

An Overview of the Key Issues to be Discussed Relating to South African Sardine

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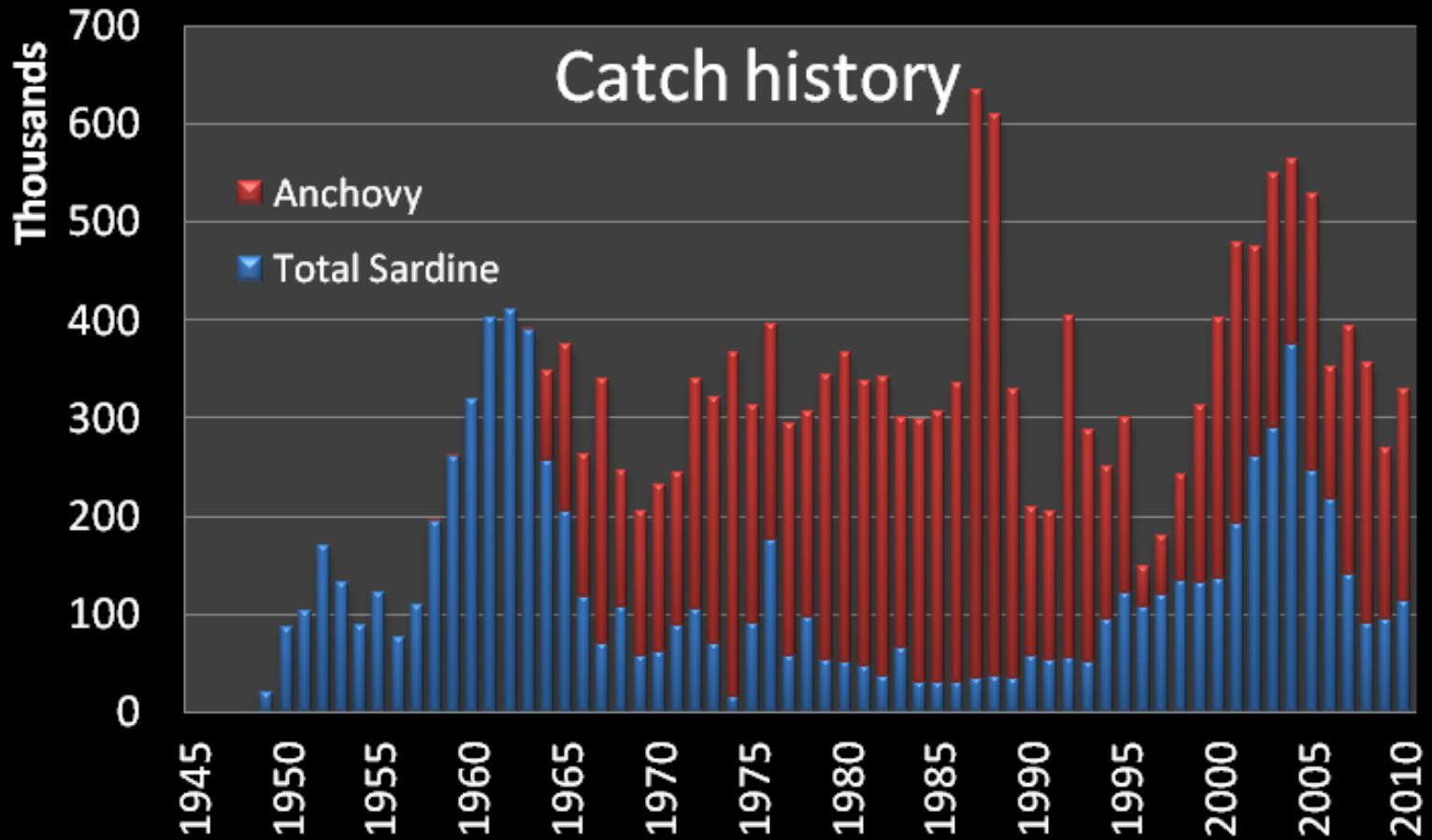
Outline

- Fishery and Data
- Stock Structure Hypotheses
- Management Timeline
- Sardine Two Stock Assessment Model Fits
- Future Two Stock Movement
- Future Projections
- **WHY 2 STOCKS AND WHERE ARE WE AT**

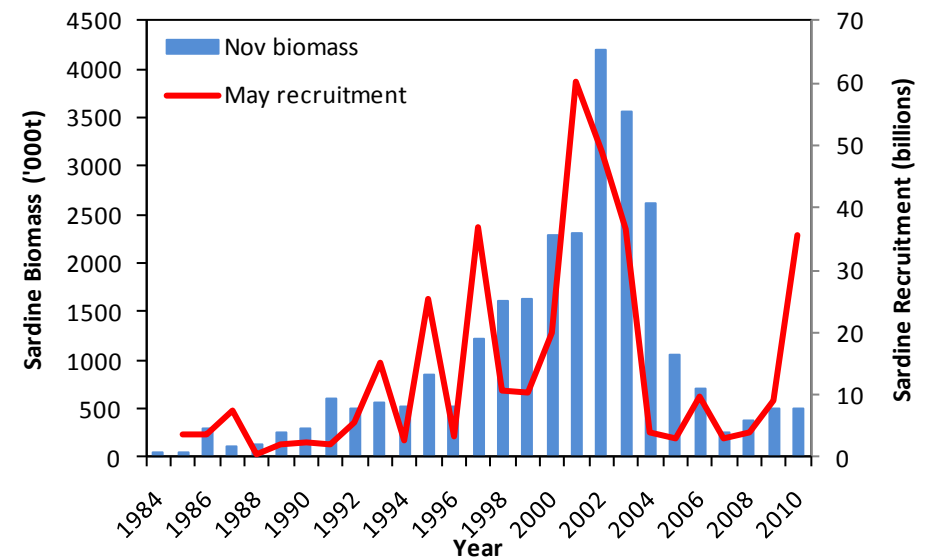
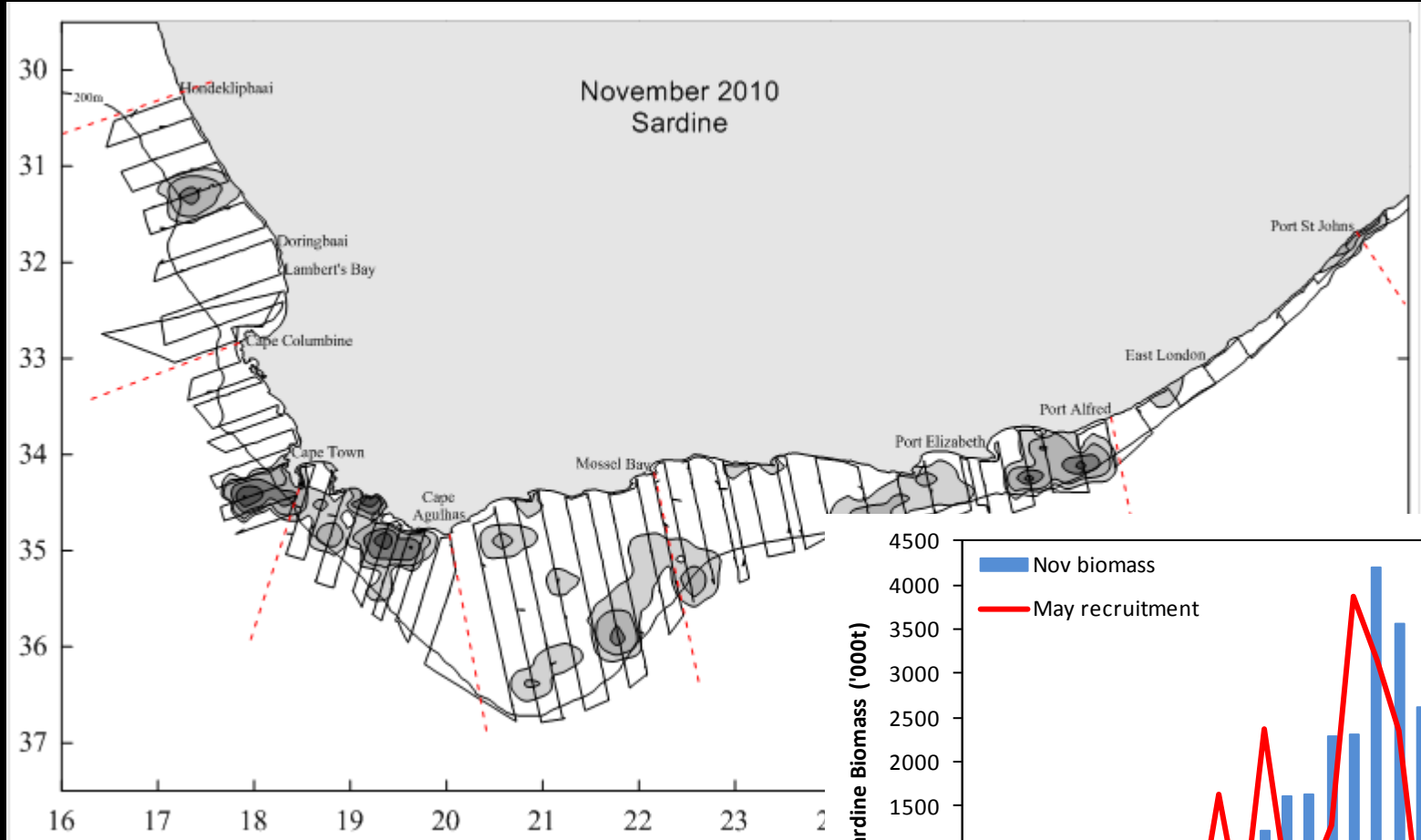
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Catch History



Hydro-acoustic Surveys



Provided by Janet Coetzee

Data

- Two annual hydro-acoustic surveys
 - November 1+ biomass; split at Cape Agulhas
 - May recruitment; split at Cape Infanta
- Limited ageing information – excluded from assessment
- Proportion at length data
 - Commercial catches (quarterly)
 - November survey
- Parasite data?

Outline

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Stock Structure Hypotheses

- Single sardine stock
 - used historically
 - previous OMP and current “Interim OMP” were developed using a single stock operating model
- Two sardine stocks (“west” and “south”) split at Cape Agulhas
 - been suggested for a number of years
 - a two stock model has been under development since 2009
- OMP-14
 - tuned to a single stock hypotheses
 - tested using two stock hypothesis

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Management Timeline

- OMP-08 (2008-2012) single stock operating model
- Interim OMP-13, Interim OMP-13v2, Interim OMP-13v3 (2013-2014)
- OMP-14 (2015-2016?) single stock operating model with some spatial management

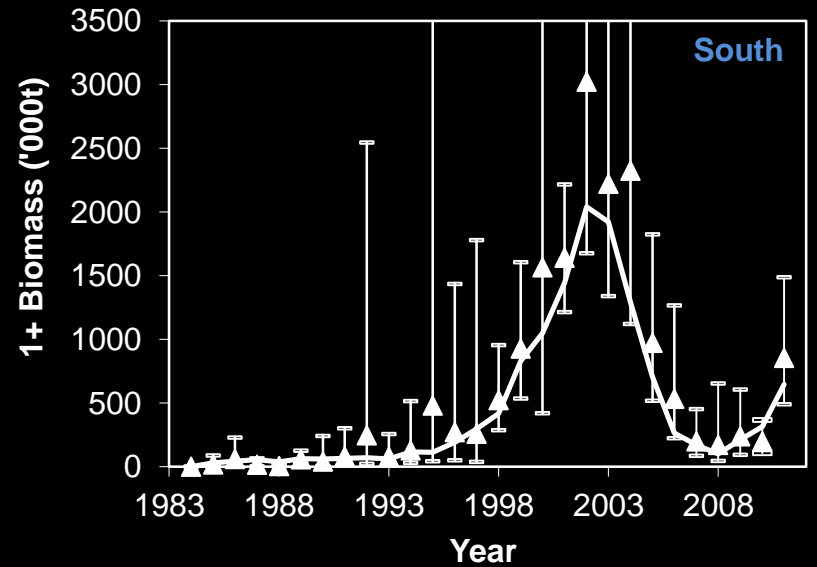
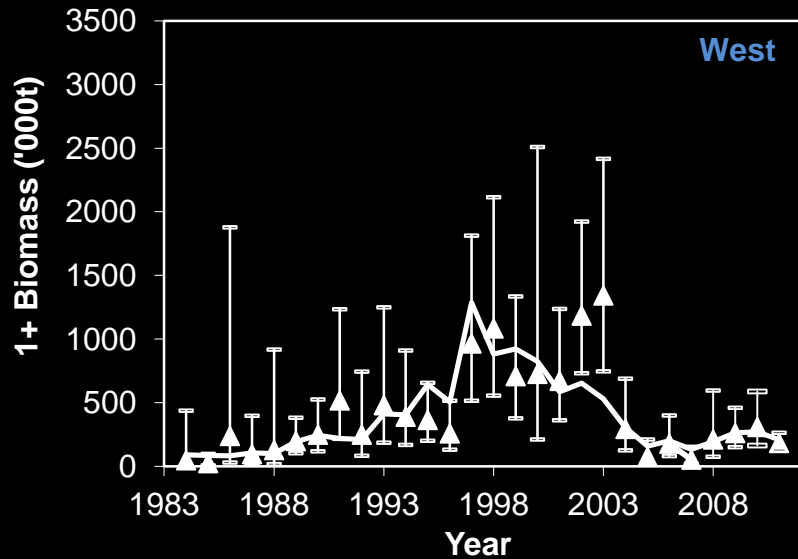
Key Model Structure/Assumptions

- Two sardine stocks: key assumptions in base case
 - mixing : “west” stock recruits move to “south” stock (estimated annually - no assumed relationship)
 - mixing : no “south” recruits move to “west” stock
 - mixing : no adult movement
 - 1+ biomass west/east of Cape Agulhas is from the “west” / “south” stock
 - recruitment west/east of Cape Infanta is from to the “west” / “south” stock
 - same M_{juv} and M_{adult} for both stocks
 - allowance for difference in May survey bias east/west of Cape Agulhas (proportion of recruits surveyed east of Cape Agulhas \leq that surveyed west of Cape Agulhas (winter spawning))
 - allowance for difference in weights and growth by stock
 - S/R curve parameters estimated separately for each stock (Hockey stick for basecase)

Outline

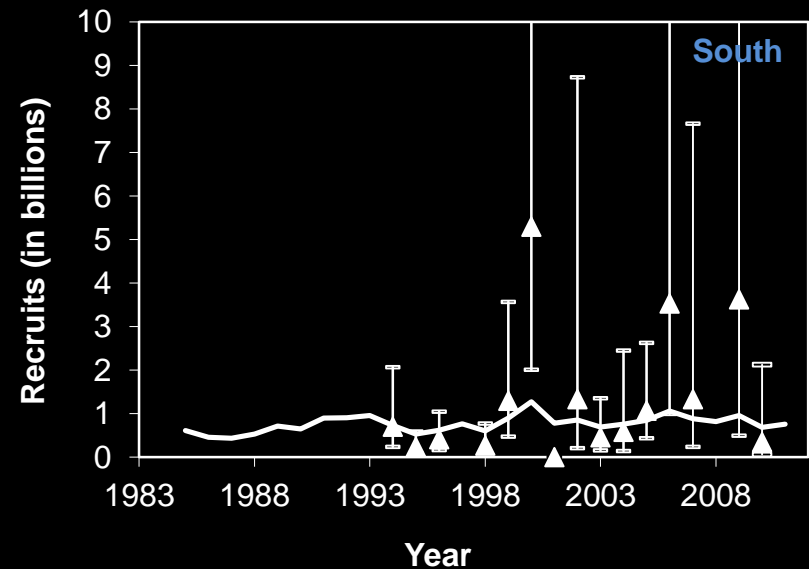
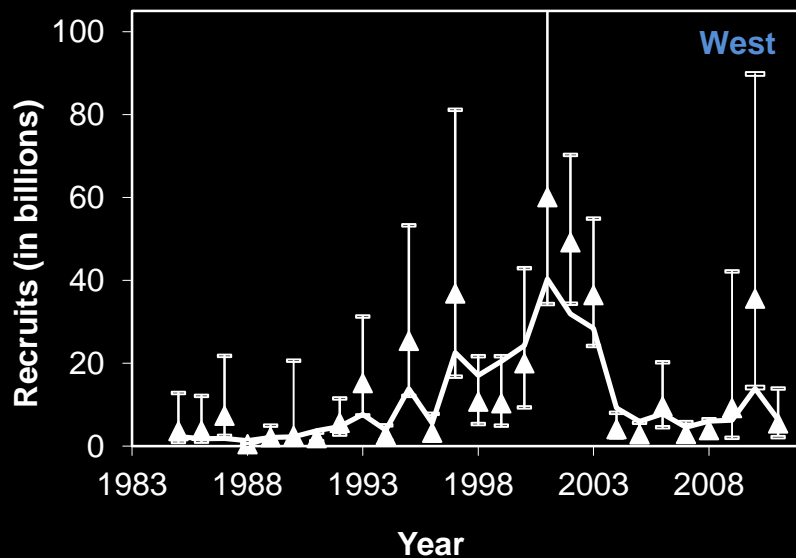
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Model Fits – Nov Biomass



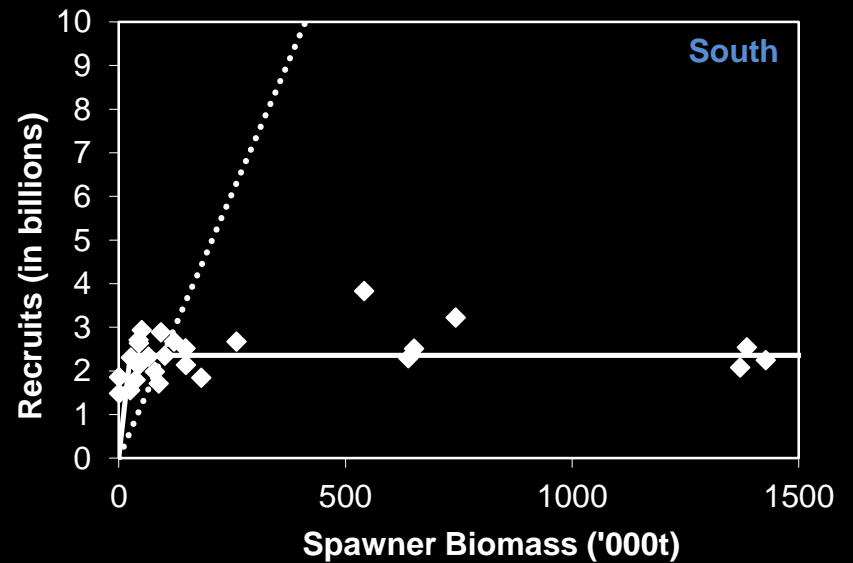
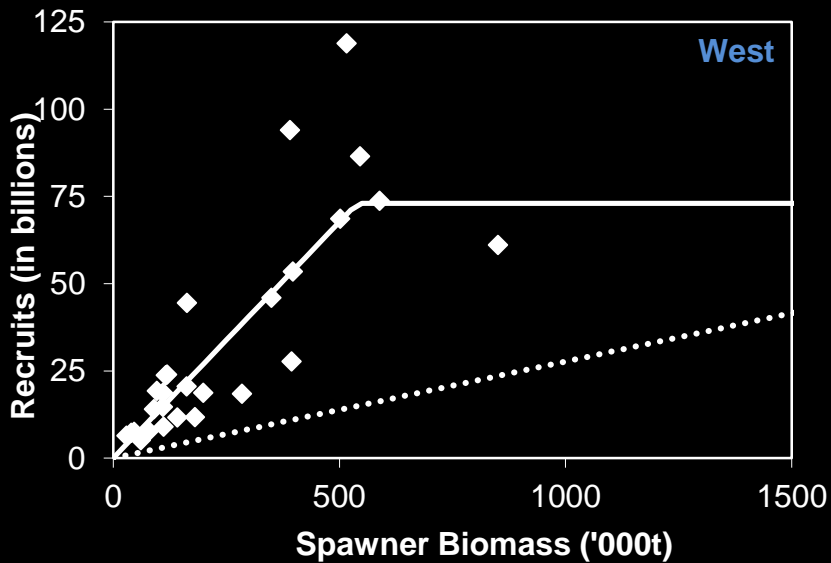
Model Fits – May Recruitment

- Note difference in y-axis
- No south coast survey estimates for early part of time series



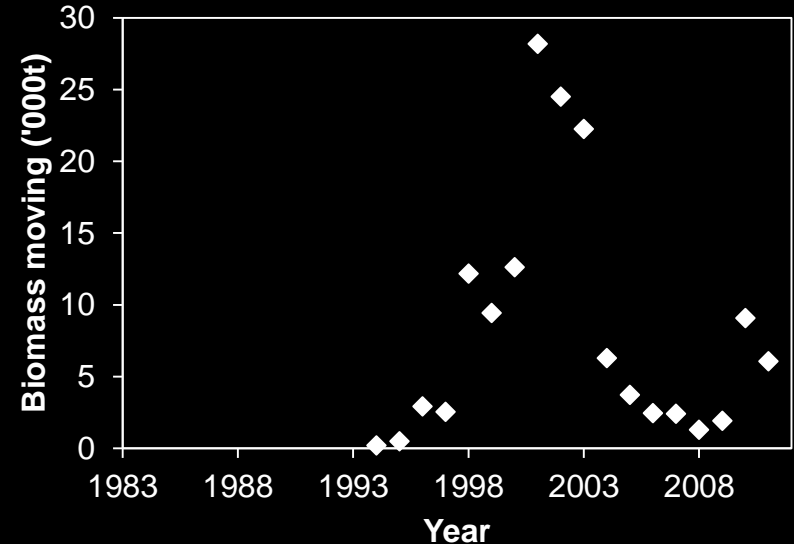
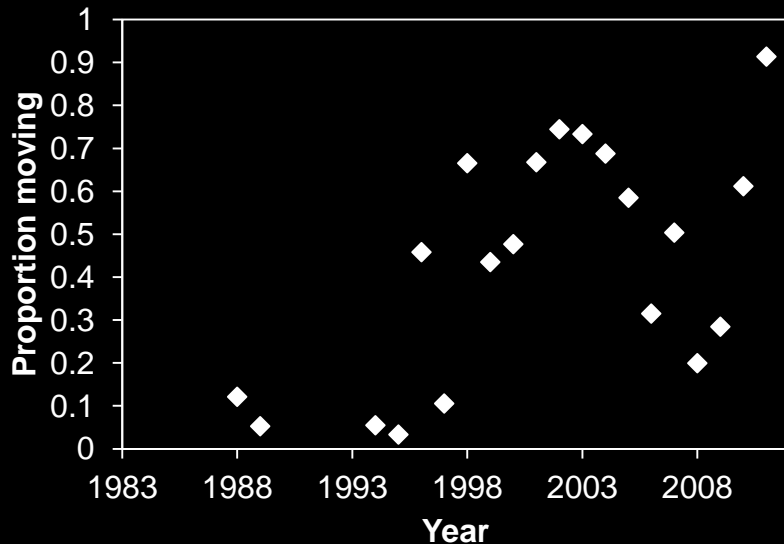
Model Fits – Stock Recruitment

- Note difference in y-axis



Model Fits – Estimated Movement

- Increase in “south” stock biomass primarily a result of movement from “west” stock rather than “south” stock productivity

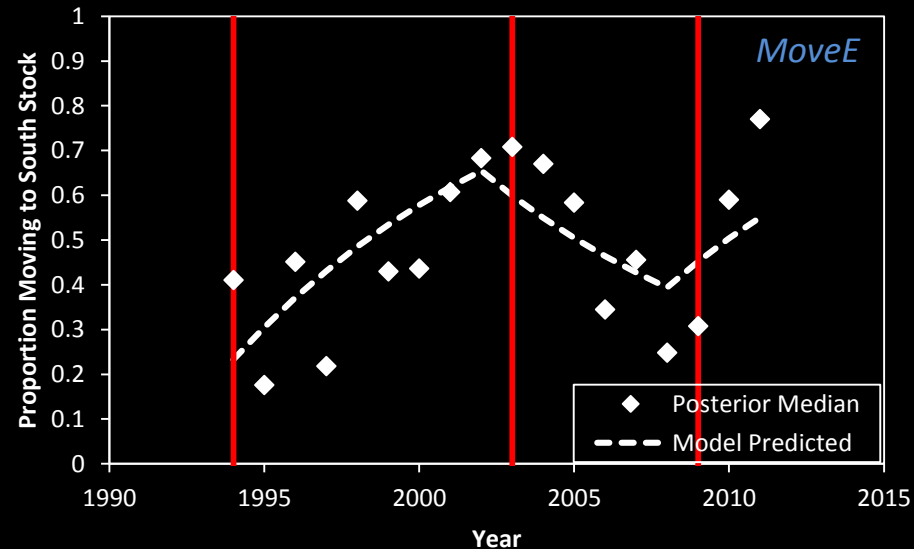
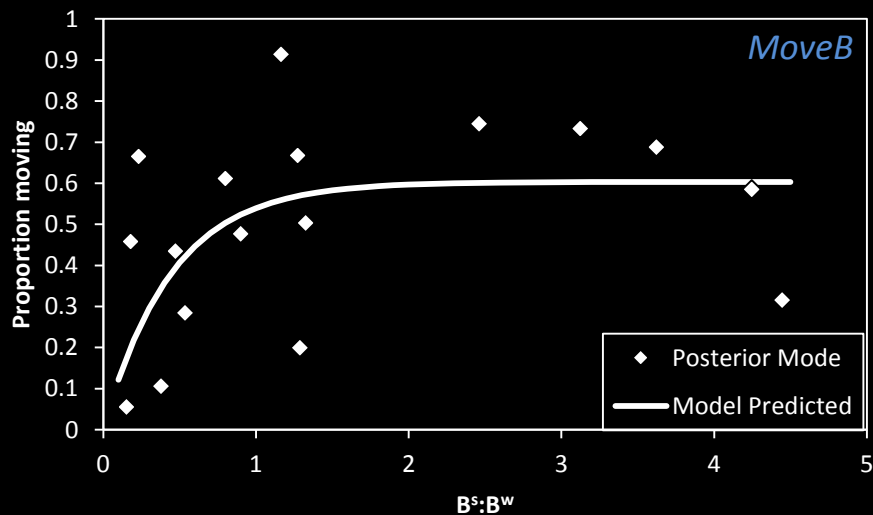


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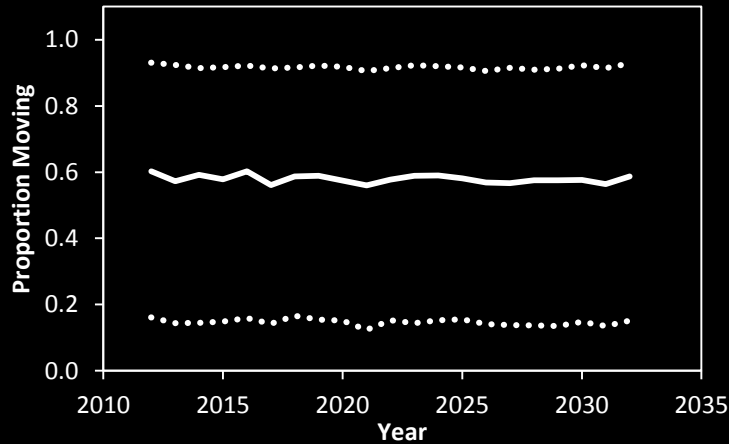
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Future Movement

- *NoMove* – no future movement
- *MoveB* – future movement is based on a relationship with the ratio of “south” : “west” stock 1+ biomass
- *MoveE* – future movement “switches” every 5-7 years between increasing and decreasing towards an equilibrium proportion, based on whether a favorable or unfavorable environment exists on the south coast. (Choice of years based on application of the STARS method to a time series of upwelling for Cape Agulhas)

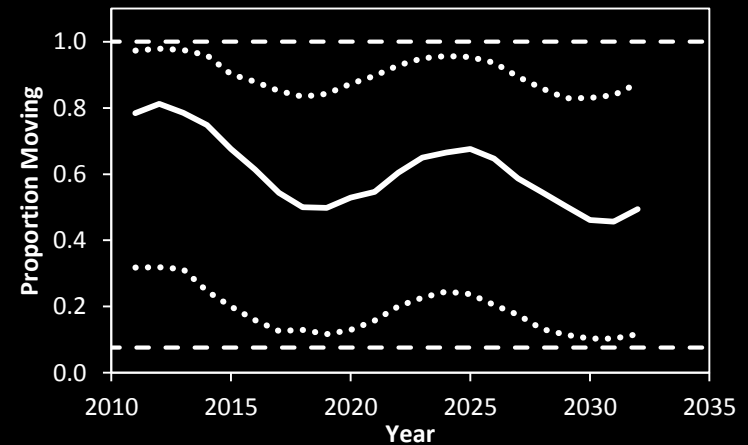


Future Projected Movement (No Catch Scenario)



Ratio of "south" : "west" 1+
biomass ($B_s:B_w$)

MoveB



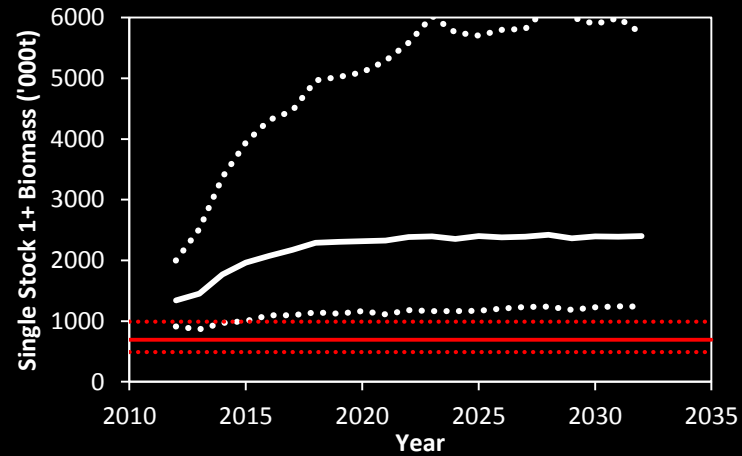
Environmental switching

MoveE

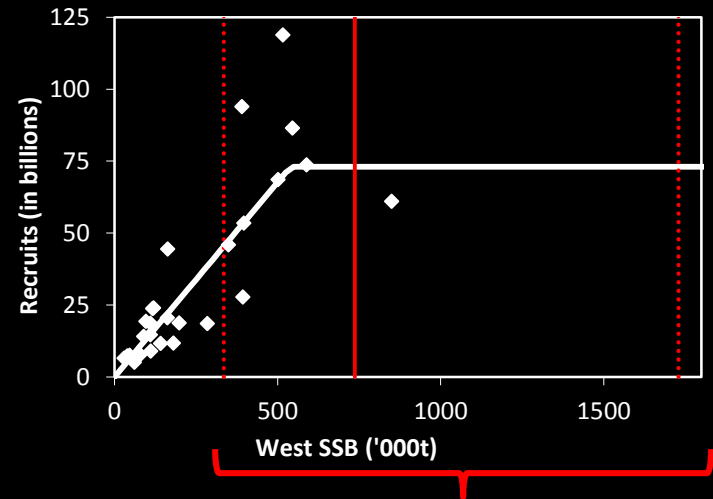
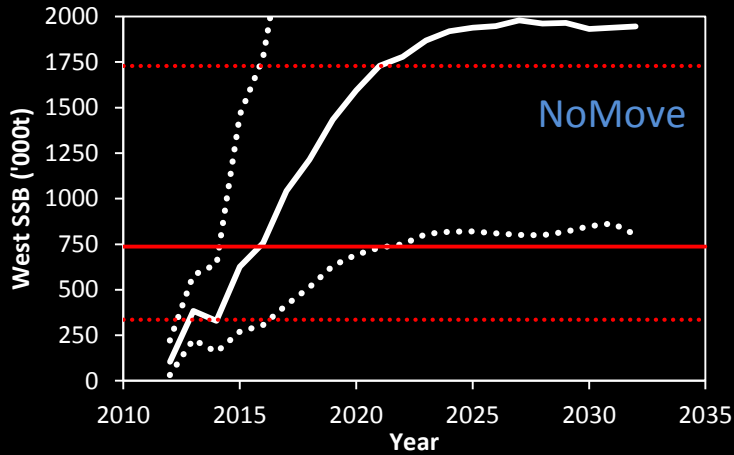
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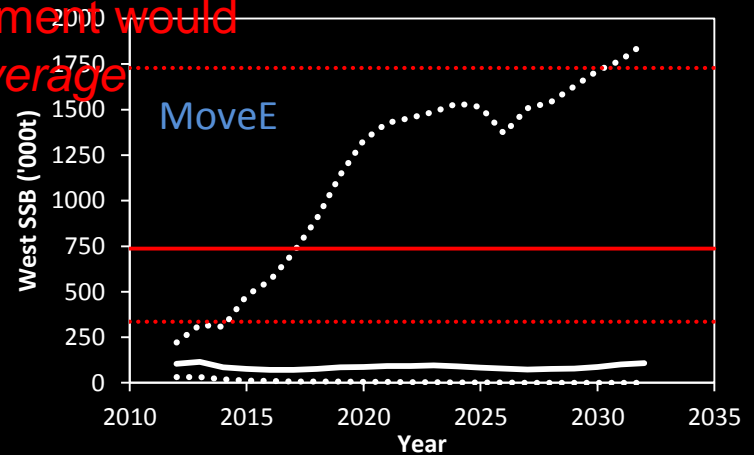
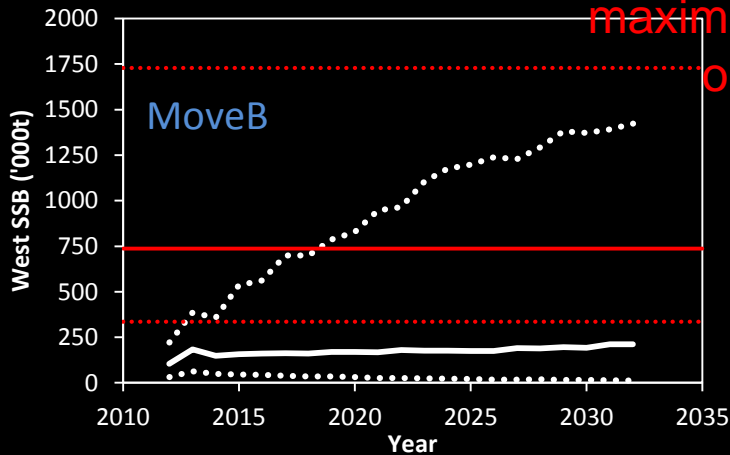
Single Stock : No Catch



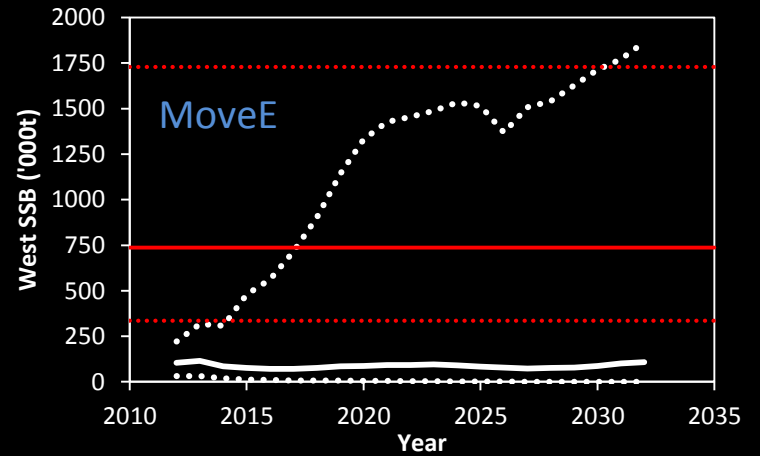
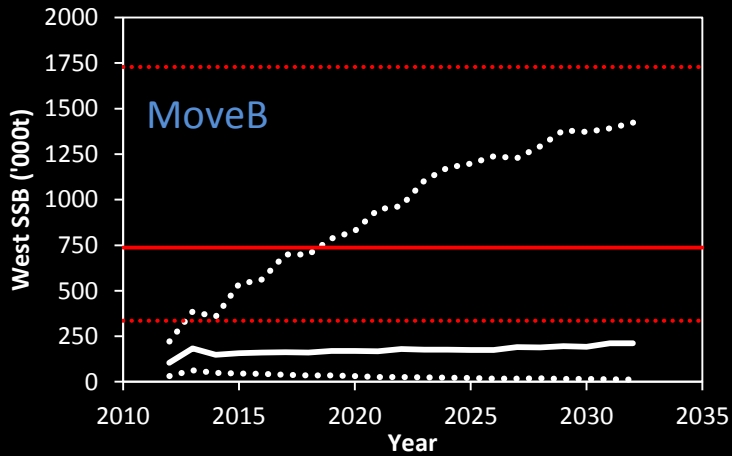
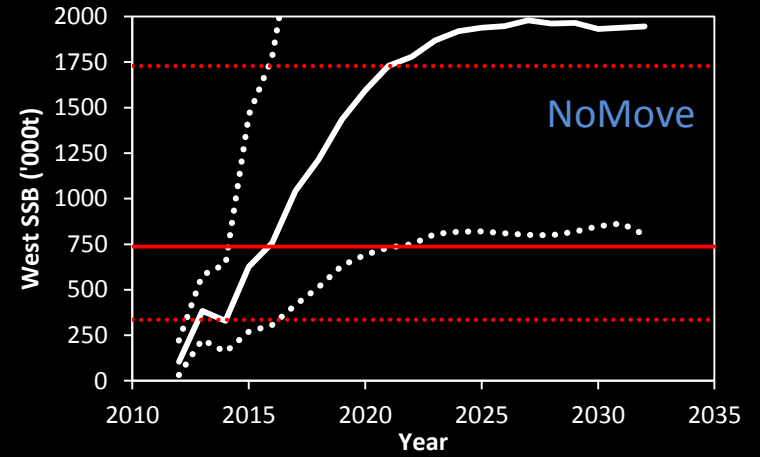
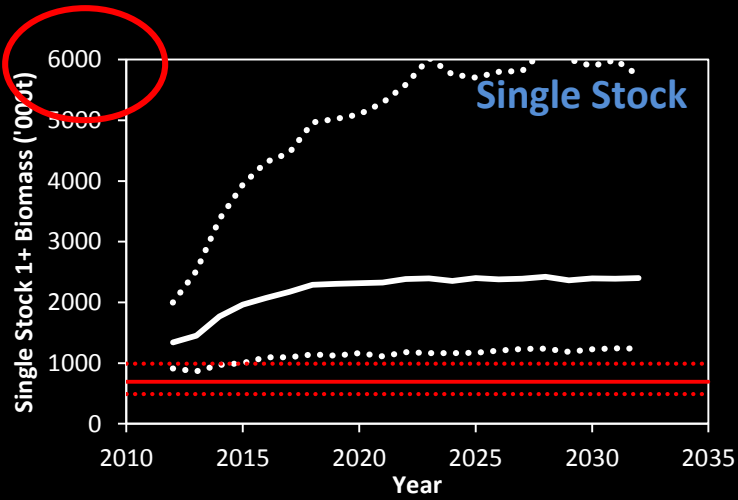
Two Sardine Stocks : No Catch



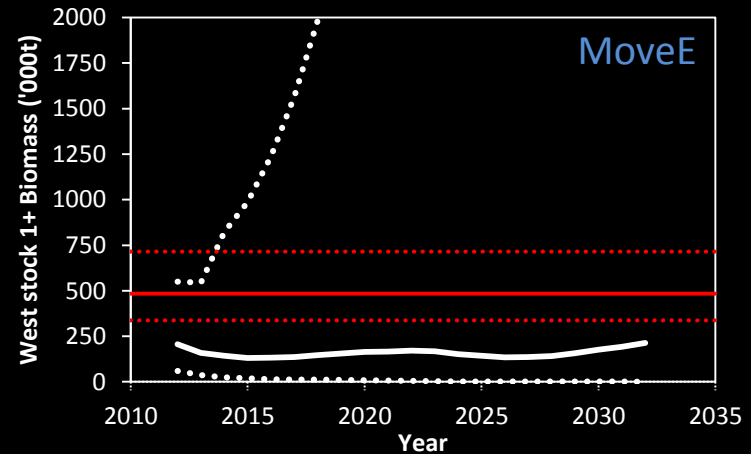
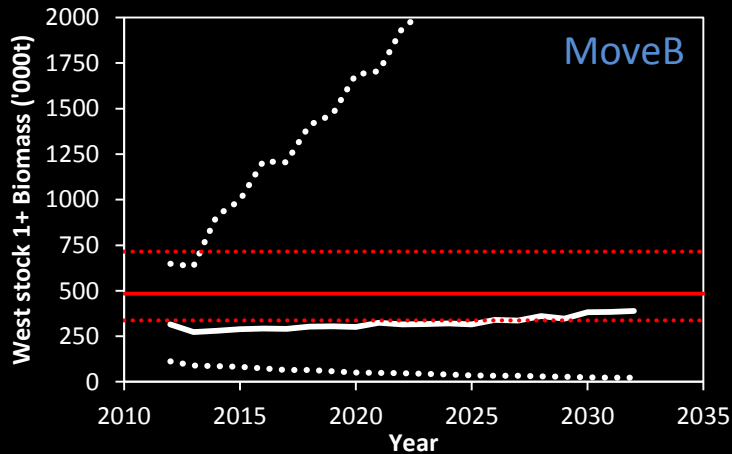
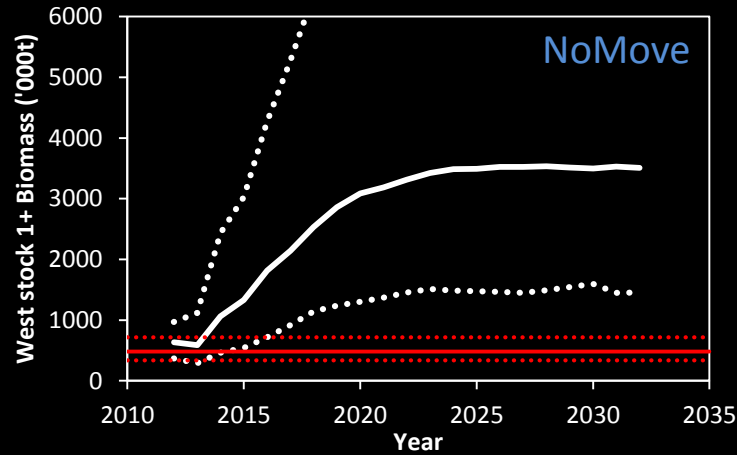
Biomass above which
maximum recruitment would
occur on average



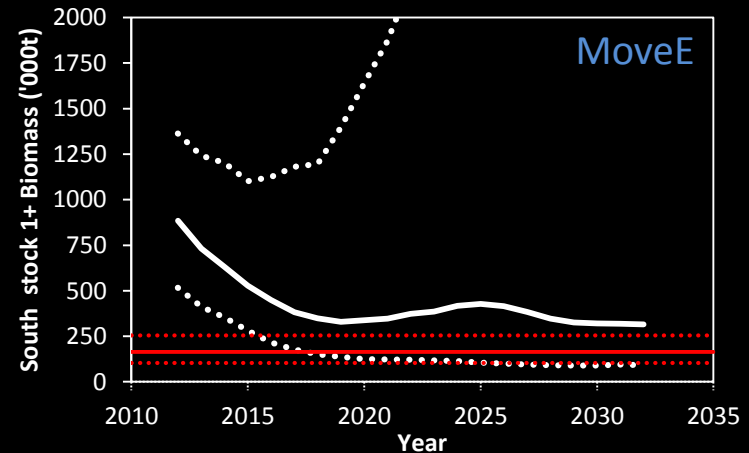
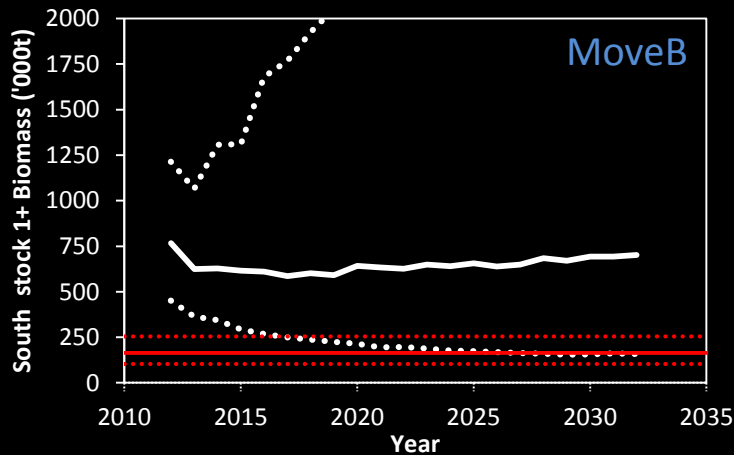
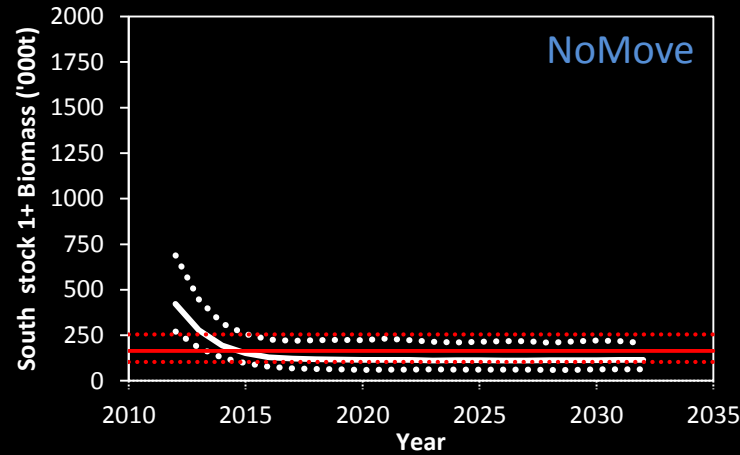
No Catch



Two Sardine Stocks : No Catch



Two Sardine Stocks : No Catch



Sardine – Part 1

- Option A: Effective Spawning Biomasses

Observation:

Eggs from sardine spawning on the south coast are transported to the west coast, and less from the west coast to the south coast (Sardine/BG7)

Hypothesis:

Some of the spawning products from south [west] coast spawning biomass contribute to west [south] stock recruitment (and future west [south] stock population dynamics)

Sardine – Part 1

- Option A: Effective Spawning Biomasses

Alternative Model Assumption:

West [south] stock recruitment is a function of *effective* spawning biomass which consists of mostly the west [south] spawning biomass, but also some south [west] spawning biomass

The proportion of eggs estimated to be successfully transported to the west [south] coast are taken to represent the proportion of south [west] coast spawning biomass that forms part of the west [south] *effective* spawning biomass

Sardine – Part 1

- Option B: Varied Recruit Distributions

Observation:

Some years of large May/June survey estimates of recruitment west of Cape Infanta correspond with high model estimated proportions of recruits moving from west to south stocks

Hypothesis:

Recruits surveyed west of Cape Infanta consist of west stock recruits AND some south stock recruits that originated from south stock spawning and will return to contribute to south stock population dynamics (natal homing)

Sardine – Part 1

- Option B: Varied Recruit Distributions

Alternative Model Assumption:

The model predicted recruits fit to the survey estimate of recruits west of Cape Infanta will be the sum of the model predicted west stock recruits and $x\%$ of the model predicted south stock recruits.

$(100-x)\%$ of model predicted south stock recruits will be fit to the survey estimated recruitment east of Cape Infanta.

For all other purposes (catch, recruitment) these recruits are assumed to form part of the south stock

Sardine – Part 1

- Option C

Observation:

Parasite infection prevalence and intensity continues to increase with length for sardine east of Cape Agulhas while the parasite is assumed endemic only to the area west of Cape Agulhas

Hypothesis:

Some part of the (primarily adult) south stock sardine are distributed west of Cape Agulhas at some point during the year, exposing them to possible (further) infection by the parasite

Sardine – Part 1

- Option C

Assumption:

Although it is likely under such a hypothesis that only some of the south stock sardine would spend a percentage of their time west of Cape Agulhas, as a 'first cut' this option assumes that $y\%$ of the south stock spend all of their time west of Cape Agulhas. The alternatives do, however, have different implications for the modelling of catch and stock-recruitment relationships.

Assumption:

The directed sardine catch and sardine bycatch with round herring taken west of Cape Agulhas is modelled to be taken from a combination of the west stock sardine and $y\%$ of the south stock sardine, instead of this catch being assumed to be only from the west stock.

Sardine – Part 1

- Option C

Assumption:

$y\%$ of the south stock spawning biomass is added to the west stock spawning biomass to formulate a west coast stock recruit relationship to estimate the recruitment to the west stock. The south coast stock recruit relationship used to estimate recruitment to the south stock would be based on $(100-y)\%$ of the south stock spawning biomass.

Alternatives:

C-1) $y=0\%$ current two stock model assumes 0% of south stock sardine are found distributed west of Cape Agulhas

C-2) $y=20\%$

C-3) $y=40\%$

C-4) $y=60\%$

Sardine – Part 1

- Option D

(Not considered with current two stock model framework)

Observation:

Parasite infection prevalence and intensity continues to increase with length for sardine east of Cape Agulhas while the parasite is assumed endemic only to the area west of Cape Agulhas

Hypothesis:

Fish older than recruits/1-year olds migrate from the west stock to the south stock

Given data limitations, proportions moving will likely have to be assumed to be independent of age

Sardine – Part 2

- The implications of the options above will be explored based on the current two stock model using data from 84-11. These will guide where further work will be focused.
- Model design for the next assessment (using data from 84-14) and data to be used will be influenced by the impact of the above alternative options on results and was thus not discussed further at this point.

Some Discussion Points

- Under Single Stock and *NoMove*, “status quo” fishing could continue at a reasonable level of risk, with *NoMove* being more optimistic than single stock hypothesis
- Under *MoveE* and *MoveB* “status quo” fishing yields very pessimistic results – most optimistic projections obtained by moving fishing pressure from the west to the south coast

Unless almost all directed fishing pressure is moved east of Cape Agulhas, there is a high probability of commercial extinction in a decade, but movement of the fishery has high socio-economic costs

An Overview of the Key Issues to be Discussed Relating to South African Sardine

Thank you for your attention