

South African Sardine: Setting TAC/Bs during Exceptional Circumstances (and beyond)

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environmental affairs

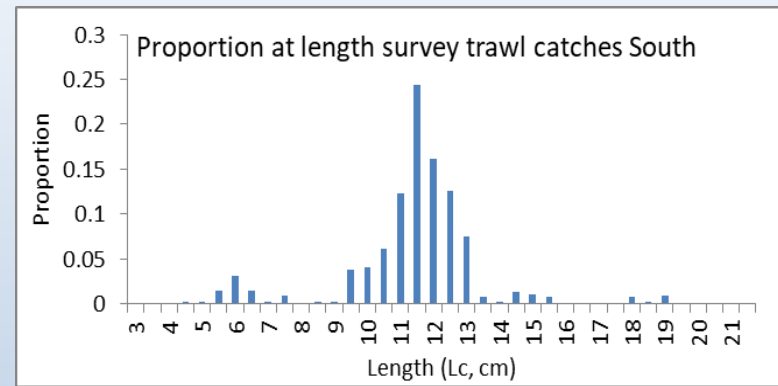
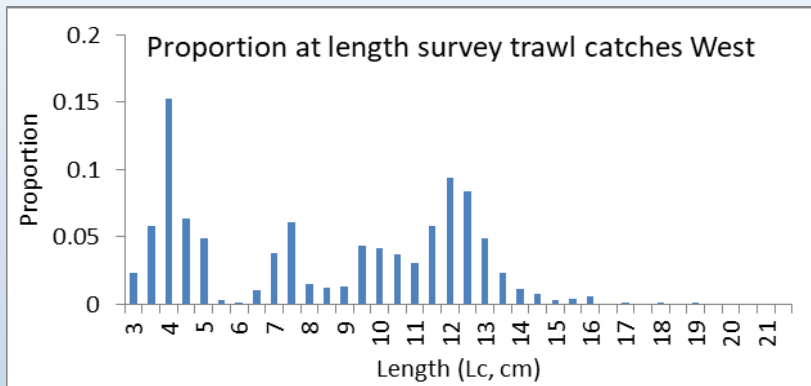
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Environmental Affairs
REPUBLIC OF SOUTH AFRICA

Length Frequencies

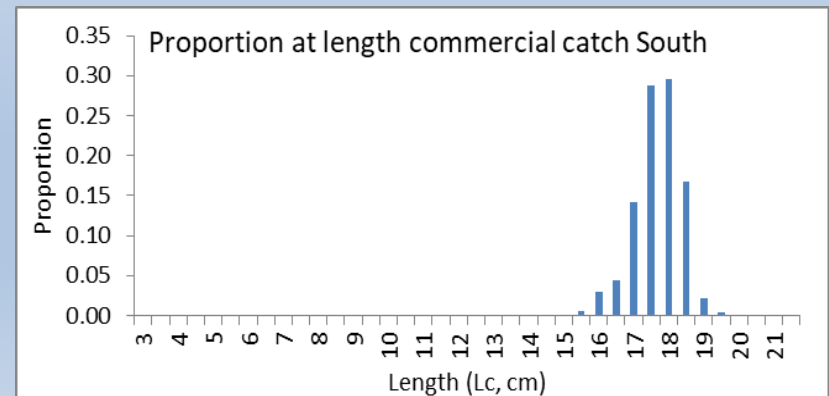
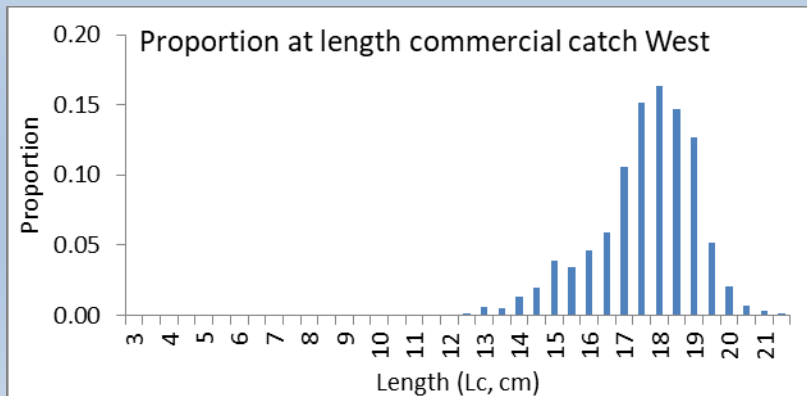
- Acoustic survey methods
 - Accurate acoustic assessment of biomass depends on successful identification and
 - Estimation of the length distribution of the sound reflecting organisms
 - Both identification and length frequency estimation relies on unbiased trawl sampling
 - Trawling success is limited by:
 - Degree of species mixing
 - Selectivity of gear
 - Ability to take spatially discrete samples

Length Frequencies

November 2019 survey length frequency



Oct-Dec 2019 commercial catch length frequency

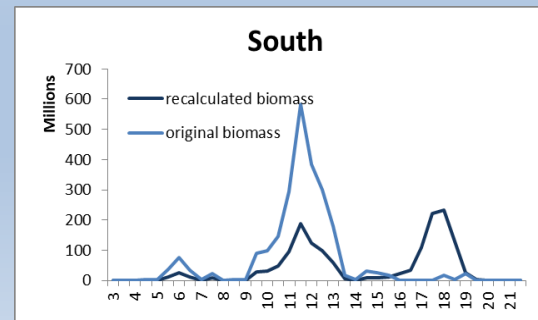
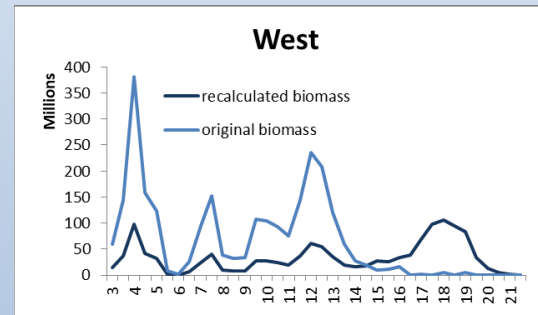
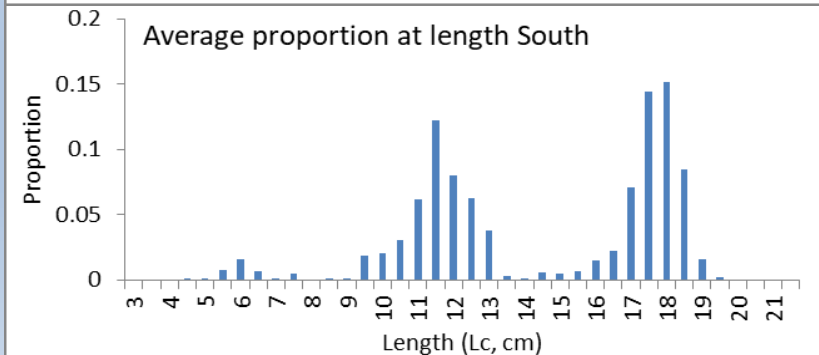
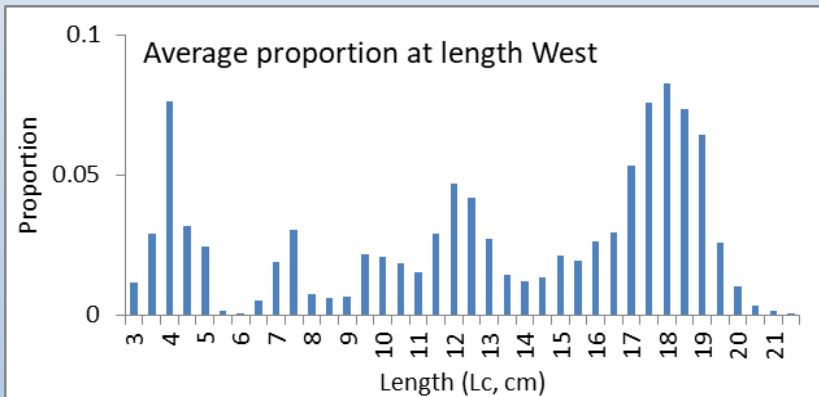


Length Frequencies

- Survey trawls under-sampled larger fish
- Impacts on biomass estimation estimated through a combined survey and catch length frequency

West	Biomass	Rev/old	Numbers	Rev/old
Original Bio	34 845		2.49E+09	
New biomass	57 448	1.65	1.29E+09	0.52

South	Biomass	Rev/old	Numbers	Rev/old
Original Bio	55 922		2.39E+09	
New biomass	75 668	1.35	1.54E+09	0.65

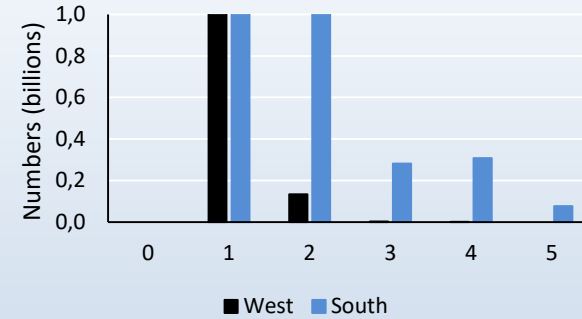
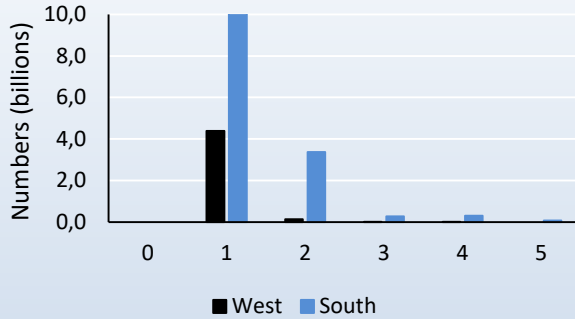


Fishery does not target <14 cm sardine → upper bound on impact of length

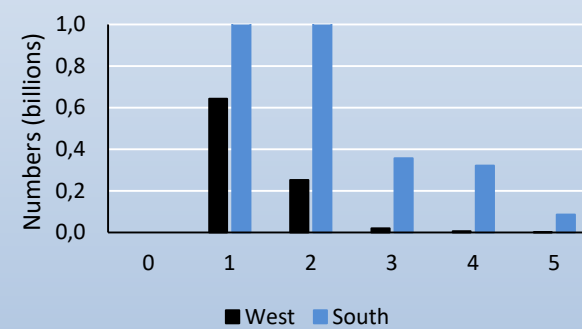
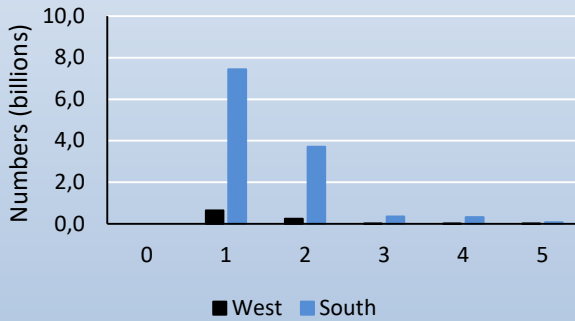
No adjustment for impacts on species composition

Length Frequencies

Baseline



Alt LF

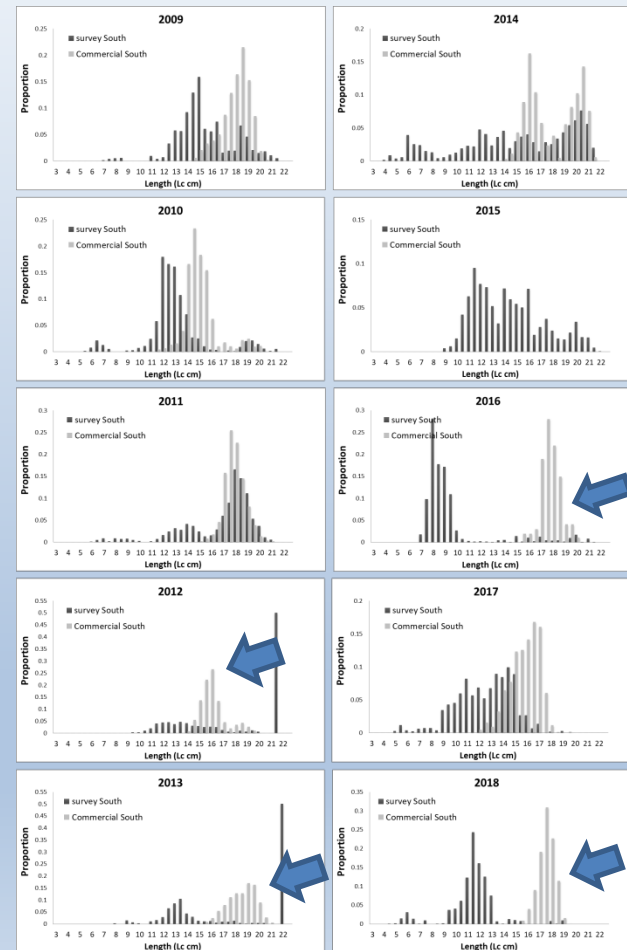
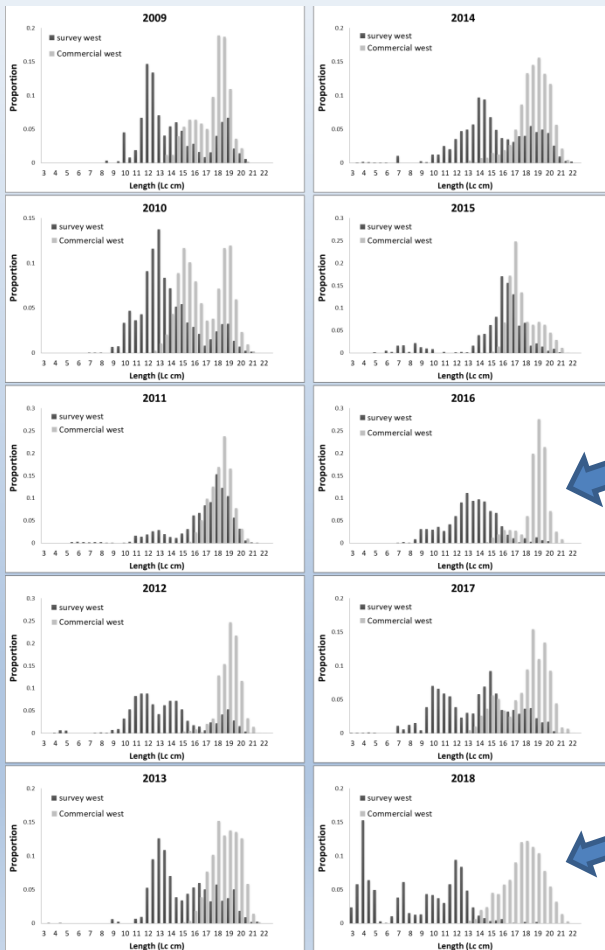


Length Frequencies

How often has this occurred previously?

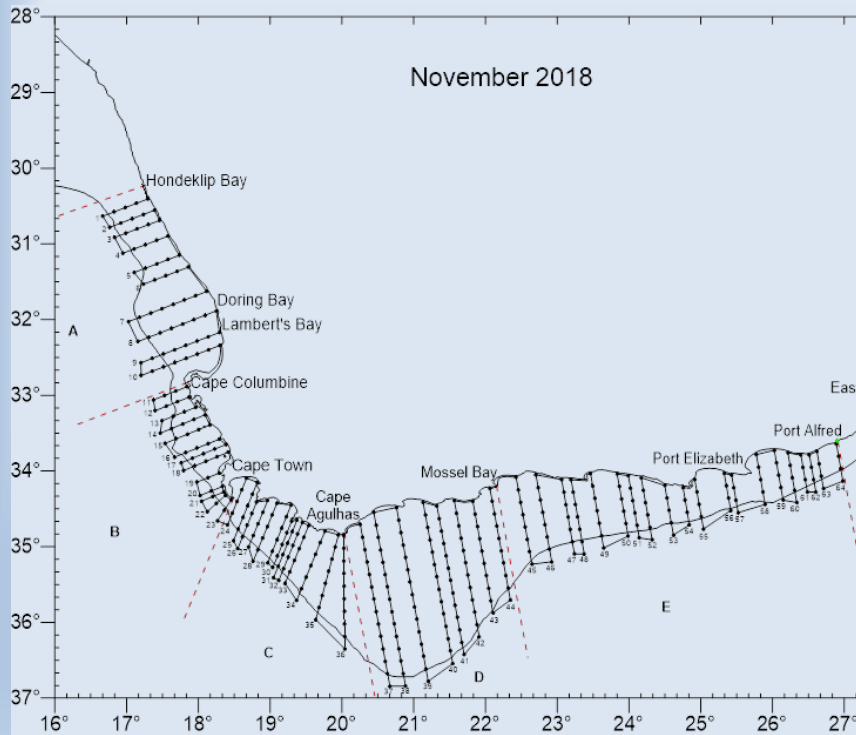
West

South



Length Frequencies

- How to incorporate alternative length into survey estimates?



- Currently density (ρ_j) for each species j is calculated for each interval (section of transect)
- This requires that a **length distribution** and **species composition** is associated with each interval (typically from the closest trawl)

$$\rho_j = \frac{w_j \cdot S_A}{4\pi \cdot 1852^2 \sum_j^n W_j (\bar{\sigma}_{bs})_j}$$

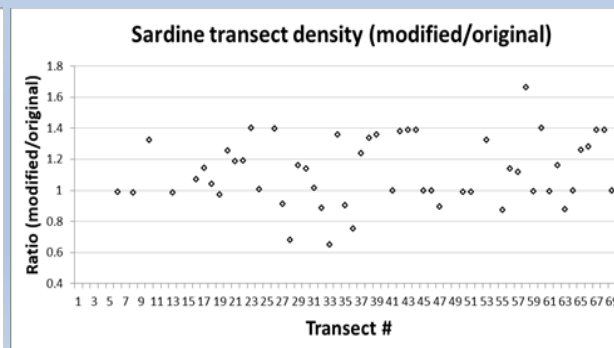
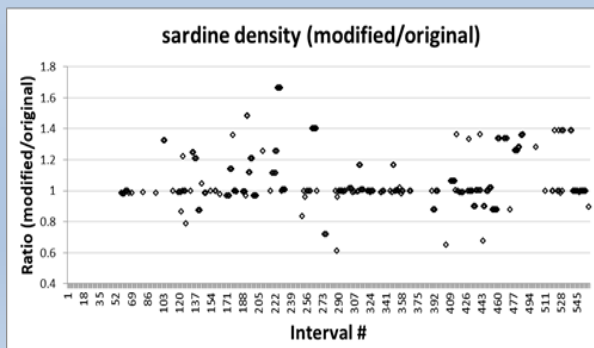
where

$$(\bar{\sigma}_{bs})_j = \frac{\sum_{li} \left[n_{li}^j (10^{(0.1)a_j}) \left(l_i \frac{b_j}{10} \right) \right]}{\sum_{li} n_{li}^j}$$

Length Frequencies

How to incorporate alternative length into survey estimates?

- Density (ρ_j) for each species j is averaged for each transect and stratum, then scaled up to biomass by stratum area.
- Commercial catch length frequency or model estimated numbers at length would typically be available at the regional scale (West Coast/South Coast)
- Incorporating **regional scale information** at the interval level disregards spatial structure in the length of the population and leads to **altered interval, transect and stratum densities** as well as altered estimates of **precision** of sardine and **other species**.



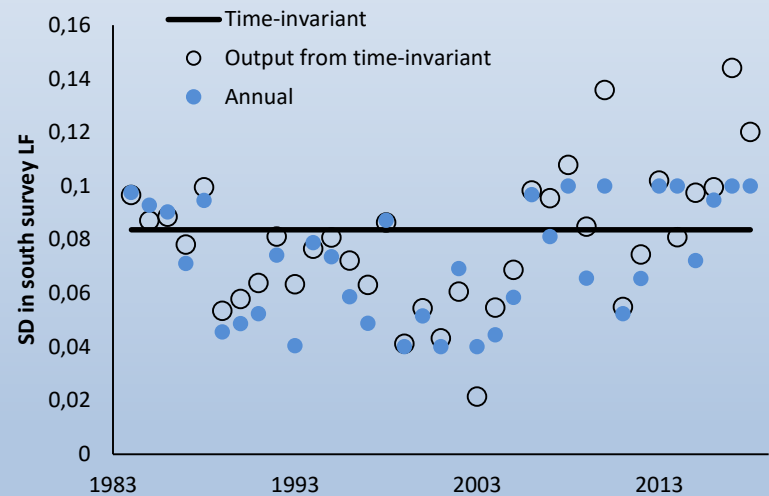
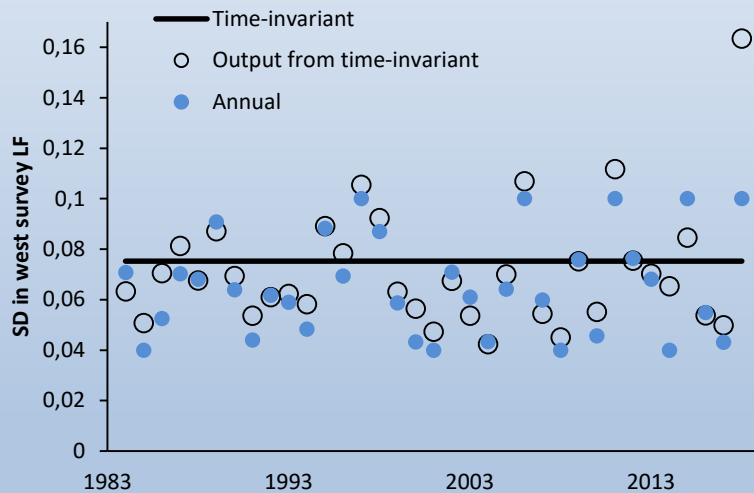
Sardine	Biomass	CV
Original trawl lf	4 206 250	0.227
Regional lf	3 435 811	0.211
% change (-)	18.32	
Anchovy	Biomass	CV
Original trawl lf	3 867 649	0.154
Regional lf	3 895 922	0.155
% change (+)	0.73	

Length Frequencies

- What is the best way to account for the under-representation of large sardine in the November 2018 survey length frequency? What is the best way to determine if a commercial or survey length frequency should be down weighted (in particular, for example, the 2019 length frequencies)? If a survey length frequency is biased or unrepresentative, what is the best length frequency (e.g. weighted survey and commercial) i) to apply to the interval-specific densities used in calculating the survey estimate of biomass and ii) to use as data to condition the assessment model. If a commercial length frequency is biased or unrepresentative, what is the best length frequency for conditioning the assessment model?
- Consider
 - in terms of short-term projections for setting 2020 TAC/Bs
 - in terms of general best practice for future survey calculations / assessments / OMP development

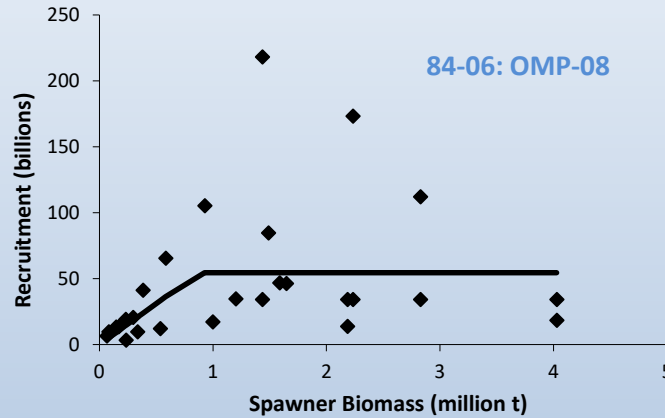
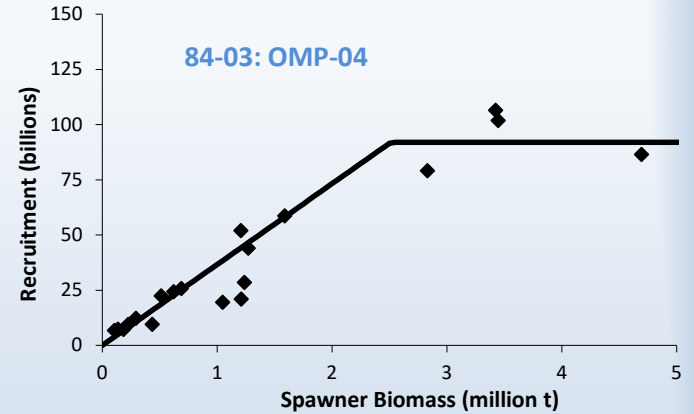
Length Frequencies

- Sensitivity test: estimate SD in survey LF annually

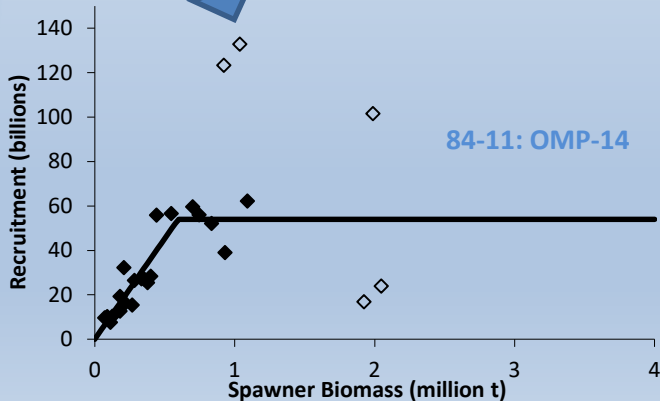


Simulating Future Recruitment

- OMPs



“pulse” years

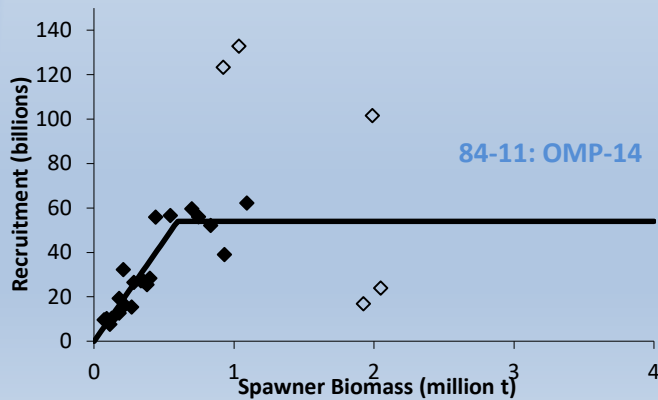
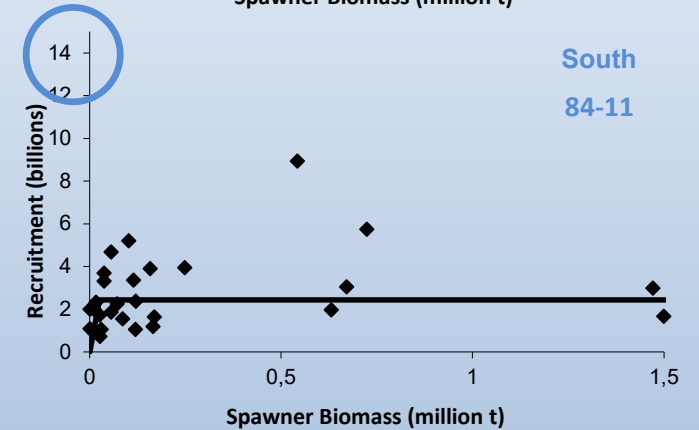
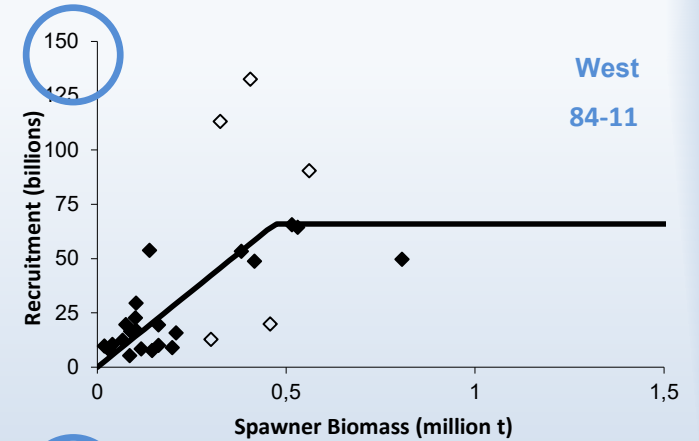


B^{SP} changed from 1+ biomass to 2+ biomass

Single stock hypothesis

Simulating Future Recruitment

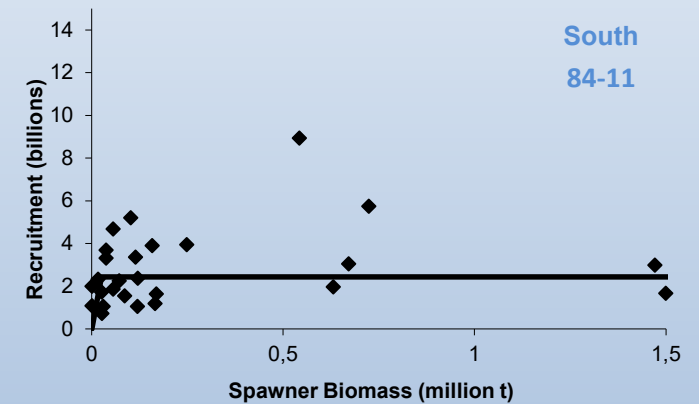
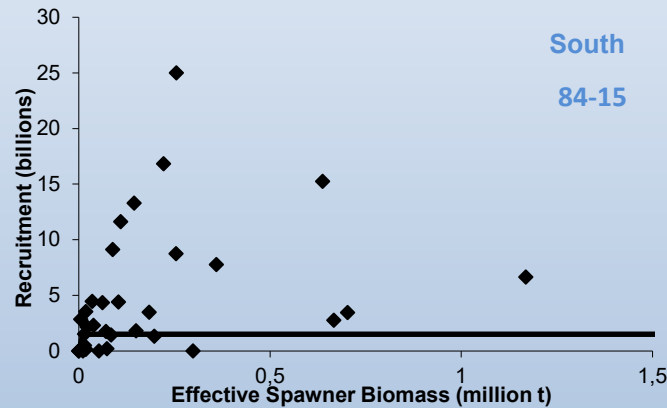
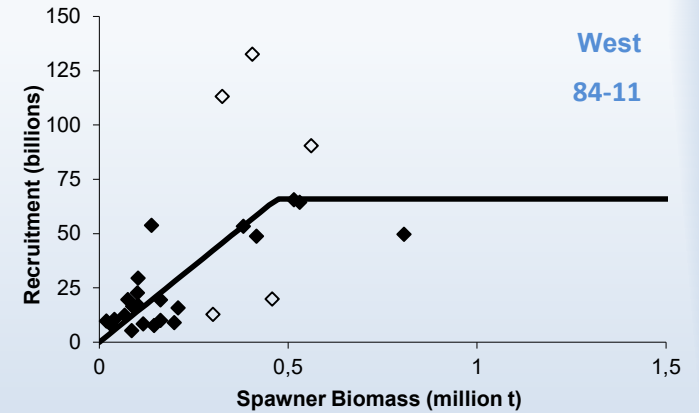
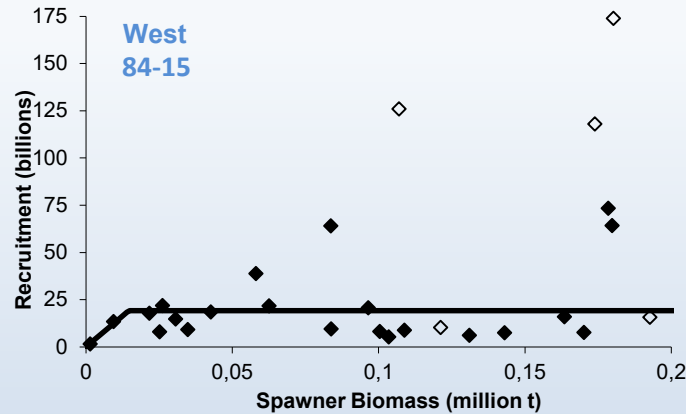
- OMPs



Two 'component'
hypothesis

Simulating Future Recruitment

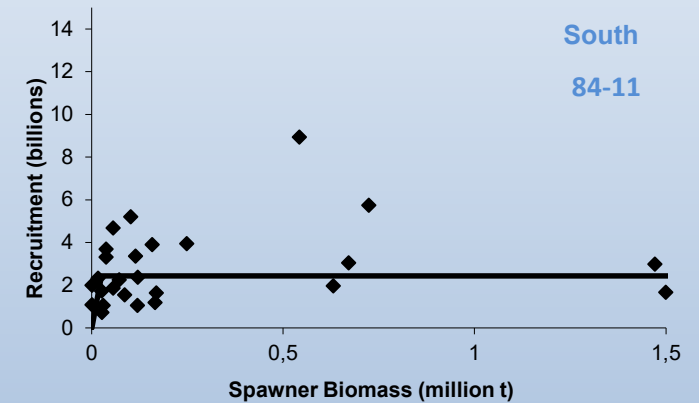
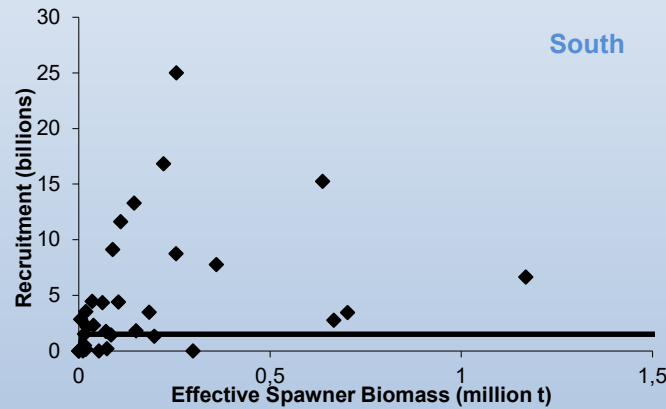
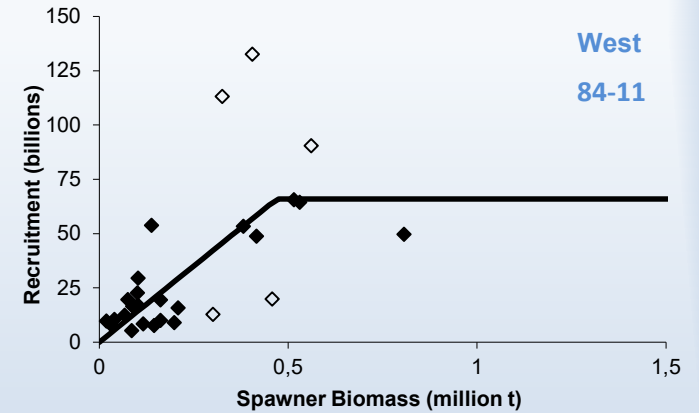
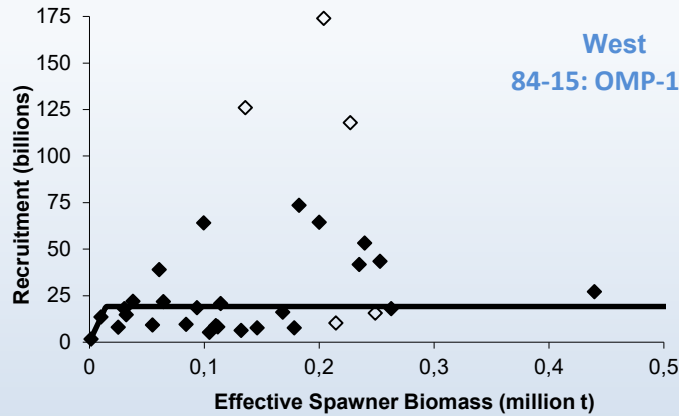
- OMPs



B^{SP} changed from knife edge (2^+ biomass) to maturity-at-length ogive AND "effective" B^{SP}

Simulating Future Recruitment

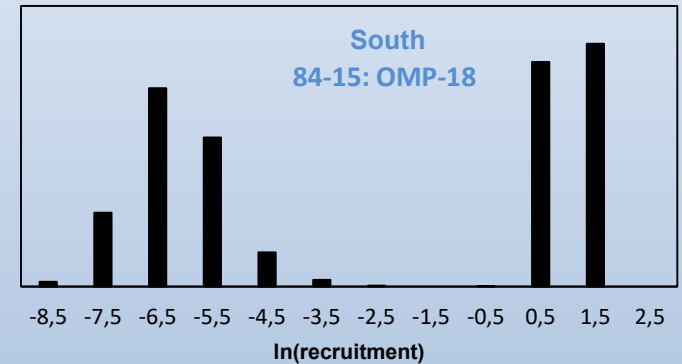
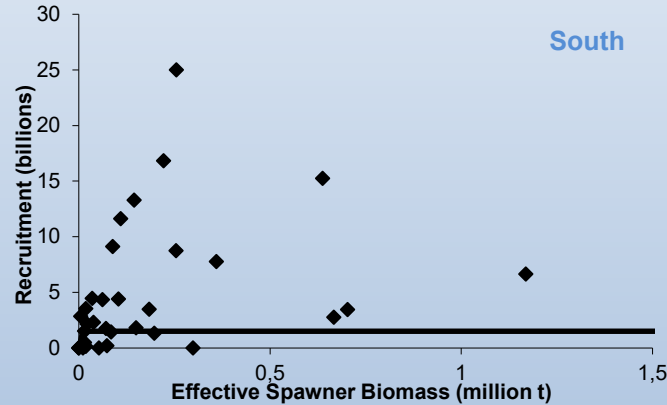
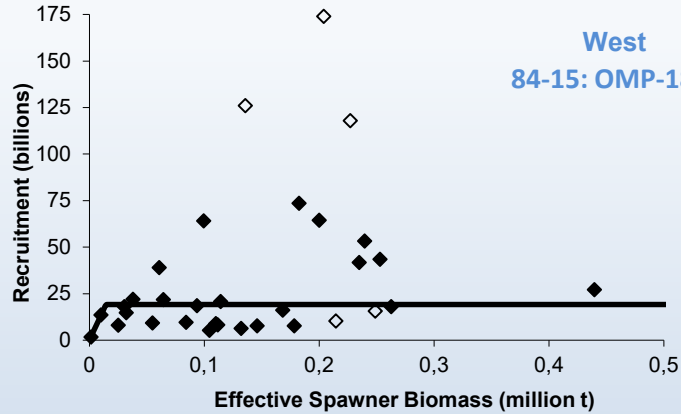
- OMPs



B^{SP} changed from knife edge (2^+ biomass) to maturity-at-length ogive AND "effective" B^{SP}

Simulating Future Recruitment

- OMPs

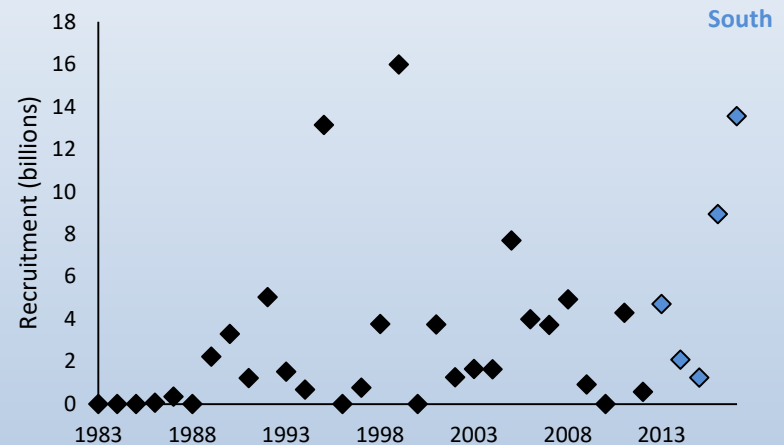
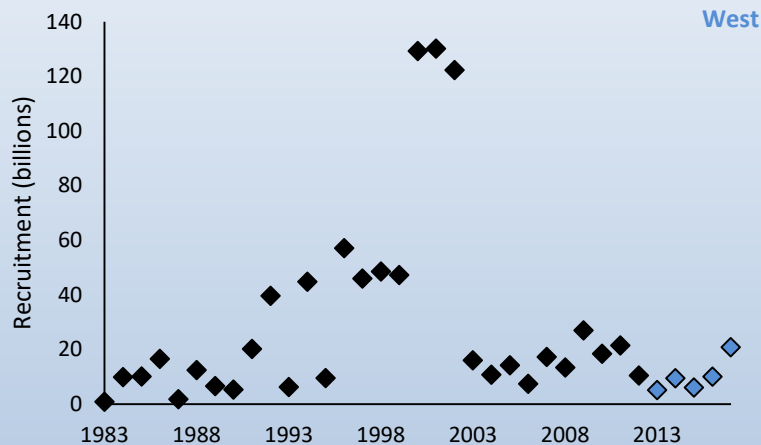


Simulating Future Recruitment

- What is the best way to model recruitment to both the west and south components of South African sardine?
- Consider
 - in terms of short-term projections for setting 2020 TAC/Bs, i.e. Nov 2019 recruitment
 - in terms of general best practice for e.g. OMP development

Simulating Future Recruitment

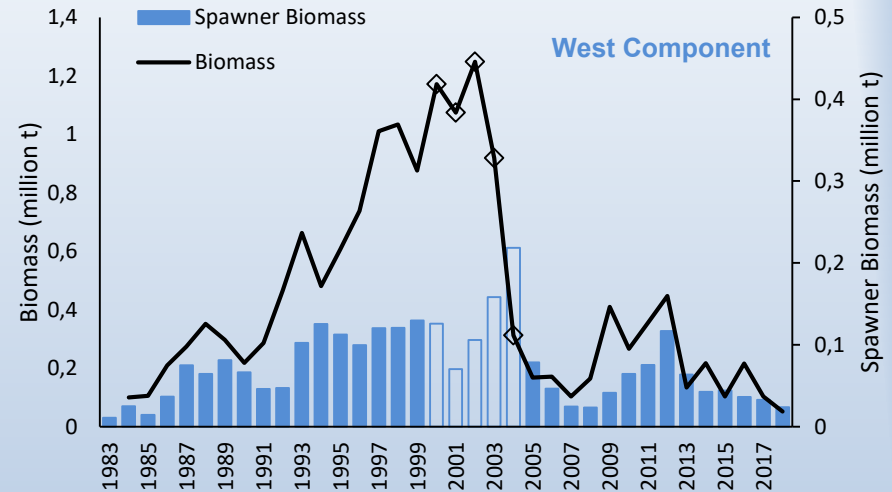
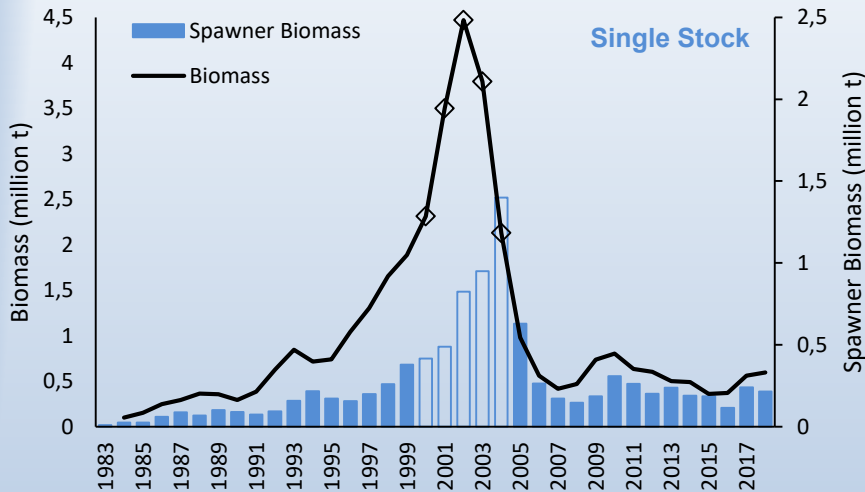
- Short-term projections to inform 2019 & 2020 TAC/Bs



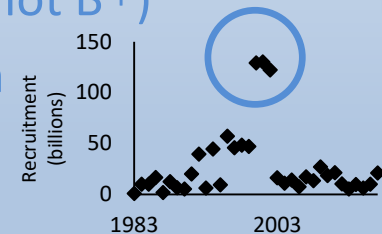
- Immediate short-term recruitment most likely from a similar “regime” to that of the recent past
- Note that 2017 recruitment may be poorly estimated
- Projections to inform 2019 TAC/Bs used 2013-2017 recruitment

Simulating Future Recruitment

- Future projections

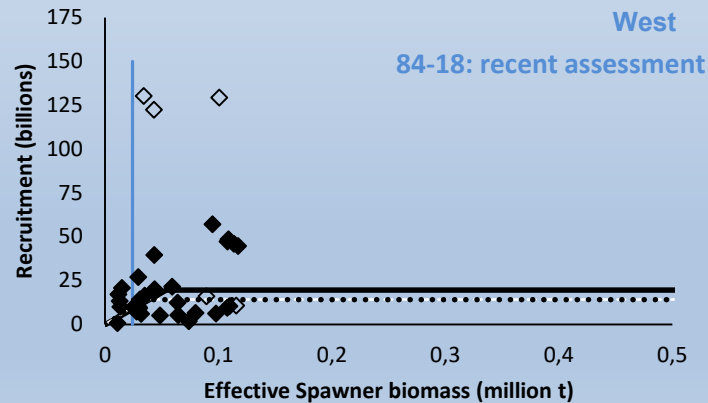
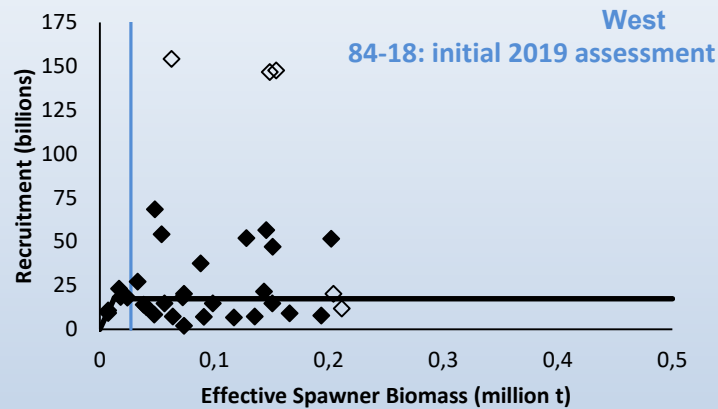
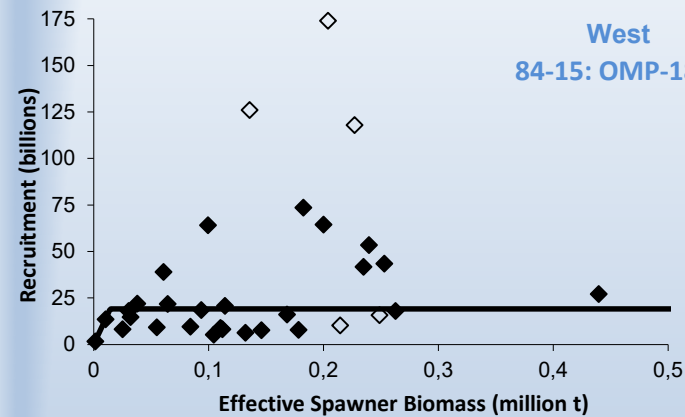


- Choice of pulse years – 2000-02 has peak west recruitment (not B^{sp})
- SR curve for west component, with residuals resampled from historical time series (nonparametric v parametric)
- ‘Two-step’ model for south component
- Or resample from historical recruitments (from which time period?)
- Note low hinge-point can be influential in management decisions!



Simulating Future Recruitment

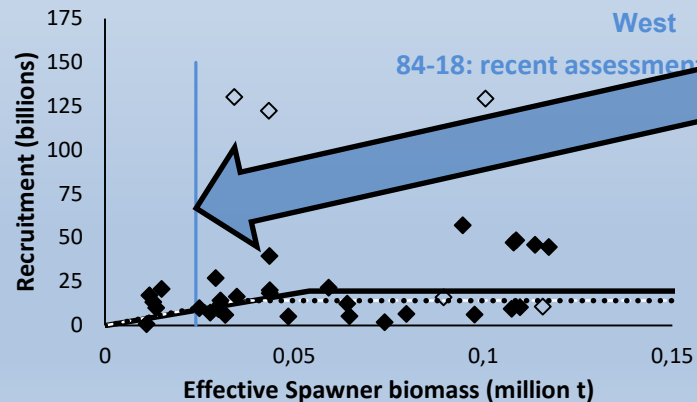
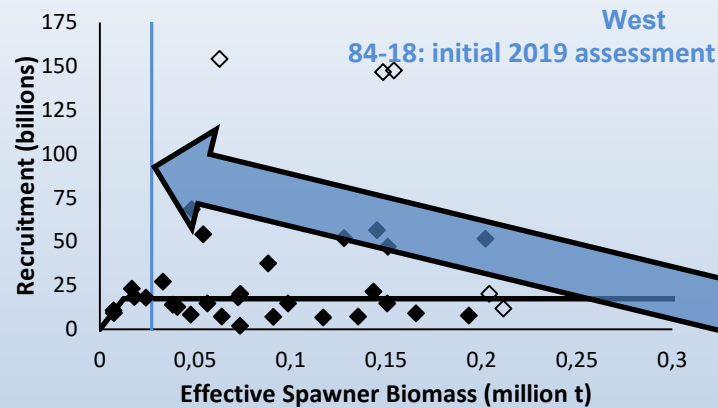
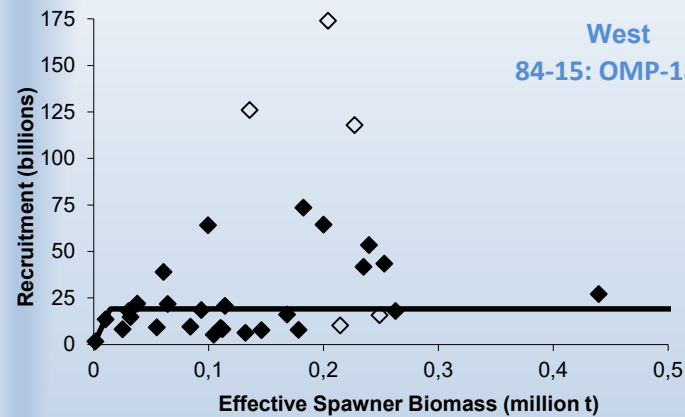
- Future projections



- Note low hinge-point can be influential in management decisions!

Simulating Future Recruitment

- Future projections



Nov 2018 B^{sp}

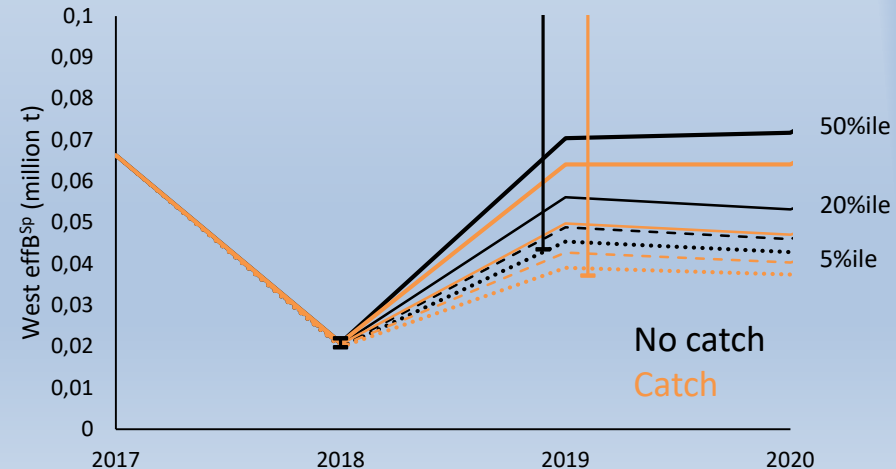
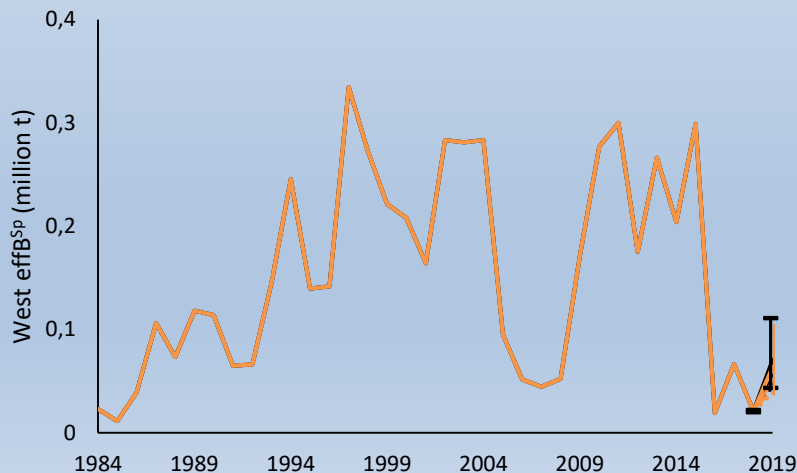
- Note low hinge-point can be influential in management decisions!

Basis for making short term management recommendations

- For the highly depleted sardine resource under Exceptional Circumstances provisions, the decision on TAC and TAB recommendations amounts to the choice of what fraction of any projected population growth should remain in the resource to improve future recovery prospects, and what should be taken as a harvest, noting the high dependency of 1-year ahead projections for this short-lived species on the assumed incoming recruitment.
- What are typical splits used in these circumstances for similar fisheries elsewhere?

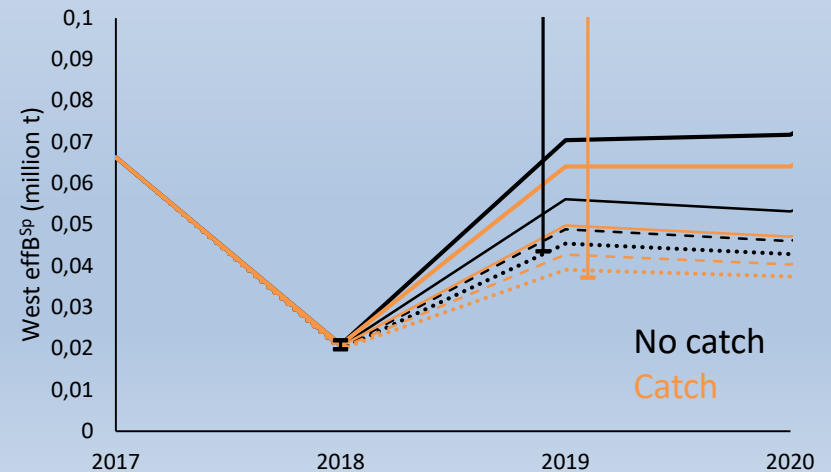
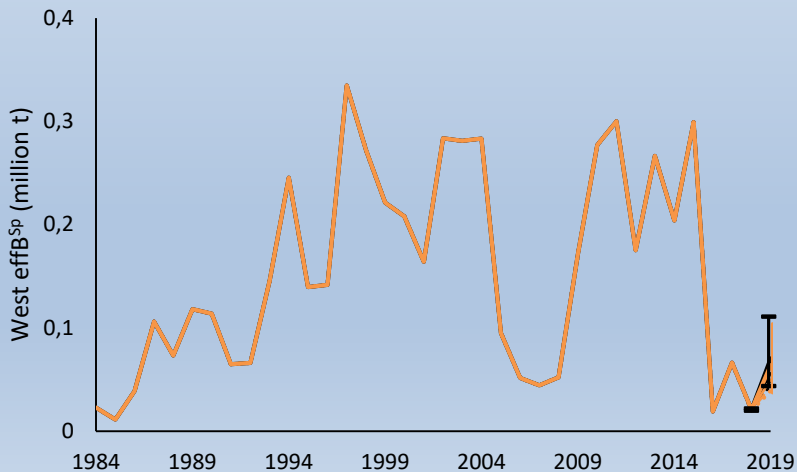
Basis for making short term management recommendations

- Recommendations based on a projection from Nov 2018-19 only
- The additive change (\uparrow or \downarrow) in west $effB^{Sp}$ ($effB_{2019}^{Sp} - effB_{2018}^{Sp}$)
- The multiplicative change in west $effB^{Sp}$ ($effB_{2019}^{Sp} / effB_{2018}^{Sp}$)
- The west $effB_{2019}^{Sp} / effB_{2007}^{Sp}$
- Considered the 20%ile of $[effB_{2019}^{Sp,i} / effB_{2018}^{Sp,i}] i = 1 \dots 100$



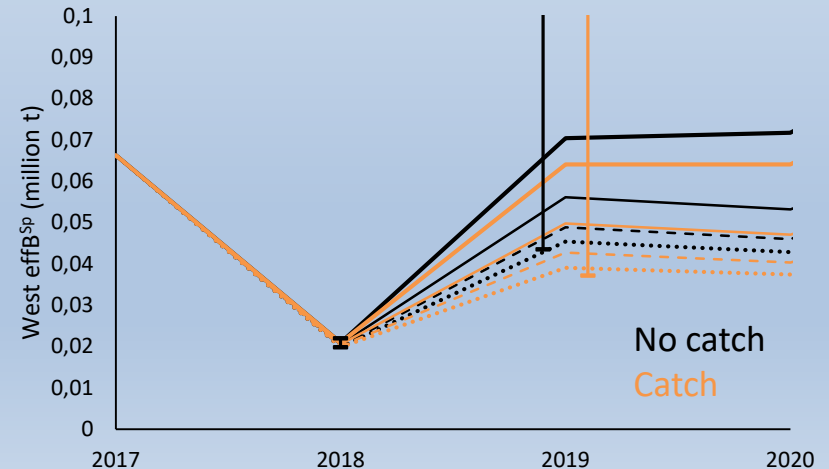
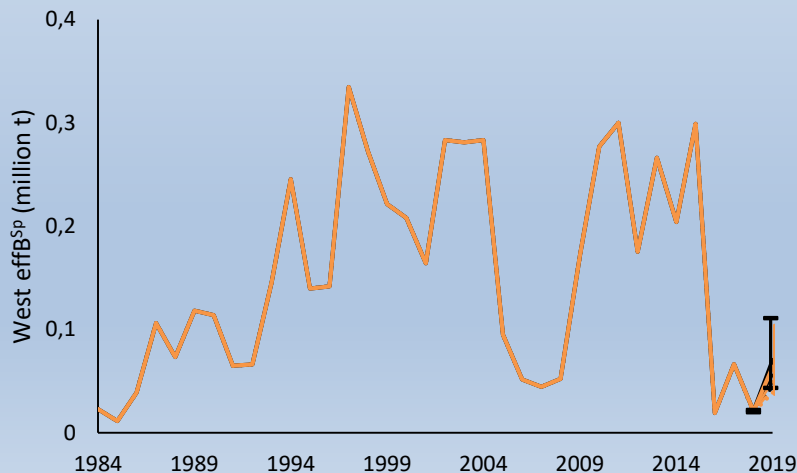
Basis for making short term management recommendations

95% Confidence Intervals	Baseline ('000t)	
$effB_{2018}^{Sp}$	[19.8, 22.0]	
No catch $effB_{2019}^{Sp}$	[43.5, 110.8]	
Catch $effB_{2019}^{Sp}$	[40.2, 107.4]	
$effB_{2019}^{Sp}/effB_{2018}^{Sp}$	[1.8, 5.1]	
$effB_{2019}^{Sp} - effB_{2018}^{Sp}$	[16.4, 84.1]	



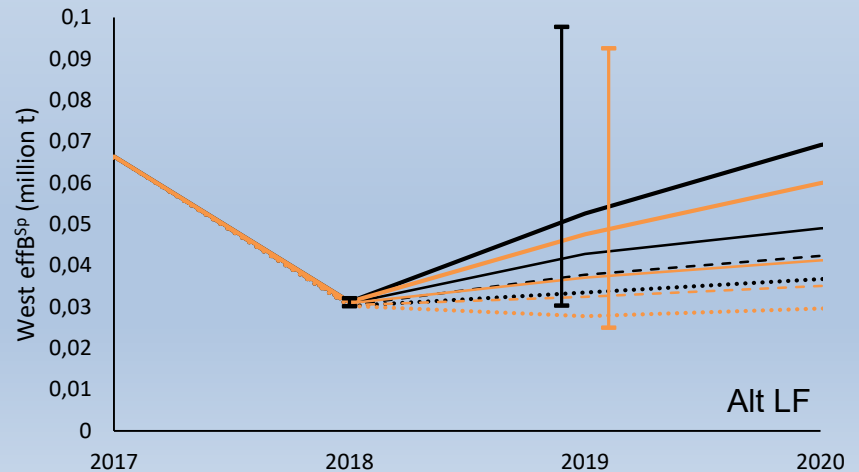
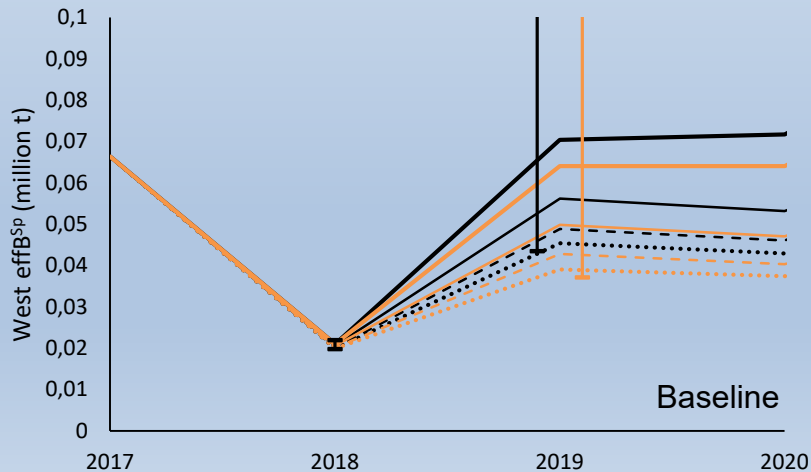
Basis for making short term management recommendations

- Recommendations based on a projection from Nov 2018-19 only
- The multiplicative change in west $effB^{Sp}$ ($effB_{2019}^{Sp}/effB_{2018}^{Sp}$)
- Considered the 20%^{ile} of $[effB_{2019}^{Sp,i}/effB_{2018}^{Sp,i}] i = 1 \dots 100$
- Aimed for 20%^{ile} of catch : 20%^{ile} of no catch ~ 0.80



Basis for making short term management recommendations

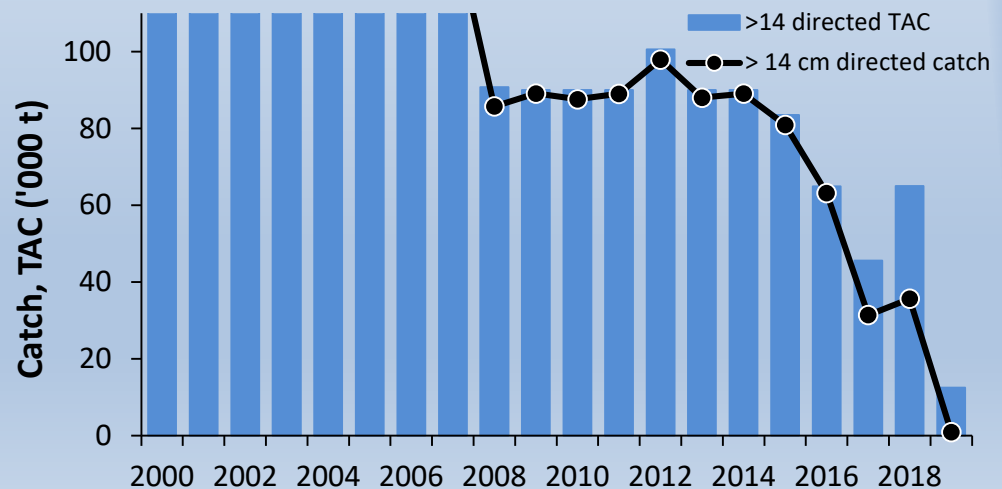
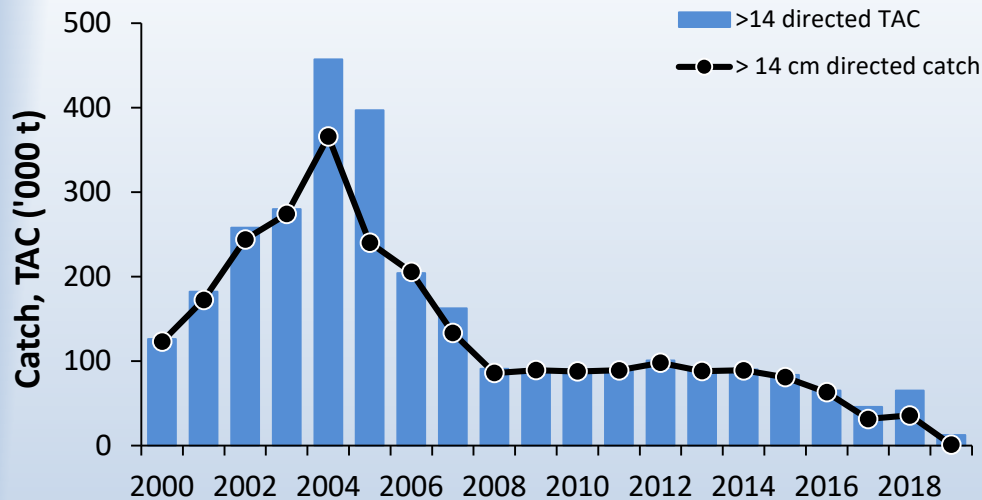
95% Confidence Intervals	Baseline ('000t)	Alternative LF ('000t)
$effB_{2018}^{Sp}$	[19.8, 22.0]	[30.1, 32.1]
No catch $effB_{2019}^{Sp}$	[43.5, 110.8]	[30.3, 97.7]
Catch $effB_{2019}^{Sp}$	[40.2, 107.4]	[25.0, 92.5]
$effB_{2019}^{Sp}/effB_{2018}^{Sp}$	[1.8, 5.1]	[0.8, 3.0]
$effB_{2019}^{Sp} - effB_{2018}^{Sp}$	[16.4, 84.1]	[-6.2, 62.1]



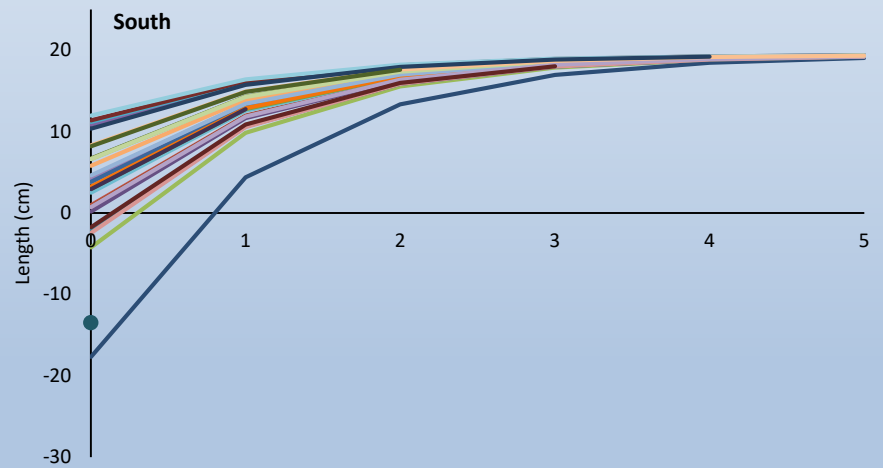
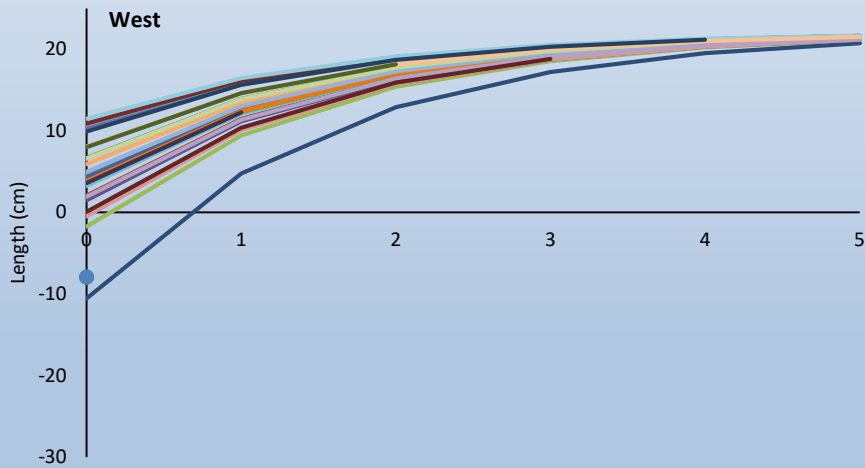
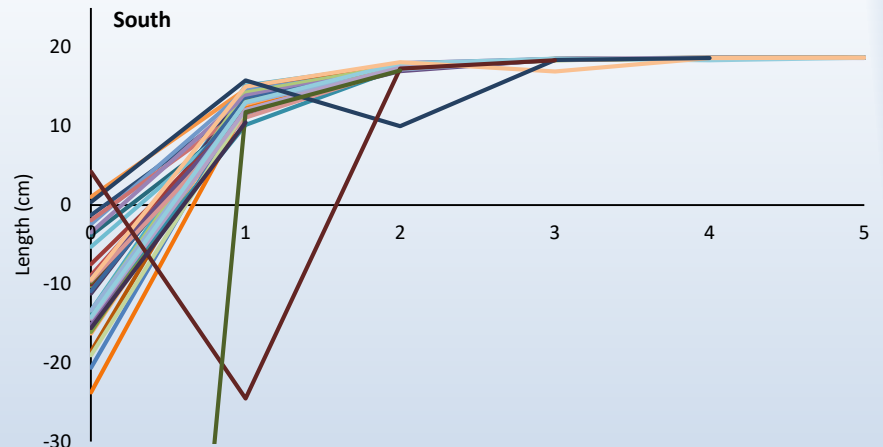
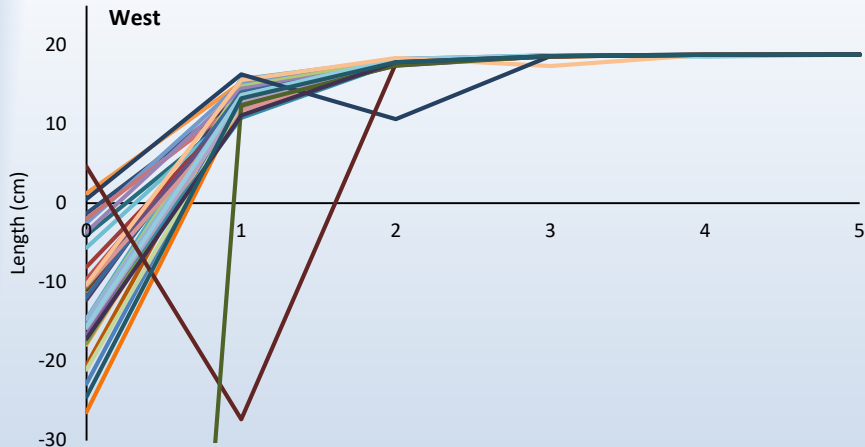
Basis for making short term management recommendations

- Four alternative hypotheses: above two most likely
- Sensitivity tests:
 - i) movement
 - ii) recruitment
 - iii) weight-at-length
 - iv) low start (survey error)
- No allowance for e.g. depensation (natural M)
- Decision still made based on “baseline” hypothesis
- 2020 hypotheses/sensitivity tests likely similar

Basis for making short term management recommendations

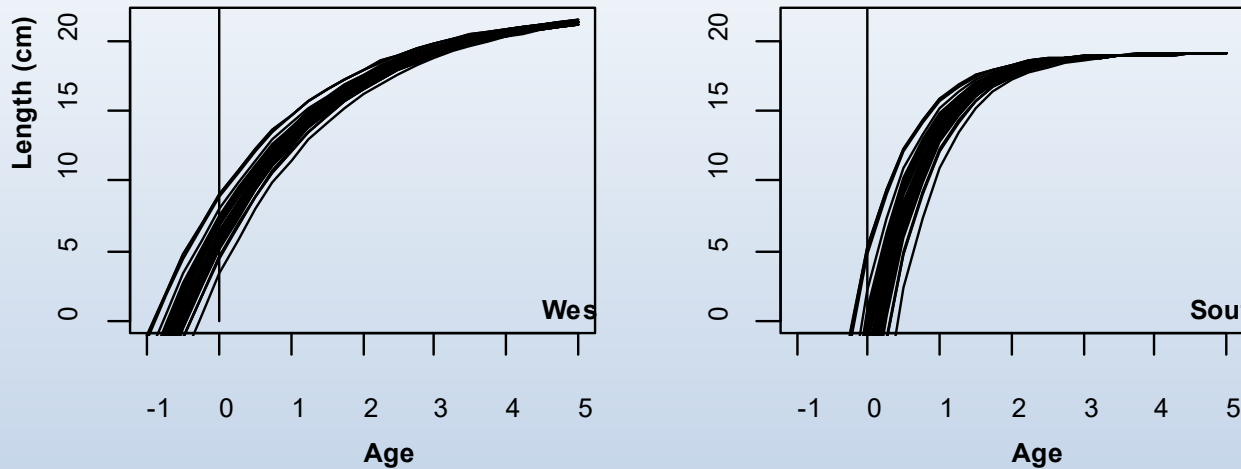


Growth



- Use growth curves according to cohort
- Decrease the range of t_0 's

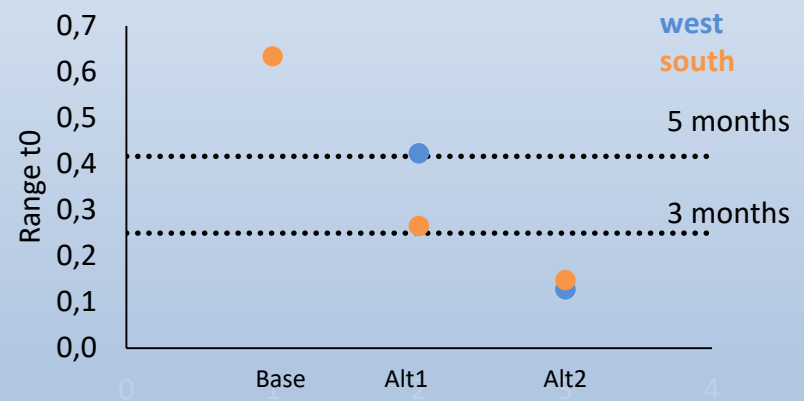
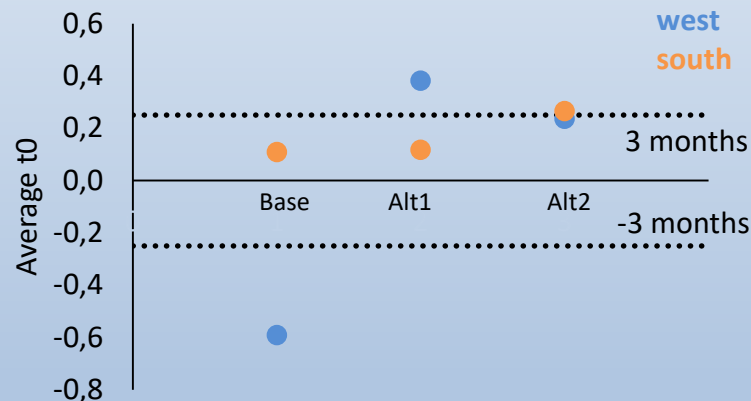
Growth



- Range of t_0 s: ~7 months
- Average t_0 west: April (early recruitment)
...but peak spawning is Aug-Feb
- Average t_0 south: December

Growth

- Alternative 1: Adjust* growth curve for $a < 1$
- Alternative 2: Adjust* growth curve for $a < 0.5$



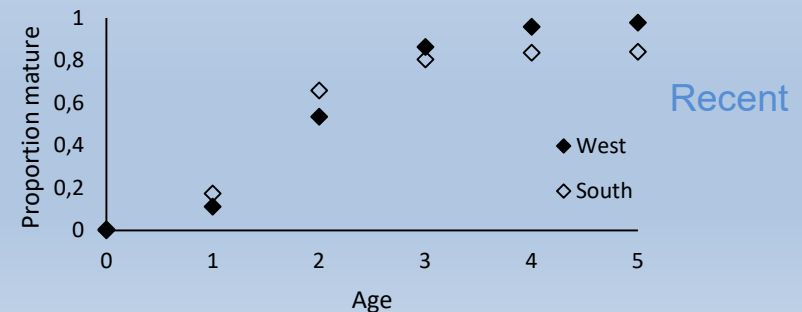
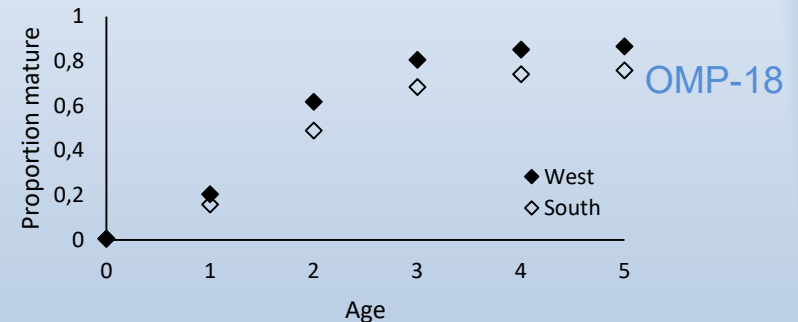
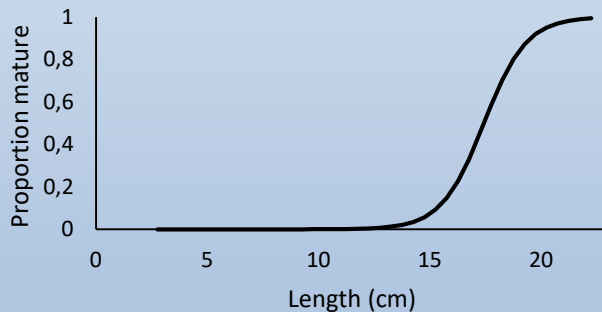
* 1.2k that is continuous and derivative continuous at 1 or 6 months

Growth

- What is the best way to account for the apparent conflict in assumptions about the shape of the growth curve and range of t_0 between the fit to the data (particularly the parasite prevalence-at-length) and 'conventional understanding' that peak spawning/recruitment occurs between September and January for the west component.

Maturity/Selectivity-at-age

- Assessment uses maturity/selectivity/weight-at-length
- Projections use maturity/selectivity/weight-at-age
- Selectivity-at-age is renormalized
- Maturity-at-age isn't



Weight-at-length

- Previously: annual weight-at-length informed by average survey weight to account for differing condition factors of sardine at the time of the survey
- Weight-at-length to apply during 2019 was a key uncertainty during projections earlier this year (sardine had a poor condition factor in Nov 2018)
- Now: time-invariant weight-at-length independent of condition factor of sardine

**South African Sardine:
Setting TAC/Bs during Exceptional
Circumstances (and beyond)**

Thank you for your attention