



The Costs of Ignoring Stock Structure



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Motivation

- The **a4a initiative** aims to provide methods to manage stocks with **moderate data series** (10 - 15 years)
- One of the discussions is about how **genetics** can help in **management**
- Currently the most powerful application of Genetic analysis in fisheries management is in **identifying sub-stocks**

**But what are the impacts of managing
(or not) sub-stocks ?**

Aims

Focusing on the problem of sub units having different life histories and productivities while living in reproductive isolation

- Investigate managing two sub-units as one stock
- or equivalently, two stocks managed as one stock

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Mixed species

- *Lophius piscatorius* and *L. budagassa*
- *Scomber scombrus* and *Scomber japonicus*

Mixed sub-units

- Atlantic Blue-Fin Tuna, Mediterranean or Gulf of Mexico
- Atlantic Cod ?
- North Sea Whiting ?

Secondary Aims

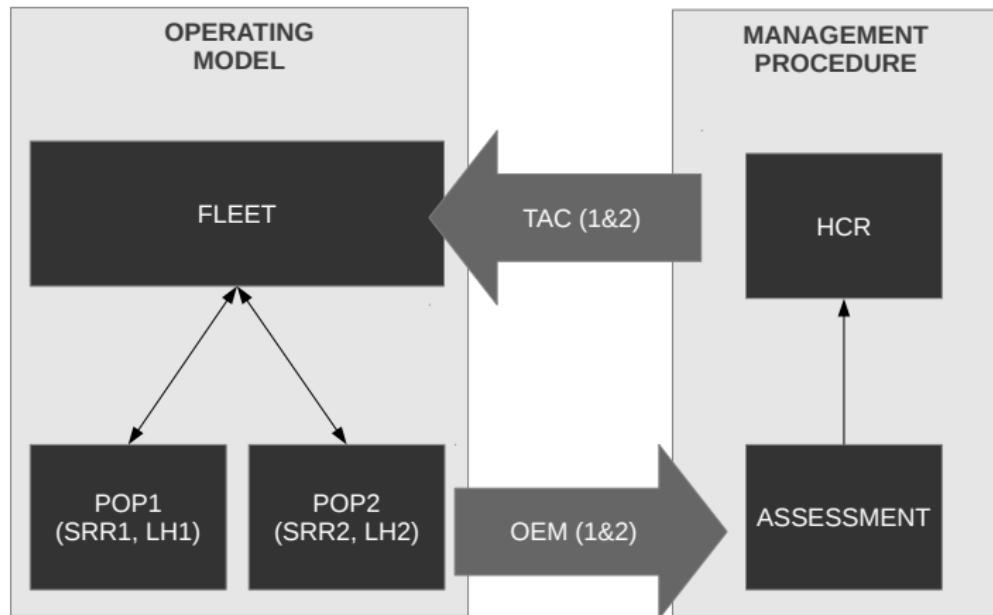
- achieve some a4a initiative objectives
- develop a statistical catch at age model
- develop a (flexible) testing framework
- develop an MSE algorithm

Outline

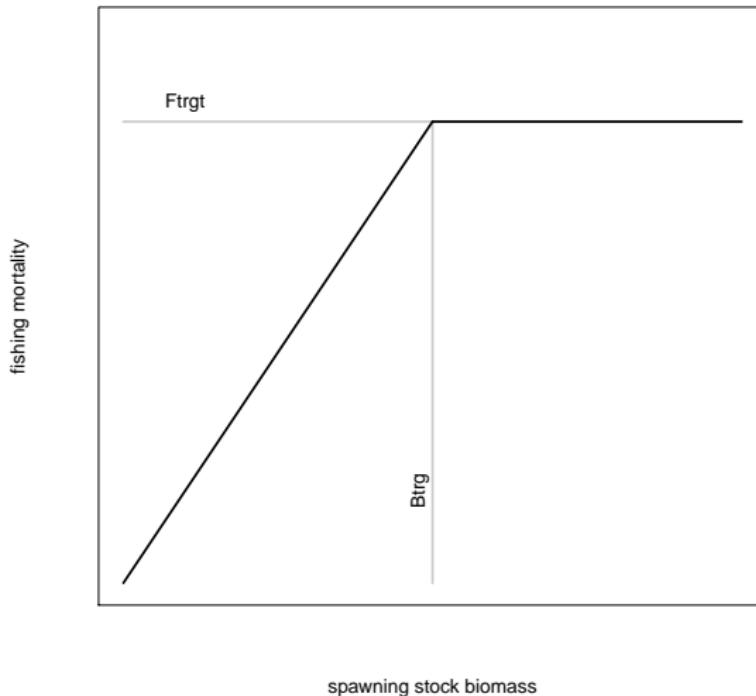
- Simulation Design
- Simulating a range of realistic stock: choosing plausible parameter values
- Brief look at the scenarios
- Results
 - Investigate the proportion in the biomass at the end of a 30 year simulation
 - Investigate stock status in comparison to the case of no difference in sub units

Simulation Design

The MSE diagram



The Harvest Control Rule



Choosing Parameter Values

- Used relationships in Gislason et al. 2008 ¹
- weight length values from FishBase
- recruitment levels - ICES north sea estimates as guide
- Stock recruit curve shapes designed to be viable under fishing

¹Gislason, H., Pope, J. G., Rice, J. C., and Daan, N. 2008. Coexistence in North Sea fish communities: implications for growth and natural mortality. ICES Journal of Marine Science, 65: 514-530.

The Simulated Sub Stock Units

Growth params:

$L_{\infty} = 60, 80, 100 \text{ cm}$

$T_0 = -1$

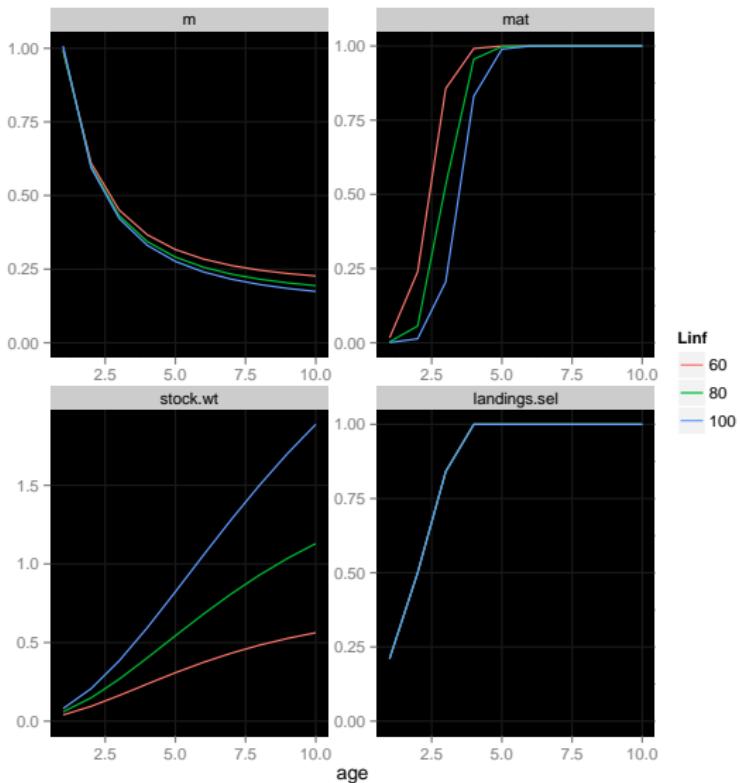
WLR:

$a = 5e^{-6}$ and $b = 2.9$

fishery selection:

trawl-like

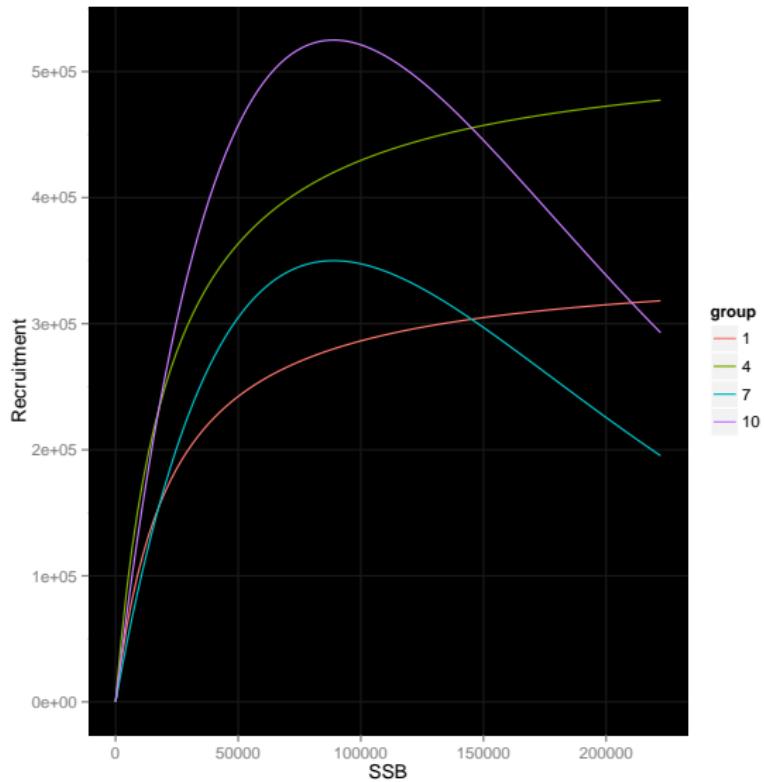
full selection at age 4



The Simulated Sub Stock Units

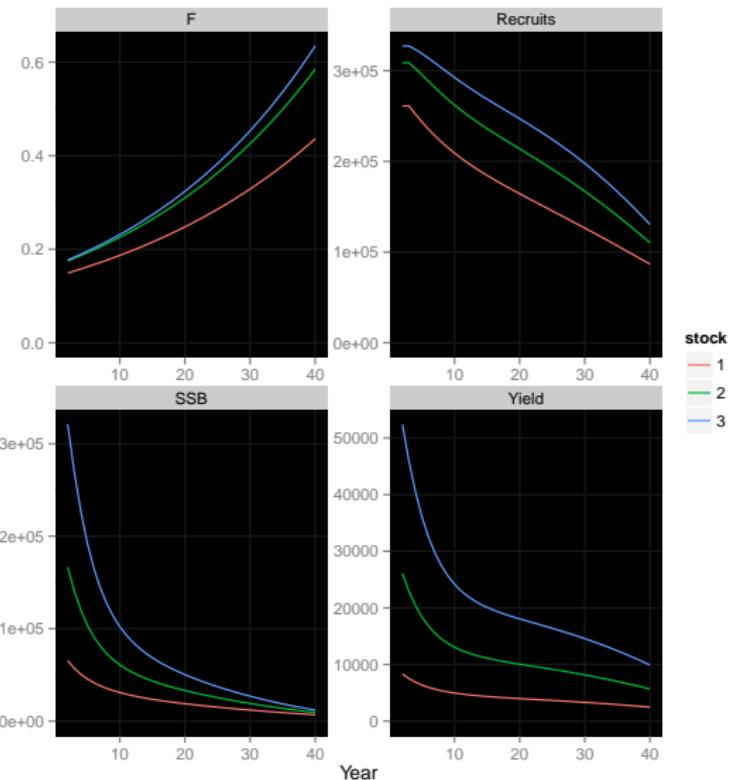
Max recruits:
at 350 and 525 million

made slopes at low
biomasses similar for
comparability



Simulated Sub Stock Units

The starting point for the simulations was at 40 yrs



Scenarios

We simulated with all combinations of:

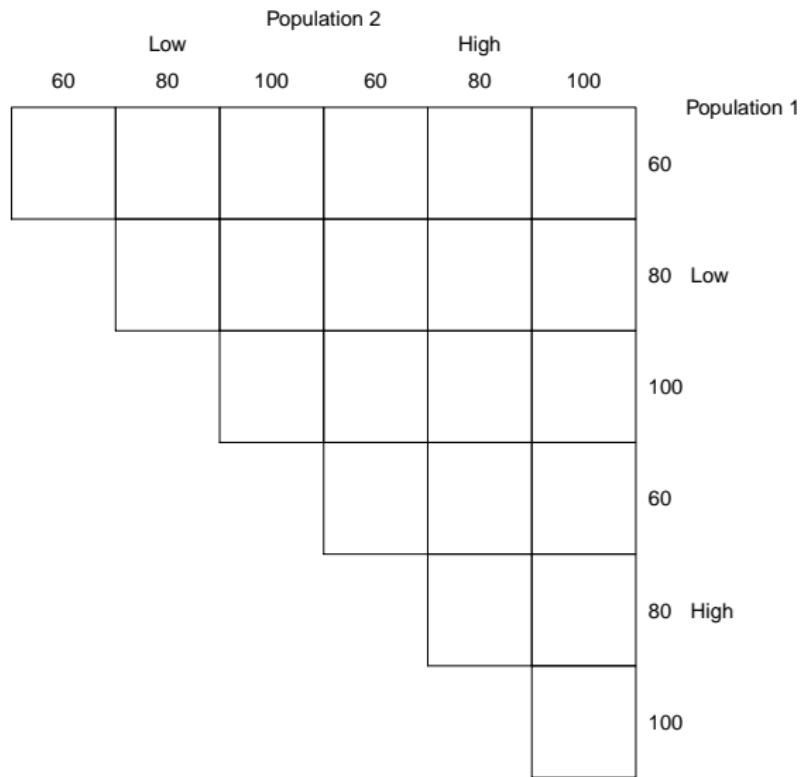
L_{∞} : 60, 80 and 100 cm

Recruitment: low and high

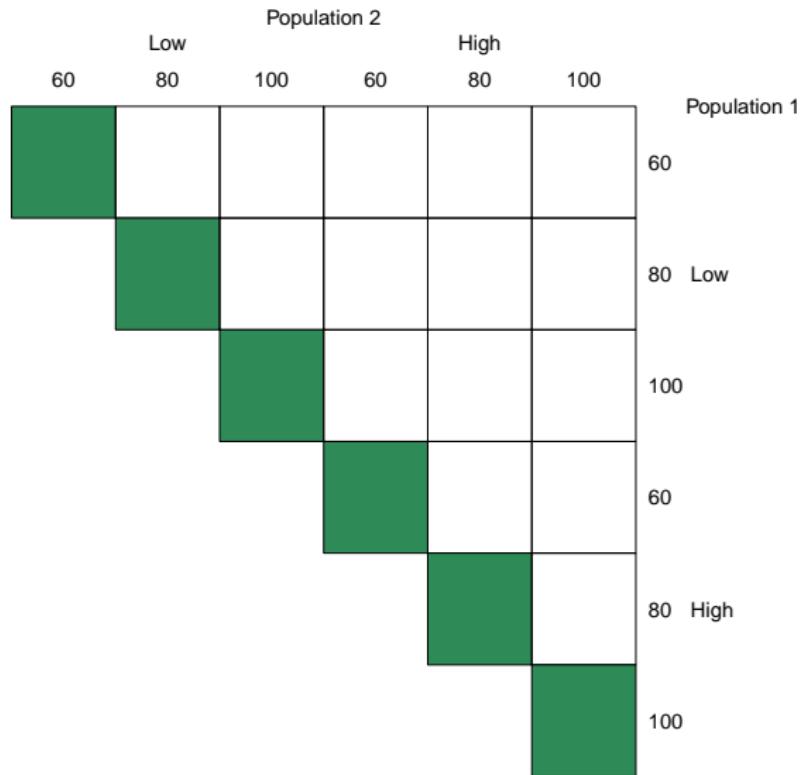
This resulted in 6 sub units giving 21 comparisons

This was done separately for the Beverton-Holt and the Ricker models

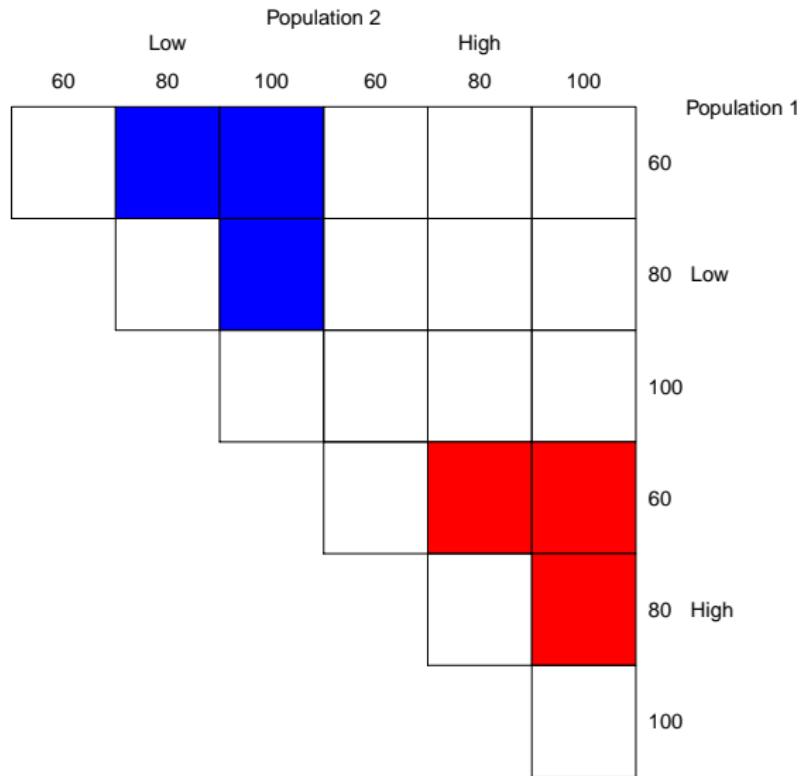
Scenarios



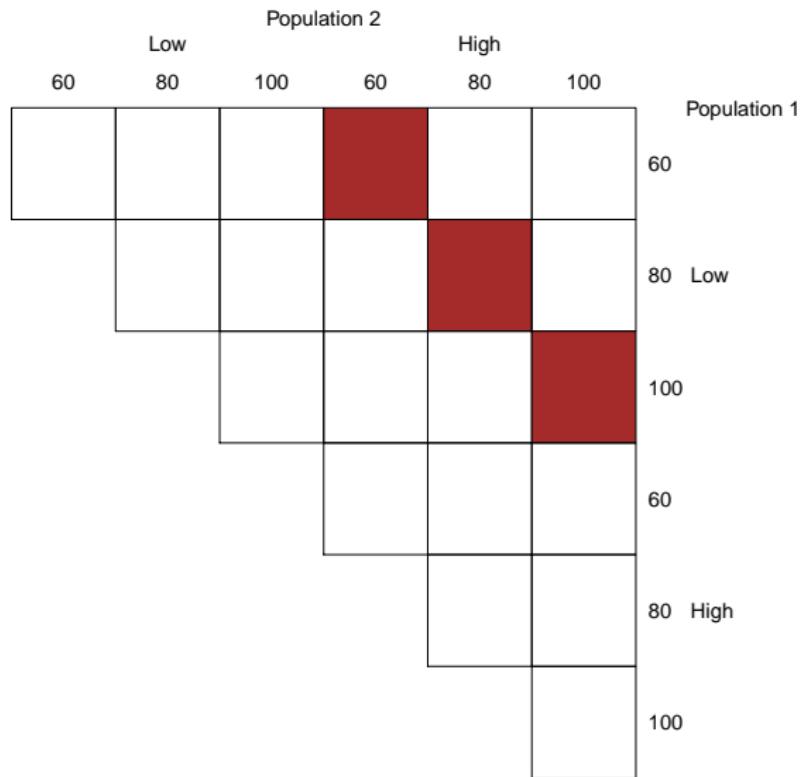
Scenarios: controls



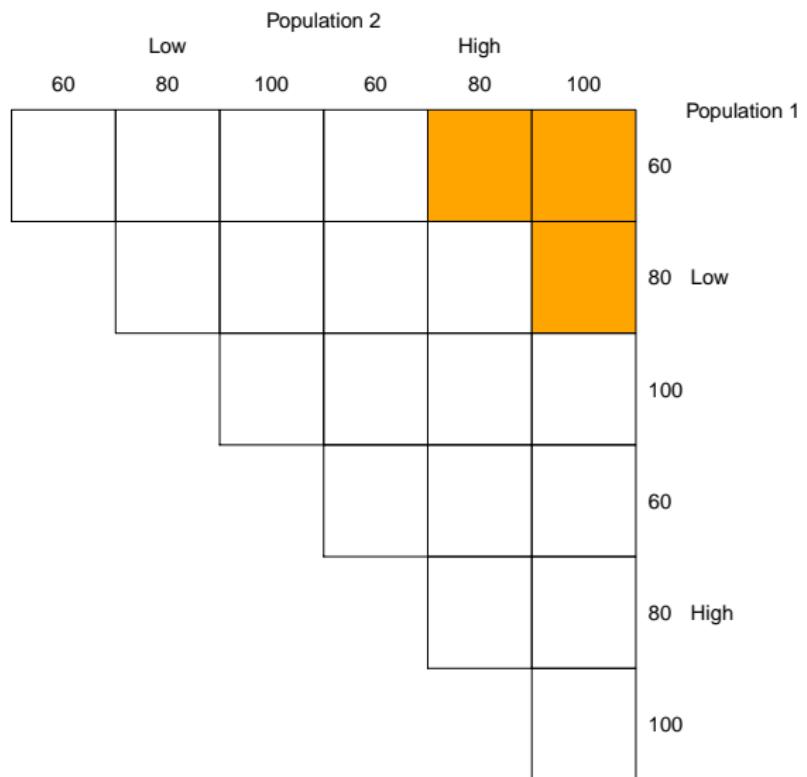
Scenarios: growth comparisons



Scenarios: Productivity

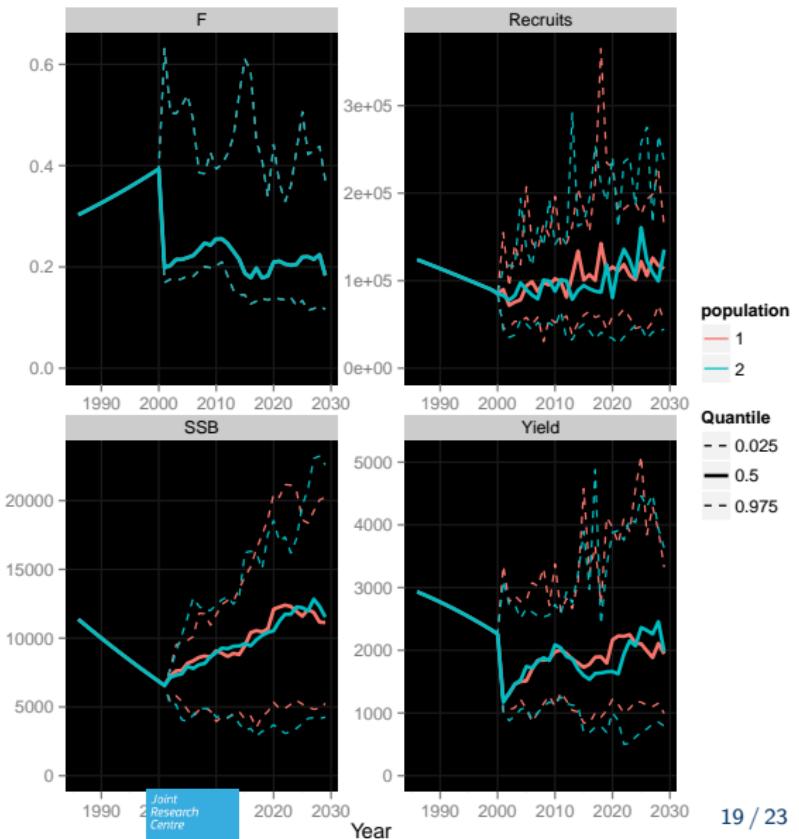


Scenarios: interaction of growth and productivity



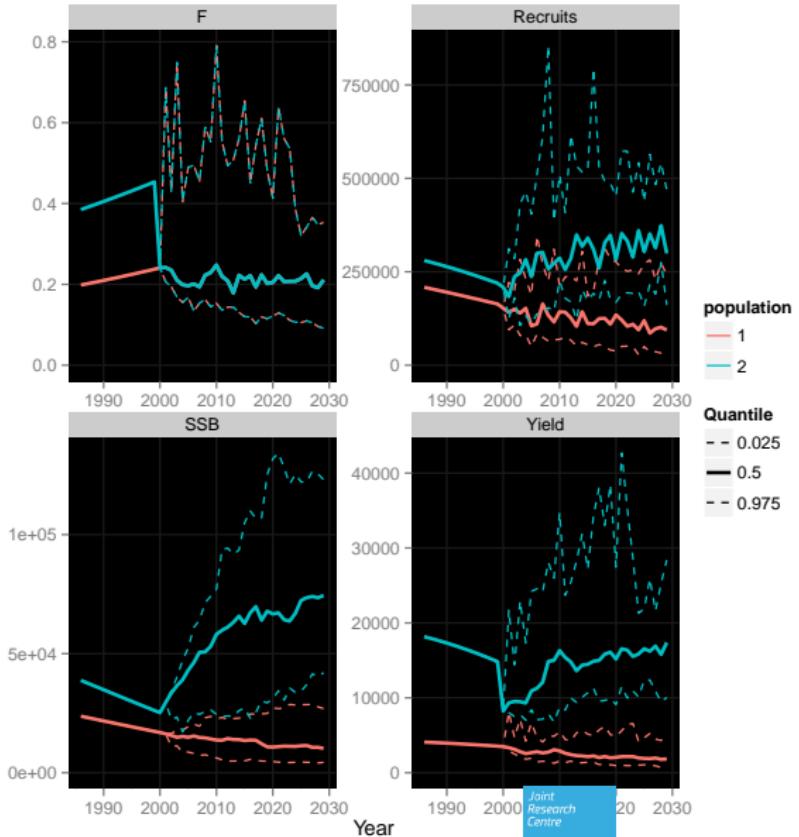
Results

Two sub-units with $L_{inf} = 60$ and low BH recruitment



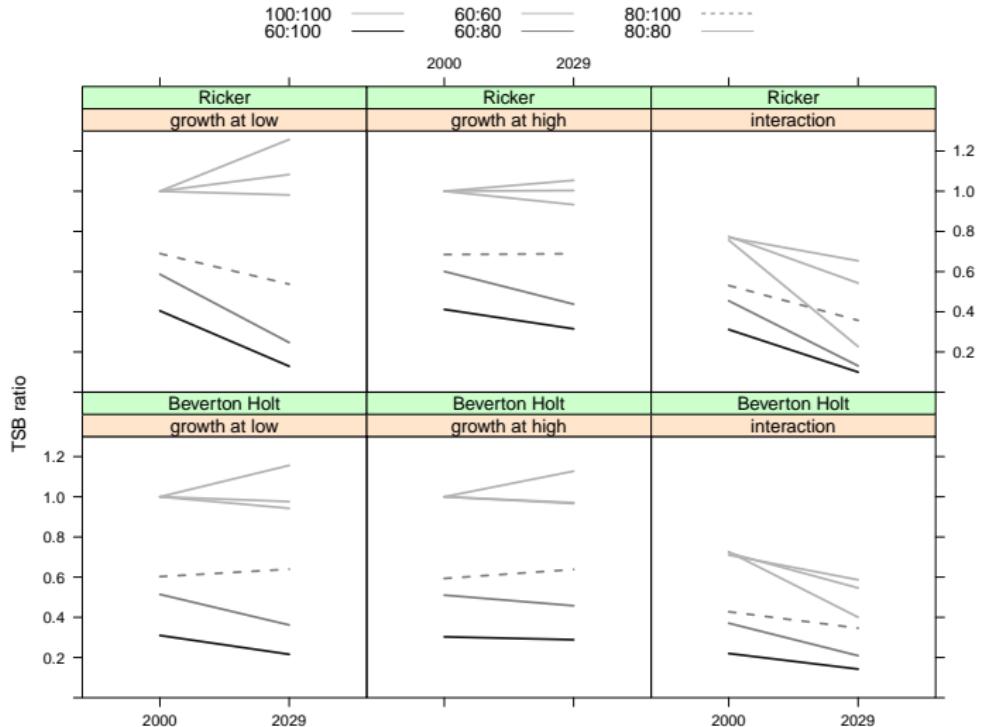
Results

$L_{\infty} = 60$ and $L_{\infty} = 100$ both with low Ricker recruitment



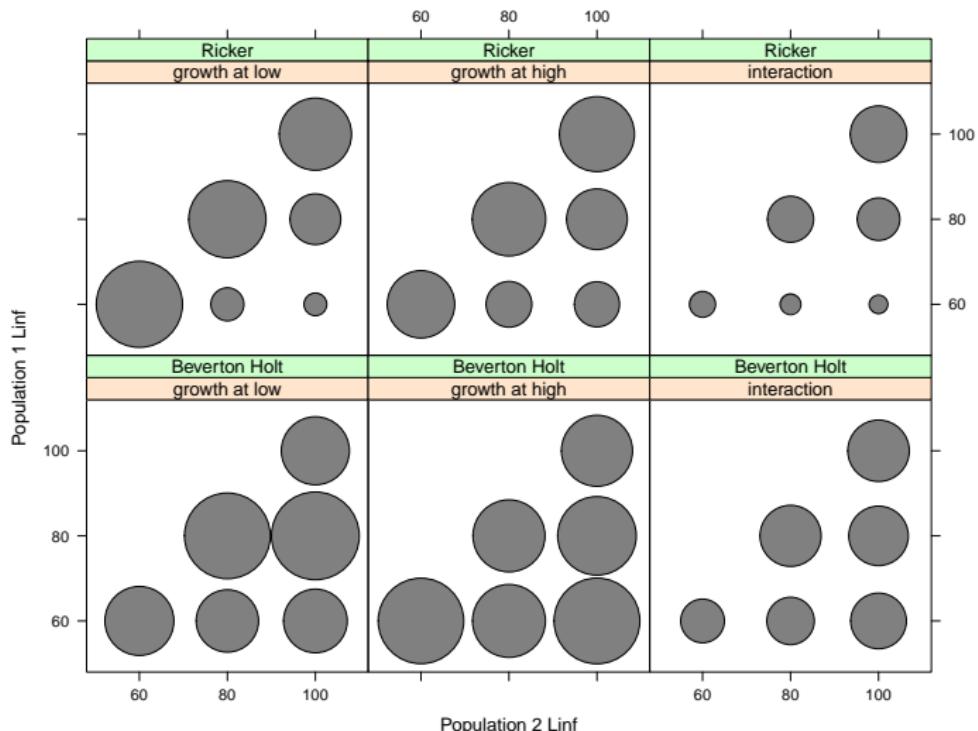
Ecosystem Changes

Changes in total stock biomass ratio



Relative stock status in 2029

Stock status $S = B/B_{msy}$, relative stock status $= S_1/S_2$



Final Thoughts

- Not considering stock structure can result in serious **over exploitation**
- **Depensation effects** make for stronger impacts on sub unit mismanagement
- Develop automatic **HCRs** that can cope with stock structure
- Ongoing work:
 - Investigate other LH parameter sets
 - Explore links between: virgin biomass and M, Recruitment with F_{msy} and F_{crash} etc.
 - Investigate alternative HCRs