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 that you would think)
- The theory
- Developing “rules of thumb”
  - Use of generic bioeconomic models
- How good are the “rules of thumb”
- Conclusions

Policy background

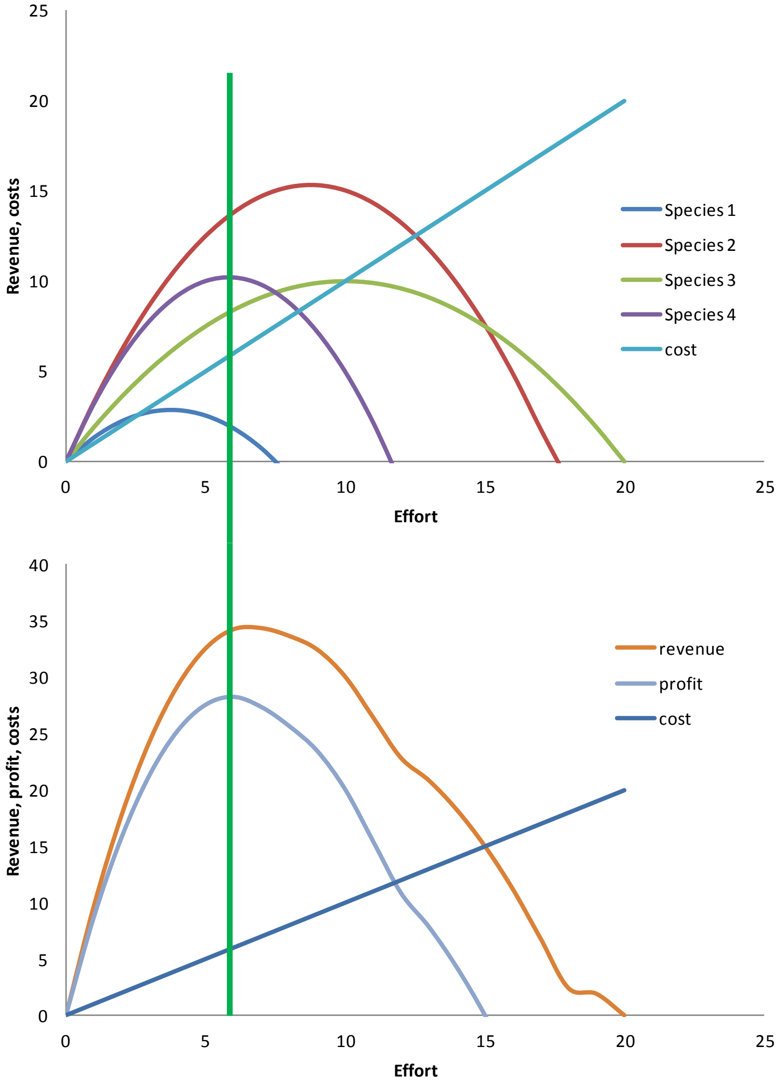
- Objective of maximise net economic returns from the fishery
- Policy requires each managed species to have an economic target reference point i.e. B_{MEY}
- Relatively easy to determine MEY for single species fisheries
  - More complicated for multispecies fisheries
  - Requires comprehensive bioeconomic 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.

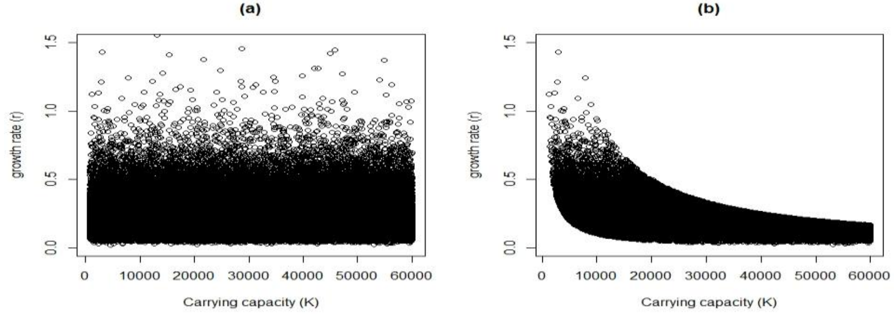
The theory … and reality

- 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



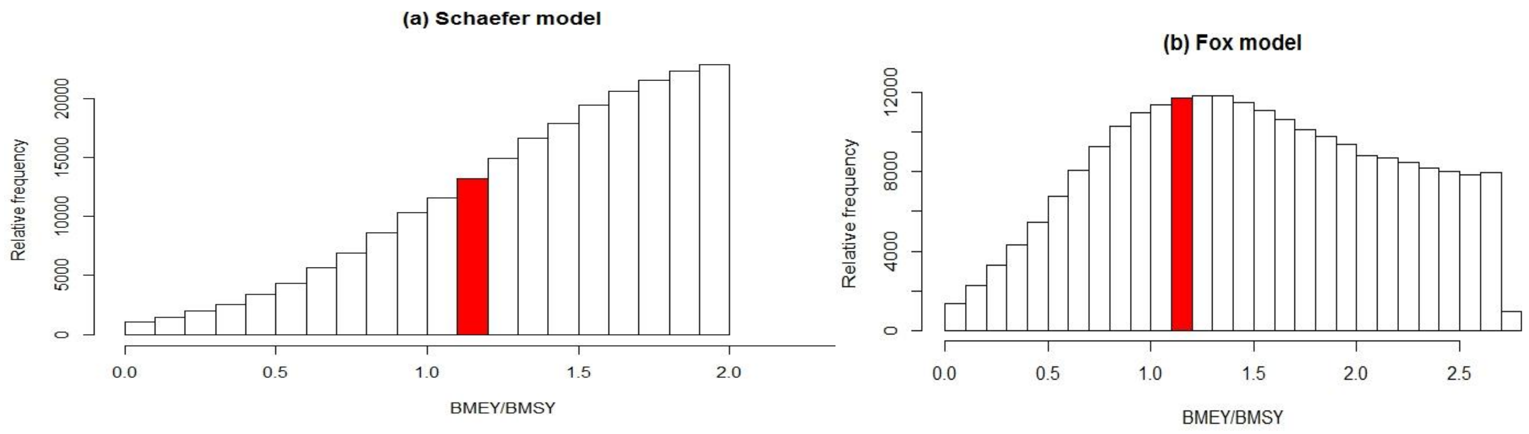
Development of a “generic” bioeconomic model

- 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_{MEY}/B_{MSY} for each species
- Default proxy generally low
  - wide dispersion
  - Fairly invariant to number of species in the simulation



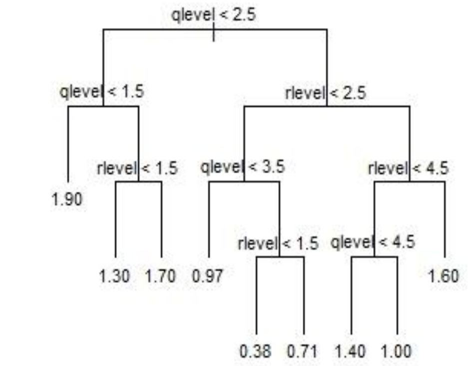
Developing "rules of thumb"

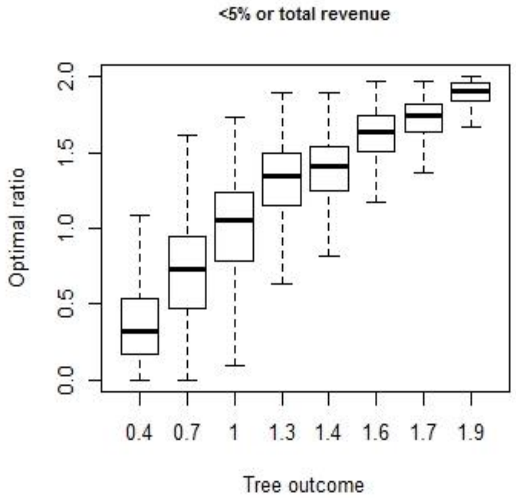
- Two approaches
  - Regression tree
  - Bayesian Network
- Initial regression model to identify key parameters

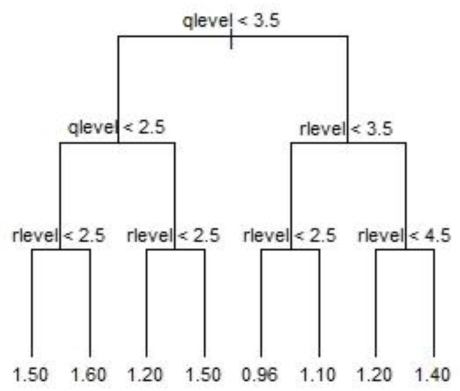
	Estimate	Std. Error	t value		Scaled Beta	Rank
Intercept	1.823	0.004	446.740	***	1.389	
Species characteristic						
• Revenue share	1.012	0.008	127.370	***	0.098	3
• p (price)	-0.022	0.000	-60.720	***	-0.031	5
• r (growth rate)	1.658	0.005	341.610	***	0.184	2
• q (catchability)	-25.010	0.035	-720.200	***	-0.359	1
• K (unexploited biomass)	0.000	0.000	-105.810	***	-0.065	4
Fishery characteristic						
• c (cost)	0.000	0.000	39.770	***	0.018	6
• Distance	-0.189	0.006	-32.640	***	-0.016	7
Diagnostics						
• N.Obs	227,181					
• $\bar{R}^2$	0.767					

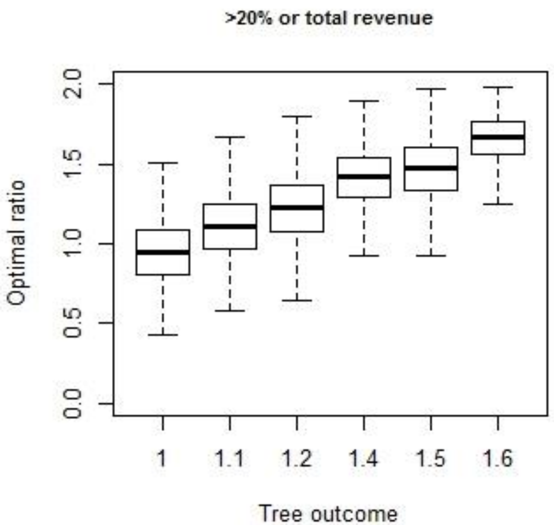
Regression tree

- Split by revenue share
  - <5%
  - 5-10%
  - 10-20%
  - >20%
- Key determinants
  - Relative catchability (q)
  - Relative growth (r)



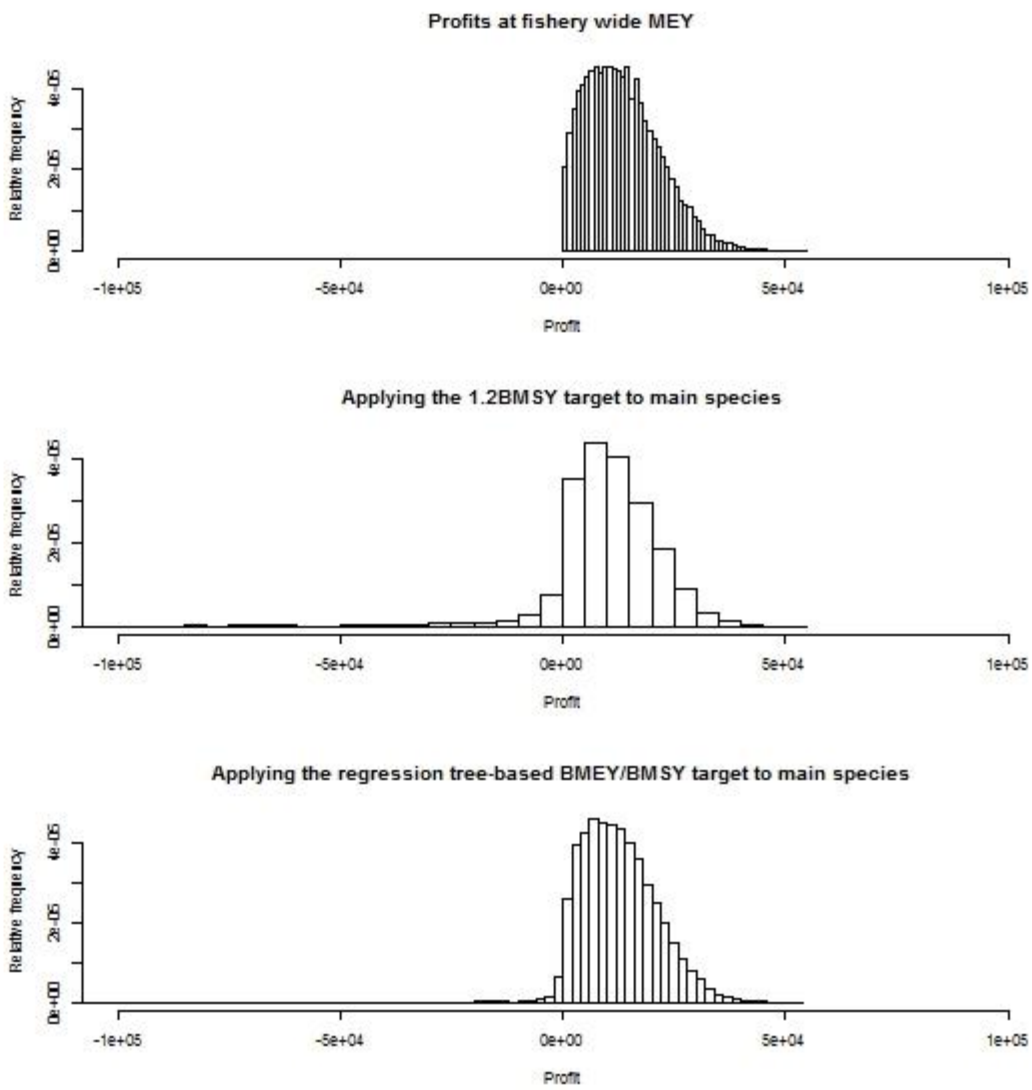






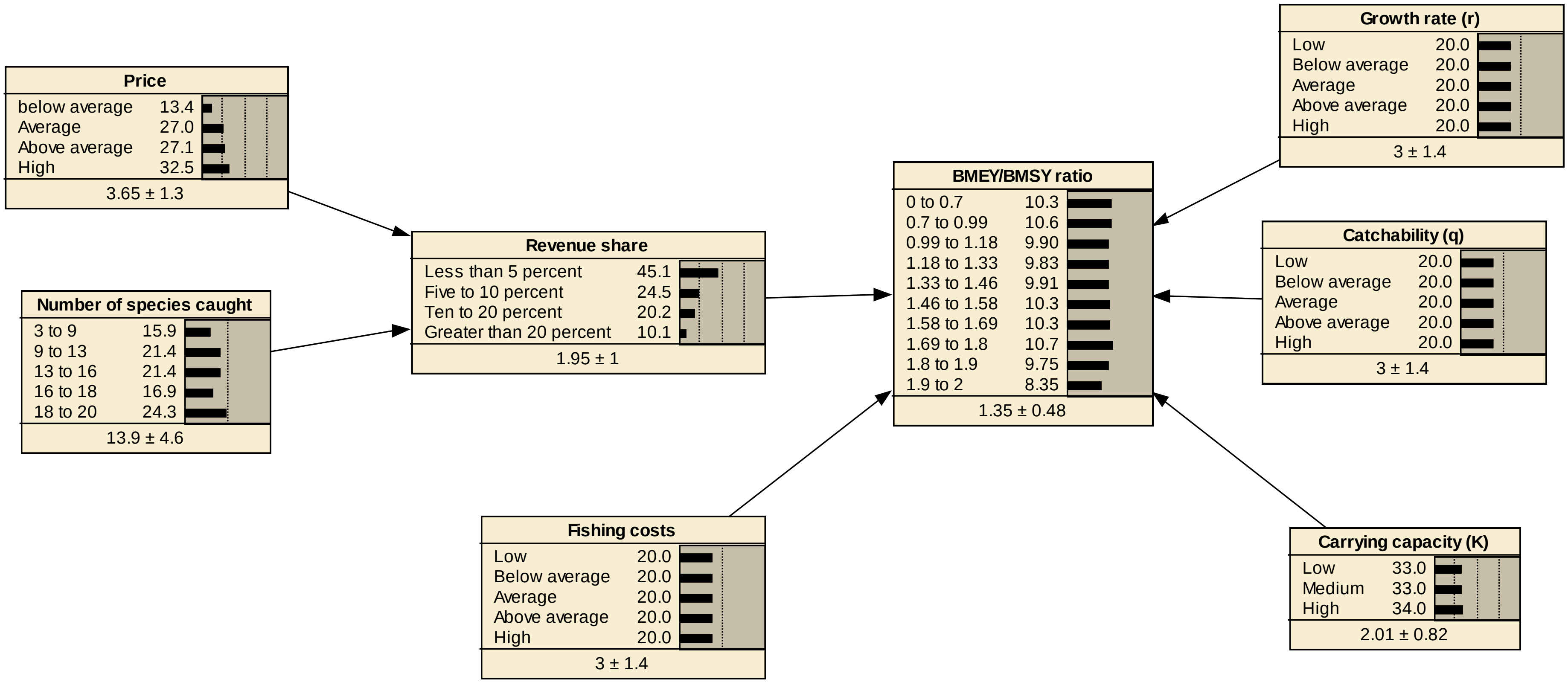
Performance

- Applied only to the "main" species
- Similar distribution to optimal "real" distribution
- Default proxy (1.2BMSY) performs reasonably well also, but some big losses



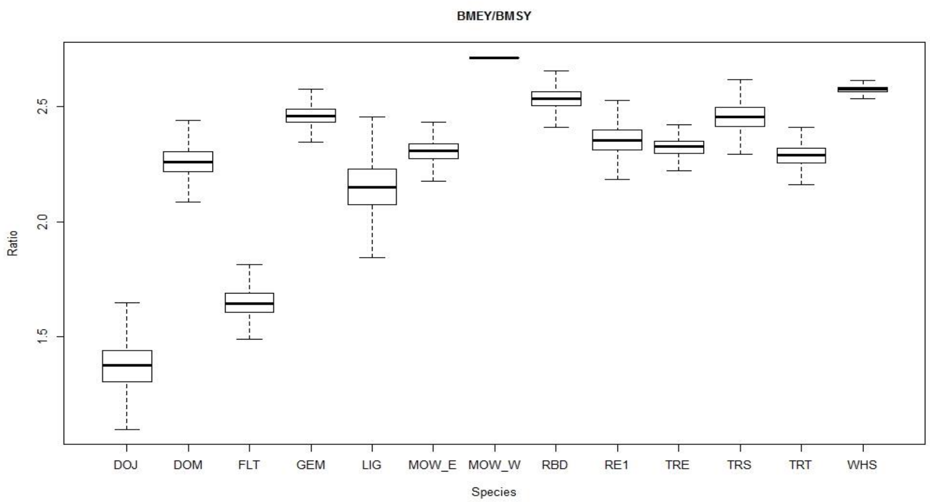
Bayesian Network

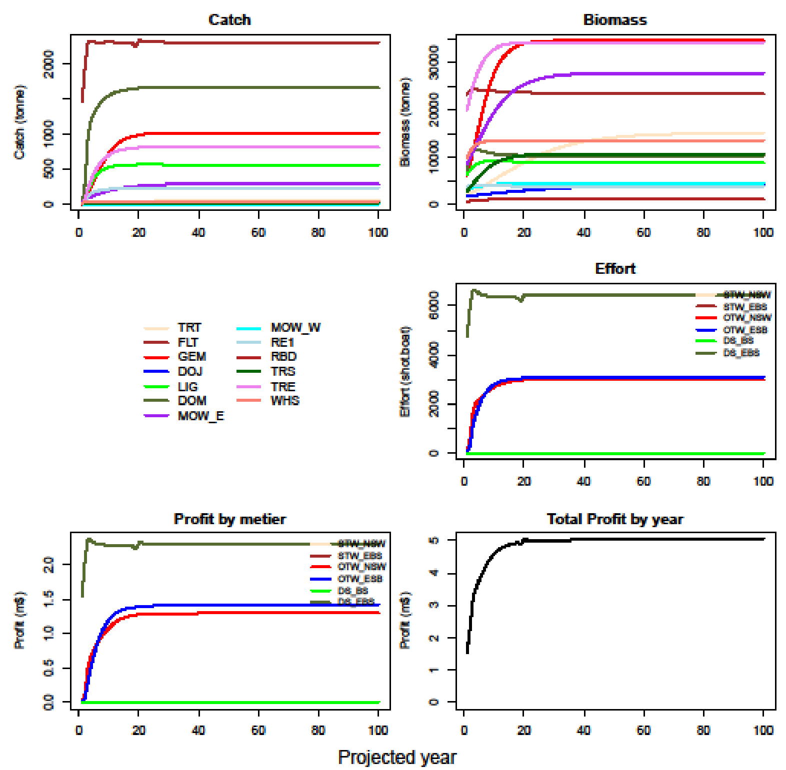
- BN relationships derived from the model output



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)

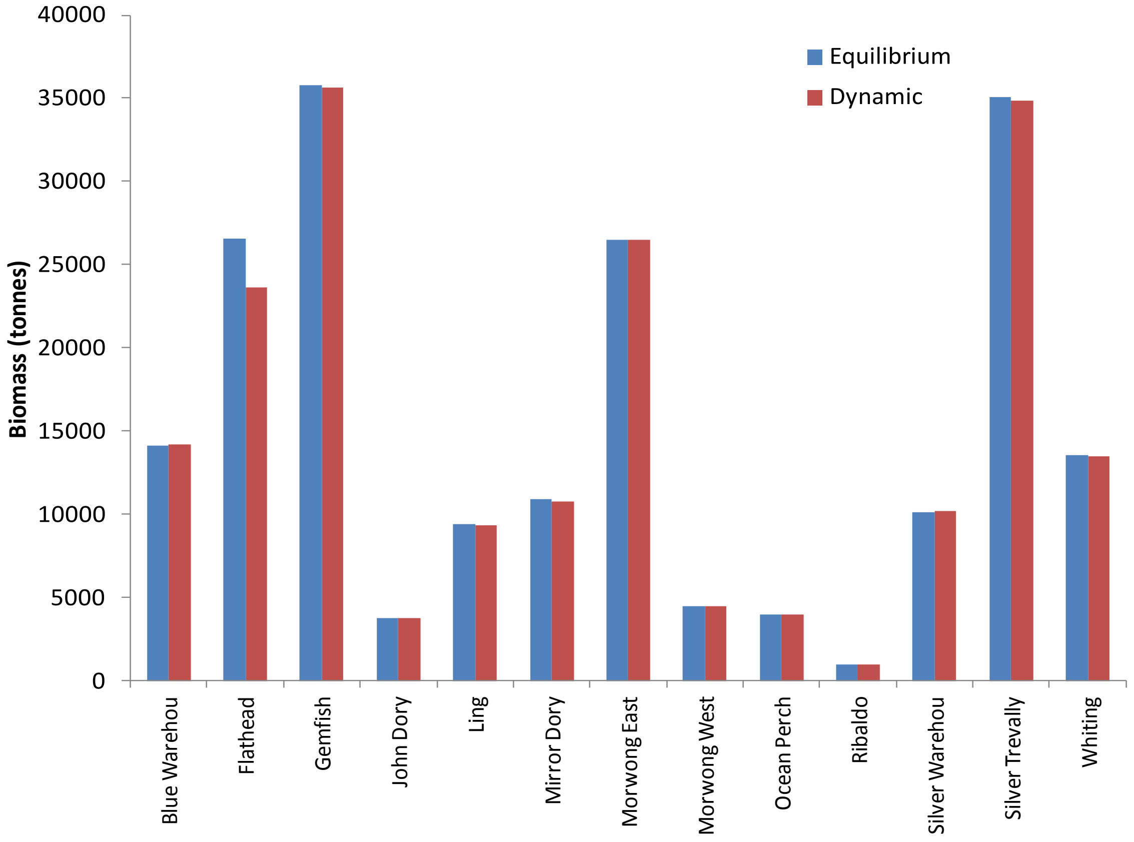




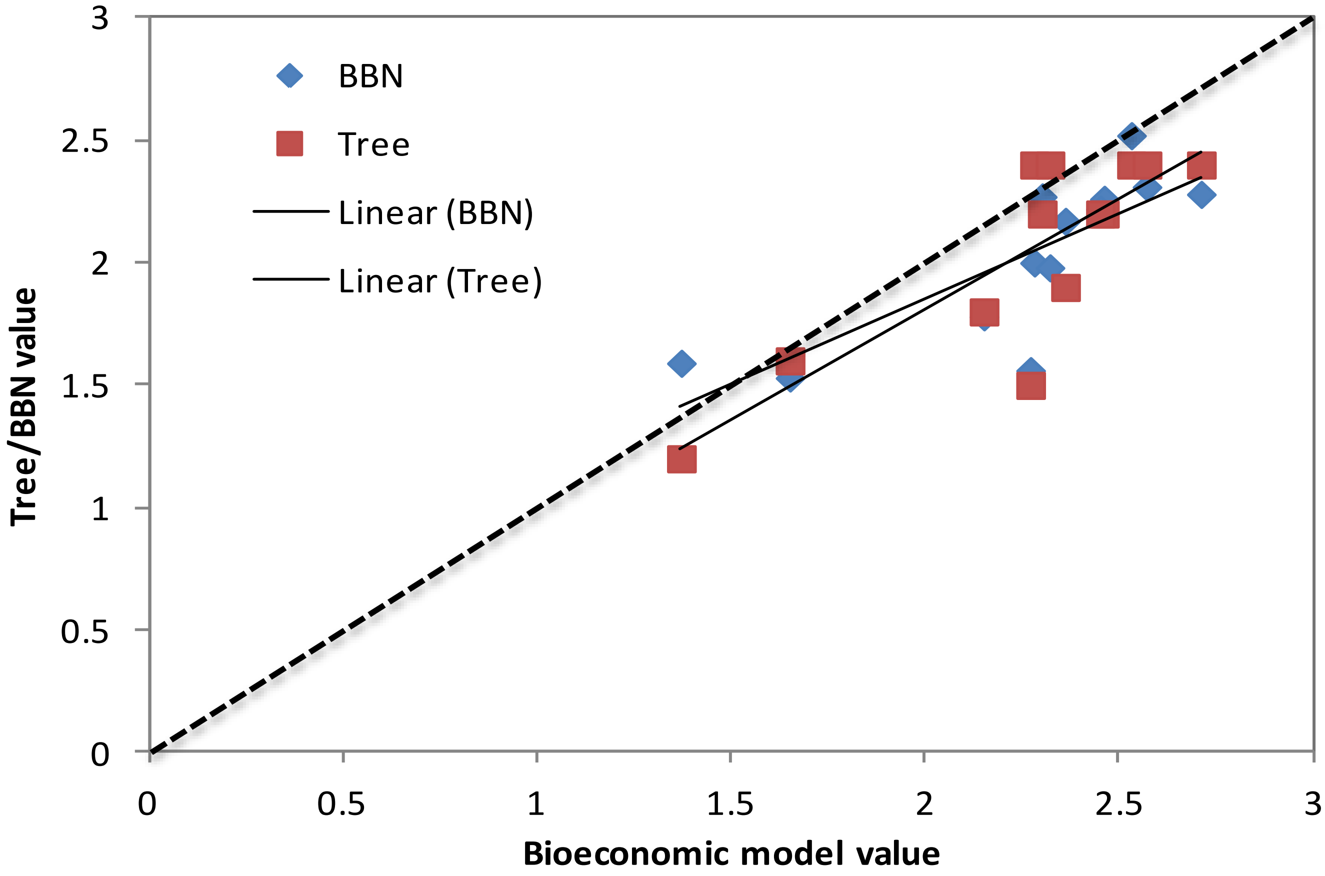
Static vs dynamic MEY

Very little difference

- 5% discount rate
- Flathead >20% of revenue



Comparison of results



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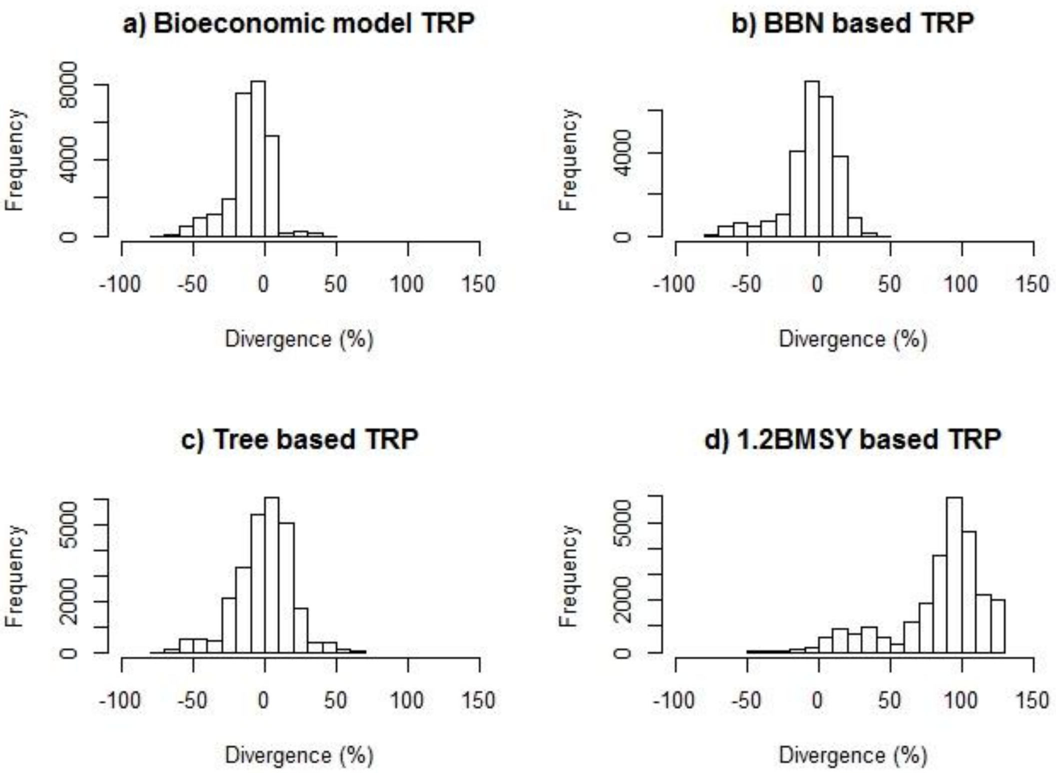
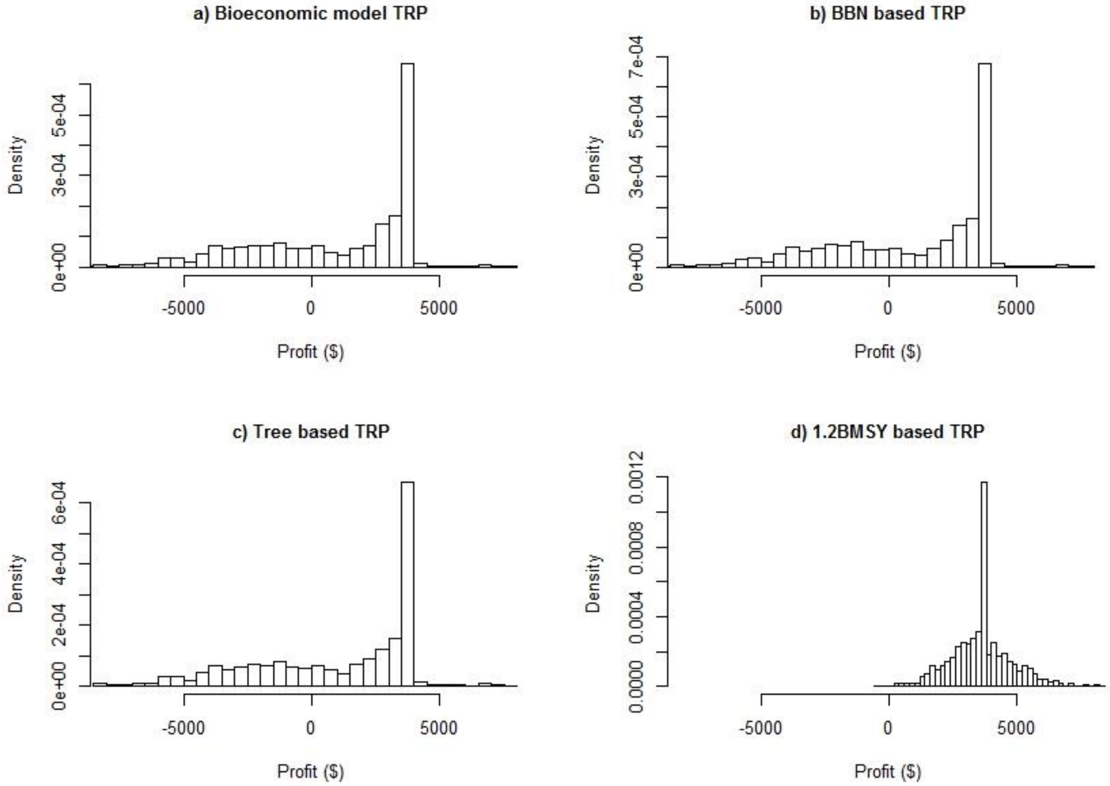
Imposing the targets on the fishery

- 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