The acceptable level of risk for the South African sardine resource

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History: OMP-14 risk

- Risk threshold: the average total sardine 1+ biomass between November 1991 and 1994

  Unchanged from earlier OMPs

- Risk definition: the probability that the total sardine 1+ biomass falls below the risk threshold at least once during the projection period of 20 years

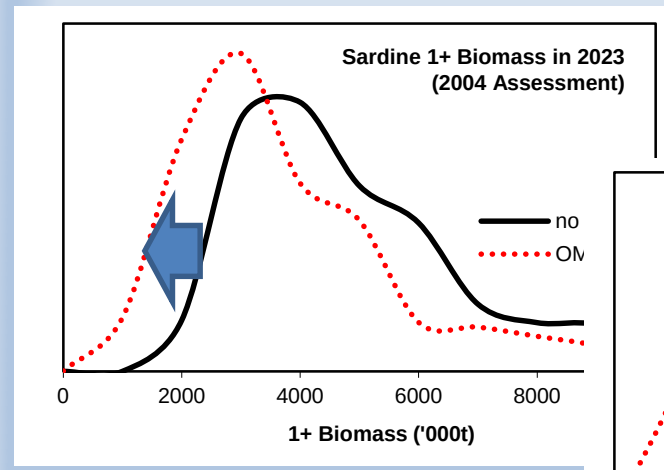
  Unchanged from earlier OMPs

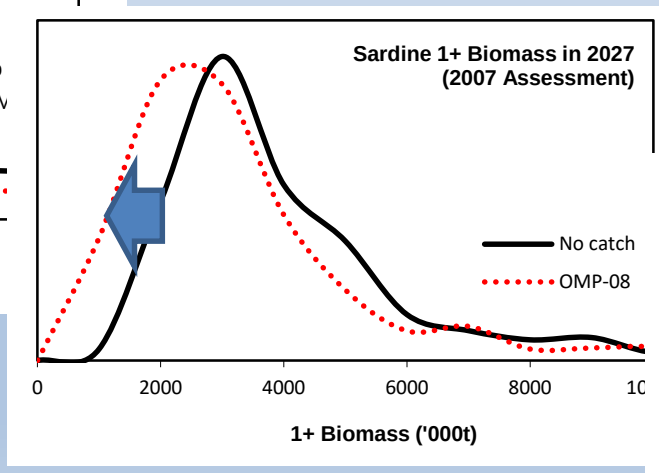
- Risk level: 21%

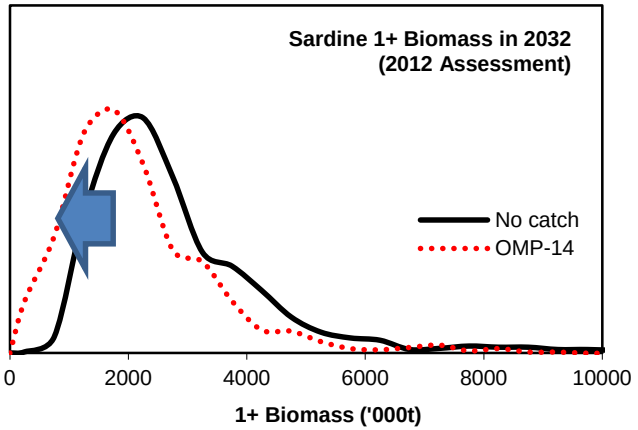
  Adjusted between OMPs to accommodate changes in understanding of resource dynamics

History: “Leftward shift”

- Maintaining the ratio of $20^{\%ile}$ B^{CMP}_{final} / B^{NoC}_{final} to be the same (=0.68) with similar ratios at other lower %iles
- Maintain the same level of ‘depletion’ of the sardine resource between OMPs, despite potential changes in understanding of resource dynamics as further data become available







Same biomass “currencies”

History:
Why the "Leftward Shift" couldn't be used straightforwardly for OMP-18

	OMP-14 (de Moor and Butterworth 2015)	OMP-18 (de Moor and Butterworth 2016)
Population structure	Single homogenous population	Two mixing stocks
Spawner biomass	2+ biomass	Maturity-at-length ogive
	Weight-at-age	Weight-at-length
Survey trawl selectivity	Three levels, with reduced availability at smaller and larger lengths	Logistic (allowing for some escapement of smaller fish)
Commercial selectivity	Time-invariant with 'inverted lognormal' distribution at larger lengths	Estimated separately for 4 time periods with logistic distribution at larger lengths
Bycatch	No observation error for bycatch	$F_{bycatch}$ estimated
Prior(Nov acoutic bias)	$k_{ac}^{S} \sim N(0.714, 0.077^2)$	$ln(k_{ac}^{S}) \sim N(-0.310, 0.094^2)$
Von-Bertalanffy growth parameters	Estimate κx L_∞ and L_∞	Estimate L_1 and L_3
t_0	Time invariant	Varies annually

- West component recruitment is primary contributor to recruitment for entire population
- West component recruitment dependent on west component $effB^{Sp}$

History:
Why the "Leftward Shift" couldn't be used straightforwardly for OMP-18

- Risk threshold: the sardine west component effective spawner biomass in November 2007
- Risk definition: the probability that the sardine west component effective spawner biomass falls below the risk threshold over the projection period of 20 years

  Less onerous measure of risk; current low sardine biomass

- The biomass "currency" of the risk threshold was changed from 1+ biomass to west component $effB^{sp}$.
- Total 1+ biomass no longer primary concern
- Leftward shift measures impact of fishing on total 1+ biomass

Draft OMP-18

- HCR parameter β tuned until depletion of total biomass under Draft OMP-18 (excluding red flags) was similar to that of total 1+ biomass under previous OMPs
- Risk level: 16% after red flags included

Bridging the inconsistencies

- Calculate ‘depletion’ of total spawner biomass under previous OMPs

	$B^{Sp,OMP}_{final} / B^{Sp,NoC}_{final}$			
	OMP-04	OMP-08	OMP-14	
10%ile	0.49	0.46	0.51	
20%ile	0.65	0.60	0.60	
30%ile	0.67	0.65	0.63	
40%ile	0.69	0.66	0.69	
50%ile	0.68	0.66	0.69	

Bridging the inconsistencies

- Calculate 'depletion' of total spawner biomass under previous OMPs
- Tune the HCR control parameter β so that CMP* (without red flags) has same level of depletion of west component effective spawner biomass

  (β=0.139 with $Risk^S$=0.166)

	$B^{Sp,OMP}_{final}$ / $B^{Sp,NoC}_{final}$			$^{eff}B^{Sp,OMP}_{final}$ / $^{eff}B^{Sp,NoC}_{final}$
	OMP-04	OMP-08	OMP-14	CMP*
10%ile	0.49	0.46	0.51	0.55
20%ile	0.65	0.60	0.60	0.60
30%ile	0.67	0.65	0.63	0.61
40%ile	0.69	0.66	0.69	0.63
50%ile	0.68	0.66	0.69	0.65

Bridging the inconsistencies

- Calculate 'depletion' of total spawner biomass under previous OMPs
- Tune the HCR control parameter β so that CMP* (without red flags) has same level of depletion of west component effective spawner biomass

  (β=0.139 with $Risk^S$=0.166)
- Realistically achievable $p(B_{west}<150)$ = that achieved with a preventative red flag of 50% TAC reduction

Corrective measure	None (CMP*)	Implicit 0.5*TAC	Implicit 0.5*TAC		
β	0.139	0.139	0.149		
$Risk^S$	0.166	0.154	0.156		
$p(B_{west}<150)$	0.116	0.108	0.110		
C^S_{tot}	**94** 77 [31,200]	**90** 73 [18,200]	**93** 78 [18,200]		

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- Realistically achievable $p(B_{west}<150)$ = that achieved with a preventative red flag of 50% TAC reduction
- Tune HCR control parameter β so that CMP** with preventative red flag has $p(B_{west}<150)$=0.110 (β=0.124 with $Risk^S$=0.155)

Corrective measure	None (CMP*)	Implicit 0.5*TAC	Implicit 0.5*TAC	CMP* with red flag	CMP**
β	0.139	0.139	0.149	0.139	0.124
$Risk^S$	0.166	0.154	0.156	0.160	0.155
$p(B_{west}<150)$	0.116	0.108	0.110	0.112	0.110
C^S_{tot}	**94** 77 [31,200]	**90** 73 [18,200]	**93** 78 [18,200]	**94** 77 [31,200]	**89 70** [31,200]

Bridging the inconsistencies

- Calculate 'depletion' of total spawner biomass under previous OMPs
- Tune the HCR control parameter β so that CMP* (without red flags) has same level of depletion of west component effective spawner biomass

  (β=0.139 with $Risk^S$=0.166)
- Realistically achievable $p(B_{west}<150)$ = that achieved with a preventative red flag of 50% TAC reduction
- Tune HCR control parameter β so that CMP** with preventative red flag has $p(B_{west}<150)$=0.110 (β=0.124 with $Risk^S$=0.155)
- Applying penalty/benefit red flag with β=0.124 results in $Risk^S$=0.153 ($CMP^{\#}$)

Managing RSA sardine using $CMP^{\#}$ means on average the west component $effB^{sp}$ would be below the lowest historical level (B_{lim}) 15% of the projection period

How does 15.3% compare internationally?

Country	Max Risk	Comments	CMP#
ICES	Risk1 = average $p(B^{sp}<B_{lim}) < 5\%$		15.3%
	Risk3 = max $p(B^{sp}<B_{lim}) < 5\%$		20% (17% over 2nd half of projection period)
Australia	$p(B^{sp}>B_{lim})>90\%$ i.e. $p(B^{sp}<B_{lim}) < 10\%$	B_{lim} ~20%B_0 or more conservative for less productive stocks and/or key forage species	15.3%
Chile Under review	$p(B^{sp}<50\%SSB_0)<10\%$	SSB_0 – level of B^{sp} in absence of catch 30% has recently been accepted for sardine	74% (55% under no catch)
Japan Under review	Minimise $p(B^{sp}<B_{lim})$	Most recent sardine risk was 0-3%	15.3%
USA	ACL ≤ ABC = 96% of OFL	OFL = catch corresp to F_{MSY}	
	If $B^{sp}_y<0.5B_{MSY}$, $p(B^{sp}_{y+10}>0.5B_{MSY})>50\%$		

Considers risk for Tier 1 stocks

Dynamic B_0

- Idea behind Leftward shift is to consider impact of harvesting in the context of what could be expected under a no catch scenario
- Dynamic B_0:

  - the reference level (B_0) is calculated under prevailing environmental conditions;

  - accounts for e.g. regime shifts

  - typically considers B_0 from recent years

$effB^{sp}_{west}{}^{CMP\#}/effB^{sp}_{west}{}^{NoC}$	5%ile	10%ile	median
2027	0.47	0.55	0.69
2028	0.47	0.53	0.69
2029	0.47	0.54	0.70
2030	0.47	0.53	0.70
2031	0.48	0.53	0.70
2032	0.47	0.54	0.69
2033	0.45	0.54	0.69
2034	0.47	0.54	0.70
2035	0.46	0.53	0.70
2036	0.47	0.53	0.70

Summary

- Applying "Leftward shift" in comparing biomass "currency" of interest (effB$^{sp}_{west}$) under CMP$^{\#}$ with that of B$^{sp}_{tot}$ under previous OMPs and following method previously used for red flags results in CMP$^{\#}$ with β=0.124 with Risk^{S}=0.153

  - "mismatching" Leftward shift based on B_{tot} had β=0.138 with Risk^{S}=0.160 for Draft OMP-18

- This level of risk (15.3%) is higher than that typically considered in other countries (5-10%)
- But risk is 7% under a no catch scenario
- In the long-term effB$^{sp}_{west}$ under CMP$^{\#}$ has 90% probability of being at least 50% of that under a no catch scenario