An overview of the key issues to be discussed relating to the South African sardine two-mixing-stock hypothesis

MARAM International Stock Assessment Workshop

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Outline

- Fishery and Data
- Stock Structure Hypotheses
- Sardine Two Stock Assessment Model Fits
- Considering the Parasite Data

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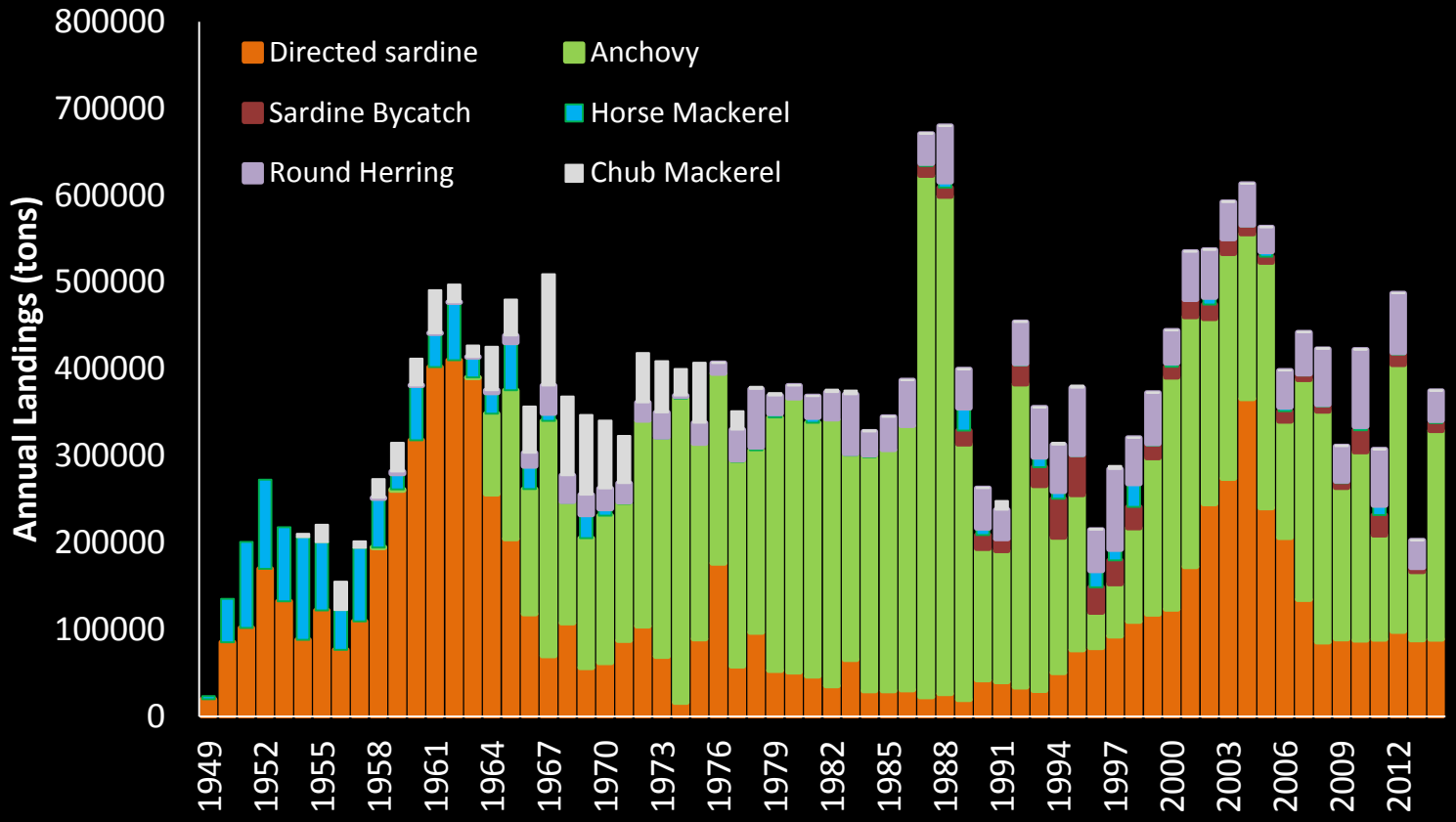
Catch History

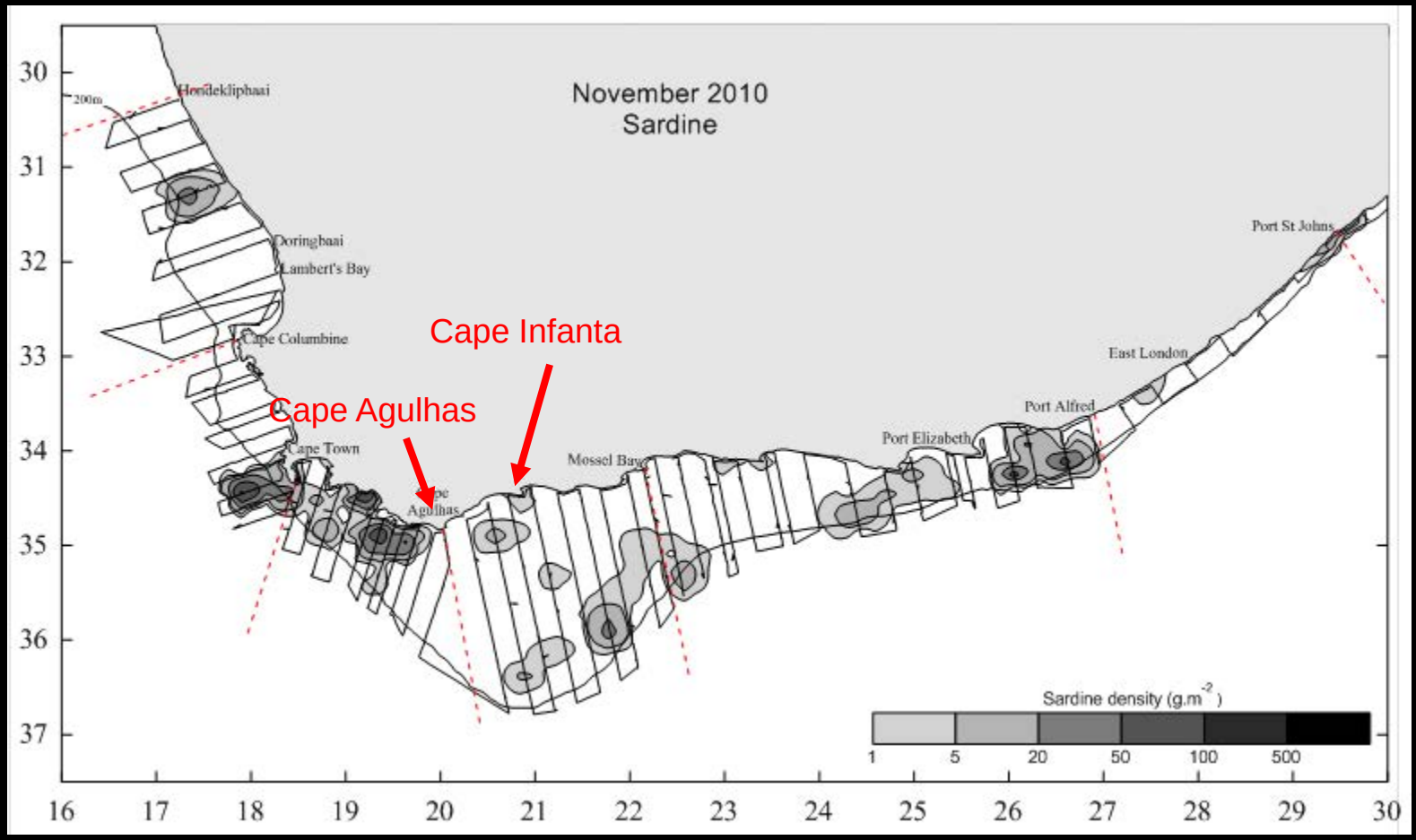


Small Pelagic Fishery: primarily sardine and anchovy, also round herring, chub mackerel and juvenile horse mackerel

Data

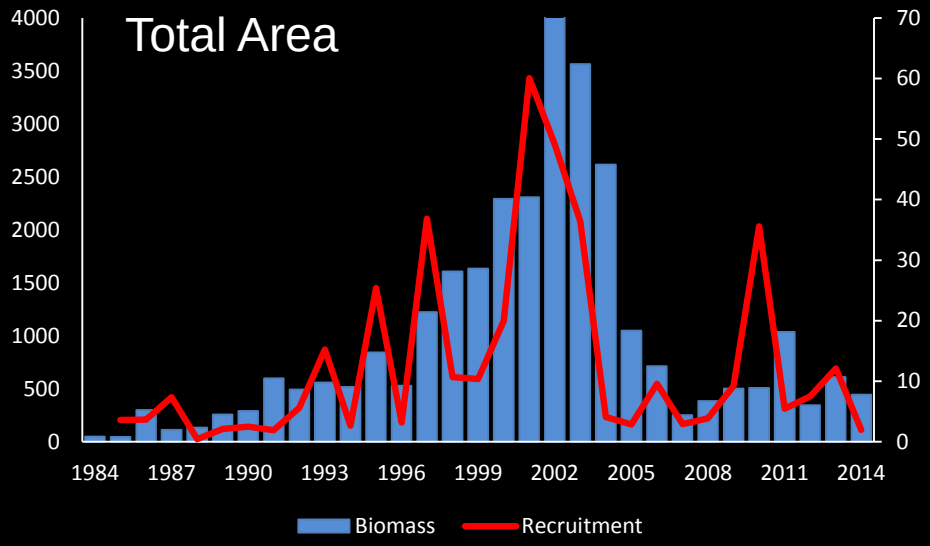
- Two annual hydro-acoustic surveys
  - November total biomass; split at Cape Agulhas
  - May recruitment; split at Cape Infanta

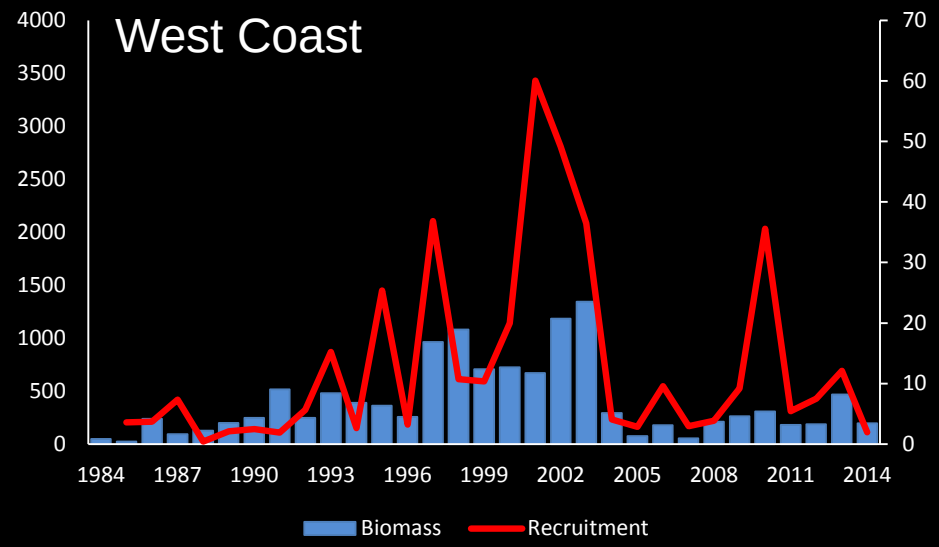
Hydro-acoustic Surveys

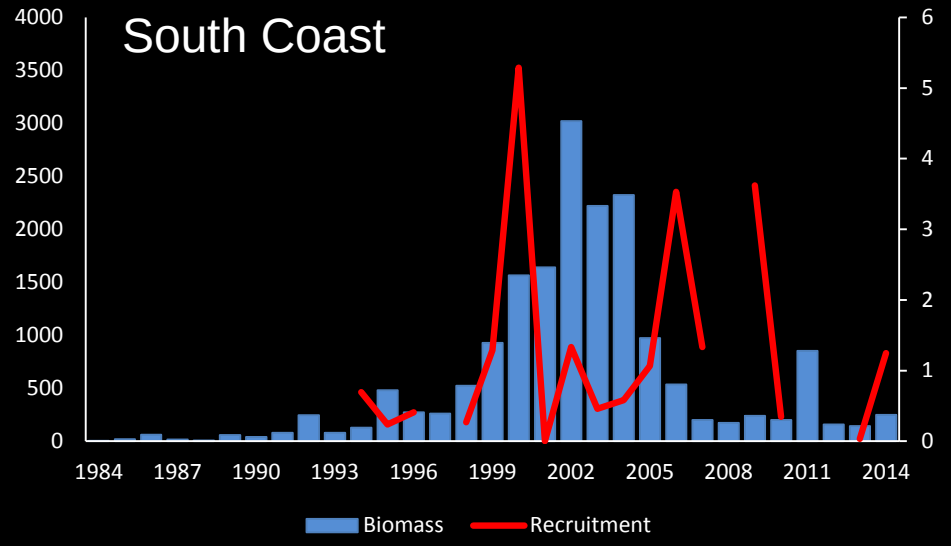


Provided by Janet Coetzee

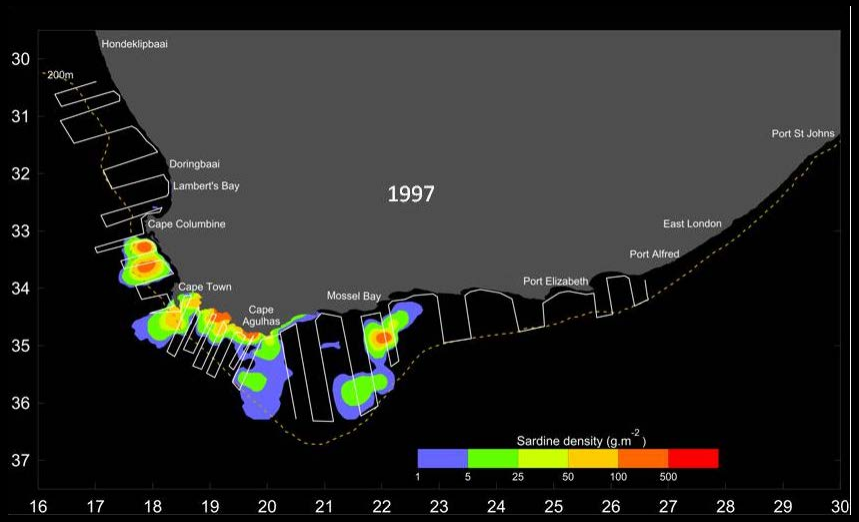
Hydro-acoustic Surveys

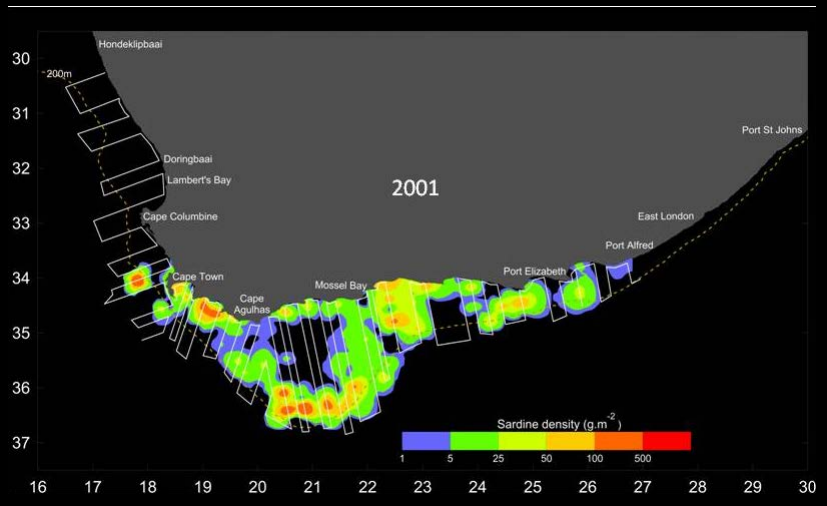


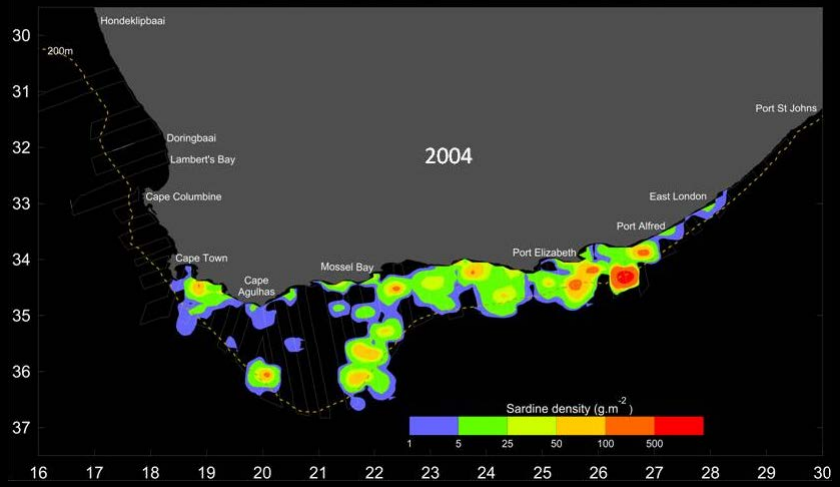


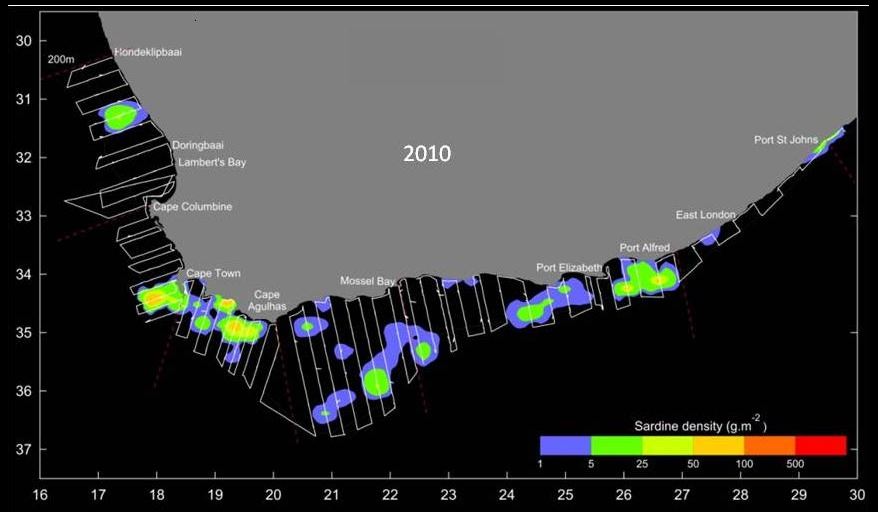


Distributional Shift









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Data

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

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- Sardine Two Stock Assessment Model Fits
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Stock Structure Hypotheses

- Single sardine stock

  - used historically

  - previous & current OMPs were developed using a single stock operating model

- Two sardine stocks ("west" and "south") split at Cape Agulhas

  - a two stock model has been under development since 2009

  - a two mixing stock hypothesis produced an acceptable fit to the data in time for OMP-14 development, but future projections were heavily dependent on assumption of future stock mixing

- Current OMP includes some spatial management advice (i.e. based qualitatively not quantitatively on two stock hypothesis)

Key Model Structure/Assumptions

- Operating model conditioned over Nov 1983 – Nov 2014
- Quarterly time steps
- Catch-at-age taken in a pulse each quarter
- Maturity ogive that is time-dependent (4 time-periods) *NEW*
- Time-invariant juvenile and adult M
- Hockey stick S/R relationship
- Estimate commercial selectivity-at-length (parametric form used which was informed by initial work with a non-parametric curve)
- Survey trawl selectivity-at-length logistic for small lengths
- Survey biomass is associated with 0+ biomass *NEW*
- Weight-at-length relationship, adjusted annually based on average survey weight *NEW*

Key Model Structure/Assumptions

- Two sardine stocks: key assumptions

  - 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
  - 0+ 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 Infanta (proportion of recruits surveyed east of Cape Infanta ≤ 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

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  - 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~~ a lower proportion of 2+ sardine move
  - 0+ biomass west/east of Cape Agulhas is from the “west” / “south” stock
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  - allowance for difference in weights and growth by stock
  - S/R curve parameters estimated separately for each stock
  - age- and time-invariant annual infection of “west” stock sardine

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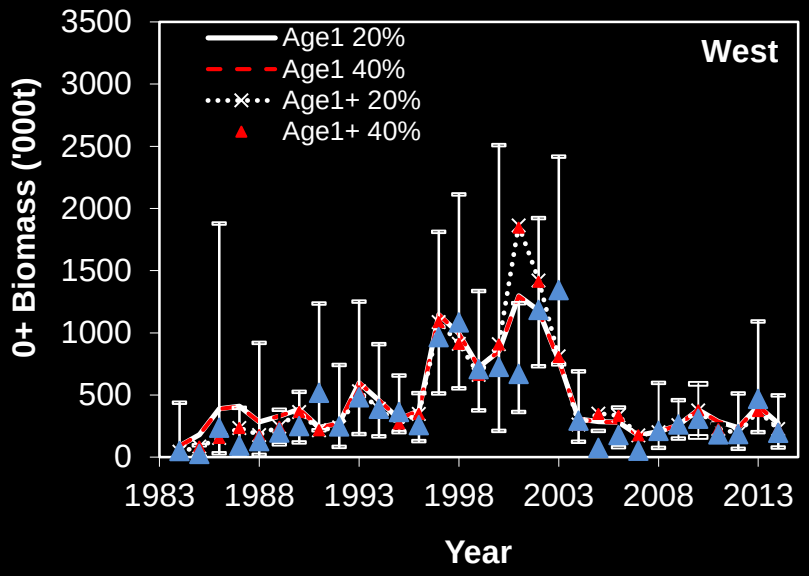
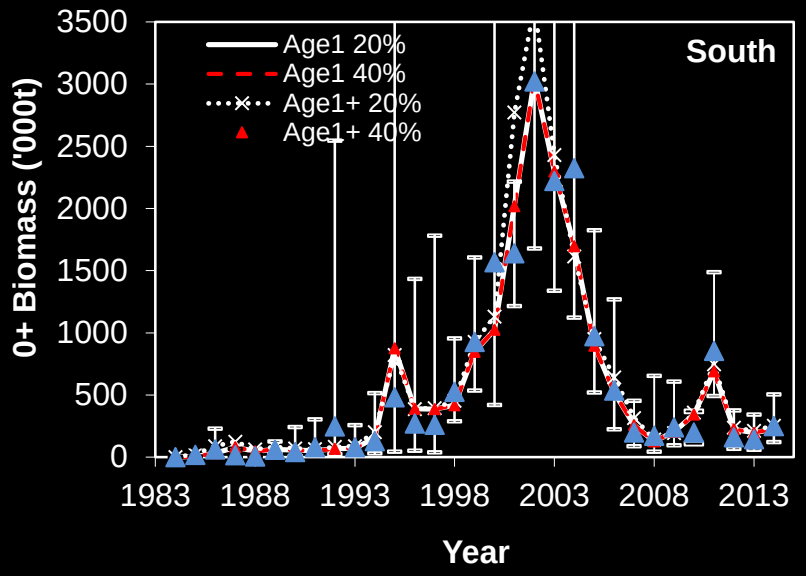
Four Alternative Initial Assumptions

Model	Annual Proportion of West Stock Infected	Age-1 fish move	Age 2-5+ fish move
a)	20%	Yes	No
b)	40%	Yes	No
c)	20%	Yes	Yes
d)	40%	Yes	Yes

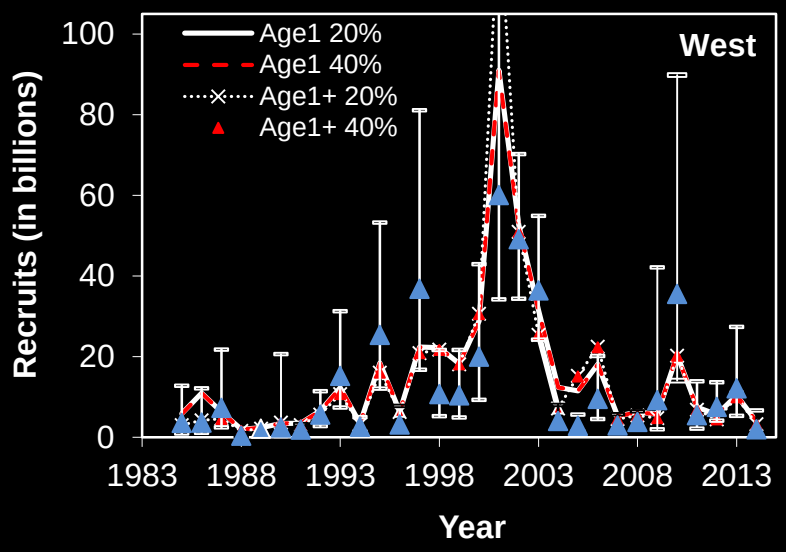
Model Fits – Nov Biomass

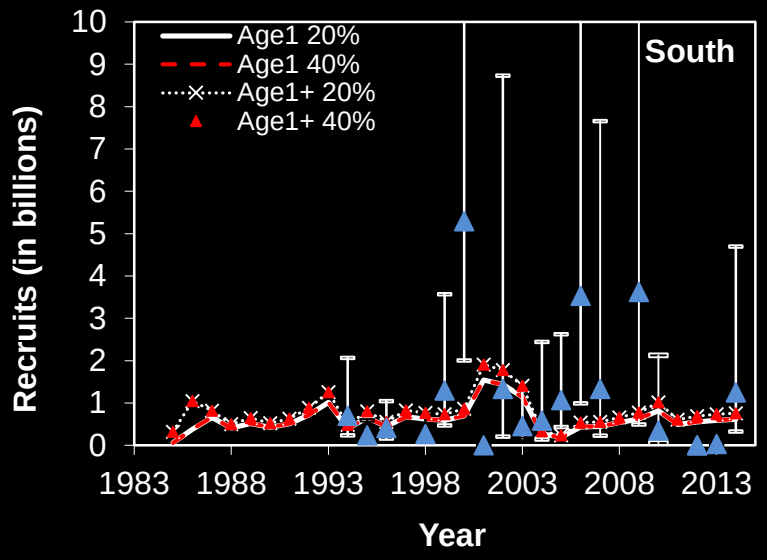




Model Fits – May Recruitment

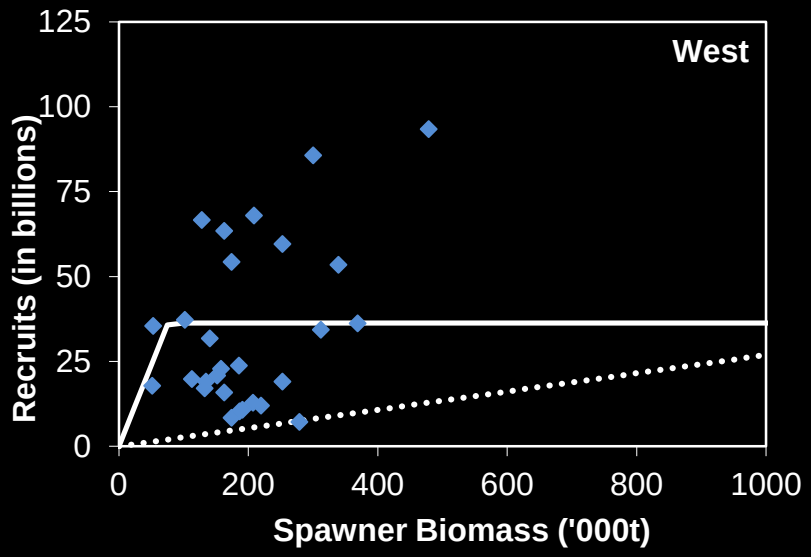
- Note difference in y-axis
- No south coast survey estimates for early part of time series

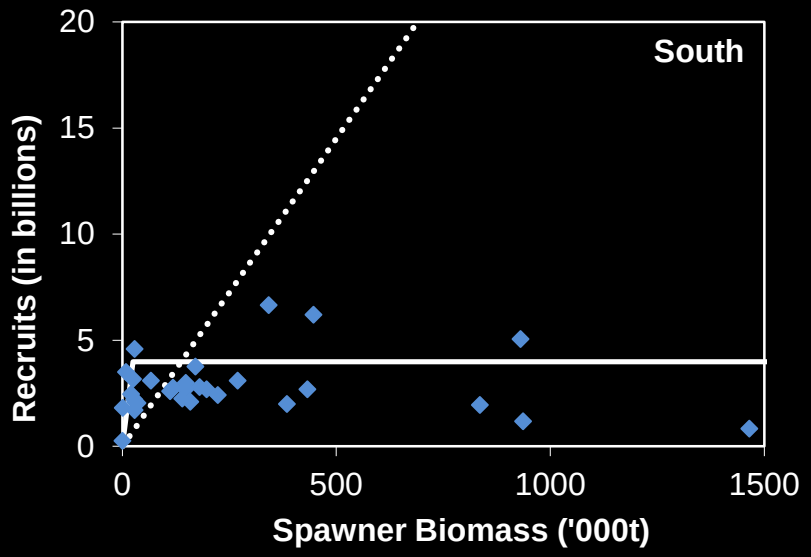




Model Fits – Stock Recruitment

- Note difference in y-axis; but west stock maximum recruitment lower than previous model
- West stock σ_R larger than previous model

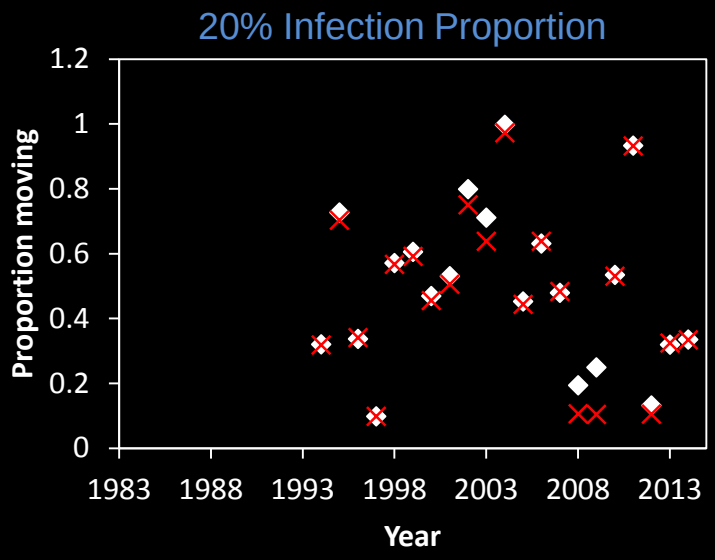


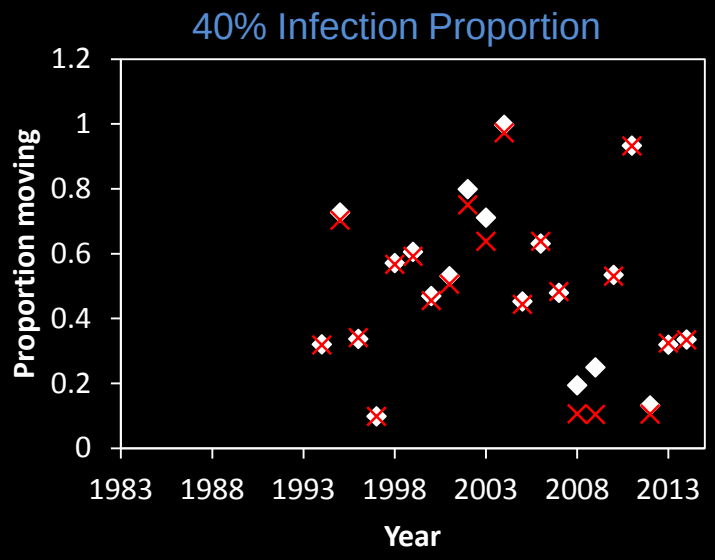


- Similar plots for alternative models

Model Fits – Estimated Movement

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





- Proportion of 2+ sardine moving is ~25% of age-1 sardine

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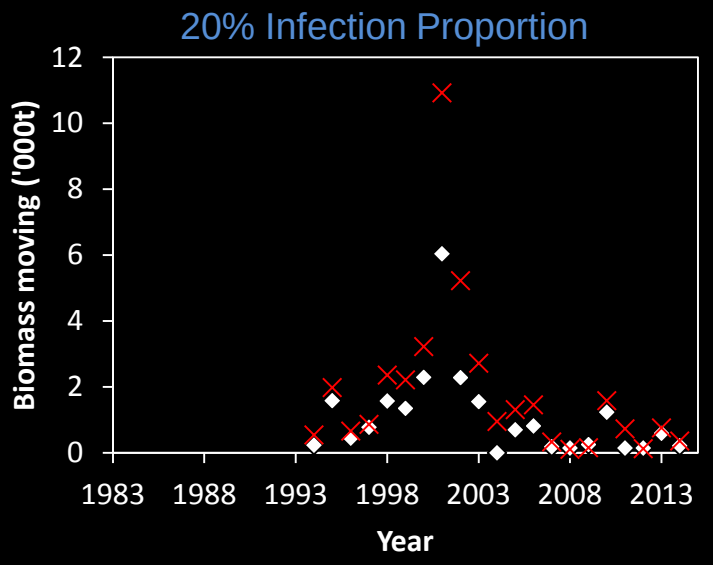

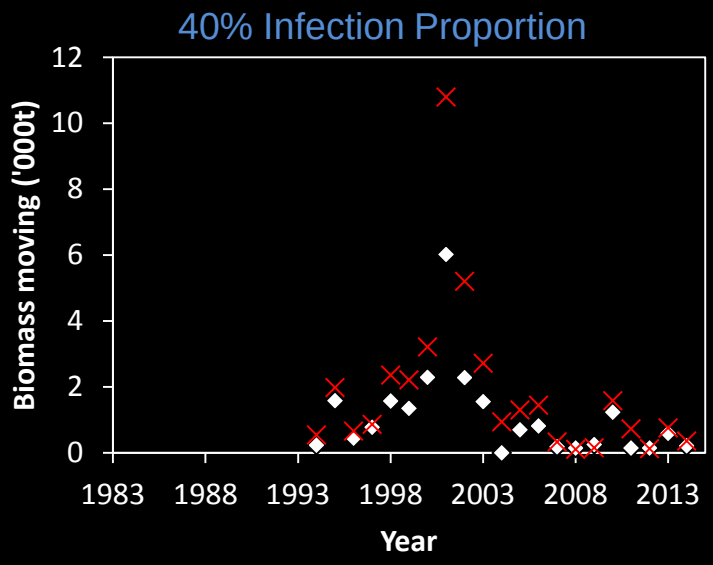

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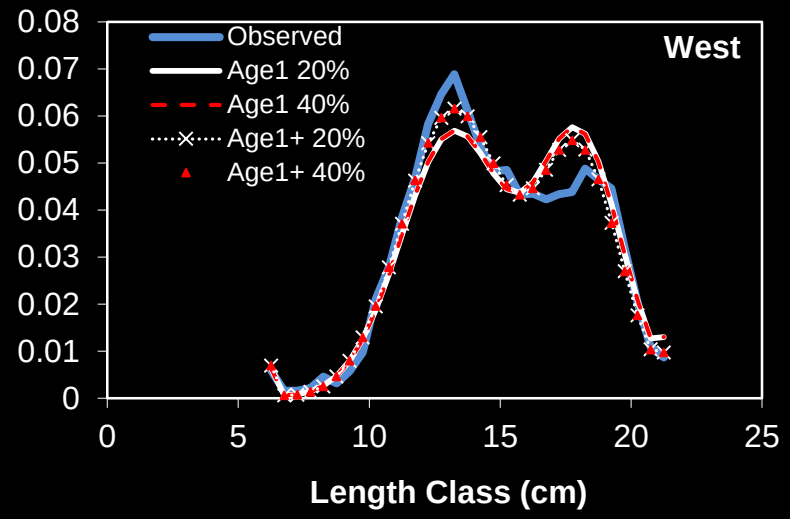
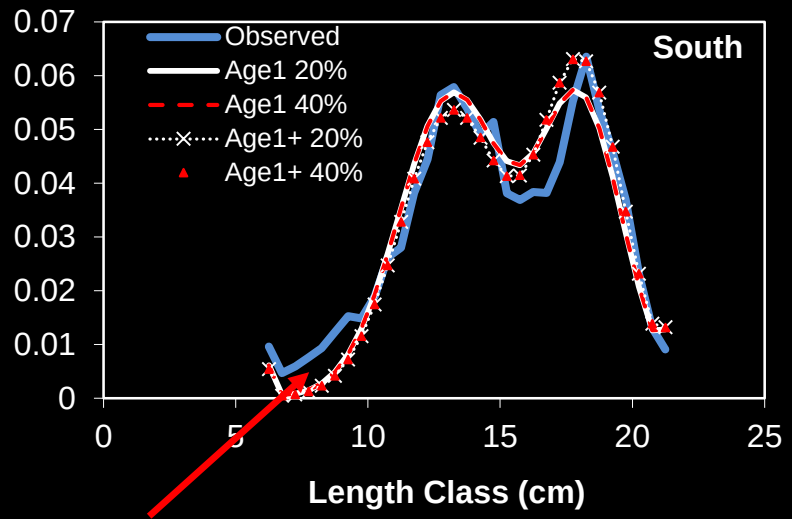
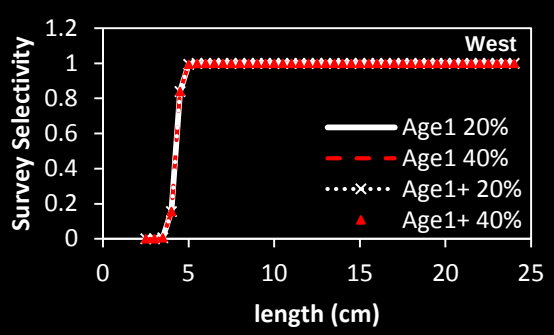
Model Fits – Survey Prop at Length

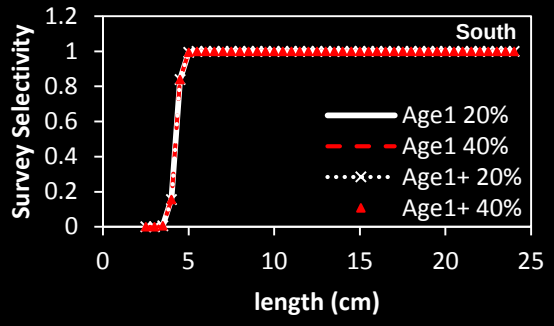
Average predicted is much closer to average observed than previous model



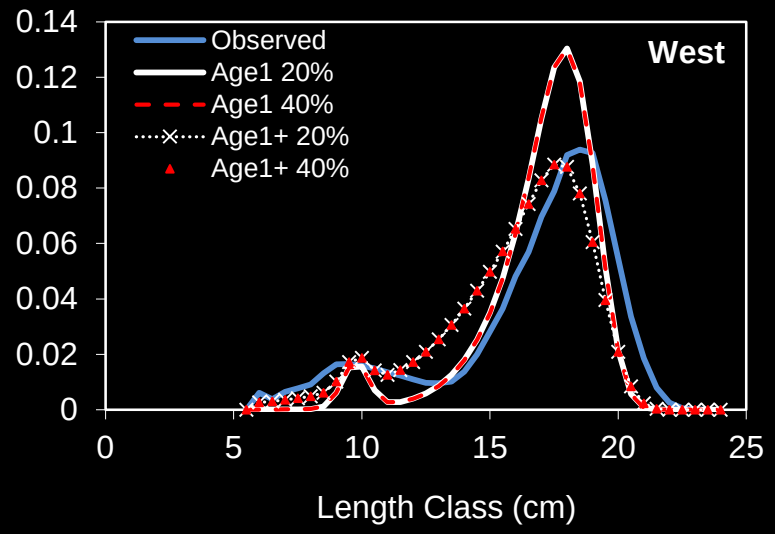


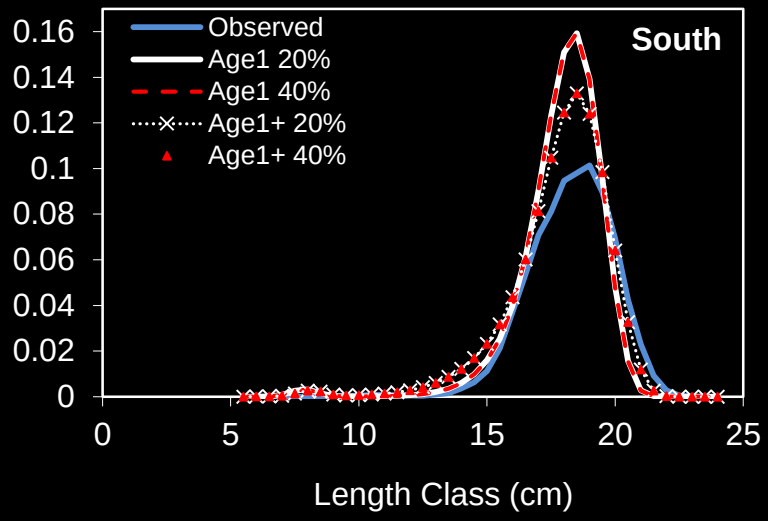
South coast winter spawning?

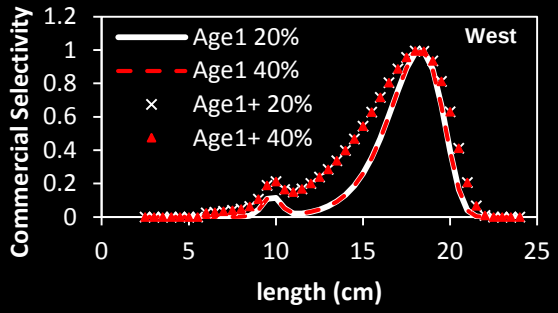


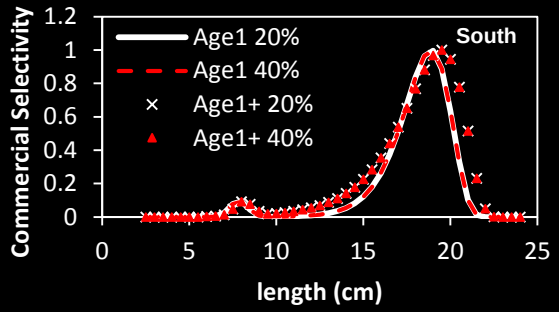


Model Fits – Commercial Prop at Length









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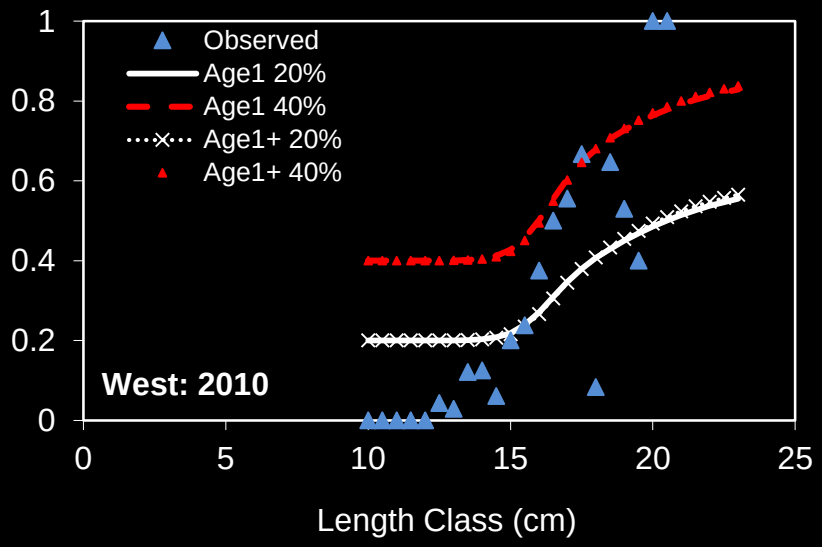
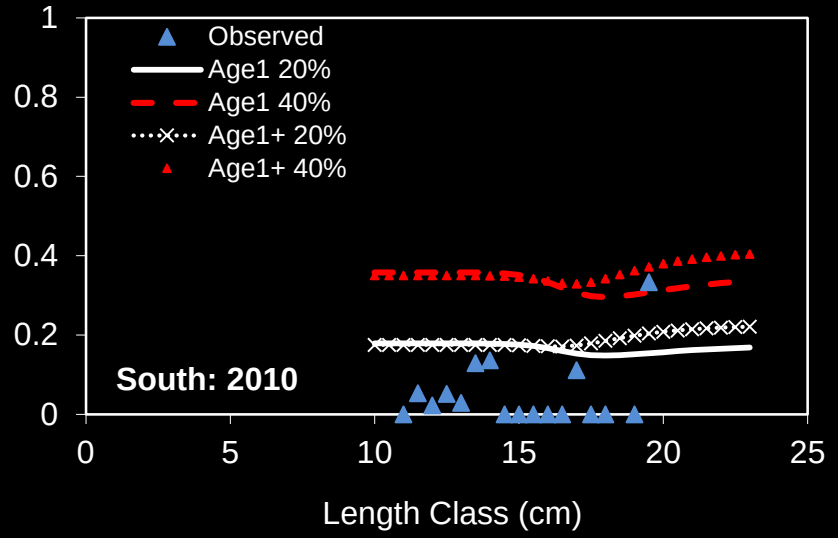
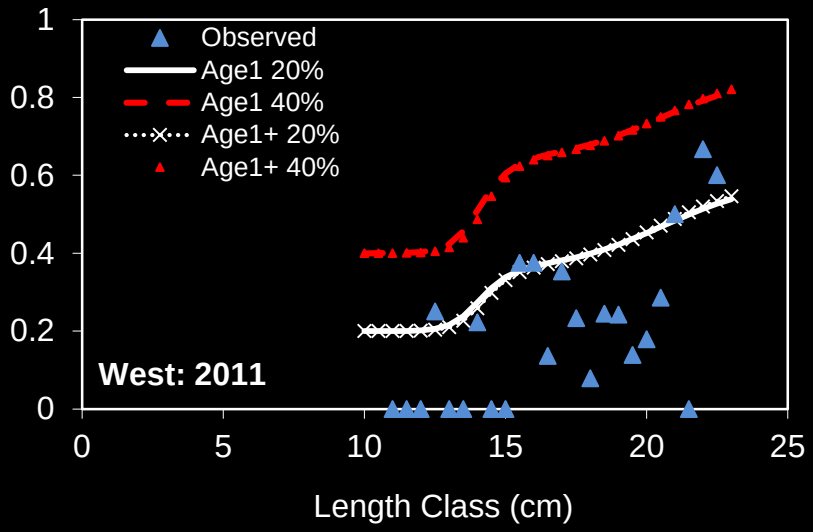
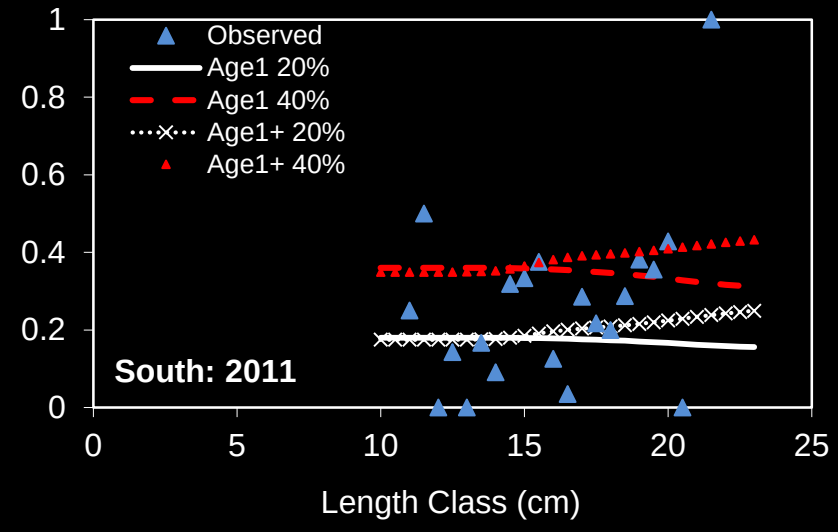
Comparison of Model Predicted Parasite Prevalence With Observations









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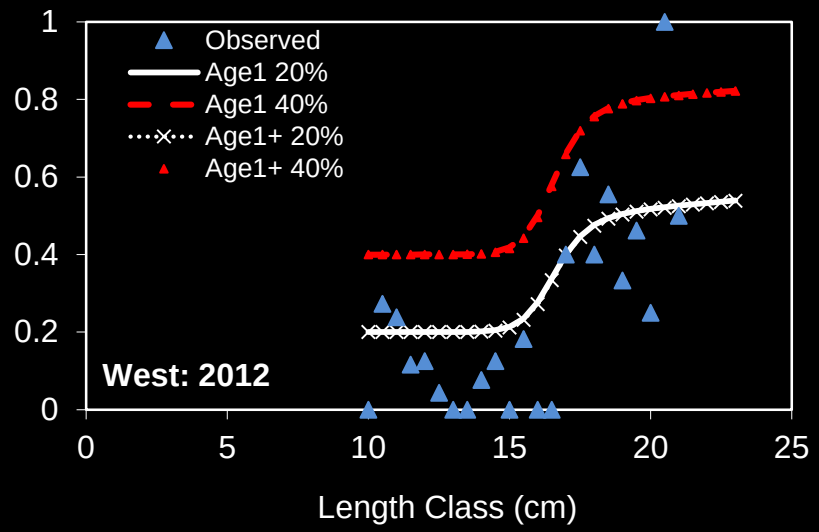

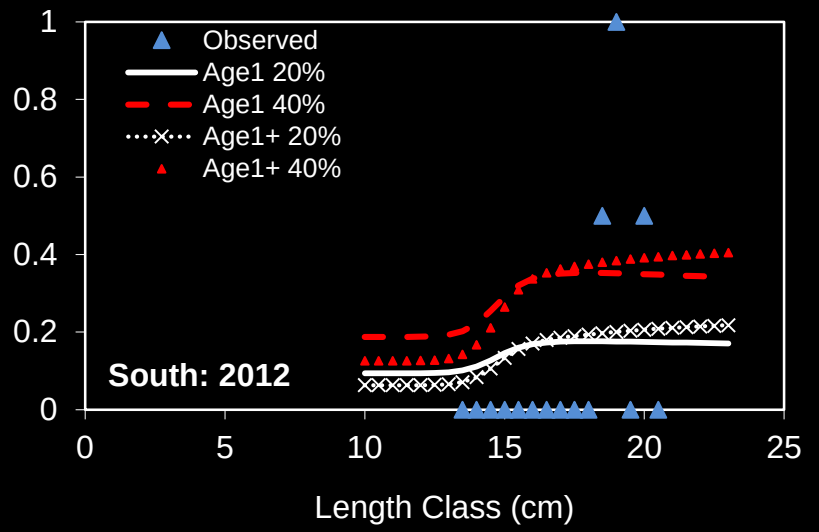

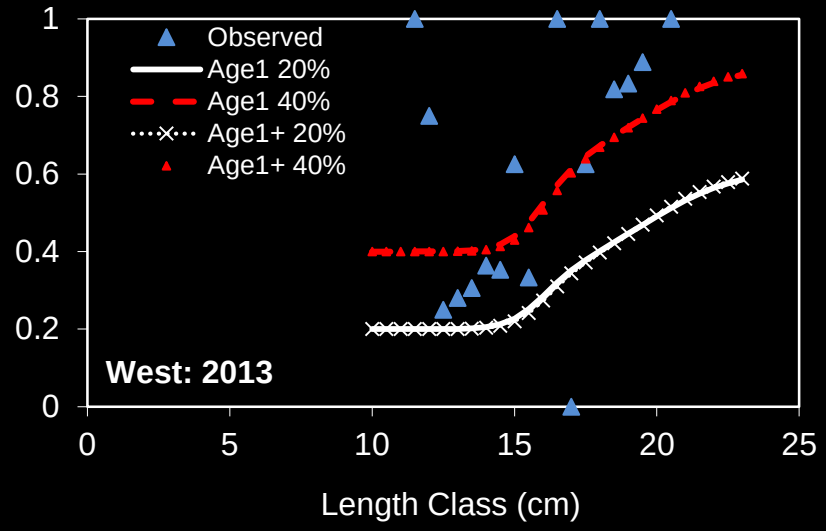

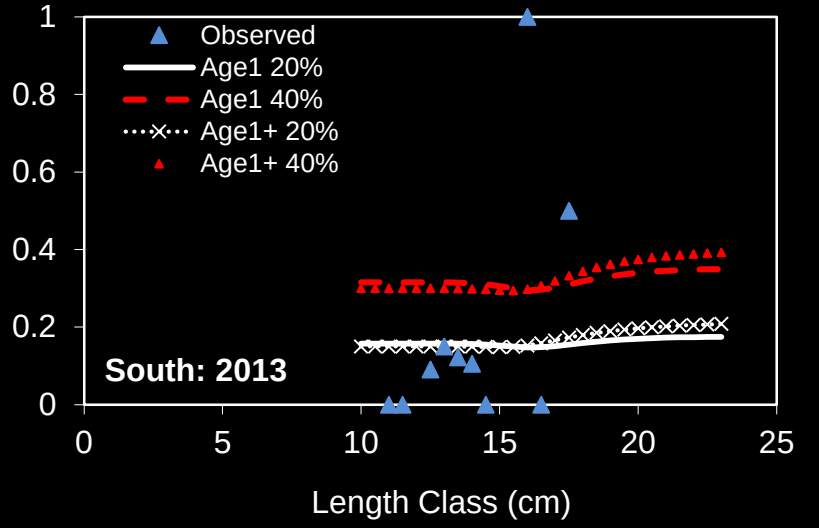

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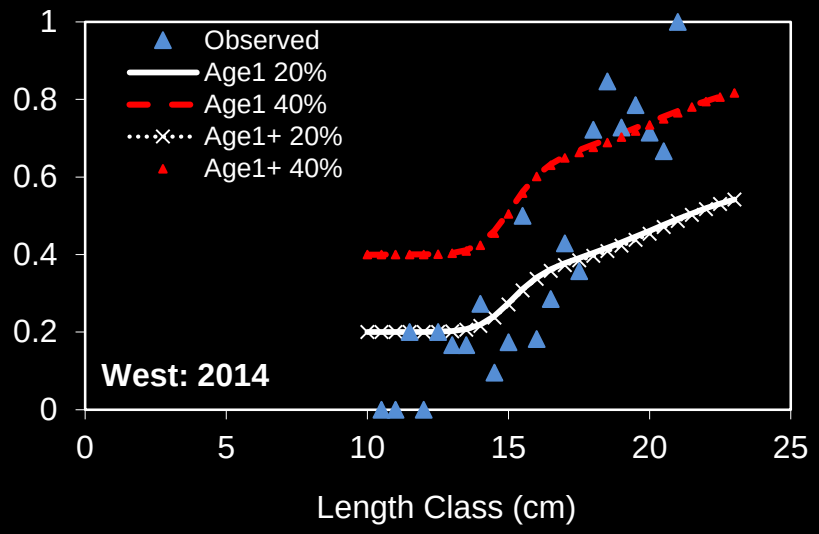

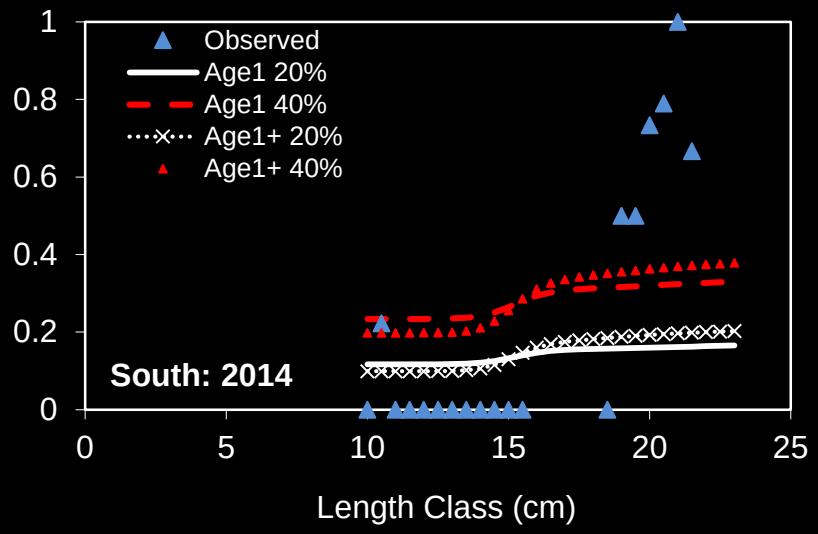

Some Discussion Points

Comment on the ongoing development of the two mixing stock hypothesis, and the use of parasite data as a 'biological tag':

- The revised model structure
- Fitting the model to parasite prevalence data (and/or parasite intensity data)
- Assuming a time- and age-invariant infection rate
- Estimating annual age-1 movement proportions, with ages 2+ a time-invariant proportion of those estimates
- Modelling two south stock co-horts (1 Nov, 1 May) to account for winter spawning
- The chosen stock-recruitment relationship

An overview of the key issues to be discussed relating to the South African sardine two-mixing-stock hypothesis

Thank you for your attention