Integrating biological and economic objectives in the harvest strategy evaluation of giant crab

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UTAS

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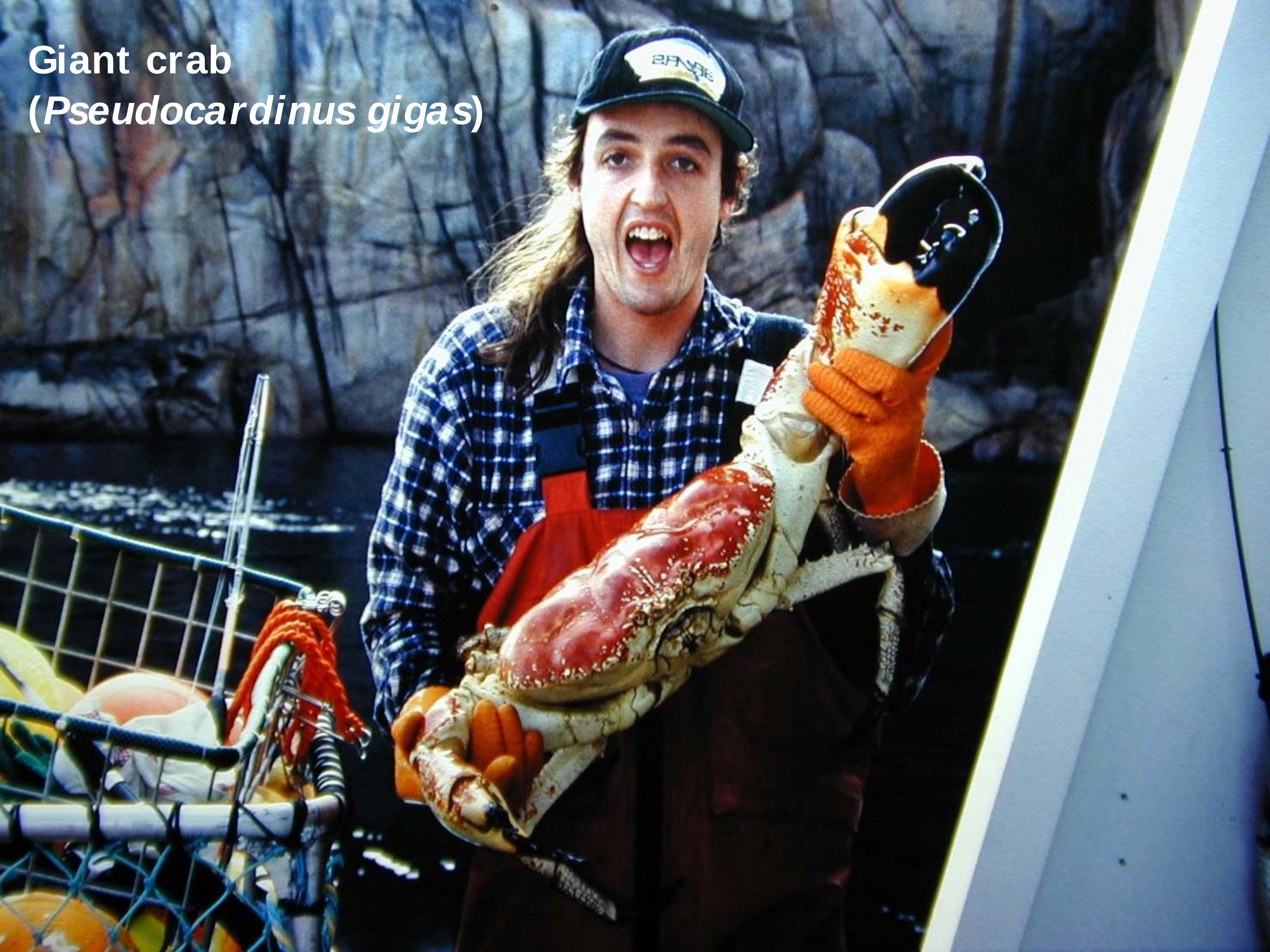
Tasmanian Aquaculture and Fisheries Institute

Tasmania
Explore the possibilities

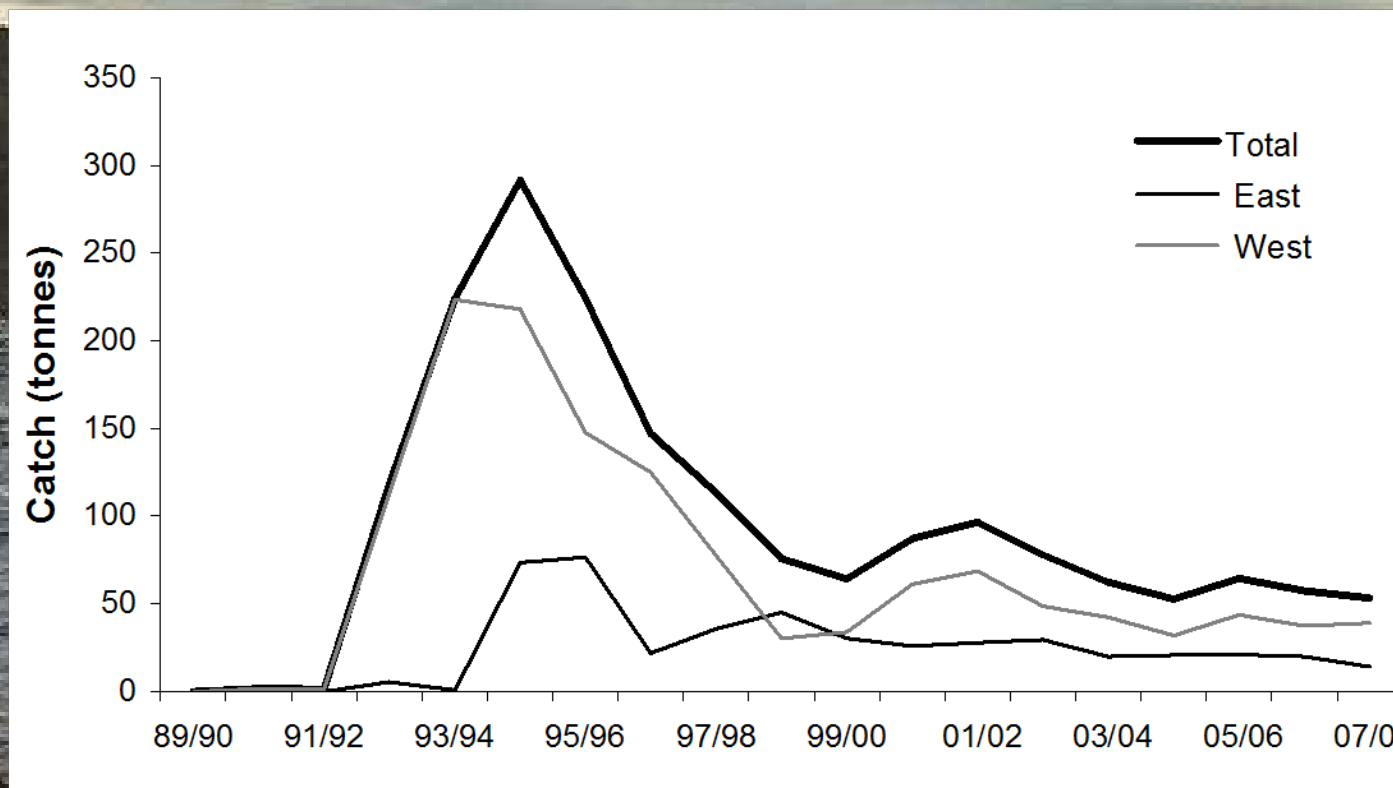
TAFI is a joint venture between the State Government and the University of Tasmania

Giant crab
(*Pseudocardinus gigas*)

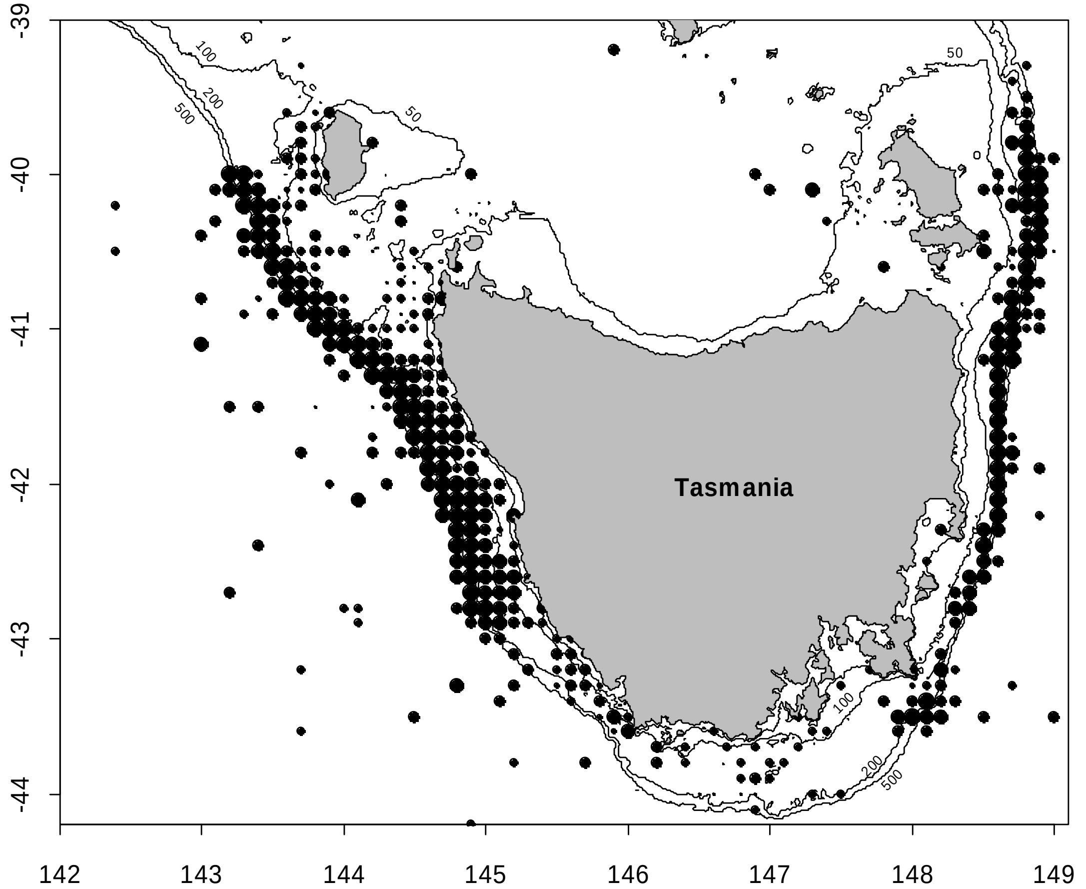


Fishery

- **Small-scale fisheries across SE Australia (SA, Vic, Tas)**
- **Markets on mainland and Asia**
- **Initially byproduct in lobster fishery, targeted fishery since 1992/93**
- **Maximum Tas catch in 1994/95: 291t (over-reporting?) Catch in 2007/08: 53t**



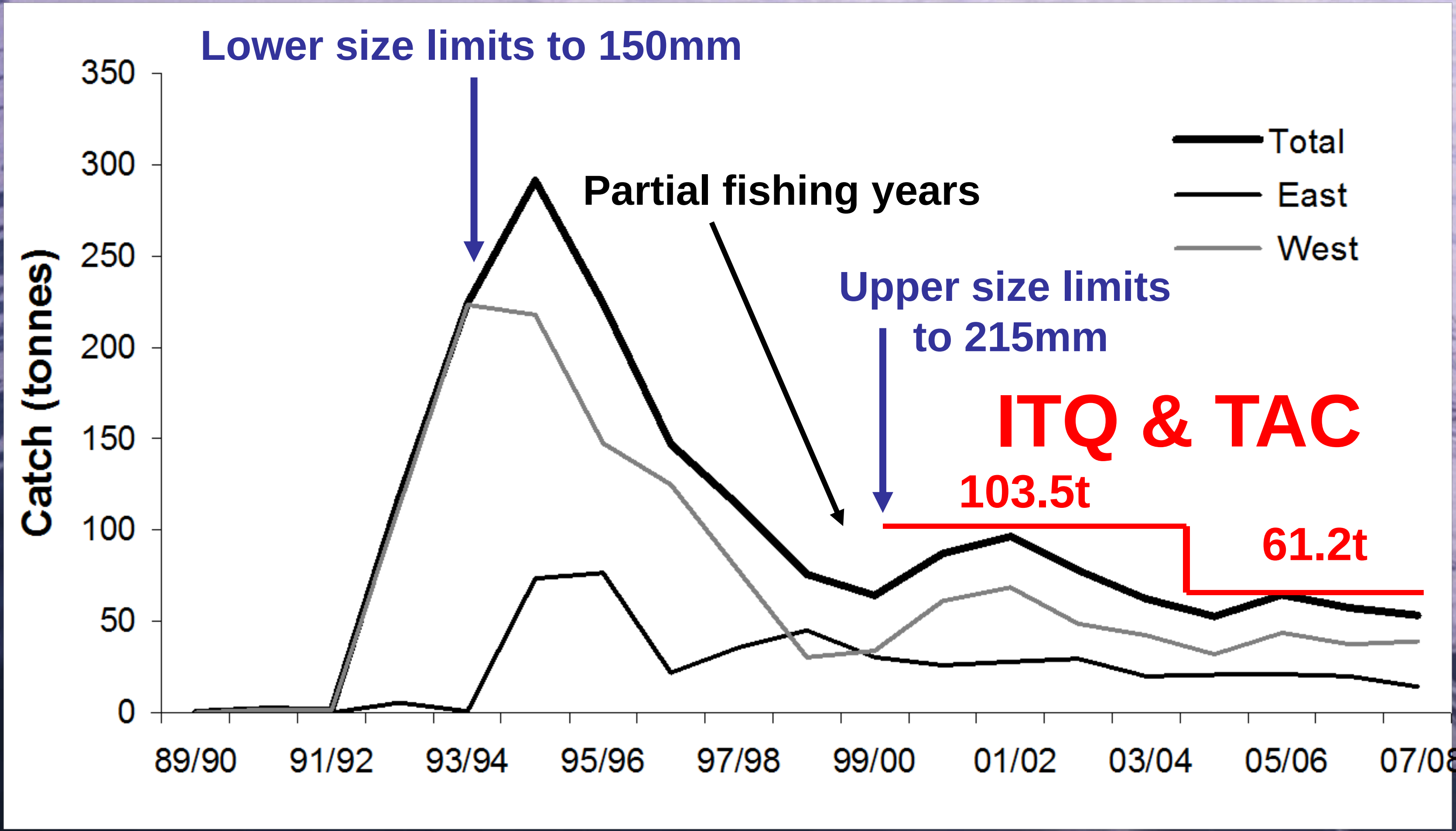
Fishery



Location of reported commercial catches for giant crab between 2000-2007 from Tasmanian waters. Circle sizes correlate to log-transformed catches. Depth contours are given in meters.

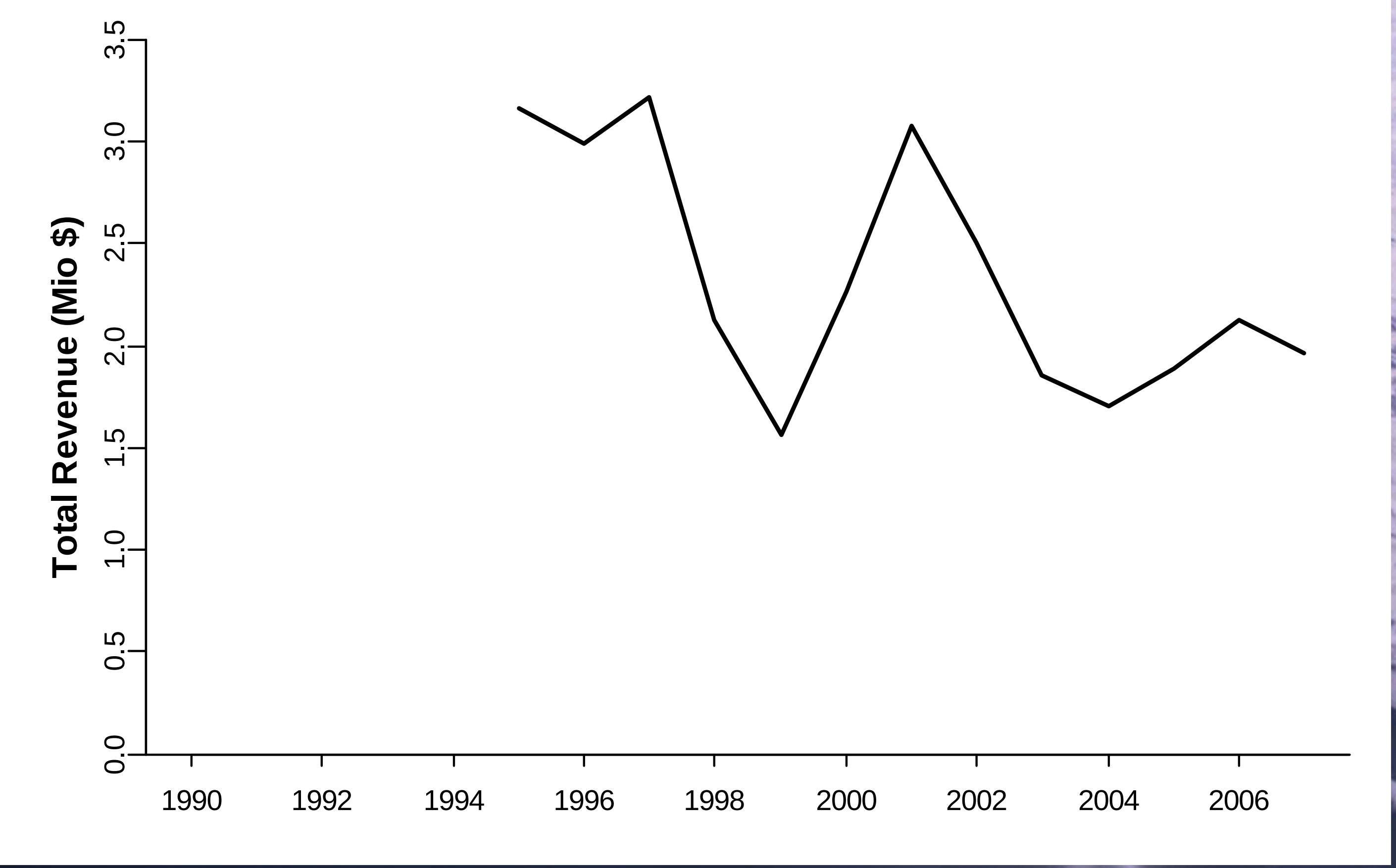
Fishery concentrated along continental shelf on W & E coast

Management measures



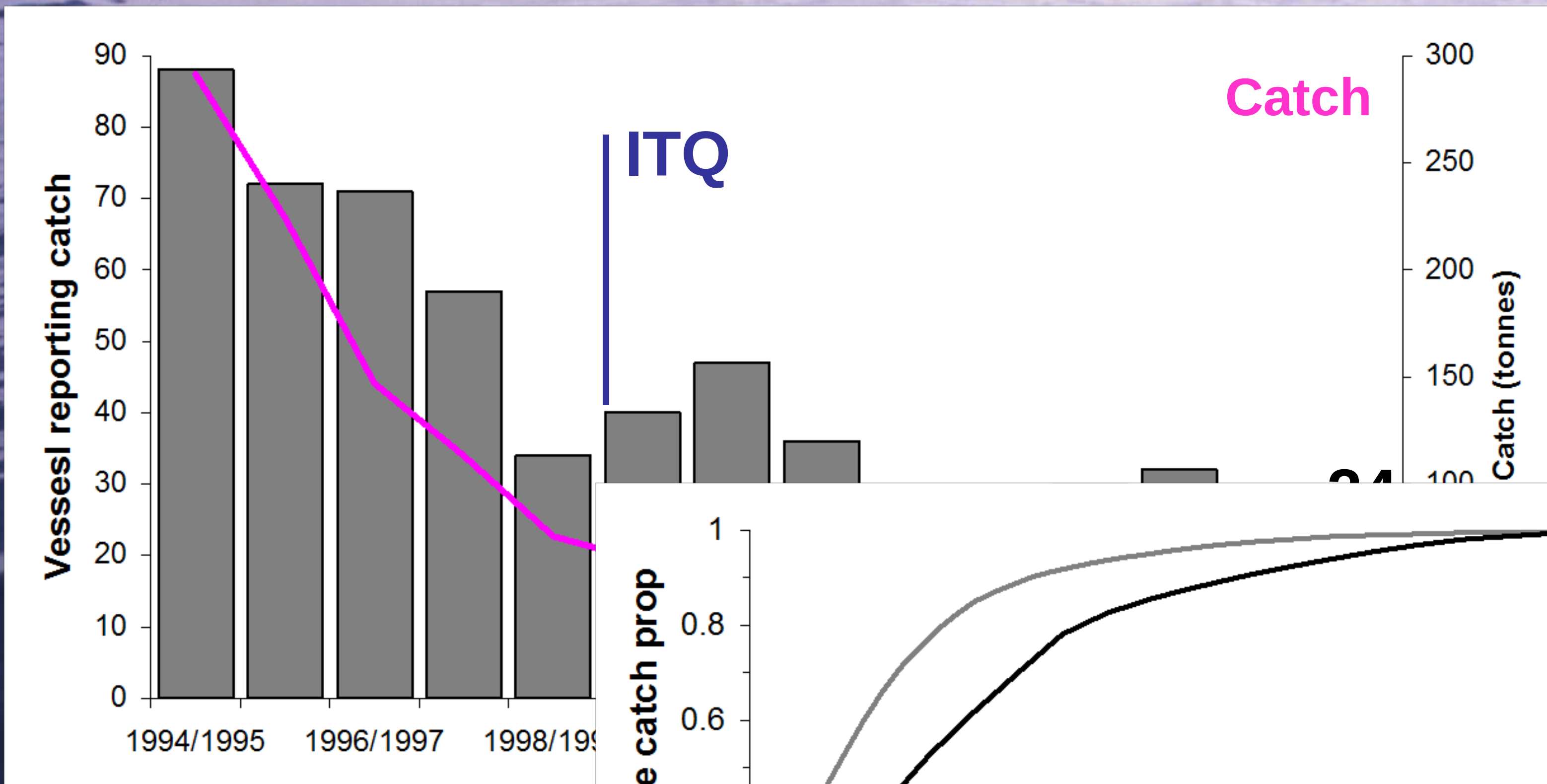
- Predominantly summer fishery
- Closed seasons for M (Sep-Oct) and F (May-Oct)
- No take of ovigerous females
- TAC not caught in recent years due to low catch rates and seasonal market saturation

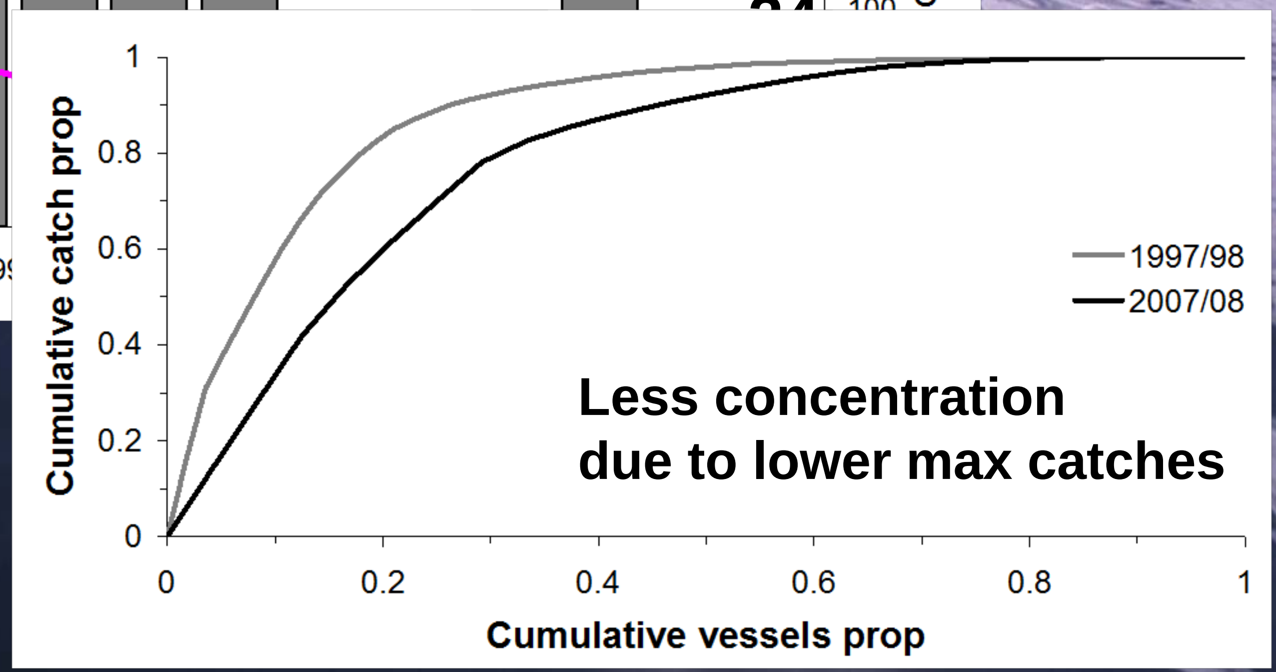
Beach price & Revenue



Price splits: Smallest crab with highest price/kg
Strong seasonal price fluctuations
Real price relatively stable over time
Strong fluctuation of revenue

Fishing fleet





Often 'part-time' fishery (e.g. fishing for lobsters or scallops)

Management objectives

- Maintain fish stocks at optimum sustainable levels;
- Sustain & optimise yield (by way of size limits; protecting under-size giant crabs)
- Mitigate competition between different fishing methods for access to shared fishing grounds;
- Provide socio-economic benefits to the community;
- Provide high quality products.

Historically: Stock sustainability & maximising yield
Now: Stock sustainability & maximising profit

Can the fishery simultaneously maintain/increase egg production and increase (net) present value by adjusting TAC and size limits:

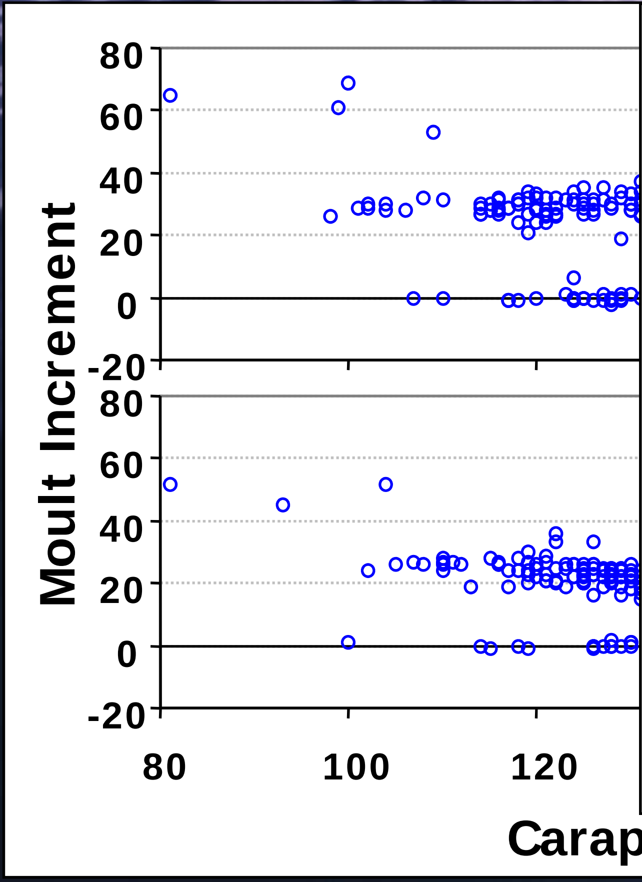
- Improve revenue by catching more small crabs (higher beach price)
- Reduce costs by lowering fishing effort

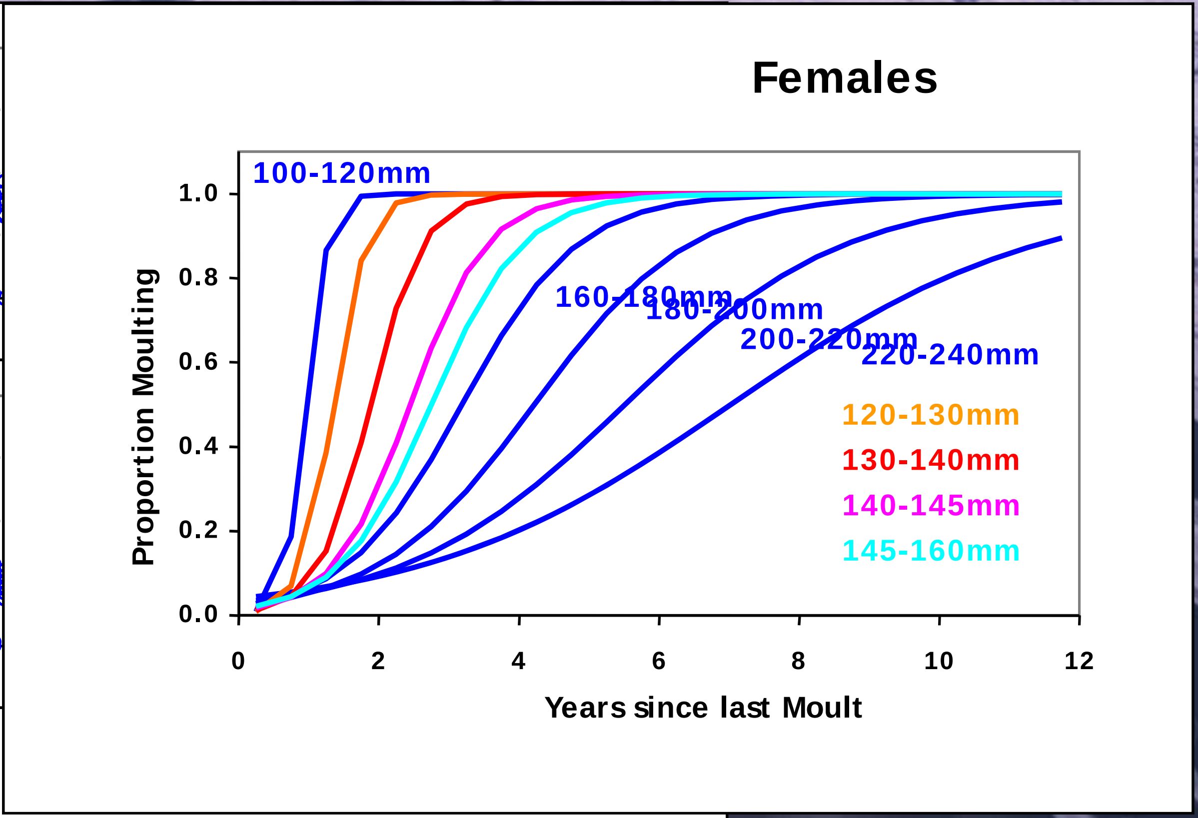
Stock assessment model

- Catch-at-length assessment model fitting to catch rates and length-frequency data to estimate annual recruitment
- Extension with an economic module for estimation of return, cost and profit (present value)
- Allows to project alternative harvest strategies into the future (e.g. varying TAC, size limits, closed seasons) using historical recruitment pattern
- Simplified economic assumptions:
  No changes in fleet dynamics in future
  (in the past little changes in effort distribution between E & W although there is no restriction on fishing location)
  Constant cost
- Marginal revenue assumed to be independent of catch
  (seasonal changes in price not driven by giant crab catches)

Biological parameters

Grow well over 12kg
Long-lived, increasingly slower growing
Growth = Growth Increment * Moult probability
→ 'Lethargic' population dynamics

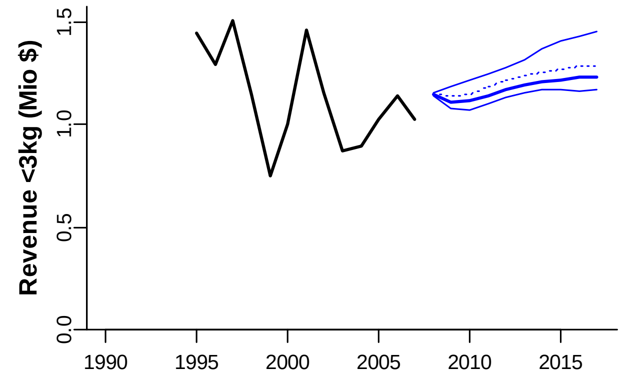


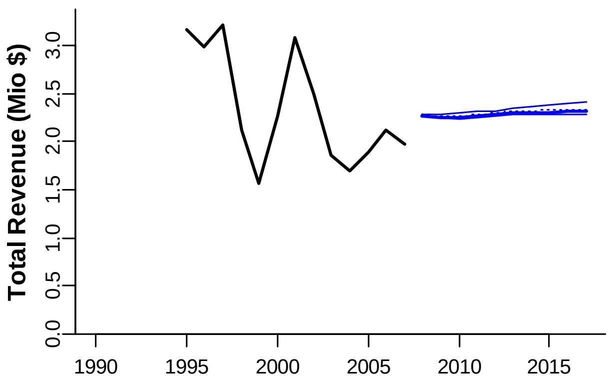


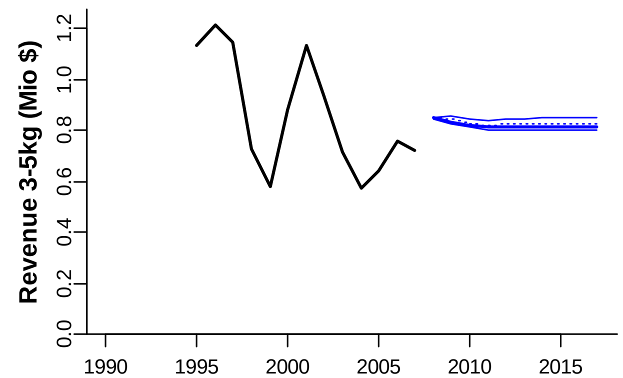
Revenue

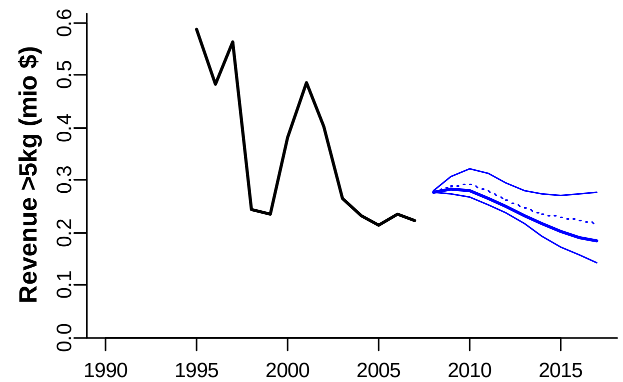
Future TAC = 62t

(current catch only 53t)









Constant beach price

Total revenue is catch*price per size splits

Cost

Costs as composite of:

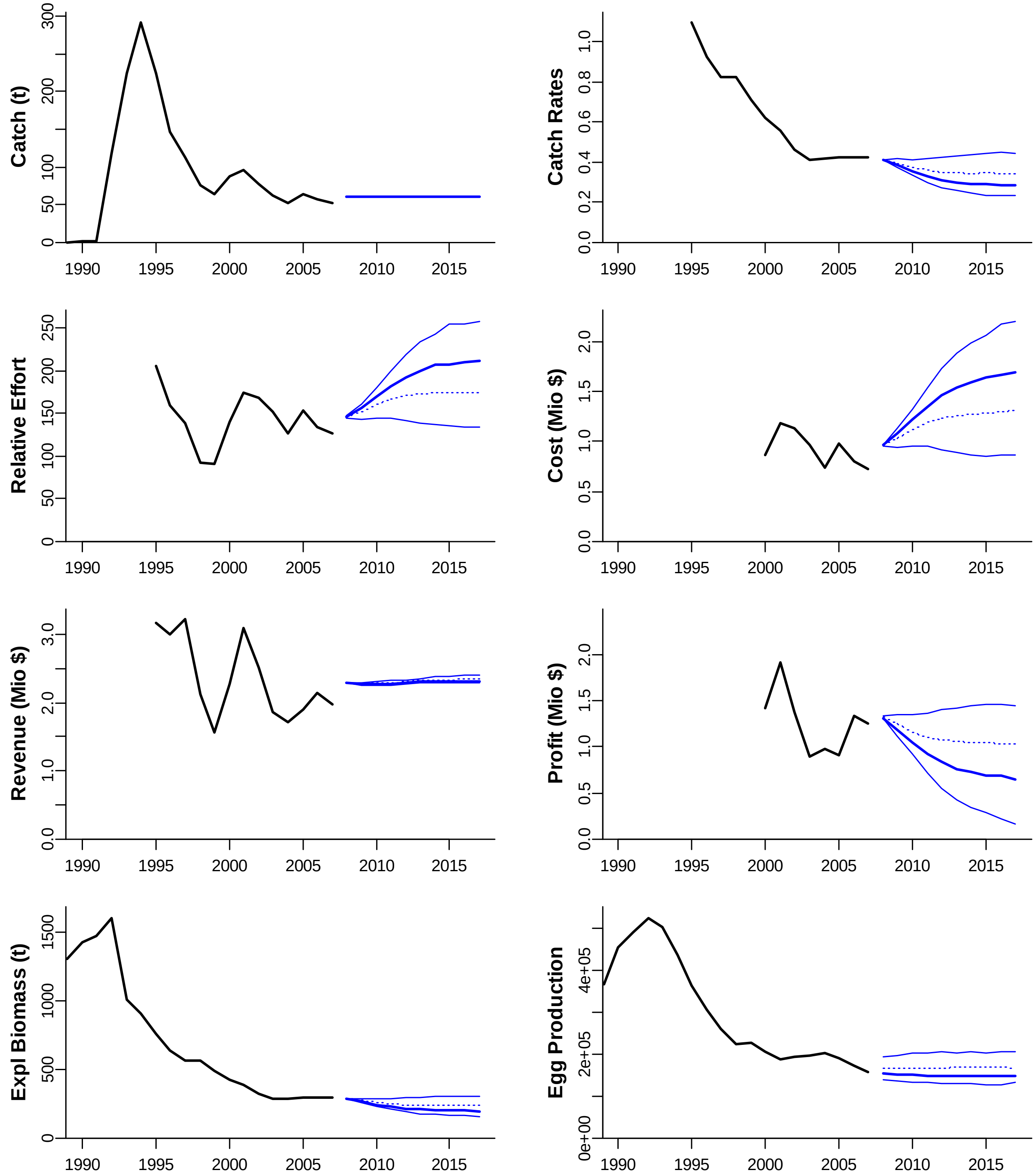
- Fixed costs (insurances, fees & levies, licenses, boat depreciation…)

- Variable costs (maintenance, gear, bait, fuel, labour…)

→ Economic survey of (lobster) fishers

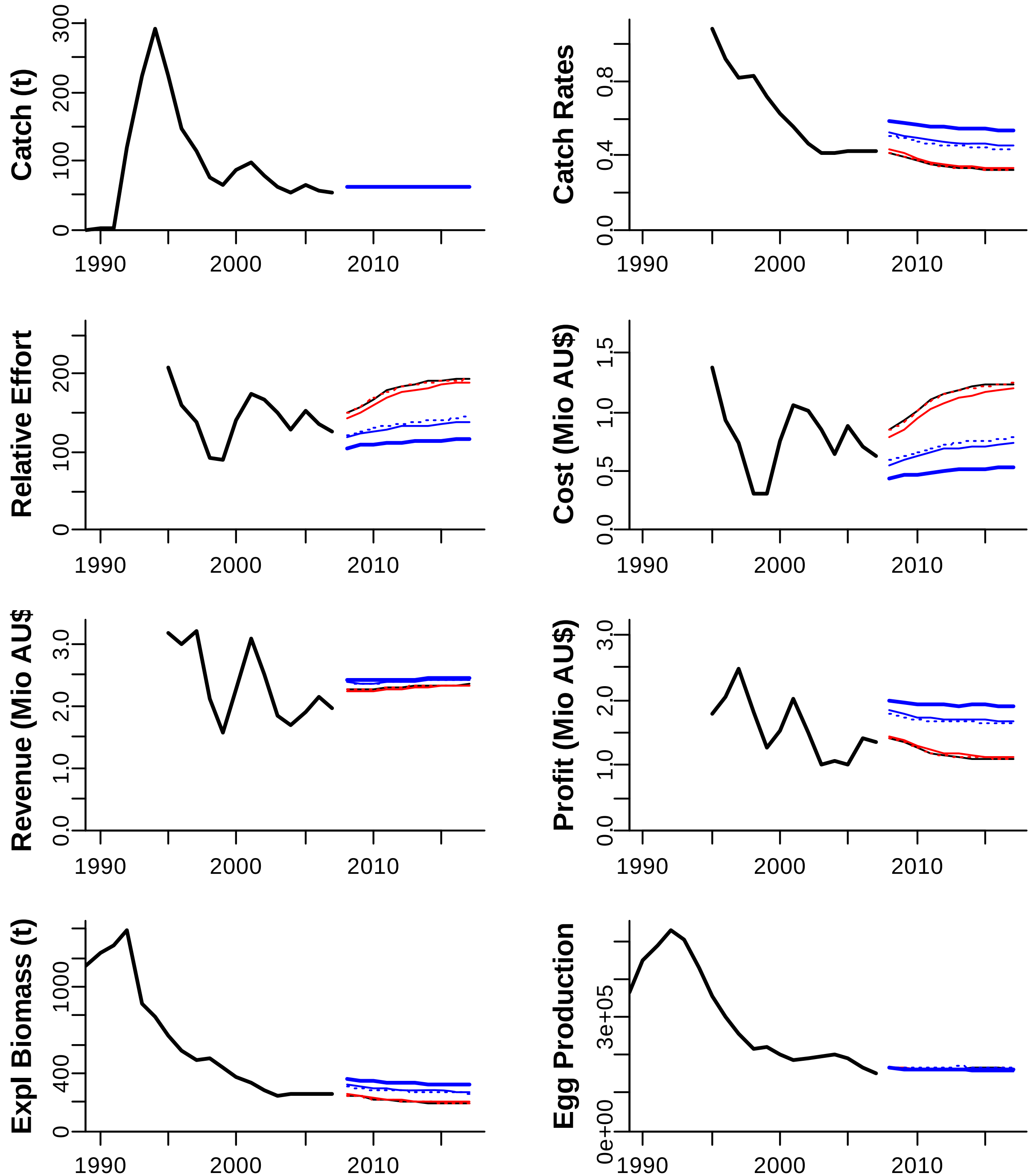
Here: Costs per trap lift assumed constant at $20/trap lift (proxy from lobster fishery)

TAC = 62t



95% CI
Median
P(80%)

Testing alternative scenarios



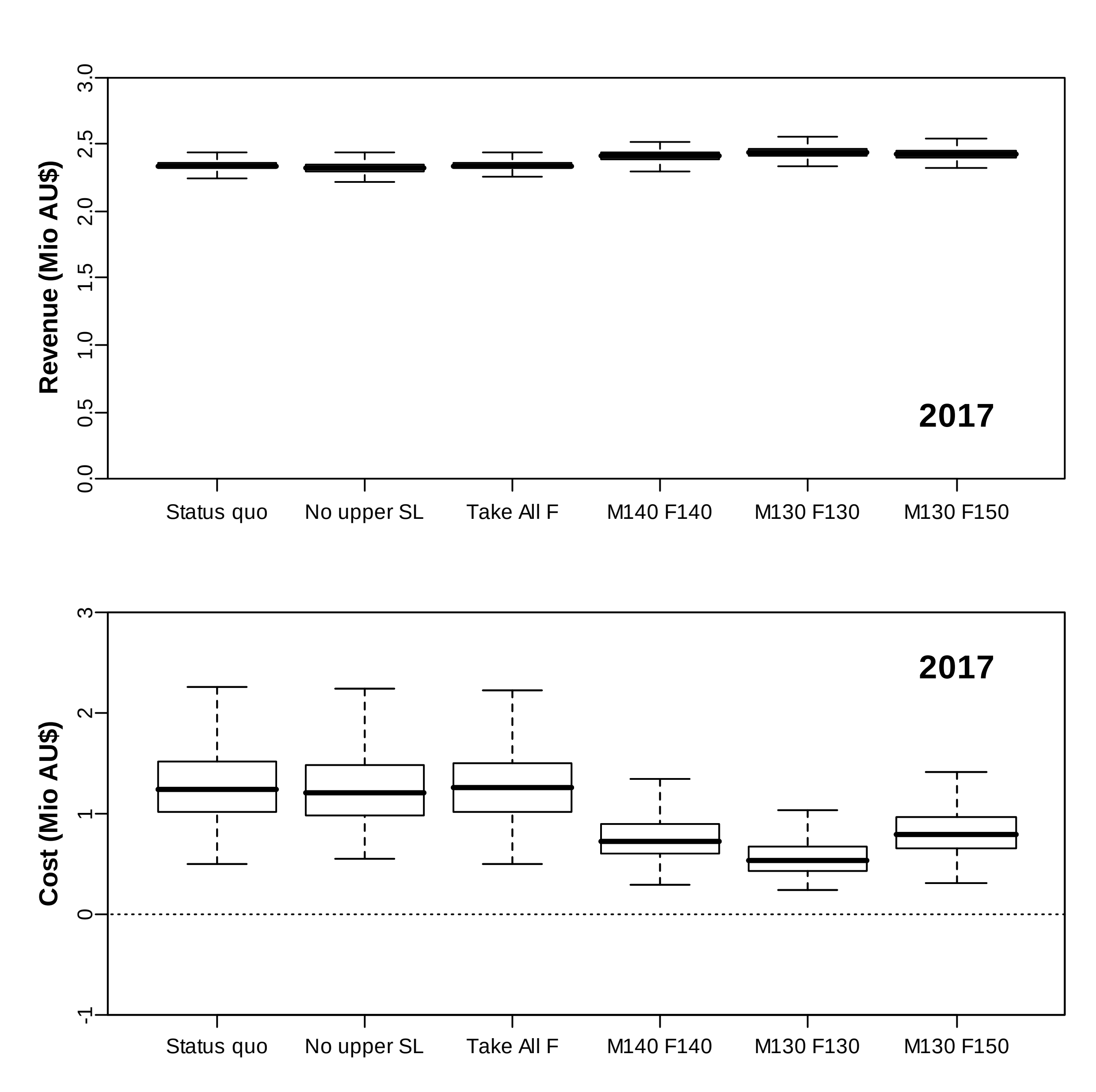
Medians only

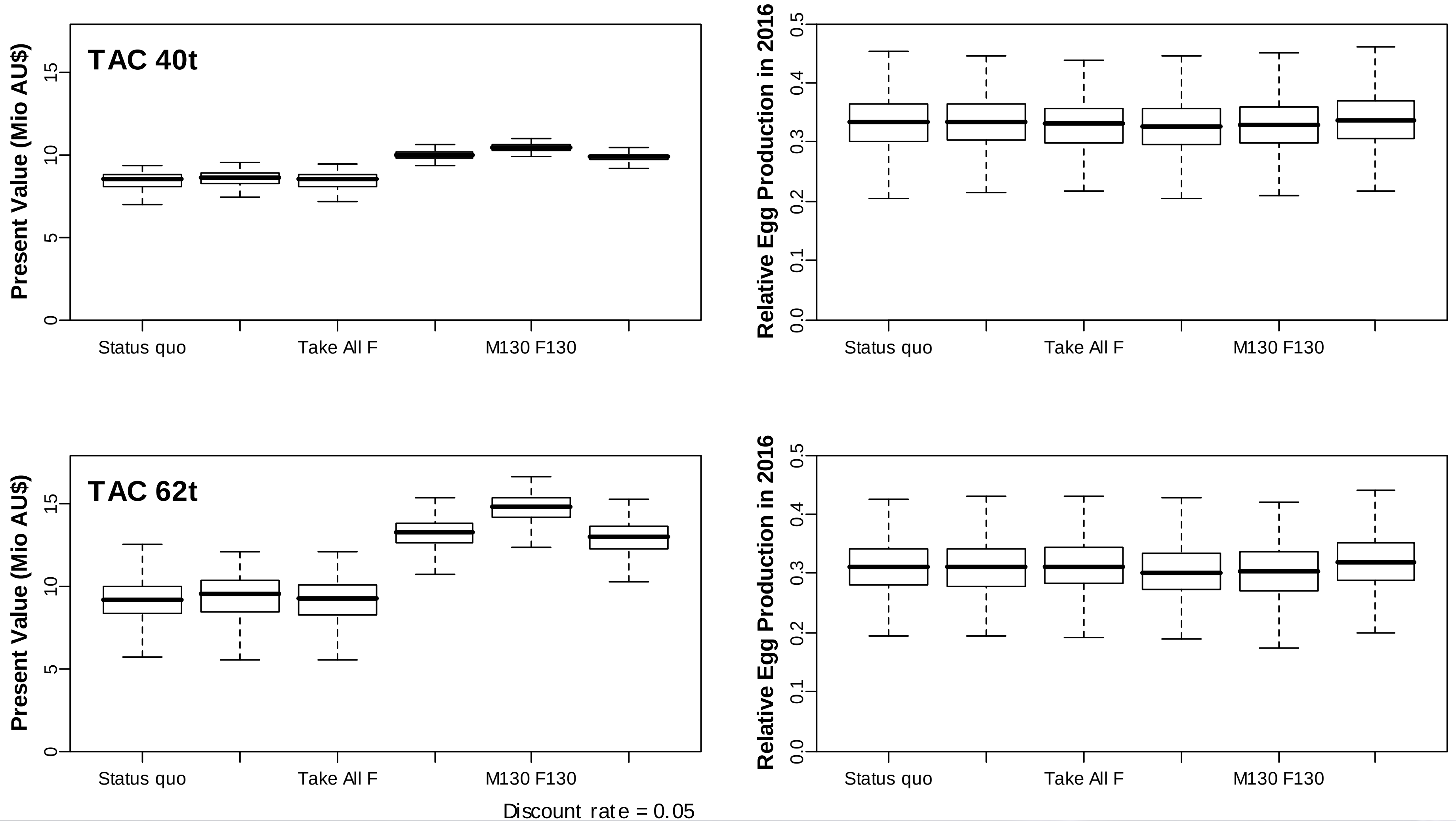
- Status quo
- No upper SL
- Take all F (all year)

Change lower SL:

- M140 F140
- M130 F130
- M130 F150

Impact on Revenue & Cost



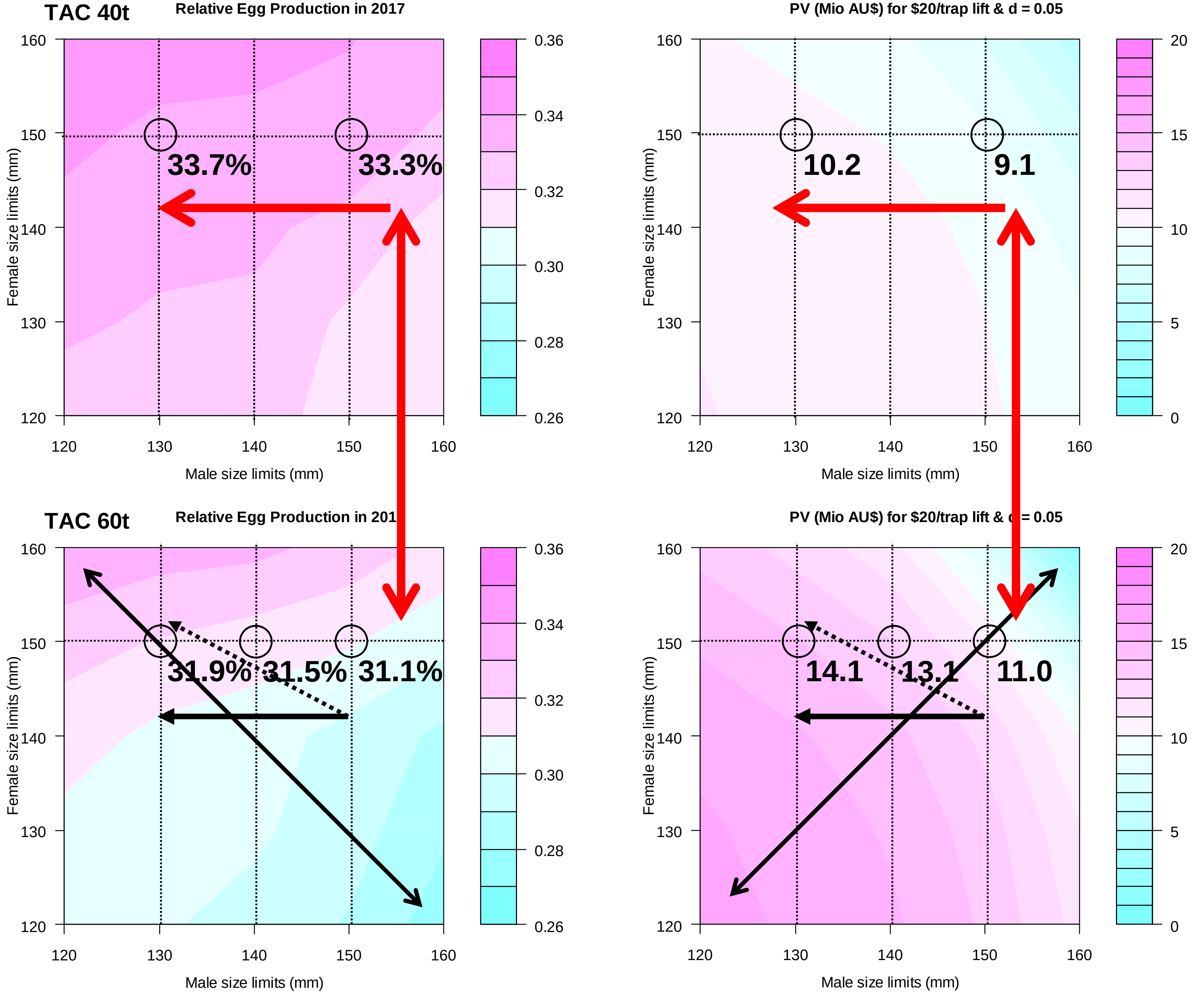


Only change of lower SL affects present value substantially

Lower catches: lower costs help balancing lower revenue; less uncertainty

'Lethargic' stock production due to slow growth:

Impact on egg production is minimal in all scenarios



TAC 40t
Relative Egg Production in 2017
PV (Mio AU$) for $20/trap lift & d = 0.05
33.7%
33.3%
10.2
9.1
TAC 60t
Relative Egg Production in 201
PV (Mio AU$) for $20/trap lift & d = 0.05
31.9%
31.5%
31.1%
14.1
13.1
11.0
Female size limits (mm)
Male size limits (mm)

Conclusions

- Trade-offs between TAC and size limits: Profitability of the fishery can be improved without compromising on egg production
- Explicit weighting of all criteria still required
- Trends in egg production & present value robust against different levels of cost and discount rate
- Simplicity of analysis allows for better understanding of basic economic dynamics in the fishery and by the fishing industry: e.g. effects on costs and revenue
- Limitations e.g. when fleet dynamics changes substantially under different management scenarios
- Cost-effective approach for low-value fisheries