Progress on the testing of decision rules for Zone F

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April 2016

Introduction

This document describes the methodology applied to test two decision rules for setting the TAC for abalone for Zone F and some preliminary results.

Methodology

Two alternative decision rules for setting catch limits for abalone in Zone F are tested using computer simulation based on Operating Models (OMs) (the nine Operating Models proposed by Brandão and Butterworth (2015)) which reflect possible underlying dynamics of the resource to enable future data to be generated which are compatible with past data. These generated future data are then used by the decision rules to compute future catch limits.

The decision rules investigated assume that commercial CPUE and FIAS indices will continue to be available annually. These indices are generated using the population dynamics equations for these indices and applying observation error (so for example CPUE indices are generated by $I_y^{CPUE} = q^{CPUE} B_y^{\exp} e^{\varepsilon_y}$ where ε_y is normally distributed with a mean zero and a standard deviation σ^{CPUE} which is the estimate obtained for the operating model as is *q*. The standard deviation for the FIAS indices is given the average of the sum of the historical sampling CVs and the estimated additional variance. Future poaching numbers are assumed to be the average of the estimated values for the

last two years of observable data (i.e. 2014 and 2015) to which an error is applied, whose variance is given by the average of the lognormal variance from the CVs estimated from the GLM used to obtain these values. At the present time, for simplification, no error is applied to the numbers-at-age and no catch-at-age data are generated.

The decision rules considered are:

1) DR1: a simplified version of the current decision rule in which the trends in the recent (last 5 years) CPUE and FIAS indices are examined. If both trends in the indices are increasing/decreasing by more than 10%, then the TAC is increased/decreased by 10% provided no change in TAC occurred in the previous year, otherwise there is no change in the TAC.
2) DR2: The TAC is set by the formulation:

$TAC_{y+1} = TAC_y \left(1 - \lambda\left(\frac{J_y^{rec} - J^*}{J^*}\right)\right)$, where

λ and J^* are tuning parameters (here set to 1 and 4 respectively), and

J_y^{rec} is a combined index of the CPUE and the FIAS indices given as $J_y^{rec} = w_1 J_y^{CPUE} + w_2 J_y^{FIAS}$, where J_y^{CPUE} and J_y^{FIAS} are the average of the most recent 5 years values of the corresponding indices, so for example $J_y^{CPUE} = \sum_{y'=y-5}^{y-1} I_{y'}^{CPUE} \Big/ 5$, and w_1 and w_2 are weights given to each index. The values for these weights are usually based on the inverse of the variance of the assessment model residuals for each index. However, since the residual variance of the FIAS indices is much greater than that of the CPUE indices, it means that very little weight was given to the FIAS indices. For the purposes of the results given here it was therefore decided to apply weights of 0.8 to the CPUE indices and 0.2 to the FIAS indices.

The TAC is constrained to a maximum annual increase or decrease of 10%.

Summary Performance Statistics

The performances of the different decision rules are considered in terms of future projections over a 20 year period, and in particular the following four statistics which were intended to capture key features of the trade-off choices to be made:

<u>Catches achieved</u>

Average annual catch: $\overline{C^s} = \frac{1}{20}\sum_{y=2016}^{2035} C_y^s$, where *s* represents simulation *s*.

<u>Risk to resource</u>

Final resource size: $B_{2035}^{sp(s)} \Big/ K^{sp(s)}$

Industrial stability

Average annual catch variation: $$AAV^s = \frac{1}{20}\sum_{y=2016}^{2035}\frac{\left|C_y^s - C_{y-1}^s\right|}{C_{y-1}^s}$$

Economic viability

CPUE relative to recent level: $$\frac{CPUE^s_{2035}}{\frac{1}{3}\sum_{y=2012}^{2014} CPUE_y^s}.$$

Over the simulations *s* there is a distribution for each of these statistics, and performance is reported in terms of statistics of those distributions (typically the median and 90% probability interval, with the probability that the last of the four is below 1 also reported here).

Results

Table 1 shows the performance of the two decision rules under the reference set OMs and these are plotted in Figure 1. Figure 2 shows some projections for decision rules DR1 and DR2 under the best fitting OM (*K* = 4 500t, average poaching since 2008 = 350t). Figure 3 shows projections of annual commercial catches under the two decision rules.

Discussion

It is clear from Figure 2 that continued poaching clearly dominates future resource trends. The legal TAC is so much smaller that changing this hardly impacts the overall abundance trend. Thus the simpler DR1 outperforms the more complex DR2 by giving TACs that vary much less from year to year. A concern, however, with DR1 is that it hardly responds to the overall downward trend in resource abundance, keeping the median legal TAC virtually unchanged.

Reference

Brandão, A. and Butterworth, D.S. 2015. Proposed Operating Models to test decision rules for Zone F. FISHERIES/2015/JUL/SWG-AB/07.

Table 1. Projected median average annual commercial catches of abalone for the period 2016 to 2035, the median spawning biomass depletion at the start of the year 2035, average annual variation (AAV) in catch and the median CPUE index in 2035 as a proportion of the average of the 2012 to 2014 CPUE indices, for the nine reference set OMs and two decision rules. The lower 5% and upper 95% percentiles are also given. The probability of the CPUE index in 2035 being less than that of the average of the 2012 to 2014 values is also given.

Reference set		Average catch			Final Bsp/Ksp			AAV			CPUE2035/CPUE2012-2014			Prob (CPUE2035/ CPUE2012-2014) < 1
		Median	lower	upper	Median	lower	upper	Median	lower	upper	Median	lower	upper	
K2000 av75	DR1	16.8	14.5	20.1	0.261	0.191	0.392	0.035	0.030	0.045	0.245	0.077	0.879	0.97
K2000 av160		15.4	13.2	18.3	0.131	0.123	0.161	0.035	0.025	0.040	0.029	0.013	0.089	1.00
K3000 av75		16.7	14.5	20.0	0.407	0.254	0.572	0.035	0.025	0.045	0.735	0.232	1.845	0.73
K3000 av160		16.8	14.0	20.1	0.208	0.158	0.295	0.040	0.030	0.045	0.146	0.047	0.477	0.99
K3000 av250		15.2	13.2	18.5	0.128	0.119	0.162	0.035	0.025	0.040	0.031	0.015	0.093	1.00
K4500 av75		16.9	14.5	20.2	0.567	0.372	0.698	0.035	0.025	0.045	1.279	0.395	2.829	0.32
K4500 av160		16.8	14.6	20.3	0.310	0.214	0.468	0.035	0.030	0.045	0.401	0.151	1.184	0.88
K4500 av250		16.8	14.0	20.0	0.213	0.163	0.304	0.035	0.030	0.045	0.159	0.063	0.518	0.99
K4500 av350		15.3	12.8	18.3	0.137	0.120	0.179	0.035	0.025	0.040	0.048	0.018	0.146	1.00
K2000 av75	DR2	16.9	7.8	27.5	0.249	0.187	0.382	0.086	0.0072	0.094	0.246	0.062	0.841	0.97
K2000 av160		7.0	7.0	9.0	0.139	0.129	0.174	0.095	0.088	0.095	0.058	0.027	0.135	1.00
K3000 av75		25.4	9.3	39.8	0.366	0.237	0.526	0.085	0.072	0.095	0.551	0.122	1.613	0.78
K3000 av160		11.1	7.0	22.8	0.202	0.157	0.287	0.089	0.077	0.095	0.160	0.046	0.492	1.00
K3000 av250		7.0	7.0	9.3	0.136	0.126	0.171	0.095	0.088	0.095	0.059	0.028	0.136	1.00
K4500 av75		33.6	15.8	45.4	0.51	0.284	0.643	0.084	0.068	0.0095	1.144	0.275	2.476	0.44
K4500 av160		18.9	8.0	33.5	0.294	0.207	0.45	0.085	0.072	0.094	0.366	0.090	1.236	0.88
K4500 av250		11.0	7.0	22.6	0.203	0.161	0.285	0.089	0.077	0.095	0.166	0.520	0.500	1.00
K4500 av350		7.3	7.0	11.5	0.142	0.122	0.175	0.093	0.085	0.095	0.072	0.029	0.168	1.00

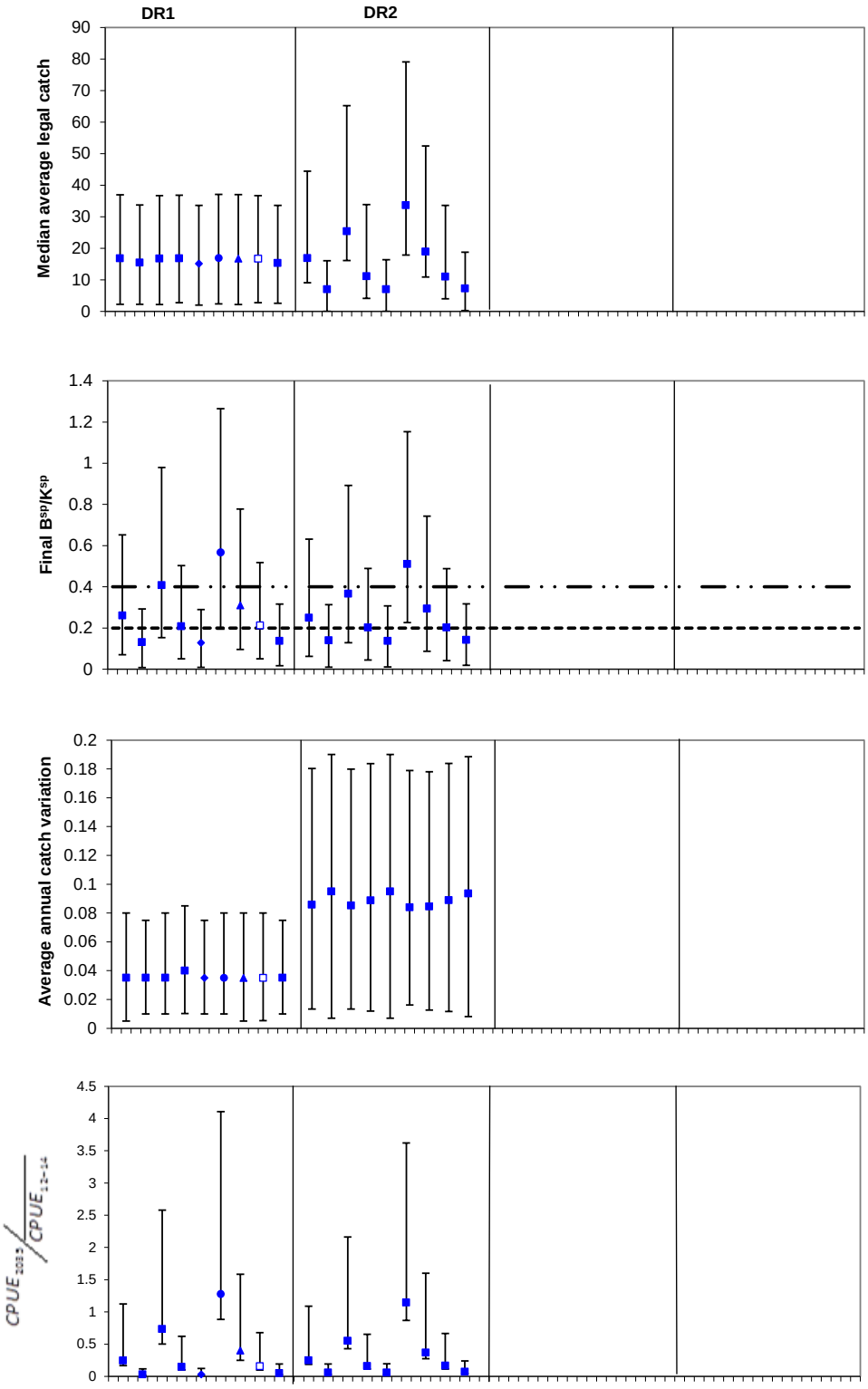

Figure 1. Projected median (and 90% percentiles) of the average annual legal commercial catches of abalone for the period 2016 to 2035, the spawning biomass depletion at the start of 2035, the average annual variation in catch and the CPUE index in 2035 as a proportion of the average of the 2012 to 2014 CPUE indices for the nine OMs and two decision rules.

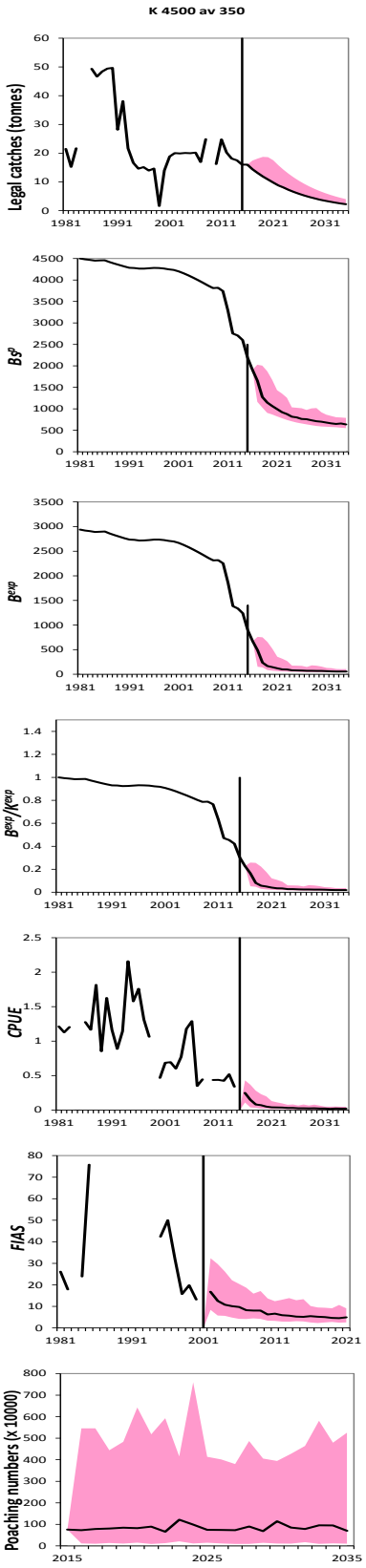

Figure 2. Median trajectories of legal annual commercial catches, spawning biomass, exploitable biomass, exploitable biomass depletion, CPUE and FIAS trends and poaching numbers under the decision rule DR2 for the K 4500 av 350 Operating Model. Projections (medians) commence to the right of the vertical lines and the shaded areas represent 90% probability envelopes.

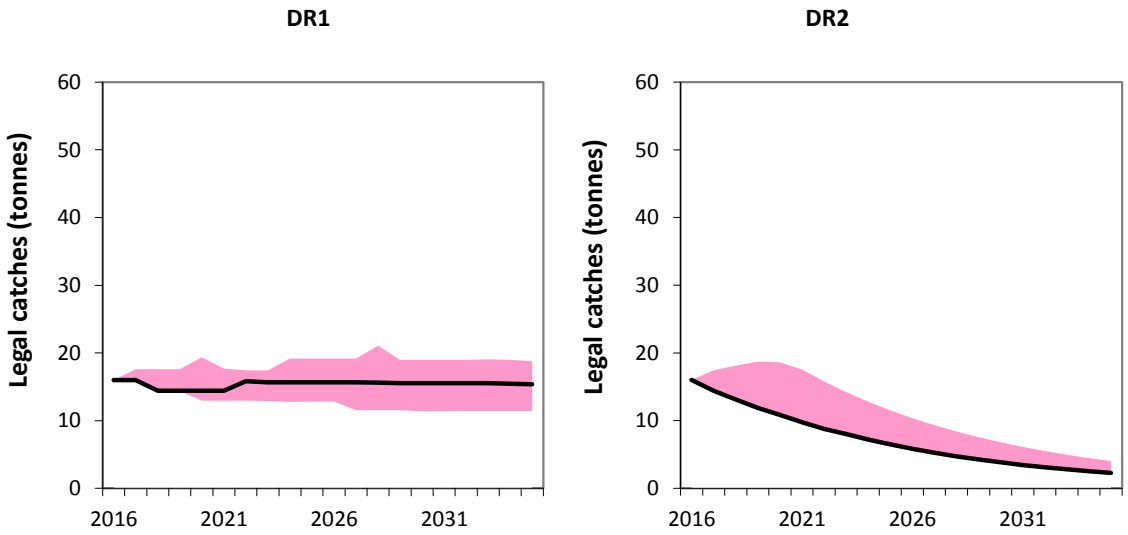

Figure 3. Median projections of legal annual commercial catches under the decision rules DR1 and DR2 for the K 4500 av 350 Operating Model. The shaded areas represent 90% probability envelopes.