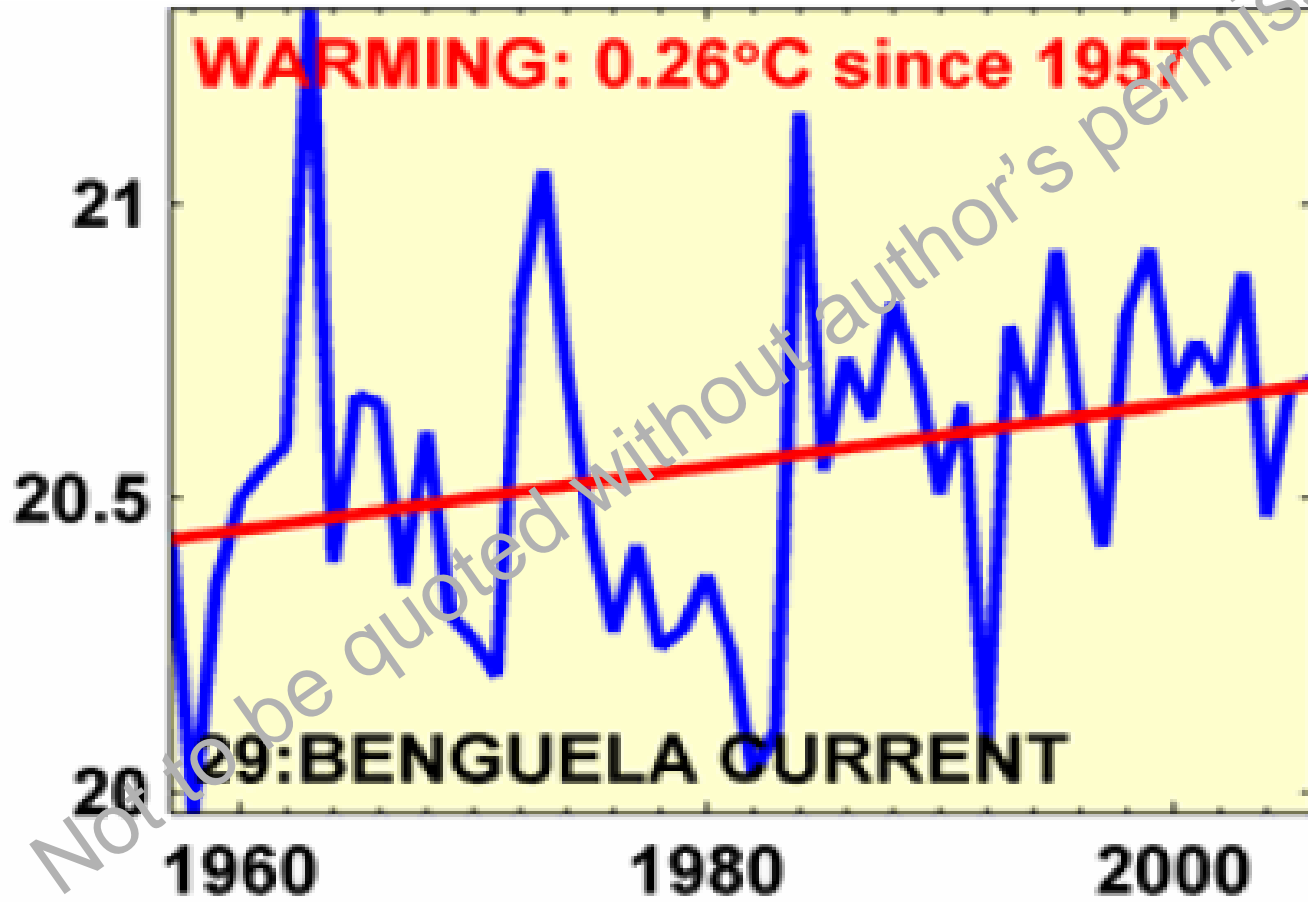


Heymans, S.J.J, Sumaila, U.R. 2007. Updated ecosystem model for the northern Benguela ecosystem, Namibia. pp. 25-70 Le Quesne, W.J.F., Arreguin-Sanchez, F., Heymans, S.J.J. (Eds). INCOFISH ecosystem models: transiting from Ecopath to Ecospace. Fisheries Centre Research Reports 15(6), 188 pages.



# Global climate change model output

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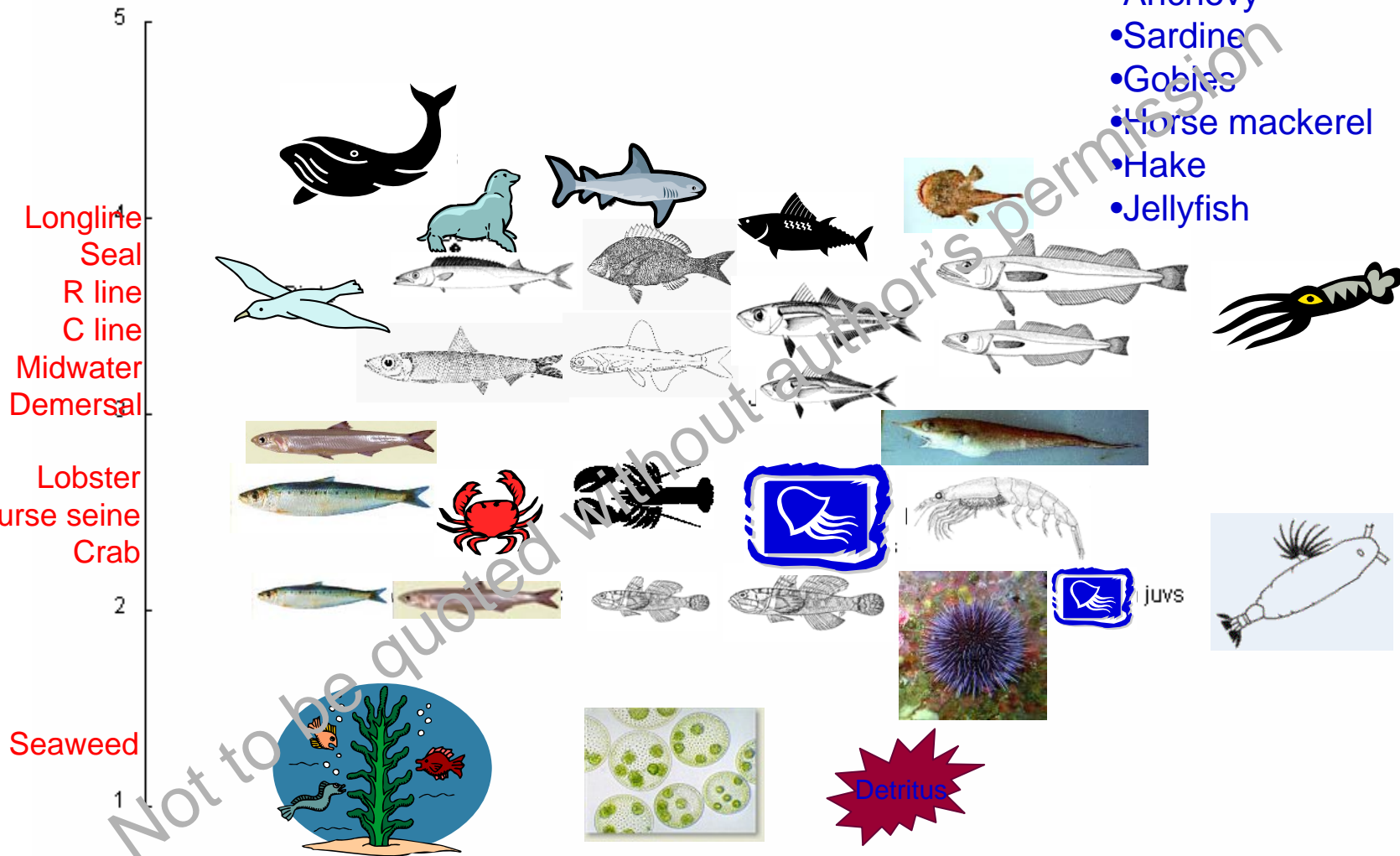
Sherman, K., Belkin, I., O'Reilly, J., Hyde, K. 2007. Variability of Large Marine Ecosystems in response to global climate change. ICES CM D:20.



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# Ecopath model

- 32 groups
- Adult-juvenile split
  - Anchovy
  - Sardine
  - Gobies
  - Horse mackerel
  - Hake
  - Jellyfish



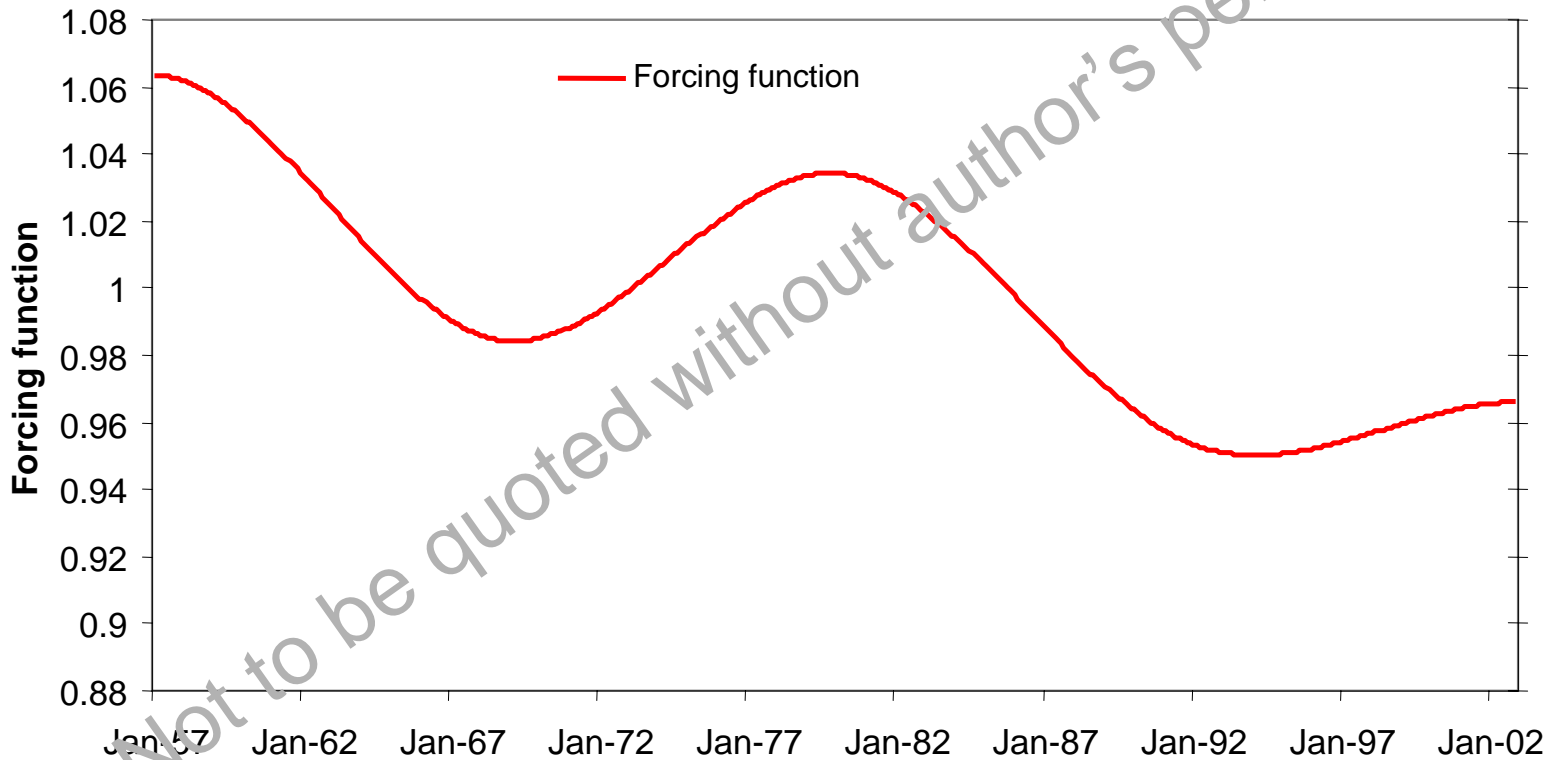
Heymans, S.J.J, Sumaila, U.R. 2007. Updated ecosystem model for the northern Benguela ecosystem, Namibia. pp. 25-70 Le Quesne, W.J.F., Arreguin-Sanchez, F., Heymans, S.J.J. (Eds). INCOFISH ecosystem models: transiting from Ecopath to Ecospace. Fisheries Centre Research Reports 15(6), 188 pages.



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# Fitting the model

**Ecosim:** time dynamic simulation tool for studying ecosystem interactions  
Drive model forward to 2002 using fishing mortality  
and estimating an environmental driver

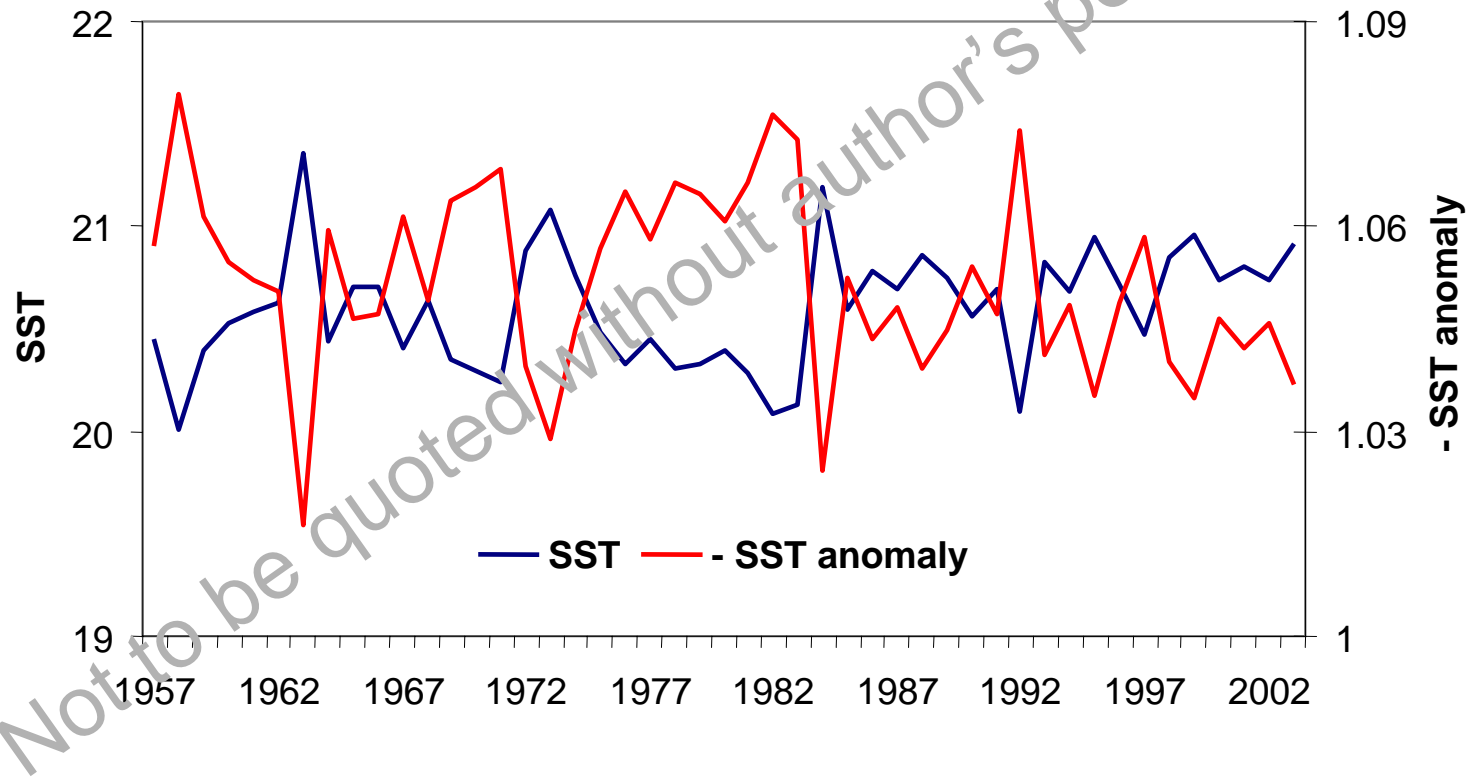




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# Environmental driver

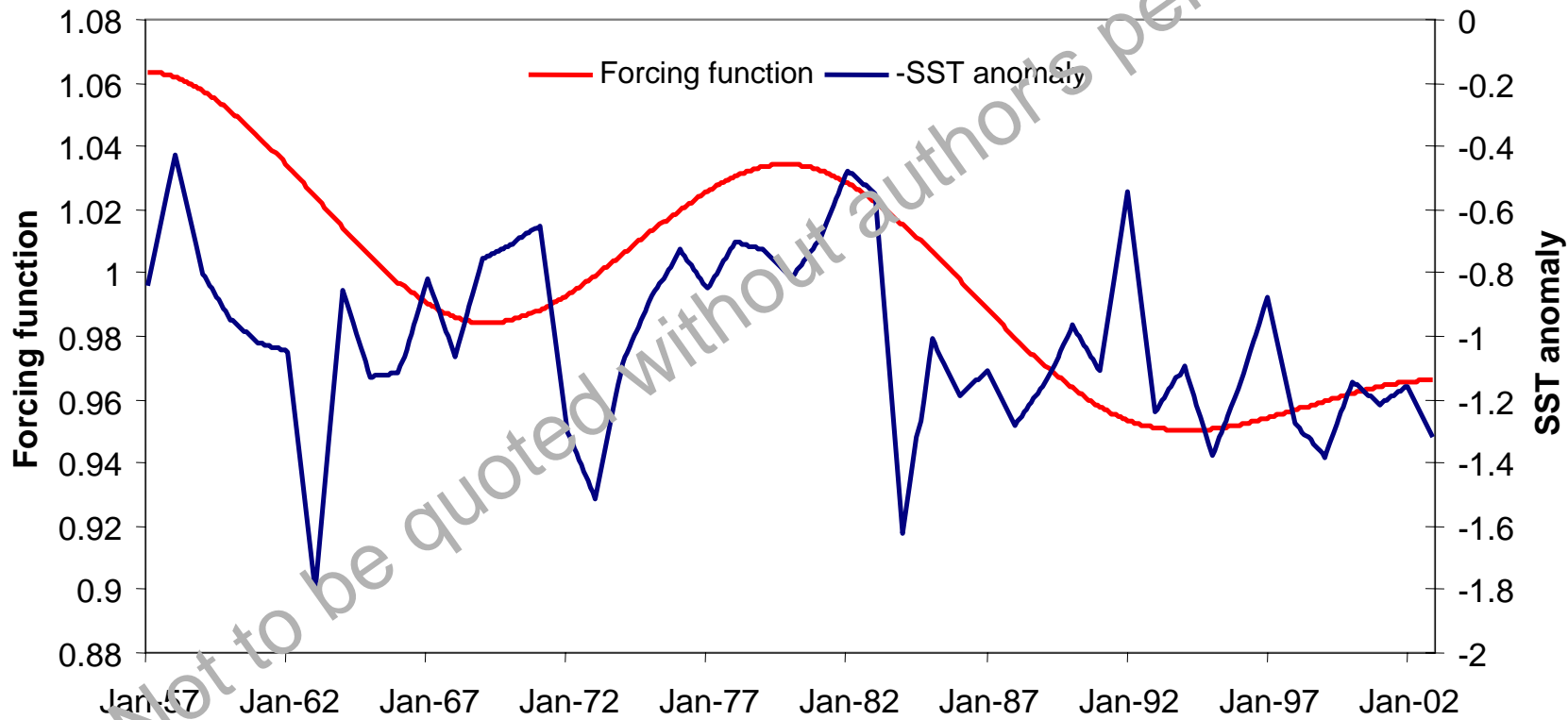
Correlation between SST and forcing function  
 $R^2 = -0.34$ , significant @ 0.05





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# Environmental driver



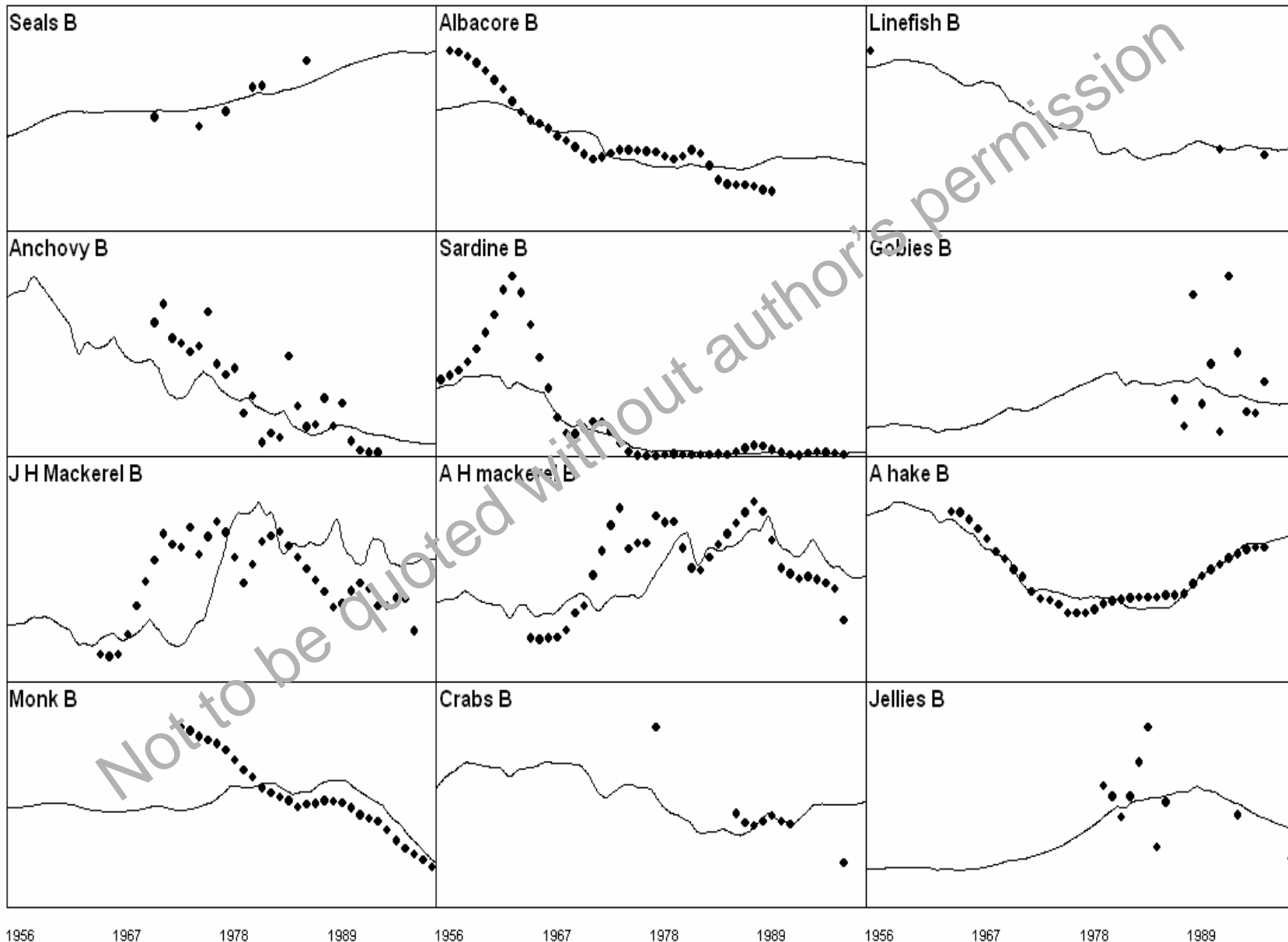




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# Ecosim fitting - Biomass

- Data
- Model

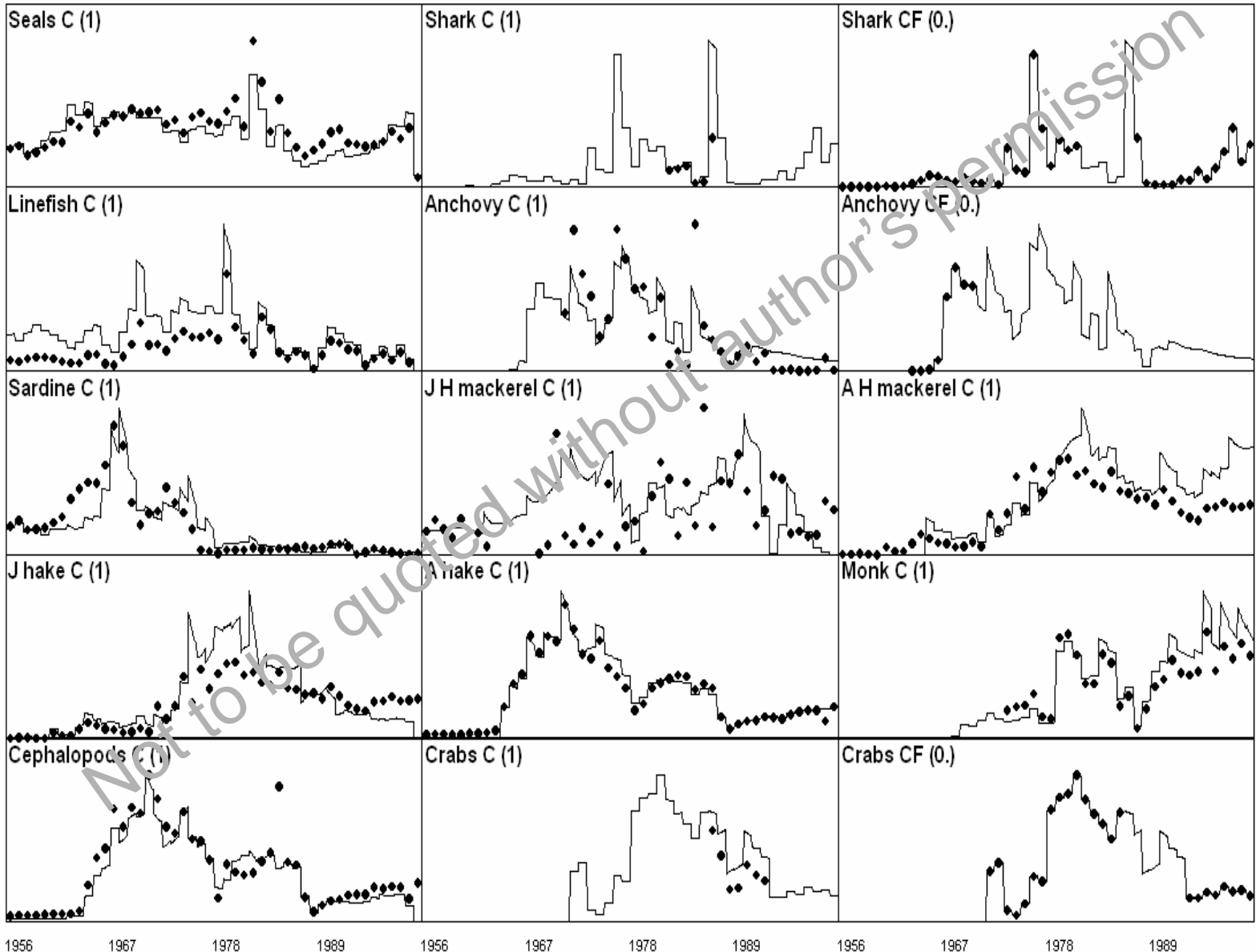




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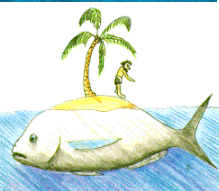
# Ecosim fitting - Catch

- Data
- Model



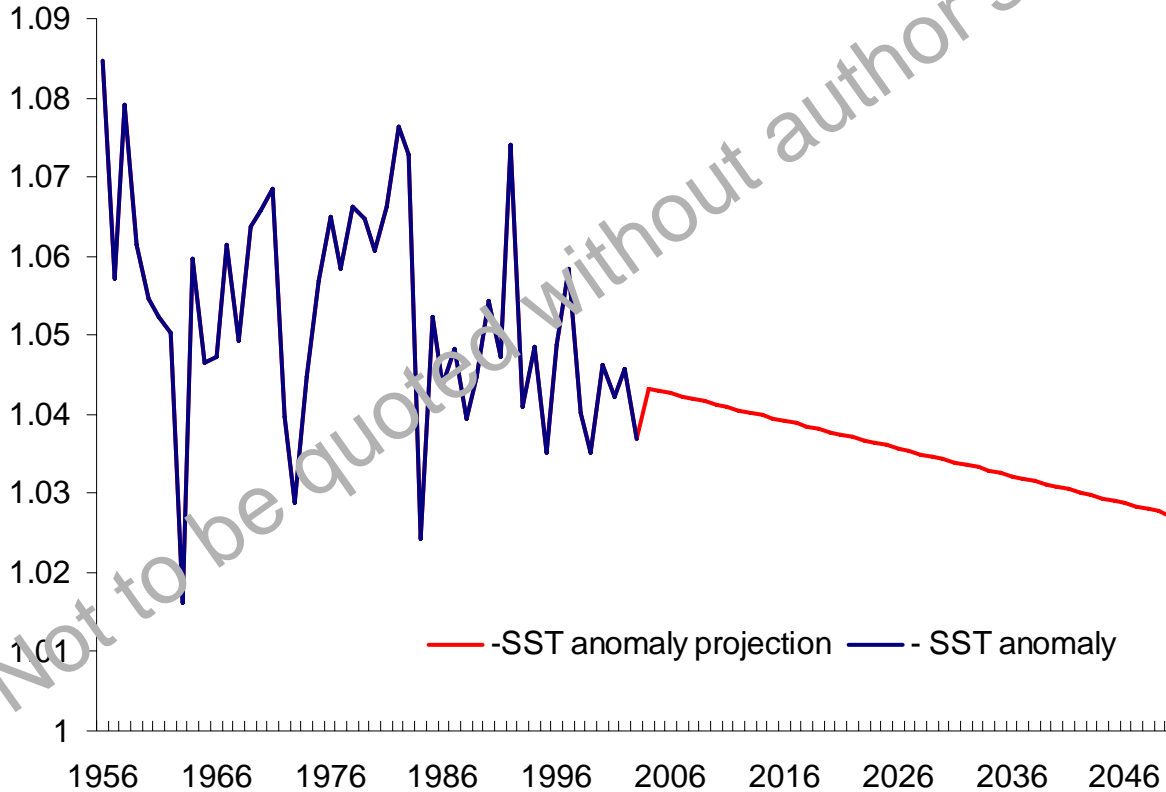


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# Future effects of climate change

**Ecosim:** time dynamic simulation tool for studying ecosystem interactions  
Drive model forward to 2000 using fishing mortality and environmental variation  
Drive model forward with constant fishing mortality and increased SST to 2050



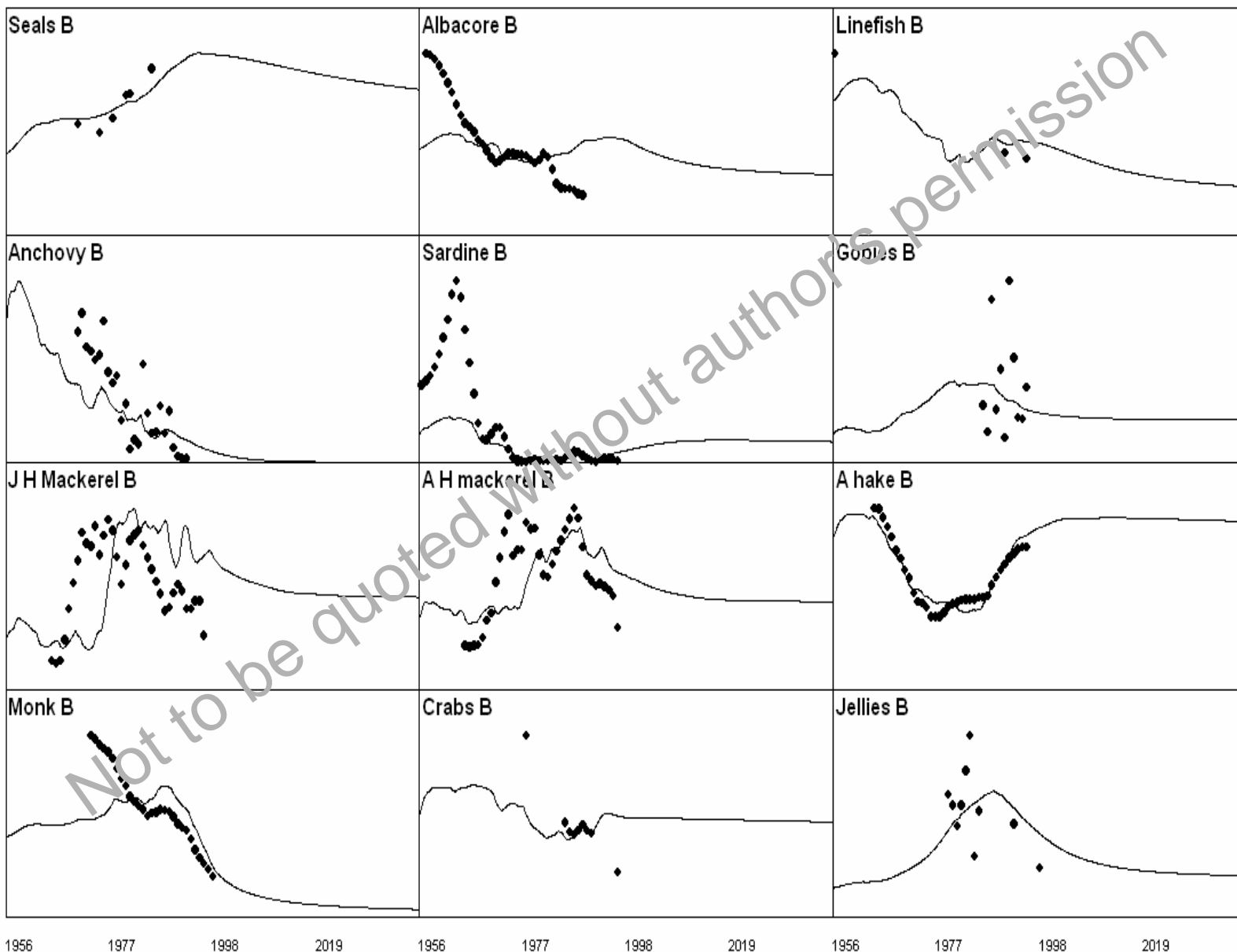
Data from Igor Belkin: Belkin, I.M. 2008. Rapid warming of Large Marine Ecosystems. Submitted to Progress in Oceanography.



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# 2050 - Biomass

- Data
- Model

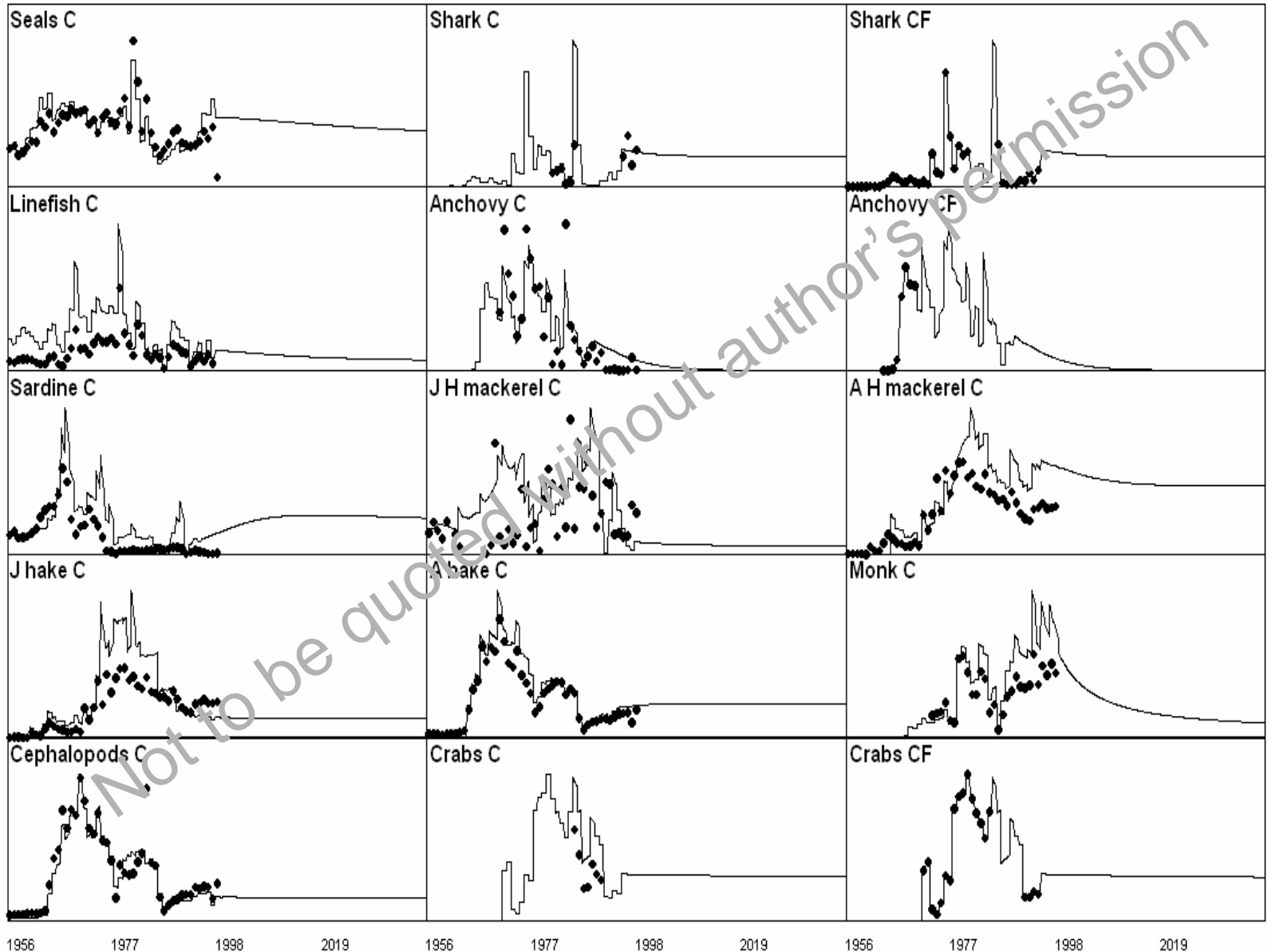




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# 2050 - Catch

- Data
- Model

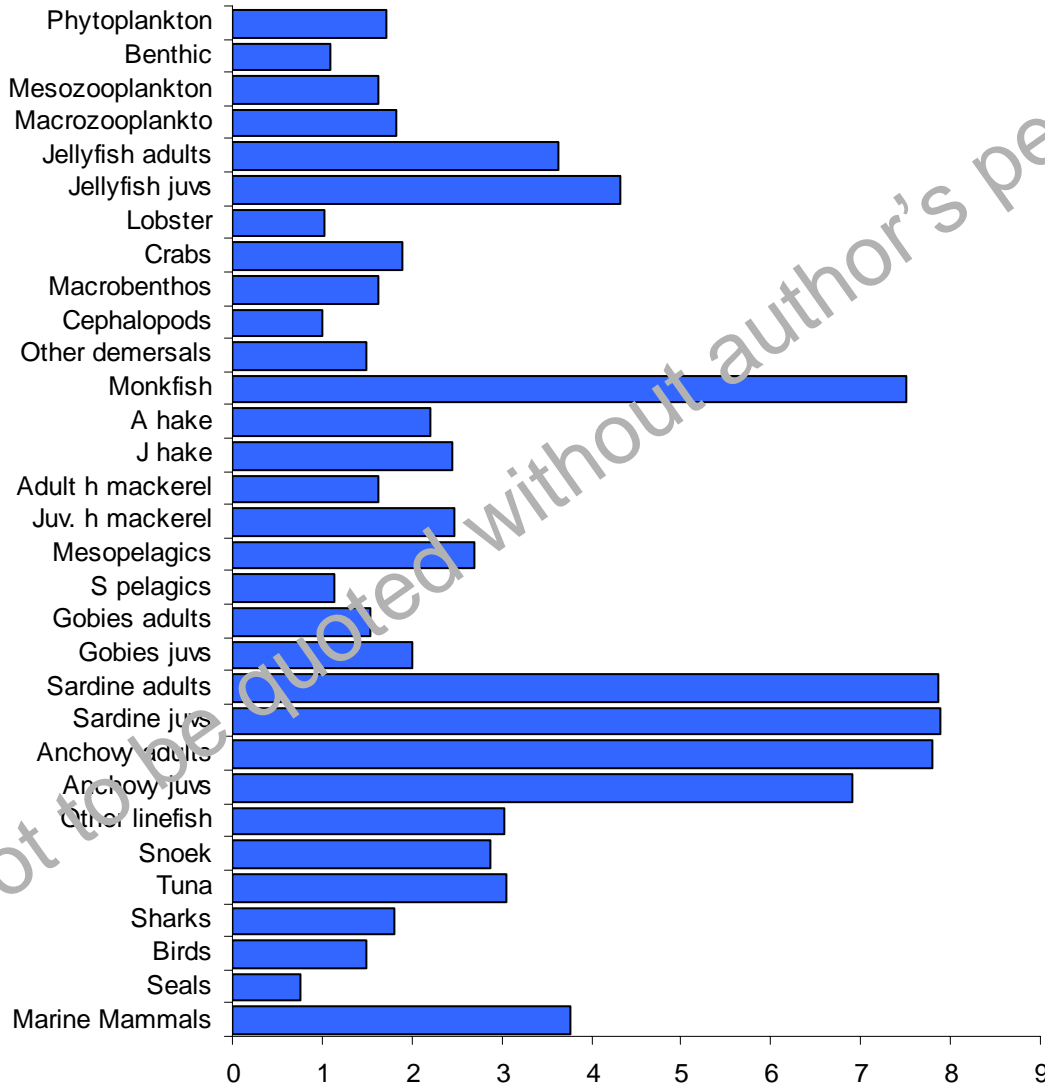




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# Changes due to climate: Biomass

% Reduction in Biomass



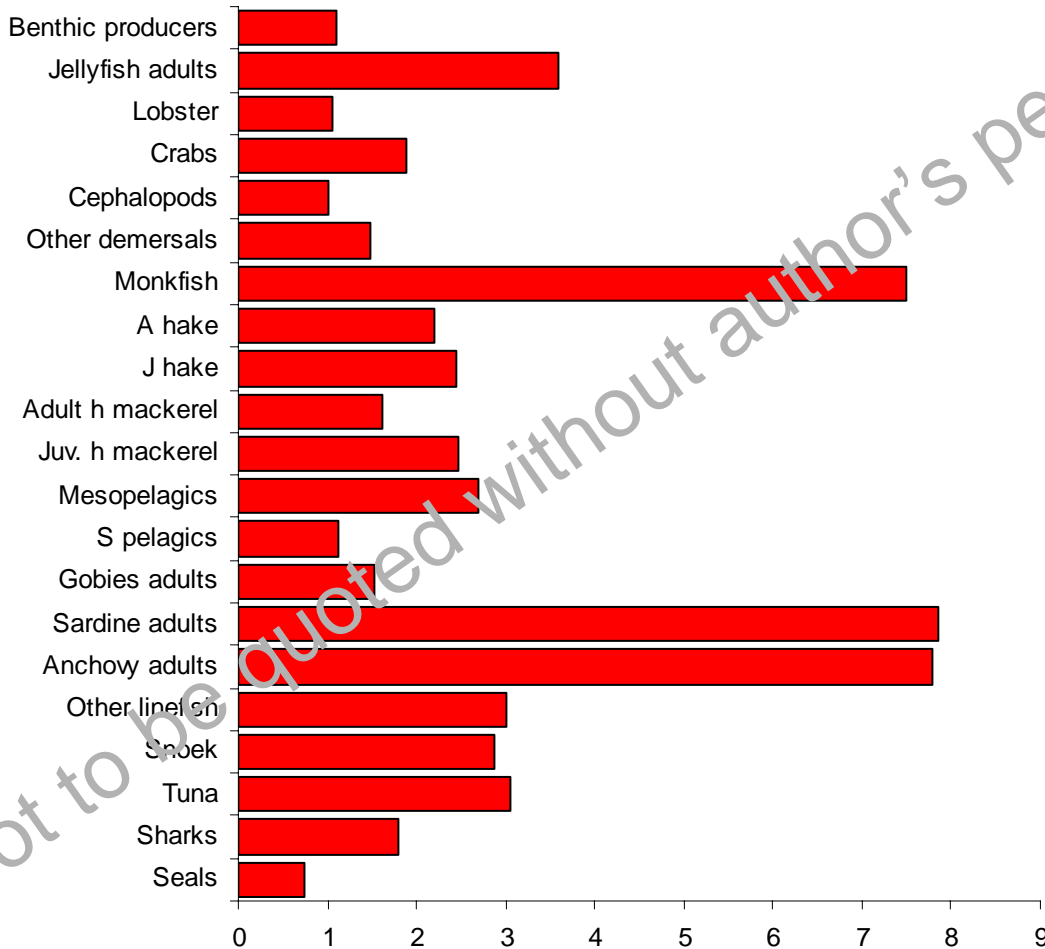
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# Changes due to climate: **Catch**

% Reduction in Catch



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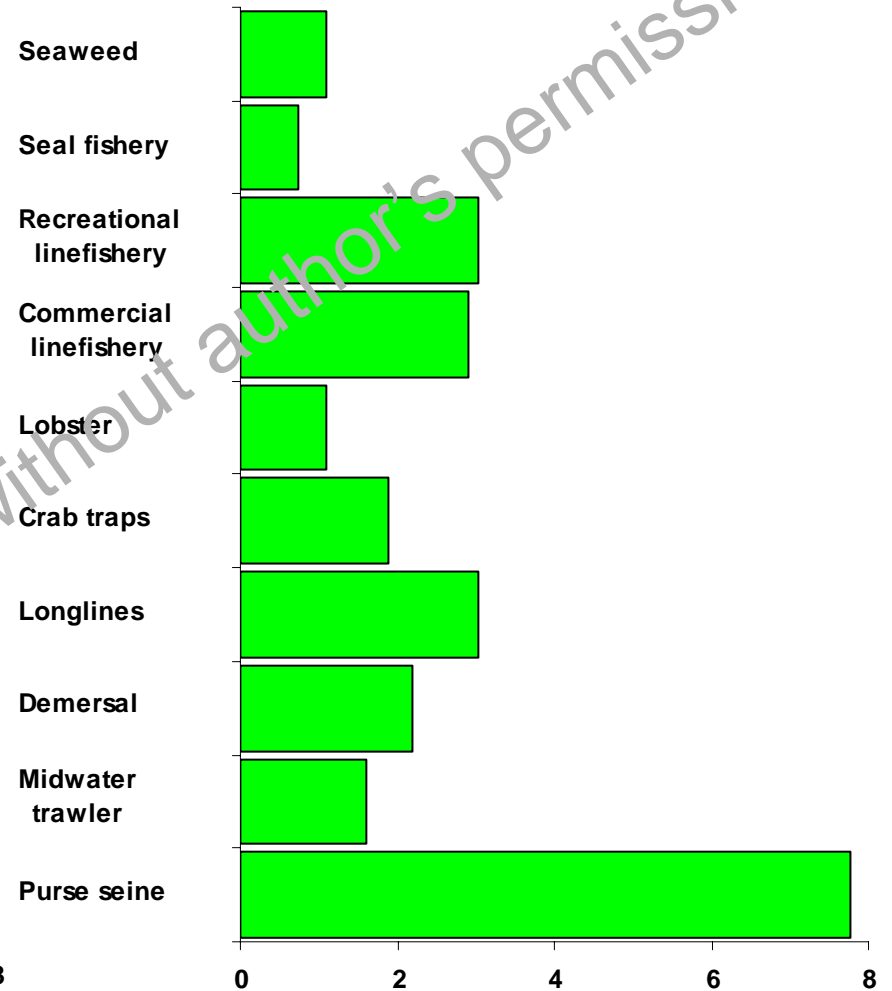
# Changes due to climate: Fisheries

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% Reduction in Catch



% Reduction in Value



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# Conclusions

Reduction in biomass of most species (<10%) but specifically commercially important species: Monkfish, sardine and anchovy

## Also

Reduction in catches possible from those species (8% from monkfish, sardines and anchovy)

## Effects

Effects mainly seen in purse seine and longline fleet although the recreational and commercial line fisheries catches are also reduced.

## Future work:

How vulnerabilities might change impacts?

What if climate change is more or less pronounced?

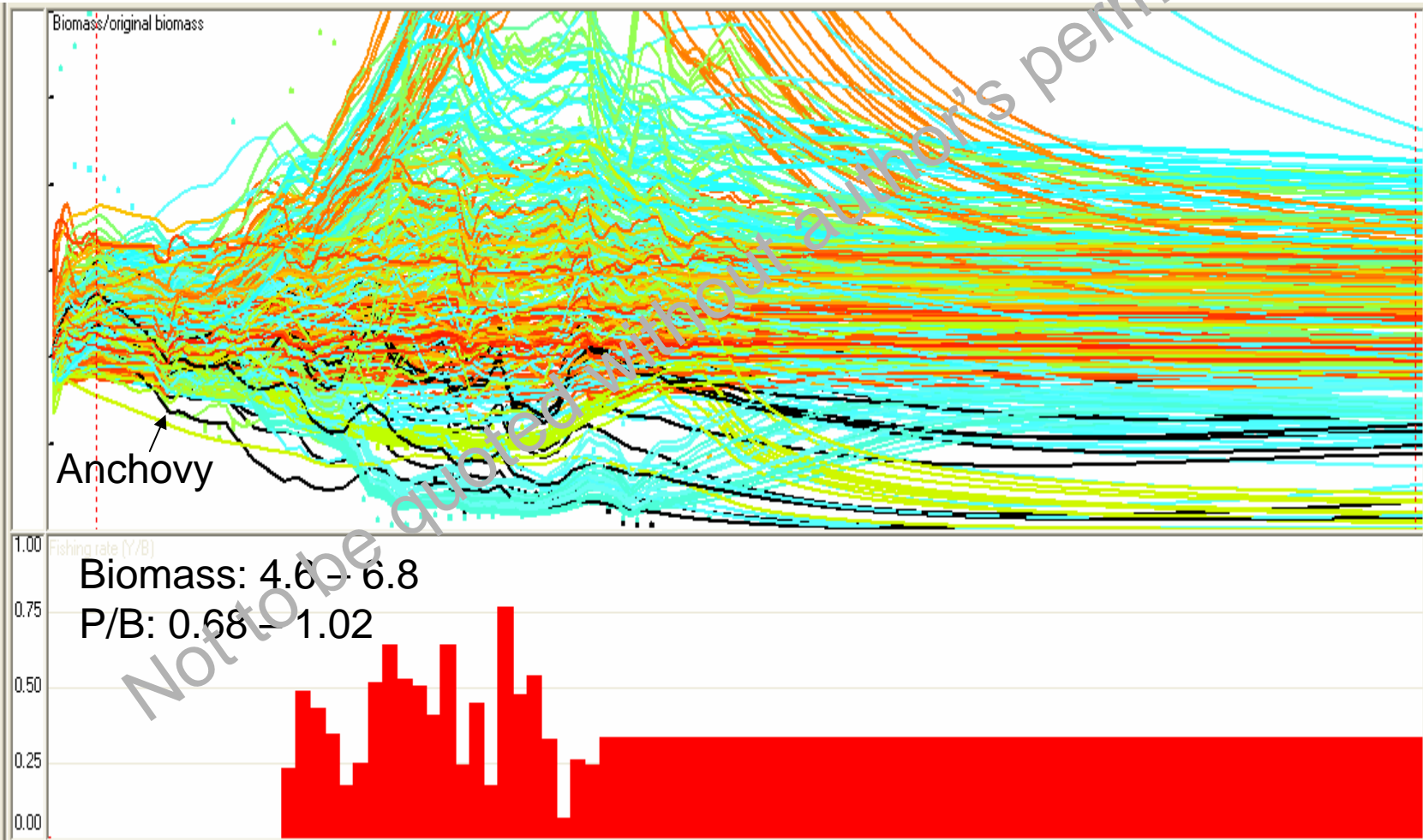
Uncertainty of estimates!



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# Uncertainty on input data

Monte Carlo simulations





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