2010 Stock Assessment Summaries for species assessed by ShelfRAG

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Introduction

Species assessed by the Resource Assessment Groups

This year AFMA decided to disband DeepRAG, allocate the species previously considered by this RAG to SlopeRAG, to move three of the species previously assessed by SlopeRAG to ShelfRAG (mirror dory, Ocean Perch and blue warehou) and to move western gemfish to GABRAG. This report covers the species assessed by ShelfRAG.

General Approach

The Harvest Strategy Framework for the SESSF that is the basis for calculations of RBCs was largely unchanged in 2010. There is a target reference point of 48% of unfished spawning biomass or B_{48} as the default proxy for B_{MEY} that applies for the calculation of RBCs for Tier 1 species. For this harvest control rule the inflection point in the control rule, between the limit of B_{20} and the target of B_{48}, has been set at 35% of unfished biomass. Previous modifications made to the Tier 3 and Tier 4 rules to overcome some problems with them and make them more consistent with Tier 1 were applied again in 2010. The changes to the Harvest Strategy Framework have now largely been tested by management strategy evaluation and the current framework has been shown to be consistent with, and meeting the requirements of, the Commonwealth Harvest Strategy Policy (Wayte 2009).

The target reference point of 48% of unfished spawning biomass is the default economic target reference point for B_{MEY}. As before, Slope/DeepRAG did not feel able to provide meaningful comment on the appropriateness of this as an economic target for any of the species it has considered. This is due to a combination of a lack of economic information available to it and a lack of economic expertise within the group. Previously, concern had been expressed about the ability to determine appropriate economic targets for individual species in a multi-species and multi-method fishery, and about the likelihood that any estimate of B_{MEY} would be very sensitive to inter-annual or within season changes in such things as market prices or fuel prices.

Estimates of total catches and discards used in assessments are detailed in Klaer (2010). Standardised catch rates used in all assessments are detailed in Haddon (2010b) and figures from this report are used in the species summaries presented here.

Tier 1 Harvest Control Rule

Wherever possible, quantitative assessments for Tier 1 species have been implemented using the Stock Synthesis version 3 (SS3) package. The use of SS3 (or its predecessor SS2) for assessments in the SESSF is becoming the standard. The advantages of using this package include

- It is well-tested and flexible
- Provides a uniform approach to stock assessment for all SEF species
- Standard outputs will allow RAG members to more easily understand assessments
- Calculation of RBCs is incorporated into the software
- A standard approach allows stock assessment scientists to more easily understand (and therefore assist with or review) other assessments
- Excellent output software allows rapid model testing and development.

This year was the first year that a Tier 1 assessment had been attempted for Mirror Dory. All other species were assessed at a similar Tier to previous years. For non-Tier 1 species, the results of both the Tier 3 and Tier 4 assessments are provided to provide and indication of the overfished and overfishing status that is used in the BRS Status Reports.

The default target reference point for the Tier 1 Harvest Control Rule for 2010 has again been set at B_{48} (the spawning biomass equal to 48% of unfished levels), the default proxy for B_{MEY} as specified in the Commonwealth Harvest Strategy Policy. The default limit reference point has also remained at B_{20}. The target level of fishing mortality is therefore F_{48}, the level that would lead to a spawning biomass of B_{48} if applied over the long term.

The break-point in the trajectory of fishing mortality between the limit and target was set at B_{35} in 2008 based on an analysis for a range of SESSF species (Day 2008a). Below this level of biomass, the level of fishing mortality will be set according to the old 20:40:40 rule. At biomasses above this level, but below the target, fishing mortality will be set at F_{48}.

Tier 3 Harvest Control Rule

The revised and improved version of the Tier 3 HCR that was developed, tested and adopted in 2008 (Klaer *et al.* 2008a, Klaer *et al.* 2008b) was applied again in 2009. The new rule overcomes problems with the previous rule by

extending the period used for calculating recent catches and matching it with the years over which mortality is calculated, by incorporating a selectivity function into the calculations, and by incorporating targets and limits into a new control rule that are more consistent with those used for Tier 1. The results for the Tier 3 analyses are provided in Klaer 2009b.

A decision is needed on whether a cap on the RBC for Tier 3 species should be introduced similar to that applied under the Tier 4 HCR.

Tier 4 Harvest Control Rule

The revised and improved version of the Tier 4 HCR that was developed, tested during 2008 (Little *et al.* 2008) and adopted last year was applied again in 2009. The new rule overcomes problems with the previous rule by incorporating targets and limits into a new control rule to make it more consistent with those used for Tier 1. Results for Tier 4 analyses are provided in Haddon (2010b) and tables and figures from this report have been used in these species summaries. During the assessment cycle, a number of extra requests for Tier 4 analyses were made for various species and are reported in Haddon (2010c).

Meta-Rules

In addition to the above harvest control rules, two meta-rules are to be applied again this year, according to the agreed TAC setting process.

CPUE Update

This meta-rule was developed that allowed adjustment of the TAC upward or downward depending on whether recent standardised CPUE levels were above or below previous values. After trialling this rule for selected species it is now applied to all species.

Discount factor

This meta-rule was proposed to explicitly introduce more precaution in TAC setting under the Tier 3 and Tier 4 harvest control rules. It was proposed that RBCs be discounted by 5% for Tier 3 species and 15% for Tier 4 species. These discounts are the default ones that are to be applied, but the RAGs were requested to examine the need for their application on a species by species basis.

Previously agreed rules regarding the deductions of catches in other jurisdictions and discards, and limiting changes in TACs to between 10% and 50% were again agreed to be implemented.

AFMA will apply the above meta-rules to the RBC in developing their TAC advice to the MAC and Commission. The RAG has provided advice on whether there was justification for not applying discount factors to the Tier 3 and Tier 4 analyses. The RAG has also provided on whether the carryover of undercatch/overcatch was appropriate for each species.

2010 Stock Assessment Summary for John Dory (*Zeus faber*)

RAG undertaking the assessment: ShelfRAG

Stock Structure

John Dory inhabit the coastal and continental shelf waters of Australia, the western Indian Ocean, eastern Atlantic Ocean, Mediterranean Sea, Japan and New Zealand. In southern Australia its distribution stretches from Moreton Bay, Southern Queensland to Cape Cuvier, Western Australia. Most of the SESSF John Dory catch is taken off NSW and it appears to have limited distribution around eastern Bass Strait. For management purposes, a single stock is assumed for the SESSF.

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	190	190	190	190	221
Actual TAC (Global)	193	na[1]	205	207	
Trawl catch (SEF2 Comm.)	84	69	136	108	
% Actual TAC .(trawl)	44	na[1]	66	52	
Trawl catch (SEF2 State)	0	<1	0	<1	
Non-trawl catch (SAN2)	<1	<1	<1	<1	
% actual (non-trawl)	0		0	0	
Estimated discards	0.6	1.4	0.6	4.3	
% Discards	0.5	1.4	0.3	2.9	
State catch	23	14	41	17	
Total retained catch	107	82	177	125	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

Synopsis of the 2009 fishery

The total landing of John Dory from all sectors during 2009 was 125 t of which the SEF2 landed weight by the trawl sector was 108 t. The 2009 SAN2 landed weight by the non-trawl sector was negligible. The NSW state catch was 17 t. ISMP data estimates that 4 t or John Dory was discarded. The 2010/11 global TAC for John Dory is 221 t.

A proportion (<14%) of the John Dory catch is taken outside the SESSF, mainly in NSW and particularly north of Barrenjoey Point. John Dory are also taken by the recreational fishery. Historically, most of the SESSF catch (about 80 % by weight) was taken in NSW zone, with virtually all the remainder from Eastern Victoria. In recent years, however, slightly over half of the catch has been taken in Eastern Victoria . In both regions, catch rates show little seasonal variation. Catches by non-SEF commercial fishers in Victorian and Tasmanian are less than 1 t annually.

There is a good size rage of fish in the retained catch. During 2009, Industry indicated that they were catching a lot of small John Dory in state waters and they have again emphasised that the stocks appear to be in good condition.

Recommended Tier Level

John Dory is a Tier 3 species. Although there is only a single snapshot age structure, application of catch curve analyses to length frequency data allowed calculation of total mortality rates used in the Tier 3 calculation.

2010 update

Klaer (2010) provides an update of Tier 3 assessment of John Dory. The information required for this assessment included: selectivity-at-age, length-at-age, weight-at-age; age-at-maturity and natural mortality (Table 1). 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 90 mm 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 1. John 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
John Dory	0.36	0.45	53.2	0.15	-1	0.0458	2.9	15.54	30	31.5	20	19	1.303

The Tier 3 model contains length data for the past five years but no age data. Estimates of total mortality and fishing mortality produced good fits to the model. 2009 length data has been added to the current Tier 3 assessment, and the output was quite similar to previous years.

RBC Calculations

Table 2. John Dory F reference points, Zcur, Ccur and RBC estimates (adapted from Klaer 2010a).

Species	Fspr20	Fspr40	Fspr48	Zcur	Fcur	ymin	ymax	Ccur	Frbc	RBC
John Dory	0.287	0.159	0.126	0.457	0.097	1991	2008	207	0.126	265

Examination of recent mortality estimates from catch curve analyses indicated the average fishing mortality is at a level that will result in a biomass near the target level of 48% of the unexploited biomass. Catch curve fits to catch frequency data are shown in Figure 2.

Based on the Tier 3 assessment, the 2010 RBC for John Dory is 265 t. The RAG noted that catches have been below 200t for several years.

Additional comments from the RAG

John Dory is largely taken as a by-catch of fishing for other shelf species (~26% targeted, Klaer 2010a) so catches are largely dependent upon the total fishing effort directed towards the depth strata occupied by John Dory. Because of the bycatch nature of the fishery, it is very unlikely that changing the TAC for this species will markedly alter fishing mortality.

Last year, industry members highlighted that they believed the stock was in "brilliant" condition and this was evident in a marked increase in both catch and catch rates. Although both catch and catch rate dropped during 2009 compared to 2008, they remain above the historical low of 2007. Total removals from the fishery during 2007 were the lowest for over 20 years (Figure 3). Standardised catch rates during 2008 and 2009 were the highest in over a decade (Figure 3). Length frequency distribution appeared stable.

Catch rates have declined since 1990 but have increased in the past couple of years and are no longer on the limit. The current Tier 4 assessment (Haddon 2010) indicated that the species is not overfished.

During 2007, it was agreed that an annual TAC of 190t would be introduced for John Dory for a period of three years, pending no major changes in the stock indicators. Although that period has now ended the RAG considered that John Dory remains a candidate for a multi-year TAC.

Discount factor

Due to the bycatch nature of this species and the long time series of consistent catches and other stable indicators, the RAG decided that the application of the 5% Tier 3 discount factor for John Dory for the 2011/12 fishing season was not required.

Overcatch/undercatch

The default 10% overcatch and undercatch values were considered to be appropriate for John Dory.

Research priorities

ShelfRAG has previously given a low research priority to this species because it constitutes a low volume fishery with stable indicators. A post-graduate research project could elucidate the biology and life-history of this species, which is poorly understood.

Last year it was suggested that a revised snap-shot age structure of this species should be collected as a priority. SETFIA members offered to take a cut in price on John Dories to enable collection of otoliths (they have to be sold for a lower price once damaged) to support having more ageing data for the next Tier 3 analyses. The ISMP is now collecting these and they will be available for analysis during 2011.

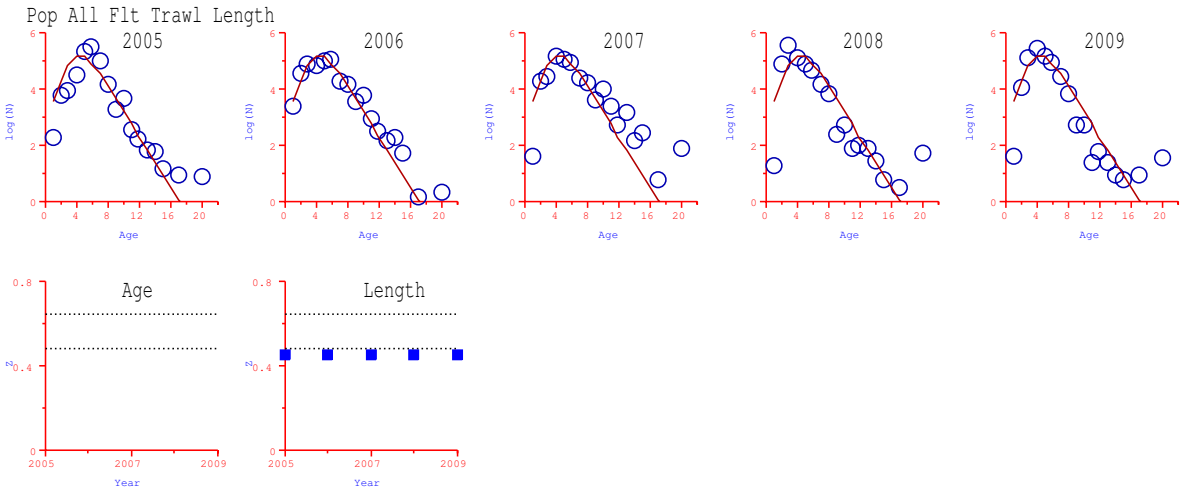


Figure 1. John Dory catch curve fits to length frequency data for years 2005–2009.

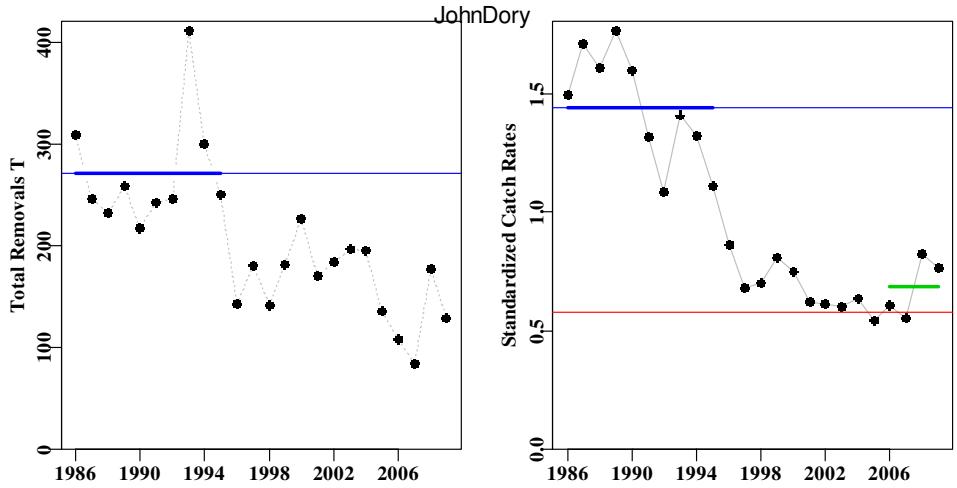


Figure 2. John Dory total removals and standardised catch rates. The total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). (Adapted from Haddon 2010b).

2010 Stock Assessment Summary for Royal Red Prawn (*Haliporoides sibogae*)

RAG undertaking the assessment: ShelfRAG

Stock Structure

Royal red prawns are found in depths of between 350 and 550 m in the Indian and western Pacific Oceans. In Australia they are caught off NSW, Queensland and Western Australia between latitude 10 and 36°S. Nothing is known of the stock structure in Australia, but they are assumed to comprise a common stock off eastern Australia which straddles the Barrenjoey Pt SESSF management line. Stock status is unknown.

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	500	374	400	400	319
Actual TAC (Global)	546	na[1]	433	431	
Trawl catch (SEF2 Comm.)	192	135	88	79	
% Actual TAC .(trawl)	35	na[1]	20	18	
Trawl catch (SEF2 State)	0	0	0	0	
Non-trawl catch (SAN2)	0	0	0	0	
% actual (non-trawl)	0	0	0	0	
Estimated discards	27	18	13	10	
% Discards	9	9	9	10	
State catch	32	20	25	9	
Total retained catch	224	155	112	87	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

Historically, catch rates of Royal Red Prawns have been cyclic but it is uncertain whether this cycle reflects changes in abundance of Royal Red Prawns or a response to environmental influence on availability.

Catches of Royal Red Prawns have been below the TAC during recent years. This is largely attributed to limited processing facilities for this species and low market demand as a result of the influx of cheaper prawns from aquaculture and imports. Industry has introduced daily/weekly catch limits to minimise the extent of oversupply to the markets. As a result, many vessels that typically fished for Royal Red Prawns have moved to target scalefish species in recent years. During 2005/06 some vessels installed freezing capacity to explore other market and processing opportunities but to date, this has resulted in limited expansion of the market.

There has been some confounding of data recorded as NSW state catches and SEF2 state catches in earlier years.

Synopsis of 2009 fishery

The total landing of Royal Red Prawn from all sectors during 2009 was 87 t of which 79 t was caught by the trawl sector in Commonwealth waters. The remainder was caught in NSW state waters north of Barrenjoey Point. It was estimated from ISMP data that 10 t of Royal Red Prawns were discarded. The agreed global TAC for Royal Red Prawns during 2010/11 remained at 400 t.

At <100t, total removals from the fishery during 2008 were the lowest on record (Figure 3). Standardised catch rates are generally variable (or cyclic) and have been fluctuating around the Tier 4 target catch rate (average of 1986-1995) over the last two decades. During 2007, however, there was a large drop in catch rates and again during 2008, the latter being the lowest on record. Catch rates during 2009 rebounded to target levels.

Recommended Tier Level

Potentially, Royal Red Prawns could be assessed as a Tier 3 species using catch curve analyses based on carapace length frequency distributions. Different growth rates of male a female Royal Red Prawn require that sex-specific size information be collected to enable Tier 3 analysis. Despite this information being collected during 2005/06, catch curve analysis of Royal Red Prawns during could not yield a valid result.

Given the above, ShelfRAG uses a Tier 4 assessment for Royal Red Prawns. There remain concerns that the daily/weekly catch limits applied by industry to meet market requirements may compromise the validity of this assessment method if it reduces catch rates.

2010 Assessment

A Tier 4 assessment of Royal Red Prawns was conducted during 2010 (Haddon 2010b) with additional analyses of the different gears used in the prawn fishery (Hadddon 2010c).

Industry has always used prawn nets to target Royal Red Prawns but their use has not always been recorded in logbook data. Based on concerns last year that the Tier 4 assessment had not focused explicitly on vessels using prawn nets, ShelfRAG examined the effects of specialised prawn trawl nets on the CPUE standardisation (Hadddon 2010c).

Shots from logbook data which had information on mesh size were only available subsequent to 2002 and were not available for the default 1986-1995 reference period. Analysis revealed the mean CPUE was higher for the prawn nets (than all nets combined), and showed an apparent increasing trend over time. When standardised for vessel, month, depth and day/night, the trend was noisy but essentially flat; not dissimilar to the results from standardised CPUE from all nets combined. Based on this, ShelfRAG members agreed to use the standardised CPUE series from all nets combined in the Tier 4 assessment as long as there was ongoing monitoring of the effects of prawn nets on the CPUE standardisations to ensure there was no divergent trend over time.

Although the size of prawns tends to increase the further north they are caught, the carapace length distribution of Royal Red Prawns has been slightly variable but stable in recent years, generally ranging between 15 and 35 mm with a mode between 23 - 26 mm. The 2007 size distribution showed a mode of a larger size than in previous years. There was no 2008 carapace length frequency data available for Royal Red Prawns which prevented ShelfRAG examining one of the major indicators for this species.

Historically, standardised CPUE has displayed a cyclic trend and generally increased from 1997 – 2005 (Figure 1). There was a peak during 2006 but it dropped during 2007 and further still during 2008.

Virtually all of the Royal Red Prawn catch in the SEF comes from the NSW zone but a significant amount of the SEF2 catch may be reported as coming from State waters north of the Barrenjoey line. Targeting of Royal Red Prawn is market driven but best catches occur in summer-autumn.

Discarding rates are generally low (~1%) for this species. The discard rate was 4% in 2005 and 2006. The discard rate for 2007 and 2008 was estimated at 11% but these data are questionable as a result of poor sampling. Discards made up 4.72 % of the catch over the 1998-2008 period. Operators often discard all of their prawn catch unless a minimum of around 20 kg is caught in any shot.

RBC Calculations

Table 3. Royal Red Prawn 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	1.0588
CE_Lim	0.4235
CE_Recent	0.9706
Wt_Discard	0.1058
Scaling	0.8612
TAC	400
C_{targ}	408.075
RBC	**351.434**

Using the Tier 4 assessment, the 2011/12 RBC for Royal Red Prawns is 351 t.

Additional comments from the RAG

As stated in previous years, complementary management controls between the SESSF and NSW state waters North of Barrenjoey need to be implemented.

The Commonwealth industry operators have been constructive and responsible in recent years by applying a self-imposed catch limit to their vessels to stop discarding / wastage and limit catches to a level which can be processed and marketed by current onshore facilities. If these fishing practices reduce catch rates (not just catches), it may compromise the application of the Tier 4 assessment to Royal Red Prawns.

There has been ongoing concern about the level of bycatch caught in the SESSF Royal Red Prawn fishery and it has been suggested that prawn gear should not have any sweeps to improve bycatch reduction. NSW is introducing mandatory BRDs into the fishery north of Barrenjoey. There is a lack of good information from vessels working in the northern SESSF, but skippers suggested that there were potentially a number of better options than removal of sweeps to reduce bycatch in the fishery. Industry members agreed to support AFMA observers monitoring of their vessels to quantify bycatch and evaluate the effectiveness of current and potential bycatch reduction techniques (detailed below). This research was apparently been completed three years ago, but ShelfRAG is yet to see any of the results of this work.

Discount factor

Last year the RAG recommended applying a 15% discount factor to the Tier 4 RBC because of the low catch, decreasing CPUE trend, and uncertainty regarding the impact of net type on CPUE. This year, catch rates have returned to target levels, catches are at historically low levels and the CPUE trend is essentially flat, and ShelfRAG has considered the effect of prawn nets on CPUE. Further, industry catch limits remain in place and the recently introduced eastern extension to the Endeavour closure will provide added protection to the stock. This year, we also had size frequency data available which showed no concerning trend. As a result, the RAG agreed that there was little justification to apply the 15% Tier 4 discount factor this year.

Overcatch/undercatch

The default 10% overcatch and undercatch values were considered to be appropriate for Royal Red Prawn.

Research priorities

Stock boundaries within the AFZ, and more particularly in the SESSF and nearby areas, need to be defined.

Size frequency and discard information has been poorly collected over the last few years. It is critical that good information is collected from the SESSF as well as North of Barrenjoey Pt.

Based on the ShelfRAG June 2006 meeting, the following research priorities have been agreed to support bycatch reduction options for the fishery.

1. AFMA observers will collect bycatch information from vessels working out of Wollongong and Sydney. Information on catch composition and gear design (sweep length, boards, mesh size / any panels) and fishing practices will be collected. Fishermen have also agreed to record gear / bycatch details in their logbooks.
2. A number of modified gears will be trialled including:
    a. Escape panels at front of codend trial position and type of panel
    b. Larger mesh 4.5 inch behind the headline to a minimum of footline (1 fathom)
    c. Wing mesh 4.5 inch from first hanging back to 3 fathoms or more
    d. Shorter bridles down to 1 fathom
3. The above information will be summarised by depth and catch by month for different areas along the coast
4. A meeting will be held in mid 2007 to discuss results and provide a paper on bycatch reduction in RRP fishery

Re-examination of the Baelde raw data and length-based assessment could be done to determine if this analysis could provide some form of stock assessment.

Investigate if there are methods of ageing Royal Red Prawns and whether this is cost effective given the current status of the fishery.

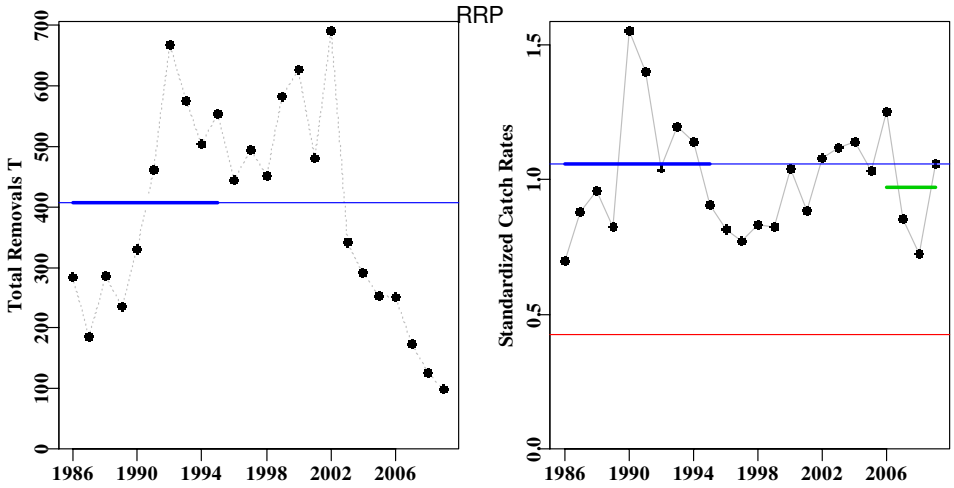


Figure 3. Royal Red Prawn total removals and standardised catch rates. The total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). (Adapted from Haddon 2010b).

2010 Stock Assessment Summary for Silver Trevally (*Pseudocaranx dentex*)

RAG undertaking the assessment: ShelfRAG

Stock Structure

Silver trevally are found in Australian and New Zealand waters. In Australia, they range from northern NSW to WA but little is known of the stock structure across Australian waters. Preliminary research suggests that the Silver Trevally off south-eastern Australia represent a single stock that is distinct from the North Island of New Zealand fishery. Whereas Silver Trevally growth rates are slower than those reported for New Zealand, the Australian stock matures comparatively early at about two years of age. Spawning occurs throughout the summer.

Note: the specific name of Silver Trevally referred to in this assessment should revert to '*georgianus*' following a review by W.F. Smith-Vaniz and Jelks 2006, ie. *Pseudocaranx georgianus*.

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	270	146	296	360	540
Actual TAC (Global)	298	na[1]	313	388	
Trawl catch (SEF2 Comm.)	69	64	111	156	
% Actual TAC .(trawl)	23	na[1]	35	40	
Trawl catch (SEF2 State)	0	0	0	0	
Non-trawl catch (SAN2)	2	2	0.3	0.7	
% actual (non-trawl)	0	0	0	0	
Estimated discards	2	3	2	0	
% Discards	0.2	0.5	0.5	0	
State catch	340	284	174	146	
Total retained catch	411	350	285	302	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

Silver trevally are caught by Commonwealth and state trawlers, and state-based trap, longline, mesh net, haul seine and purse seine vessels. Overall, most of the catch is taken by fish trawling. Prior to 2008, NSW catches accounted for nearly 80% of the total Silver Trevally catch, but in 2009 NSW catches were just less than 50% of the total. There is also a significant recreational catch. Analyses of commercial catch data showed a decline in catches of Silver Trevally from about 1500t in 1985 to about 500t in 1999. Catches then remained stable at between 500 – 600 t until a decline in 2004 and 2005. There was a large increase and subsequent decline in standardised CPUE of the Commonwealth trawl sector between 1986 and 1992. Standardised CPUE has been variable, but reasonably stable since 1997.

Synopsis of the 2009 fishery

The total landings of Silver Trevally from all sectors during 2009 were 302 t of which the SEF2 landed weight by the trawl sector was 156 t (all in Commonwealth waters). NSW state landings in 2009 were the lowest since the early 1960s, largely attributable to the implementation on the Batemans Bay MPA, a higher size limit and commercial fisheries buyout. State catches from Victoria and Tasmania were 66 t and 5 t, respectively. The 2010 agreed Commonwealth TAC is 360 t.

Recommended Tier Level

A formal quantitative assessment was conducted in 2006 but despite additional data and analyses there remained too much uncertainty in the model outputs to consider it as a Tier 1 or 2 assessment. Unfortunately, due to the dome-shaped selectivity (larger fish are under-represented in the catch) and the fact that there is only ageing data for one year, a Tier 3 analysis also could not be supported. As a consequence, Silver Trevally is now analysed as a Tier 4 species for the calculation of RBCs.

2010 update

The first formal stock assessment on Silver Trevally was undertaken during 2005 using Coleraine. During 2006, the assessment software was updated to SS2 which allowed better fits to length frequency data, age data and CPUE series

and allowed the age data to be entered as conditional age-at-length data, which (in theory) enables simultaneous fitting of the growth curve, as well as fits to CPUE, length frequencies and age-at-length data. It was hoped that this would provide an improved assessment but attempts at fitting a four-fleet model resulted in model instability, unrealistic growth estimates and uncertainty in selectivity parameters. Although the 2006 assessment was an improvement over 2005, it still had difficulty fitting significant aspects of the data and was generally considered not stable enough to produce defensible RBC figures at Tier 1 or Tier 2 levels. It was recognised that there would be insufficient data (especially age data) in the short term to resolve many of the uncertainty issues and this species was relegated to a lower assessment priority during 2007.

A Tier 4 assessment was conducted for Silver Trevally during 2010 (Haddon 2010). In the previous Tier 1/2 assessment, a large "bump" in standardised catch rate and catches was noted during the years 1988 – 1991 (highlighted in Figure 4). Exploration of the reason for this revealed that it most likely resulted from about 4 NSW trawl vessels that used increased engine power and high trawl speeds to particularly target Silver Trevally during this period. In consideration of an appropriate reference period on which to base target catch and catch rate indices, the RAG felt that these catch rates were not representative of a sustainable period of the history of the fishery and were not expected to be repeated. Therefore, the Tier 4 reference period used for Silver Trevally was 1992 – 2001.

The implementation of the Batemans Bay Marine Park in June 2007 has influenced the Silver Trevally assessment. A total of 29 fishing businesses which caught Silver Trevally between 2000 and 2005 were bought out by the NSW Government. The fishers bought out were active in the area of the Marine Park and annually landed between 127 t and 218 t of Silver Trevally in the period from 2003 to 2005. This represented between 36% and 48% of the total commercial catch of Silver Trevally in NSW for these years. The implementation of the Marine Park has also closed significant areas of trawl ground to fishing by trawlers which remain active on the south coast, including the most productive grounds for Silver Trevally fishing in the area of Montague Island - these areas are now "habitat protection" zones within the Marine Park and trawling is banned.

In order to discount the influence of catches taken within the Batemans Bay MPA, catch rate data derived from within the MPA have been excluded from the Tier 4 analysis. Nevertheless, Silver Trevally are highly mobile pelagic species and as such the fish would be available to be taken as part of the commercial catch.

Because of the recent reduction in NSW catches (Figure 5) resulting from the implementation of the MPAs, increased size limits and commercial buy-outs, the total removals during 2008 were the lowest on record. Rather than the average catch over the previous four years (Figure 5) as is typically used in a Tier 4 assessment to estimate the state catches for the next year, it was considered more appropriate to base the estimate of the expected 2010 state catch on the average of the previous three years. This will increase to the default four year average next year.

RBC Calculations

Table 4. Silver Trevally 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).

Ref_Year	1992-2001
CE_Targ	0.8234
CE_Lim	0.3294
CE_Recent	0.8023
Wt_Discard	0.0036
Scaling	0.9572
TAC	360
C_{targ}	787.685
RBC	**753.972**

Using the Tier 4 assessment method, the 2011/12 RBC for Silver Trevally is 754 t. Given the previous evidence of depletion and continued evidence of growth overfishing, some members considered that although this RBC is very unlikely to be taken, the Catch target used in the Tier 4 assessment it is likely to be an optimistic estimate of an ongoing sustainable catch, particularly given the impact of the Batemans Bay MPA.

Additional comments from the RAG:

A significant portion of the Silver Trevally catch is taken outside of the SESSF, in a number of commercial fisheries under state jurisdiction and recreational fisheries. RAG members noted that recent Commonwealth trawl catch rates for Silver Trevally have been increasing and are now close to the Tier 4 target level (Figure 4). Industry has stated that the fishery appears to be very healthy but this view is not shared by all members/observers of the RAG, particularly with regard to the issue of growth overfishing.

Studies have shown Silver Trevally in Australia to be long-lived (maximum age 25 - 30 years) and relatively slow growing. NSW data available for both commercial and recreational catches since the late 1980s suggests a significant reduction in the mean size of trevally. In recent years the modal size of trevally in commercial catches has been relatively stable between 20 and 25 cm LCF, which is small for a fish which can grow to around 65 cm in length. Yield modelling indicates Silver Trevally are being caught well below the size for optimum biological yield. Industry indicated a market preference and optimal prices for fish 25-35 cm (fork length) which reduces the economic importance of fish this size being below optimal kg yield per recruit. They also noted that very large fish sometimes have honeycombed air pockets in the flesh which reduce market value. This price reduction was not apparent in market data for medium sized fish.

Historical catch rate data together with the reduction in the size structure of Silver Trevally since the 1970s suggest that there had been a fish-down of trevally since the beginning of the fishery, but there is little certainty as to the extent of this reduction.

The recent review of NSW fishing regulations introduced a 30cm (total length) minimum size for Silver Trevally (commercial and recreational) in NSW waters from September 2007, which is a positive step to reduce growth overfishing in the NSW sectors. Whilst this does not technically apply to SEF catches, it is likely to cause compliance issues on SEF catches landed in NSW. If the size limit was applied to SEF trawl catches, however, it would result in dumping of commercially valuable fish if the current gear configuration is used, but these smaller fish are not as valuable ($/kg) as those >30cm. There remains evidence of growth overfishing in the Commonwealth trawl sector and suggestions and suggest that management action to reduce catches of silver trevally of less than 25 cm LCF would have significant benefits to both the biological and economic yields available from the trevally resource. Currently, discarding of Silver Trevally in the SEF is negligible, but the information on discard rates during recent years has been poor.

Discount factor

It was recognised that the Bateman's Bay MPA provided large habitat protection and spatial/temporal refuge for adult spawning and juvenile growth across a significant portion of their distribution in NSW. As such, RAG members agreed that the 15% precautionary discount factor that is applied to Tier 4 RBCs was not necessary in this case.

Overcatch/undercatch

The default 10% overcatch and undercatch values were considered to be appropriate for Silver Trevally.

Research priorities

As far as supported by the data, ShelfRAG has now developed an agreed catch history for the fishery, incorporating annual catches from each sector.

In the short term, ShelfRAG believe that the high uncertainty in the Tier 1 assessment model results is not likely to be resolved with future assessments based on the current data series. The Group considered that further data are required before it would be worth conducting another quantitative assessment (Tier 1 or 2) on this species.

Monitoring of the size composition of trevally caught by the different fisheries and fishing methods needs to be continued and improved. More ageing data is required than the current snapshot of one year but care would need to be taken to ensure a representative sample was taken across the various sectors of the fishery. Silver trevally could be a priority for further work under the RUSS project. Inclusion of the recreational sector catches also needs to be considered.

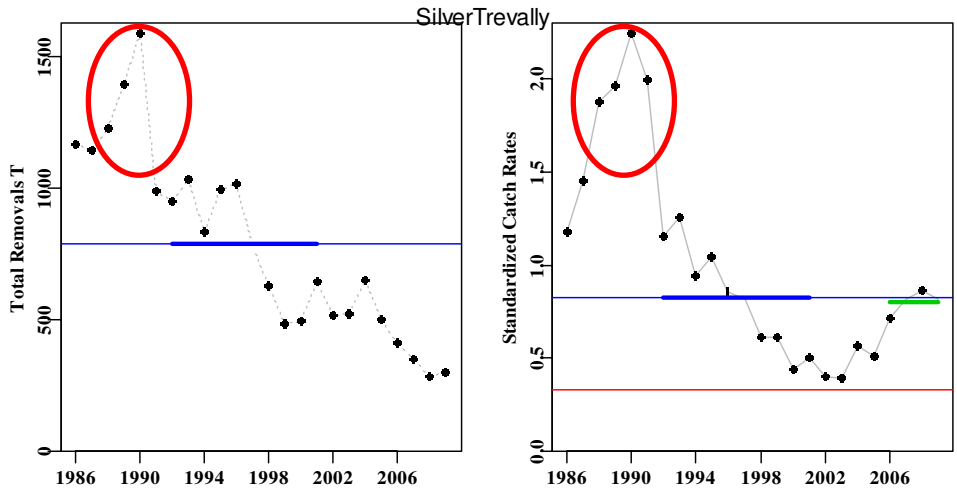


Figure 4. Silver Trevally total removals and standardised catch rates. The total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). (Adapted from Haddon 2010b). The "bump" in the time series is highlighted. Data does not include recreational catches.

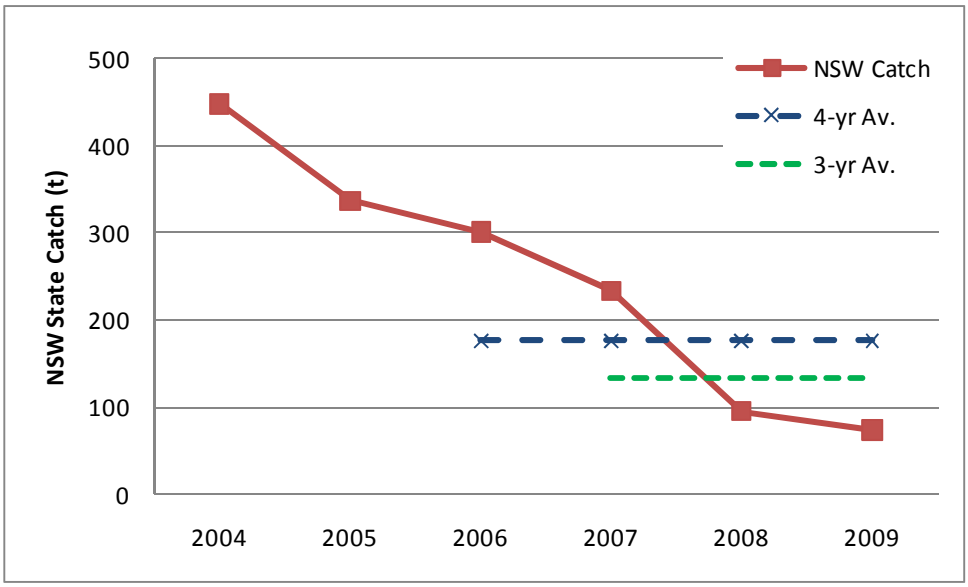


Figure 5. Recent NSW state catches of Silver Trevally show a continuous and steady decline (—). The average of the last four years' catches (blue dashed line) typically used in the Tier 4 assessment would have produced a predicted NSW catch of 176 t which is likely to be significantly greater than the 2010 state catch. Instead the average of the last three years (green dashed line) was used.

2010 Stock Assessment summary for Eastern Gemfish (*Rexea solandri*)

RAG undertaking the assessment: ShelfRAG

Stock structure

Genetic analysis recognised two separate stocks of *Rexea solandri* with a boundary at the western end of Bass Strait (Paxton and Colgan 1993). The current assessment is based solely on Eastern Gemfish which are defined by those caught south and east of the 43° latitude off western Tasmania.

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	100	100	100	100	100
Actual TAC (Global)	100	na[2]	109	104	
Trawl catch (SEF2 Comm.)	80	69	87	74	
% Actual TAC .(trawl)	80	na[2]	80	71	
Trawl catch (SEF2 State)	0	0	0	0	
Non-trawl catch (SAN2)	7	10	20	12	
% actual (non-trawl)	<1	<1	<1	<1	
Estimated discards	46	129	164	168	
% Discards	28	55	56	60	
State catch	15	14	11	14	
Total retained catch	102	93	119	100	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

Synopsis of the 2009 fishery

The total landing of Eastern Gemfish from all sectors during 2009 was 100 t of which the SEF2 landed catch by the Commonwealth trawl sector was 74 t from a bycatch TAC of 100 t. The 2008 SAN2 landed weight by the non-trawl sector was 12 t. Industry continues to report increasing difficulty in avoiding Eastern Gemfish, even though most operators try to avoid the depths at which they are usually caught during the winter run. This may be evidenced in the increasing levels of discarding of this species; during 2009 it was estimated from ISMP data that 168 t of Eastern Gemfish was discarded. The RAG is concerned that there remains evidence of gemfish targeting by a few operators. During 2010/11 the agreed global bycatch TAC for Eastern Gemfish was 100 t.

Recommended Tier Level

The Eastern Gemfish assessment is considered as Tier 1; it is a historically robust assessment and there was general acceptance of the results of the last full assessment conducted during 2008.

The Tier 1 harvest control rule specifies a target and a limit biomass reference point, as well as a target fishing mortality rate. For the 2011/12 TACs AFMA has directed that the 20:40:40 (B_{lim}:B_{msy}:F_{targ}) form of the rule will be used up to where fishing mortality reaches F_{48}. Once this point is reached, the fishing mortality is set at F_{48}. Day (2008) has determined that for most SESSF stocks where the proxy values of B_{40} and B_{48} are used for B_{MSY} and B_{MEY} this form of the rule is equivalent to a 20:35:48 strategy.

The 20:35:48 harvest control rule was applied to Eastern Gemfish.

2010 Assessment

The most recent full assessment (Little and Rowling 2008) was based on the results of the 2008 industry surveys. No surveys have since been conducted. During 2009 the assessment was updated to Stock Synthesis 3 (SS v3). This year, the SS3 assessment was re-run with the 2009 logbook and ISMP data. The CPUE series derived from the ISMP data indicating the winter bycatch index was replaced with another logbook derived CPUE series corresponding to the spawning season (June - August) (Haddon 2009).

The data in the model is divided into four fleets:

- A non-trawl fleet (1993 – 2009);
- A fleet targeting the winter spawning run (1975 – 2000 and inclusion of the results of the 2007 and 2008 surveys);

– A non-spawning (summer) season fleet (1975 – 2009); and,
– A recent (spawning season) winter bycatch fleet (2000 – 2009).

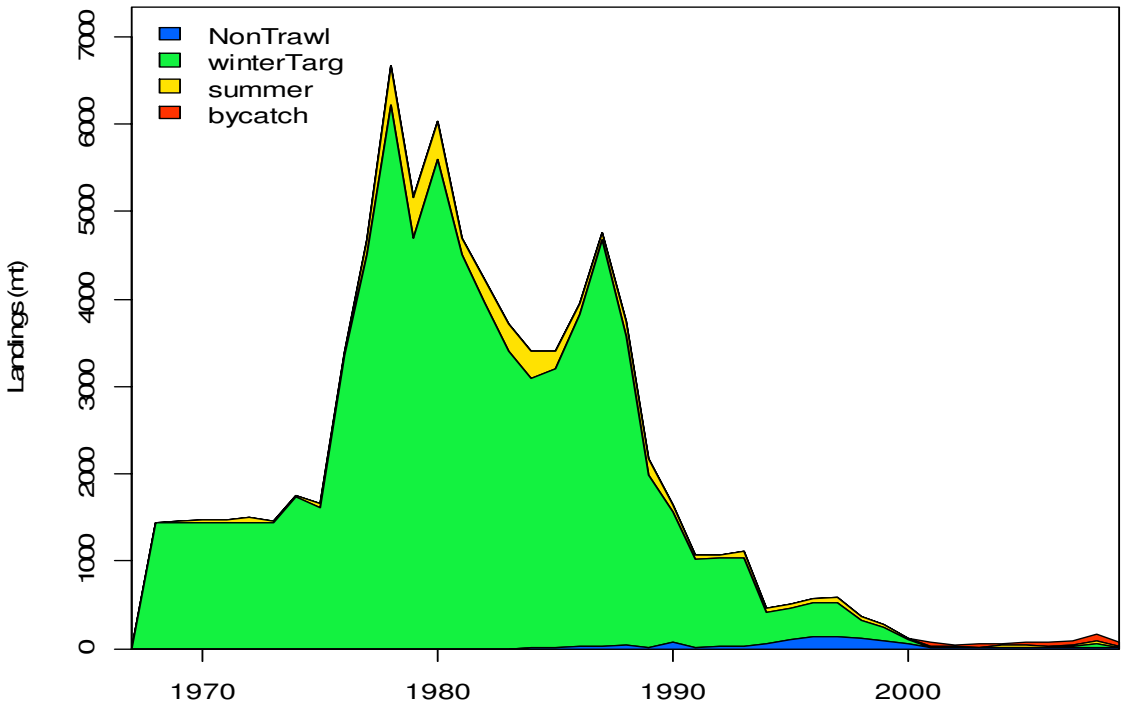


Figure 6. Catches of Eastern Gemfish by fleet (1968-2009).

Green: targeted winter spawning run fleet, yellow: non-spawning season trawl fleet, blue: non-trawl fleet, red: winter bycatch trawl). The early catch history was developed by EGAG members and is reported in Punt *et. al.* 2001, Series B).

The fits to the catch-rate indices are reasonable (Figure 7). The model had difficulty fitting to the large change in discarding experienced by the summer trawl fleet following 2003, and the steady increase in discard rate by the winter bycatch trawl fleet to levels above 50% (Figure 8). This poor fit is possibly due to the discard data being driven by TAC cuts or trip limits. The fit of discard rates for the summer trawl fleet for 2003 to 2005 is particularly poor given that this is when the 'strong' 2002 cohort entered the fishery and was discarded en masse.

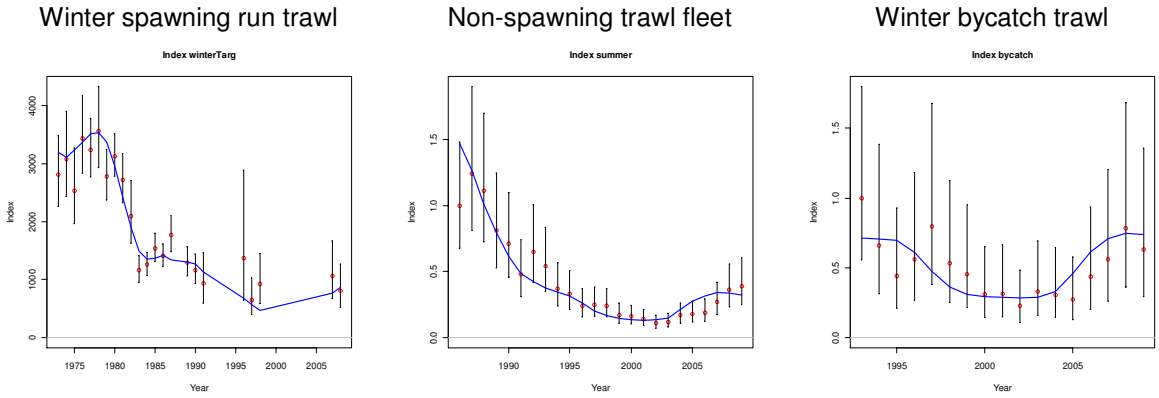


Figure 7. Eastern Gemfish observed (solid dots) and model-estimated (lines) catch rates versus year for 2008 assessment under SS3. The vertical lines indicate approximate 95% confidence intervals for the data.

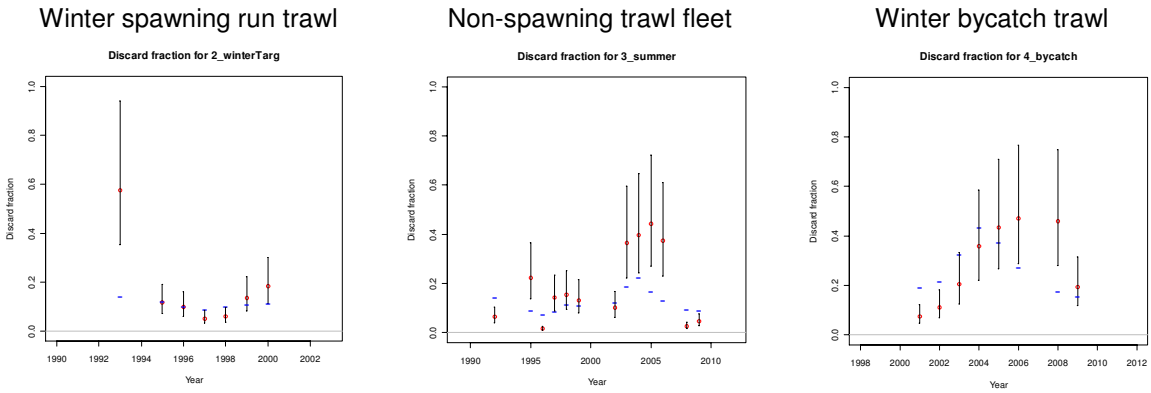


Figure 8. Eastern Gemfish observed (solid dots) and model-predicted (lines) discard rates versus year for 2008 assessment under SS3. The vertical lines indicate approximate 95% confidence intervals for the data.

The stock is estimated to have declined from the beginning of the fishery in 1968, fluctuated in abundance during the 1970's, before declining in the 1980's and 1990's, due to a period of low recruitments and high catches (Figure 9). The updated assessment estimated a current spawning biomass of 16% - similar to previous model outputs. A relatively large spawning event (given the stock size) was estimated to have occurred in 2002 which has lead to slight recovery of biomass. Fits to the length, age, and catch-rate data were reasonable. RBCs were not calculated for Eastern Gemfish given the low biomass estimates, the current management arrangements, and the history of the fishery.

The model estimates that most of the recruitments during the last 25 years have been relatively weak which contrasts with the 1970's when recruitment was highly variable, but generally higher (Figure 10).

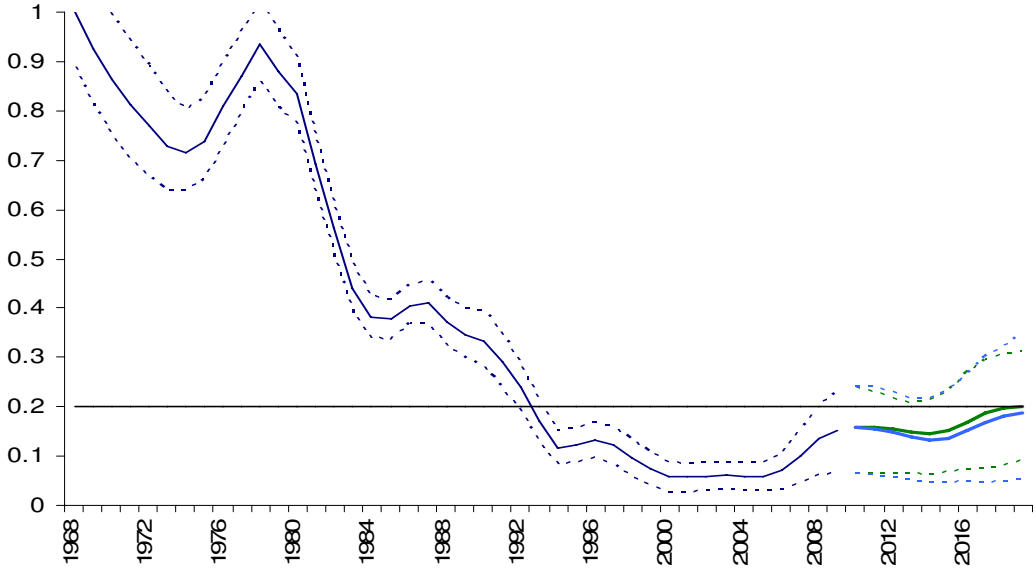


Figure 9. Eastern Gemfish base-case time-trajectories of spawning biomass depletion with projections under 0t catch (green) and 100 t catch (blue) (0.05 and 0.95 precentile). Note: catches are often in excess of the current 100t bycatch TAC, which means the above trajectories are optimistic.

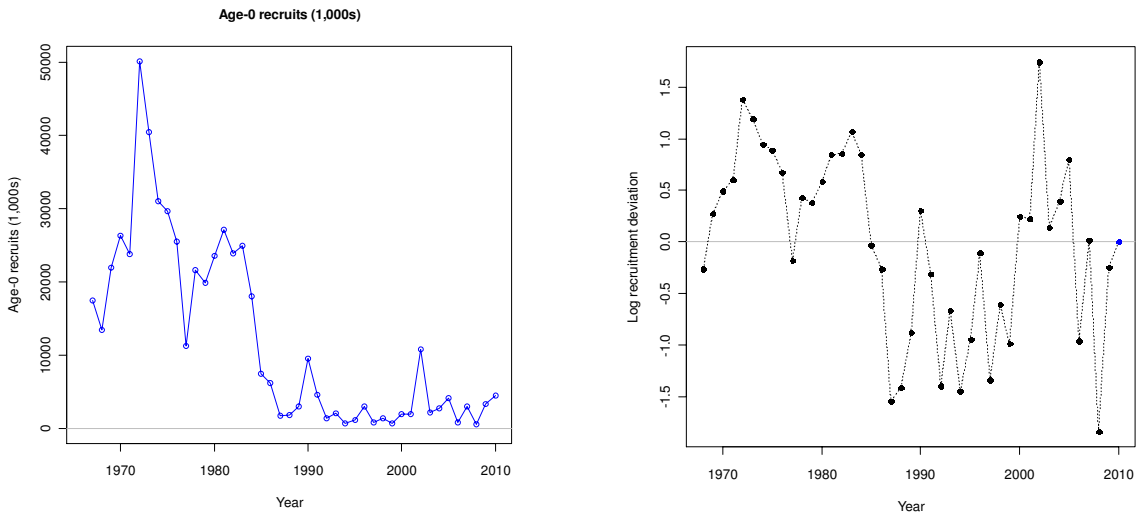


Figure 10. Base-case time-trajectories of (a) recruitment, and (b) the recruitment residuals from the 2008 SS3 assessment updated with 2009 data.

RBC Calculations

Because the base-case assessment estimated the current depletion at below 20%, no RBCs were calculated for Eastern Gemfish as *F* should be zero.

Additional Comments from the RAG

The primary indicators show that the decline in spawning stock biomass has ceased. There remains significant concern, however, that the increase in spawning biomass observed in recent years relied predominantly on the influx a single stronger-than-average year class spawned in 2002 and that the model may over-estimate the strength of this cohort. Further, there is potential that the use of targeted fishing of the main spawning run as the main index of abundance may lead to hyperstability in CPUE thereby overestimating spawning stock abundance.

Conversely, the assessment's inability to fit the recent high discard rates in both the summer and winter bycatch trawl data sets may result in an under–estimation of any stock rebuilding. It was highlighted that prior to the 2007 survey, these discard rates were one of the main indicators that pointed to some level of rebuilding of the stocks. In sensitivity runs last year that explored a better a fit to the discard data by allowing a change in selectivity or retention post-2002 resulted in 2009 spawning biomass indices of between 23-27%. Also, it is becoming increasingly difficult to interpret commercial CPUE data as an index of abundance due to the high level of avoidance by fishermen working under a bycatch TAC of 100t. This issue is not restricted to Eastern Gemfish and also applies to Blue Warehou and School Shark. This issue will be the focus of a workshop in early 2011.

The extent to which the current assessment can support statements of "stock rebuilding" is debated within the RAG. There appears to be little likelihood that the stock will rebuild above the reference point within the next decade. The projected future increase in biomass (Figure 9) only moves slowly up to the 20% limit reference point (with or without fishing) and is based on an assumption of average recruitment. Recruitment during the last 25 years, however, has been much weaker compared to the period from the 1970's to mid 1980's.

Although there is little evidence outside of the gemfish assessment itself, there is growing acknowledgement within the RAG that a "regime shift" may have occurred that is hindering the recovery of stock back to levels witnessed during the 1970's.

Eastern gemfish is now listed as "Conservation Dependent" under the EPBC Act and is operating under Stage 1 of a 3-staged Conservation Program. As highlighted last year by Rowling (2009), there is critical concern that Stage 1 of the rebuilding strategy is not working and that Stage 2 will be ineffective. Spatial closures during the winter spawning run (Stage 3) would probably be the most effective method of reducing fishing mortality, but if in fact, there *has* been a regime shift, it may be necessary to completely re-examine the management of this species under the Conservation Program.

Although the stock is still considered severely depleted, there was unanimous agreement by ShelfRAG members that there is no appreciable risk of catch levels under the current management arrangements causing the species to become extinct.

Discount factor

As a Tier 1 species, there is no discount factor applied to Eastern Gemfish.

Overcatch/undercatch

Because it is overfished, no overcatch/undercatch provisions were set for Eastern Gemfish for the 2011/2012 fishing season.

Research needs

There is considerable concern about the potential of hyperstability in an industry survey that targets the main spawning run and especially in using this as the main index of abundance. For this reason, there are some questions about the value of further surveys. An alternative primary index of abundance needs to be developed as a high priority for use in future stock assessments. The issue of how to address the loss of the primary index of abundance for species under a bycatch TAC is a high priority and will be the focus of a workshop during 2011.

Ways that might improve future assessments of Eastern Gemfish include:

Conduct retrospective analyses.

Resolving the poor fits to the discard rate data.

2010 Stock Assessment Summary for Jackass Morwong (*Nemadactylus macropterus*)

RAG undertaking the assessment: ShelfRAG

Stock Structure

Jackass Morwong are distributed around the southern half of Australia (including Tasmania), New Zealand, the St Paul and Amsterdam Islands (Indian Ocean), and off south-eastern South America and southern Africa. They occur to depths of 450 m and, in Australian waters, are most abundant between 100 and 200 m.

Recent genetic studies conducted by CSIRO have shown no evidence of separate stocks in Australian waters, but New Zealand and Australian stocks are distinct. Analysis of otolith microstructure found differences between Jackass Morwong from southern Tasmania and those off NSW and Victoria, but it is unclear if such differences indicate separate stocks.

Differences among Jackass Morwong in the western and eastern zones have been suggested, and it was assumed for the purposes of this assessment that there are separate stocks of Jackass Morwong in the eastern and western zones.

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	1,200	750	560	450	450
Actual TAC (Global)	1,268	na[1]	641	493	
Trawl catch (SEF2 Comm.)	773	563	697	451	
% Actual TAC .(trawl)	61	na[1]	109	91	
Trawl catch (SEF2 State)	0	0	0	0	
Non-trawl catch (SAN2)	5	5	6	3	
% actual (non-trawl)	0	0	0	0	
Estimated discards	79	71	86	56	
% Discards	9	11	11	11	
State catch	34	18	12	10	
Total catch	813	585	715	464	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

Catches of Jackass Morwong rose to a peak in 1989 of 2067 t (including state catches and discards) and subsequently dropped to remain relatively stable at between 800 and 1,200 t (Haddon 2010). Jackass Morwong are caught predominantly by trawlers in the eastern zones but increased catches are now taken west of Bass Strait. Targeting of morwong in the western regions of the SESSF has increased since 2001. Historically, discard rates have generally been low (<5%), but they have increased to around 10% in recent years. Fish less than 30 cm are often discarded due to market preferences. There is more likely to be discarding of morwong in the southern areas off the east coast.

Synopsis of the 2009 fishery

The total landing of Jackass Morwong from all sectors during 2009 was 464 t almost all of which came from the trawl sector (451 t in Commonwealth waters and 0 t in State waters). The 2008 SAN2 landed weight by the non-trawl sector was 4 t and the state catch was 10 t. In 2010/11 the agreed global TAC for Jackass Morwong was 450 t.

Recommended Tier Level

Shelf RAG considers morwong as a Tier 1 species with a mature and reasonably well accepted stock assessment.

The Tier 1 harvest control rule specifies a target and a limit biomass reference point, as well as a target fishing mortality rate. For the 2010 TACs AFMA has directed that as a default, the 20:40:40 (B_{lim}:B_{msy}:F_{targ}) form of the rule will be used up to where fishing mortality reaches F_{48}. Once this point is reached, the fishing mortality is set at F_{48}. Day (2008) has determined that for most SESSF stocks where the proxy values of B_{40} and B_{48} are used for B_{MSY} and B_{MEY} this form of the rule is equivalent to a 20:35:48 strategy.

The 20:35:48 harvest control rule was applied to Jackass Morwong in the 2010 assessment.

2010 Assessment

ShelfRAG has previously discussed the influence of zero catches on the morwong CPUE time series. An analysis undertaken by BRS (Darbyshire *et al.* 2008) compared the CPUE trend from used all shots in defined morwong fishing areas (including those with zero morwong catches – Delta model) against all shots which contained >0 kg catch of morwong. The Delta model had an obvious effect on the trend in the standardised CPUE series at the zone level but there was very little difference between the Delta and log models at either of the finer spatial scales relating to fishing grounds. Although there were differences in the early years, in CPUE data from the early 1990s onwards, all models show similar trends. The current base case does not include CPUE data with a zero catch of morwong; ShelfRAG agreed to wait until the current CSIRO project on CPUE standardisation is completed before resuming discussions about the inclusion of zero catches in the CPUE data series.

Wayte (2010) has updated the 2009 assessment (Wayte 2009) to provide estimates of stock status in the eastern and western areas of the SESSF at the end of 2010. The assessment is conducted using Stock Synthesis 3 (SS v3) and includes and the addition of 2009 catch, retained length-composition, age-at-length and catch rate data. The assessment data for Jackass Morwong have been separated into seven 'fleets'(Figure 11):

- Eastern trawl otter trawlers from NSW, eastern Victoria and Bass Strait (1986 – 2009);
- Danish seine Danish seine from NSW, eastern Victoria and Bass Strait (1986 – 2009);
- Tasmanian trawl otter trawlers from eastern Tasmania (1986 – 2009);
- Steam trawl steam trawlers (1915 – 1961);
- Early Danish seine Danish seine (1929 – 1967, may include a small diesel trawl catch);
- Mixed mixed Danish seine and diesel trawl catch (1968 – 1985);
- Western trawl otter trawlers from western Victoria and western Tasmania (1986 – 2009).

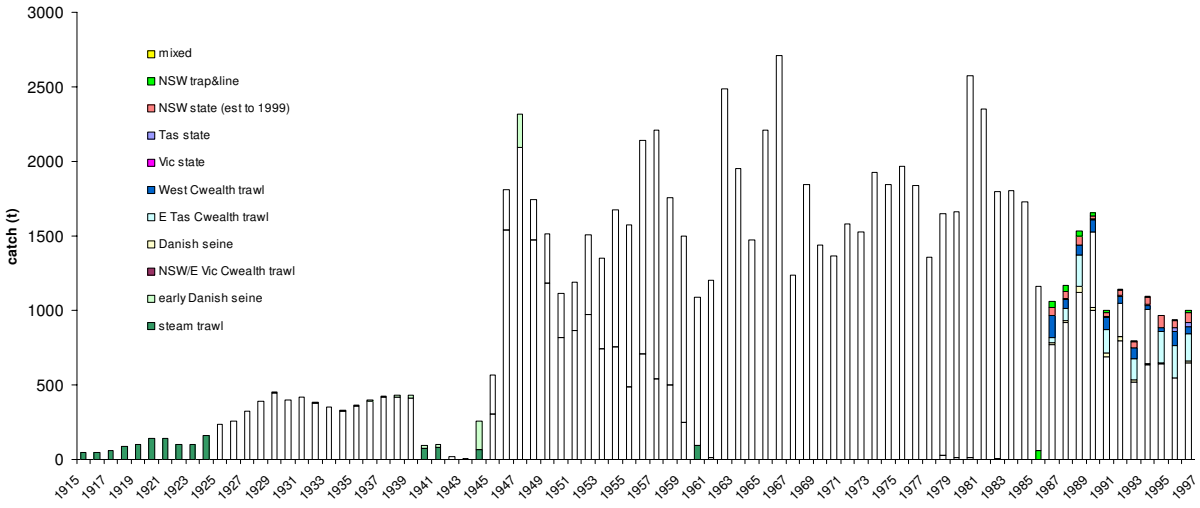


Figure 11 Landed catches of Jackass Morwong by fleet (including state catches), 1915 – 2009

Results

Eastern areas

The base-case assessment for the eastern stock estimates that current spawning stock biomass is 26 % of unexploited stock biomass. The 2011 recommended biological catch (RBC) under the 20:35:48 harvest control rule is 228 t and the long-term yield (assuming average recruitment in the future) is estimated to be 1,101 t.

The model fits to all catch rate indices were reasonable except for the ability to mimic the initial hump in the Tasmanian series (Figure 12). The model is able to fit the retained length-frequency and age distributions adequately except for the recent Danish seine fleet, for which sample sizes are very small. Fits to the discard rate for the eastern and Tasmanian trawl fleets are adequate.

The stock declines slowly from the beginning of the fishery in 1915, fluctuates during the 1940s, 50s and 1960s, before a sharp decline in the mid-1960s, after a period of low recruitments and high catches. The recovery in the late 1960s is

driven by the very high recruitment in 1968, which appears to be well-supported by both the age and length data. The model estimates a 70 % decline in the stock over the last 20 years. In order to fit to the catch rate indices, the model estimates that most of the recruitments in the last 25 years have been below average (). This contrasts with the earlier period from 1940–1970 where recruitment was highly variable, but largely above average. All data sources provide evidence for an above average recruitment in 2003. The current (2011) spawning stock biomass is estimated to be 25.7 % of unexploited stock biomass.

The Jackass Morwong assessment now only estimates recruitment deviations up to four years before the end of the data. This decision was partly driven by the poor standard of data collection during 2007 and 2008. Thus the 2010 base-case estimates recruitment deviations up to 2005 only, and recruitment for 2005 onwards is assumed to be at average levels. Given that recruitment has generally been estimated to have been below the average predicted by the stock-recruitment curve in recent years (

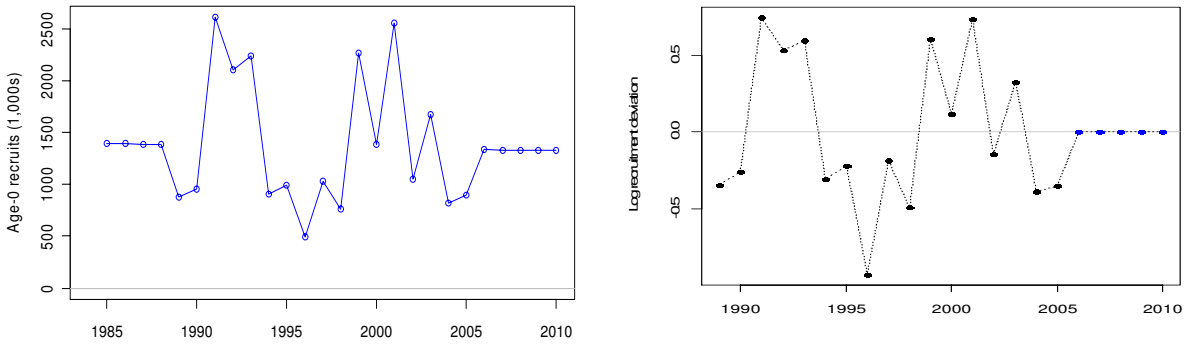
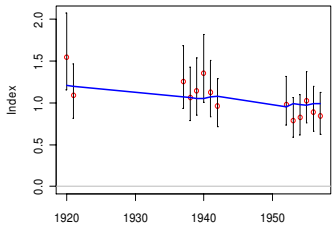


Figure 16), it is possible that assuming the average level for 2005 onwards will lead to an over-optimistic estimate of 2011 stock status. Conversely, industry has indicated improved recruitment in recent years.

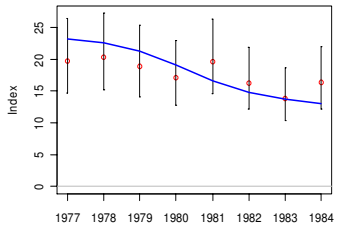
Similar to Eastern Gemfish, the current model estimates that annual recruitments have been mostly below average over the last 25 years, suggesting the possibility of a regime shift. This was examined last year and the RAG considered there was insufficient evidence to support the existence of a regime shift at this point in time. Unlike gemfish, the eastern stock of Jackass Morwong appears to be rebuilding under the current management regime and has recovered to above the limit reference point.

Punt (2010) states that B_{MSY} should not be based on the estimate from the output of a stock assessment when steepness is assumed (rather than estimated); as is the case for this assessment. Instead, estimates of B_{MSY}/B_0 were examined for a range of steepness values. Although a steepness value of about 0.3 produced the best fit to the data, a value this low is rarely used for a broadcast spawning species such as morwong, which as a member of the order Perciformes has a mean value of 0.73 with a 95% confidence interval of 0.11 (Myers *et al* 1999). A figure of 0.7 is used in the base-case assessment. Thus, the RAG agreed that a proxy of B_{40} for B_{MSY} is probably a sensible and precautionary approach at this time, given the uncertainty in the value of steepness and therefore the estimate of B_{MSY}.

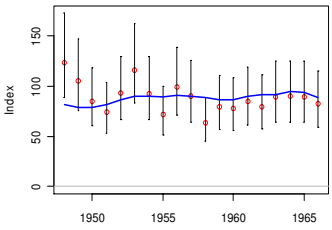
Steam trawl



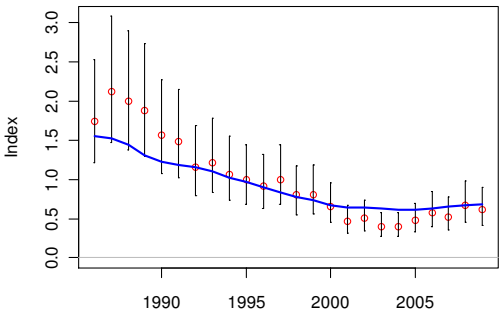
mixed fleet



Smith CPUE



Eastern trawl



Tasmanian trawl

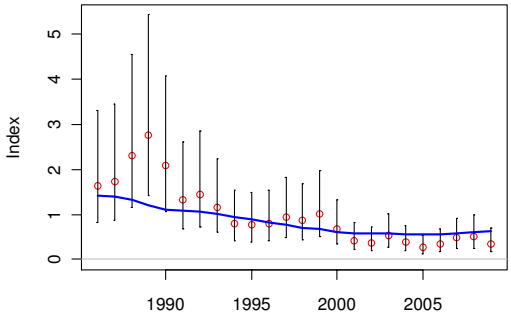


Figure 12. Jackass Morwong observed (circles) and model-estimated (lines) standardised catch rates versus year. The vertical lines indicate approximate 95% confidence intervals for the data.

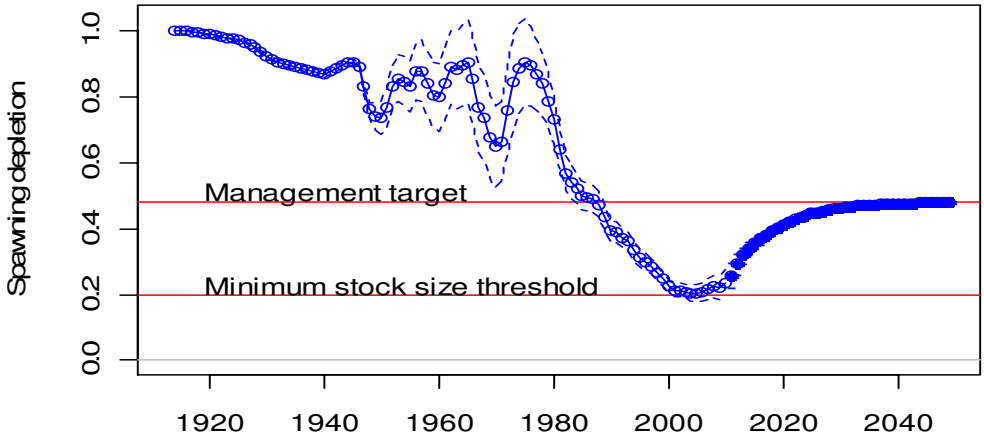


Figure 13. Jackass Morwong time-trajectory of spawning biomass depletion (with 95% confidence intervals) corresponding to the MPD estimates for the base-case analysis for the eastern stock. The first solid dot is 2011 depletion, and subsequent solid dots are forecast depletion under the 20:35:48 harvest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

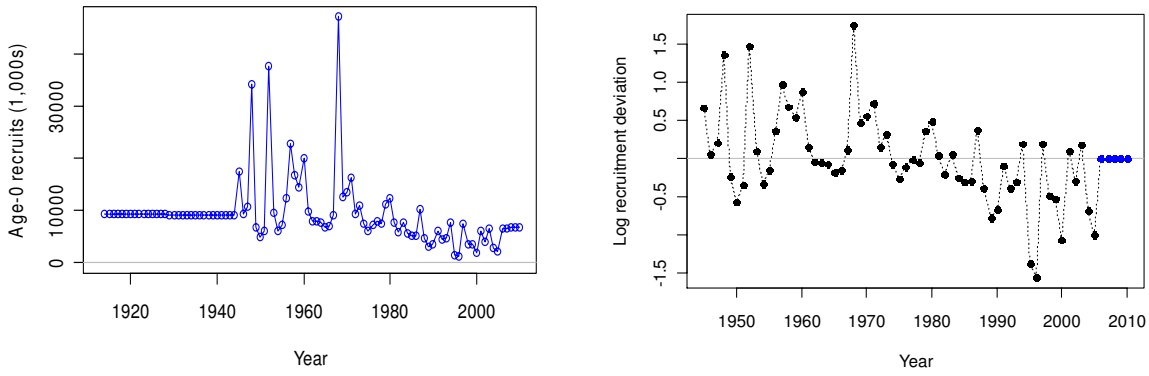


Figure 14. Jackass Morwong time-trajectories of recruitment (left) and recruitment deviations (right) for the base-case analysis in eastern areas.

Western areas

The assessment for the western stock is based on much less information than the eastern stock assessment is increasingly uncertain, as there are no length frequency data for 2007–2009. The assessment indicates that the stock has declined in recent years as fishing pressure has increased, but spawning stock biomass is still considerably higher than the target level – 69 % of unexploited stock biomass (Figure 15). The 2011 RBC under the 20:35:48 harvest control rule for the base-case model is 329 t – higher than any catches yet taken in the western zone. The long-term yield is estimated to be 194 t.

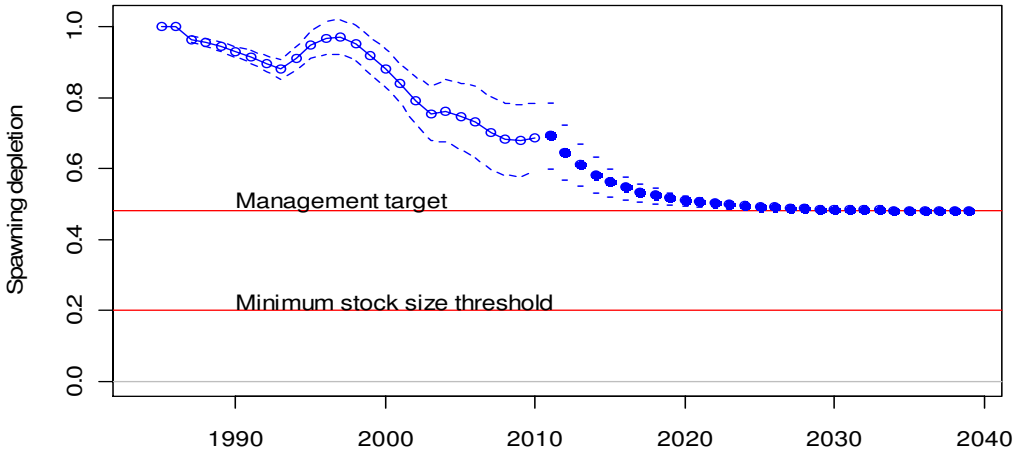


Figure 15. Jackass Morwong time-trajectory of spawning biomass depletion of in western areas corresponding to the base-case estimates. The first red dot is the estimated 2011 depletion, and subsequent red dots are forecast depletion under the 20:35:48 harvest control rule assuming average recruitment.

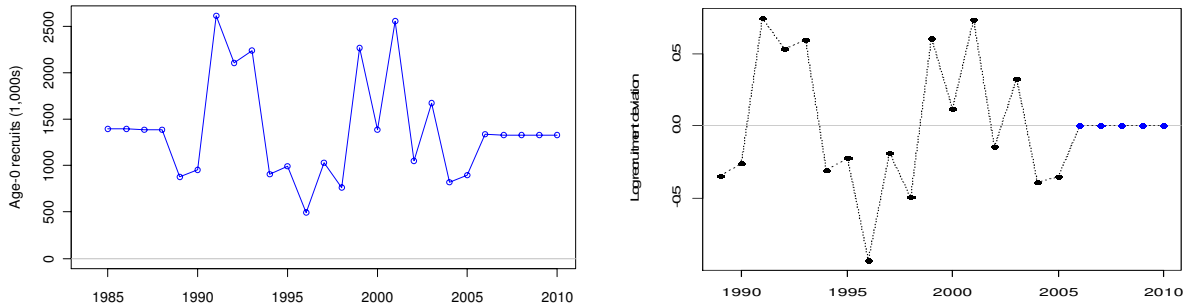


Figure 16. Jackass Morwong time-trajectories of recruitment (left) and recruitment deviations (right) for the base-case analysis in western areas.

RBC Calculations

Under application of the Tier 1 20:35:48 Harvest Control Rule, the 2010 Jackass Morwong RBC from the updated base-case model is 557 t — 228 t in the east and 329 t in the west. The long-term yield under this harvest control rule is 1,295 t — 1101 t in the east and 194 t in the west.

As highlighted below, that application of this RBC through a global TAC should consider the very different status of the stocks in the east and west.

Additional comments from the RAG

RAG members were again disappointed at the quality length frequency, age and discard data, particularly in the west and stressed that this is significantly undermining the quality of the assessment.

The eastern stock of morwong is still significantly depleted, but appears to be recovering and has now rebuilt to above the limit biomass reference point of 20%. At a spawning stock depletion of 26%, however, the stock is still well under the target reference point and all efforts should be made to ensure there is no overfishing in the east. The RAG has previously stated that east and west areas could (and probably should) be treated as different stocks for management but in practice, the TAC applies across the species regardless of stock boundaries. Unfortunately, having the two stocks (east and west) at very different levels of biomass depletion makes them difficult to manage under one global TAC. The RAG encourages all industry efforts to minimise the take from the eastern region to less than the RBC while this part of the stock is recovering to the target reference point.

To this end, it was discussed whether the bycatch TAC should be reduced, but evidence that targeting has reduced in the east (Klaer 2010b) and the stock is rebuilding suggested this was probably unnecessary.

The RAG acknowledged that there is some targeting of Jackass Morwong in the east and that this was allowable given the stock was above the limit, but agreed to maintain the bycatch TAC at 450t even though the potential RBC for the total stock is about 550t. They advised against increasing the TAC because of the current status of the eastern stock and that catches are still likely to exceed the RBC in the east.

The RAG noted that Jackass Morwong is likely to be classified as subject to overfishing in the east for the next 3 years if the TAC remains the same.

Discount factor

As a Tier 1 species, there is no discount factor applied to Jackass Morwong.

Overcatch/undercatch

The default 10% overcatch and undercatch values were considered to be appropriate for Jackass Morwong.

Research needs and future assessment:

Consideration should be given to re-ageing old otoliths so that more ageing data can be used in the assessment.

The reports of expansion of the trawl grounds into previously inaccessible inshore reef areas in order to target Jackass Morwong in parts of the fishery, especially western Victoria, should be quantified and monitored.

The stock relationship between the eastern and western portions of the fishery needs to be established.

2010 Stock Assessment Summary for Redfish (*Centroberyx affinis*)

RAG undertaking the assessment: ShelfRAG

Stock Structure

Redfish (also known as nannygai) occur throughout southern Australia and in New Zealand. Other species of Centroberyx and some Beryx species look similar to Redfish and may also be landed from time to time; however, they are considered to be only a minor component of the catch designated as Redfish in the SESSF. Catches of very large Redfish have been observed from Gascoyne Seamount – these fish may represent a new species of Centroberyx.

No formal stock discrimination studies have been done in Australia. Tagging studies suggested a single unit stock of Redfish off NSW, however recent studies of mean length at age suggest differences in growth rates between the 'northern' and 'southern' sectors of the fishery off eastern Australia. Recent assessments of the Redfish stock have therefore also considered that the fishery exploits two separate populations, with the boundary between these 'stocks' being 36ºS (just north of Montague Island).

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	900	740	850	678	551
Actual TAC (Global)	899	na[1]	912	756	
Trawl catch (SEF2 Comm.)	321	230	201	182	
% Actual TAC .(trawl)	36	na[1]	22	24	
Trawl catch (SEF2 State)	0	0	0	0	
Non-trawl catch (SAN2)	0.5	0.1	0.2	0.1	
% actual (non-trawl)	0	0	0	0	
Estimated discards	13	3	2	226	
% Discards	3	1	1	50	
State catch	76	54	29	21	
Total retained catch	397	283	230	203	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

Synopsis of the 2009 fishery

The total landing of Redfish from all sectors during 2008 was 203 t of which the SEF2 landed weight by the trawl sector was 182 t (0 t in State waters). Non-trawl catches were less than 1 t, and landings reported in 2008 by fishers operating under state jurisdiction were about 21 t. The 2010/11 agreed global TAC was 551 t.

Total removals of Redfish during 2008 were the lowest on record (Figure 19) as were the standardised catch rates. Landed catches during 2009 were the lowest on record, but, due to the increase in discarding, there was an increase in both total removals and catch rates.

The ISMP estimate of discards was 226 t, which is a significant increase compared to previous years. This has occurred with an indication from the age structure that new recruits may be entering the fishery (Figure 17). Industry reported that there was no real targeting of redfish during 2009 but noted that Redfish have a more scattered distribution than they have seen before and can be found from the shore to the deepwater.

Recommended Tier Level

Formal quantitative assessments have been conducted for Redfish in the past, including a VPA model, various other approaches applied during Redfish workshops and an integrated analysis model was run during 2001. Uncertainties in the model structure, assumptions and the data on which they were based were reflected by a wide range of estimates for biomass, to the extent that ShelfRAG was not able to class it as a Tier 1 or 2 assessment. If there was confidence in the assessment model, spawning biomass would be used as the primary indicator, with secondary indicators including fishing mortality, age structure and size structure. There are generally good ageing samples of Redfish, however, which have allowed the species to be assessed as a Tier 3 species.

Previous assessments

All previous modelling work indicates that Redfish has been depleted to a level that is below that at which optimal

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

Additional comments from the RAG

Although there are large uncertainties about the current biomass level of Redfish stocks, it is likely that they would benefit from rebuilding.

Growth overfishing and discarding has been an ongoing issue for Redfish but recently, discard rates have reduced from a high of 56% when a pulse of new recruits entered the fishery in 2002, to almost zero as these fish reached a marketable size and industry adopted larger mesh sizes. Unfortunately, poor and biased ISMP data collection since 2007 has made the situation in recent years difficult to interpret but higher levels of discarding were evident during 2009 which, based on the age data, may represent a new pulse of recruits entering the fishery. Given the uncertainties in discard data and biases in north / south sampling, not all RAG members were convinced of such a recruitment event and its ability to lead to a strong recovery of the fishery in coming years.

Sampling improved during 2009 but still appeared biased towards the southern region. The RAG considered that this bias may have influenced the inconsistencies between the Tier 3 and Tier 4 assessment results. Tier 4 results show that CPUE is very low, but Tier 3 suggests the Redfish age and size structure is indicative of a healthy stock. The RAG discussed how best to deal with these conflicting results in terms setting an appropriate RBC and TAC. Given the historically low catch rates at present, the overall RAG concern about the stock, and that the CPUE indicator was below the limit reference point, the RAG could not justify acceptance of the Tier 3 RBC of 1985 t, even though it would be limited by the 50% meta-rule. There was agreement that a reduction in the RBC was probably warranted but the extent of the reduction was tempered by the recognition that the harvest strategy must enable catches to increase relatively quickly should stock availability recover rapidly (it was not clear that this would happen) to ensure that high levels of discarding do not recur. RAG members were cognisant of the fact that there has been similar occurrences of poor catches and catch rates in the Redfish fishery before, but often quickly followed by periods of high catches of fish across a broad size range. This tends to support that such poor years may reflect some environmental reduction in availability rather than a rapid stock reduction. RAG members were concerned that the meta-rule that determined a maximum of a 50% decrease or increase in TAC results in a quick and more significant downward response in TAC and the upward response is slower and more gradual. This could be inappropriate for Redfish if the availability increased rapidly.

Considering the above, the RAG discussed the following options:

1. Rollover the 2010 TAC of 551t.
2. Cut the TAC in response to the Tier 4 assessment, but remove the 50% change limiting rule for increases to the TAC.

There was general agreement with Option 2, but it was noted that there needs to be some limit placed on the potential increase to the TAC in any one subsequent year (a sudden increase to a 2,000t RBC under the Tier 3 assessment was not considered appropriate). It was suggested that the limit could be the equivalent of three consecutive years of a 50% increase in any one year. There was general agreement by RAG members that this could be a reasonable approach for redfish if another cut in TAC was made this year. The extent of the cut was not agreed, but a cut as large as 50% was considered not appropriate given that total removals were in the vicinity of 450 t last year.

The RAG noted that although there is no overfishing, the stock could be currently classified as overfished based on the results of the Tier 4 assessment.

Discount factor

The default discount factor for a Tier 3 species is 5%. Application of the discount factor to Redfish will depend on which of the above options is chosen to set the TAC.

Overcatch/undercatch

There was no proposal to change the default 10% overcatch and undercatch values applied to Redfish.

Research priorities

ShelfRAG supports the need for a better assessment of Redfish as a priority which includes some quantification of the effectiveness of increased mesh size needs to be performed.

Non-equilibrium methods of Tier 3 assessment for Redfish such as VPA or Bravington and Peel (2005) should be investigated and MSE tested if Redfish is to be continually assessed as a Tier 3 species under the proposed Harvest Strategy.

The need for more stock structure work has been suggested and this would be assisted by more systematic collection of samples from across the species range.

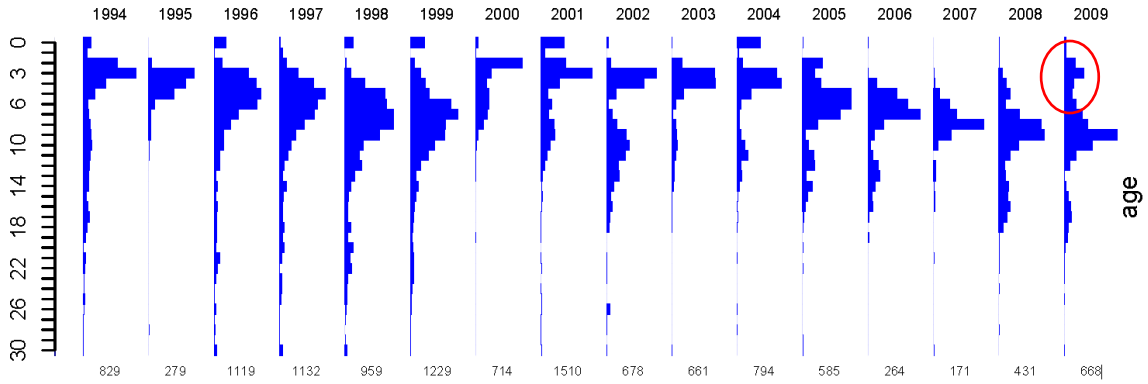


Figure 17. Redfish age frequency time series (1994–2009) highlighting the possibility of a new recruitment pulse into the fishery.

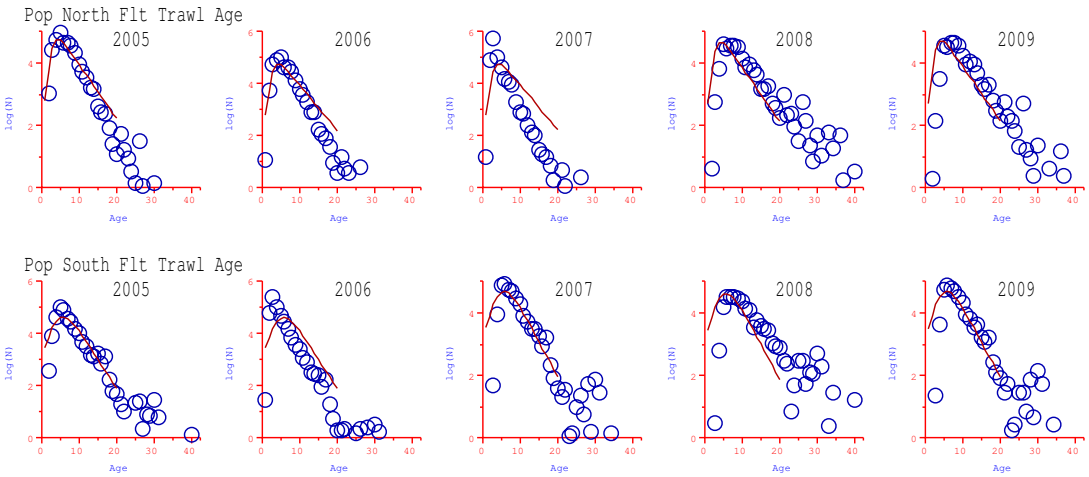


Figure 18. Redfish catch curve fits to age frequency data of northern (2005–2009) and southern (2005–2009) stocks (Adapted from Klaer 2010a).

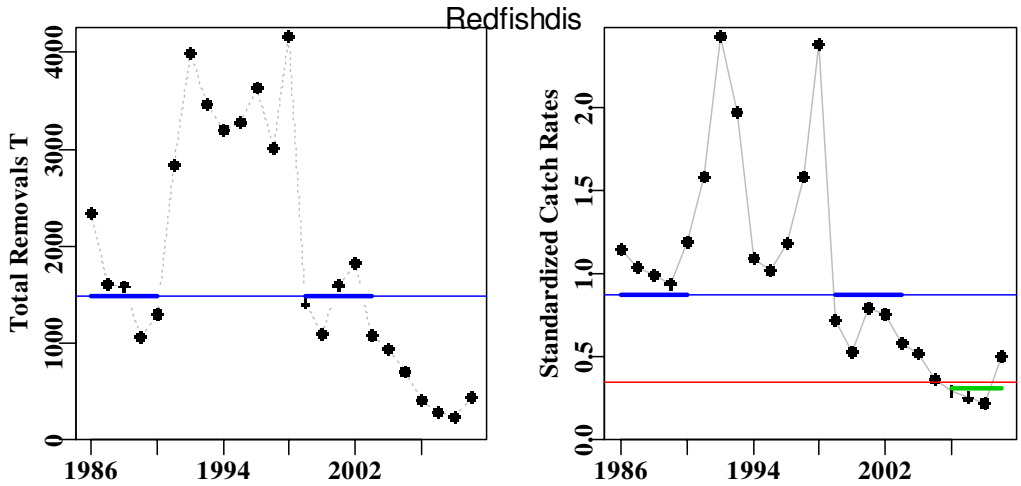


Figure 19. Redfish total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates including discards with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick horizontal line represents the split reference period (Adapted from Haddon 2010b).

2010 Stock Assessment Summary for Tiger Flathead (*Neoplatycephalus richardsoni)*

RAG undertaking the assessment: ShelfRAG

Stock Structure

For SEF management purposes, 'flathead' refers to a group of flathead species consisting predominantly of Tiger Flathead (*Neoplatycephalus richardsoni*) but including sand flathead (*Platycephalus bassensis*) and, from 1996 onwards, southern or 'yank' flathead (*Platycephalus speculator*), bluespot flathead (*Platycephalus caeruleopunctatus*) and gold-spot/toothy flathead (*Neoplatycephalus aurimaculatus*). Tiger Flathead is the only species being considered for stock assessment purposes at this stage.

Tiger Flathead are endemic to Australia and are found on sandy or muddy substrates in continental shelf and upper slope waters from about Coffs Harbour in northern NSW through Bass Strait and around Tasmania to south-east South Australia. Most of the Australian commercial catch comes from depths between 50 m and 200 m.

The stock structure of Tiger Flathead is still poorly understood. There is some evidence of morphological variation across the species distribution range with observed regional differences in growth, appearance and the timing of reproduction, especially off eastern Tasmania. No stock identification studies have been carried out using genetic or other techniques and for management purposes a single continuous stock has been assumed throughout all zones of the SESSF.

In the model, it is assumed that fishing selectivity by different fleets accounts for the different sized fish caught in NSW and Eastern Bass Strait compared to eastern Tasmania.

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	3,000	2,850	2,850	2,850	2,750
Actual TAC (Global)	2,999	na[1]	3,026	2,960	
Trawl catch (SEF2 Comm.)	2,698	2,847	3,197	2,678	
% Actual TAC .(trawl)	90	na[1]	106	90	
Trawl catch (SEF2 State)	0	25	0.5	4	
Non-trawl catch (SAN2)	0.6	0.5	0.4	0.4	
% actual (non-trawl)	0	0	0	0	
Estimated discards	202	279	44	153	
% Discards	6	8	1	5	
State catch	319	180	249	193	
Total retained catch	3,017	3,052	3,448	2,875	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

Catches of flathead are recorded back to 1915 and tend to show a cyclical pattern. In recent years there has been evidence to support that these cycles may be a result of environmental influences. The current TAC is effectively limiting Commonwealth catches, confounding any strong evidence of this cycle in recent years.

Landed catches have fluctuated between 2,700 and 3,700 t for the last two decades. Discard levels are generally low, around 5% for the trawl sector in recent years. Extremely low discard rates (<1%) were recorded during 2007 and 2008, but it is uncertain if this is actually representative or a result of the poor standard of AFMA observer coverage during those year. The 2009 catches have been the lowest since 1996.

The bulk of historical catches have come from NSW, eastern Victoria and Bass Strait zones, accounting for 92% of Commonwealth catches since 1986. Catches off eastern Tasmania have increased in recent years.

Synopsis of the 2009 fishery:

The total landing of flathead from all sectors during 2009 was 2,875 t derived mainly from the Commonwealth trawl sector (2,678 t in Commonwealth waters and 3.5 t in State waters). Non-trawl catches were negligible, but the total state catches were 193 t. Discards were estimated at 193 t. The 2010 agreed global TAC was 2,750 t.

Both trawl and Danish seine catch rates have been higher in recent years. Fishermen continue to report that catches of flathead are very good and are significantly limited by the TAC because of the lack of quota available to lease. The RAG has consistently heard from industry that high abundance of flathead has been evident across the east coast over

extended periods.

Increasing numbers of operators in both trawl and Danish seine are using larger mesh during to reduce the capture of small fish, including flathead. Larger mesh codends or escape panels are now mandatory for trawlers and nearly all Danish seiners are using larger mesh.

Recommended Tier Level

Flathead is considered a Tier 1 species under the Harvest Strategy Framework, because it has an established and robust assessment with good acceptance by RAG members.

The Tier 1 harvest control rule specifies a target and a limit biomass reference point, as well as a target fishing mortality rate. For the 2010 TACs AFMA has directed that as a default, the 20:40:40 (B_{lim}:B_{msy}:F_{targ}) form of the rule will be used up to where fishing mortality reaches F_{48}. Once this point is reached, the fishing mortality is set at F_{48}. Day (2008) has determined that for most SESSF stocks where the proxy values of B_{40} and B_{48} are used for B_{MSY} and B_{MEY} this form of the rule is equivalent to a 20:35:48 strategy.

As a result of the long history of fishing and collapses of the fishery in the past, Tiger Flathead is one of the few SESSF species for which an estimate of the stock recruitment relationship and Beverton-Holt steepness parameter can be calculated. As a result, the RAG was comfortable to consider model estimates of B_{MSY} from which to apply the Commonwealth Harvest Strategy proxy multiplier of 1.2 to obtain the target biomass of B_{MEY}, where B_{MEY}=1.2 x B_{MSY}. This is the first year where this approach has been adopted.

2010 assessment

Klaer (2010c) updated the 2009 assessment of Tiger Flathead to provide estimates of stock status at the start of 2011. Dr Klaer presented the final stock assessment. Some slight changes to the 2009 model were made including: changing the discard fraction for historical (pre-1960) Danish Seine and steam trawl to 17% of the total catch (=20% of the retained catch); estimating discard rates since 1960 by fitting a retention curve to the selectivity; estimating more growth parameters in the model (including the minimum length at age) to take full advantage of the age-length data which required an adjustment of natural mortality to $M = 0.27$.

The assessment data for tiger flathead have been separated into four 'fleets':

- Steam trawl steam trawlers (1915 – 1961);
- Danish seine Danish seine from NSW, eastern Victoria and Bass Strait (1929 – 2009);
- Eastern trawl diesel otter trawlers from NSW, eastern Victoria & Bass Strait (1971 – 2009);
- Tasmanian trawl diesel otter trawlers from eastern Tasmania (1985 – 2009).

Catches of each of the fleets is shown in Figure 20.

The fits to the catch rate indices are variable in quality (Figure 21). Indices for the steam trawl fleet show a considerable decline from 1915 to 1950, consistent with overexploitation during that time but the early Danish seine index from 1950 to 1978 was relatively flat or increasing. Recent abundance indices from 1986 to present also show reasonably flat trends. The Tasmanian trawl fleet index is the worst fit for the recent indices, but the catch contribution by that fleet is also the smallest.

The model fits the retained length-frequency distributions adequately with the exception of the Tasmanian trawl fleet. The fits to the discarded length compositions are variable largely because the actual sample sizes are small in comparison to retained. The model mimics the observed age data reasonably well for all three recent fleets.

The stock declines substantially from the beginning of the fishery in 1915 to 1950, fluctuates near the minimum threshold of 20% SSB_0 during the 1950s and 1960s, before an increase to above 40%SSB_0 by the 1980s (Figure 22). This increase in the 1980s was driven by a combination of favourable recruitments (Figure 23) and total landings of less than 2,000t in the late 1970s and early 1980s. The stock has fluctuated near or above 40% SSB_0 since the late 1980s.

The time-trajectories of recruitment and recruitment deviation are shown in Figure 23. Estimates of recruitments since about 1940 are generally variable, but periods of above and below average recruitment levels appear for periods of up to 12 years. Long-term regular cycles are not evident however. Recruitment in the past 15 years has been highly variable, but largely above average.

Table 7. Tiger Flathead base-case assessment results and sensitivity tests.

Case	SSB0	SSB2011	SSB2011/SSB0	Steepness	SSBmsy/SSB0	RBC2011	RBClongterm
0 base case 20:35:48 *M* 0.27	21,856	9,713	0.44	0.62	0.30	2,406	2,513
1 *M* 0.2	22,809	6,848	0.30	0.79	0.25	1,101	2,274
2 *M* 0.35	25,092	15,499	0.62	0.46	0.36	3,692	2,850
3 wt x 2 length comp	21,207	9,303	0.44	0.63	0.30	2,327	2,460
4 wt x 0.5 length comp	22,051	9,884	0.45	0.63	0.30	2,444	2,543
5 wt x 2 age comp	21,693	9,207	0.42	0.62	0.30	2,268	2,492
6 wt x 0.5 age comp	22,054	10,217	0.46	0.62	0.30	2,522	2,532
7 age + length lambda 1	17,093	5,747	0.34	0.76	0.25	1,540	2,288
8 20:40:40 HCR	21,856	9,713	0.44	0.62	0.30	3,097	2,717
9 estimate *M* (0.417), *h* 0.75	26,392	23,178	0.88	0.75		10,525	5,816
10 plus onboard retained lengths	20,721	9,719	0.47	0.67	0.29	2,517	2,480

RBC Calculations

In order to calculate the Recommended Biological Catch (RBC) for 2011, it is necessary to estimate the Commonwealth calendar year catch for 2010. The calendar year catch in 2009 was 94% of the 2009/10 fishing year TAC of 2,850t. It was assumed that a similar ratio would apply to the 2009 calendar year catch, which was estimated as 94% of 2,700t, or 2,538t. State catches for 2010 were assumed to be the same as the 2009 values.

For the base-case, the 2011 RBC under the 20:35:48 harvest control rule is 2,406 t and the long-term yield (assuming average recruitment in the future) is 2,513 t. SSB_{MSY} is estimated to be 30% of SSB_0. If the standard MEY proxy multiplier of 1.2 is applied to this MSY estimate, the SSB_{MEY} estimate for the base case is 36% of SSB_0.

Under the 20:40:40 HCR, the 2011 RBC is 3,097 t.

Additional comments from the RAG

Total removals of flathead during recent years have been above the long-term RBC, largely supported by higher than average recruitments over a number of years. It was accepted that these recent high recruits are likely to underpin the high catches/catch rates currently being experienced by fishermen on the water.

RAG members noted the model tended to fit a cyclic trend to catch rate data in recent years that was less apparent than in the actual catch rate data (Figure 21). There was a suggestion that this could reflect cyclic trends in availability.

In recent years, based on previous work by ABARE, the formula 1.03 x B_{40} was used to derive a biomass at maximum economic yield (B_{MEY}) of 41% for flathead. Klaer (2010c) conducted extensive studies on MSY estimates. Because Tiger Flathead is one of the few SESSF species for which an S-R steepness parameter can be calculated and therefore an estimate of B_{MSY}, the RAG was comfortable to use the relationship B_{MEY}=1.2 x B_{MSY} to set the target biomass. The base case estimate of B_{MSY} from the model is 30%, which gives a B_{MEY} estimate of 36%. A sensitivity analysis on *M* resulted in B_{MSY} values between 25% and 36%.

The results above presented a number of options for the RAG with respect to setting a biomass target. It was agreed that the continued use of the default harvest strategy and proxies that result in a target of B_{48} was no longer appropriate given the availability of a better estimate of B_{MSY} than simply using the B_{40} proxy. Further supporting this, using the base case model, *M* would need to be about $0.4yr^{-1}$ to achieve a B_{MSY} of 40%, which would give implausible model results. The option of using the 36% target derived from 1.2 x B_{MSY} was considered. The RAG has long held the view that 40% virgin biomass is a safe biological target for the flathead. Although a B_{MEY} target of less than 40% is plausible based on the current B_{MSY} results, RAG members decided that without further harvest strategy evaluation of the biological and economic implications of a 36% target, the lowest economic target it was comfortable in recommending was 40% virgin biomass.

Based on the above, the RAG recommended a biomass target of 40% virgin biomass. Under this target, the 20:35:48 HCR used in the base case assessment no longer applied and the 20:40:40 HCR sensitivity test was accepted by the RAG as more appropriate. Although it was pointed out that the middle (B_{MSY}) figure of the HCR may need to be changed so the inflexion point did not occur at the target, the RAG did not consider this to be an issue at this stage while the stock was above the target but suggested that SESSFRAG review the pivot point in during 2011. The RAG therefore accepted the 20:40:40 HCR for 2011, which produced an RBC of 3,097t. It was noted that since the current biomass is above the target, there can be a small amount of flexibility in the stock is fished down to the target.

The RAG determined that Tiger Flathead satisfied the criteria to be considered for a multi-year TAC: the current biomass is above the target; the fishable biomass can be predicted with an acceptable precision; and the fishery is expected to be stable. Although a number of possible multi-year TAC options were discussed, the RAG members ultimately decided that it did not have enough information and/or guidance to set a multi-year TAC for Tiger Flathead. This maybe better available for the MAC TAC meeting in 2011.

Discount factor

As a Tier 1 species, there is no discount factor applied to Tiger Flathead.

Overcatch/undercatch

The default 10% overcatch and undercatch values were considered to be appropriate for Tiger Flathead.

Research needs

As a staple of the east coast fishery, flathead will remain a high priority for future assessments. Given how long this assessment has been operating at Tier 1 and the importance of flathead to the SESSF, the RAG suggested an external review of the assessment would now be appropriate.

The flathead TAC is applied to multiple flathead species but the assessment is conducted on Tiger Flathead. This has been justified previously by the relatively low proportion of other flathead species in the catch (<5%). The RAG agreed that it is time to re-examine the information that supports this justification.

The following are some ways in which future assessments of Tiger Flathead could be improved.

1. Plot the raw data (SEF1, length-frequency, discards) and use this as the basis to evaluate the definitions of "stocks" on which the present assessment is based.
2. Obtain pre-1998 otoliths. Include the ability to fit biased age-composition data (i.e. the data collected using the whole vs break and burn methods) in the assessment model.
3. Investigate appropriate bin sizes for length data.
4. Calculate CVs for discard rates.

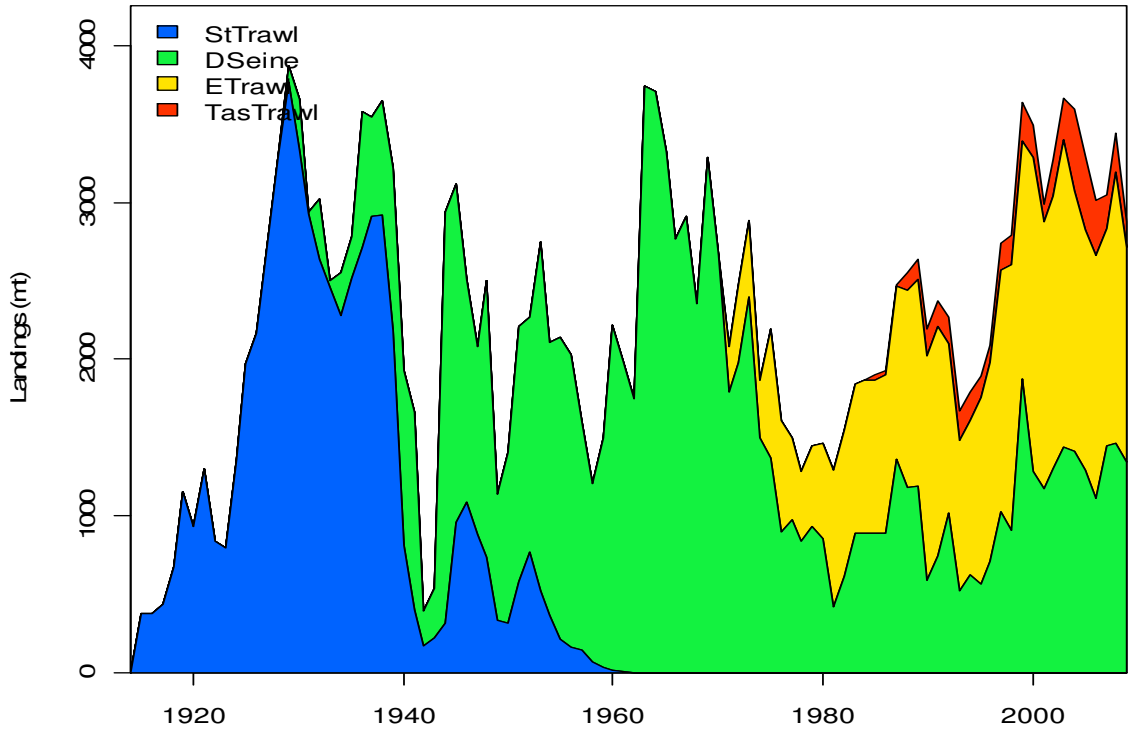


Figure 20. Tiger Flathead total landed catch by fleet 1915-2009.

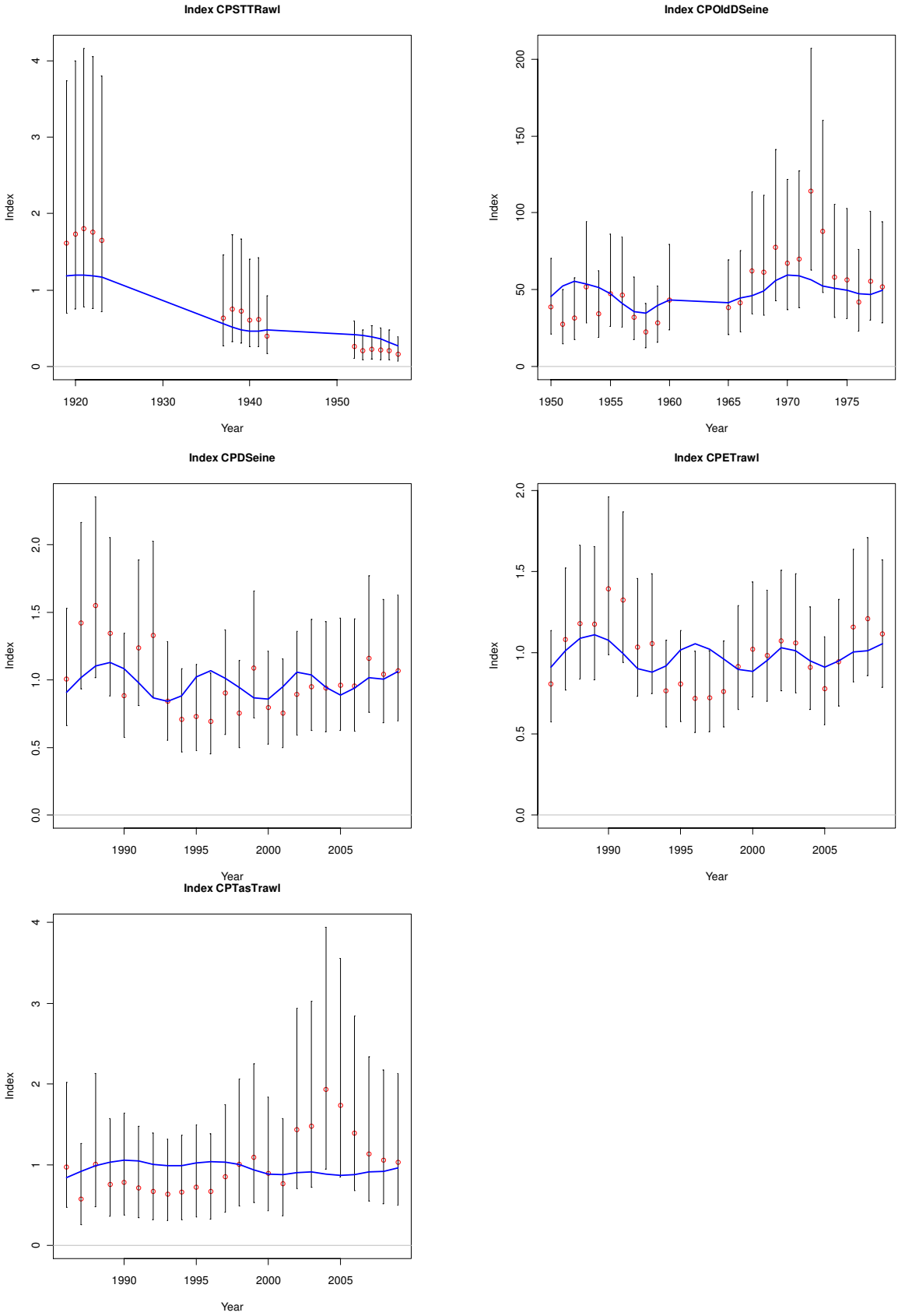


Figure 21. Tiger Flathead observed (solid dots) and model-estimated (lines) catch rates versus year. The vertical lines indicate approximate 95% confidence intervals for the data.

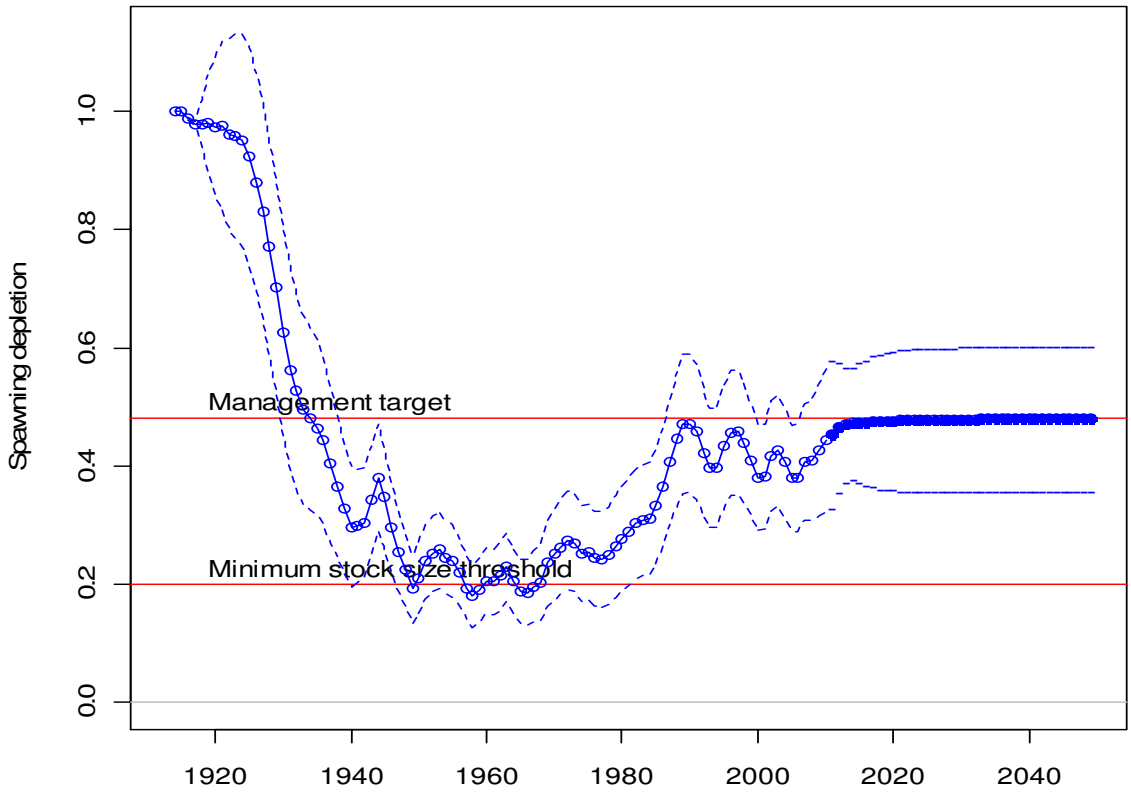


Figure 22. Tiger Flathead time-trajectory of spawning biomass depletion (with 95% confidence intervals) corresponding to the MPD estimates for the base-case analysis for the eastern stock. The first solid blue dot is 2011 depletion, and subsequent solid dots are forecast depletion under the 20:35:48 harvest control rule assuming average recruitment. The horizontal lines represent the 20% and 48% SB_0 limit reference points.

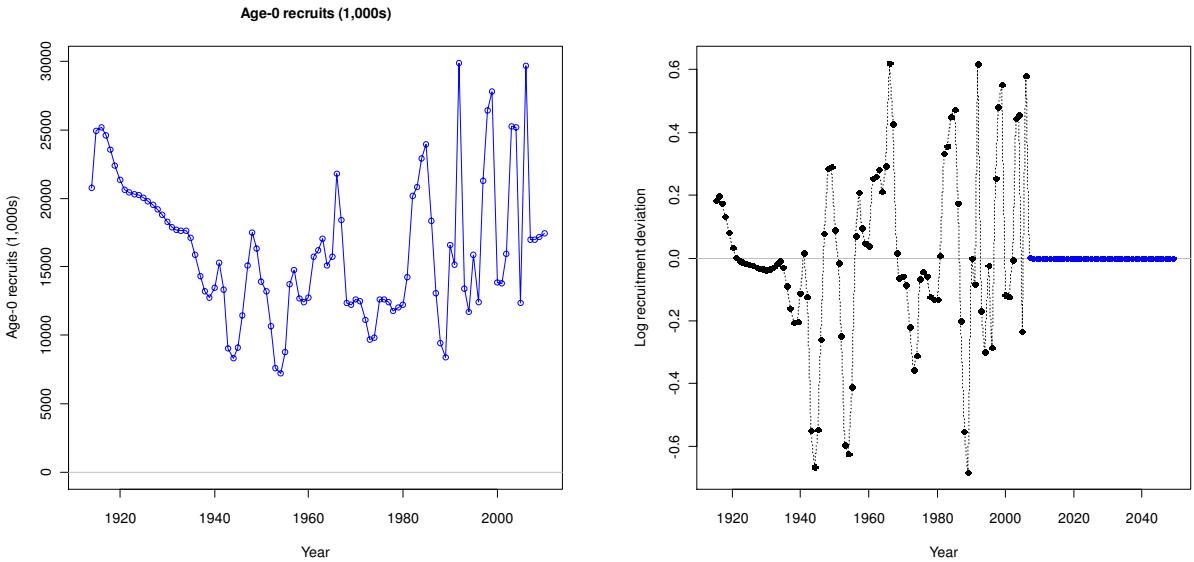


Figure 23. Tiger Flathead time-trajectories of recruitment (left) and recruitment deviations (right) for the base-case analysis.

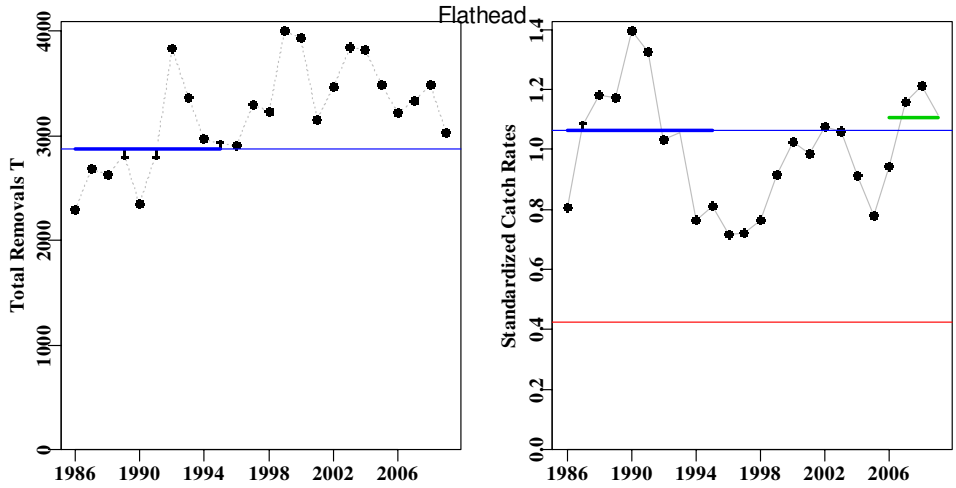


Figure 24. Flathead total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick horizontal line represents the split reference period (Adapted from Haddon 2010b).

2010 Stock Assessment Summary for School Whiting (*Sillago flindersi*)

RAG undertaking the assessment: ShelfRAG

Stock Structure

This assessment is based only on eastern School Whiting, *Sillago flindersi* which is the species that dominates the SESSF catch. Eastern School Whiting (also known as red spot whiting) occur from southern Queensland to western Victoria. Early genetic studies suggested two stocks in this range, with the division between 'northern' and 'southern' stocks in the Sydney – Jervis Bay area. The evidence for two stocks is weak, however, and current SESSF management assumes a single stock.

The closely related western School Whiting *Sillago bassensis* is caught in much smaller quantities and is not significant in the SESSF. Stout whiting (*Sillago robusta*) is a similar species that occurs off northern NSW and southern Queensland. Fishers often separate these species but generally don't report them separately in catch returns. For this assessment, historical NSW commercial catch statistics were analysed and stout whiting catches were removed from eastern School Whiting catches, using an algorithm which reflected the geographic overlap of the two species.

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	1,500	750	750	1,125	664
Actual TAC (Global)	1,619	na[1]	841	1,192	
Trawl catch (SEF2 Comm.)	456	439	411	413	
% Actual TAC .(trawl)	29	na[1]	49	35	
Trawl catch (SEF2 State)	16	72	43	59	
Non-trawl catch (SAN2)	0	0	0	0	
% actual (non-trawl)	0	0	0	0	
Estimated discards	3	3	3	3	
% Discards	0.2	0.2	0.2	0.2	
State catch	1,080	1,125	1,056	799	
Total retained catch	1,553	1,636	1,509	1,271	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

About 75% of the School Whiting catch from Commonwealth waters is taken by Danish seiners working from Lakes Entrance. Since the mid 1980s, there has been an increasing catch of whiting by state trawlers working in waters off New South Wales and it is now a significant proportion of the total catch for School Whiting. From 1986-1996 the state catch averaged around 30% of the total catch, but from 1997-2007 the state catch has increased and averaged around 60% of the total catch in this period. Recent annual catches from Commonwealth waters have been stable, but lower than in the early 1990s, reflecting mainly the reduced availability of export markets. This issue has increased in recent years on the back of a stronger Australian dollar.

Synopsis of the 2009 fishery:

The total landings of School Whiting from all sectors during 2009 were 1,271 t of which the SEF2 landed weight by the trawl sector was 472 t (413 t in Commonwealth waters and 59 t in State waters). The 2009 state catch of School Whiting was 799 t. There were virtually no discards of whiting recorded by the ISMP. In 2010 the agreed TAC for School Whiting in the SESSF was 664 t.

Total removals of whiting during 2009 were the lowest since 1992 and standardised catch rates have been increasing reasonably consistently over the last decade (Figure 28). The length frequency of the catch has been relatively stable although there appears to be a greater proportion of smaller fish in the 2009 catches.

Industry continues to emphasise that the limited markets for whiting has significantly reduced Danish seine catches in recent years and is also likely to have influenced targeting and catch rates. The recent high Australian dollar has all but extinguished the overseas markets for whiting and good recent prices for flathead have seen the Danish seine fleet target this species in preference to whiting over recent years.

Recommended Tier Level

School Whiting is considered a Tier 1 species under the Harvest Strategy Framework, because it has an established assessment with reasonable acceptance by RAG members despite highly fluctuating RBC predictions in recent years.

The Tier 1 harvest control rule specifies a target and a limit biomass reference point, as well as a target fishing mortality rate. Since 2005 various values have been used for the target and the breakpoint in the rule. For the 2011TACs AFMA has directed that the 20:40:40 (B_{lim}:B_{msy}:F_{targ}) form of the rule will be used up to where fishing mortality reaches F_{48}. Once this point is reached, the fishing mortality is set at F_{48}. Day (2008a) has determined that for most SESSF stocks where the proxy values of B_{40} and B_{48} are used for B_{MSY} and B_{MEY} this form of the rule is equivalent to a 20:35:48 strategy.

The 20:35:48 harvest control rule was applied to School Whiting in the 2010 assessment.

Previous Assessments

The first attempt to undertake an assessment of school whiting was during 1999 (Punt 1999). Another integrated stock assessment was performed in 2004 by Cui *et al.* (2004), but this assessment only used data from Commonwealth fishers, and ignored catches taken under state jurisdictions and all catches before 1991. As a result, it was only able to give information about biomass levels relative to 1991. During 2007, considerable effort went towards developing a full Tier 1 stock assessment for school whiting using the software package SS2 (Day 2007). This model has been subsequently improved and updated each year. The assessment data for School Whiting was separated into three 'fleets':

- Victorian Danish seine fleet;
- Otter trawl fleet; and,
- NSW Danish seine fleet.

The most recent was the 2009 School Whiting assessment (Day 2009) which used Stock Synthesis 3 (SS v3) and with the addition of updated length frequencies, catches and catch-rates for data collected during 2008. Catches of each of the fleets is shown in Figure 25. The 2009 model estimated the spawning stock biomass at the start of 2010 to be 50% of the unfished stock biomass (Figure 26). The recent recruitment history estimated in this assessment (Figure 27) showed mostly below average over the last 4 years estimated to 2005.

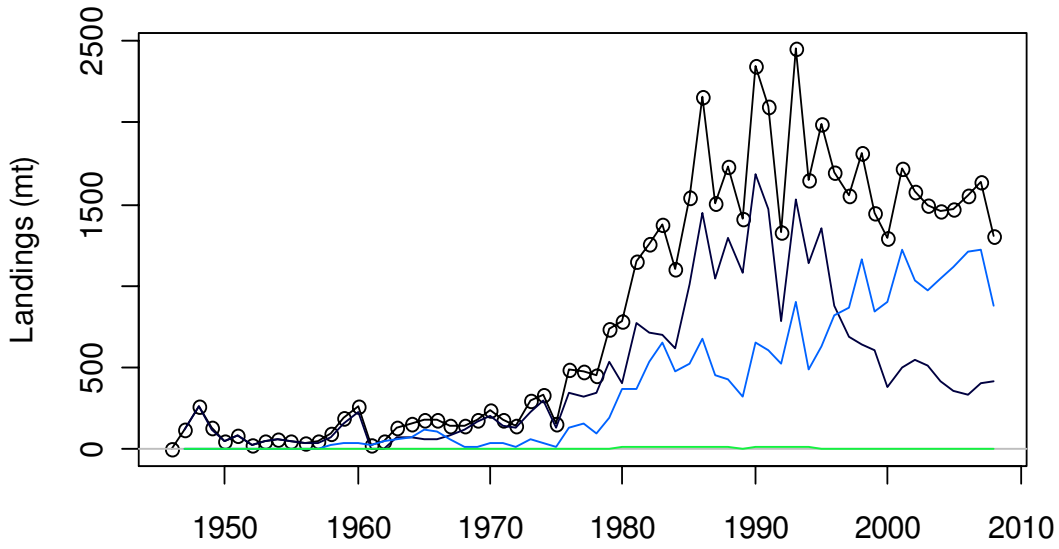


Figure 25. School Whiting total landed catches in the SESSF from 1947-2008 (black with circles) . These catches are also separated by fleet: the Victorian Danish seine fleet (fleet 1, navy blue); the otter trawl fleet (fleet 2, royal blue) and the NSW Danish seine fleet (fleet 3, green).

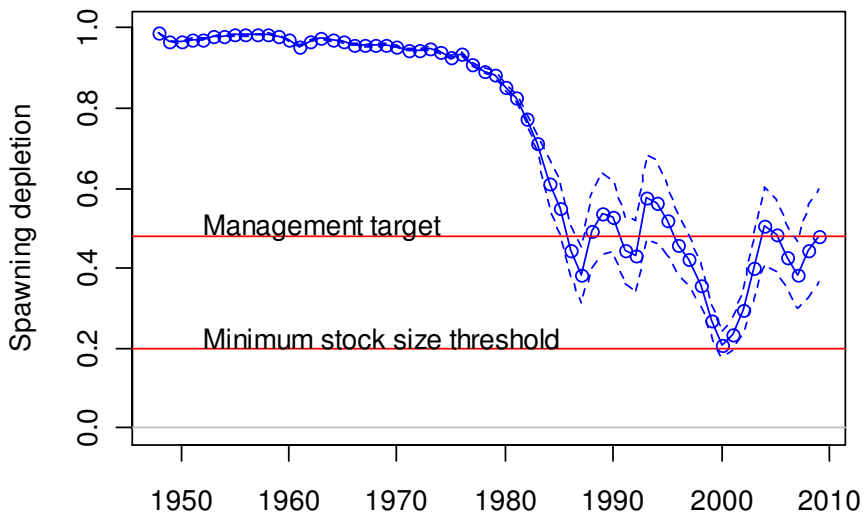


Figure 26. School whiting time-trajectory of spawning biomass depletion with 95% confidence intervals corresponding to the 2009 base-case estimates.

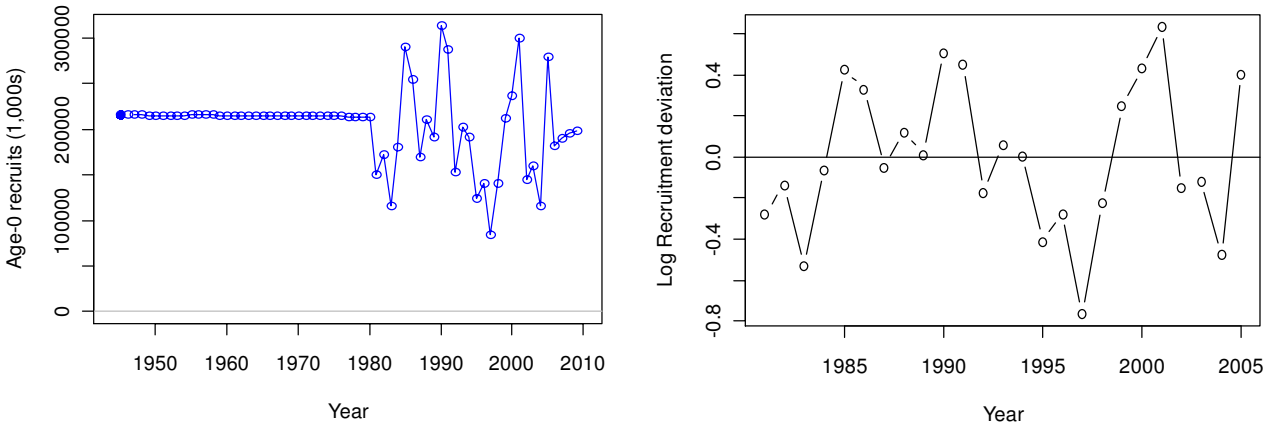


Figure 27. School whiting time-trajectories of recruitment (left) and recruitment deviations (right) for the 2009 base-case analysis.

2010 Assessment:

School Whiting is a relatively short lived teleost species, spawning biomass is particularly sensitive to variation in recruitment events. Good and bad recruitment years can have a rapid impact on fish stock abundance and estimated depletion levels and forward projections will always be subject to uncertainty relating to very recent recruitment events which are poorly informed until these cohorts fully enter the fishery. Model estimates of stock depletion and RBC outputs have been highly variable, which has made the provision of useful management advice and application of the agreed harvest strategy extremely difficult. As a result, TACs during recent years have been set at levels that could potentially lead to over- or under-catch of the RBC in any one year. This does not provide certainty to industry and other stakeholders about harvest levels and stock sustainability.

Last year, some preliminary retrospective analyses were undertaken to explore the School Whiting harvest strategy. The results of these retrospective analyses (Figure 29) showed that annual RBC outputs (using the same model applied to different years of data) vary greatly from zero to over 2500t, with changes of about this magnitude occurring over single years. This occurs because the model is trying to provide an immediate response to recent stock biomass and recruitment, and the most recent recruitment estimate is uncertain. Not surprisingly, the long term RBC estimates, which are not related to current stock size and do not account for recruitment variability, are much more stable, ranging between 1,500 and 1,750 t. Total catches have ranged between 1,250 and 2000t over the same period.

This year, the RAG requested that no formal stock assessment be undertaken in preference for further exploration of whether there is a more appropriate combination of data inputs, assessment criteria and harvest strategy for School Whiting than is currently used (Day 2010). This was considered a high priority in order to provide more economic

certainty for the Commonwealth operators without compromising the sustainability of the stock and spawning stock levels, which the current assessment indicates can vary by >40% of B_0 in one year.

To investigate this problem for the assessment there were a number of issues and strategies for mitigating its affects that were explored:

- **Pre-recruit survey**: Simulate a pre-recruit survey and examine the potential benefits of including such a survey in assessment results using retrospective analyses. This could be used to determine the magnitude of error in the biomass estimates that could be potentially corrected with additional information.
- **Fixed catch**: Using model projections with a fixed catch into the future to examine the proportion of the time that biomass is likely to be at the target and below the limit biomass in the future
- **Recruitment driven fishery**: explore the impact of a series of recruitment failures. With a constant catch, how many years of below average recruitment are required to lead to the stock falling below the limit biomass.
- **Recruitment retrospectives**: How much do estimates of recruitment change as the number of years of data informing these recruitment events increases? This will be tested by examining variations in the estimate of recruitment as a function of the number of years of data used to estimate them.

Of these, the RAG recommended focussing on the fixed catch option as well as further exploring the recruitment retrospectives. Preliminary results of this ongoing work were presented to the RAG.

Fixed catch

Projected annual catch was estimated based on 5 different fixed-catch levels through to 2028: 2000t; 1700t (close to the long term RBC of 1660t according to 2009 assessment); 1600t; 1500t; and 1400t. Using MCMC projections, the probability of achieving the target and going below the target, breakpoint or limit biomass was investigated (Table 8). Examples of the 2000 t, 1700 t and 1400 t projections are provided in Figure 30.

MCMC runs estimated high recruitment for 2005 and 2006, but this isn't based on reliable data (assessment assumes average recruitment for these years). The RAG noted that it is difficult to get Stock Synthesis to deal with this appropriately and it results in large predicted recruitment in 2009. Work will continue to try and resolve this issue during 2011. The RAG noted that sensitivities were not looked at, so there is more uncertainty in the projections than what the analysis shows. These sensitivities would only be evident in a full MSE approach. Funds were sought to conduct such and MSE but the application was not supported.

The RAG noted that in undertaking this work and using it as a potential method to set RBCS, it must be consistent with the HSP. The entails how to interpret the requirement that there should be no more than a 1 in 10 year risk of the biomass going below the biomass limit B_{lim}. The RAG recommended that an appropriate time-frame needs to be chosen for such projections.

Table 8. School whiting fixed catch projections and the probability of being below B_{20}, B_{35} and B48 at the end of 2028 and the probability of dipping below B_{20} and B_{35} during the period 2010 – 2028.

Fixed catch level	2028			2010-2028	
(t)	Pr. <B20	Pr. <B35	Pr. <B48	Pr. <B20	Pr. <B35
2000	25%	57%	81%	32%	79%
1700	3.0%	21.0%	54.0%	5.6%	44.0%
1600	1.3%	13.0%	43.0%	2.6%	30.0%
1500	0.3%	7.0%	32.0%	0.7%	20.0%
1400	0.0%	3.0%	23.0%	0.1%	12.0%

RBC Calculations

Based on the 2009 assessment, under application of the Tier 1 20:35:48 HCR, the School Whiting depletion level at the start of 2010 was 50% and the RBC was 1,723 t. The long-term yield under this harvest control rules was 1,660 t. A Tier 1 stock assessment was not performed during 2010, so these figures have not been updated.

RAG members acknowledged that the current work is leading to potentially new control rule for School Whiting to use for determining the RBC, in order to avoid the TAC varying too much due to the high recruitment and biomass variability. It was agreed that although promising, at this stage the work is still preliminary and in order to properly explore variability, the biomass projections should be done using alternative models or a harvest strategy evaluation. The RAG decided that further work should be done before applying the approach to setting RBCs, with the aim of applying it for the 2012 season.

Given the above, and without an update Tier 1 assessment, the RAG discussed what the RBC for 2011 should be. Given the high variability in the biomass, concerns were expressed that if the RBC is set too high then large TAC cuts may be required in the future to get the biomass up to the target.

There were no concerns with the stock falling below B_{lim}, so the RAG agreed to set the RBC at 1,660t, in line with the long-term RBC. It was noted that this value hasn't been updated from the 2009 assessment but it was noted that long-term RBC estimates have been generally stable.

Additional comments from the RAG

Industry is aware of this and would like better and complementary management between the State and Commonwealth so as to provide some level of certainty for Commonwealth operators.

Last year, ShelfRAG highlighted the need to provide better management advice regarding appropriate annual RBCs for this stock and recognised that there will be some trade-off between TAC stability and responding to current stock situations. The fixed catch method being currently explored may provide a solution and will be the focus of work during 2011.

Another approach would be to conduct a survey using smaller mesh seine nets to obtain a relative abundance index of pre-recruits that would not depend on the current commercial net selectivity, thereby improving precision of recruitment estimates for 0+ to 2+ fish and also reducing the lag in model response. This would take a number of years, however, before it could be used in the assessment. Before committing to this work and expense, the RAG considered it was worth continuing with the fixed catch analysis to see if it might provide a more cost-effective and cheaper solution.

Discount factor

As a Tier 1 species there is no discount fact considered for School Whiting.

Overcatch/undercatch

The default 10% overcatch and undercatch values were considered to be appropriate for School Whiting.

Research needs

Care should be taken to ensure that good length frequency samples and representative ageing samples are collected on School Whiting in the future to ensure the best information on recruitment is collected from commercial catch sampling. . These should not just be based on the Danish seine samples.

During the 2009 assessment, the RAG explored the information that was available on size at maturity and compared the results of the investigation by NSW DPI and historical data from Hobday and Wankowski. Based on this, members were reasonably satisfied that the model is using an appropriate maturity function but a number of Industry RAG members thought the age at maturity was too high and they are investigating the option of collecting more recent data from the Lakes Co-op.

Work is continuing on the development of a harvest strategy evaluation of more appropriate mechanisms of applying RBCs in this fishery given the relatively low age structure of the population and the poor information and variability in recruitment.

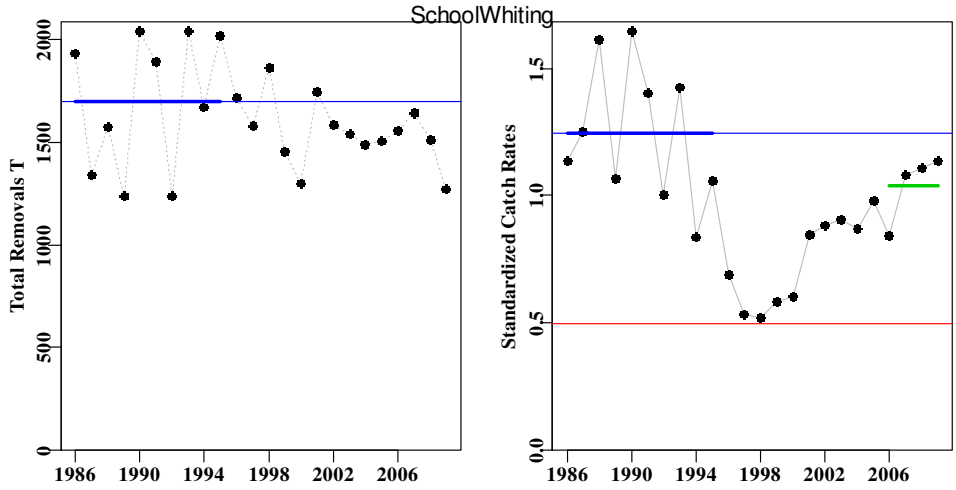


Figure 28. School Whiting total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick horizontal line represents the default reference period (Adapted from Haddon 2010b).

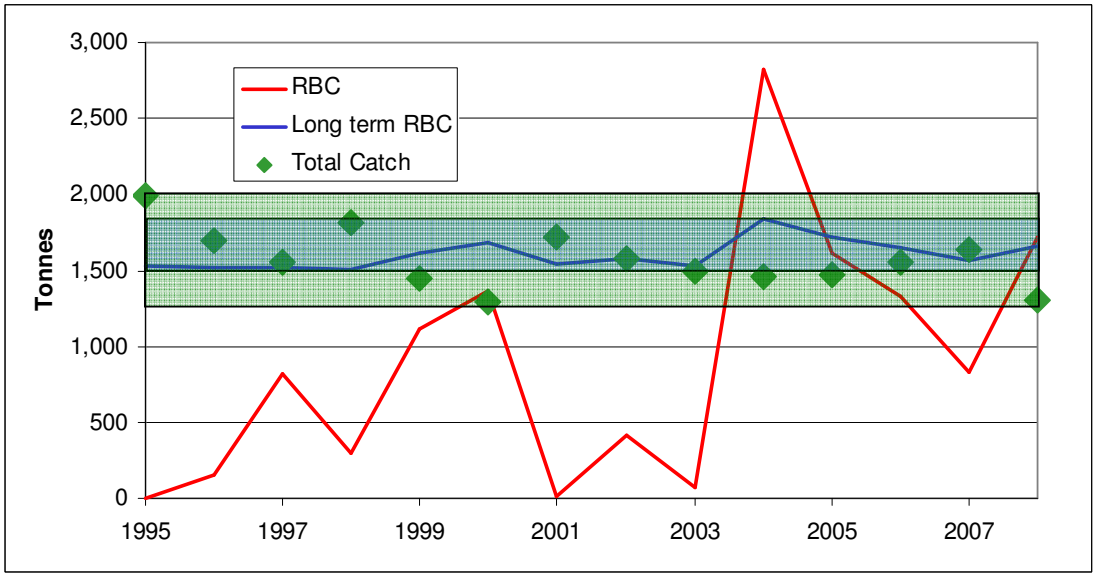


Figure 29. Retrospective analysis to explore RBC parameter estimates that would have been produced using the 2009 assessment applied to all data available up until a range of years from 2009 back to 1995.

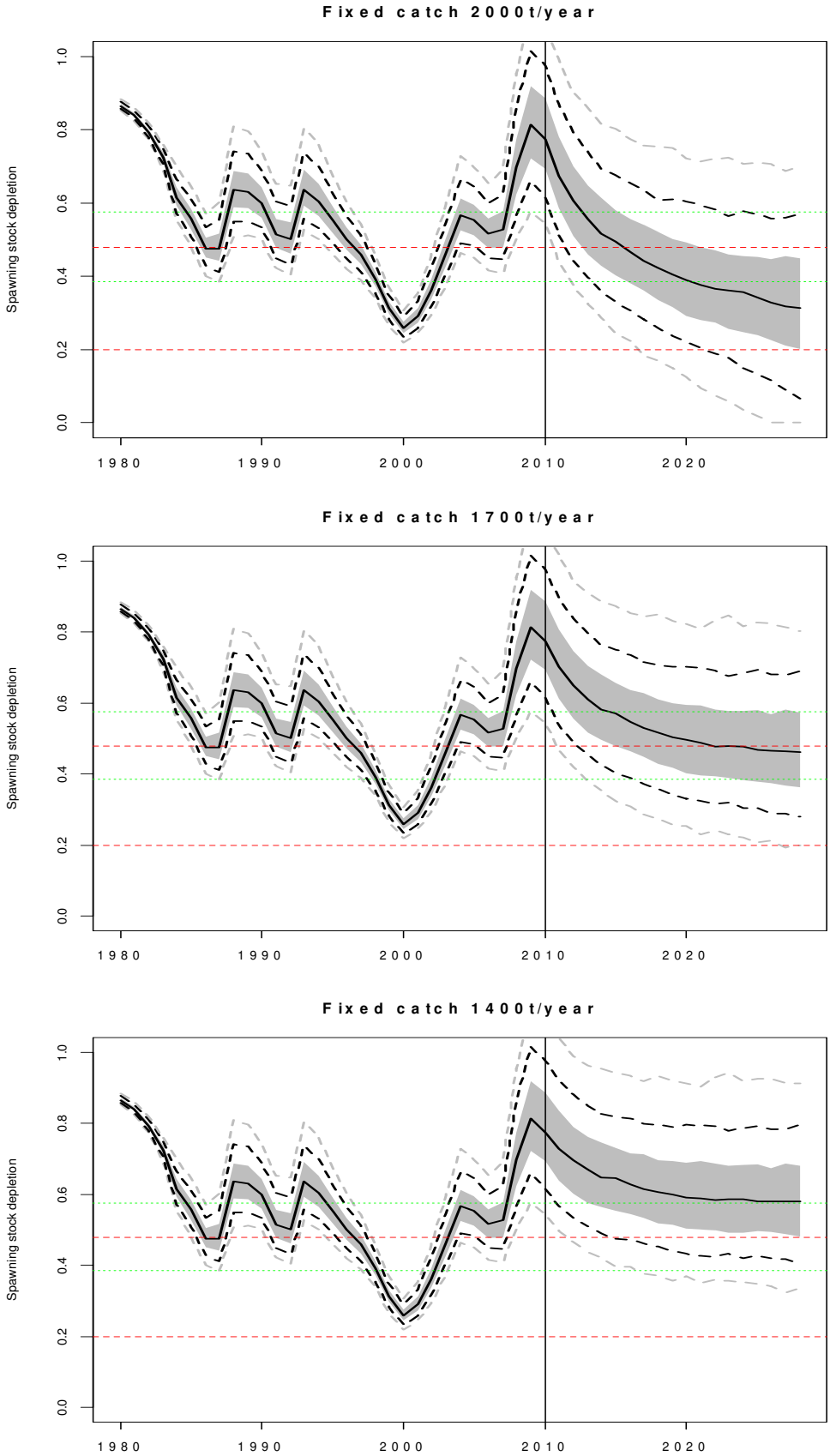


Figure 30. School Whiting fixed catch projections at 2000 t, 1700 t and 1400 t per year.

2010 Stock Assessment Summary for Mirror Dory (*Zenopsis nebulosus)*

RAG undertaking the assessment: ShelfRAG

Stock structure

Uncertain - probably separate stocks east and west of Bass Strait, but a single stock currently assumed for assessment purposes.

Recent catch history

	2006	2007	2008	2009	2010
Agreed TAC (Global)	634	634	634	718	718
Actual TAC (Global)	686	669	689	761	
Trawl catch (SEF2 Comm.)	405	307	441	526	
% Actual TAC .(trawl)	59	46	64	69	
Trawl catch (SEF2 State)	0	0.3	0	0	
Non-trawl catch (SAN2)	<1	0	0	<1	
% actual (non-trawl)	0	0	0	0	
Estimated discards	27	65	90	369	
% Discards	4	15	16	38	
State catch	85	29	22	35	
Total retained catch	491	336	463	561	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

Synopsis of 2009 fishery

The total landings of Mirror Dory from all sectors during 2009 were 561 t of which the SEF2 landed weight by the trawl sector was 526 t (all in Commonwealth waters). The 2009 state catch was 35 t. In 2010 the agreed TAC for Mirror Dory in the SESSF was 718 t.

Total removals of Mirror Dory during 2009 are the highest since 1986 and standardised catch rates were over the target level and were the higher since 1989. This supports Industry's positive outlook for the stock. As for last year, the depth distribution of the Mirror Dory catch was tightly constrained to the 300-550m depth band, with a smaller proportion of the catch coming from shallower depths than in previous years.

Discarding of small fish as a result of high-grading has been an issue for Mirror Dory. Industry has previously reported that there were a lot of small fish around and expected that discarding levels would be high. During 2009, there was a larger proportion of smaller fish in the retained catch, and discarded fish were in the range 32-40 cm.Based on ISMP data, it is estimated that 369 t of Mirror Dory were discarded during 2009 representing a discard rate of 38%. The RAG discussed the high levels of discards during 2009 which increased by about 300t from 2008. Last year the TAC was 718t, and the total catch was 561t plus 370t of discards which results in total removals of 931t. About 2/3 of the discarded catch was in the east. Industry representatives noted that the sizes of the retained and discarded fish were similar which may suggest that the discards were driven by quota limitations and not the market.

Recommended Tier Level

Although Mirror Dory is considered a Tier 3 species, last year the Tier 3 result was not accepted and the TAC was rolled over. A Tier 1 assessment was conducted this year on Mirror Dory but the assessment was not yet considered robust enough to be used. As with the Tier 1 assessment the Tier 3 assessment suffers from the lack of age data and uncertainty in the natural mortality.

Tier 3 and Tier4 assessments were used to discuss appropriate RBCs for this species. The 20:35:48 harvest control rule was applied to Mirror Dory in the 2010 assessment.

Previous Assessments

An exploration of the data available for Mirror Dory was undertaken last year (Thomson and Fay 2009) as a prelude to the development of a Tier 1 assessment in SS3. This identified some previously unknown potential issues with the representativeness of the sampling of Mirror Dory. It confirmed industry reports that fish caught in the eastern zones are

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**

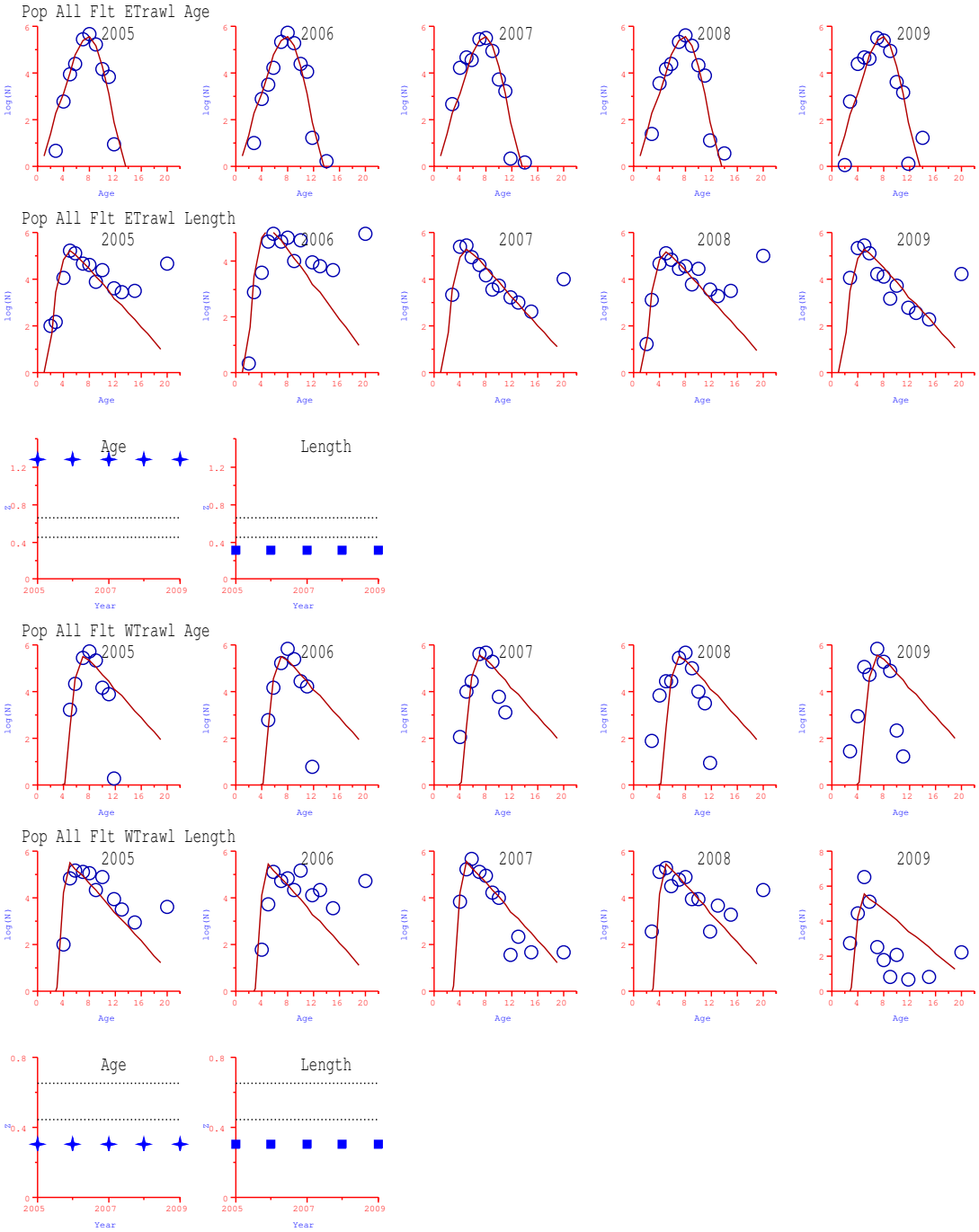
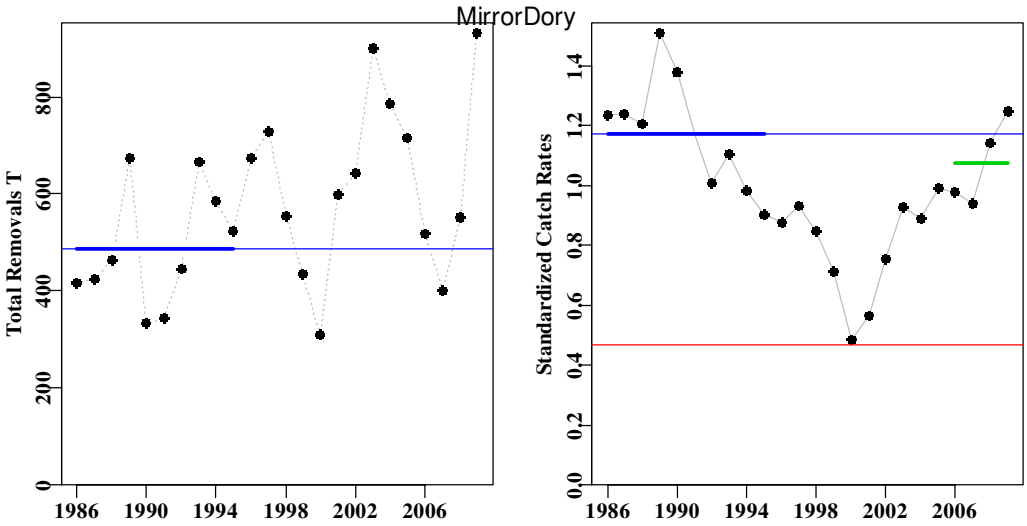
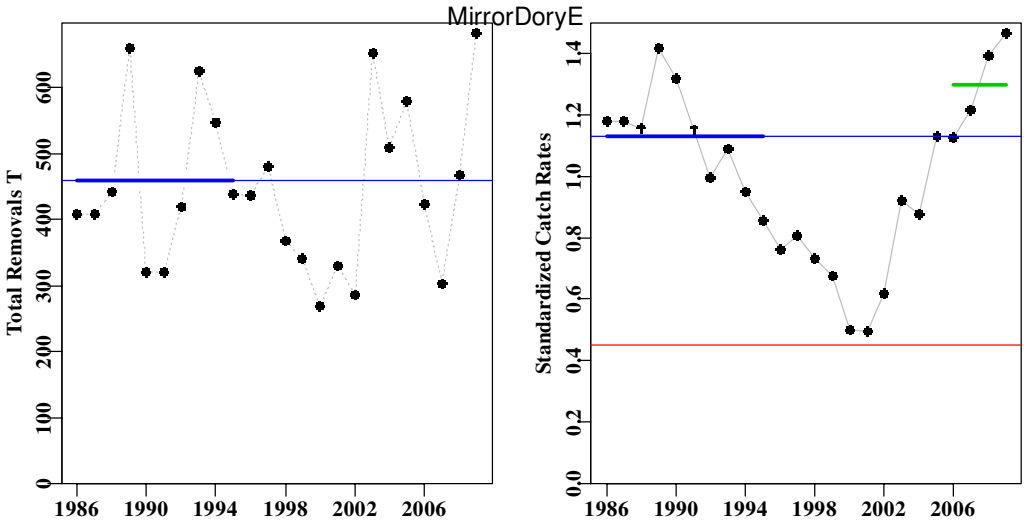


Figure 31. Mirror Dory catch curve results from the Tier 3 analysis. (from Klaer 2010a)

A) Combined East / West



B) East only



C) West only

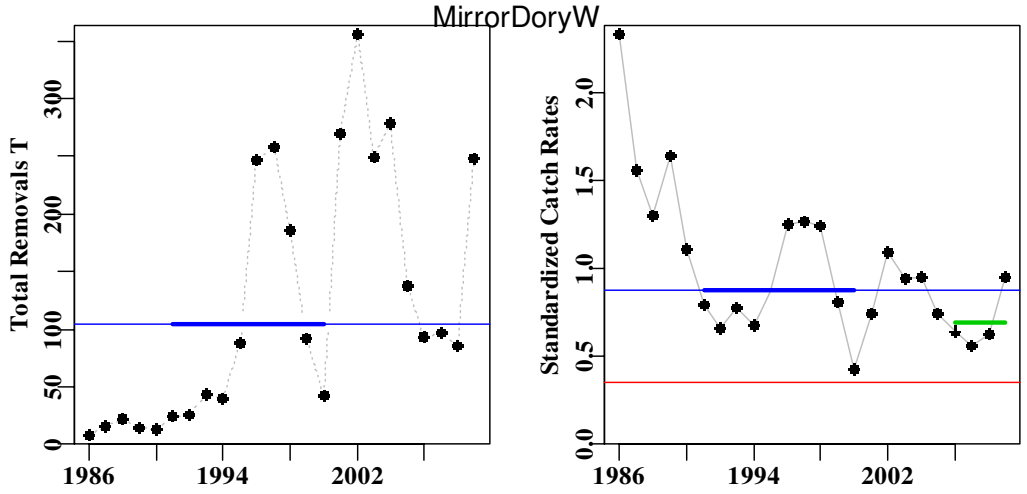


Figure 32. Mirror Dory total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick horizontal line represents the reference period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

2010 Stock Assessment Summary for Ocean perch (*Helicolenus spp.*)

RAG undertaking the assessment: ShelfRAG

Stock structure

Uncertain but there is probably an east/west structuring of stocks. A single TAC is set for the two distinct species: the inshore species *H. percoides,* also known as coral cod, and the offshore species (*H. barathri*).

Recent catch history

Inshore and offshore spp combined.

	2006	2007	2008	2009	2010
Agreed TAC (Global)	500	417	500	400	300
Actual TAC (Global)	540	na[1]	546	446	
Trawl catch (SEF2 Comm.)	209	171	178	180	
% Actual TAC .(trawl)	39	na[1]	33	40	
Trawl catch (SEF2 State)	0	0	0	0	
Non-trawl catch (SAN2)	46	34	43	36	
% actual (non-trawl)	9	na[1]	8	8	
Estimated discards	31	92	54	279	
% Discards	10	29	18	55	
State catch	21	18	18	9	
Total retained catch	277	223	239	225	

[1] 2007 TACs are for the 12 months to Dec 2007, 2008 & 2009 TACs are for the new fishing year (May to April)
NB, Most of the State catches are *H. barathri* but they include an unknown proportion of *H. percoides.*

H. barathri have comprised a significant catch by NSW trawlers since the continental slope fishery developed in the late 1960s and early 1970s. On average *H. barathri* are larger than the inshore Ocean Perch *H. percoides*, and the offshore form has comprised the majority of landings by the trawl fishery. Small quantities of offshore Ocean Perch are also taken by dropline off NSW. Annual landings off NSW have varied between 200 and 400 t since the 1970s (Rowling 2008).

Offshore Ocean Perch live to at least 62 years old but in the east most fish in the catch are now between 6 and 13 years of age and in the west they are between 6 and 20 years of age but with significant numbers of fish between 20 and 50 years old. It is likely that the difference in age structure reflects the higher fishing pressure in the eastern regions of the SEF, and is indicative of there being separate stocks in the two areas. Most of offshore Ocean Perch discarded in the eastern region consist of fish less than 10 years old.

Synopsis of 2009 fishery

The total landings of Ocean perch from all sectors during 2009 were 225 t of which the SEF2 landed weight by the trawl sector was 180 t (all in Commonwealth waters). The auto-longline sector takes a minor component of the total catch of the offshore species, but it is reported that the catch by this sector was from different areas than the catch taken by trawlers. The 2009 SAN2 non-trawl catch was 36 t and the state catch was 9 t. In 2010 the agreed TAC for Ocean Perch in the SESSF was 300 t. Recent lower catches have been attributed in part to the decline in fishing effort off NSW.

Ocean Perch is generally regarded as a bycatch species but there has been some limited targeting. Catch rates have been declining for both offshore and inshore stocks since the mid-1990s but have started to rise in recent years.

Recommended Tier Level

Ocean Perch is assessed as a Tier 4 species.

It had been suggested that Ocean Perch may be able to be elevated to a Tier 3 species, but this has not yet been accomplished and there will need to be careful consideration on how to take account of the two species and the east/west differences in age structure.

Previous Assessments

Virtually all the Ocean Perch catch is taken between depths of 100-650 m. Although the precise depth distributions of each species are unknown, and the species caught are not recorded in logbooks, a 250m depth criterion has been used to separate the catches of the two species. Last year, SlopeRAG discussed this issue and inspected the depth distribution of the catches, it was agreed to use 300 m as the basis for classifying catches.

SlopeRAG previously decided that both species of Ocean Perch should be assessed as Tier 4 species using the default period of 1986-1995 as the reference period for calculation of the target CPUE level and the reference catch level. Both species were to be regarded as having been fully fished by the period.

Inspection of the catch series for Ocean Perch identified some potential double counting of catches over several years before 1994 with fishers reporting the same catches to NSW and AFMA. This was resolved and the revised catch series was used as the basis for the 2010 RBC calculations. The changes include splitting the reported landings between Offshore and Inshore Ocean perch relative to the Commonwealth log book catches for the two depth ranges. This increased the total catches reported, but these data are now considered to be the best available information on Ocean Perch catches.

2010 Assessment

Interpretation of landed catch rates has been confounded by the inclusion of two species and by the high discard rates particularly for the inshore species. As for last year, the RAG is basing its advice on separate analyses of the inshore and offshore species.

Last year, the suggested RBC was to be the sum of the RBCs calculated separately for the two species. It was acknowledged that this will most likely make little difference to the final RBC, because the inshore species comprises a small proportion of the catch, but it was felt that it was important to be seen to be monitoring the status of both species independently. During that assessment, only the landed catch rate (not accounting for discards) was used in the Tier 4 analysis.

The situation changed this year because of the extreme estimates of discarding for the inshore species during 2009 (the landed catch was only 17t with 260t discarded). Because the Ocean Perch are grouped together under one RBC, to conduct the assessment without including catch rates of discards for the inshore species would have lead to a negative RBC, once discards were subtracted, despite relatively stable catch rates of the offshore species. So the RAG had to reconsider its approach and it agreed that Malcolm Haddon would conduct a re-analysis of Inshore Ocean Perch out of session, – in a manner similar to redfish, which also can have high discard rates.

RBC Calculations

The Tier 4 assessment for Offshore Ocean Perch resulted in a RBC of 219t.

The difference made by using Inshore Ocean Perch discards in the standardised catch rate analyses is marked (Figure 34) highlighted by the red circles. Rather than leading to a 26t RBC (Table 13), the analysis with discard catch rate lead to a 95t RBC (Table 14).

The simple combination of these two RBCs leads to a total RBC of 314t. The agreed TAC for 2010 was 300t.

Additional Comments from the RAG

Apart from having to reconsider this assessment out of session, the RAG found itself in a difficult position with recommending an RBC for this species. As commented in Haddon 2010b, the Tier 4 analysis relies on the catch rate time series to reflect the underlying relative abundance of the stock and ignoring discards can greatly alter the catch rates if the discards make up a significant proportion of the total catch. Haddon states correctly "the change in the perceived catch rates between 2008and 2009 are so extreme that even if there had been a large recruitment event such a large apparent change (a 300% increase) in the stock size seems intuitively unlikely". Based on recent years' data collection, the RAG is also wary of placing too much credence in the ISMP estimates of discard rate, although they were generally acknowledged to have improved sampling during 2009. Exacerbating this, the combination of the effects of discards into the catch rate analyses in the Tier 4 assessment is ad-hoc and relatively crude; there is no estimate of the uncertainty that this process introduces to the catch rate trends.

Taking this into account, the RAG could have simply recommended that the simple addition of RBCs for both Inshore and Offshore Ocean Perch, but this suggests some level of confidence in the Tier 4 analysis of Inshore Ocean Perch, which, at this stage, is not founded. The other option available is to roll over the TAC from the previous year and conduct further work during 2011 on the reliability of the discard rate estimates and the manner in which Tier 4 assessments include catch rates that include discards.

The RAG again emphasised the problems associated with applying a single TAC to two different species with very different fishing characteristics.

Discount factor

Last year, SlopeRAG considered that the 15% discount factor should be applied to Ocean Perch. Although the catch and catch rates have been stable or increasing, the truncated size and age compositions in the east are an indication that the fishery has had a substantial impact on the stock. It was noted, however, that a 15% reduction in the TAC is unlikely to reduce catches which have historically been well below the TAC.

The RAG is probably more uncertain about this assessment during 2010, given the large change in discard rates for Inshore Ocean Perch and as such, the 15% discount factor should still apply. It seems inappropriate, however, that the high uncertainties of Inshore Ocean Perch should be transferred to a significant change to the Offshore Ocean Perch TAC given its relative stability.

Overcatch/undercatch

The RAG considered that a 10% allowance for overcatch/undercatch was acceptable for Ocean Perch.

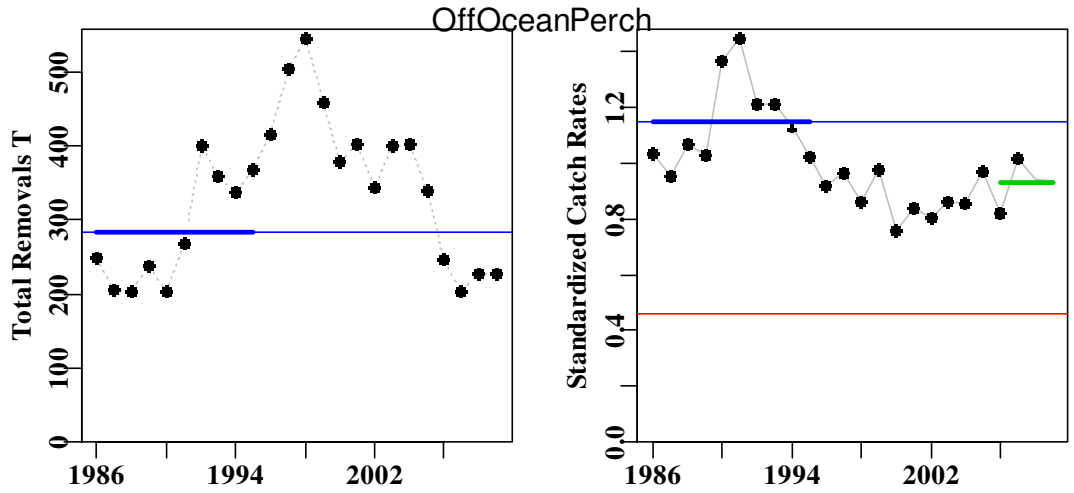


Figure 33. Offshore Ocean Perch total removals with the fine line illustrating the target catch. Top right represents the standardized catch rates with the upper fine line representing the target catch rate and the lower line the limit catch rate. Thickened lines represents the reference period for catches, catch rates, and the recent average catch rate (green) (from Haddon, 2010b).

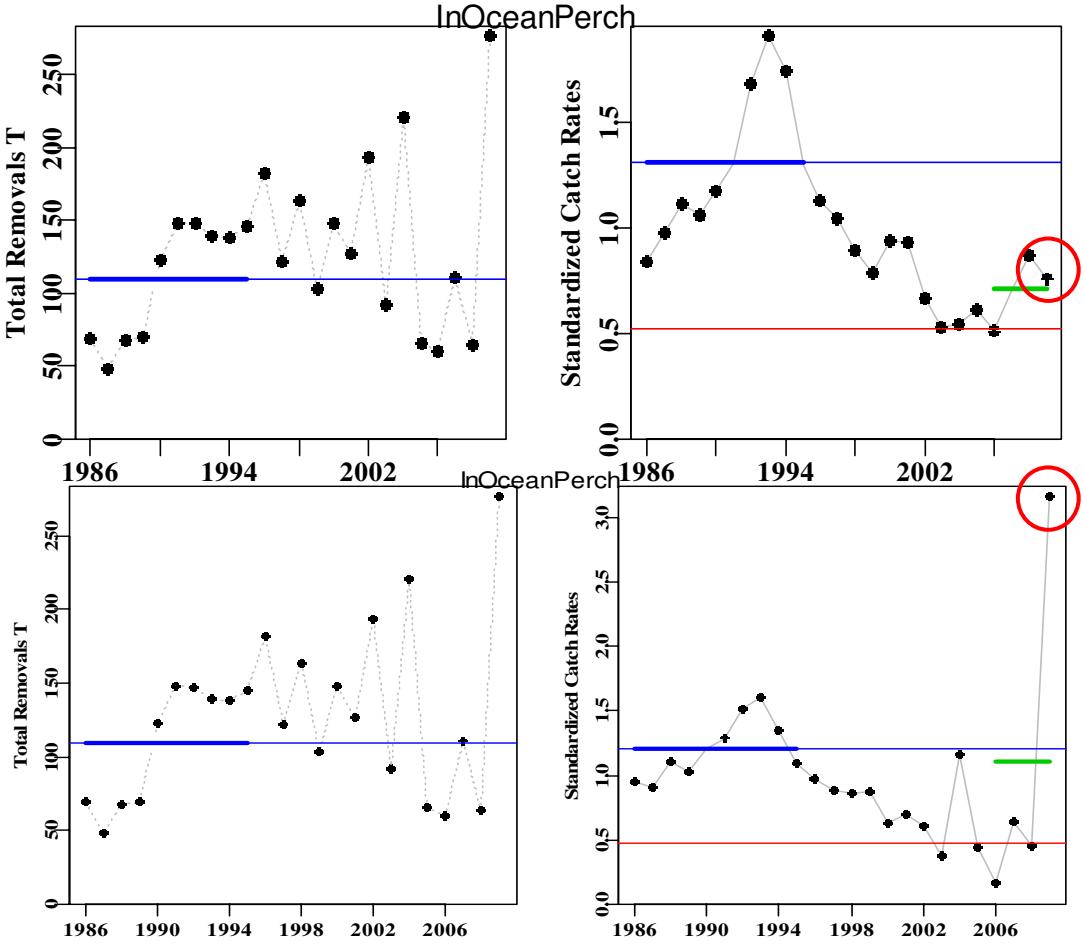


Figure 34. Inshore Ocean Perch total removals with the fine line illustrating the target catch. Top right represents the standardized catch rates without discards (Top) and with discards (Bottom) with the upper fine line representing the target catch rate and the lower line the limit catch rate. Thickened lines represents the reference period for catches, catch rates, and the recent average catch rate (green) (from Haddon, 2010b, 2010c).

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**

2010 Stock Assessment Summary for Blue Warehou (*Seriolella brama*)

RAG undertaking the assessment: ShelfRAG

Stock structure

There are two stocks east and west Bass Strait, but a single TAC is applied to these. In recent years, there has been separate catch limits applied to the east and west stocks..

Recent catch history

A) East and West combined

	2006	2007	2008	2009	2010
Agreed TAC (Global)	650	288	365	183	183
Actual TAC (Global)	661	338	381	214	
Trawl catch (SEF2 Comm.)	386	195	156	136	
% Actual TAC .(trawl)	58	58	41	64	
Trawl catch (SEF2 State)	0	<1	0	0	
Non-trawl catch (SAN2)	1	1	1	1.7	
% actual (non-trawl)	0	0	0	1	
Estimated discards	109	25	266	17	
% Discards	20	9	53	7	
State catch	26	29	37	34	
Total retained catch	413	225	194	172	

[1]Due to the change in length of the fishing year, the actual TAC for the 2007 calendar year can not be reported.

B) East only

Need table produced

C) West only

Need table produced

Synopsis of 2009 fishery

Need to update with data from east and west analysed separately.

The landings during the 2008 calendar year were 196 t of which 19% was taken in the east. This catch was up slightly on the 2007 catch of 174 t. The landed catch in the east continues to be a low fraction of historical values, while the landed catch in the west during 2008 is even lower than that for 2007 which was the lowest since 1989. This is again attributable in no small part to the TAC for 2007 of 219 t (both stocks). The standardized catch-rates for both stocks continued to be low in 2008 (Figure 35 and Figure 36).

At the end of the quota year (April 2009) the landed catch was 161 t which represented 42% of the actual TAC.

Discard rates had fallen from 46% in 2005 to 13% in 2006 in the east, but a much smaller drop (from 47% to 40%) was recorded in the west. In 2008 the overall estimated discard rate was 12% but it was reported that this estimate may be biased low because of an unwillingness of some industry members to follow their normal discarding practices when carrying an AFMA observer. Active avoidance of Blue Warehou in the east due to limited quota had previously reported as one reason why the discard rate had fallen. Discarding was mostly smaller fish (less than 30cm) in 2008 as the result of high-grading (see Hobsbawn 2009 p44).

Recommended Tier Level

Although Tier 1 assessments have been developed for Blue Warehou, due to a variety of problems with the data and the lack of robustness of the assessment, they are now analysed as a Tier 4 species.

2010 Assessment

Last year there were some concerns about the accuracy of data on State catches (both recent and historical) and an agreement that this required further investigation as it may impact on the assessment.

The assessment remained as a Tier 4. Age compositions were dominated by 2 year old fish in both the east and west but these distributions are inconsistent with the size composition data and may be unrepresentative of the catch.

Dr Haddon advised that in 2004-06 there were large discards of large fish, and no discards data for 2007-09. Last year the catch levels were 40t in the east and 140t in the west, with a TAC of 183t.

The RAG discussed targeting. The companion species paper showed that there is more targeting in the west, where 9.6t was targeted out of a total catch of 38 t compared to the east, where 66 t was targeted out of a total catch of 94 t. The RAG noted that quota in the east is being leased to the west for targeting, and recommended that AFMA and SETFIA discuss ways to try and reduce targeting.

It is unknown if the current catches are inhibiting rebuilding of the stock.

The RAG agreed to rollover the bycatch TACs that were in place last year. Noting that 60% of the catch is targeted in the west, however, the RAG also recommended that if targeting is not addressed properly at the workshop, the bycatch TAC should be reduced.

RBC Calculations

The target catch rate was selected as the average standardised catch rate for 1986-1995 and the limit catch rate at 40% of this target.

RBCs for both eastern and western stocks remain at zero as standardized catch rates are below the limit reference points.

Additional Comments from the RAG

The RAG noted again its concern that the CPUE is not a good index of abundance while the TAC is so low and industry attempts to avoid catching the species. The need for a fishery-independent survey to obtain an improved index was again raised, but it was also noted that it will be difficult even for such a survey to achieve this aim given the schooling nature of the species.

As with eastern gemfish, an alternative primary index of abundance needs to be developed as a high priority for use in future stock assessments. The issue of how to address the loss of the primary index of abundance for species under a bycatch TAC is a high priority and will be the focus of a workshop during 2011.

Discount factor

The TAC is set at a level that is intended to allow landing of incidental catches. As a species under a 'bycatch' TAC, it was not considered that a discount factor would apply to Blue Warehou. AFMA or SESSFRAG may have a different opinion.

Overcatch/undercatch

Last year, SlopeRAG considered that there should be no allowance for undercatch for Blue Warehou given that the analysis suggests the standardized catch rates are below the limit reference points and AFMA will set a TAC at a level to allow incidental catches only. SlopeRAG also considered that overcatch should be managed within the limits set by the 'determined amount' for small quantities of catch above an operator's quota. There were no comments from SHelfRAG members that this arrangement should change for 2011.

Other comments previously reported from the RAG that are still relevant:

1. Limited quota availability has been reported to affect the extent of targeting and hence catch rates.
2. Market factors were also reported as reducing catch rates.
3. There was an acknowledgment by the RAG that Blue Warehou exhibit considerable variation in availability that affects catches, catch rates and variability in catch rates.
4. There is inconsistency between calculated RBCs and industry perceptions of stock status. Industry have argued that previously high discard rates were an indication of a much larger stock size than is suggested by the TAC.
5. Many observed shifts in catches and changes in CPUE could be attributed to transfers of quota from operators in the east to those in the west.
6. It was more difficult for fishers to locate spawning areas as these were not in consistent over time and there had been a large reductions in the number of operators.

Research needs

The issue of how to address the loss of the primary index of abundance for species under a bycatch TAC is a high priority and will be the focus of a workshop during 2011. The following is a list of previously highlighted research

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**

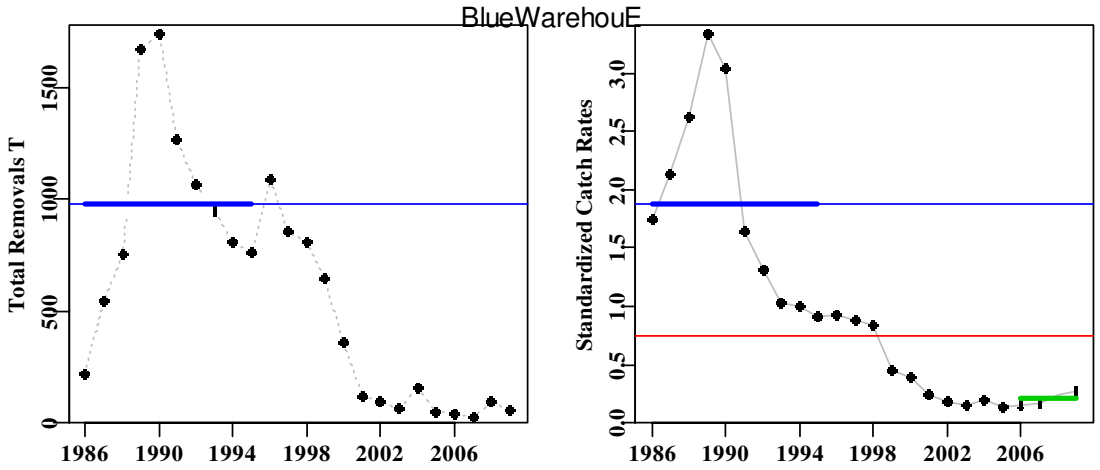


Figure 35. Blue Warehou east total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates including discards with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick blue horizontal line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

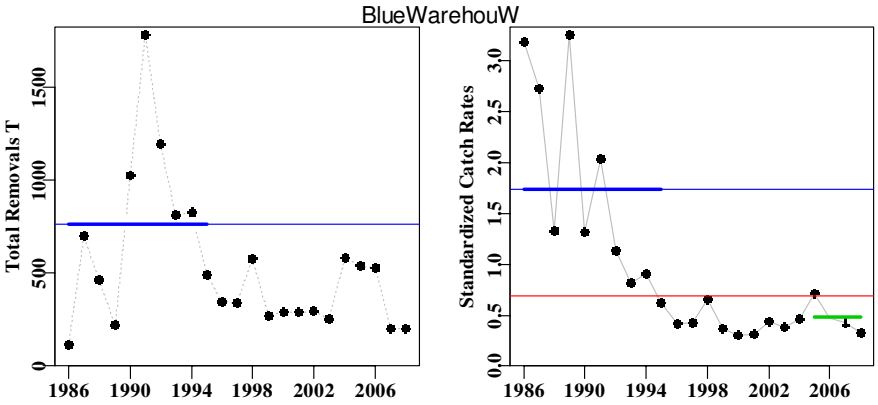


Figure 36. Blue Warehou west total removals with the fine line illustrating the target catch (left panel), and the standardized catch rates including discards with the upper fine line representing the target catch rate and the lower line the limit catch rate (right panel). The thick blue horizontal line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

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