Further results towards finalizing HCRs for OMP-18

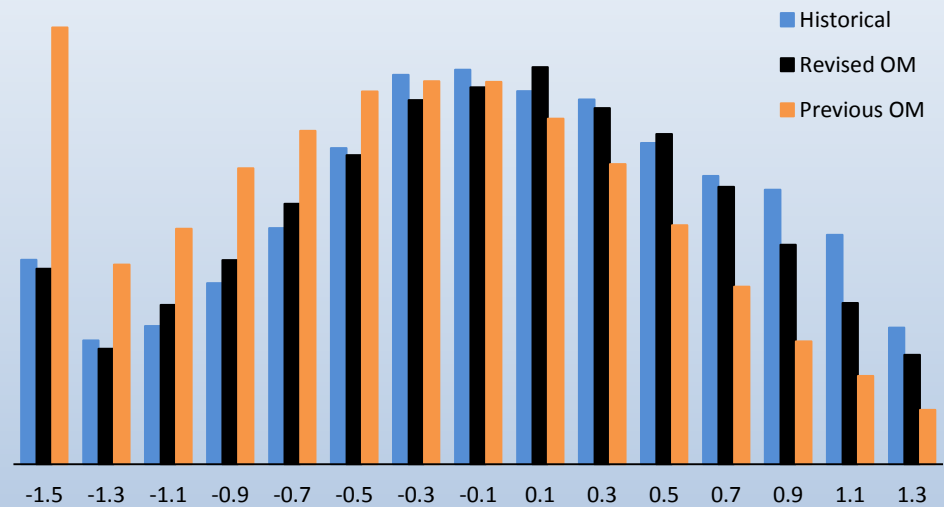SWG-PEL Meeting
21st November 2018

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Marine Resource Assessment and Management Group (MARAM)
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University of Cape Town

Updated Anchovy & Sardine OMs

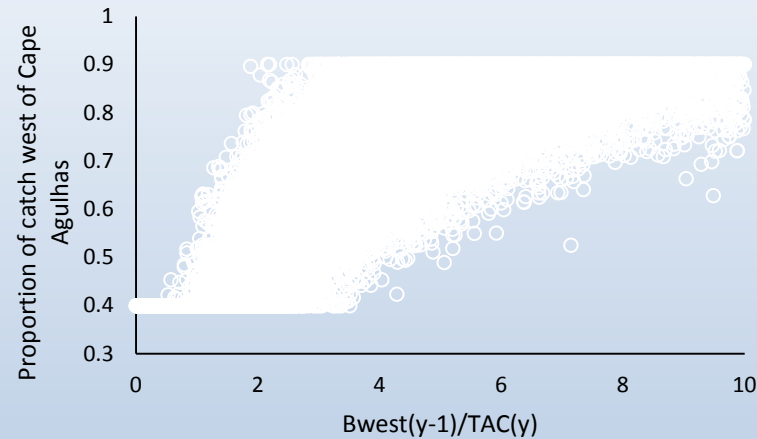- Patch to anchovy stock-recruitment residuals

Updated Anchovy & Sardine OMs

- Patch to anchovy stock-recruitment residuals
- MoveD

Updated Anchovy & Sardine OMs

- Patch to anchovy stock-recruitment residuals

- MoveD

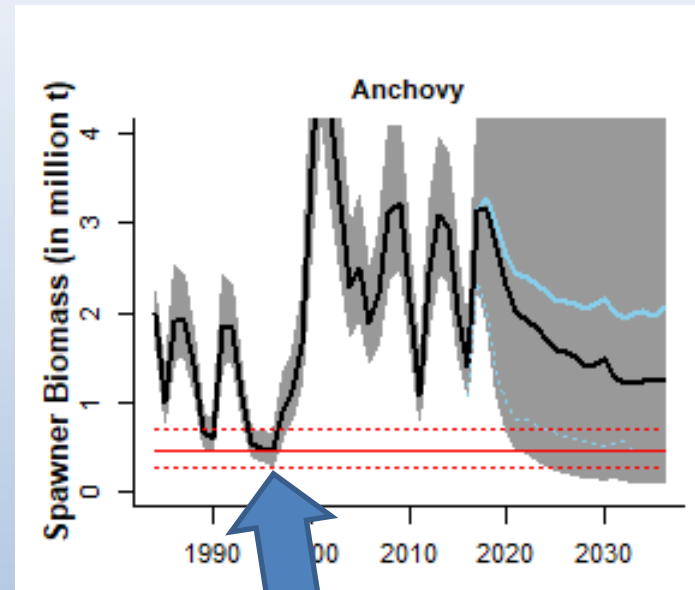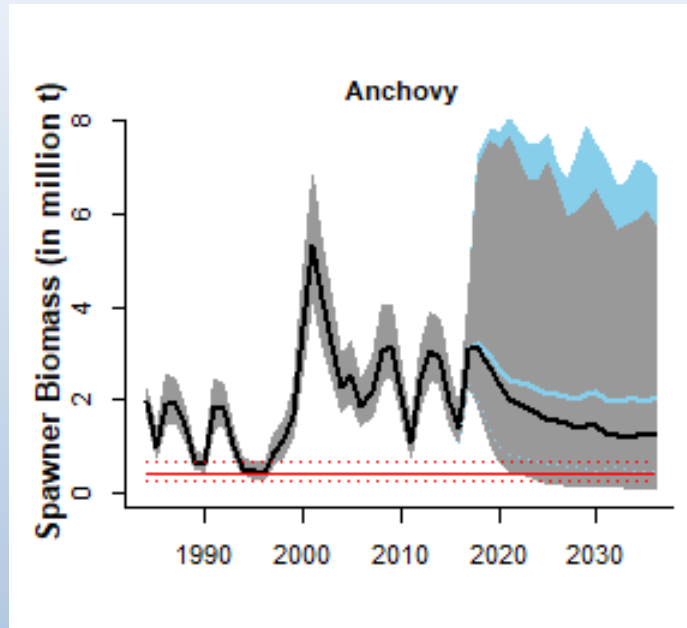- $0.4 \leq p_{west} \leq 0.9$

Candidate Management Procedure 3

No catch: $Risk_A = 0.026$

CMP3: $Risk_A = 0.134$

Risk level achieved from OMP-14 HCR under this OM

Risk threshold:
lowest historical spawner biomass

Candidate Management Procedure 3

No catch: Risk$_S$ = 0.070

CMP3: Risk$_S$ = 0.182

Risk level achieved from leftward shift
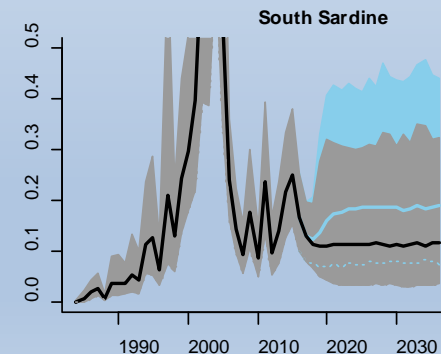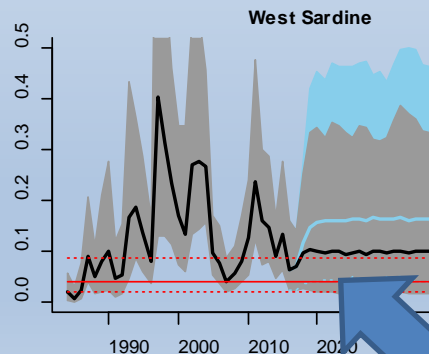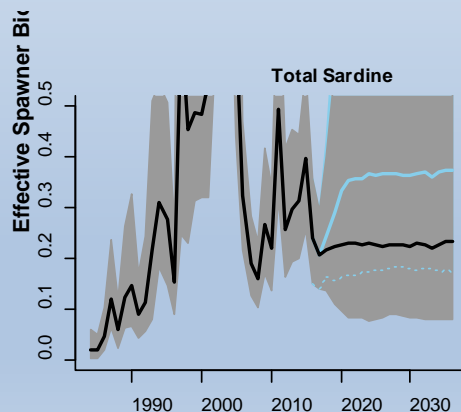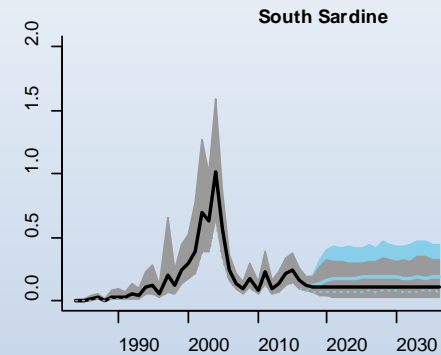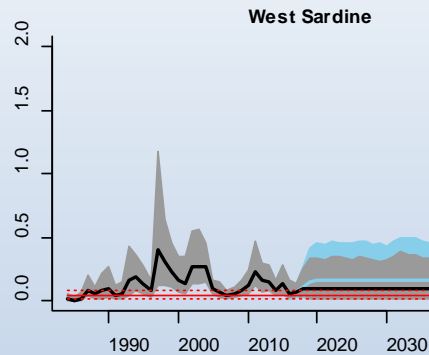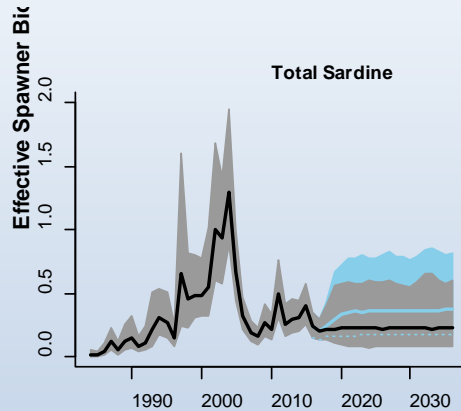
Risk threshold: lowest historical spawner biomass

The idea behind "implicit" spatial management

- Continue to 'fish-as-in-the-past' subject to explicit spatial management when 'red flags' are raised

  - Preventative red flags

  - Penalty red flags (with benefit green flags)

Preventative red flags

- Implicit spatial management until...

    Red flag raised if $B^{obs}_{west,y-1}$ < threshold

- Conserve the west component biomass

    - a primary producer of recruitment to the whole population

    - a primary source of forage for range-restricted west coast top predators

Preventative red flags

- Corrective measures:

    - implicit spatial management, 0.5xTAC

    - 0.31xTAC west of Cape Agulhas

- Corrective measures introduced over a smooth range:

    - no corrective measure at 165 000t / 110 000t

    - half corrective measure at 150 000t / 100 000t

    - full corrective measure at 135 000t / 90 000t

Preventative red flags

Red Flag at:	N/A	$B_{y-1}^{obs,S} < 150$		$B_{y-1}^{obs,S} < 100$	
Corrective Measure once red flag raised:	N/A (CMP3)	Implicit 0.50*TAC	Max 31% TAC west	Implicit 0.50*TAC	Max 31% TAC west
β					
$Risk_S$					
$p(B_w^S < 150)$					
C_{tot}^S					
C_{west}^S					
C_{south}^S					
MAV_{tot}^S					
MAV_{west}^S					
MAV_{south}^S					
p(preventative)					
$p(B_w^{obs,S} < 336)$					
$avg\ \#\ years\ B_w^{obs,S} < 336$					

Preventative red flags

Red Flag at:	N/A	$B_{y-1}^{obs,S} < 150$		$B_{y-1}^{obs,S} < 100$	
Corrective Measure once red flag raised:	N/A (CMP3)	Implicit 0.50*TAC	Max 31% TAC west	Implicit 0.50*TAC	Max 31% TAC west
β	0.175	0.200	0.171	0.186	0.172
$Risk_S$	0.182	0.164	0.162	0.167	0.168
$p(B_w^S < 150)$	0.128	0.114	0.112	0.117	0.117
C_{tot}^S	104 93 [31,200]	103 94 [16,200]	104 93 [31,200]	103 94 [19,200]	104 93 [31,200]
C_{west}^S	70 61 [22,155]	70 61 [13,158]	65 58 [11,154]	70 61 [15,157]	67 59 [13,154]
C_{south}^S	34 25 [5,100]	33 23 [2,101]	39 32 [5,102]	33 23 [3,99]	37 28 [5,100]
MAV_{tot}^S	0.49 [0.26,0.50]	0.57 [0.30,0.75]	0.49 [0.27,0.50]	0.50 [0.28,0.75]	0.49 [0.27,0.50]
MAV_{west}^S	0.37 [0.23,0.51]	0.48 [0.28,0.69]	0.50 [0.29,0.73]	0.44 [0.27,0.64]	0.45 [0.26,0.65]
MAV_{south}^S	0.67 [0.47,0.84]	0.80 [0.54,0.94]	0.58 [0.40,0.80]	0.75 [0.52,0.91]	0.63 [0.42,0.82]
p(preventative)	-	0.23	0.26	0.14	0.15
$p(B_w^{obs,S} < 336)$	0.62	0.61	0.60	0.61	0.61
$avg~\#~years~B_w^{obs,S} < 336$	3.41	3.30	3.26	3.33	3.32

Same average/median catches; lower risk

Lowest risk
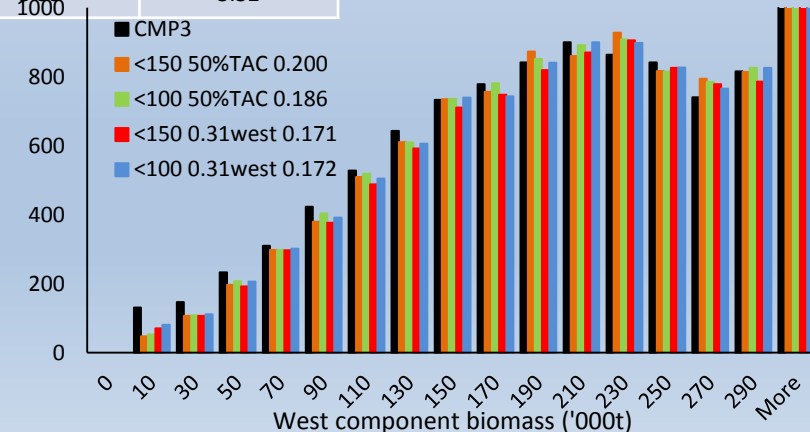
West component biomass ('000t)

- CMP3
- <150 50%TAC 0.200
- <100 50%TAC 0.186
- <150 0.31west 0.171
- <100 0.31west 0.172

The idea behind "implicit" spatial management

- Continue to 'fish-as-in-the-past' subject to explicit spatial management when 'red flags' are raised

  - Preventative red flags
  - Penalty red flags (with benefit green flags)

Penalty red flags

- Implicit spatial management assumes future catches spread according to past behaviour, but if not...

  - Red flag (penalty) raised if p(west) too high

  - Green flag (benefit) raised if p(west) too low
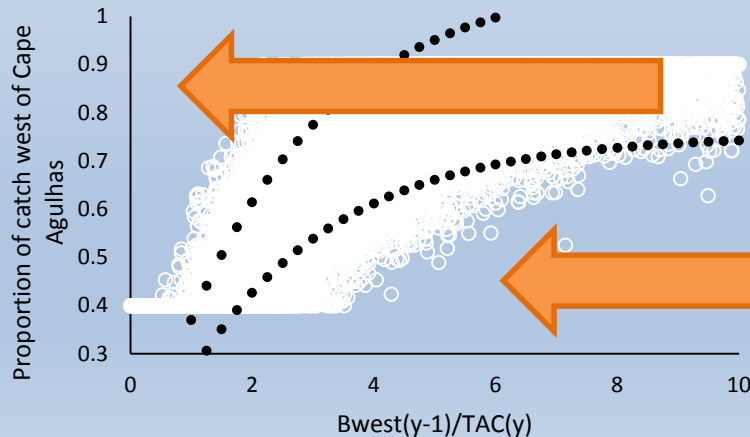
If OM1 is most realistic model, then future p(west) should NOT be here

Penalty red flags

- Testing alternative catch patterns:
- OM1: baseline
- OM-60: catches at least 60% west of Cape Agulhas
- OM-UL: relationship moves 'up and left'
- OM-70: catches 70% west of Cape Agulhas
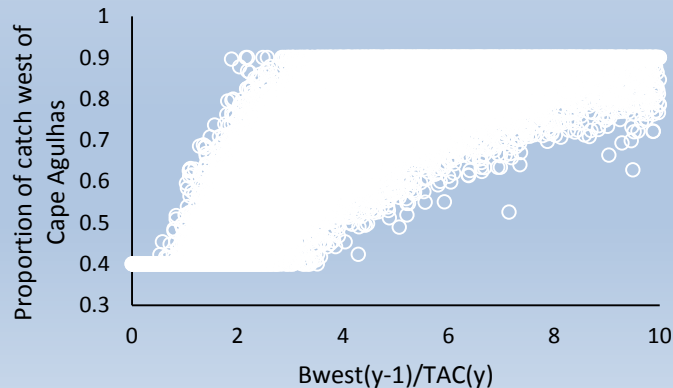
Penalty red flags

- p(y) = proportion of HCR-calculated TAC(y), subject to preventative red flag

- Corrective (benefit) measures:

  - initially p(y)=1

  - re-adjust p towards 1 at start of each year

    $(p_{start}(y) = x*1 + (1-x) * p(y-1))$

  - red flag: $p(y) = p_{start}(y) - PENALTY$

  - green flag: $p(y) = p_{start}(y) + BENEFIT$

Penalty red flags

- For example, 10% readjustment, PENALTY = -0.10, BENEFIT = +0.03:

- $p(2018) = 1$

- Red flag based on 2018 catches

- $p_{start}(2019) = 1$ $p(2019) = 1-0.1 = 0.9$

- No flag based on 2019 catches

- $p_{start}(2020) = 0.91$ $p(2019) = 0.91$

- Green flag based on 2020 catches

- $p_{start}(2021) = 0.92$ $p(2021) = 0.92+0.03=0.95$

Penalty red flags

Operating Model	CMP	Annual readjustment towards 1	Penalty if red flag	Benefit if green flag	Max proportion	$Risk_S$	$p(B^S_w < 150)$	C^S_{tot}	p(Red flag)	p(Green flag)	p(Red flag x2)
OM1	CMP3	N/A	N/A	N/A	N/A	0.182	0.128	104	N/A	N/A	N/A
OM-60	CMP3	N/A	N/A	N/A	N/A	0.200	0.138	104	N/A	N/A	N/A
OM-UL	CMP3	N/A	N/A	N/A	N/A	0.198	0.139	104	N/A	N/A	N/A
OM-70	CMP3	N/A	N/A	N/A	N/A	0.206	0.145	103	N/A	N/A	N/A

Increasing risk

Penalty red flags

Operating Model	CMP	Annual readjustment towards 1	Penalty if red flag	Benefit if green flag	Max proportion	$Risk_S$	$p(B_w^S < 150)$	C_{tot}^S	p(Red flag)	p(Green flag)	p(Red flag x2)
OM1	CMP3	N/A	N/A	N/A	N/A	0.182	0.128	104	N/A	N/A	N/A
	Opt1	10%	-0.10	+0.03	1.1	0.178	0.126	101	0.19	0.23	0.05
	Opt2	20%	-0.10	+0.01	1.1	0.178	0.125	101	0.19	0.23	0.05
	Opt3	20%	-0.075	+0.01	1.1	0.179	0.126	102	0.19	0.23	0.05
OM-60	CMP3	N/A	N/A	N/A	N/A	0.200	0.138	104	N/A	N/A	N/A
OM-UL	CMP3	N/A	N/A	N/A	N/A	0.198	0.139	104	N/A	N/A	N/A
OM-70	CMP3	N/A	N/A	N/A	N/A	0.206	0.145	103	N/A	N/A	N/A

Penalty red flags

Operating Model	CMP	Annual readjustment towards 1	Penalty if red flag	Benefit if green flag	Max proportion	$Risk_S$	$p(B_w^S < 150)$	C_{tot}^S	p(Red flag)	p(Green flag)	p(Red flag x2)
OM1	CMP3	N/A	N/A	N/A	N/A	0.182	0.128	104	N/A	N/A	N/A
	Opt1	10%	-0.10	+0.03	1.1	0.178	0.126	101	0.19	0.23	0.05
	Opt2	20%	-0.10	+0.01	1.1	0.178	0.125	101	0.19	0.23	0.05
	Opt3	20%	-0.075	+0.01	1.1	0.179	0.126	102	0.19	0.23	0.05
OM-60	CMP3	N/A	N/A	N/A	N/A	0.200	0.138	104	N/A	N/A	N/A
	Opt1	10%	-0.10	+0.03	1.1	0.186	0.131	98	0.26	0.18	0.09
	Opt2	20%	-0.10	+0.01	1.1	0.186	0.132	99	0.26	0.18	0.09
	Opt3	20%	-0.075	+0.01	1.1	0.188	0.133	100	0.27	0.18	0.09
OM-UL	CMP3	N/A	N/A	N/A	N/A	0.198	0.139	104	N/A	N/A	N/A
	Opt1	10%	-0.10	+0.03	1.1	0.187	0.132	95	0.31	0.07	0.11
	Opt2	20%	-0.10	+0.01	1.1	0.189	0.133	97	0.32	0.07	0.12
	Opt3	20%	-0.075	+0.01	1.1	0.191	0.134	99	0.33	0.07	0.12
OM-70	CMP3	N/A	N/A	N/A	N/A	0.206	0.145	103	N/A	N/A	N/A
	Opt1	10%	-0.10	+0.03	1.1	0.193	0.136	99	0.24	0.28	0.09
	Opt2	20%	-0.10	+0.01	1.1	0.193	0.136	99	0.24	0.28	0.09
	Opt3	20%	-0.075	+0.01	1.1	0.196	0.138	100	0.25	0.27	0.10

Limiting penalty to at most -0.10 – ability to correct different fishing patterns is constrained

Trade-off curve

Y-axis: Average directed sardine catch ('000t)

X-axis: Average anchovy catch ('000t)

CMP3 with $B_{y-1}^{obs,S}$<150 and 50% TAC; penalty of -0.10, benefit of 0.03, readjustment of 10%