Proxy measures for economic target reference points in data poor multispecies fisheries

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Outline

- Policy background
  - Australian Commonwealth Fisheries Harvest Strategy and Policy
  - Data poor fisheries (more common than you would think)
- The theory
- Developing “rules of thumb”
  - Use of generic bioeconomic models
- How good are the “rules of thumb”
- Conclusions
Policy background

• Objective of maximise net economic returns from the fishery
• Policy requires each managed species to have an economic target reference point i.e. $B_{MEY}$
• Relatively easy to determine MEY for single species fisheries
  • More complicated for multispecies fisheries
  • Requires comprehensive bioeconomic model
• Stocks of many “less important” species are not regularly assessed
  • Development of bioeconomic models not possible without the biology
  • Not able to identify/estimate $B_{MEY}$
• Default in the Commonwealth Harvest Strategy and Policy is:
  $$B_{MEY} = 1.2B_{MSY}$$
• Aim of this study is to see if we could do better.
The theory ... and reality

- Maximising economic profits in a multispecies fishery may result in:
  - Some species being well above BMSY
  - Some species being well below BMSY
  - Some species being around BMSY
  - Some species becoming extinct
- A set of single species based $B_{MEY}$ TRF would not be feasible
- Without a “real” bioeconomic model of the fishery, need some other way to derive estimates of where we want to be for each species
Development of a “generic” bioeconomic model

- Two underlying biological models (surplus production)
  - Schaefer and Fox
  - Joint production (only one fishing effort)
  - Objective function: maximise total economic profits in the fishery

- Randomly varied
  - Number of species: 2 to 20
  - Prices and cost per unit effort (based on South East fishery as a base for orders of magnitude)
  - q, k and r (again, based around parameters for South East fishery)
    - Dropped “unrealistic” combinations
Stochastic simulations

- Ran the models 20,000 times
  - Estimated the ratio $B_{\text{MEY}}/B_{\text{MSY}}$ for each species
- Default proxy generally low
  - wide dispersion
  - Fairly invariant to number of species in the simulation
Developing “rules of thumb”

- Two approaches
  - Regression tree
  - Bayesian Network
- Initial regression model to identify key parameters

<table>
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<th></th>
<th>Estimate</th>
<th>Std. Error</th>
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<td>• Revenue share</td>
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<td>• r (growth rate)</td>
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Regression tree

- Split by revenue share
  - <5%
  - 5-10%
  - 10-20%
  - >20%

- Key determinants
  - Relative catchability ($q$)
  - Relative growth ($r$)
Performance

• Applied only to the “main” species
• Similar distribution to optimal “real” distribution
• Default proxy (1.2BMSY) performs reasonably well also, but some big losses
Bayesian Network

- BN relationships derived from the model output
Comparison model

- Bioeconomic model of the south east trawl fishery
  - 6 metiers (4 otter trawl, 2 Danish seine)
  - 13 species
  - Fox equilibrium model and dynamic model (100 years)
Static vs dynamic MEY

Very little difference

• 5% discount rate
• Flathead >20% of revenue
Comparison of results

![Graph showing comparison of Tree/BBN values against Bioeconomic model values. The graph includes data points for BBN and Tree, with linear trend lines for both BBN and Tree.]
Imposing the targets on the fishery

- Goal programming model
  - Objective to minimise the total divergence from
    - the individuals TRP weighted by revenue share and overall 60% weight
    - The optimal average fishery profits 40% weight

- Average TRPs from bioeconomic model
- Compared final stock status with optimal status
  - 1000 runs
Impact on fleet profits

- Rules of thumb generally performed as well as a “proper” bioeconomic model
- Default proxy appears to perform better, but artefact that it essentially abandoned attempting to achieve the set of TRPs imposed (which were unachievable) and just maximised the profit component
Summary

• Rules of thumb approaches can provide reasonably good estimates of economic target reference points with limited information
  • Even “good” bioeconomic models are not perfect
• The current proxy default TRP (BMEY=1.2BMSY) is not achievable in multispecies fisheries
• There still is an issue as to how many and which species should have TRPs in a multispecies fishery
  • Too many may cause more problems than it solves
  • With (perfect) joint product, just one for the main species seems to result in good outcomes