Using aggregate biomass data to understand predation effects on surplus production

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QERM Seminar

February 20, 2013

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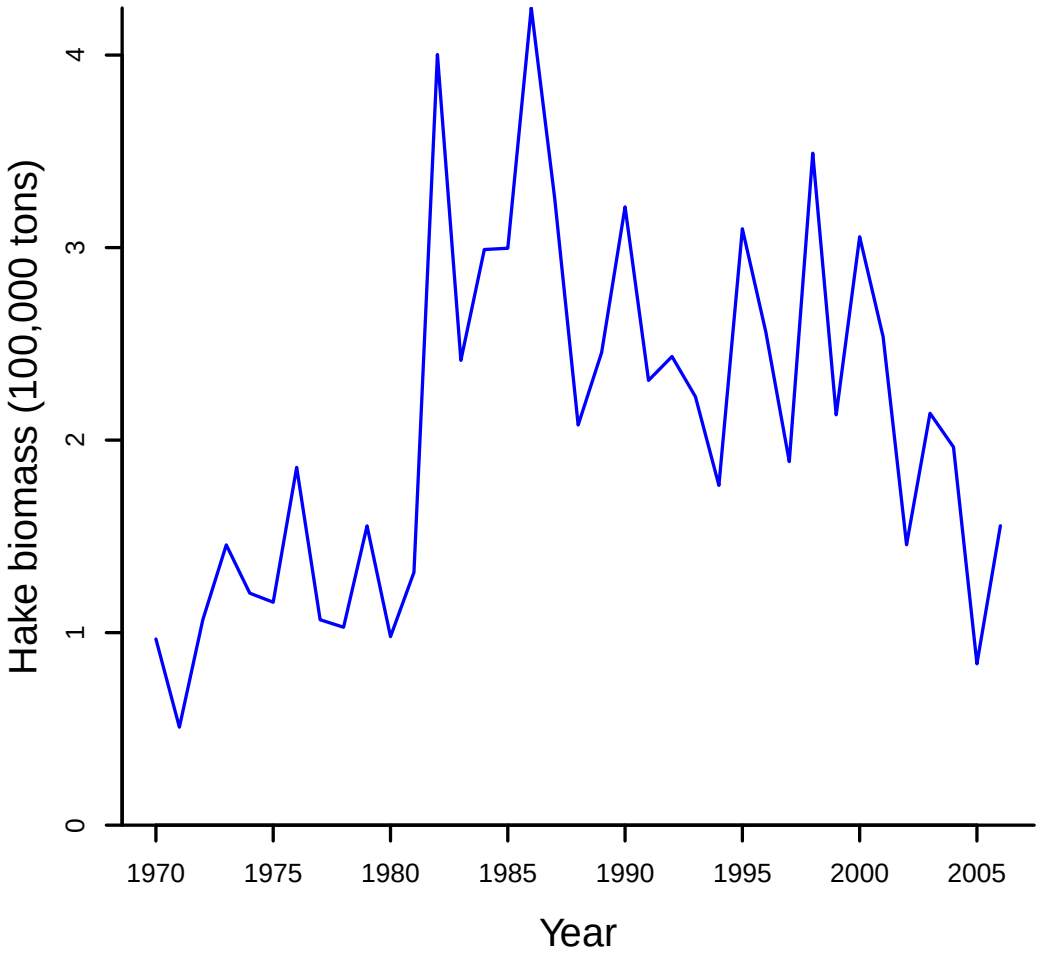
- Part of ecosystem-based management
  - Trade-offs
  - Natural mortality
- Top-down effects
- To estimate, comparative approaches useful

Aggregate biomass data



Surplus production

$$\text{Surplus production}_y = \text{Biomass}_{y+1} - \text{Biomass}_y + \text{Catch}_y$$

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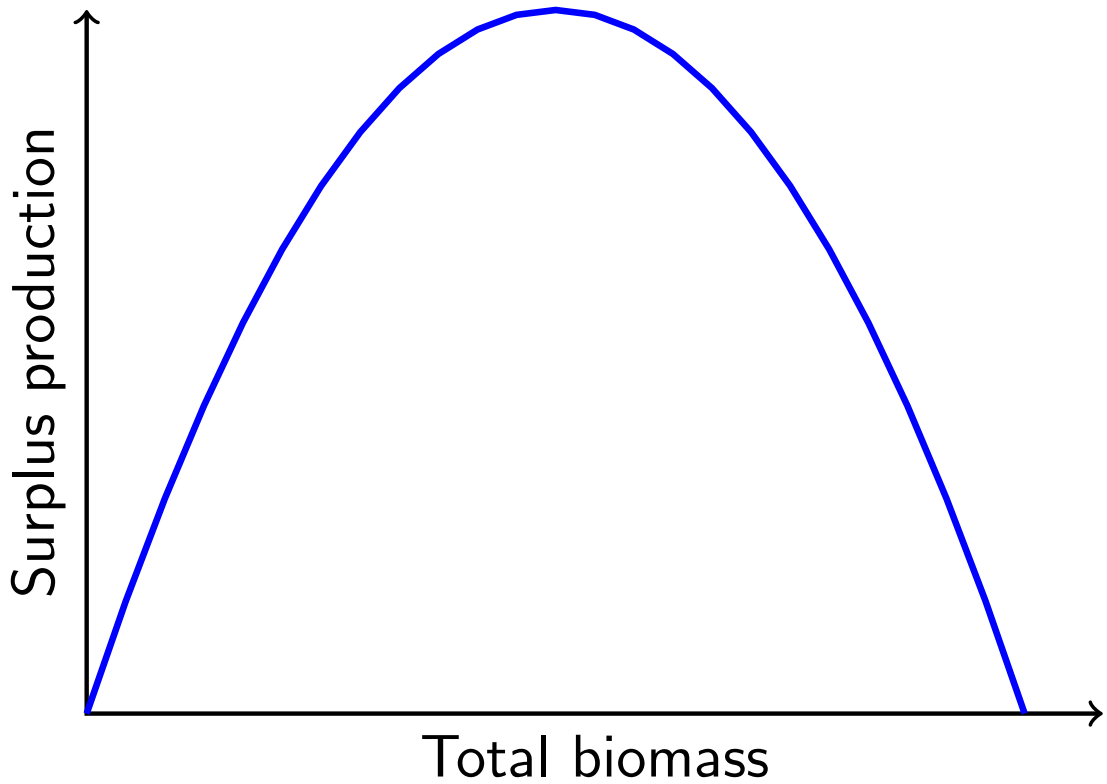
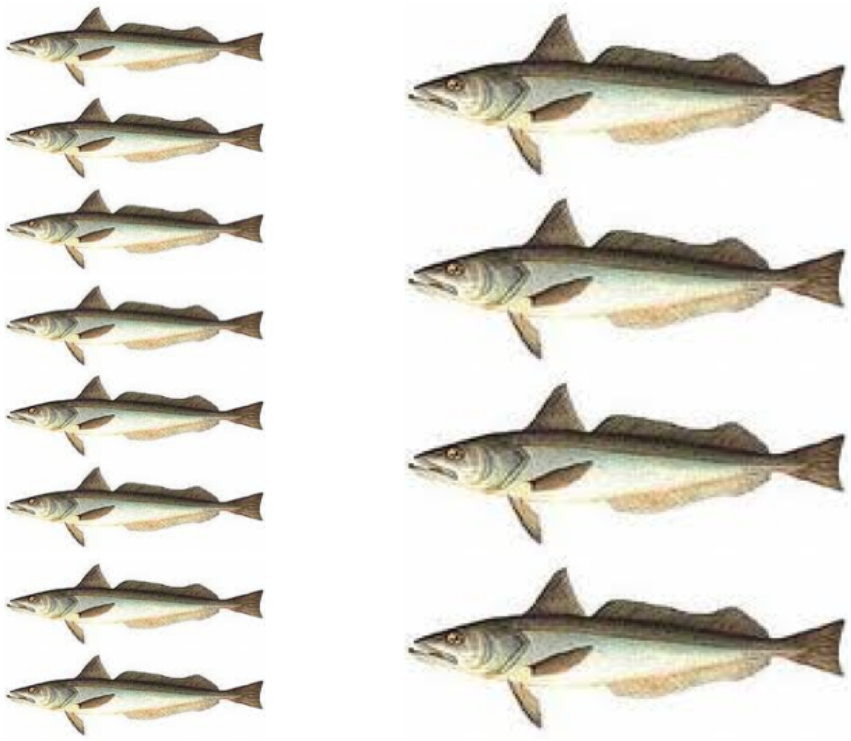
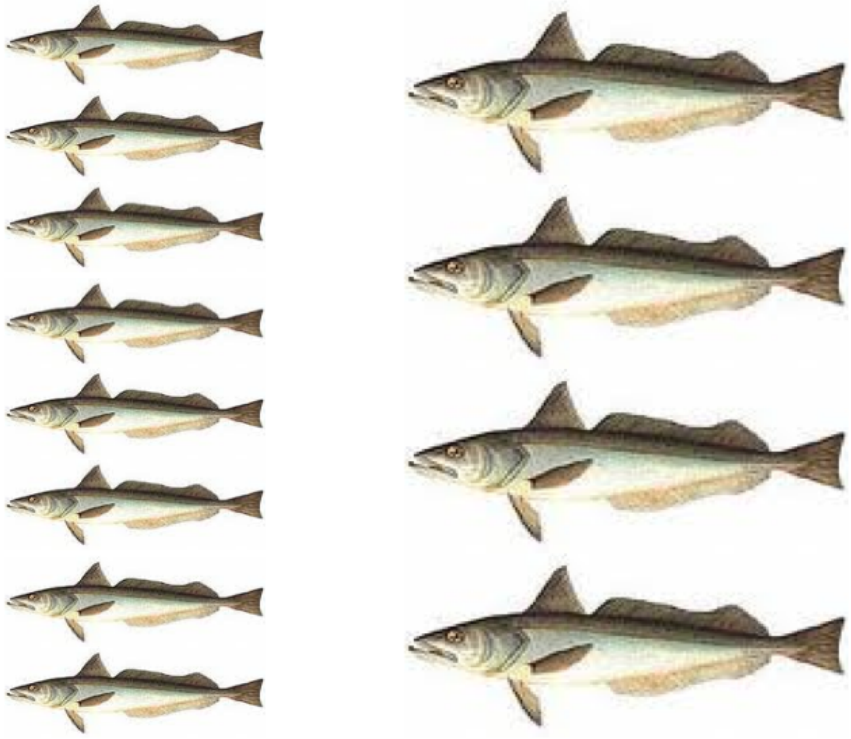


Age-structured populations



Age-structured populations

Low spawning potential



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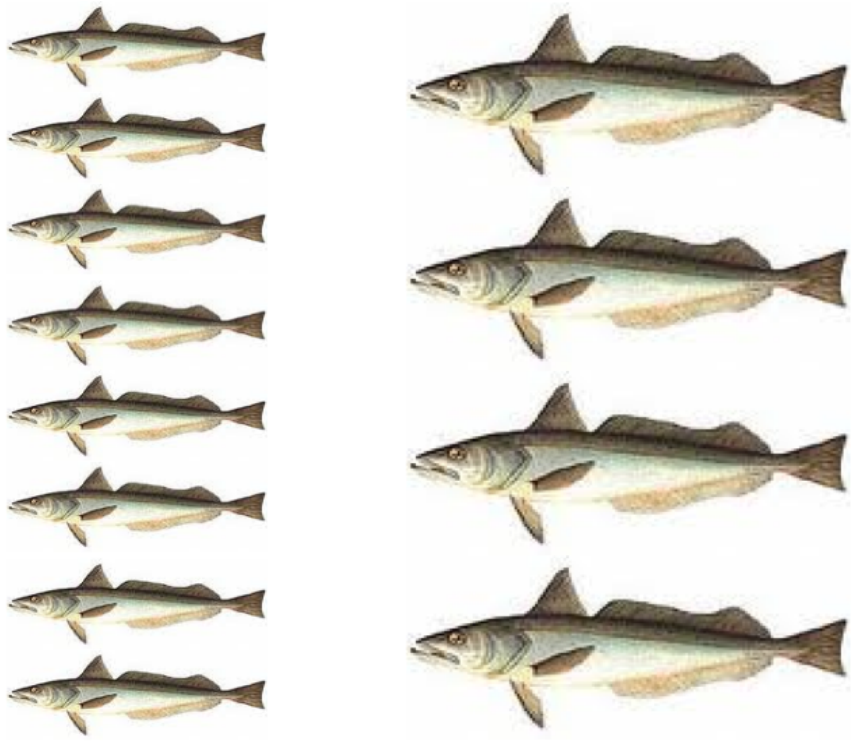
Vulnerable to predators



High spawning potential

Less vulnerable to predators

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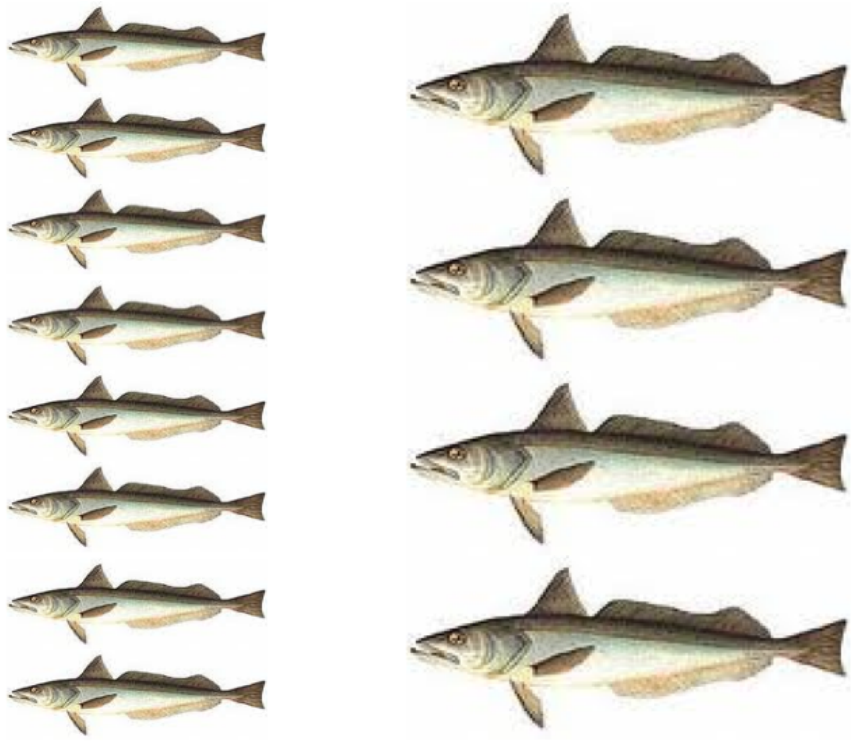
Vulnerable to predators

Low catchability



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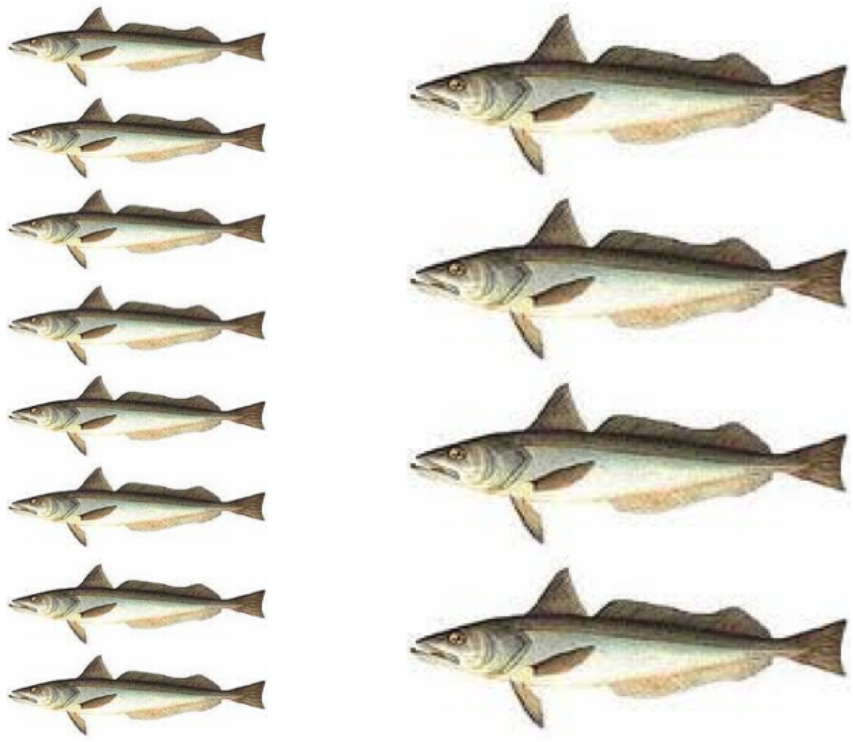
Large growth increment



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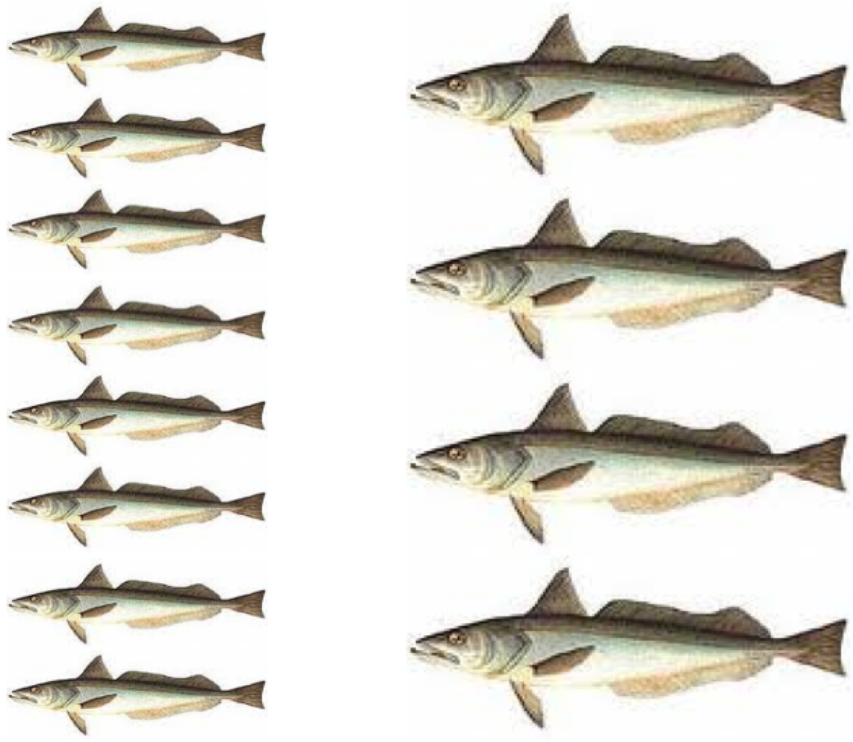

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Equal biomasses!

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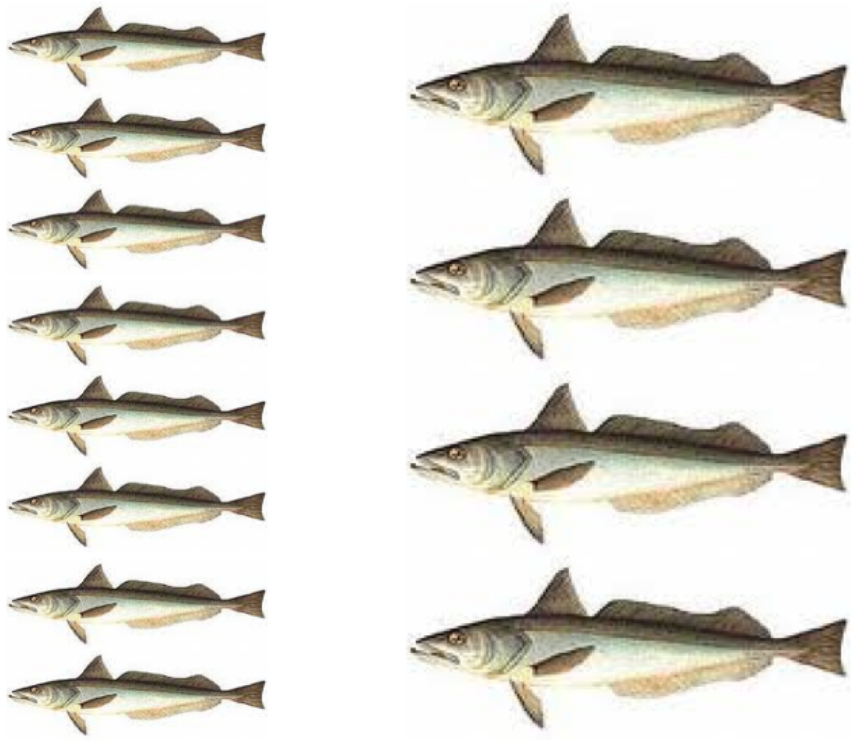

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Questions

What can we glean from surplus production models that account for predation?

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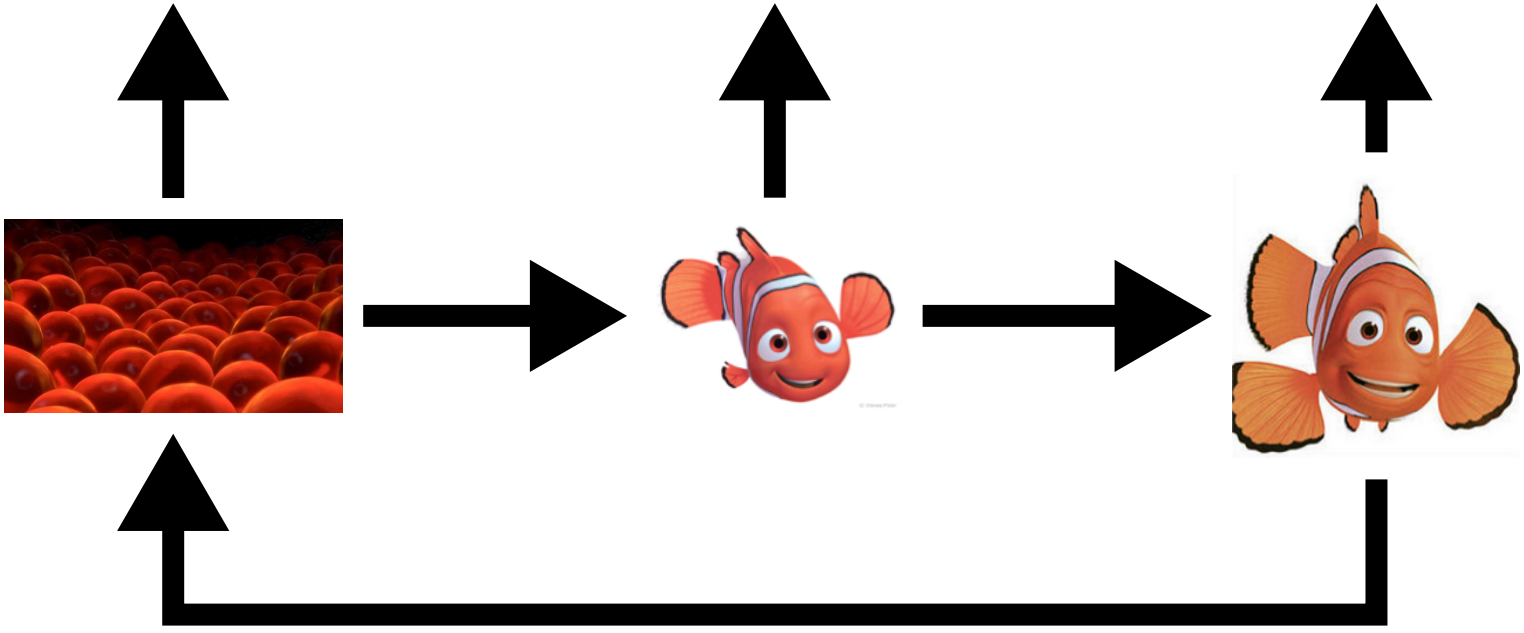
- Model used to simulate data
- Statistical model fit to simulated data
- Results and conclusions

Operating model



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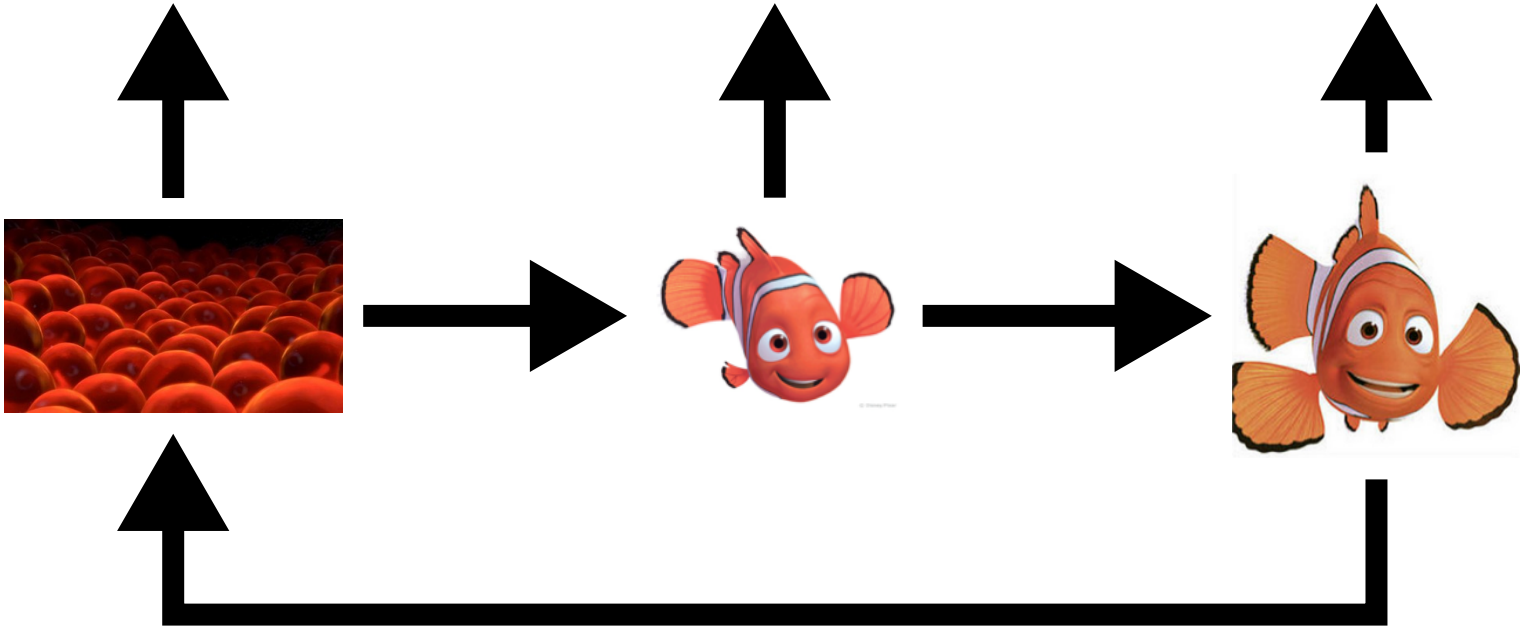

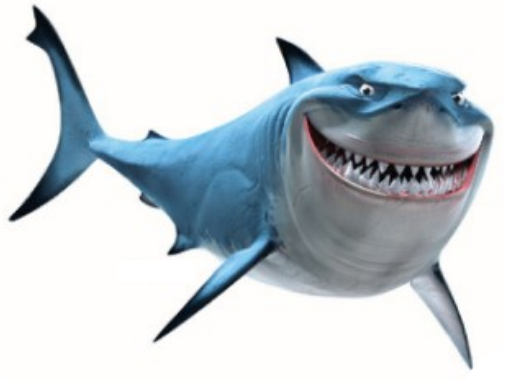

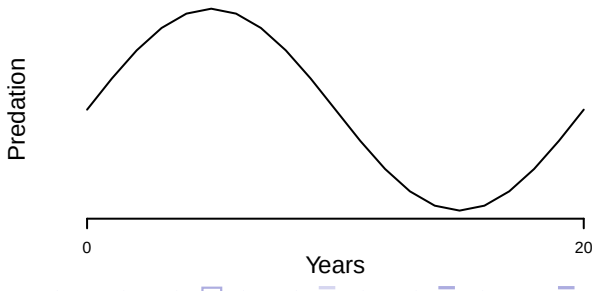

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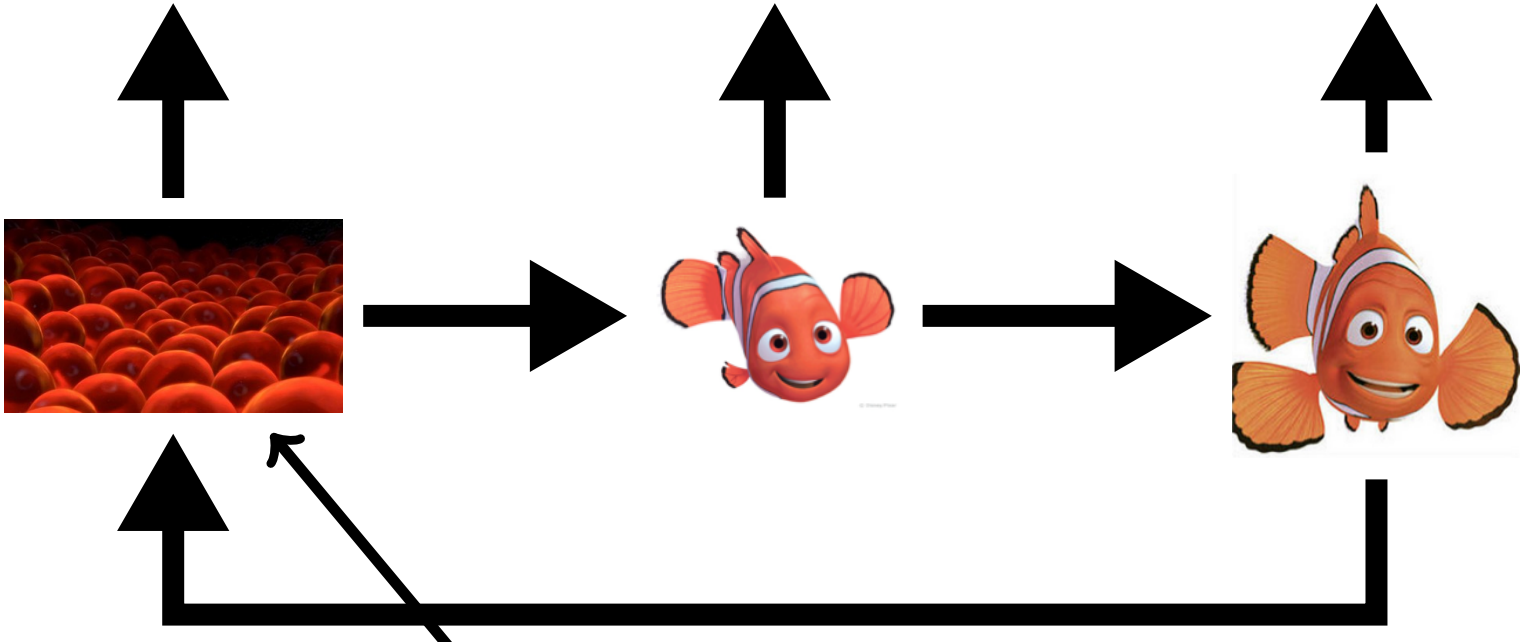

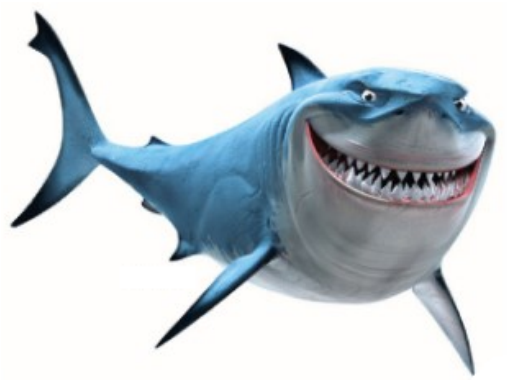

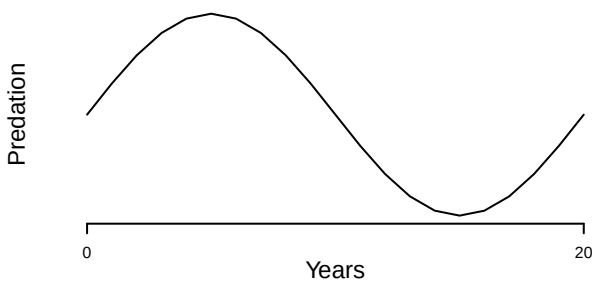

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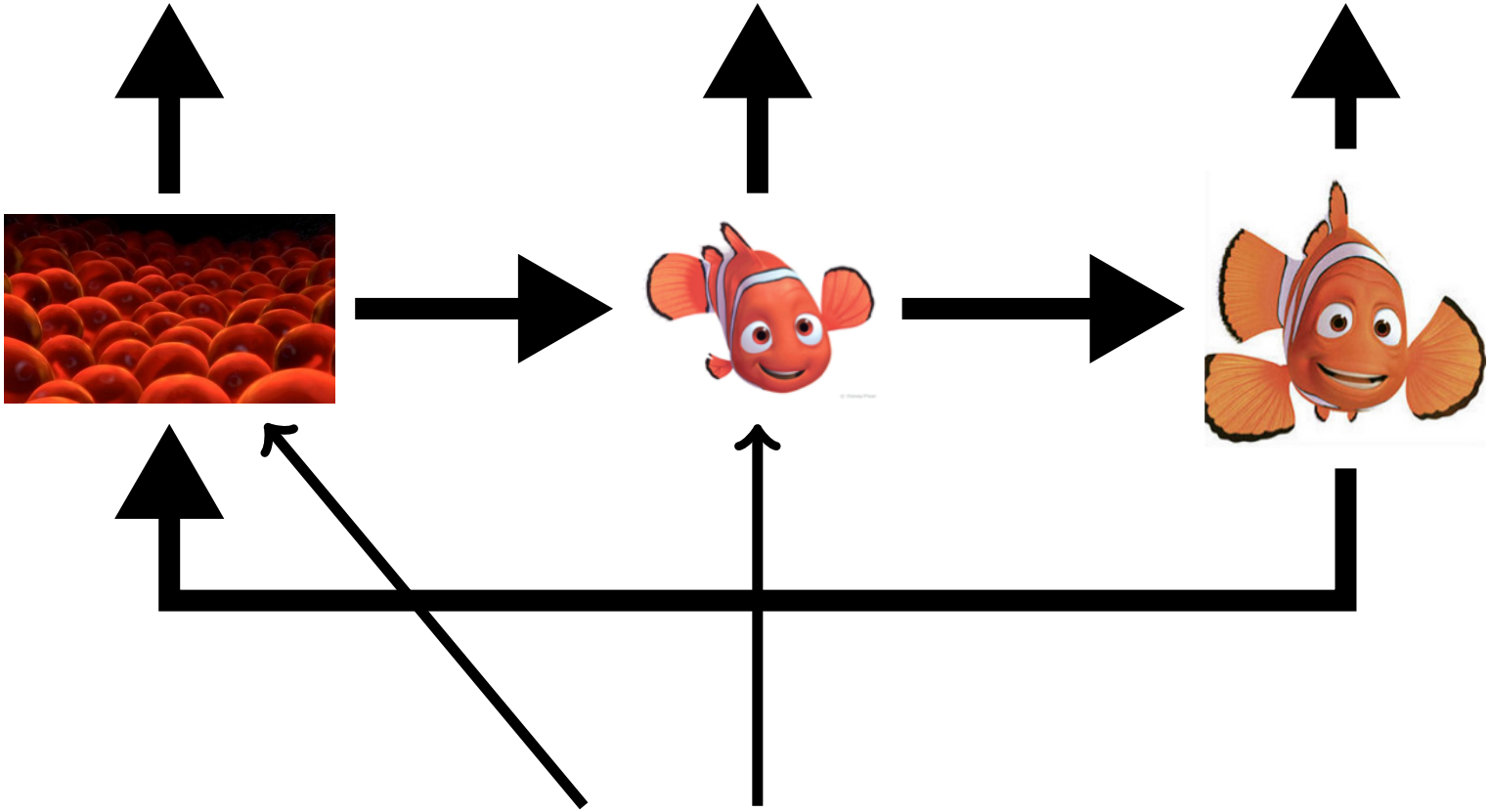

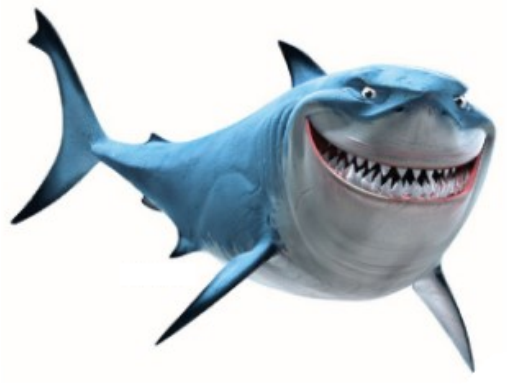

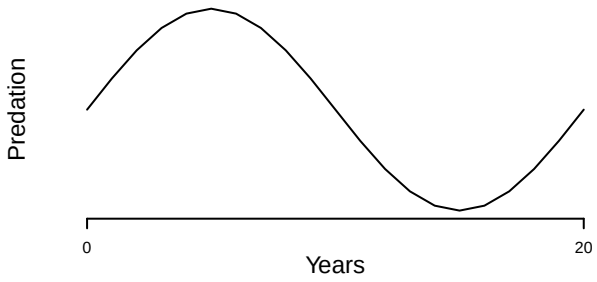

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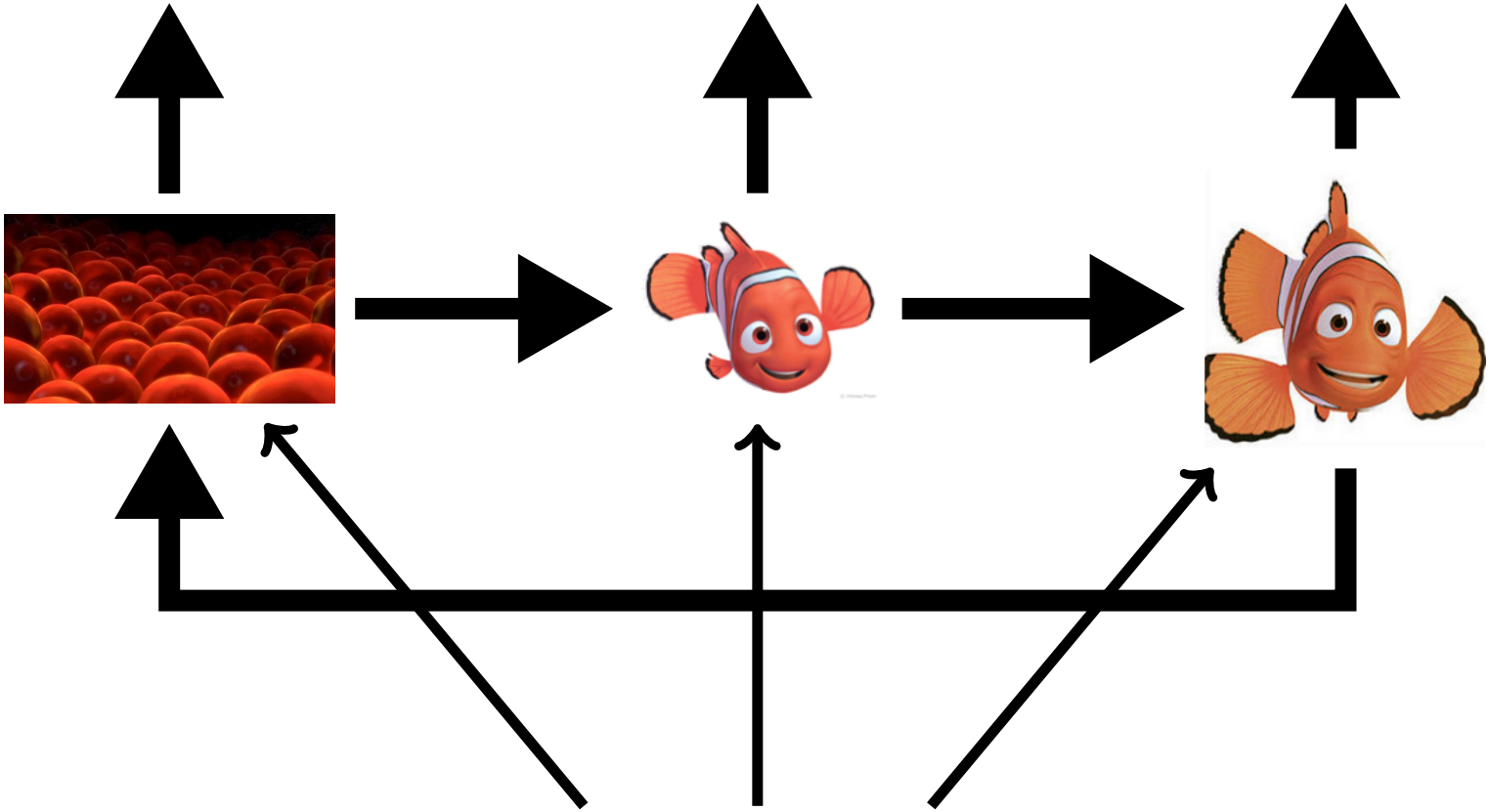
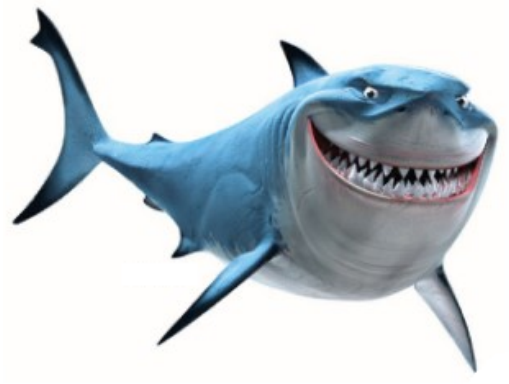
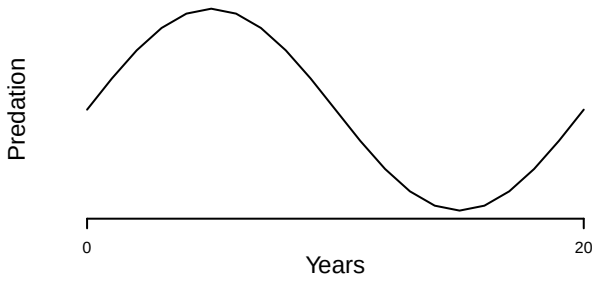
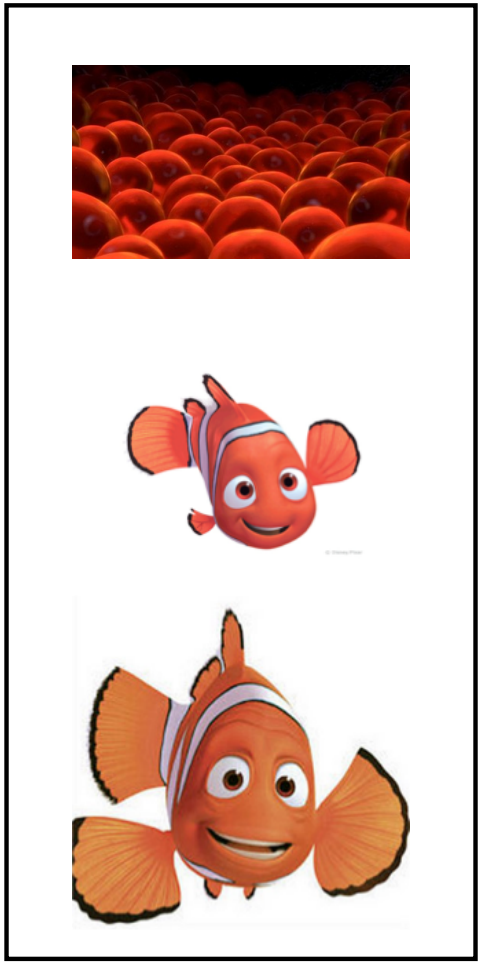
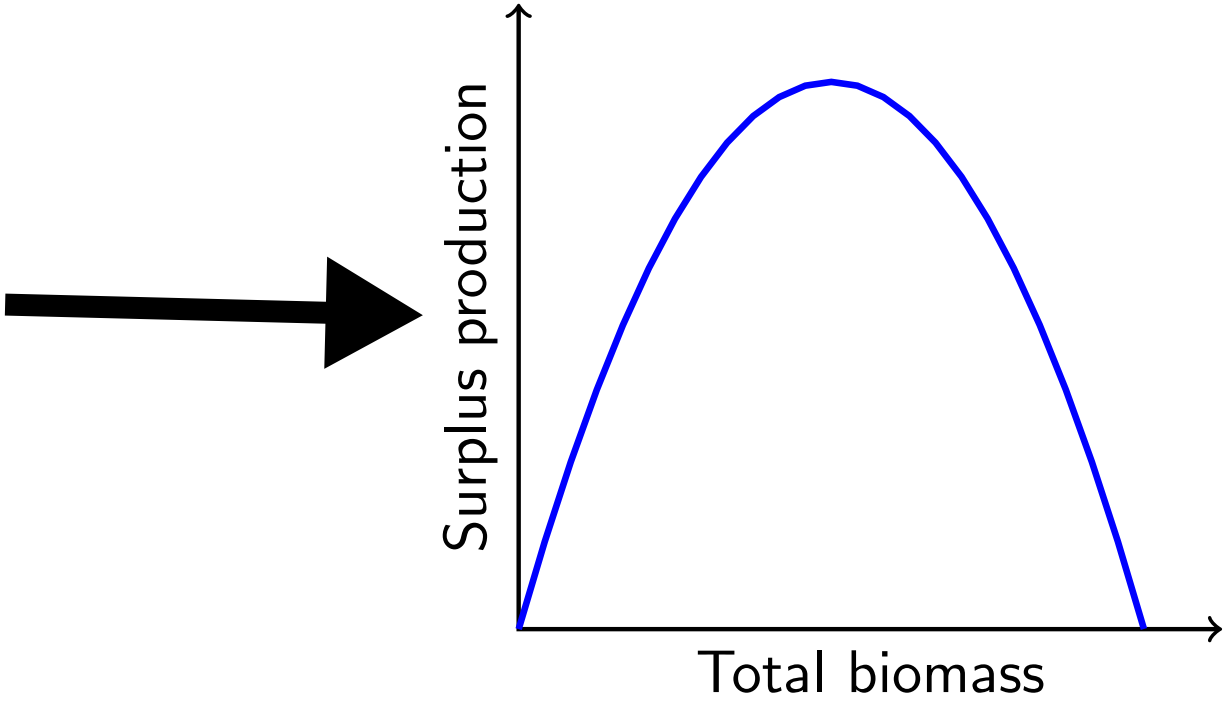






Simulated data

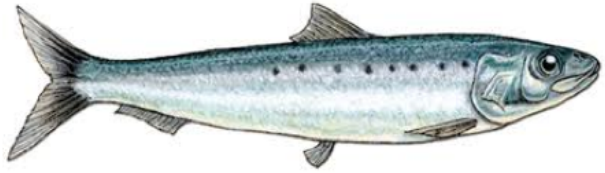




Life histories

Atlantic menhaden

- Age at 50% maturity: 2.5
- Adult natural mortality: 0.47



Pacific sardine

- Age at 50% maturity: 1.2
- Adult natural mortality: 0.4

English sole

- Age at 50% maturity: 3.5
- Adult natural mortality: 0.26

Silver hake

- Age at 50% maturity: 1.6
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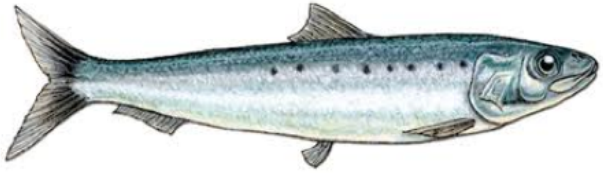

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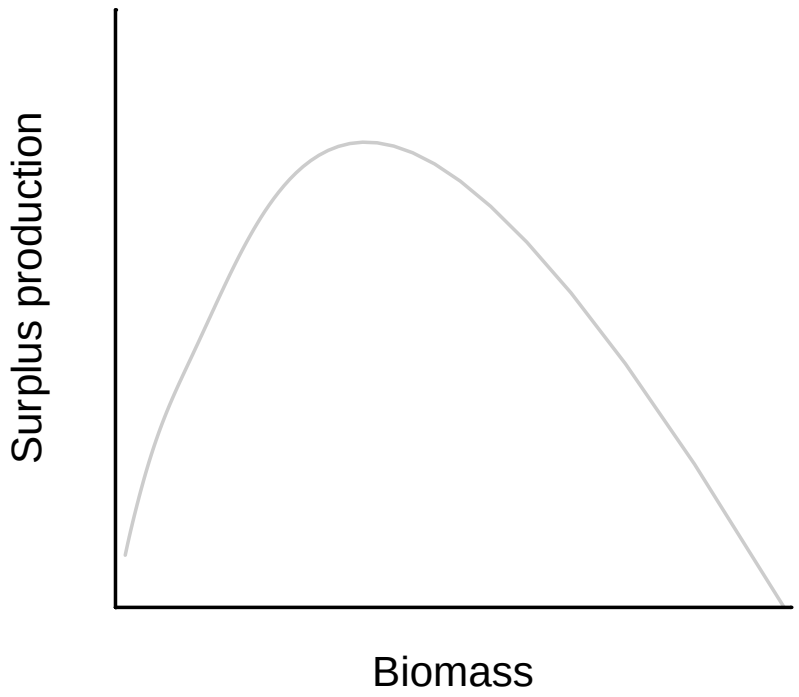

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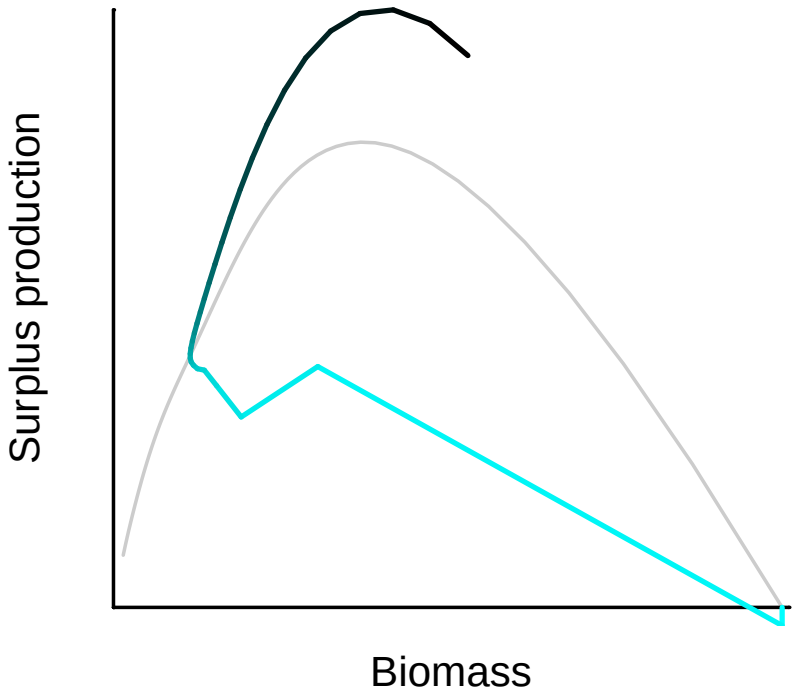

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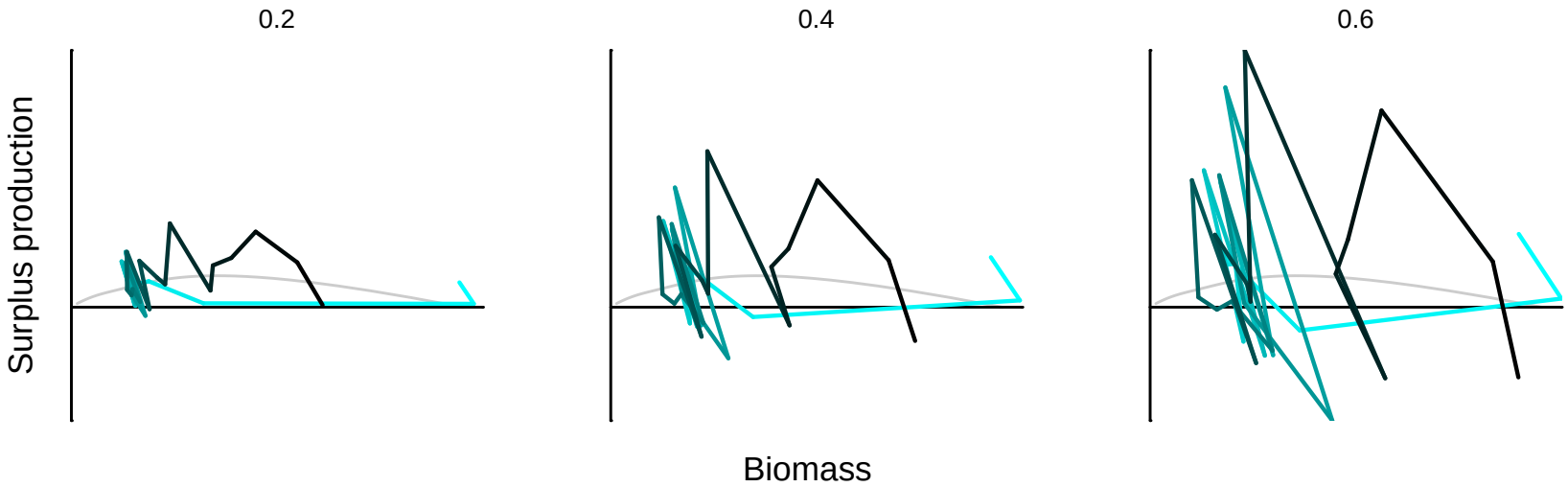

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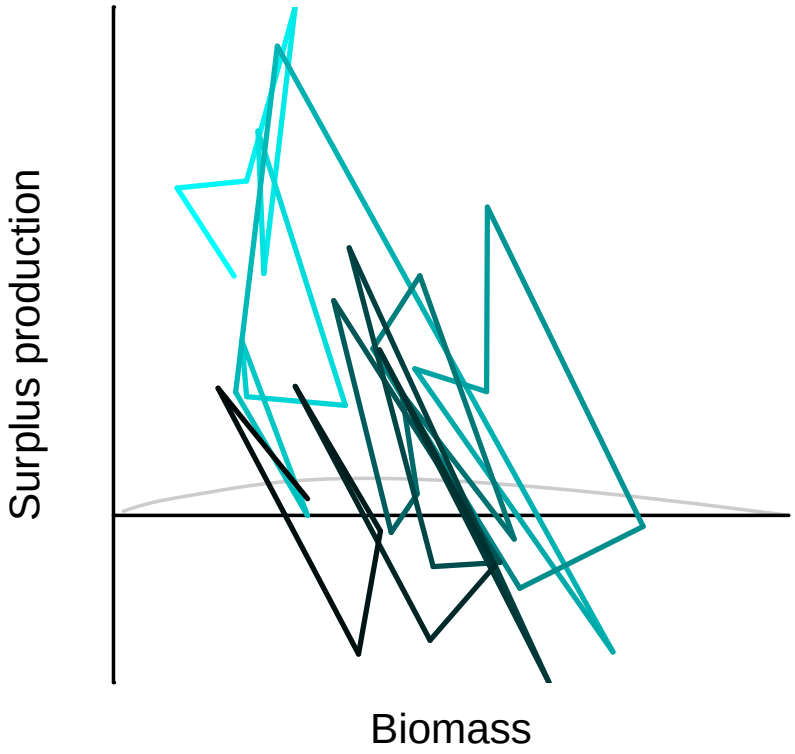
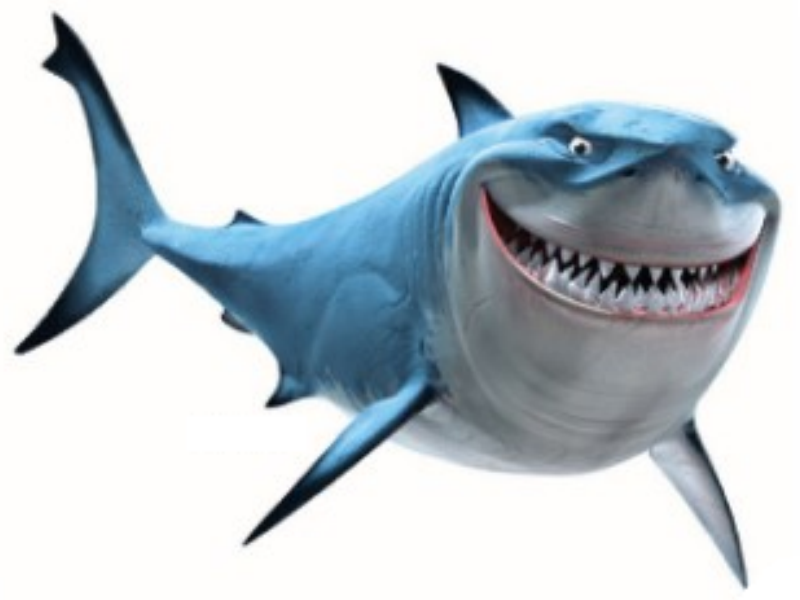
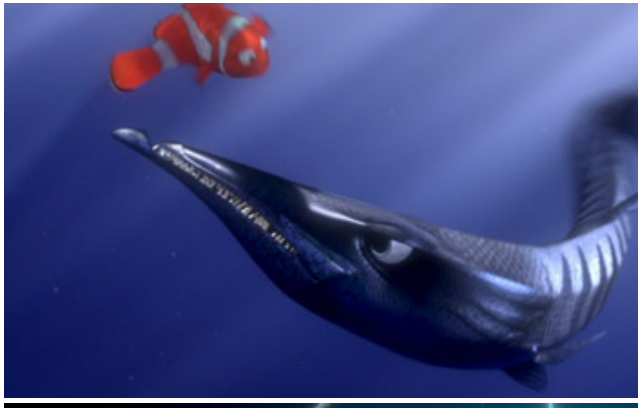
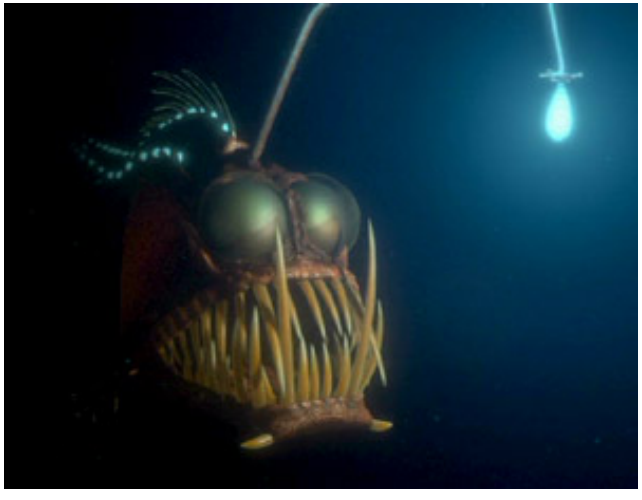


Multiple predators







Statistical model

$$\mathrm{ASP}_t = rB_t(1 - B_t/K) + \beta P_t + \varepsilon_t$$

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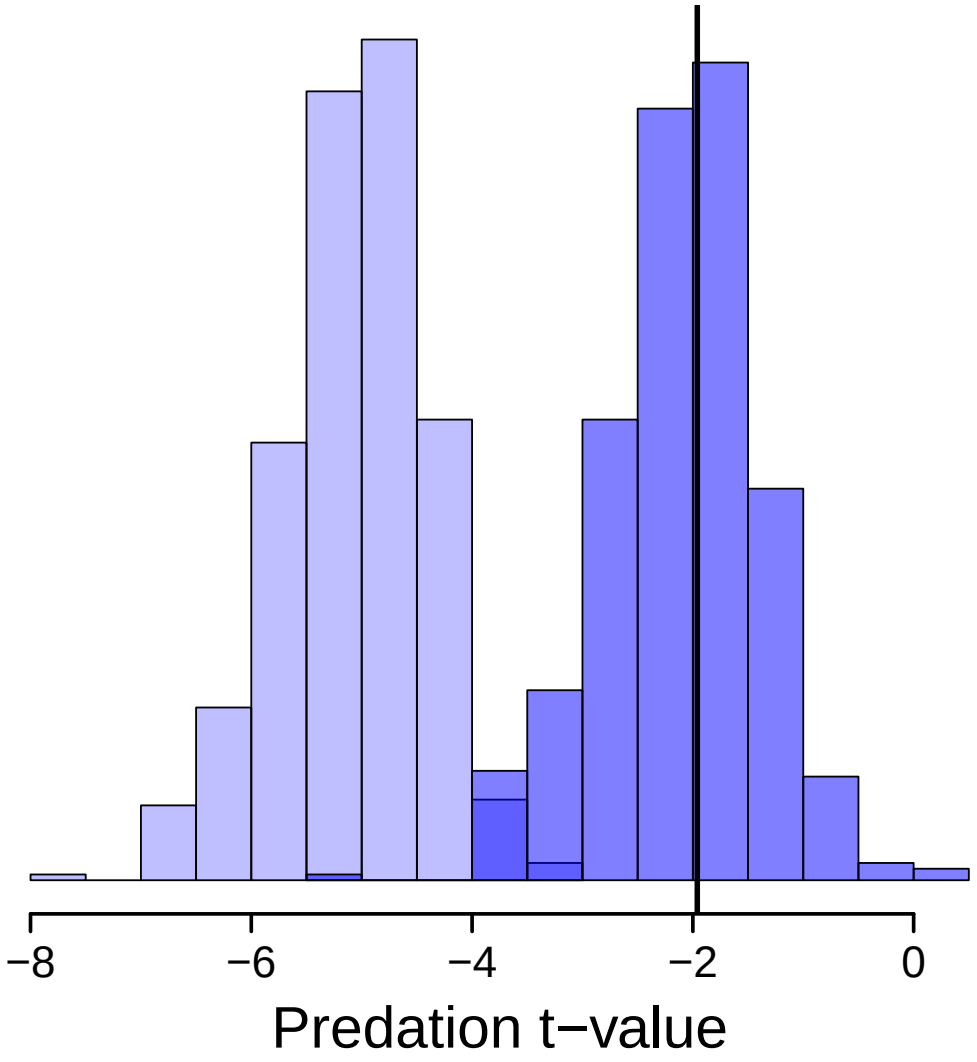
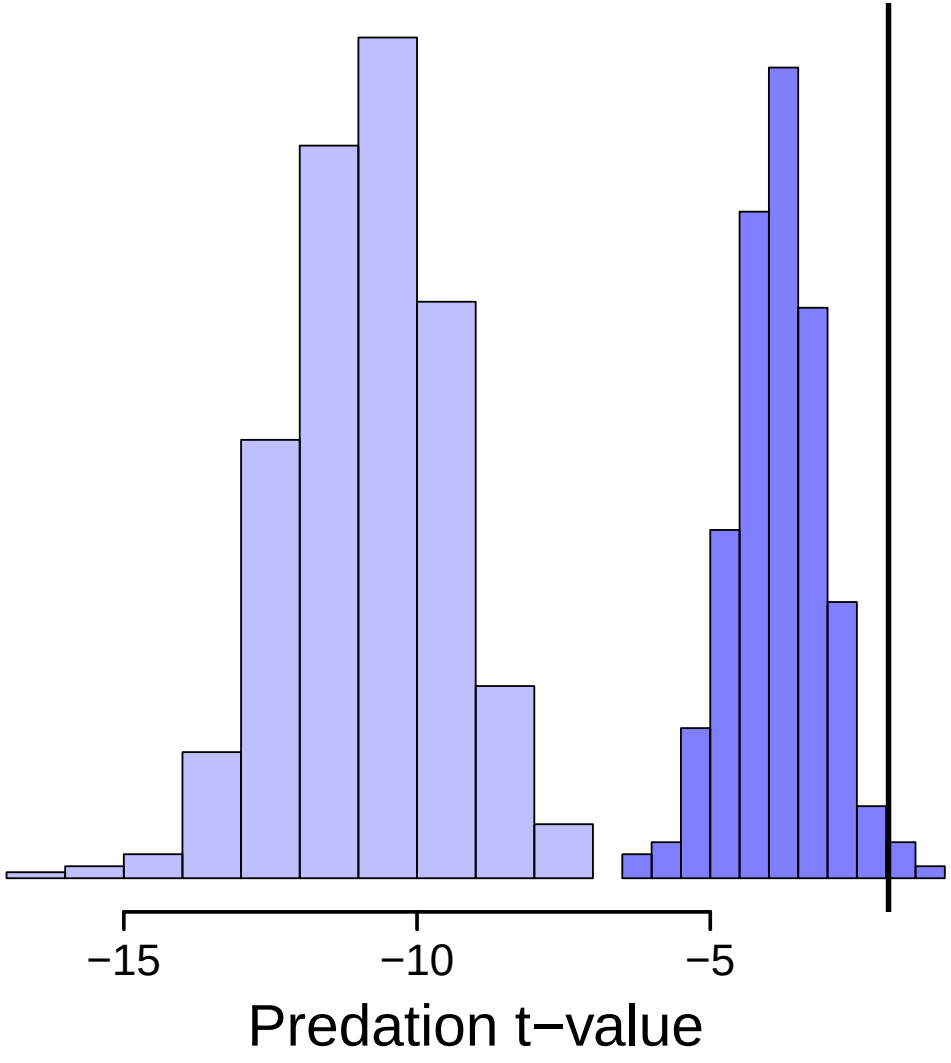
Assumptions

- B_t, P_t known perfectly without error (for now)
- $\varepsilon_t \sim N(0, \sigma^2)$, iid

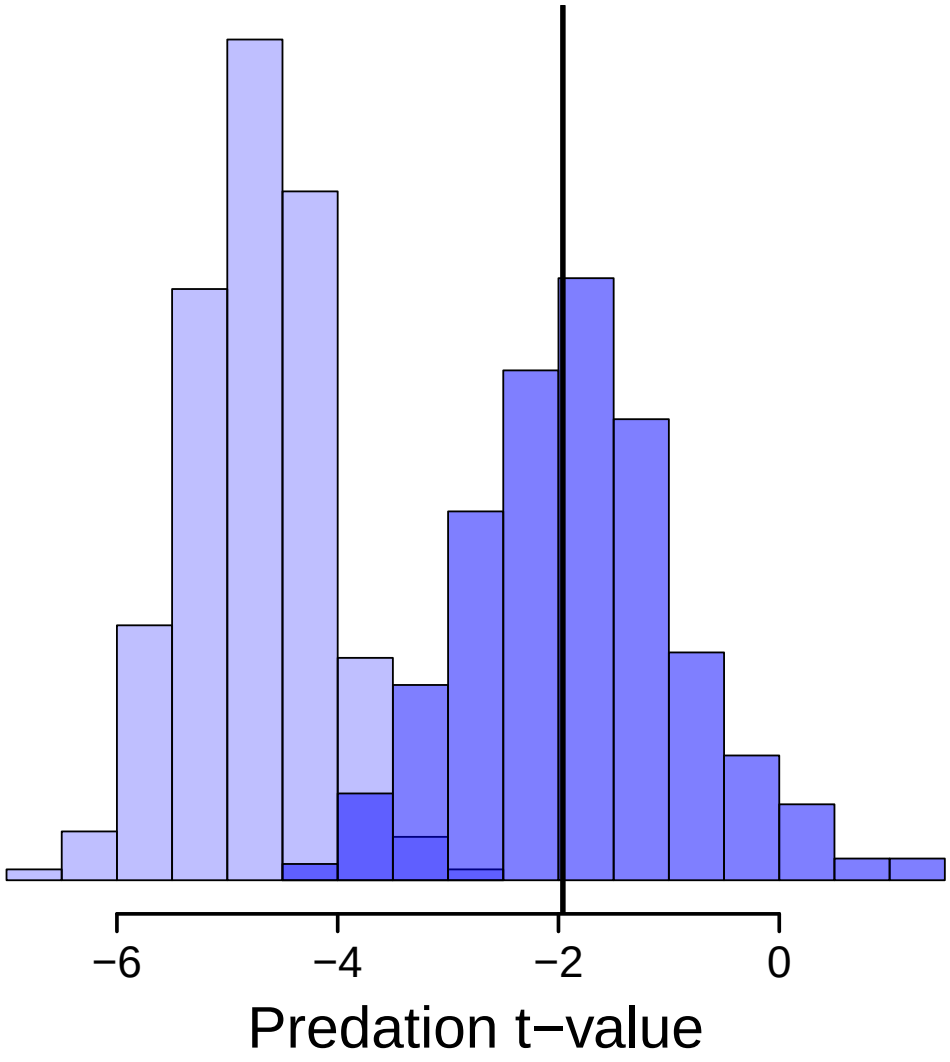
Top-down effects: Recruits



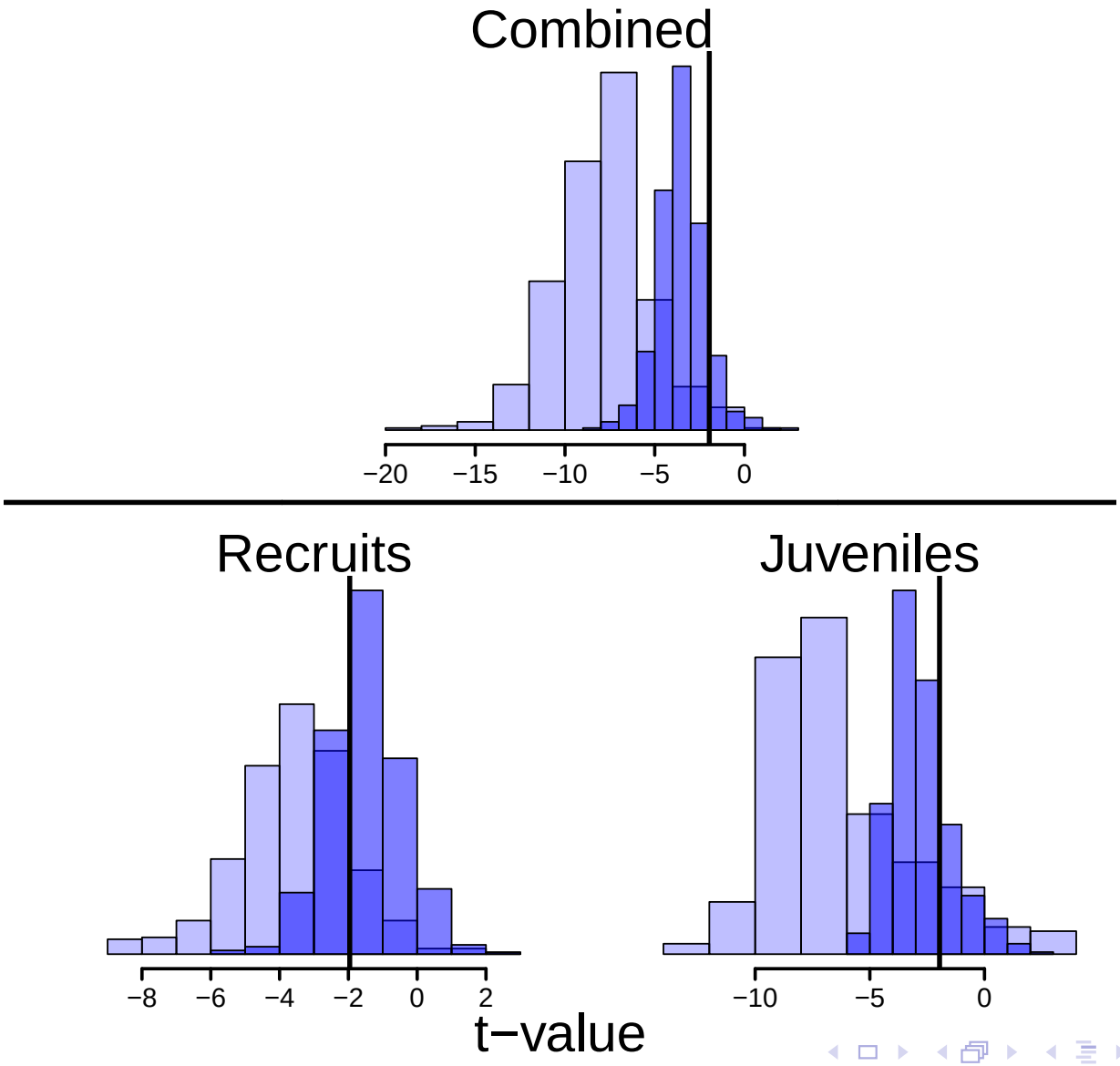
Top-down effects: Juveniles



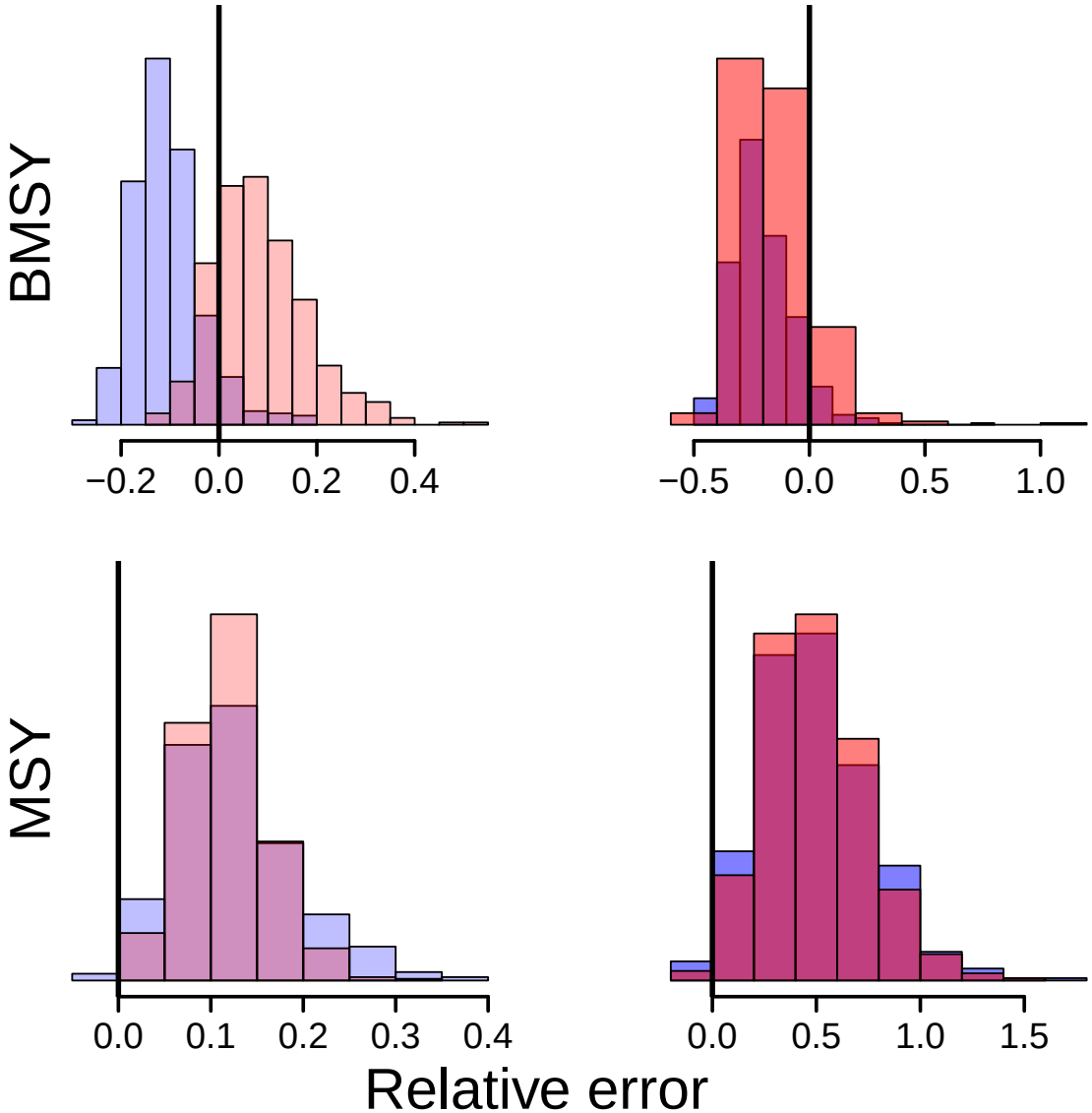
Top-down effects: Adults



Top-down effects: Multiple predators



Reference points: Recruits



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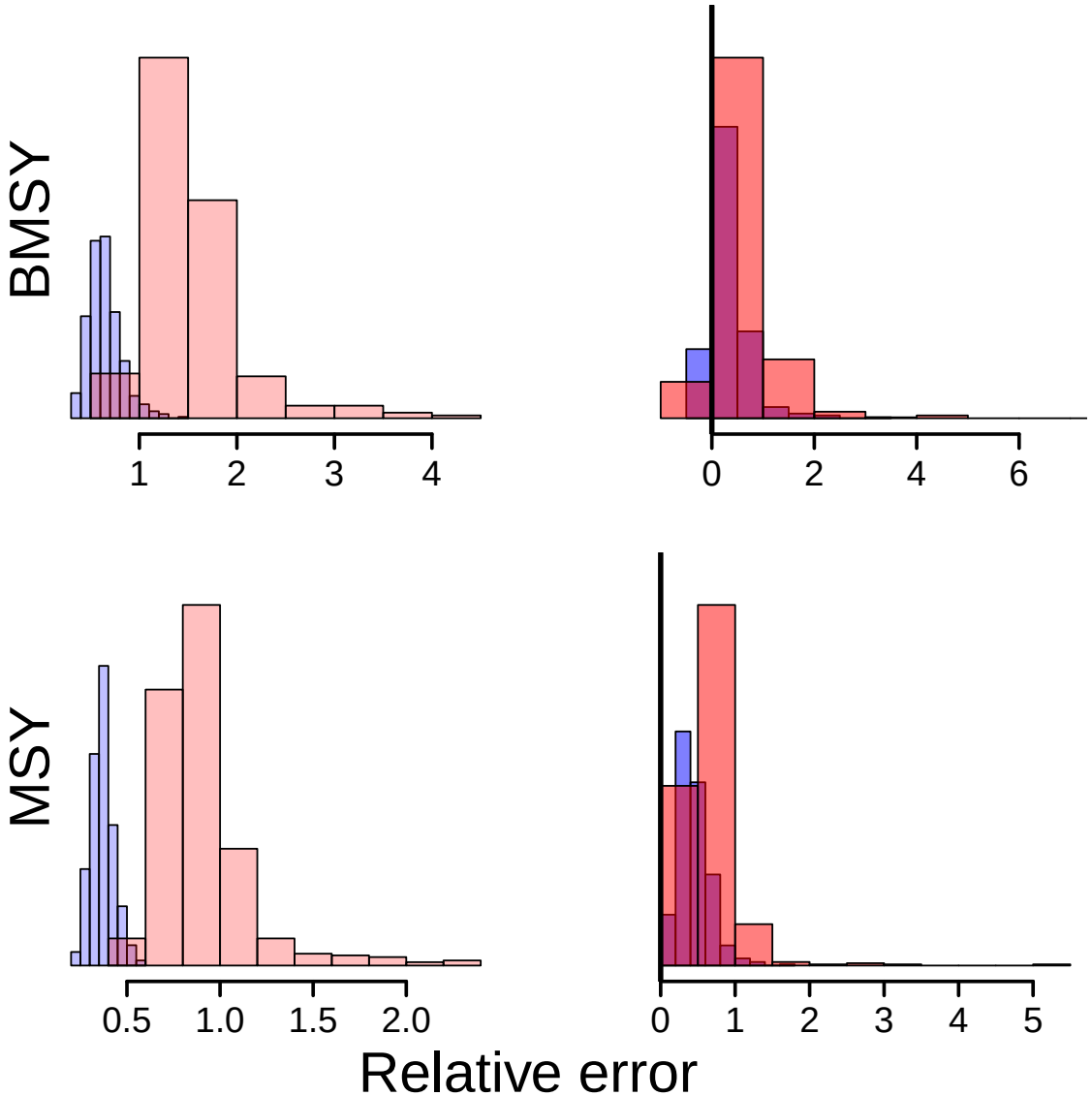

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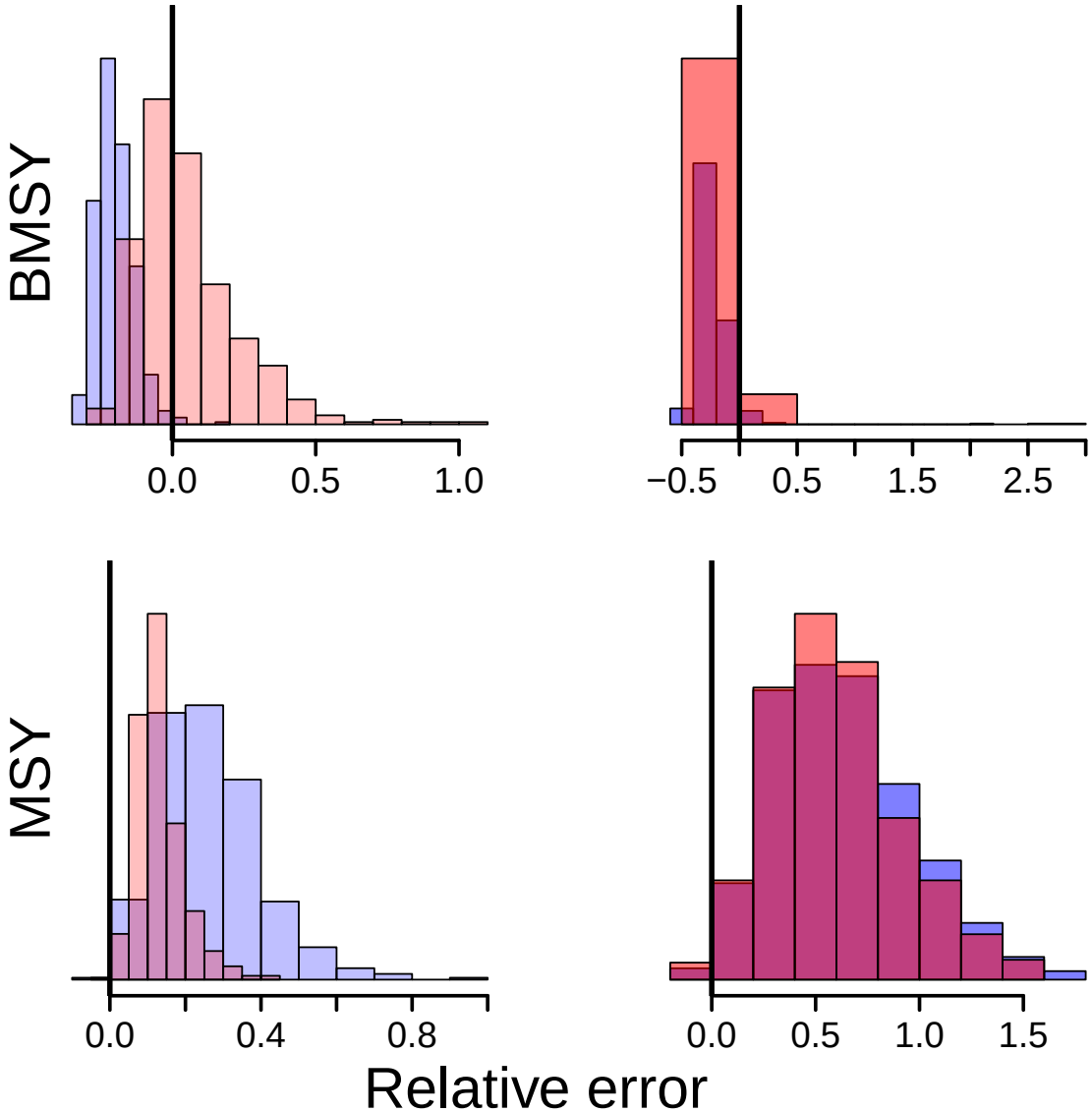

Conclusions

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- Quantify top-down predation effects:

- Estimates of management reference points:

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  - Combine all predators into one index
- Estimates of management reference points:

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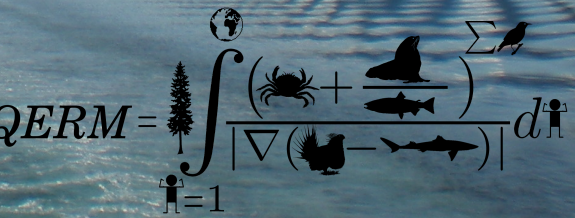
- Quantify top-down predation effects:
  - When predators affect juvenile mortality
  - Combine all predators into one index
- Estimates of management reference points:
  - Including predation does not improve estimates
  - Estimates from surplus production models are unreliable

Thanks!

- Tim Essington
- Trevor Branch, Jason Link, Andre Punt
- Essington lab

National Science Foundation
WHERE DISCOVERIES BEGIN



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