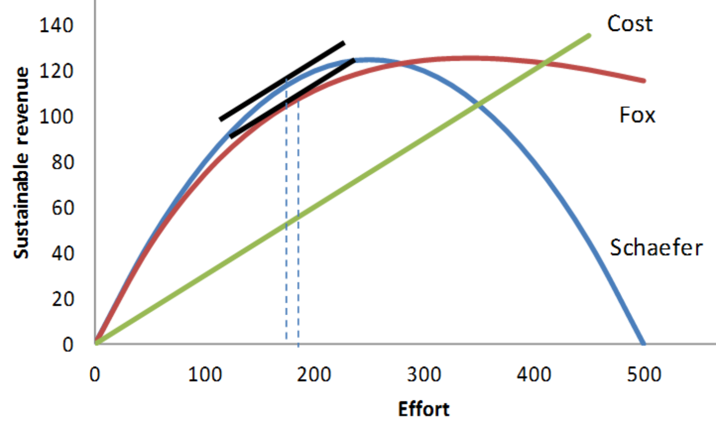
Maximising net economic returns in mixed fisheries: how many species do we need to control?

Trevor Hutton, Sean Pascoe, James Innes, Satoshi Yamazaki and Tom Kompas

Contributed presentation at the 60th AARES Annual Conference,
Canberra, ACT, 2-5 February 2016



Maximising net economic returns in mixed fisheries: how many species do we need to control?

Trevor Hutton, Sean Pascoe, James Innes, Satoshi Yamazaki and Tom Kompas

AARES 2016: Canberra, Australia

Key issues to be looked at in the study

- How do you identify MEY (maximum economic yield) for different species in multispecies and multi-fleet fisheries?
- How different are dynamic estimates of MEY to static estimates?
- In multispecies fisheries characterised by technical interactions, do we need to control the catch of all species?
  - If not, how many?
- How does bycatch and byproducts affect our estimates of MEY for target species?
  - If we set a “price” on bycatch (e.g. seals, seabirds, dolphins), what does this do to our targets?

Approach

- Model based on Southern and Eastern Shark and Scalefish Fishery (SESSF) developed in an earlier study to assess proxy target reference points in multispecies fisheries
  - Static equilibrium optimisation model
  - Dynamic optimisation model
- Model to be updated and expanded to allow for some of these issues to be addressed
  - Work still in progress
  - Combination of optimisation and simulation approaches to be used to test different harvest strategies
- Aim of this presentation is to present the model as it currently stands, and what some of the results indicate

Outline of the remainder of the talk

- Overview of MEY in single species and multispecies fisheries
- Description of the bioeconomic model
- Some earlier results
  - Relationship between $B_{\mathbf{MEY}}$ and $B_{\mathbf{MSY}}$
  - Comparison of static and dynamic equilibrium levels of biomass (B)
- Where to next

MEY: Classic fisheries bio-economic models

Equilibrium derivation

Schaefer formulation

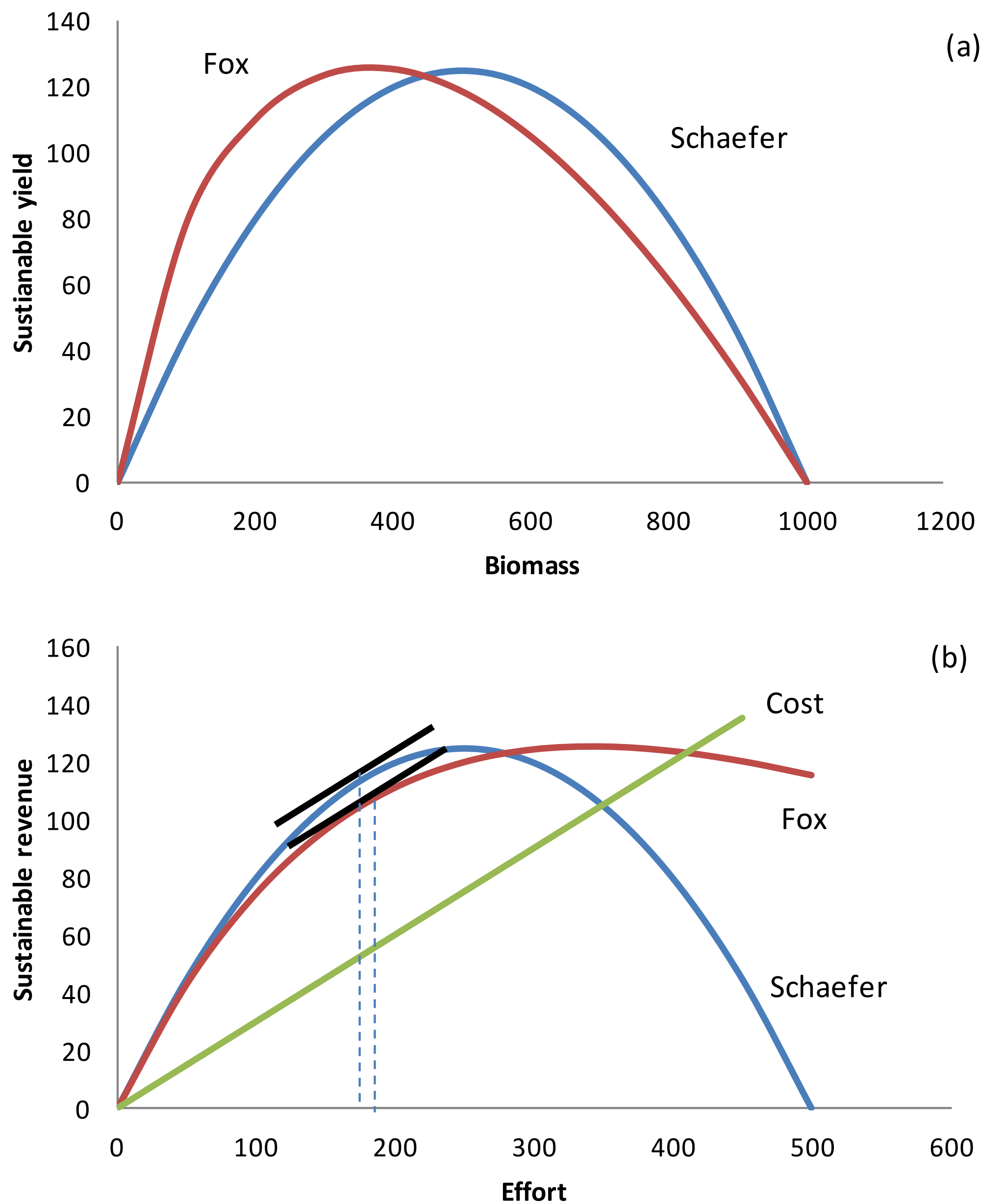
Fox formulation

MSY –know where it is, and corresponding B_{msy}

E_{mey} – lower than E_{msy}

Revert back to top graph ~

$B_{mey} > B_{msy}$ (but by what factor?) ~ 1.2!



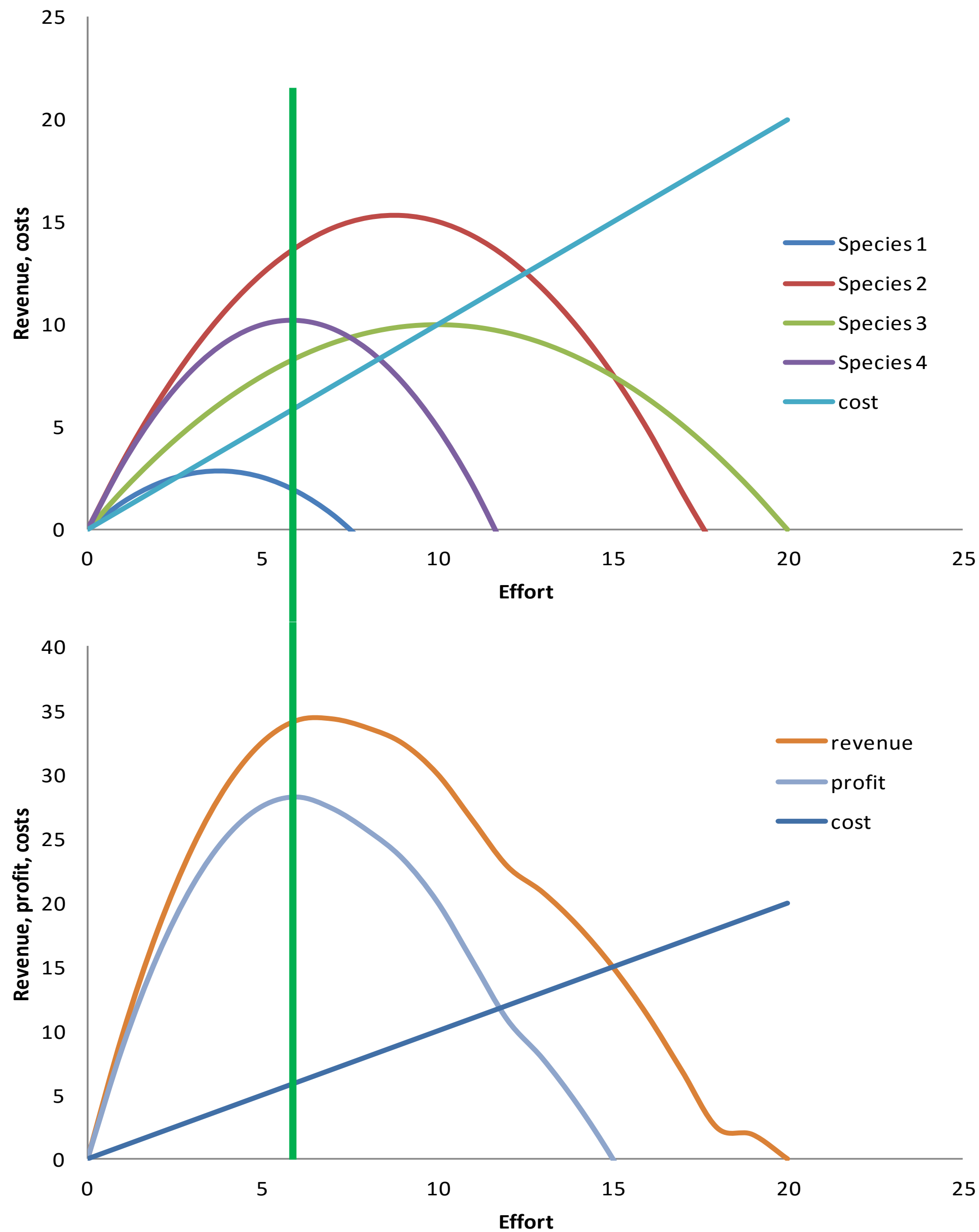
Multi-species Reference Points

Can be sub-optimal

The Multi-species MSY (and MEY) is not on par with single species

MEY – depends on revenue share

What is a species MEY (stated as B_{mey} in a multi-species fishery?)



Specification of models

Schaefer $$C_i = q_i K_i E - (q_i^2 K_i / r_i) E^2$$ logistic growth

Fox $$C_i = q_i K_i E \exp(-q_i E / r_i)$$ exponential growth

Objective Function $$\underset{E}{Max}\ \Pi = \sum_i p_i C_i - cE$$

C - catch (yield), *K* - carrying capacity (B_0), *E* - effort, *q* - catchability coefficient (major technical interaction term), *r* - growth rate (very species specific)

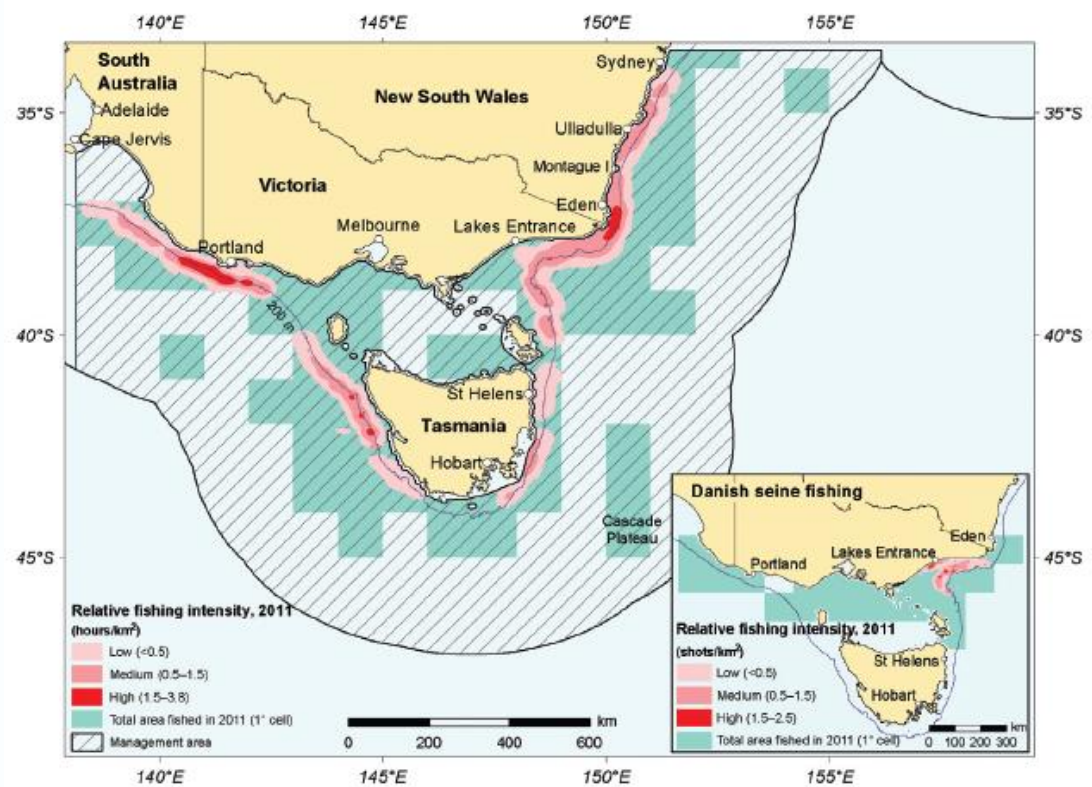
Pi - Profit, *p*-price, *c* - cost

Current model: Trawl sector of SESSF

Southern and Eastern Shark and Scalefish Fishery

Two types of vessel (Otter trawl and Danish seine)

- Markets: Sydney and Melbourne
- 20 + species landed
- Flathead, Ling, Whiting, Silver warehou, John Dory, Morwong, Silver trevally
- Flathead contributed $14.6 million, Pink Ling $6.6 million and Silver warehou $2 million.



Features of the model

- Catch effort models based on fox model
  - Parameters estimated dynamically over a 20+ year period
- Catchability of each defined spatially and by gear type
  - Four regions
  - Two gears

  Six "metiers"
- Technical interactions captured by deriving fishing mortality spatially based on effort levels of each gear type and catchability coefficients
- Model is limited only to species that are caught jointly
  - Excludes blue grenadier, orange roughy and other highly targetable species

Biological parameters + price

	Growth (r)	Carrying capacity (K)	Price (p)
Blue Warehou	0.069	16086	2.33
Flathead	0.153	44566	5.23
Gemfish	0.208	40000	2.83
John Dory	0.044	5431	6.80
Ling	0.215	11960	6.50
Mirror Dory	0.614	13389	2.54
Morwong –East	0.128	30231	2.52
Morwong- West	0.151	4447	2.52
Ocean Perch	0.311	4657	2.74
Ribaldo	0.288	1077	2.85
Silver Warehou	0.197	10654	1.75
Silver Trevally	0.204	38577	2.78
Whiting	0.420	13586	2.76
Other species	-	-	2.75

Fleet structure (6 metiers)

Trawlers operating in

- Shelf trawl – Eden to Sydney (NSW)
- Shelf trawl – Eastern Bass Strait (EBS)
- Offshore - NSW
- Offshore – EBS

Danish seiners operating in

- Bass Strait (west of Lakes Entrance)
- Eastern Bass Strait (east of Lakes Entrance, Eden to NE Tas) (EBS)



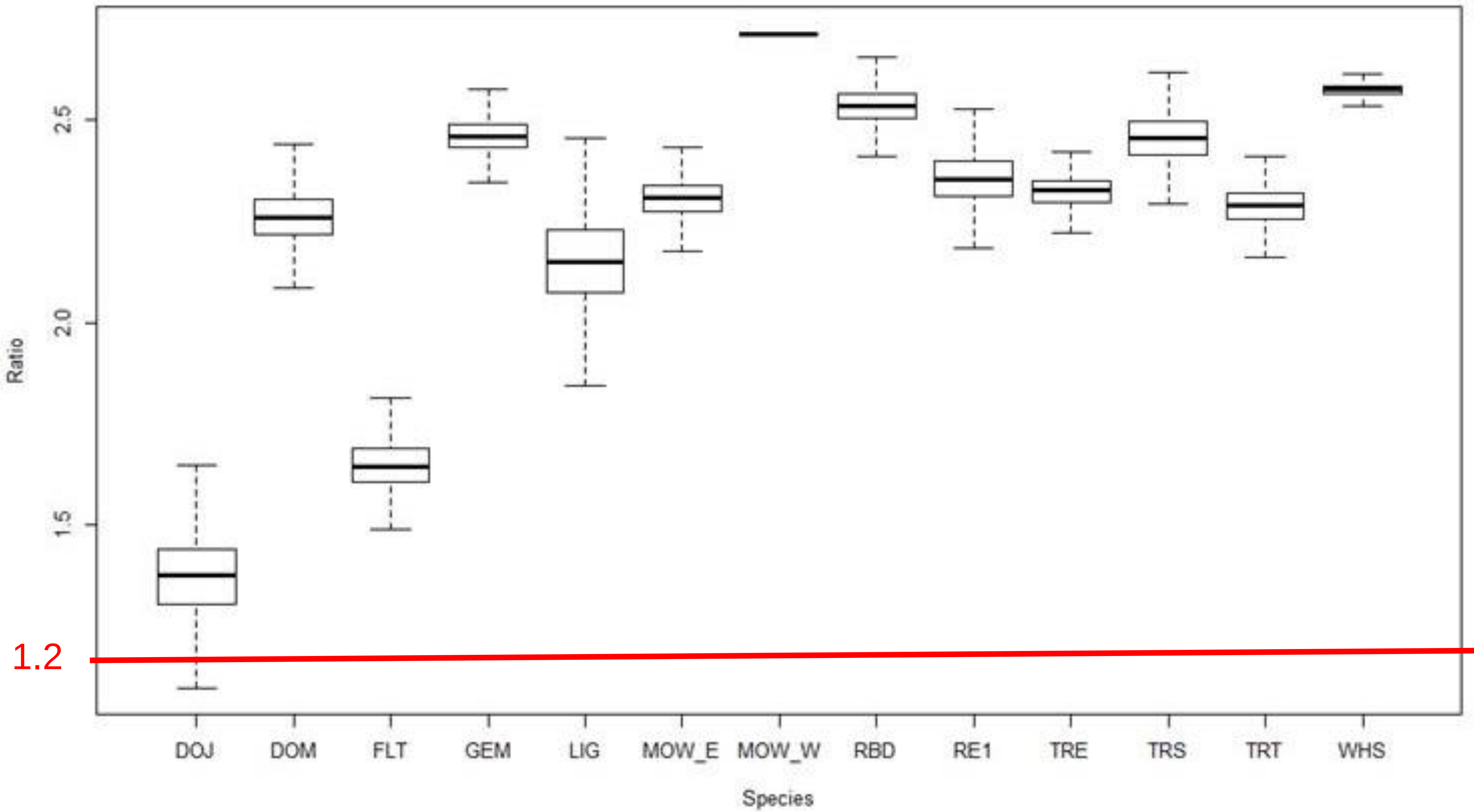
Parameterisation – economic

Effort is measured per shot

Vessel costs converted to unit cost/per shot

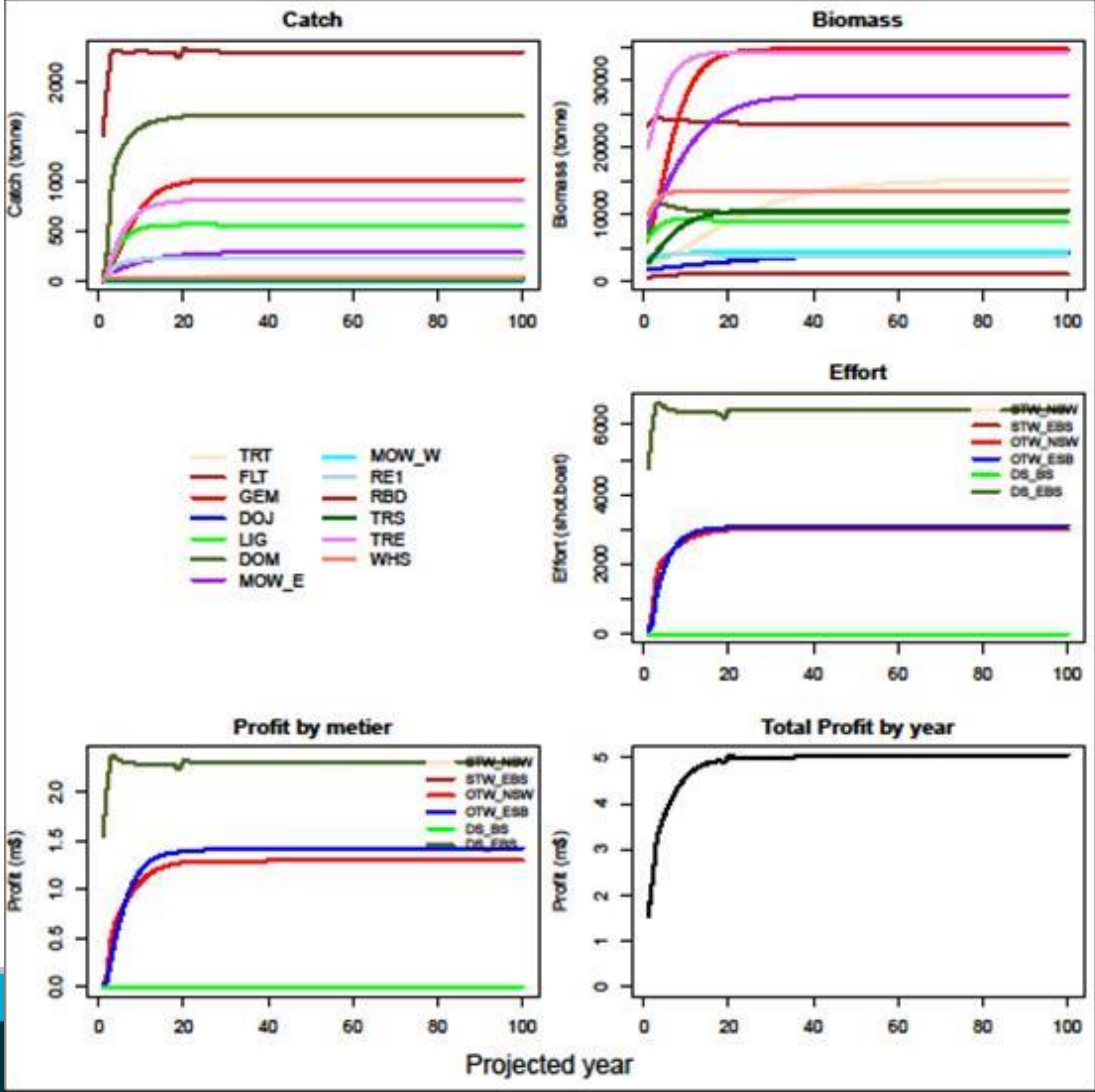
Metier	Fuel cost ($/shot)	Vessel costs ($/shot)	Crew share	Freight
Original				
Shelf trawl NSW	526	865	0.3	0.13
Offshore trawl NSW	526	865	0.3	0.13
Shelf trawl EBS	526	865	0.3	0.13
Offshore trawl EBS	526	865	0.3	0.13
Danish Seine Bass Strait	107	245	0.44	0.16
Danish Seine EBS	107	245	0.44	0.16

RESULTS: Case study equilibrium estimates of B_{mey}/B_{msy}

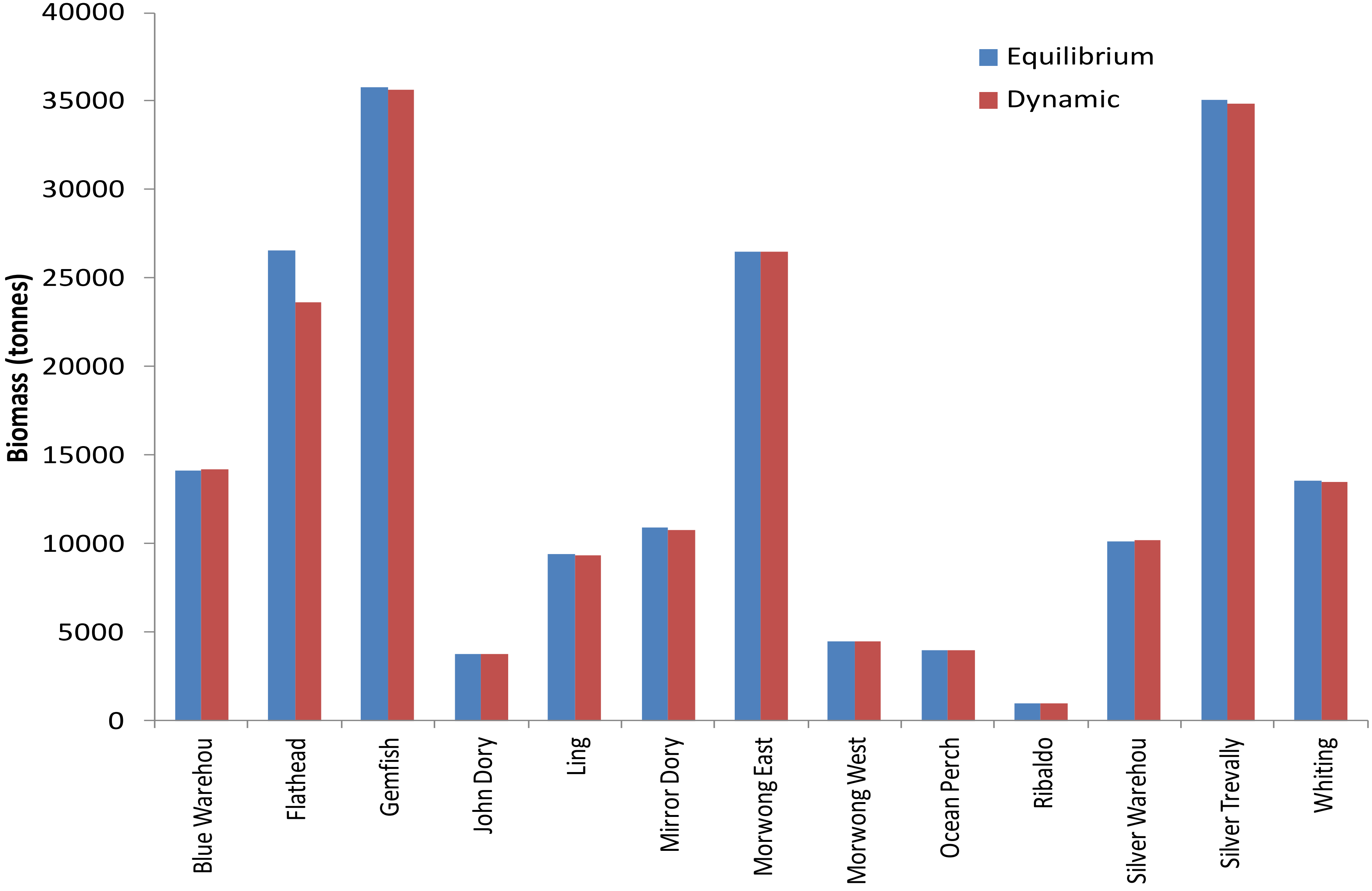


Dynamic results

Example of 1 run



Biomass estimates (equilibrium versus dynamic)



Main findings

Results indicate:

- Default proxy target reference point of B_{mey} = 1.2 B_{msy} is not appropriate in multi-species fisheries
- Problematic to achieve multiple targets simultaneously
- Many species contribute small amount to revenue share (byproduct species)
- Potentially better to "indirectly" control impact on them (byproduct species) via controlling only the major species in terms of revenue shares

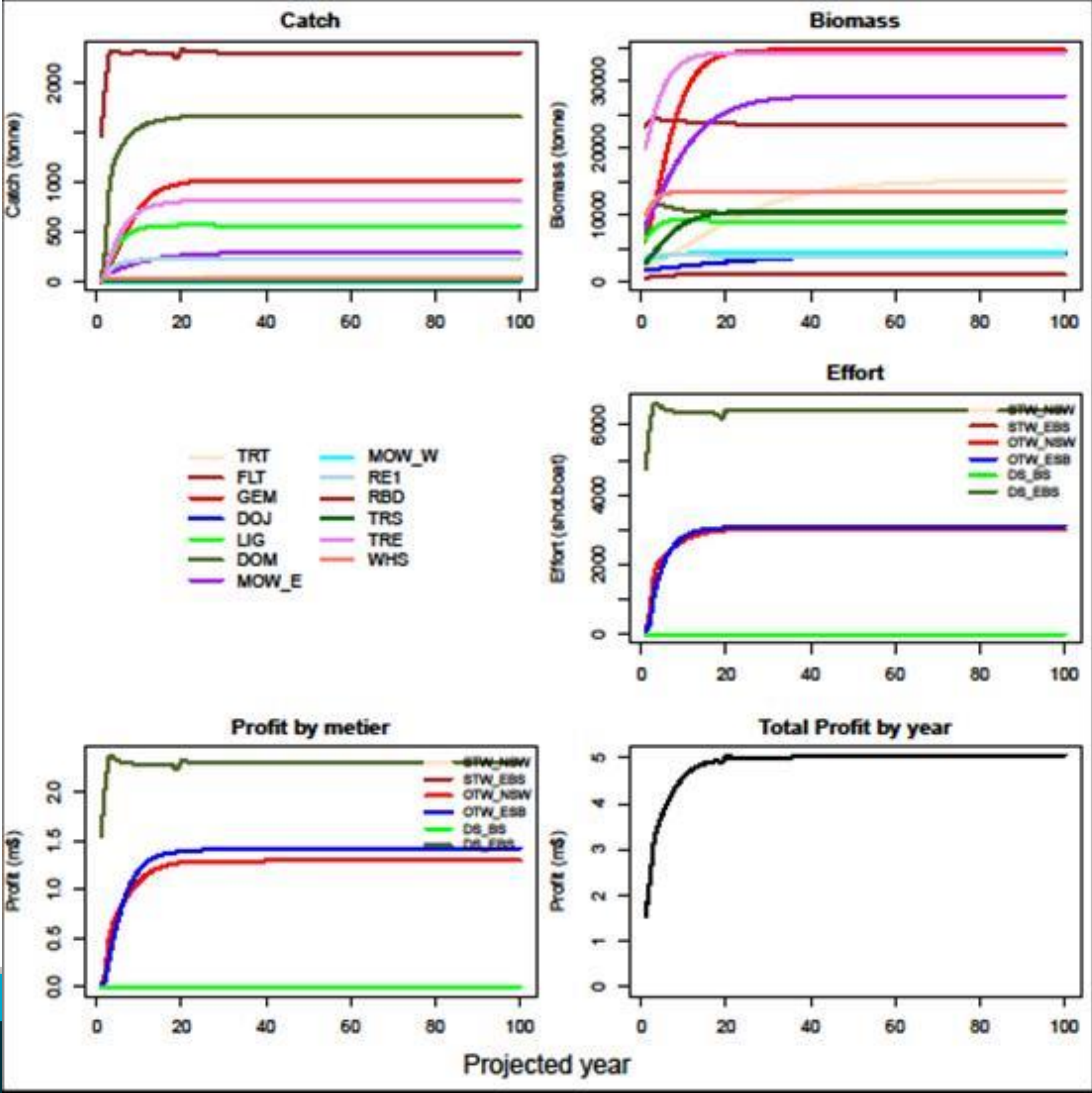
Future work

Plans for re-developed model to facilitate operationalisation:

- Consider short run versus long run dynamics
  - Plus account for multi-fleet (metier) sub-optimal conditions
- Include bycatch (non-commercial: negative prices – penalty)
- Include up-to-date costs and prices (and estimates of productivity)
- Include price-quantity (demand) relationships
- Run scenario simulations: varying number of species controlled

Dynamic results

Example of 1 run



Future work

<u>Plans for re-developed model to facilitate operationalisation:</u>

- Consider short run versus long run dynamics
  - Plus account for multi-fleet (metier) sub-optimal conditions
- Include bycatch (non-commercial: negative prices – penalty)
- Include up-to-date costs and prices (and estimates of productivity)
- Include price-quantity (demand) relationships
- Run scenario simulations: varying number of species controlled

Thank you

Questions:

Sean Pascoe: sean.pascoe@csiro.au (Project Leader)

Trevor Hutton trevor.hutton@csiro.au

Acknowledgements: 2015-Maximising net economic returns from a multispecies fishery is supported by funding from the FRDC (Fisheries Research & Development Corporation) on behalf of the Australian Government

Other contributors: Neil Klaer, Roy Deng, Olivier Thebaud (IFREMER), Simon Viera, Pierre Lelong (Ecole P, France)

Key reference: Pascoe, S., Hutton, T., Thebaud, O., Deng, R., Klaer, N., and S. Viera 2015. Setting economic target reference points for multiple species in mixed fisheries. FRDC Project No 2011/200. (93pp.)

CSIRO