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

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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: r- vs. K- strategists

Type I \( \frac{M}{k} > 1 \)

Clupeidae

![Graph showing SPR vs. Standardized Weight with n=49 and Clupeidae fish image]
SPR at Size: r- vs. K- strategists

Type I \[ \frac{M}{k} > 1 \]

Type II \[ \frac{M}{k} < 1 \]
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

\[ \frac{M}{k} = 1.5 \]

\[ \frac{L_m}{L_\infty} = 0.66 \]

\[ M \times Age_m = 1.65 \]

Fec. ~ Adult Wt.
\[ \frac{L_m}{L_\infty} = \frac{3}{3 + M/k}. \]
Unfished Length Composition

![Graph showing frequency distribution for different normalized lengths with varying Mark parameters.]
Length Based SPR Estimation Method

: expected unfinished length distribution

Unfinished
\( \frac{M}{k} \)

Standardised to \( L_\infty \)
Length Based SPR Estimation Method

: expected unfished length distribution

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

SPR & F/M:
Calculated from \(M/k\) & \(L_m/L_\infty\)

Standardised to \(L_\infty\)
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

Neoplatycephalus richardsoni

Figure 16. Spawning biomass depletion level per year for the base case.
Calibration against Stock Assessments

Pacific Hake

*Merluccius productus*

![Graph showing SPR and Scawning depletion over years from 1975 to 2006 with management and minimum stock size thresholds.](image)
Calibration against Stock Assessments

Northern Hake – ICES dataset

Merluccius merluccius

LB-SPR

Assessment

Fishing Mortality

F(15-80cm)

Years


0 0.2 0.4 0.6 0.8 1.0 1.2

0.0 0.2 0.4 0.6 0.8 1.0 1.2

est F


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. |
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Calibration against Stock Assessments

Arrowtooth Flounder

*Atheresthes stomias*
Estimation Model

Model input parameters:

\[ M/k \]
\[ L_\infty \]
\[ CV_{L_\infty} \]
\[ L_{50} \& L_{95} \]

Female parameters

\[ \frac{M_{L E}}{S_{L 50}} S_{L 95}, \frac{F}{M} = \arg \min \left( S_{L 50}, S_{L 95}, \frac{F}{M} \right) \]

Estimated parameters:

\[ F/M \]
\[ S_{L 50} \& S_{L 95} \]
\[ SPR \]

\[ \text{MLE} \left( S_{L 50}, S_{L 95}, \frac{F}{M} \right) = \arg \min_{(S_{L 50}, S_{L 95}, \frac{F}{M})} \left[ \sum_{L=L_{\text{min}}}^{L=L_{\text{max}}} O_L \log \frac{P_{PL}}{O_{PL}} \right] \]