Potential estimation of stock-recruitment steepness

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Development of stock-recruitment relationships and their parameter estimates

- Stock productivity, and reference points, are determined predominantly by Stock-Recruitment (S-R) steepness and natural mortality rate.
- Kai &Fujinami (2018) presented an approach based on the method of Mangel *et al* (2010), and applied it to North Pacific blue shark.
  - In a conventional assessment, we might estimate the S-R steepness from paired estimates of stock size and recruitment, but this is rarely successful.
  - Tuna assessments usually assume a value for steepness, and explore sensitivity to alternatives.
  - In Kai &Fujinami (2018), the S-R steepness is estimated from life history parameters.

- Question: Is the Kai & Fujinami (2018) approach useful, and might it be applied elsewhere?
- Answer: In progress, our first step has been to duplicate the results.

Kai, M., Fujinami, Y. (2018) Stock-recruitment relationships in elasmobranchs: Application to the North Pacific blue shark. *Fish Res*
Mangel, M. et al. (2010) A perspective on steepness, reference points, and stock assessment. *CJFAS*

Current thoughts about the approach

- The approach derives steepness h from life history parameters.
- S-R models assume that individual productivity increases as stock size decreases. This increase is, theoretically, brought about by changes in key life history rates (survival, maturity, fecundity).
- The method used by Kai &Fujinami (2018) uses life history rates for an unfished stock (expected spawning biomass per recruit), and for the stock at a very low stock size (maximum number of new individuals per spawning biomass; the S-R slope at the origin).
- It also assumes a known S-R model (BH or Ricker evaluated; could be other).
- Estimates of S-R steepness, and reference points, were sensitive to these rates, in particular to how M is estimated, and also to the S-R model assumed.

On plausibility and application

- With regard to the assumptions surrounding mortality, Kai & Fujinami (2018) stated "Population or cohort data that could be used to verify these assumptions for blue shark are still lacking".
  - Do we have credible (i.e., better) data for other stocks?
  - What was the stock status when life history was measured?
  - How much might we expect life history to vary with density?
- For blue shark, the h=0.58 estimate meant individual productivity was predicted to increase roughly 3-fold as the stock declined.
  - Is this plausible for a shark?
- The results varied substantially depending on which S-R model was assumed; Beverton-Holt (h=0.58) or Ricker (h=0.85). This is concerning because steepness should be a result of life history rates, not a consequence of the S-R model.
- Although Brooks et al. (2010) compared a life-history based approach to results from some traditional stock assessments, further testing of this method with data-rich stocks would be useful.
- Arguably, the results of the method are hypotheses, and so should not be used as evidence of a particular estimate of steepness (and reference points).