SCIENTIFIC COUNCIL MEETING –JUNE 2025

Addendum to:

OUTLINE OF A SIMPLE APPROACH TO DEVELOP A MSE FOR 3LN REDFISH – NOW MODIFIED TO INCORPORATE DENSITY DEPENDENT PRODUCTIVITY AND TO FIT TO A LONGER TIME SERIES OF HISTORICAL DATA

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Abstract

Results for performance of the Baseline CMP of the main text are given for two sets of robustness tests: for the r and *MSY* parameters input for the Schaefer model, and for the Q parameter which effectively constrains how low absolute biomass estimates can go. Performance is reasonably robust except for the lowest value of r and the highest value of Q considered. Whether values that "extreme" are plausible merits discussion.

Initial robustness tests

This Addendum reports on results for the first two robustness tests suggested (given there in rough order of priority) in the main text: those regarding OM values for the r and *MSY* population dynamics parameters, and those related to the value of the Q parameter which effectively constrains estimates of survey catchabilities towards more realistic values.

The Baseline CMP only of the main text is used throughout.

r and *MSY* robustness tests

Five robustness tests with varying values for r (0.15, 0.20 and 0.25) and *MSY* (25 000t and 20 000t) have been selected (note that the Base Case OM has r=0.2 and *MSY*=25 000t), based primarily on their total negative loglikelihood values (Table A1). For MSY values above 25 000t and below 20 000t, the fit deteriorates substantially, and similarly (in general) for r values above 0.25 and below 0.15, so that values outside these

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ranges seem unlikely even though the log-likelihood used here is somewhat *ad hoc* given the way it handles process errors.

Figures A1a and b compares the Base Case OM's historical catch, the annual productivity and the biomass trajectories to those robustness tests, while Table A2 provides the associated estimates of parameter values. In terms of past trajectories, these robustness tests principally affect the scale of the pre-1990 biomass.

Results for the Baseline CMP for a 20-year projection period are compared in Figures A2a and A2b and in Table A3 under the Base Case OM and these five robustness tests.

Penalty on survey q's:

For the Base Case OM, a penalty factor in the -ln$L$ has been added to avoid the survey q estimates going to unrealistic values:

$$\sum_i (q_i - Q)^2 / \sigma_q^2 \tag{A1}$$

where Q =2 and $\sigma_q = 0.2$.

Results for two robustness tests varying Q (Q=1.5 and Q=3) are presented here. Figure A1c compares the historical catch, the annual productivity and the biomass trajectories for those robustness tests, while Table A2 provides the associated estimates of parameter values.

Results for a Baseline CMP for a 20-year projection period are compared in Figures A2a and A2b, and in Table A3 under the Base Case OM and these two robustness tests.

Discussion

The CMP performance seems reasonably robust across most of the scenarios considered. A primary concern is if the lower 10%ile for the biomass drops to zero. For the results shown here, that occurs in two cases: r=0.15 and Q=3.

Both of these instances merit further discussion – how important is it to have a CMP that avoids this behaviour? The key question is: how plausible are these scenarios? The r=0.15 scenarios seem on the edge of that plausibility space (see Table A1). The high Q value (of 3) suggests values for biomass which are much less than the survey estimates – is the associated indication of a high degree of herding by the trawl net used plausible?

Table A1. Comparison of total -ln*L* for a series of *r* (columns) and *MSY* (rows) values. The Base Case OM is dark grey highlighted, while the five robustness tests selected are light grey highlighted. For some combinations of *r* and *MSY*, the model did not converge; these combinations are shown by "x".

	0.05	0.1	0.15	0.2	0.25	0.3
10	x	3.2	x	x	x	x
15	x	-10.2	-8.6	-2.0	16.4	x
20	-7.4	-14.5	-18.1	-19.9	-21.1	-21.8
25	-8.1	-16.1	-19.7	**-21.2**	-21.8	-11.7
30	24.3	19.5	14.6	4.8	-1.5	-10.0

Table A2. Comparison of -ln*L* and some results for the Base Case (BC) OM and robustness tests with different *r* and *MSY* values (first block of results), and for different levels of penalties on the survey *q*'s (second block of results, "Rq1.5": $Q=1.5$ and "Rq3": $Q=3$ (for the BC, $Q=2$)

	R015_25	BC	R025_25	R015_20	R020_20	R025_20	R_Q1.5	R_Q3
K	667	500	400	533	400	320	500	500
MSY	25	25	25	20	20	20	25	25
r	0.15	0.2	0.25	0.15	0.2	0.25	0.2	0.2
-lnL								
Total	-19.74	-21.23	-21.83	-18.06	-19.94	-21.09	-18.31	-24.57
Process error	13.56	13.92	14.48	13.58	13.64	13.61	14.91	11.56
survey *q* penalty	0.22	0.24	0.22	0.18	0.16	0.11	0.45	0.04
surveys	0.78	-0.56	-1.88	1.19	0.11	-0.98	1.33	-1.48
CPUE	-34.29	-34.83	-34.65	-33.01	-33.85	-33.83	-35.00	-34.69
B_{1959}	224.3	179.5	150.6	261.6	222.1	198.5	179.6	179.4
B_{1959}/K	0.34	0.36	0.38	0.49	0.56	0.62	0.36	0.36
B_{2024}	79.7	85.9	92.3	79.4	85.4	91.6	127.8	51.5
B_{2024}/K	0.12	0.17	0.23	0.15	0.21	0.29	0.26	0.10
$B_{2024}/MSYL$	0.24	0.34	0.46	0.30	0.43	0.57	0.51	0.21

Table A3. Performance statistics (median and 80%iles) for a series of robustness tests under the Baseline CMP. Values for Cav, Blowest and Bfinal are in kt.

| CMP	Cav			Blowest			Bfinal			AAV		
MSY = 25kt												
r=0.15	6.0	(1.2;	18.4)	68.9	(0.0;	80.9)	265.0	(0.0;	446.8)	0.19	(0.14;	0.24)
r=0.20 (BC)	9.2	(1.7;	20.2)	90.7	(10.5;	90.7)	310.3	(50.2;	424.6)	0.20	(0.17;	0.25)
r=0.25	10.6	(2.7;	20.6)	100.7	(62.8;	100.7)	285.3	(149.8;	370.6)	0.19	(0.17;	0.21)
MSY = 20kt												
r=0.15	6.0	(1.4;	17.5)	71.8	(0.0;	80.1)	231.4	(0.0;	370.5)	0.19	(0.16;	0.25)
r=0.20	8.4	(1.9;	18.7)	89.5	(39.6;	89.5)	252.8	(96.3;	345.6)	0.19	(0.17;	0.22)
r=0.25	9.7	(3.0;	18.9)	98.6	(67.7;	98.6)	225.8	(110.2;	297.5)	0.19	(0.17;	0.21)
Varying Q												
Q=1.5	9.1	(2.7;	18.8)	137.5	(108.1;	137.5)	366.9	(239.8;	459.8)	0.19	(0.17;	0.21)
Q=2.0 (BC)	9.2	(1.7;	20.2)	90.7	(10.5;	90.7)	310.3	(50.2;	424.6)	0.20	(0.17;	0.25)
Q=3.0	5.8	(0.9;	20.6)	31.7	(0.0;	51.4)	200.1	(0.0;	383.4)	0.20	(0.12;	0.29)
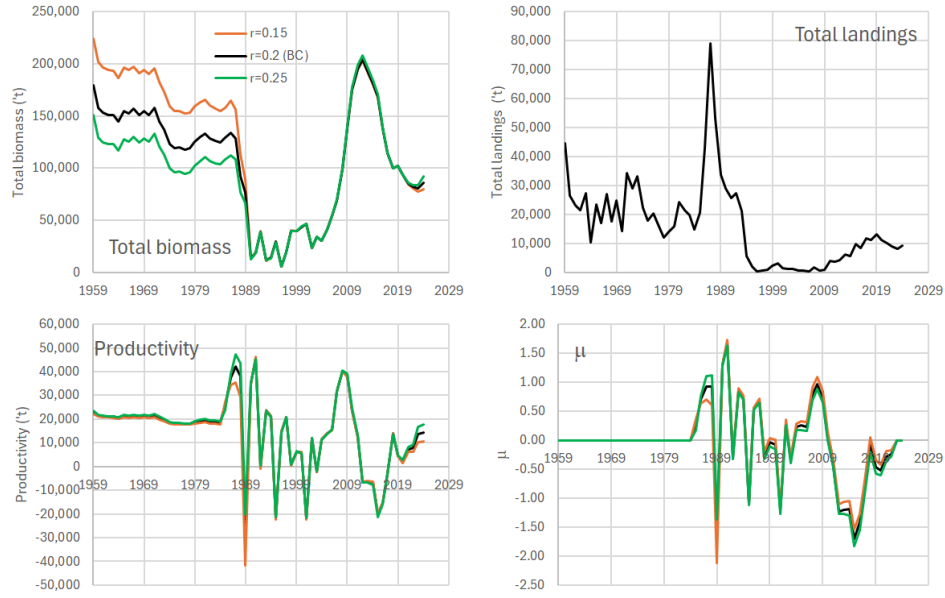
Figure A1a. Historical total annual landings together with estimated annual total biomass, total landings and productivity (including process error) (in kt) for the Base Case (*r*=0.2 and *MSY*=25kt), and two robustness tests varying *r* (*r*=0.15 and *r*=0.25). **MSY=25kt** for all three cases.
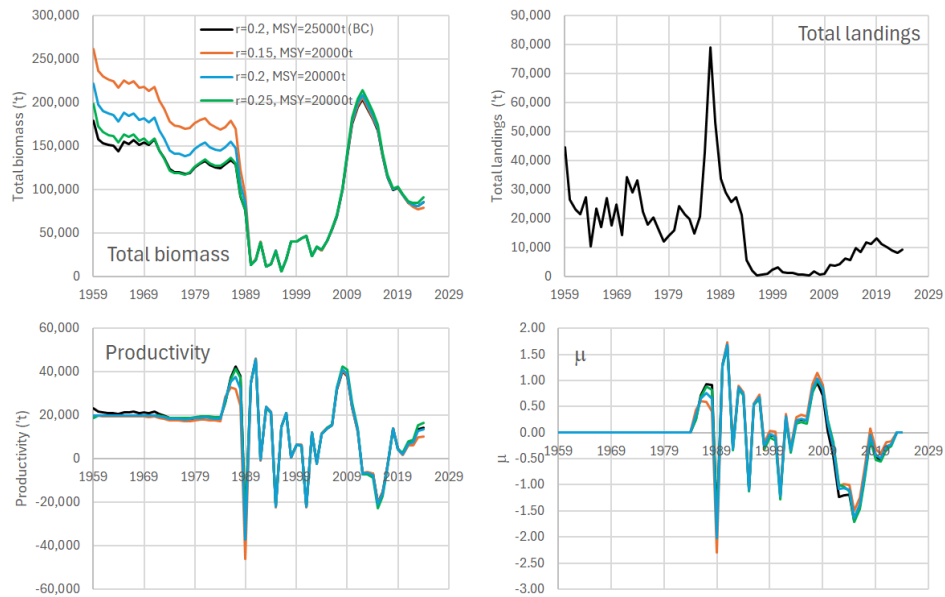
Figure A1b. Historical total annual landings together with estimated annual total biomass, total landings and productivity (including process error) (in kt) for the Base Case (*r*=0.2 and *MSY*=25kt) and three robustness tests varying *r* (*r*=0.15, *r*=0.20 and *r*=0.25) with **MSY=20kt**.
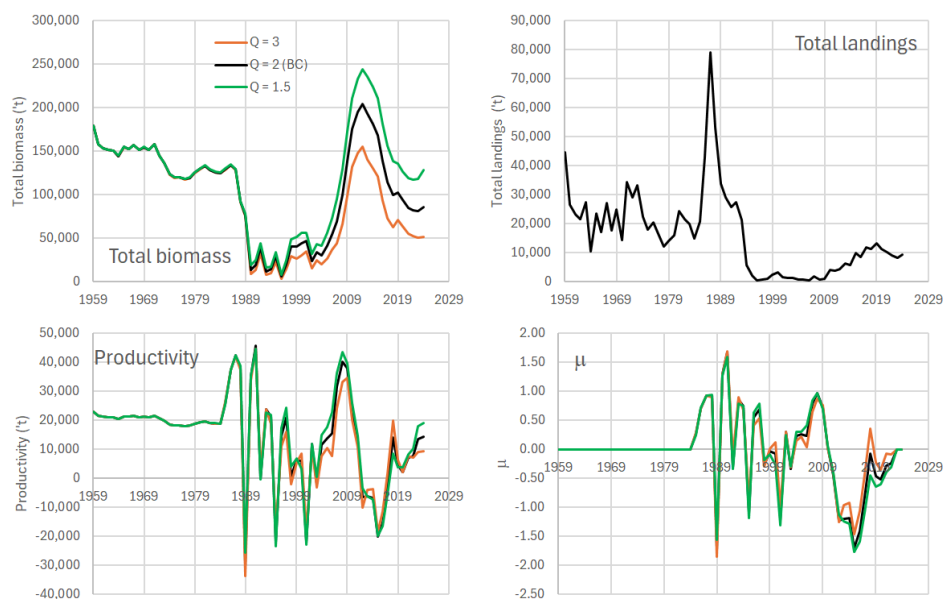
Figure A1c. Historical total annual landings together with estimated annual total biomass, total landings and productivity (including process error) (in kt) for the Base Case (Q = 2) and two robustness tests regarding the penalty on the survey q's (Q = 1.5 and Q = 3).
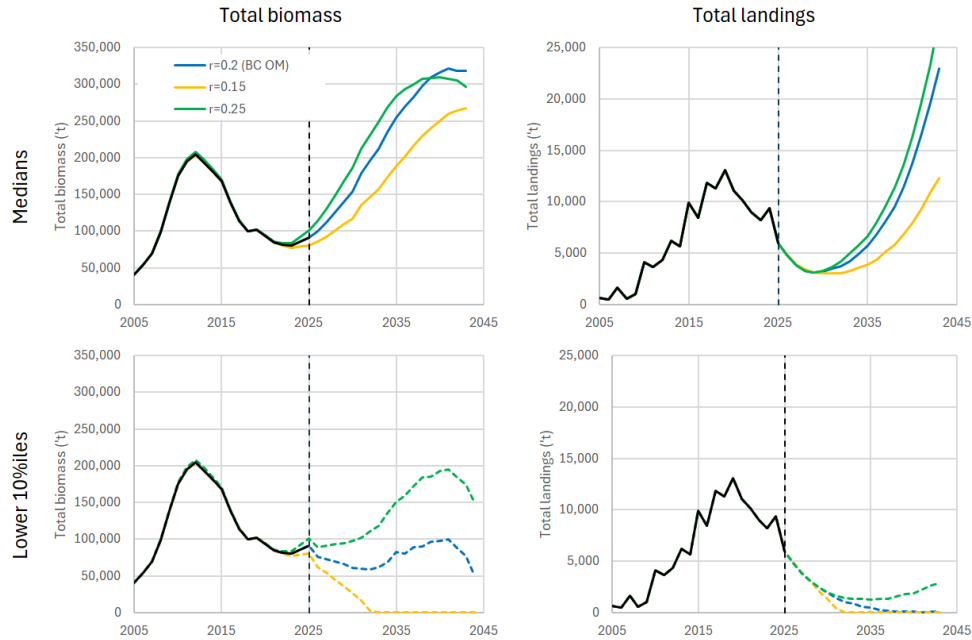
Figure A2a. Projected total biomass and landings (medians top row and lower 10%iles bottom row) for the Base Case OM (***MSY=25kt***) and two robustness tests varying *r* under the Baseline CMP.
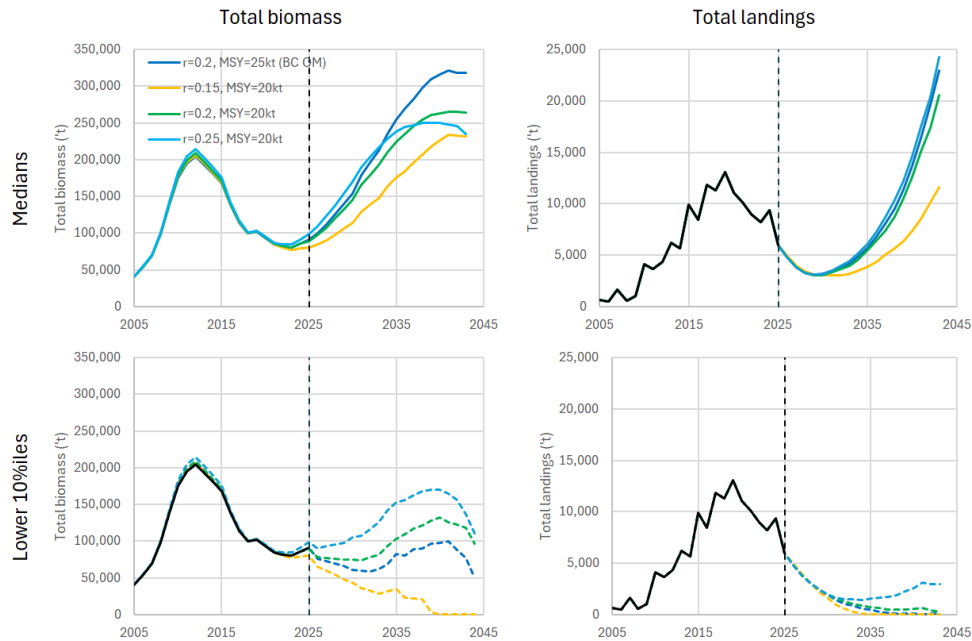

Figure A2b. Projected total biomass and landings (medians top row and lower 10%iles bottom row) for the Base Case OM and three robustness tests varying *r* (*r*=0.15, *r*=0.20 and *r*=0.25) with ***MSY=20kt*** under the Baseline CMP.
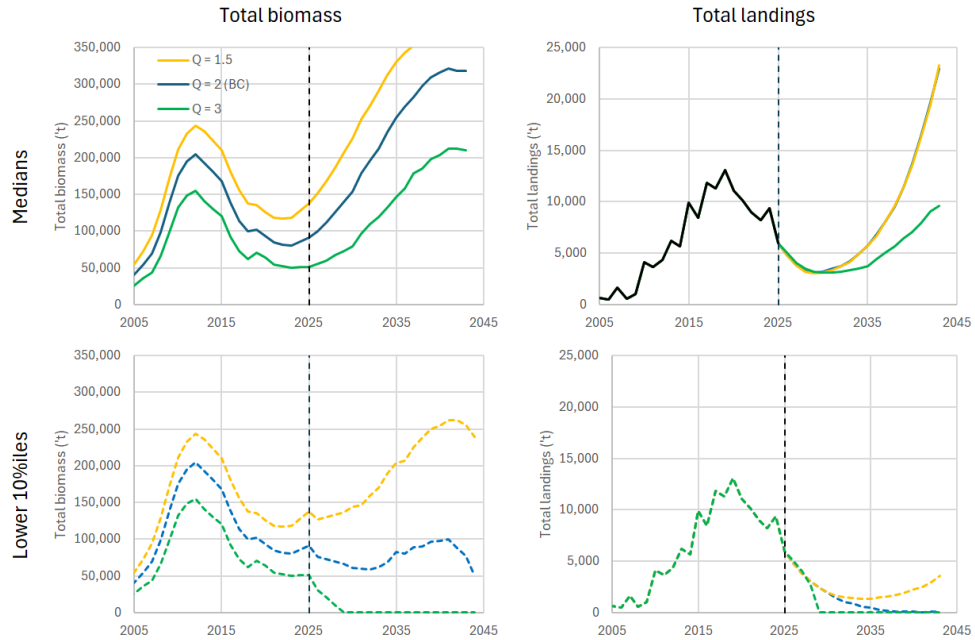
Figure A2c. Projected total biomass and landings (medians top row and lower 10%iles bottom row) for the Base Case OM (*Q* = 2) and two robustness **tests for the penalty on the survey *q's*** (*Q* = 1.5 and *Q* = 3) under the Baseline CMP. In the top right panel, the blue curve is under the orange one.