Deriving Steepness from F_{MSY} or F_{SPR}

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Motivation

Why do we use proxies for $\mathrm{F}_{\mathrm{MSY}}$?

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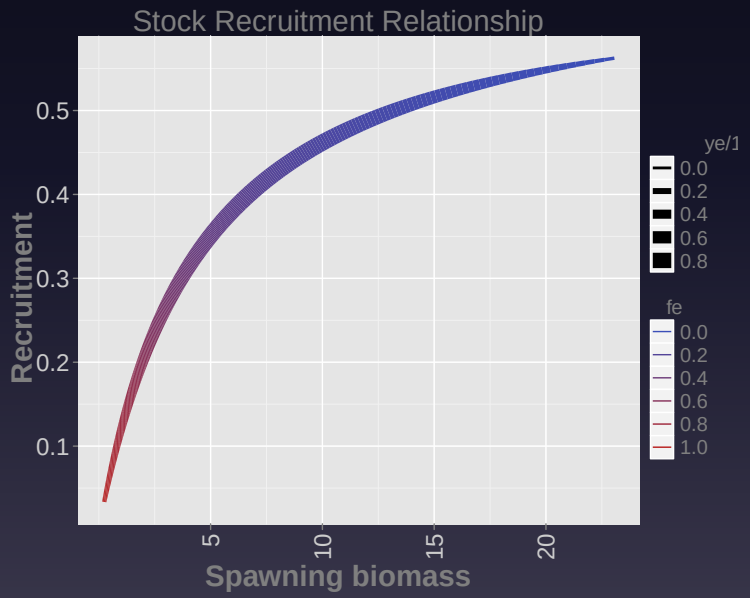
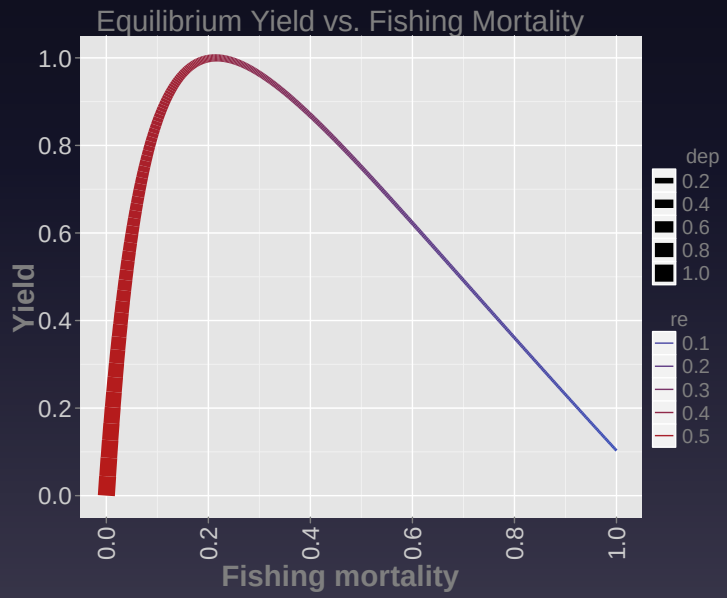
  - $\mathrm{F_{35\%}}$ can lead to severe depletion (Clark, 2002).

Deriving $\mathrm{F}_{\mathrm{MSY}}$

$(B_0, h) \Rightarrow (\mathrm{MSY}, \mathrm{F}_{\mathrm{MSY}})$ transition

Estimated parameters used to derived reference points





Deriving $\mathrm{F}_{\mathrm{MSY}}$

Given $\Theta = (B_0, h, M, f_a, s_a)$,
$\mathrm{F}_{\mathrm{MSY}}$ is calculated by maximizing:

$$C_e = F_e g(\Theta) \tag{1}$$

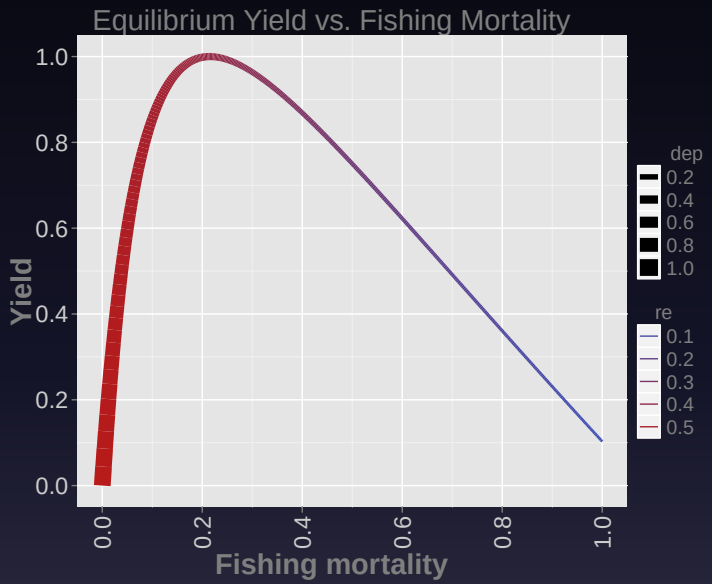
$$\frac{\partial C_e}{\partial F_e} = g(\Theta) + F_e g(\Theta) \frac{\partial g(\Theta)}{\partial F_e} \tag{2}$$

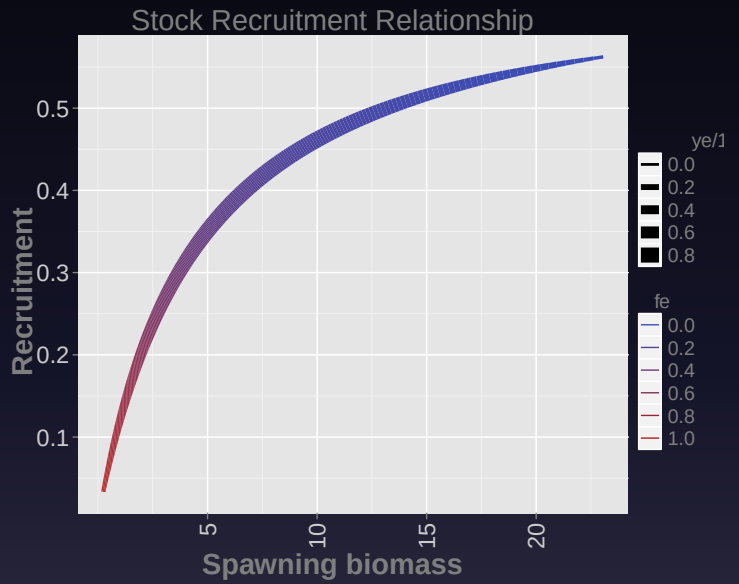
Set (2) equal to 0 and numerically solve for F_e.

Deriving steepness (h) from $\mathrm{F_{MSY}}$

(MSY,$\mathrm{F_{MSY}}$) $\Rightarrow$ (B_0, h) transition

In this case estimate reference points directly.





Given $\Theta = (\mathrm{MSY}, \mathrm{F_{MSY}}, \mathrm{M}, \mathrm{f_a}, \mathrm{s_a})$,
then solve the catch equation for h.

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$$C_e = F_e g(\Theta) \tag{3}$$
$$= F_e R_e \phi_q \tag{4}$$

R_e is the equilibrium recruitment (includes h)

ϕ_q is the yield per recruit

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$$\frac{\partial C_e}{\partial F_e} = 0 = R_e \phi_q + F_e \phi_q \frac{\partial R_e}{\partial F_e} + F_e R_e \frac{\partial \phi_q}{\partial F_e} \tag{5}$$

In this case there is an Analytical solution for h for Beverton-Holt & Ricker models.

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IPHC: fixed harvest rate of 21.5%, what is the implied h?

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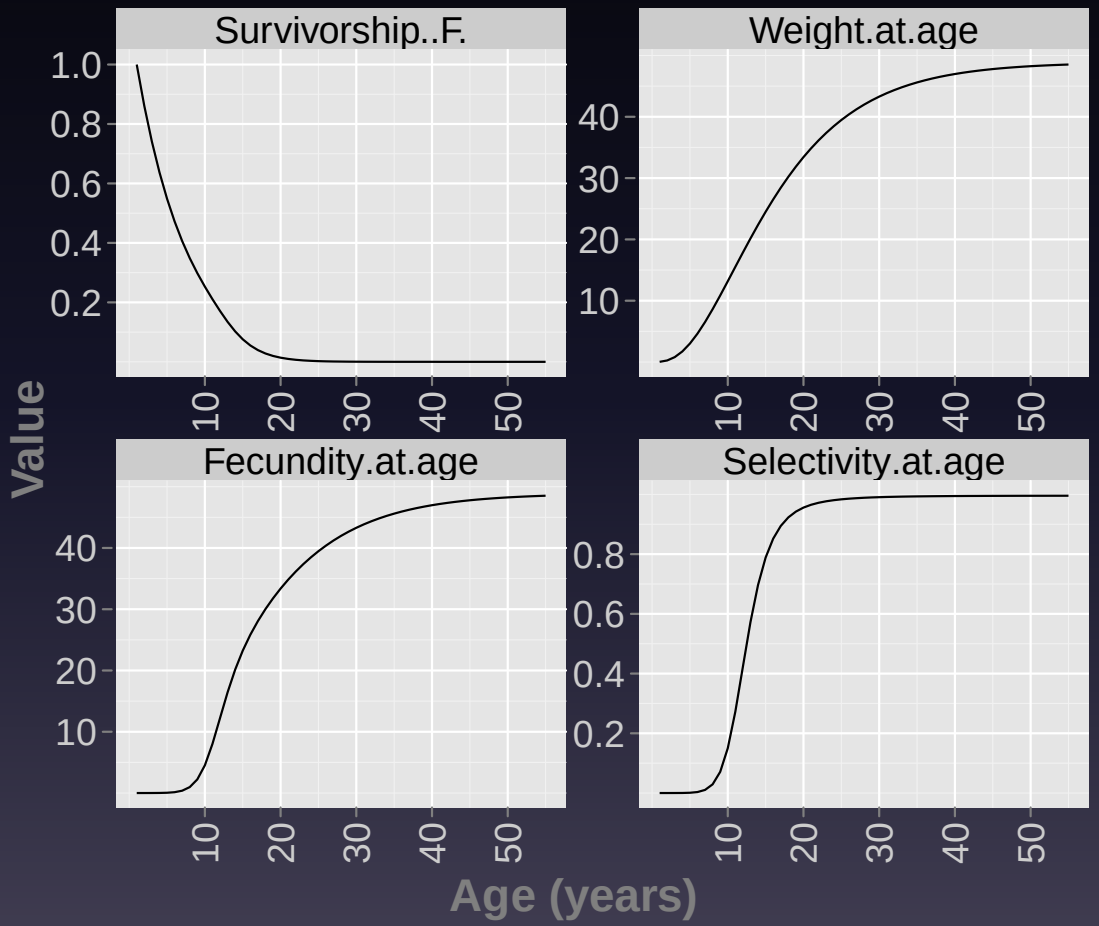

Figure: Pacific halibut life-history & selectivity.

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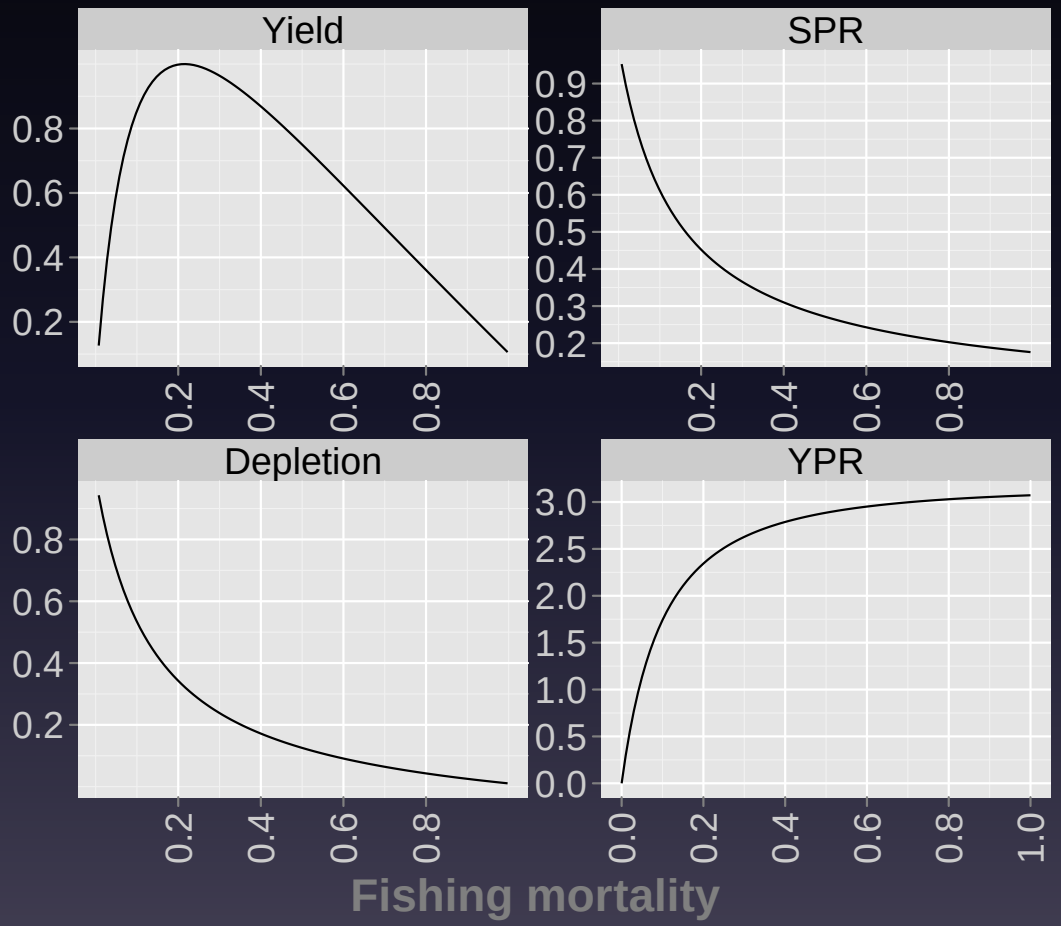

Figure: Yield, depletion, SPR and YPR for Pacific halibut.

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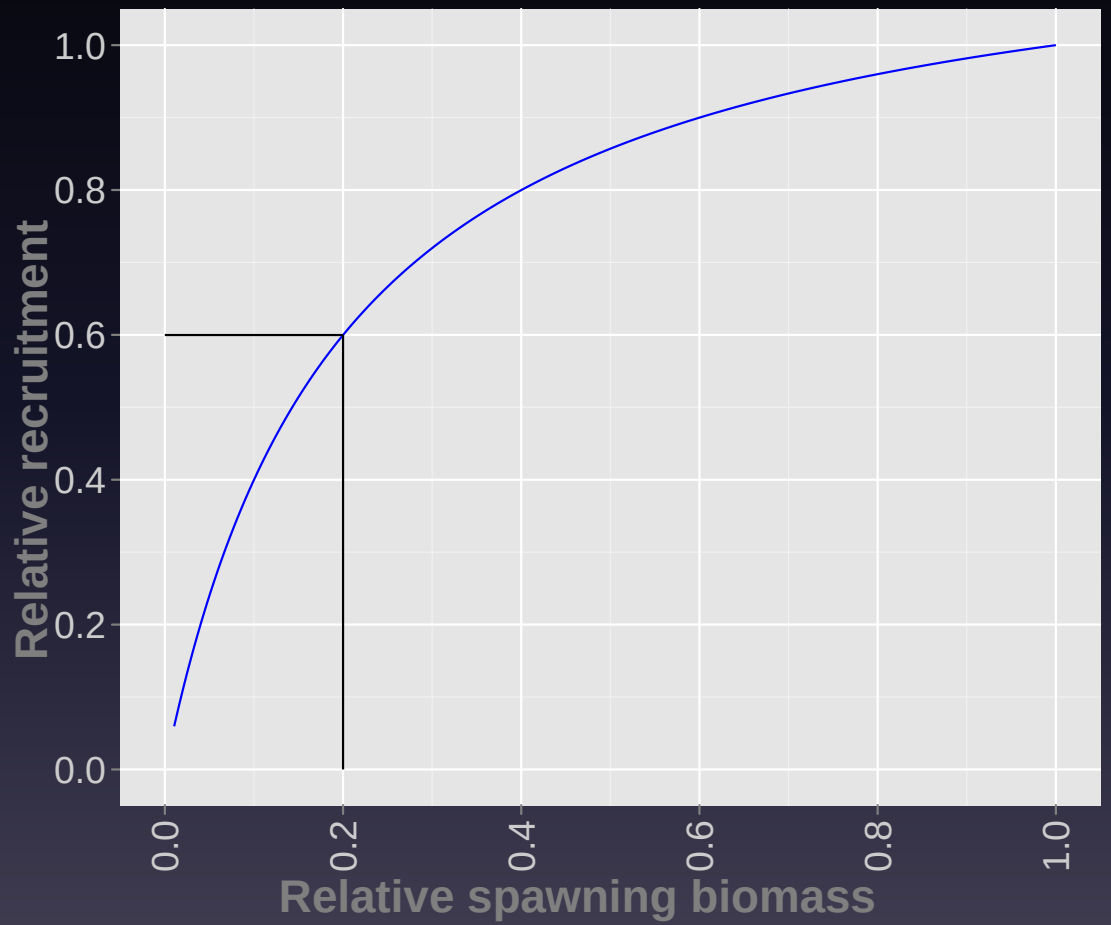

Figure: Steepness ($h = 0.5997$) for the assumed $\mathrm{F}_{\mathrm{MSY}}$=0.215.

Relationship between $\mathrm{F_{MSY}}$ and *h*

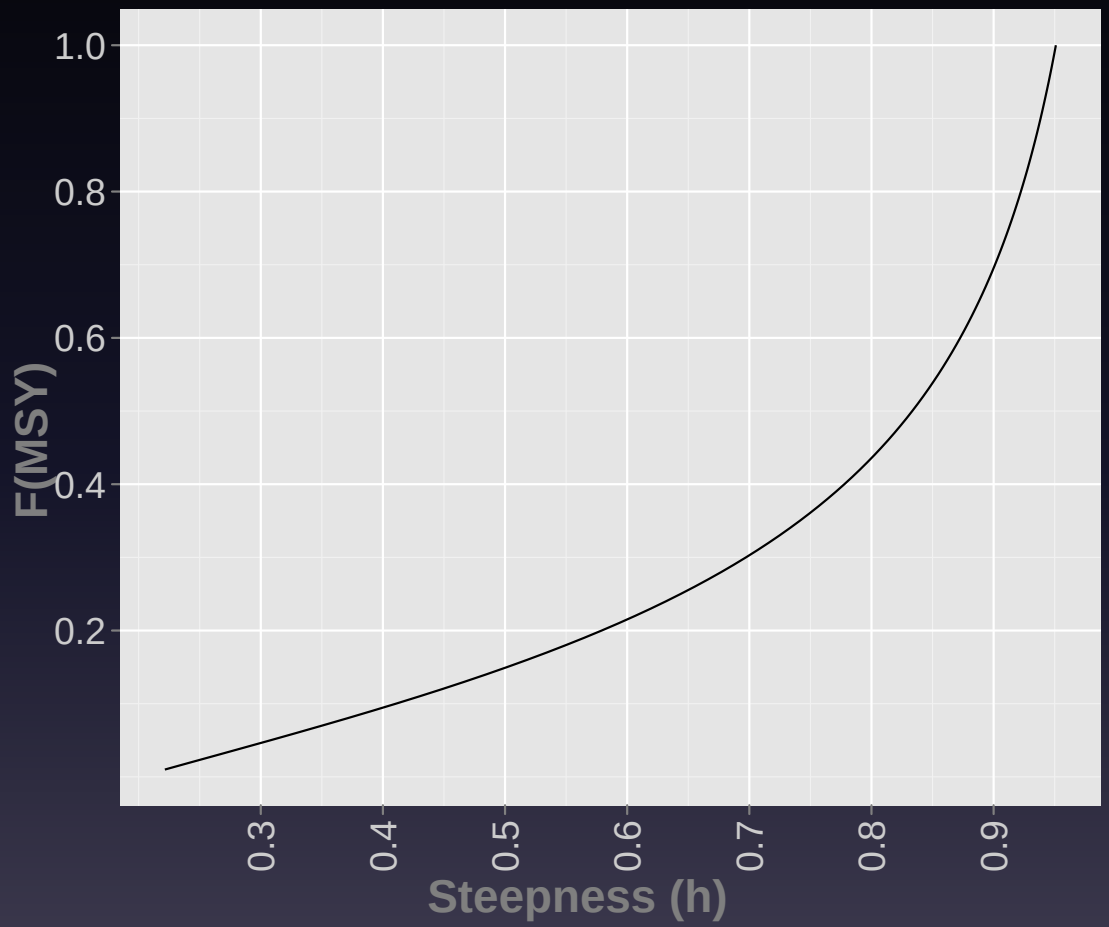

Figure: Exponential increase in $\mathrm{F_{MSY}}$ with increasing *h*

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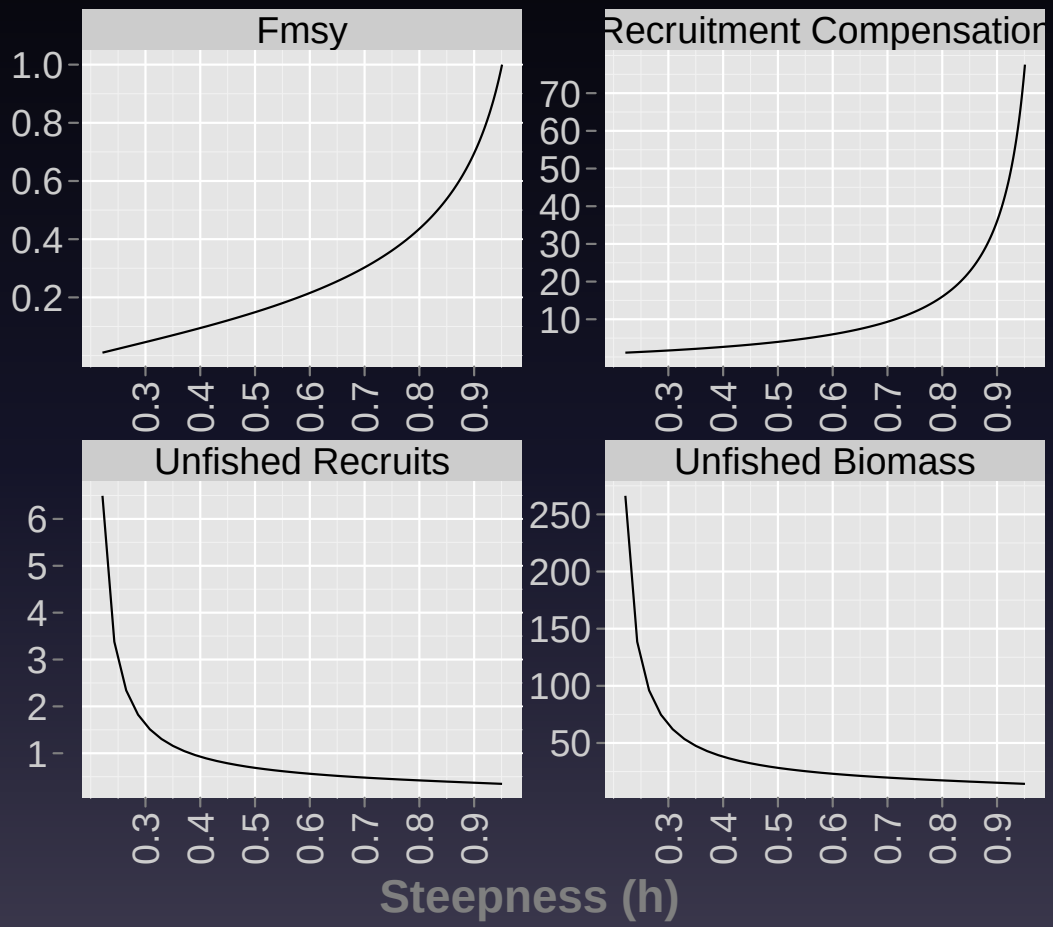

Figure: Relationship between *h* and other population parameters.

Deriving implied priors for steepness

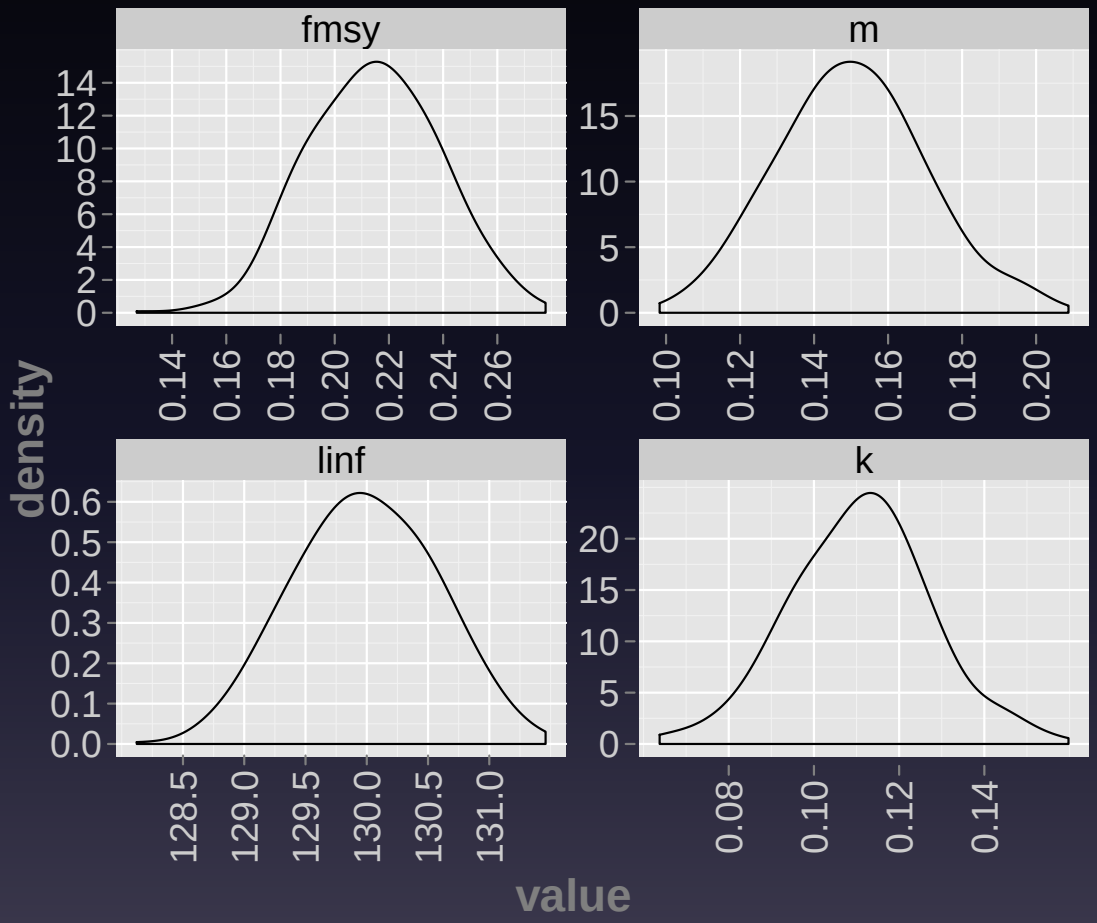

Figure: Prior densities for $\mathrm{F}_{\mathrm{MSY}}$, natural mortality, growth, imply ...

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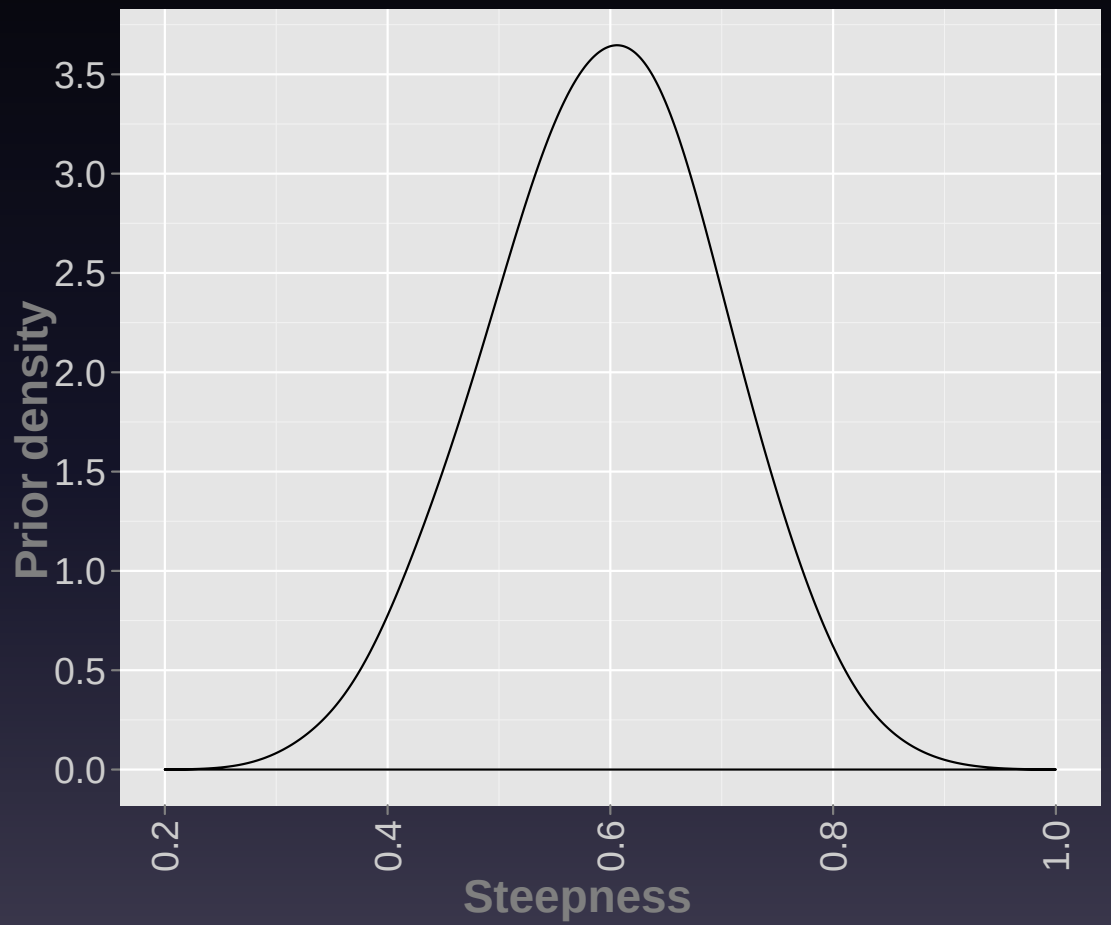

Figure: Prior density for steepness.

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- $\mathrm{F}_{\mathrm{MSY}}$ proxy implies steepness is known.
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- Parametrize with ($\mathrm{F}_{\mathrm{MSY}}$, MSY) instead of ($B_0, h$) (Martell et al., 2008).
- Not to be used with Hierarchical models for generating Posterior predictive distributions.
  - Definition of a recruit is a vulnerable fish of any age.

References

Clark, W. (1991). Groundfish exploitation rates based on life history parameters. *Canadian Journal of Fisheries and Aquatic Sciences*, *48*(5), 734–750.

Clark, W. (2002). F 35% revisited ten years later. *North American Journal of Fisheries Management*, *22*(1), 251–257.

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Rcode for .fmsy2h available from me.

Acknowledgements

IPHC for office space.

Swedish Medical Center for pain relief.