Hordyk, A. and Prince, J.D. (2013) Extending the principal of Beverton-Holt Life History Invariants for length based assessment of SPR.
In: ICES World Conference on Stock Assessment Methods for Sustainable Fisheries (WCSAM 2013), 15 - 16 July, Boston, USA.

4.07 - Extending the principal of Beverton-Holt Life History Invariants for length based assessment of SPR

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Meta-analysis

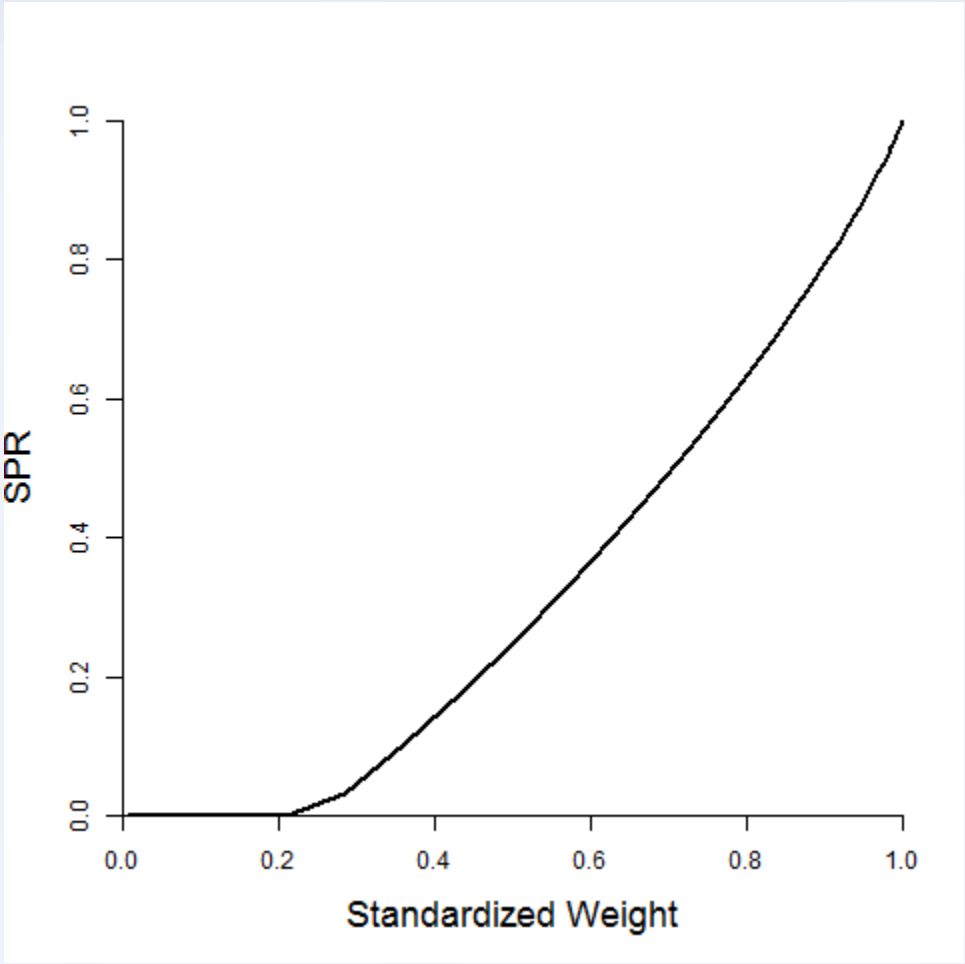
Collected high quality biological parameters for range of marine species (Gislason et al. 2010 – Criteria used).

For each species:

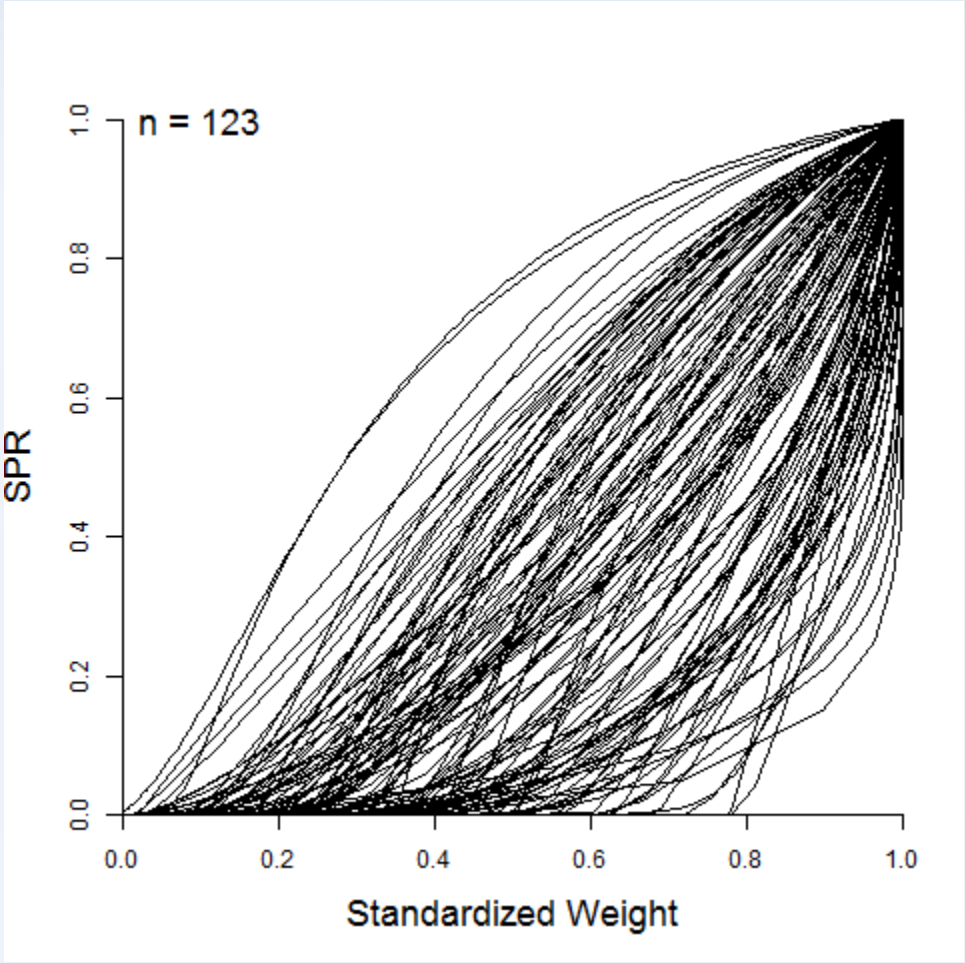
- **Growth model**
- **Natural mortality (*M*)**
- **Size-fecundity model or maturity ogive**
- **Length – weight model**

Examined patterns life history strategies

SPR at Size

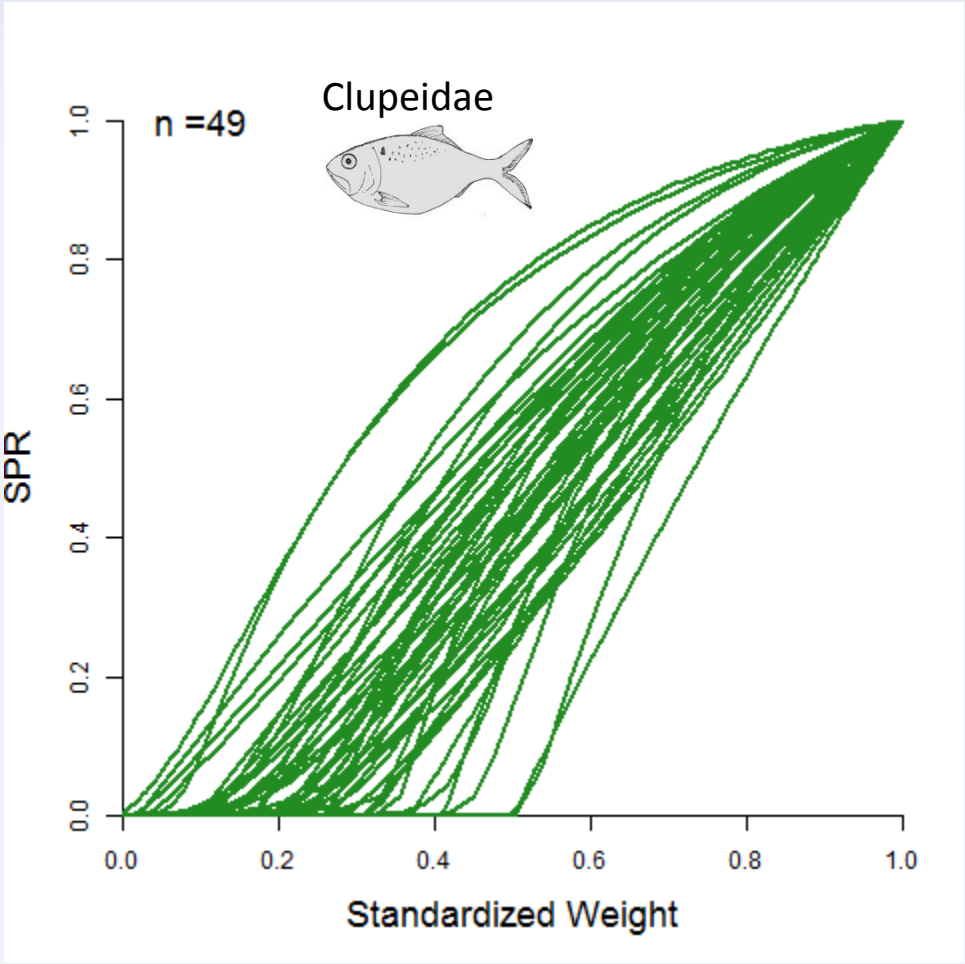


SPR at Size



SPR at Size: r- vs. K- strategists

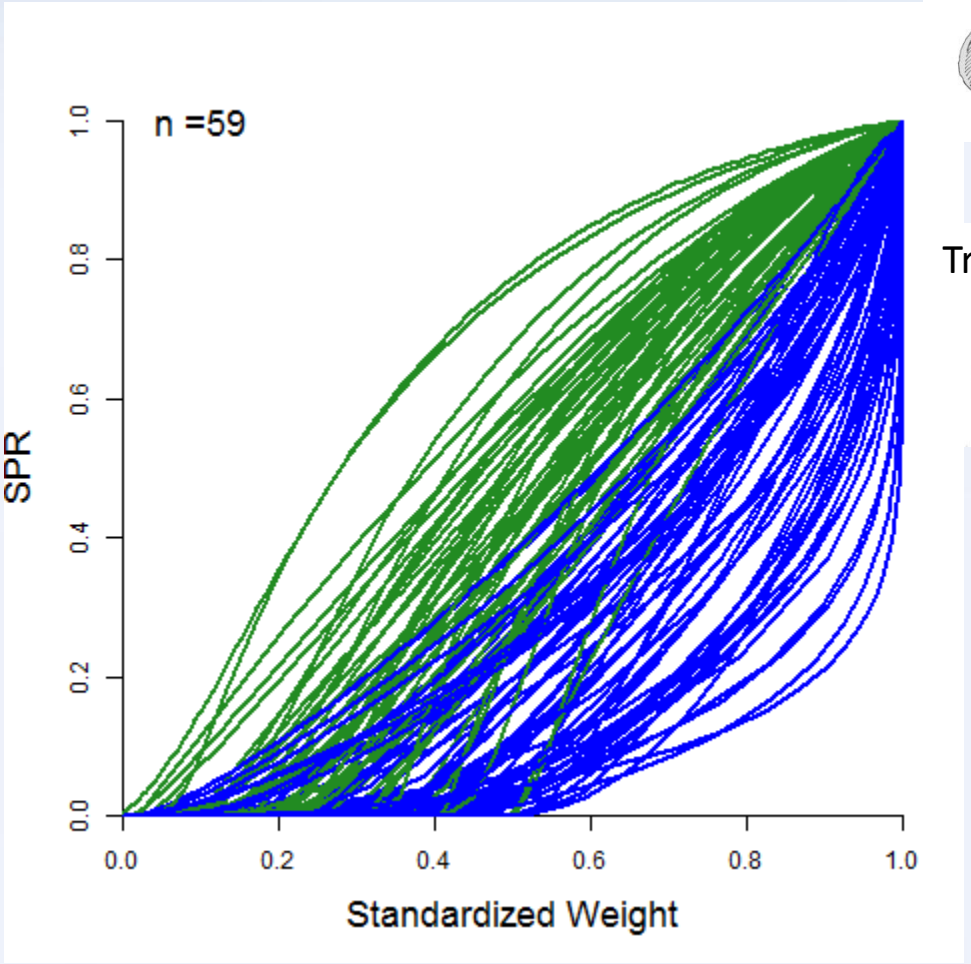
Type I $\frac{M}{k} > 1$



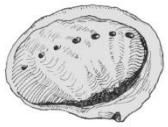
SPR at Size: r- vs. K- strategists

Type I $\frac{M}{k} > 1$

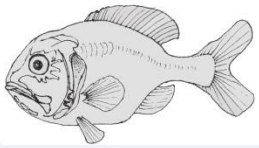
Type II $\frac{M}{k} < 1$



Haliotidae



Trachichthyidae

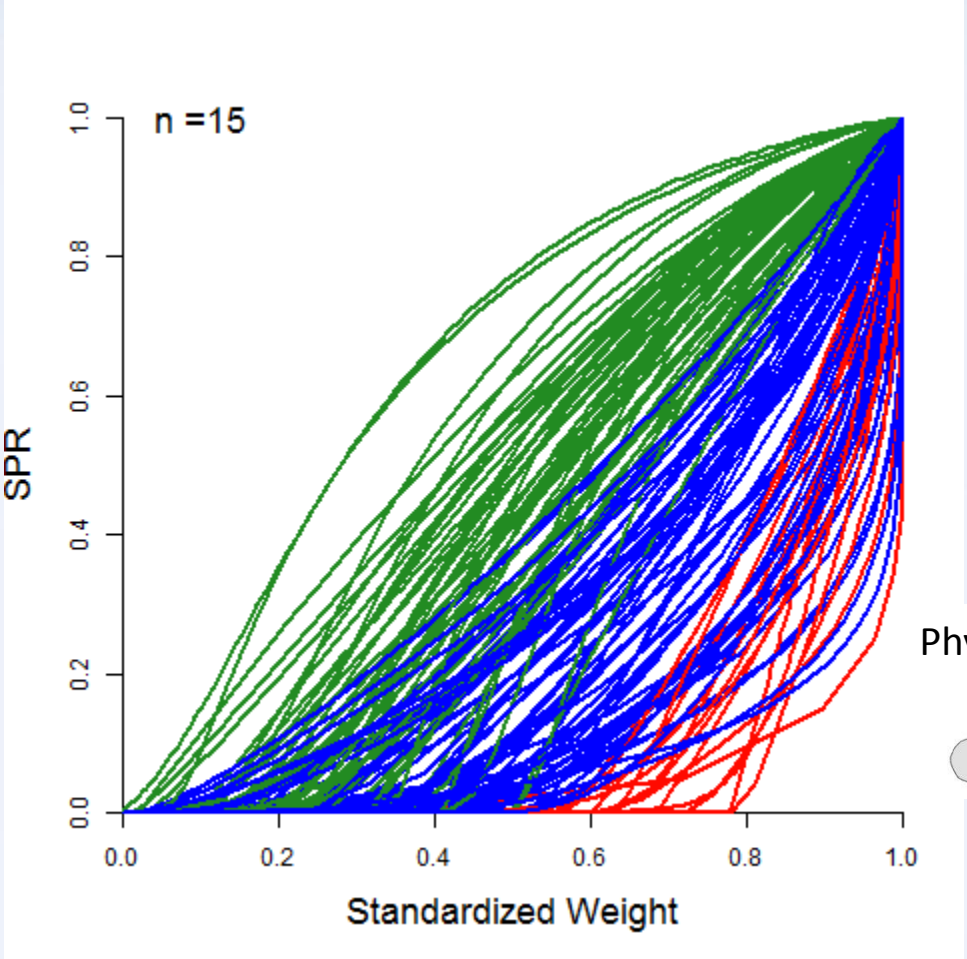


SPR at Size: r- vs. K- strategists

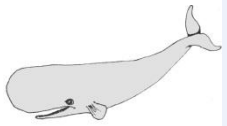
Type I $\frac{M}{k} > 1$

Type II $\frac{M}{k} < 1$

Type III $\frac{M}{k} < 1$ & $\frac{L_m}{L_\infty} > 0.85$



Physeteridae



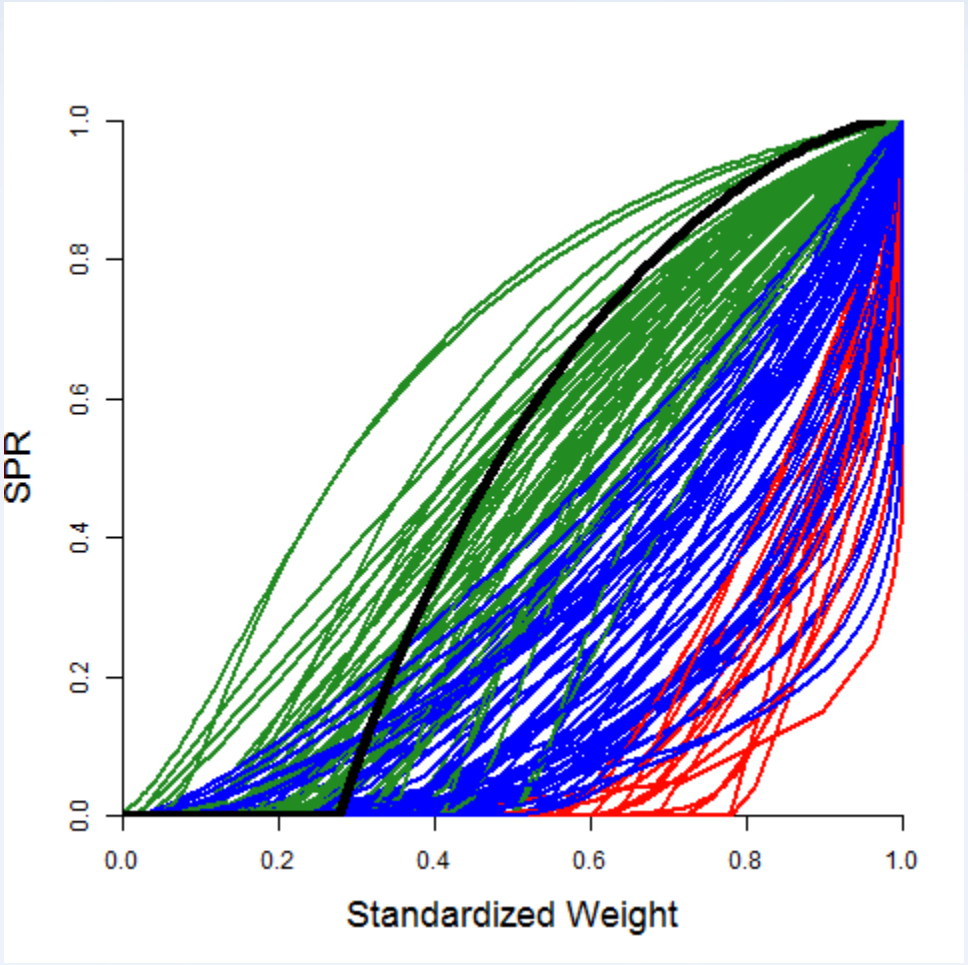
Beverton-Holt Life History Invariants

$M/k = 1.5$

$L_m/L_\infty = 0.66$

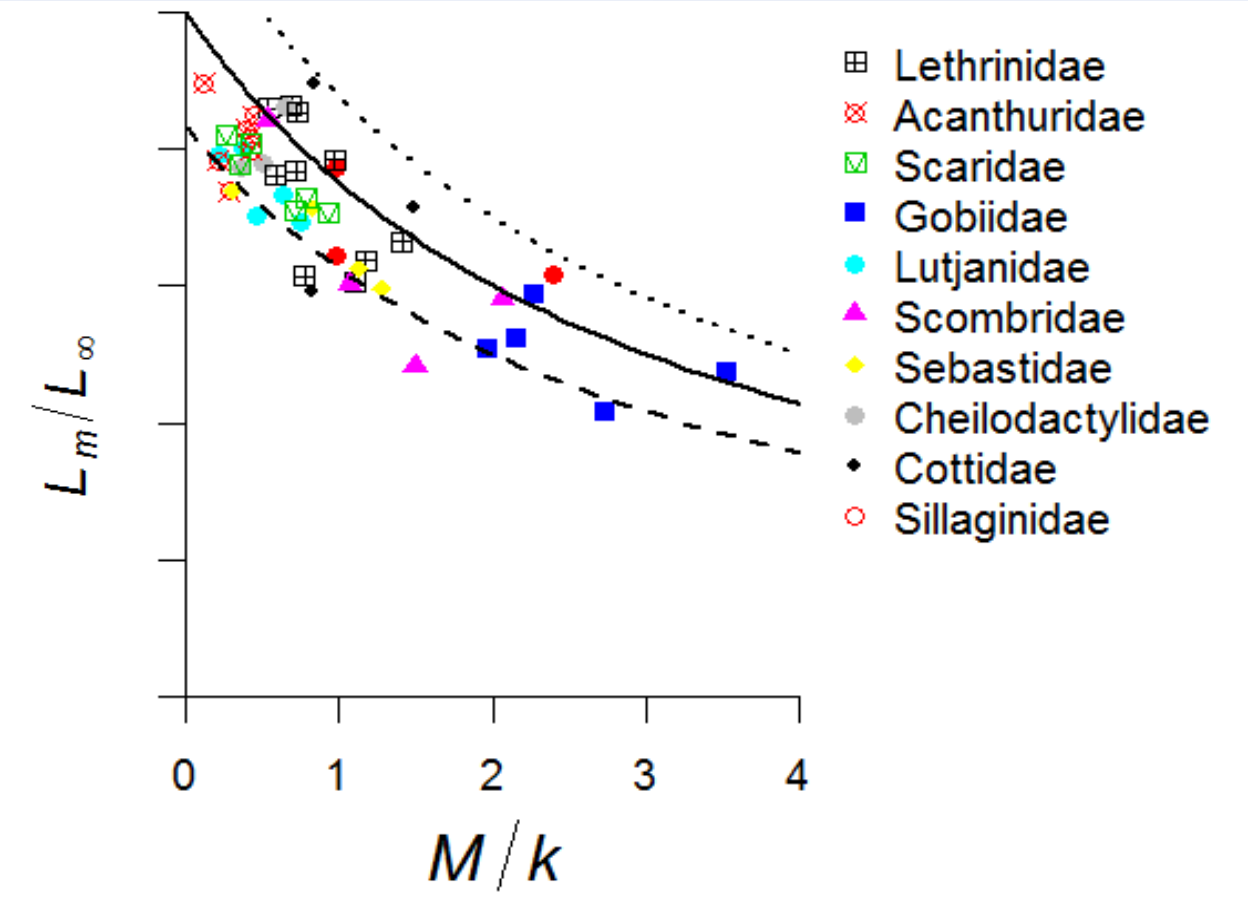
$M \times Age_m = 1.65$

Fec. ~ Adult Wt.

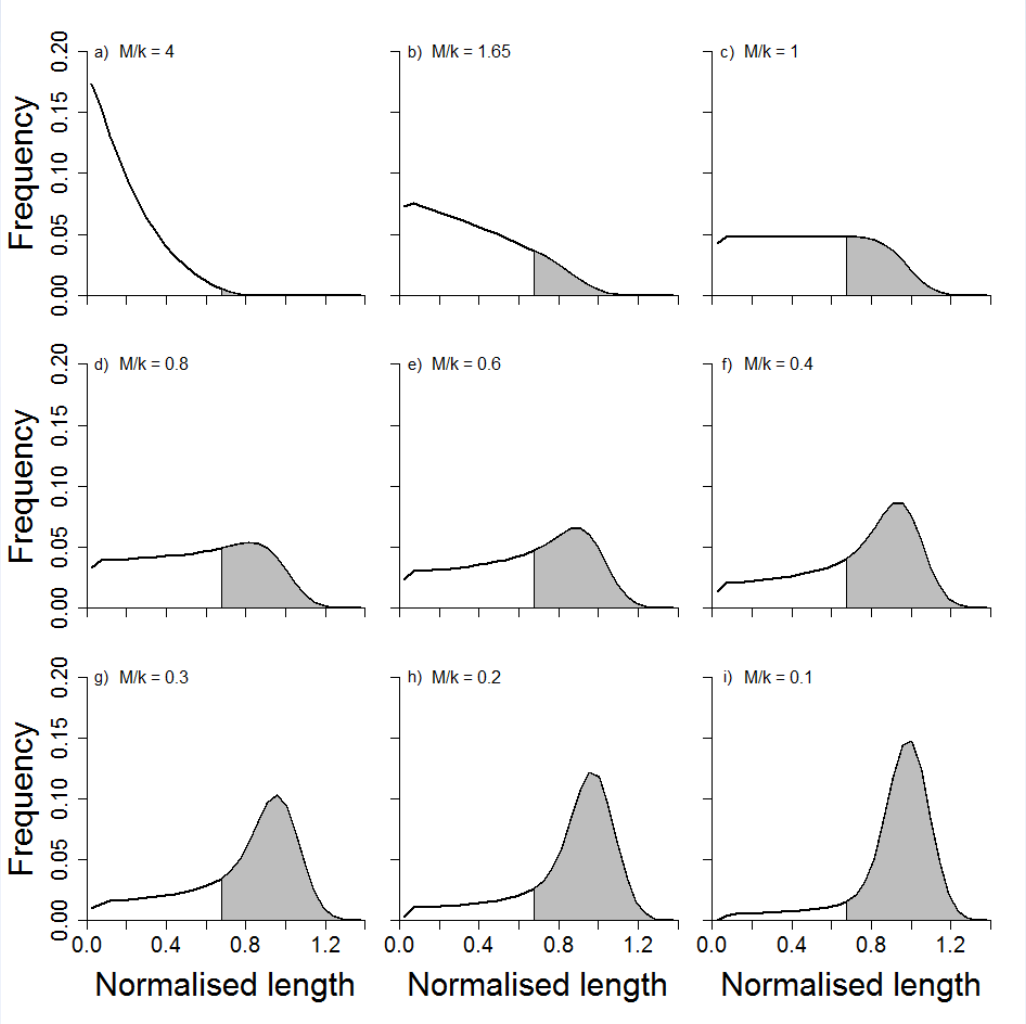


Meta-analysis & Beverton (1992)

$$L_m/L_\infty = 3/(3+ M/k).$$



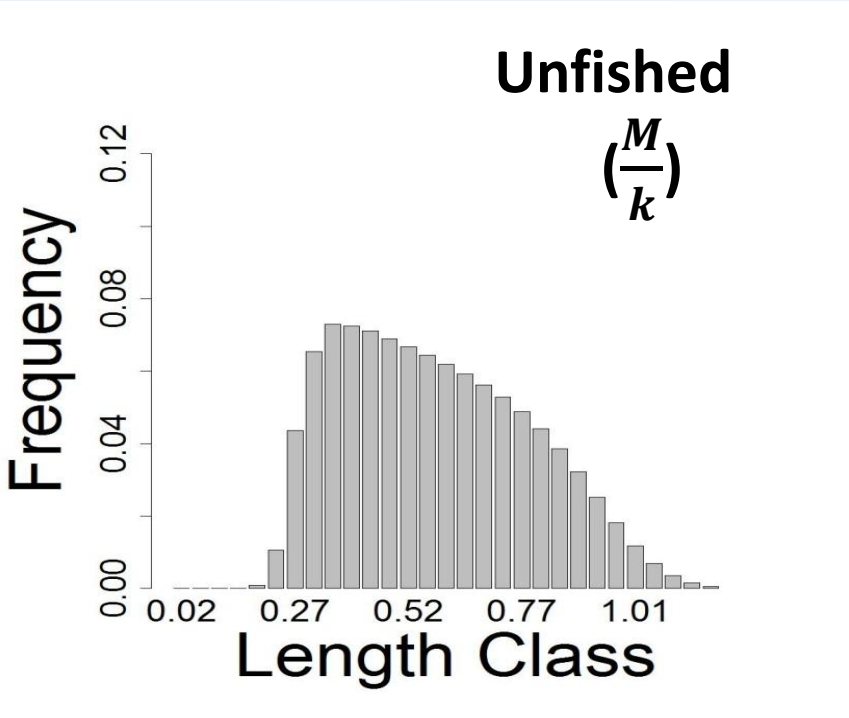
Unfished Length Composition



Length Based SPR Estimation Method

: expected unfished length distribution

Unfished $(\frac{M}{k})$

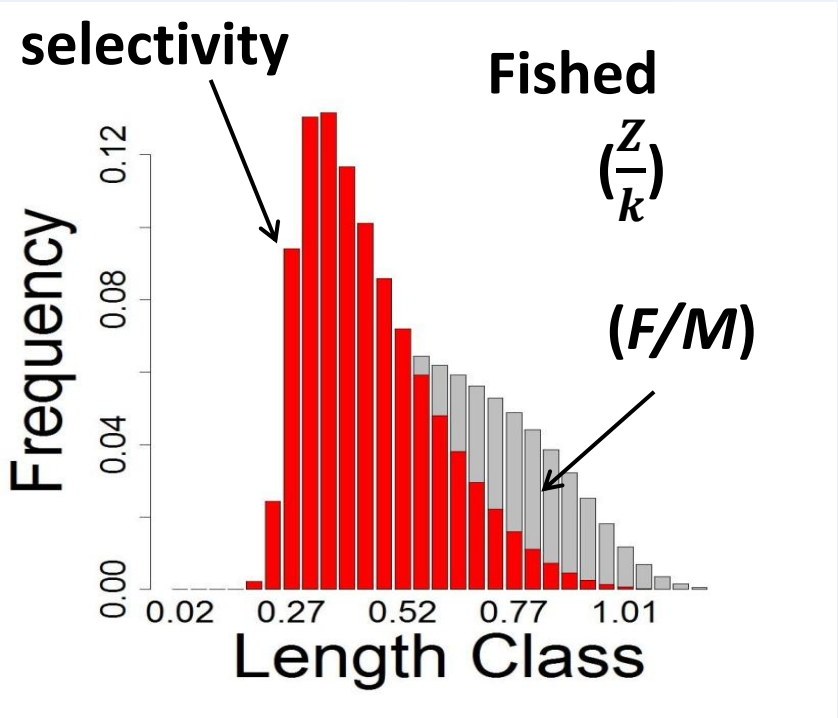


Standardised to L_∞

Length Based SPR Estimation Method

: expected unfished length distribution

: length frequency of catch ($Z = F + M$)



Standardised to L_∞

SPR & F/M:
Calculated from M/k & L_m/L_∞

Important Assumptions

Length frequency of catch representative of exploited stock

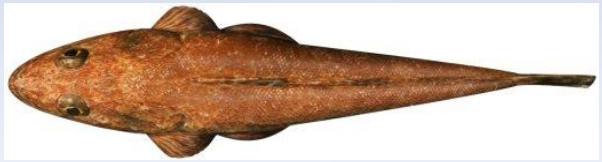
Asymptotic selectivity

Same growth curve or female length data

Knowledge of maturity at size

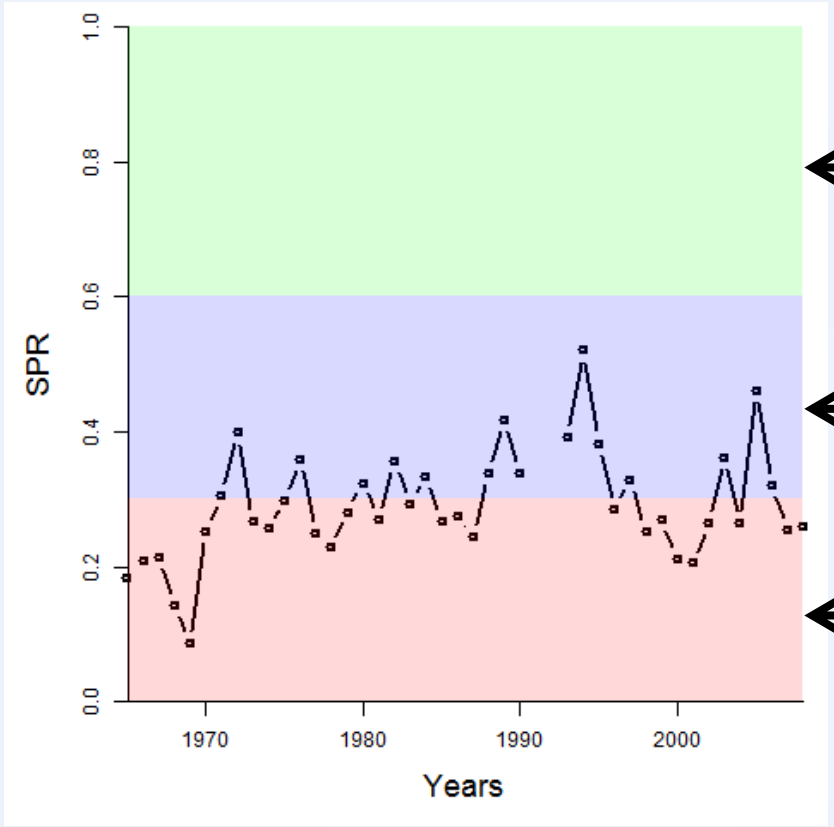
Equilibrium method

Calibration against Stock Assessments



Tiger Flathead

Neoplatycephalus richardsoni



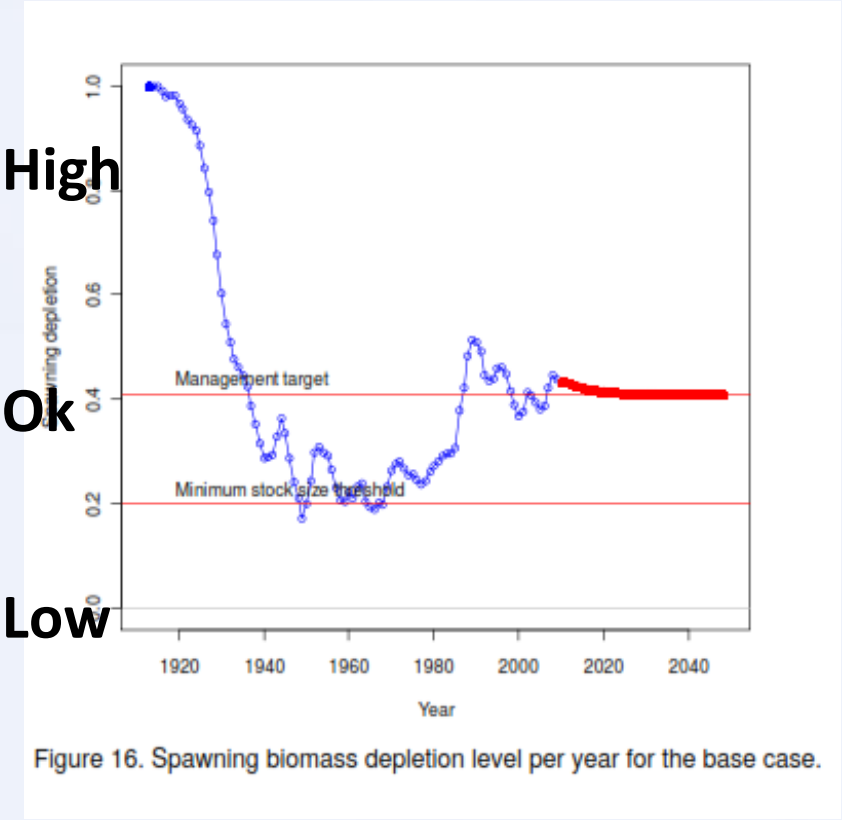
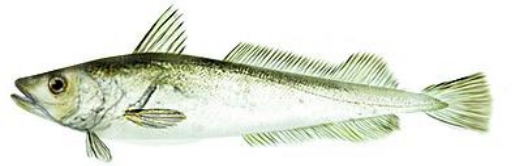


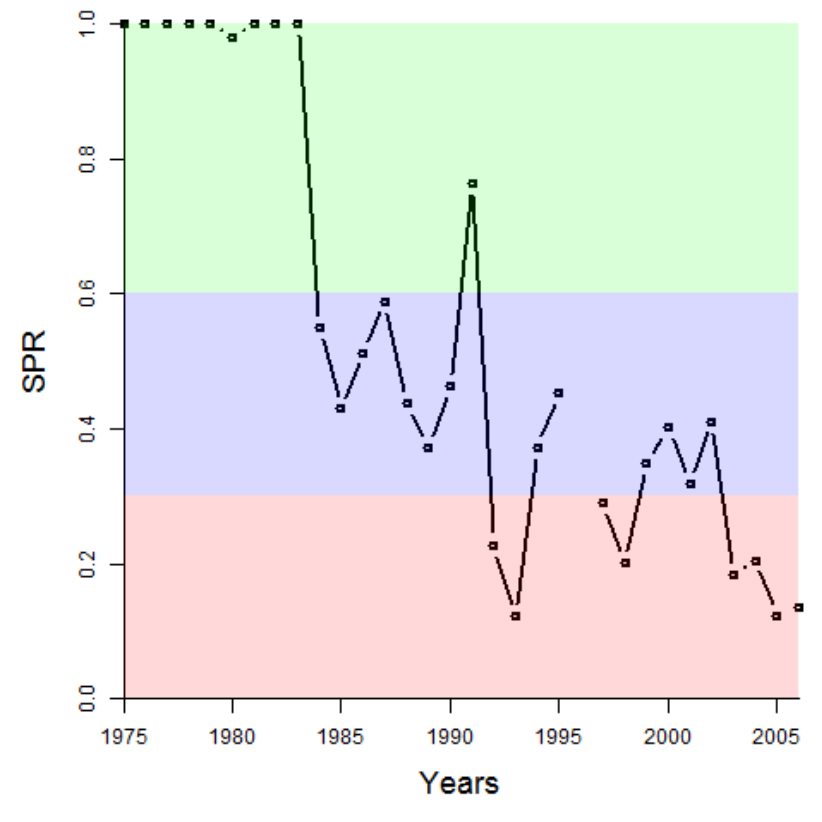
Figure 16. Spawning biomass depletion level per year for the base case.

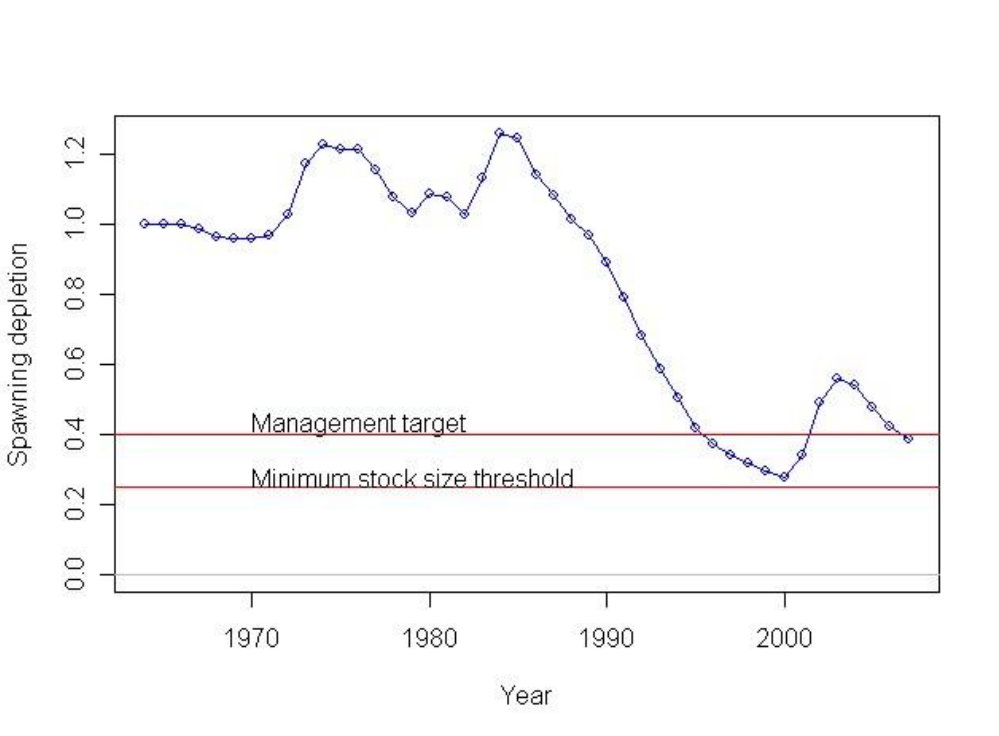
Calibration against Stock Assessments



Pacific Hake

Merluccius productus



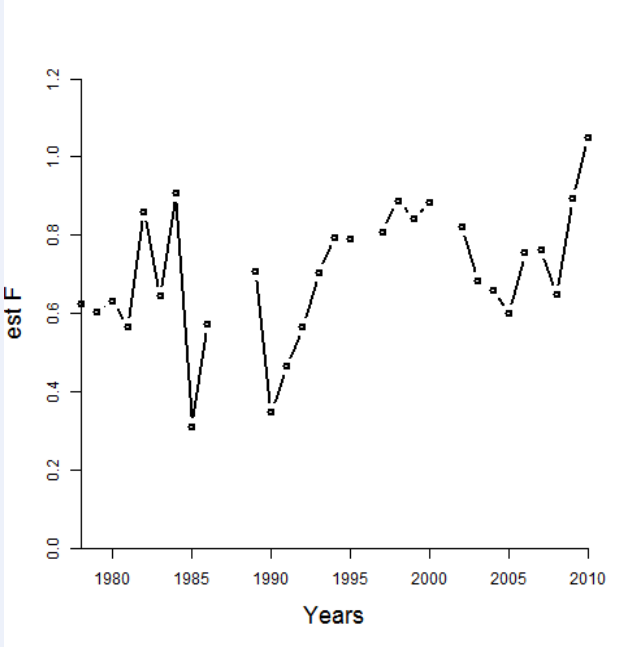


Calibration against Stock Assessments

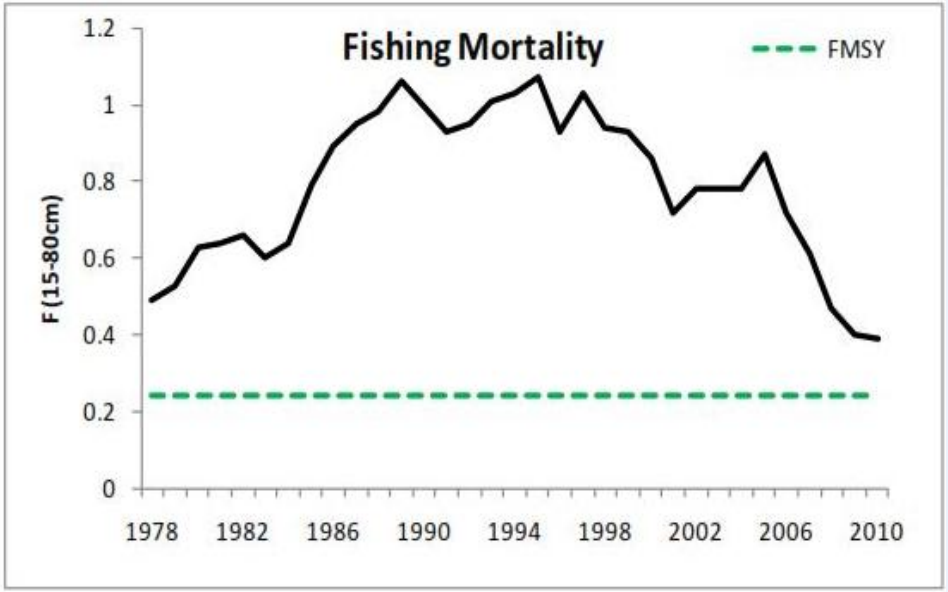
Merluccius merluccius

Northern Hake – ICES dataset

LB-SPR



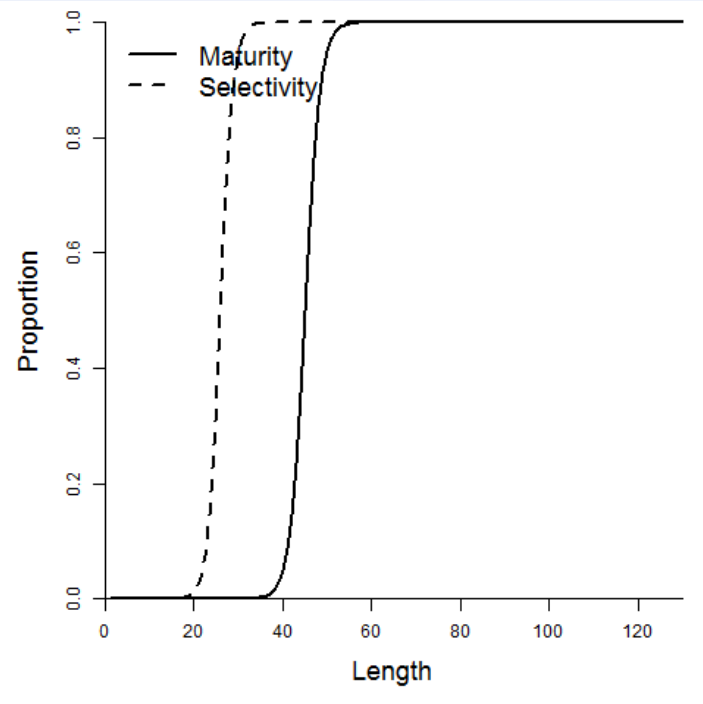
Assessment

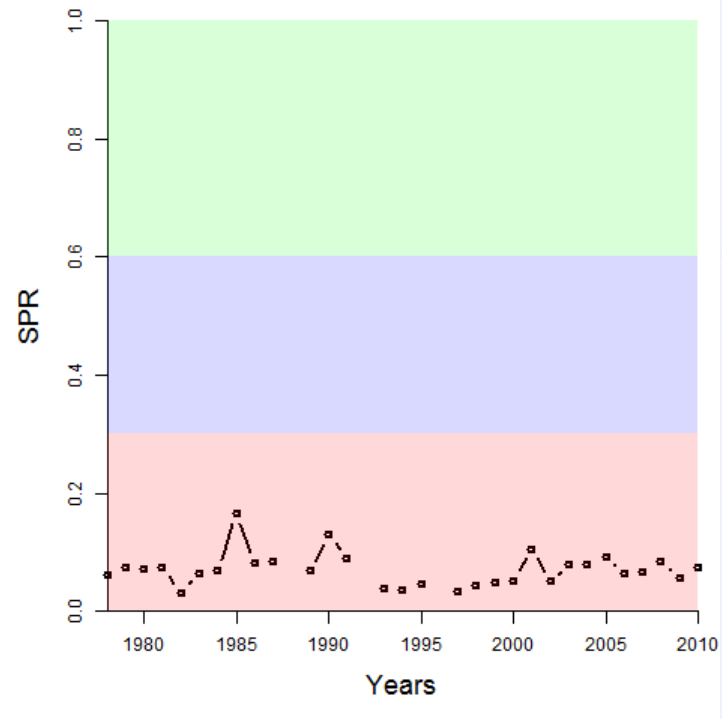


Calibration against Stock Assessments

Northern Hake – ICES dataset

Merluccius merluccius





Conclusion

Meta-analysis *M/k* ratio defines life-history strategy & Size composition e.g. tuna are just scaled up anchovy. Conceptual framework for borrowing information from data-rich species.

BH-LHI Only covers a small subset of the species in the meta-analysis.
Productivity of K-strategists parameterised by BH-LHI have been over-estimated.

Application Cost-effective estimation of SPR & *F/M* from length-data, L_m & meta-analysis for Data-poor and small scale fisheries.

Acknowledgements

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David and Lucile Packard Foundation
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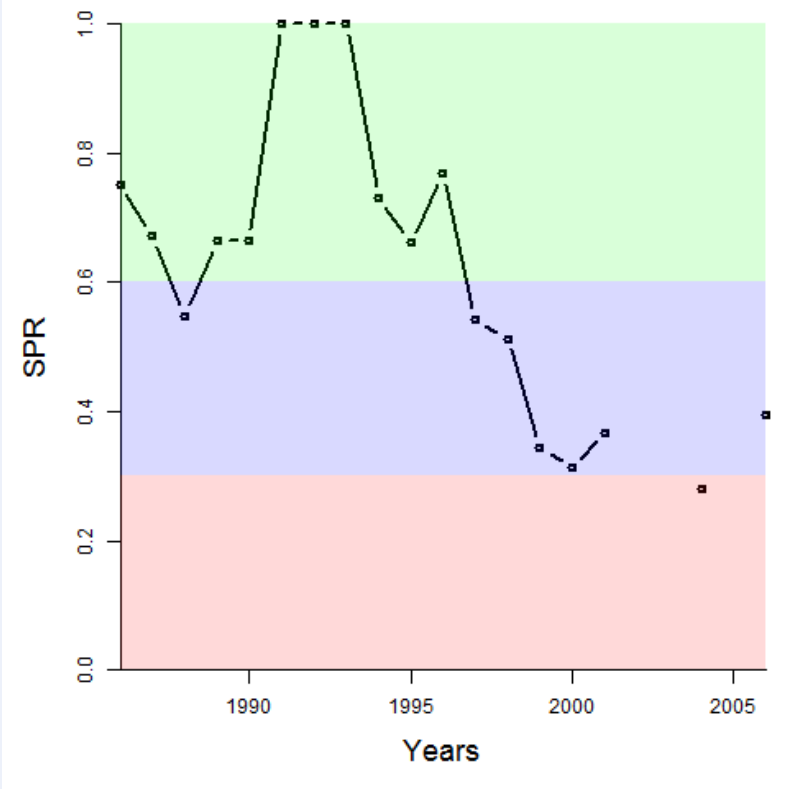
The Nature Conservancy
Murdoch University

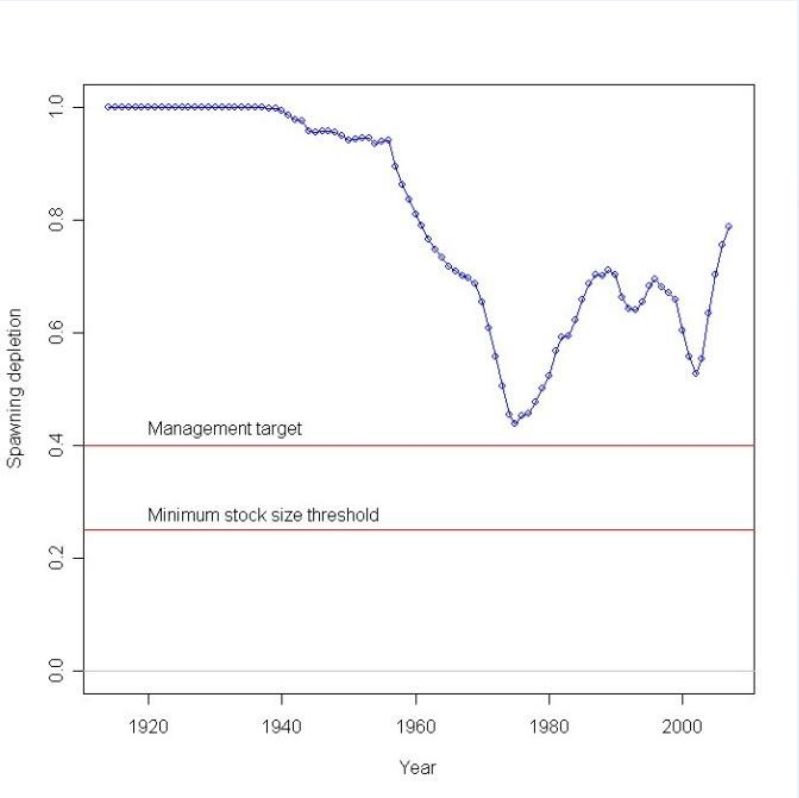
Data & Assistance
Kotaro Ono, Sarah Valencia, Keith Sainsbury, Neil Loneragan

Calibration against Stock Assessments

Arrowtooth Flounder

Atheresthes stomias





Estimation Model

Model input parameters:

- M/k
- L_∞
- $CV_{L\infty}$
- L_{50} & L_{95}

} Female parameters

Estimated parameters:

- F/M
- S_{L50} & S_{L95}
- SPR

$$\boldsymbol{MLE}\left(\widehat{\boldsymbol{S_{L50}}}, \widehat{\boldsymbol{S_{L95}}}, \widehat{\boldsymbol{F/M}}\right) = \underset{(\boldsymbol{S_{L50}}, \boldsymbol{S_{L95}}, \boldsymbol{F/M})}{\boldsymbol{arg\ min}} \left[\sum_{\boldsymbol{L=L_{min}}}^{\boldsymbol{L=L_{max}}} \boldsymbol{O_L log \frac{P_{PL}}{O_{PL}}}\right]$$