MareFrame

Spawning stock recruitment in ecosystem models

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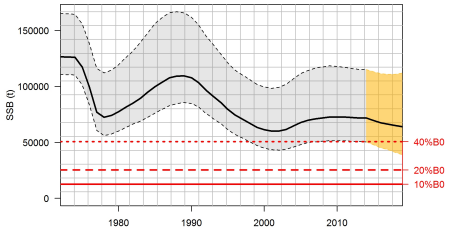
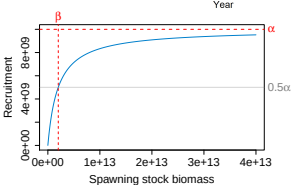
December 2017

NIWA

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 613571

Underlying theory developed for single-species fisheries models





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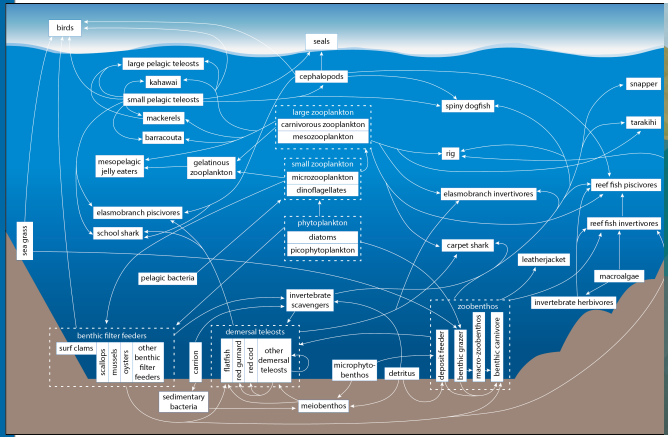
Applied to multi-species models with varying dynamics —and sometimes it will matter...



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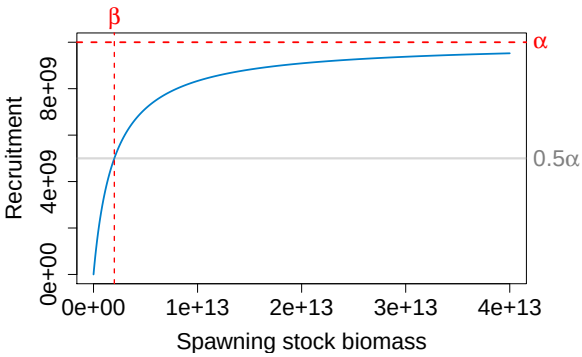
Spawning stock recruitment in single-species fisheries modelling: Beverton-Holt

$$R = \frac{\alpha S}{\beta + S}$$

where
R is recruitment
S is spawning stock biomass



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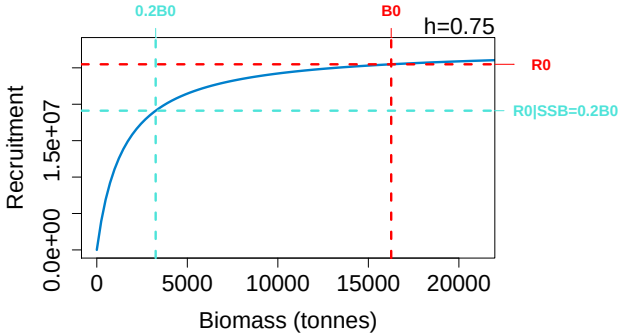
Beverton-Holt: steepness (h)

$$h = \frac{R_{|S=0.2B_0}}{R_0}$$

Focus:
early part of the curve

Higher h:
more productive



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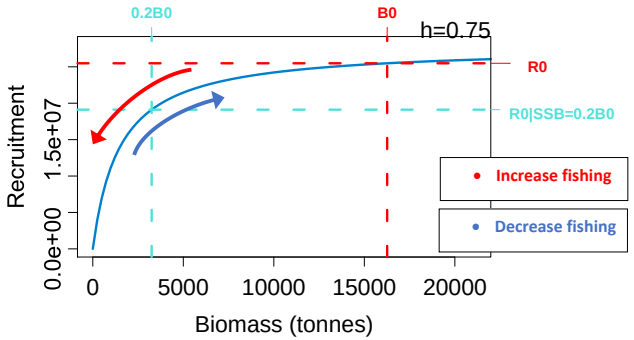

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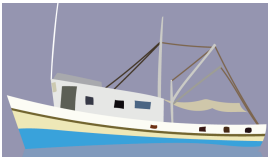
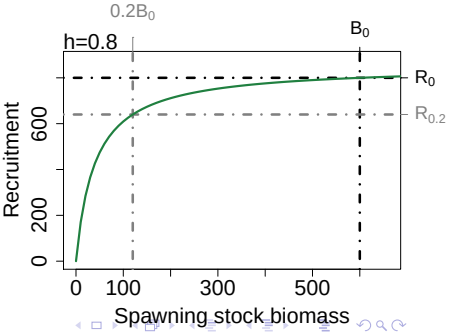
Multi-species: predation release



- Predation release can result from fishing pressure on predators
- This can reduce mortality on a prey species
- What if mortality is reduced and the population increases beyond B_0..?



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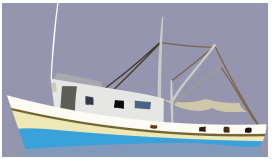

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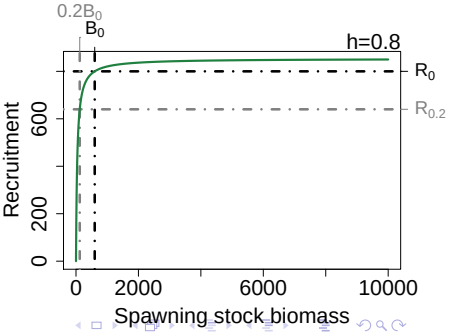
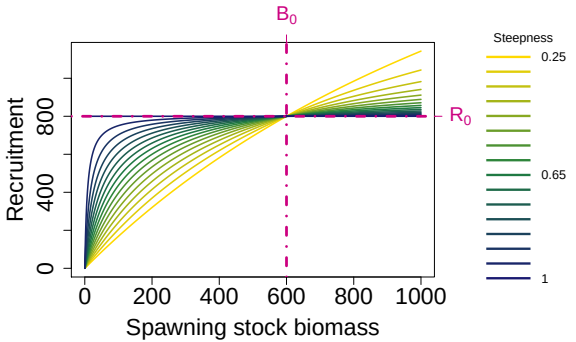


Steepness beyond B_0

- The effect of steepness reverses after B_0
- Low steepness gives low productivity when the biomass is $\leq B_0$, but high productivity for biomass $> B_0$



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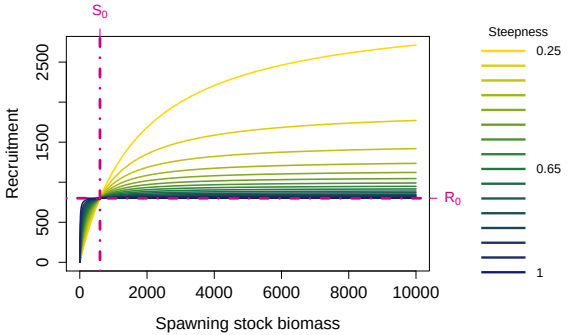

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A solution ...

- Create a new asymptote (α') that is higher for higher steepness and lower for lower steepness

$$\alpha' = (1 + \xi h) R_0$$

- Switch the curve to the new asymptote when biomas $\approx B_0$

$$R = \frac{1}{1 + e^{(B - B_0)/e^{\lambda}}} \left(\frac{\alpha B}{\beta + B} \right) + \frac{1}{1 + e^{-(B - B_0)/e^{\lambda}}} \left(\frac{\alpha' B}{\beta + B} \right)$$

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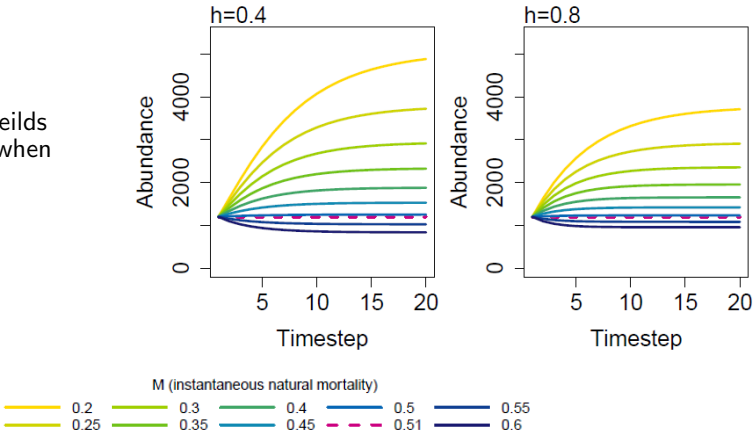
The result: modelled abundance using *un*adjusted SSR

Unadjusted:
Low steepness yeilds higher biomass when mortality is low



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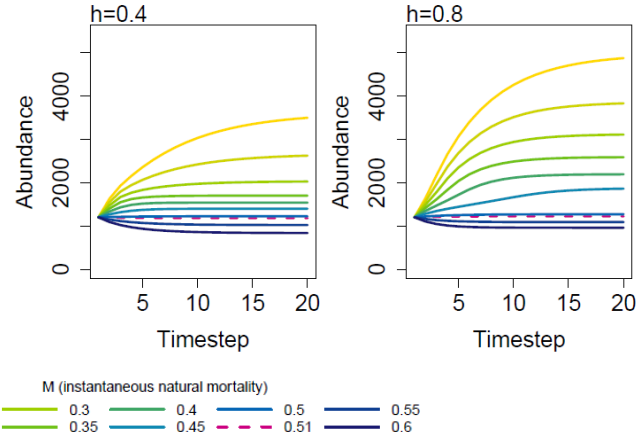
The result: modelled abundance using *adjusted* SSR

Adjusted:
Low steepness yeilds lower biomass when mortality is low



Questions..?

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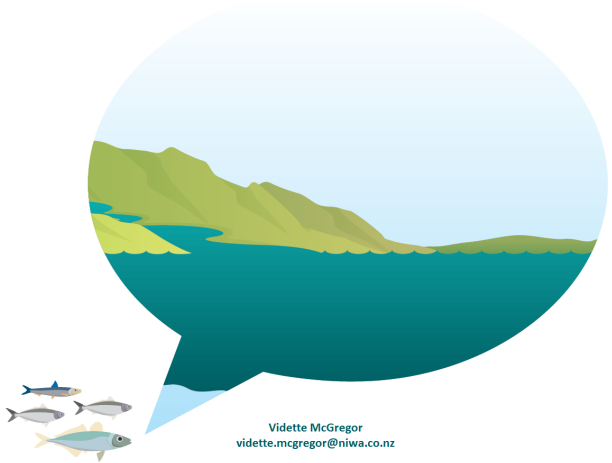

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