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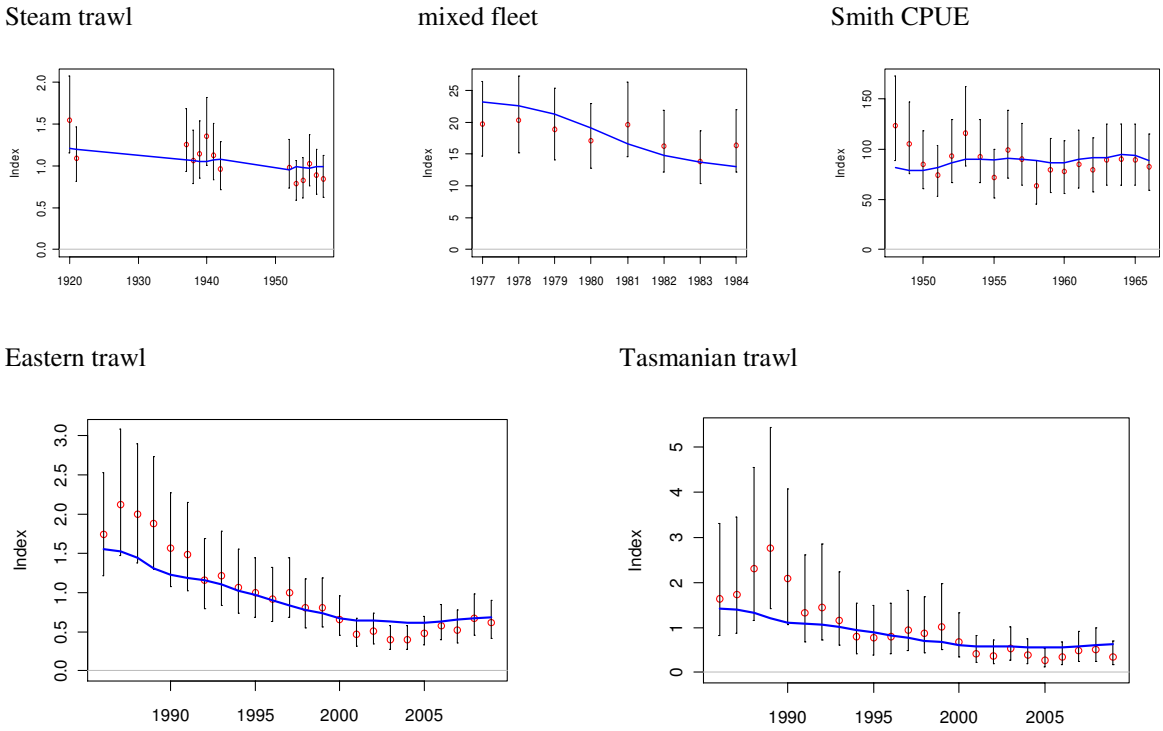


Figure 12. Jackass Morwong observed (circles) and model-estimated (lines) standardised catch rates versus year. The vertical lines indicate approximate 95% confidence intervals for the data.

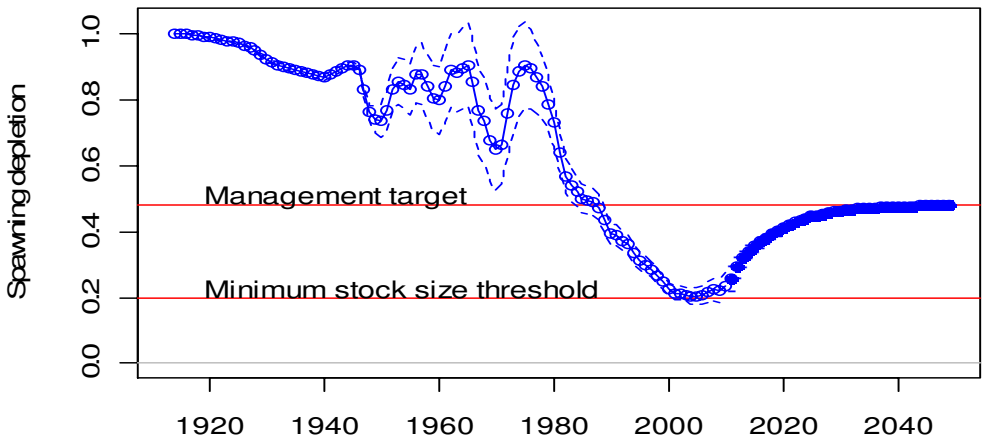


Figure 13. Jackass Morwong time-trajectory of spawning biomass depletion (with 95% confidence intervals) corresponding to the MPD estimates for the base-case analysis for the eastern stock. The first solid dot is 2011 depletion, and subsequent solid dots are forecast depletion under the 20:35:48 harvest control rule assuming average recruitment.

yields could be taken. Although the exact size and level of the depletion of Redfish is not known, it is clear that rebuilding is necessary. Growth overfishing has been an issue in the fishery since it was identified as a significant problem in the early 1990s.

A quantitative assessment of Redfish was run in 2005 using Integrated Analysis to evaluate different harvest strategies (TAC or mesh size changes) for this species. As with the 2001 assessment, uncertainties in the model structure and assumptions, and the accuracy of data on which they were based were reflected by the wide ranges of estimates for the quantities of interest to management. While this uncertainty prevented the use of model results for absolute biomass predictions, the model was still useful for understanding relative importance of different harvest strategies on future biomass projections.

The harvest strategy evaluation compared the use of a range of larger mesh or square mesh codends using forward simulations with a constant F strategy. Forward simulations on the northern stock using these mesh sizes performed as expected, with increased mesh size resulting in average biomass increase across scenarios and lower portions of the catch discarded in the future. In the southern stock, for which there is greater uncertainty, changes in mesh selectivity proved insufficient to cause stock recovery because of the high current fishing mortality. In both cases, increased mesh size decreased the portion of catch by weight that was discarded.

The age and length data suggests that there was a strong recruitment to the stock during 1998-99 which entered the fishery in 2001 with high levels of discarding of small fish. Discard levels reduced significantly as these recruits reached a marketable size and ISMP data shows negligible discarding during 2007 and 2008 although there remains some concern about the quality of this information.

2010 assessment

A Tier 3 assessment of Redfish was performed during 2010 (Klaer 2010a). The information required for this assessment included parameters that define: selectivity-at-age, length-at-age, weight-at-age; age-at-maturity and natural mortality (Table 5). Length-at-age was calculated using the von Bertalanffy growth equation (parameters are l_∞, k and t_0) and the weight-at-age using the allometric length-weight relationship (parameters are a and b). Maximum observed age (a_{max}) values were selected after examining available aged otolith samples and a maximum age for catch curve analysis (cca_{max}) was developed that was usually at least one age less than the maximum. A logistic selectivity curve based on a 90mm trawl mesh was assumed (selectivity parameters l_{25}, l_{50}). Natural mortality (M) figures were obtained from previous studies or meta-analysis of the SESSF species. A single-parameter (steepness - h) formulation of the Beverton-Holt stock-recruit relationship was used.

Table 5. Redfish parameters used in the Tier 3 (adapted from Klaer 2010a).

Species	M	h	Linf	k	t0	a	b	l25	l50	lmat	amax	ccamax	S25
Redfish	0.1	0.75	25.28	0.224	-0.719	0.0577	2.77	15.94	17.25	19	40	20	3.727

Two Tier 4 assessments were conducted, one using standard procedures and the other which added discards to the catch rates. The latter mainly added noise to the data and didn't change the trend evident in the standard Tier 4 assessment. The Tier 4 assessment showed that the catches and CPUE have been decreasing consistently over 9 years and although there was an increase during 2009 due to the high discard levels (included in the catch rate series (Figure 19) the CPUE indicator is currently below the limit.

RBC Calculations

Examination of recent mortality estimates from catch curve analyses indicated the average fishing mortality is at a level that will result in a biomass close to the target of 48% of the unexploited biomass. Catch curve fits to age data are shown in Figure 18.

Using the Tier 3 method, the 2011 RBC for Redfish is 1985 t.

Table 6. Redfish F reference points, Z_{cur}, C_{cur} and RBC estimates (adapted from Klaer 2010a).

Species	Fspr20	Fspr40	Fspr48	Zcur	Fcur	ymin	ymax	Ccur	Frbc	RBC
Redfish	0.213	0.098	0.074	0.174	0.074	1990	2006	2,003	0.074	1,985

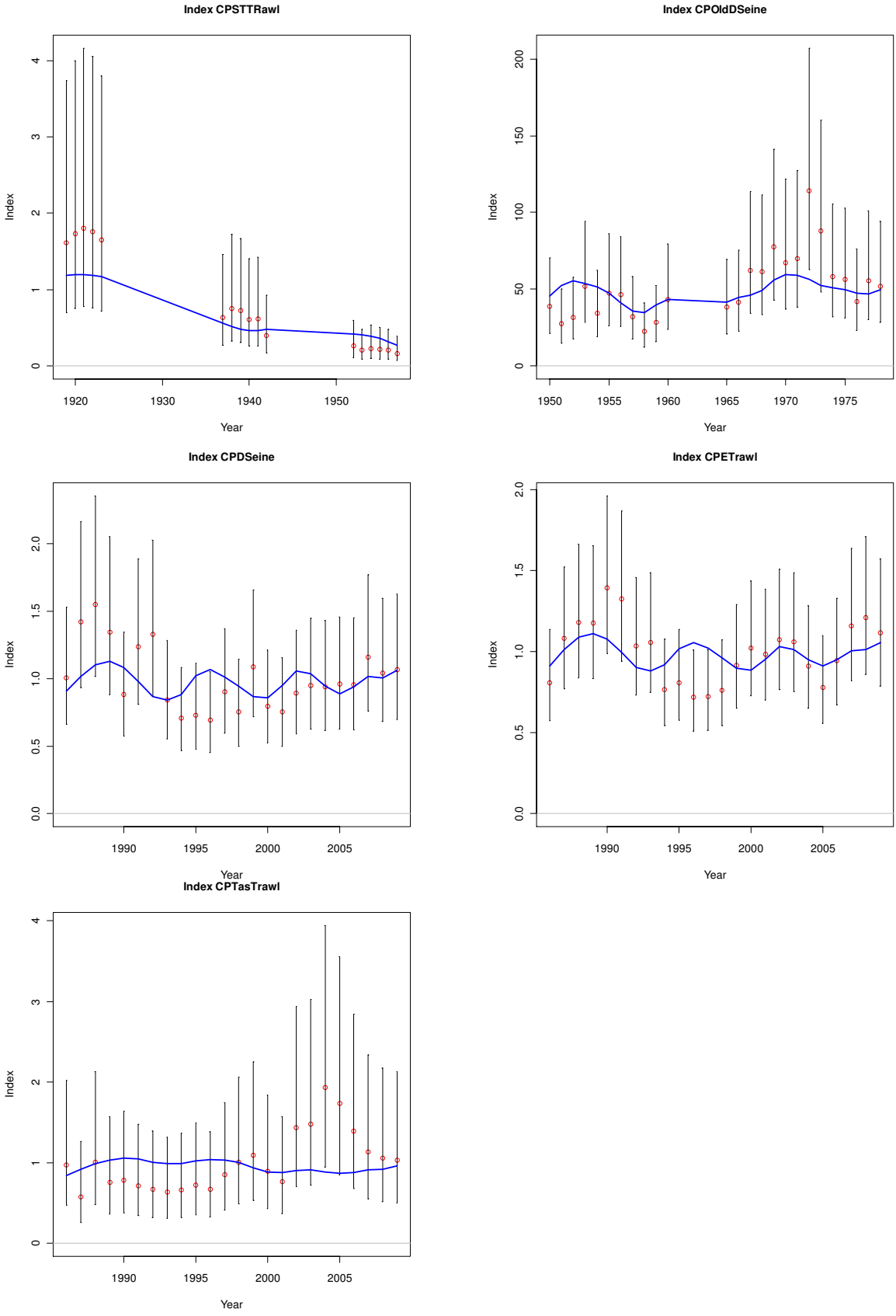


Figure 21. Tiger Flathead observed (solid dots) and model-estimated (lines) catch rates versus year. The vertical lines indicate approximate 95% confidence intervals for the data.

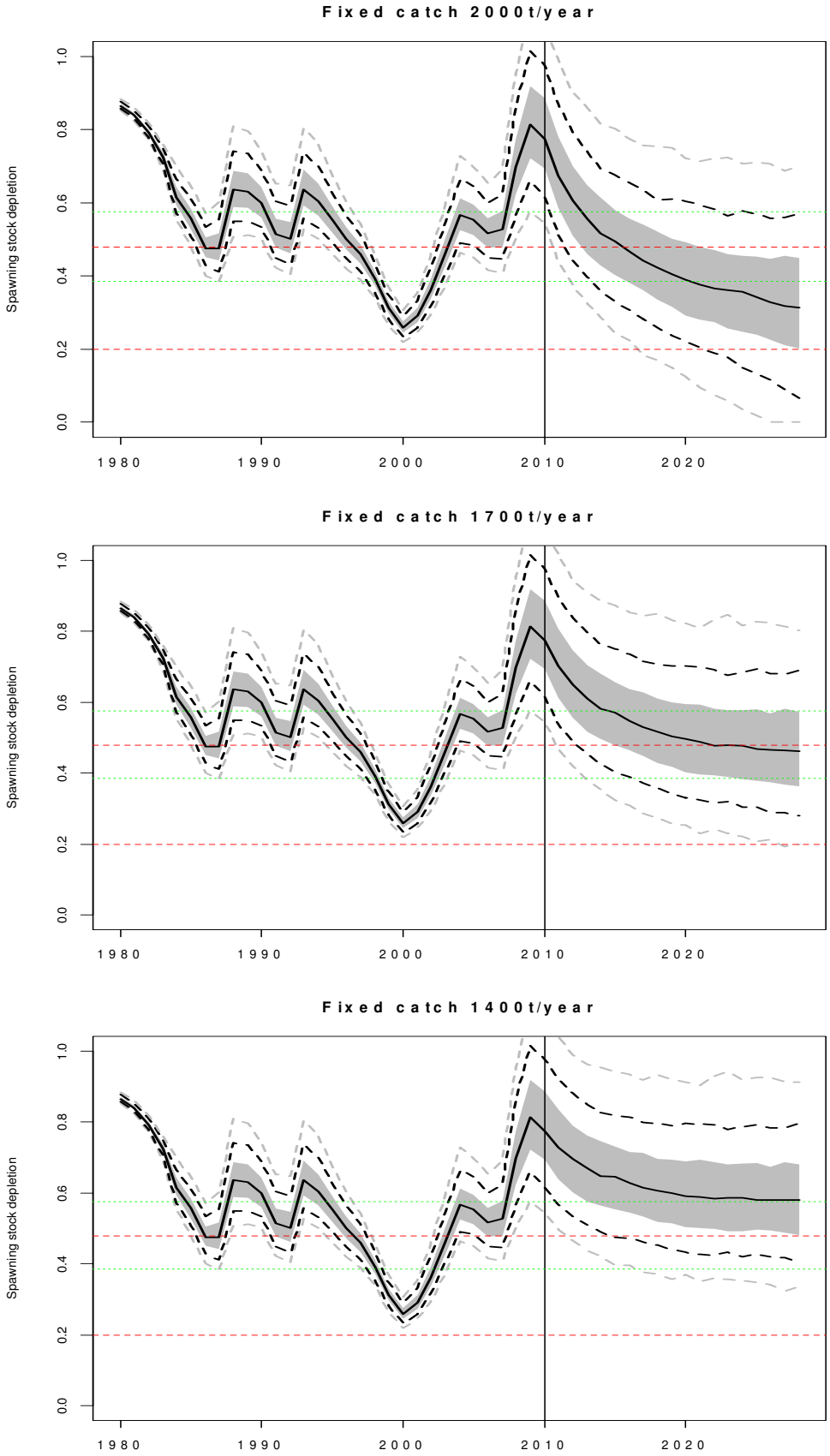


Figure 30. School Whiting fixed catch projections at 2000 t, 1700 t and 1400 t per year.

generally smaller than those caught in the west.

Last year, a discrepancy emerged between the yield-per-recruit parts of the Tier 3 assessment model and the maximum age of 11 years indicated in the ageing data. In the east, the Tier 3 assessment indicated that recent F levels were well below target levels, whether the assessment used the size or age data. In the west, however, the analysis using the size composition data indicated that recent F levels are also below target levels, but the analysis with the age composition data indicated that recent F levels are well above limit levels. This indicated that there were issues with the estimates of either the growth parameters or natural mortality in the assessment. An additional problem noted with the Tier 3 approach was that it uses a combined growth model for both sexes, but there are major growth differences between males and females.

2010 Assessment

Tier 1

This is the first year a Tier 1 assessment has been attempted for Mirror Dory (Thomson and Fay 2010). The assessment assumes a single stock, and uses SS3 to apply a 2-sex, age-structured integrated analysis model to all data up to the end of 2008.

Fits to the proportion discarded, retained and discarded length frequencies and age data were acceptable to good, but those to the CPUE data were poor, particularly in the east in recent years when the observed CPUE increases but the model CPUE decreases due to the natural senescence of a very large cohort spawned in 1998, evident in sequential years of length frequency data. The fits to the standard deviation in age-at-size are not good. Estimated natural mortality rates are consistently higher than those initially assumed. Although males and females had different growth curves and natural mortality rates, the model was able to estimate growth parameters with surprising precision, given a paucity of age data, but estimates of growth rate (K) are correlated with estimates of natural mortality (M), which in turn are correlated with estimate depletion of the stock..

Based on the assessment, estimates of current depletion of the spawning biomass vary between 26 and 29% if natural mortality is assumed to be 0.3 and 0.4 y^{-1} for females and males respectively. If these parameters are estimated in the model, the higher M values yield depletions of 44-49%. If the CPUE data are given much greater weight in an attempt to force a better fit to these data, even higher depletions of 53-76% are attained.

While the RAG commended the work on the Tier 1 assessment, it was agreed that paucity of ageing data was a critical issue for the model and it was recommended that no further work on the Tier 1 assessment be done until more ageing data from the east and west is available, and further work is done on estimating the natural mortality M for males and females. Until this is done, the Tier 1 assessment will not be robust enough to use for estimation of RBCs.

Tier 3

A Tier 3 assessment was conducted on Mirror Dory this year (Klaer 2010a). The parameters used in the assessment are shown in Table 9 and the catch curve graphs are shown in Figure 31. Becasue there is only a single snapshot of age data, the model relies mainly on length rather than age data, and indicates that the effect of fishing on the stock has recently been very low. This results in an unreasonably large RBC of 7,528 t (The Tier 3 RBC estimated for Mirror Dory was 7,528 t. While a couple of people were quite excited about this prospect, the RAG considered this an unlikely figure was neither achievable nor sustainable.

Table 10).

Table 9. Mirror Dory parameters used in the Tier 3 assessment (adapted from Klaer 2010a).

Species	M	h	Linf	k	t0	a	b	l25	l50	lmat	amax	ccamax	S25
Mirror Dory	0.3	0.75	57.44	0.2345	0	0.0164	3	15.54	40	35	20	19	1.345

Tier 4

Last year, SlopeRAG examined catches and catch rates for the Tier 4 default reference period of 1986-1996 and decided that, although catch rates were declining over the latter part of this period, there were no compelling reasons not to use it as the reference period. This year ShelfRAG looked at the Tier 4 analyses in the east and west separately (Table 11 and Figure 32) and noted that the default reference period in the west did not encompass any of the larger catches taken after the fishery developed. We agreed that the period 1991-2000 was a preferred reference period for the west.

When analysed separately, it was apparent that the combined east/west Tier 4 assessment was driven predominantly by the eastern trends. Quite different catch and catch rate trends were evident in the east and west. Catch rates have been consistently increasing in the east and were higher than the target. In the west, catch rates increased markedly during 2009 to above the target reference point.

Given the above, the RAG considered that if a Tier 4 assessment is to be used for Mirror Dory, it would be more appropriate to use separate analyses of the east and west regions rather than a combined analysis.

RBC Calculations

Tier 3

The Tier 3 RBC estimated for Mirror Dory was 7,528 t. While a couple of people were quite excited about this prospect, the RAG considered this an unlikely figure was neither achievable nor sustainable.

Table 10. Mirror Dory *F* reference points, Z_{cur}, C_{cur} and RBC estimates (adapted from Klaer 2010a).

Species	Fspr20	Fspr40	Fspr48	Zcur	Fcur	ymin	ymax	Ccur	Frbc	RBC
Mirror Dory	0.355	0.188	0.147	0.310	0.010	1991	2008	569	0.147	7,528

Tier 4

Separate Tier 4 assessments for the east and west stocks gave:

- East: RBC 569t (current spawning depletion is 125%).
- West: RBC 69t (current spawning depletion is 66%), using the new reference period.

Adding these gives a combined Mirror Dory RBC of 638t.

Additional Comments from the RAG

It was agreed that a Tier 3 assessment is preferable as it is considered to be more robust, but this assessment can't be used for Mirror Dory until more recent ageing data is obtained. With the collection of Mirror Dory otoliths now occurring in both the east and west, it was expected that next year the assessment will return to a Tier 3. The RAG debated whether the Tier 4 result should be accepted for setting the RBC. It was of concern that application of the Tier 4 assessment to set an RBC would lead to a reduction in the TAC even though the primary indicator – CPUE – has increased in both the east and the west. Of further concern was the inconsistency in the assessment in that the CPUE has increased even though catches last year were significantly higher than the RBC. This occurred despite fewer boats in the fleet and with no increase in targeting in the east or west. The RAG considered it possible that the reference periods used are not quite appropriate for setting the catch targets. Although this could be explored during 2011, it is hoped that the return to a Tier 3 assessment will remove the reliance on a Tier 4 assessment to set RBCs.

Ultimately, due to the apparent high availability, positive CPUE indicators, and lack of concern regarding other indicators or the status of the stock, the RAG recommended to again rollover the TAC for 2011.

The RAG understood that the decision not to apply the Tier 4 RBC had implications for the application (or non-application) of Tier 4 results to other stocks. The problem with this Tier 4 assessment is that there have been continuous catches above the RBC, so it was recommended that guidance is needed about when a reference period should be adjusted or when the Tier 4 assessment is accepted or rejected.

Discount factor

Considering the final decision to rollover the TAC for Mirror Dory, the RAG considered the application of an additional discount factor was not warranted.

Overcatch/undercatch

The RAG considered that the application of the default 10% level for overcatch and undercatch was reasonable for Mirror Dory in the current circumstances.

Research needs

There is an urgent need to update the estimates of the age composition of the catch and to ensure that samples for size and age are obtained for both the eastern and western parts of the fishery and are representative of the catch.

Further investigation of stock structure for Mirror Dory is also a priority, particularly whether there are separate stocks east and west of Bass Strait.

Table 11. Mirror Dory RBC calculations. C_{targ} and CE_Targ relate to the period 1986-1995, CE_Lim is 40% of the target, and CE_Recent is the average catch rate over the last four years. The RBC calculation does not account for predicted discards of predicted State catches. (Adapted from Haddon 2010a).

A) Combined East / West

Ref_Year	1986-1995
CE_Targ	1.1721
CE_Lim	0.4688
CE_Recent	1.0761
Wt_Discard	0.2799
Scaling	0.8636
TAC	718
C_{targ}	488.941
RBC	**422.240**

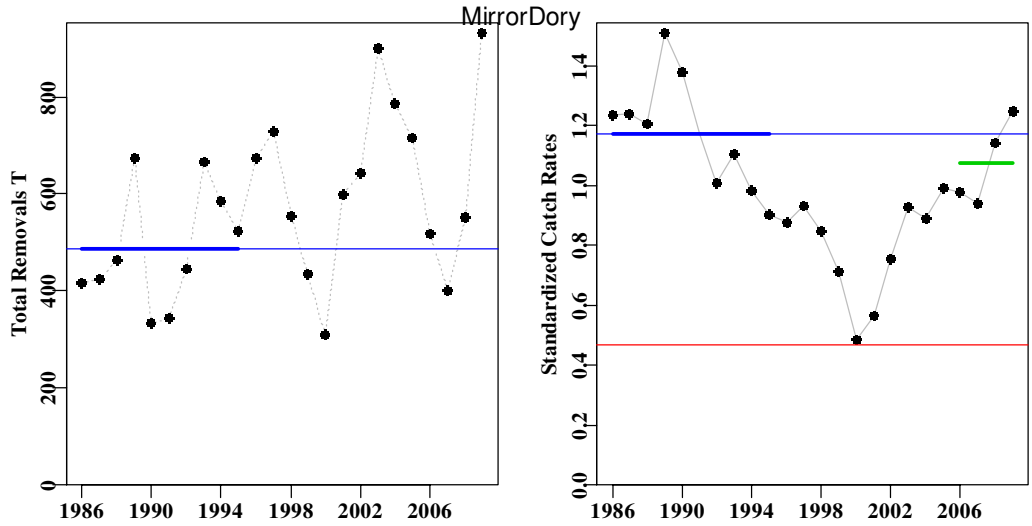
B) East only

Ref_Year	1986-1995
CE_Targ	1.129
CE_Lim	0.4516
CE_Recent	1.2992
Wt_Discard	0.2799
Scaling	1.2512
TAC	718
C_{targ}	454.697
RBC	**568.918**

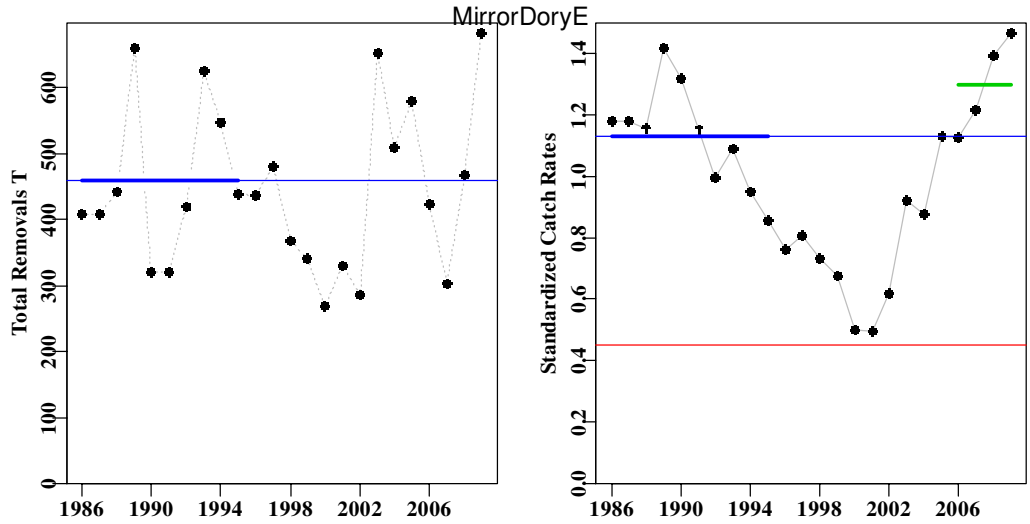
B) West only

Ref_Year	1991-2000
CE_Targ	0.8779
CE_Lim	0.3511
CE_Recent	0.698
Wt_Discard	0.2799
Scaling	0.6584
TAC	718
C_{targ}	104.665
RBC	**68.915**

A) Combined East / West



B) East only



C) West only

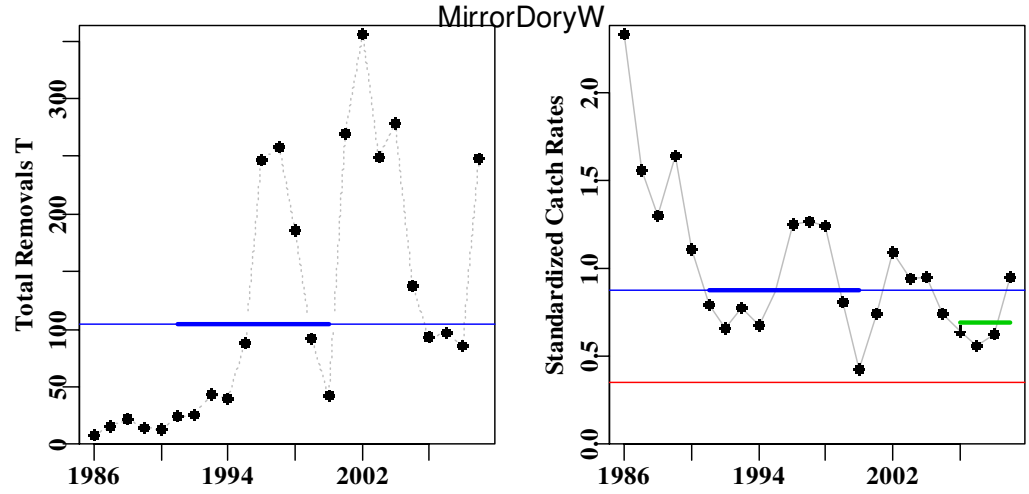


Figure 32. Mirror Dory total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick horizontal line represents the reference period which is different in the east (1986-1995) compared to the west (Adapted from Haddon 2010b).

Table 12. Offshore Ocean Perch RBC calculations. C_{targ} and CE_Targ relate to the period 1986-1995, CE_Lim is 40% of the target, and CE_Recent is the average catch rate over the last four years. The RBC calculation does not account for predicted discards of predicted State catches. (Adapted from Haddon 2010b).

Ref_Year	1986-1995
CE_Targ	1.147
CE_Lim	0.4588
CE_Recent	0.9286
Wt_Discard	0.0848
Scaling	0.6827
TAC	400
C_{targ}	283.202
RBC	**193.335**

Table 13. Inshore Ocean Perch RBC calculations with no discards included in the standardized catch rate. C_{targ} and CE_Targ relate to the period 1986-1995, CE_Lim is 40% of the target, and CE_Recent is the average catch rate over the last four years. The RBC calculation does not account for predicted discards of predicted State catches. (Adapted from Haddon 2010a).

Ref_Year	1986-1995
CE_Targ	1.3084
CE_Lim	0.5234
CE_Recent	0.7104
Wt_Discard	0.7444
Scaling	0.2383
TAC	400
C_{targ}	109.802
RBC	**26.163**

Table 14. Inshore Ocean Perch RBC calculations with discards included in the standardized catch rate. C_{targ} and CE_Targ relate to the period 1986-1995, CE_Lim is 40% of the target, and CE_Recent is the average catch rate over the last four years. The RBC calculation does not account for predicted discards of predicted State catches. (Adapted from Haddon 2010b).

Ref_Year	1986-1995
CE_Targ	1.2056
CE_Lim	0.4822
CE_Recent	1.1056
Wt_Discard	0.7444
Scaling	8618
TAC	400
C_{targ}	109.802
RBC	**94.628**

needs for Blue Warehou.

a) Consideration should be given to including sex-structure into the population dynamics model. Although the length-frequency data are not sex-specific, much of the recent ageing data include the sex of the animal.
b) The fishery catches are very low at present. This leads to lower sample sizes for length-frequency and further concern regarding the validity of catch-rates as indices of abundance.
c) Consideration should be given to evaluating objective methods for detecting resource recovery. Such methods may also be of value for several of the other species in the SESSF (e.g. eastern gemfish).
d) There is a need to collect additional length-frequency data for the Tasmanian component of the fishery (owing to the present size of this sector relative to the rest of the fishery in the east).
e) The impact of the catches from northwestern Tasmania coming from the western rather than the eastern stock should be examined. Such an examination requires information on the length-composition of the catches from northwestern Tasmania.
f) In principle, the ages obtained from reading of whole (rather than sectioned) otoliths should be included in the assessment.
g) Consideration should be given to estimating selectivity patterns for various time-blocks (particularly for the western stock).
h) The approach used to derive the standardized indices of abundance based on the logbook data ignores zero catches (and particularly trends in zero catches).

Table 15. Blue Warehou East RBC calculations for C* and $CPUE_{targ}$ relate to the period 1986-1995, $CPUE_{Lim}$ is 40% of the target, C_{max} = 1.25 C*, and is the average catch rate over the last four years. The RBC calculation does not account for predicted discards of predicted State catches or recent CPUE adjustments (Adapted from Haddon 2010b).

Ref_Year	1986-1995
CE_Targ	1.8782
CE_Lim	0.7513
CE_Recent	0.2086
Wt_Discard	0.2282
Scaling	0
TAC	183
C_{targ}	976.653
RBC	**0**

Table 16. Blue Warehou West RBC calculations. C* and $CPUE_{targ}$ relate to the period 1986-1995, $CPUE_{Lim}$ is 40% of the target, C_{max} = 1.25 C*, and is the average catch rate over the last four years. The RBC calculation does not account for predicted discards of predicted State catches or recent CPUE adjustments (Adapted from Haddon 2010b).

Ref_Year	1986-1995
CE_Targ	1.7756
CE_Lim	0.7102
CE_Recent	0.3875
Wt_Discard	0.2282
Scaling	0
TAC	183
C_{targ}	734.826
RBC	**0**

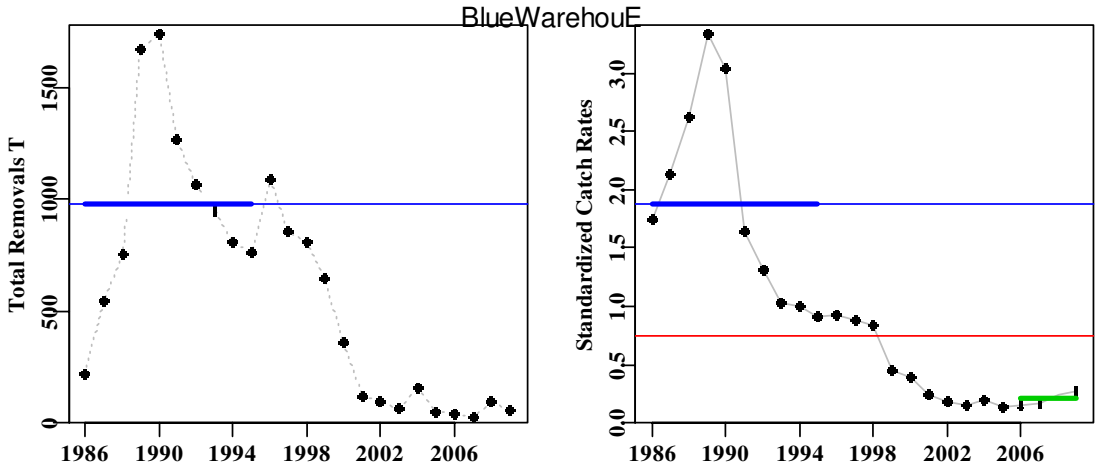


Figure 35. Blue Warehou east total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates including discards with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick blue horizontal line represents the targets during the reference period and the green line is the recent average catch rate (Adapted from Haddon 2010b).

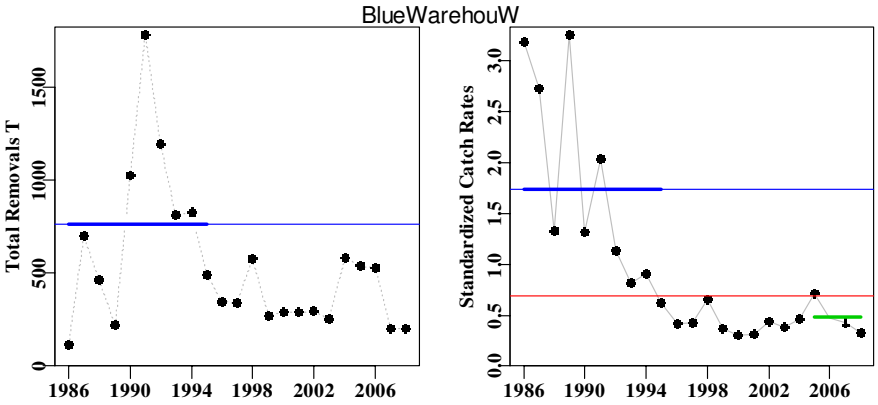


Figure 36. Blue Warehou west total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates including discards with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick blue horizontal line represents the targets during the reference period and the green line is the recent average catch rate (Adapted from Haddon 2010b).