



Australian Government

Australian Fisheries Management Authority



Harvest Strategy Framework

FOR THE SOUTHERN AND EASTERN SCALEFISH AND SHARK FISHERY

2009 AMENDED (FEBRUARY 2015)

Version Control

#	Status	Change Description	Author(s)	Date
01	Version 1.1 to 1.2	Drafting the Harvest Strategy Framework into template	Sharon Koh, Steve Auld	22 Sep 2009
	Version 1.3	Redraft following outcomes of SESSFRAG meeting February 2011	Sharon Koh	July 2011
	Version 2	<p>Updates to web links and accessibility changes.</p> <p>Integration of GAB section, multi-year TACs, consistent application of discards and discount factor guidance. Removal of CPUE multiplier. Research needs, now included in the strategic research plan and the annual research plan, have been removed.</p>	George Day	February 2014
	Version 3	<p>Providing for alternative TACs to those produced by the Tier 1 harvest control rule in defined circumstances.</p> <p>Removal of the small change limiting rule.</p> <p>Clarification of how to apply the discount factor.</p> <p>Documenting the limit placed on the Tier 3 harvest control rule multiplier as recommended by SESSFRAG in March 2013.</p> <p>Specifying the approach for setting TACs when the Recommended Biological Catch is 0.</p> <p>To provide guidance on 'step down' and 'step up' TACs.</p>	George Day	February 2015

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Table 1: Harvest Strategy Summary Table

Tier level (Species vary)	Reference Point / Trigger point	Reference Point function*	Information requirements to monitor Reference Point	Control Rule	Research priorities
Tier 1	B ₂₀	Limit	Catch, effort, discards, age, length, relative abundance, biomass information from: - Logbook and catch landing records - ISMP - FIS	<B ₂₀ : No targeted fishing, rebuilding strategy will be developed ¹	ISMP FIS
	B ₃₅	HCR inflection	Same as above	<B ₃₅ : TACs are set at levels that allow stocks to rebuild to target levels	Same as above
	B ₄₈	Target	Same as above	<B ₄₈ : Rebuild stocks towards B ₄₈ >B ₄₈ : At or above target, fish at F ₄₈ .	Same as above
Tier 3	F ₂₀	Limit	Catch, discards, age, length information from: - Logbook and catch landing records - ISMP	<F ₂₀ : No targeted fishing, rebuilding strategy will be developed	ISMP Stock recruitment relationships
	F ₄₀	MSY proxy	Same as above	<F ₄₀ : TACs are set at levels that allow stocks to rebuild to target levels	Same as above

¹ Commonwealth Fisheries Harvest Strategy Policy 2007 at page 4.

	F_{48}	Target	Same as above	$<F_{48}$: Rebuild stocks towards F_{48} $>F_{48}$: At or above target, fish at F_{48} .	Same as above
Tier 4	$CPUE_{20}$	Limit	Catch, effort, discards information from: - Logbook and catch landing records - ISMP	$<CPUE_{20}$: No targeted fishing, rebuilding strategy will be developed	ISMP
	$CPUE_{40}$	MSY proxy	Same as above	$<CPUE_{40}$: TACs are set at levels that allow stocks to rebuild to target levels	Same as above
	$CPUE_{48}$	Target	Same as above	$<CPUE_{48}$: Rebuild stocks towards $CPUE_{48}$ $>CPUE_{48}$: At or above target, fish at F_{48} .	Same as above
Tier 3	5%	Discount Factor (metarule)	Same as for Tier 3 – applies for assessments which are more uncertain	Reduces the TAC derived from the RBC - applied on an individual species basis ²	
Tier 4	15%	Discount Factor (metarule)	Same as for Tier 4 – applies for assessments which are more uncertain	Reduces the TAC derived from the RBC - applied on an individual species basis	
All Tier levels	50%	Large Change Limiting rule (metarule)	Same as above	TACs between fishing seasons to change by no more than 50%, where this will not pose a significant risk to stock status	

N.B. The Harvest Strategy Policy allows alternative reference points to the recommended defaults – B_{MEY} , B_{MSY} , B_{LIM} – to be used where they better pursue the objectives of the Policy.

² SESSFRAG 4-5 March 2014 recommended guidance for the Commission for when the Tier 3 and Tier 4 discount factors are not applied - see below at section 6.4.1.

GLOSSARY

Types of reference points:

Reference Point	Description
Metarule	a rule that describes how the RBCs obtained from an assessment should be adjusted in calculating a recommended TAC
Target	relates to a target reference point as per the Harvest Strategy Policy. May be expressed in terms of biomass, fishing mortality or CPUE
Limit	relates to a limit reference point as per the Harvest Strategy Policy. Fishing stops at this reference point. May be expressed in terms of biomass, fishing mortality or CPUE
MSY	maximum sustainable yield
MEY	maximum economic yield
Override	under exceptional circumstances, enables adjustment to a recommended TAC where certain conditions are met, e.g. to take advantage of a “boom” period for highly variable species, or to impose additional restrictions when stocks are thought to be under threat
Inflection point	the reference point below which TACs are adjusted to allow stocks to rebuild to target levels. Also known as a breakpoint

Notation:

Notation	Description
B	spawning biomass level
B_{CUR}	the current spawning biomass level
B_0	the unfished spawning biomass (determined from an appropriate reference point)
B_x	the biomass level representing x% of the unfished spawning biomass B_0
F	fishing mortality rate
F_{CUR}	the current fishing mortality rate
F_x	the fishing mortality rate which would achieve a spawning biomass level of B_x
M	the natural stock mortality rate
$CPUE_x$	catch per unit effort which would achieve a spawning biomass level of B_x

Other acronyms:

Acronym	Description
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
CDR	Catch Disposal Record

Acronym	Description
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CPUE	Catch per unit of effort
ERA	Ecological Risk Assessment
FIS	Fishery Independent Survey
GAB	Great Australian Bight
GABMAC	Great Australian Bight Management Advisory Committee
GABTS	Great Australian Bight Trawl Sector
GHAT	Gillnet, Hook and Trap
HSP	Commonwealth Fisheries Harvest Strategy Policy 2007
HSF	Harvest Strategy Framework
HCR	Harvest Control Rule
ISMP	Independent Scientific Monitoring Program
MAC	Management Advisory Committee
MSE	Management Strategy Evaluation
RAG	Resource Assessment Group
RBC	Recommended Biological Catch
SEMAC	South East Management Advisory Committee
SESSF	Southern and Eastern Scalefish and Shark Fishery
TAC	Total Allowable Catch
TEP	Threatened, Endangered and Protected

1. OVERVIEW OF THE SESSF HARVEST STRATEGY

1.1. The Harvest Strategy Policy

The objective of the Commonwealth Fisheries Harvest Strategy Policy 2007 (HSP) is the sustainable and profitable use of Australia's Commonwealth fisheries in perpetuity through the implementation of harvest strategies that maintain key commercial stocks at ecologically sustainable levels, and within this context, maximise the economic returns to the Australian community.

To meet this objective, harvest strategies are designed to pursue an exploitation rate that keeps fish stocks at a level required to produce maximum economic yield (MEY) and ensure stocks remain above a limit biomass level (B_{LIM}) at least 90% of the time. Alternative reference points may be adopted for some stocks to better pursue the objective of maximising economic returns across the fishery as a whole.

The HSP provides for the use of proxy settings for reference points to cater for different levels of information available and unique fishery circumstances. This balance between prescription and flexibility will encourage the development of innovative and cost effective strategies to meet key policy objectives. Proxies must ensure stock conservation and economic performance as envisaged by the HSP. Such proxies, including those that exceed these minimum standards, must be clearly justified.

With a harvest strategy in place, fishery managers and industry are able to operate with greater confidence, management decisions are more transparent, and there are fewer unanticipated outcomes necessitating hasty management responses.

Further detail on how to use harvest strategies is provided in the Guidelines to the Harvest Strategy Policy (*Commonwealth Fisheries Harvest Strategy Policy Guidelines 2007*).

1.2. The SESSF Harvest Strategy Framework

The SESSF Harvest Strategy Framework (HSF) sets out the management actions necessary to achieve defined biological and economic objectives, and describes the indicators used for monitoring the condition of stocks, the types of assessments conducted and the rules applied to determine the recommended total allowable catches.

The HSF was developed in 2005. Since that time it has been reviewed in line with the HSP which was developed to help give effect to the requirements of the Ministerial Direction (2005).

The HSF uses a three tier approach designed to apply different types of assessments and cater for different amount of data available for different stocks. The HSF adopts increased levels of precaution that correspond to increasing levels of uncertainty about stock status, in order to reduce the level of risk associated with uncertainty. In this approach, each stock is assessed using one of three types of assessment depending on the amount and type of information available to assess stock status, where Tier 1 represents the highest quality of information available (i.e. a robust integrated quantitative stock assessment). The previous Tier 2 analysis, which applied to species and/or stocks which have a less robust quantitative assessment, is no longer being used.

Each Tier has its own harvest control rule (HCR) that is used to determine a recommended biological catch (RBC). The RBCs provide the best scientific advice on what the total fishing mortality (landings from all sectors plus discards) should be for each species/stock. For all Tier levels, once the RBC is determined from the results of the assessment and the application of the relevant HCR, a recommended total allowable catch (TAC) is calculated based on the TAC setting rules described in section 6.4.

The HCRs for the three tier levels differ depending on the types of indicators used. For Tier 1, the HCR is based on the following reference points:

- *The limit biomass B_{LIM}* – represents the spawning biomass level below which the risk to the stock is unacceptably high and the stock is defined as “overfished”. The default B_{LIM} proxy is $B_{20} = 20\%$ of the unfished spawning biomass.
- *The B_{MSY}* – represents the spawning biomass level which would result in a maximum sustainable yield (MSY), which is the point at which additional fishing effort is most likely to decrease the total catch and any profit. The default B_{MSY} proxy is $B_{40} = 40\%$ of the unfished spawning biomass.
- *The target biomass B_{TARG}* – represents the spawning biomass level which would result in a maximum economic yield (MEY), which is the point at which the sustainable catch or effort level for the fishery maximises profits. B_{TARG} is generally equal to B_{MEY} , for which the default proxy is approximated by $1.2 * B_{MSY}$. If the default B_{MSY} proxy is used, this results in $B_{48} = 48\%$ of the unfished spawning biomass.

Tier 3 and Tier 4 assessments use other indicators (relating to fishing mortality and catch rates respectively) and reference points which are taken as proxies for the biomass reference points for Tier 1. The HCRs for each tier level are outlined below.

1.2.1. Tier 1

A Tier 1 stock assessment uses an integrated biological and statistical approach that combines a wide variety of data inputs, generally including CPUE, other abundance indices and size and age composition. The Tier 1 harvest control rule applies to species and/or stocks where there is a robust quantitative assessment that provides estimates of current biomass levels, and where estimates or appropriate proxies are available for B_{LIM} , B_{TARG} and F_{TARG} . The default targets and limits are set to comply with the HSP. The RBC is calculated by applying target fishing levels determined from the harvest control rule to the current biomass, to calculate the total catch (including discards) in the next year, using the agreed base case assessment model.

1.2.2. In some circumstances, a different TAC to that produced by the Tier 1 HCR may be set - refer to section 6.4. Tier 3

A Tier 3 stock assessment uses information available on the age structure of annual catches and annual total catch weight, as well as knowledge of basic biological parameters, e.g. natural mortality, length at age, weight at length, the stock recruitment relationship steepness, fecundity at age and selectivity at age. The estimation of current fishing mortality is made using all this information. The catch control rule uses the ratio of the target exploitation rate to the actual exploitation rate as a multiplier on the current average catch to determine the RBC.

Limit and target reference points, which may be estimated using a yield-per-recruit analysis, are applied to the fishing mortality and are comparable to the limit and target reference points used in the Tier 1 harvest control rule. The period over which average current catch is estimated is chosen to match the period to which the estimated fishing mortality applies. The estimate of fishing mortality is limited to not less than 0.1 of natural mortality.

1.2.3. Tier 4

The Tier 4 assessment is based entirely on catch and CPUE.

The Tier 4 analysis determines an RBC by selecting CPUE reference points that are taken as proxies for the estimated B_{LIM} and B_{TARG} . This is done by assuming that the CPUE is proportional to stock abundance, an assumption that is made in most SESSF assessments. If the stock was at unexploited equilibrium at the start of fishing, then the initial CPUE level at the start of the time series would correspond to the unexploited biomass or B_0 , and the other reference points are the appropriate fractions of this (e.g. 20% for B_{20}). For most SESSF stocks there is not a full CPUE time series back to the start of fishing, so it is necessary to choose a reference period from the data series that we do have where we think we can make

a reasonable estimate of the level of depletion of the stock. Most SESSF species are considered to be fully exploited by 1986, so a reference period against which current rates are compared is chosen around this time when CPUE levels and catches were relatively stable. The default period is 1986-1995, but other periods are used for some species and fisheries which were not fully developed in 1986.

It is then assumed that during the reference period the stock was at the level that will provide maximum economic yield, i.e. the CPUE corresponds to B_{MEY} (which as a default is assumed to be B_{48}). This is why, for these stocks, the Tier 4 rule uses the average CPUE in the reference period as a CPUE target, and the average catch in that period as a catch target.

1.3. Alignment of the HSF with the HSP

The HSF meets the requirements of the HSP by applying a precautionary approach, standards for reference points, and measures to be implemented in accordance with the reference points as specified in the HSP. These are reflected in the use of a tiered approach to control rules, and decreases in exploitation rates as the stock size decreases below a target reference point or as uncertainty about stock status increases. The HSF involves the use of maximum economic yield (MEY) as a target, a biomass limit reference point to trigger no further targeted fishing, and the proxies $B_{LIM} = 20\%$ of B_0 , $B_{MSY} = 40\%$ of B_0 , and $B_{MEY} = 1.2B_{MSY}$. The HSF also requires rebuilding strategies for stocks below B_{LIM} , and TACs are set an appropriate level to rebuild stocks to B_{MSY} or B_{MEY} in line with the HSP.

For multi-species fisheries, the HSP requires MEY to be applied to the fishery as a whole and optimized across all species in the fishery, so that some secondary species may be fished at levels that will result in their biomass remaining below B_{MEY} . The SESSF will continue to move towards applying MEY at a whole-fishery level, but the way that this can be best achieved may develop over time.

1.4. Governance

The status of fish stocks in the SESSF, and how they are tracking against the HSF, is reported to the RAGs, MACs and AFMA Commission as part of the yearly TAC Setting process (see section 6.1). Stock assessments for each quota species, produced by the RAGs each year, include consideration of the catch rates for each quota species in the current and previous fishing years, how catches compare to the TAC, where the stock status indicators sit in relation to the reference points, and a recommended biological catch (RBC) for the upcoming fishing year. The TACs are determined by the AFMA Commission on the basis of the RBCs and advice from the RAGs, MACs, and AFMA Management.

2. BACKGROUND TO THE SESSF

An overview of the fishery can be found in the latest SESSF Management Arrangements booklet, which is available on the AFMA website at: <http://www.afma.gov.au/managing-our-fisheries/fisheries-a-to-z-index/southern-and-eastern-scalefish-and-shark-fishery/publications-and-forms/>.

The booklet includes:

- the geographical distribution of the fishery, closures and fishing seasons
- value of the fishery and management arrangements
- historical and current trends in catch and effort.

3. KEY COMMERCIAL SPECIES OR STOCKS AND ERA PRIORITY

Harvest Strategies are in place for all 34 species subject to quota (including target and non-target species) in the SESSF. An Ecological Risk Assessment at the SAFE level was first conducted for the SESSF in 2007. This assessment was updated in 2012 to include distribution and effort data from 2007-2010 in the fishery.

4. OBJECTIVES OF THE SESSF HARVEST STRATEGY

The objectives of this harvest strategy include:

4.1. Biological

- To maintain stocks at (on average), or return to, a target biomass point B_{TARG} or equivalent proxy (e.g. F_{TARG} or $CPUE_{TARG}$) equal to the stock size that aims to maximise net economic returns for the fishery as a whole.
- To maintain stocks above the limit biomass level, or an appropriate proxy, at least 90% of the time.
- A reduced level of fishing if a stock is below B_{TARG} but above B_{LIM} (or an appropriate proxy).
- To implement rebuilding strategies, no-targeting and incidental bycatch TACs if a stock moves below B_{LIM} (or an appropriate proxy).
- To ensure the sustainability of fisheries resources, including consideration of the individual fishery circumstances and individual species or stock characteristics, when developing a management approach.

4.2. Socio-economic

- To maintain stocks at (on average), or return to, a target biomass point B_{TARG} equal to the stock size that aims to maximise net economic returns for the fishery as a whole.
- To maximise the profitability of the fishing industry and the net economic returns to the Australian community.
- To minimise costs to the fishing industry, including consideration of the impacts on the industry of large or small changes in TACs and the appropriateness of multi-year TACs.

4.3. Ecosystem

- To be consistent with the principles of ecologically sustainable development, including the conservation of biological diversity, and the adoption of a precautionary risk approach.

5. MONITORING

The biological and economic conditions in the fishery are monitored by the following three methods:

5.1. Logbooks and catch records

AFMA requires fishers to record catch and effort information in logbooks at sea, and in catch disposal records (CDRs) which record the actual landed catch at port. CDRs are considered more accurate than logbook records.

The following data is recorded for each fishing operation: the port and date of departure and return; gear type and fishing method; number of fish kept and discarded; and resultant catch

including what is included in the weight (e.g. trunked, gutted, filleted, whole). Further information on logbooks and CDRs is available at: <http://www.afma.gov.au/services-for-industry/logbooks-and-catch-disposal/current-logbooks-and-catch-disposal-records/>.

5.2. The Integrated Scientific Monitoring Program (ISMP)

A key component of the ISMP is the sampling and recording of catches at ports and on board fishing vessels using fishery-independent observers. The purpose of the ISMP is to provide reliable, verified and accurate information on the fishing catch, effort and practice of a wide range of vessels operating inside and, periodically, outside the Australian Fishing Zone.

Biological and environmental data are collected on: catch composition including size and weight; amount and type of incidental catch; number of fish kept and discarded; fate of target and non-target species; interactions with TEP species; and fishing effort. Further information on the Observer program is available at: <http://www.afma.gov.au/services-for-industry/observer-program/>.

5.3. Fishery Independent Surveys (FIS)

The FIS is an industry-based fishery-independent resource survey which provides a time-series of relative abundance indices for key target species. A FIS has been conducted for Deepwater Flathead and Bight Redfish in the GABTS since 2005, and for key target species in the SESSF since 2008.

Biological and environmental data are collected such as: target species; catch rate (kg/shot); fishing method; and fishing depth. Information which provides a relative abundance index of other main byproduct and incidental catch species is also obtained.

5.4. Data Availability

The ability to meet the objectives of the HSF relies on obtaining the required data in time for stock assessments to be carried out.

Future information and ongoing monitoring requirements are identified through regular reporting from the above monitoring programs, and regular meetings of RAGs which are responsible for overseeing and managing the stock assessment process under the HSF.

6. REFERENCE POINTS AND DECISION RULES

6.1. TAC setting process

The data used for input into the stock assessment process are collected by the ISMP, AFMA logbooks and CDRs and FISs. Otoliths from the biological sampling are provided to a private contractor for ageing. All sampling and age data are provided to stock assessment scientists for analysis or reporting. The analyses are then discussed by RAGs, which produce final stock assessment reports for quota species in the SESSF during October and November each year.

The stock assessment reports provide recommended biological catch (RBC) amounts for each quota species. Each stock is assessed under the appropriate Tier level as advised by the RAGs and SESSFAG.

In mid-December, AFMA produces a position paper with recommended TACs for quota species for the upcoming fishing season, based on the stock assessments and RAG advice. The paper is distributed to interested parties and undergoes a public comment period. For some GAB species, TAC recommendations are conducted according to a pre-agreed set of decision rules, which are associated with the FIS or CPUE and incorporated into the TAC-setting cycle.

In early February, a South East Management Advisory Committee (SEMAC) TAC Setting meeting is held where TAC recommendations are made. The Great Australian Bight Management Advisory Committee (GABMAC) also provides advice on TAC recommendations.

The outcomes of RAGs, SEMAC and GABMAC, together with the AFMA position paper and any public comments received, are then sent to the AFMA Commission to determine TACs for the upcoming fishing season in mid-February. In determining the TACs, the AFMA Commission may provide AFMA with direction in instances where there is concern that current management strategies for depleted or at risk stocks may not meet the objectives of the HSP in a timely manner. The TACs for Bight Redfish and Deepwater flathead are set using the decision rules outlined in section 6.5 under co-management arrangements with the Great Australian Bight Fishing Industry Association.

6.2. Overfishing and reference points

A stock is defined as *subject to overfishing* if the current fishing mortality rate (also known as exploitation rate) exceeds the limit reference point F_{LIM} for a particular biomass value (see Figure 1). F_{LIM} is the fishing mortality rate that would result in a spawning biomass of B_{LIM} (the default proxy for which is B_{20}). The stock is defined as *overfished* if stock levels are below B_{LIM} . B_{LIM} is the point below which there will be no further targeted fishing for that species, and a stock rebuilding strategy will be developed. Refer to section 6.4 regarding the setting of incidental bycatch TACs.

The recommended maximum fishing mortality rate for Tiers 3 and 4 is F_{MSY} (the default proxy for which is F_{40}). This represents the fishing mortality rate that would cause the spawning biomass to decline to its maximum sustainable biomass B_{MSY} (the default proxy for which is B_{40}). The breakpoint, or HCR inflection point, in the overfishing line in Figure 1 occurs at a biomass corresponding to B_{MSY} . If $B < B_{MSY}$ or $F > F_{MSY}$, the TACs should be reduced to limit fishing effort and the fishing mortality rate. For Tier 1, the recommended maximum fishing mortality rate and HCR inflection point occurs at a proxy of F_{35} (see Table 1 and section 6.3).

The target fishing mortality rate F_{TARG} represents the fishing mortality rate that would result in a spawning biomass of B_{TARG} (equal to B_{MEY}). The default value for F_{TARG} is F_{48} , the value of F corresponding to a B_{TARG} of B_{48} . Alternative reference points may be adopted for some stocks to better pursue the objective of maximising economic returns across the fishery as a whole.

The guidelines to the HSP provide that in multi-species fisheries 'MEY applies to the fishery as a whole and is optimized across all species in the fishery. As a result some secondary species (e.g. lower value species) may be fished at levels that will result in their biomass remaining below their target biomass reference point (i.e. B_{MEY}). In such circumstances, the estimated biomass of these secondary species must be maintained above their limit reference point, B_{LIM} . Consideration should also be given to:

- demonstrating that economic modelling and other advice clearly supports such action
- no cost-effective, alternative management options (eg gear modification or spatial management are available)
- the associated ecosystem risks have been considered in full.'

Consideration should also be given to whether the quota species is targeted, its contribution to the value of the fishery, any sustainability concerns and the level of quota latency for that species.

For computational purposes, the target and limit reference points are calculated via a "spawning biomass per recruit" analysis (Reference plus Appendix to be provided). While F_{LIM} is fixed, F_{TARG} will decrease as uncertainty about the assessment increases.

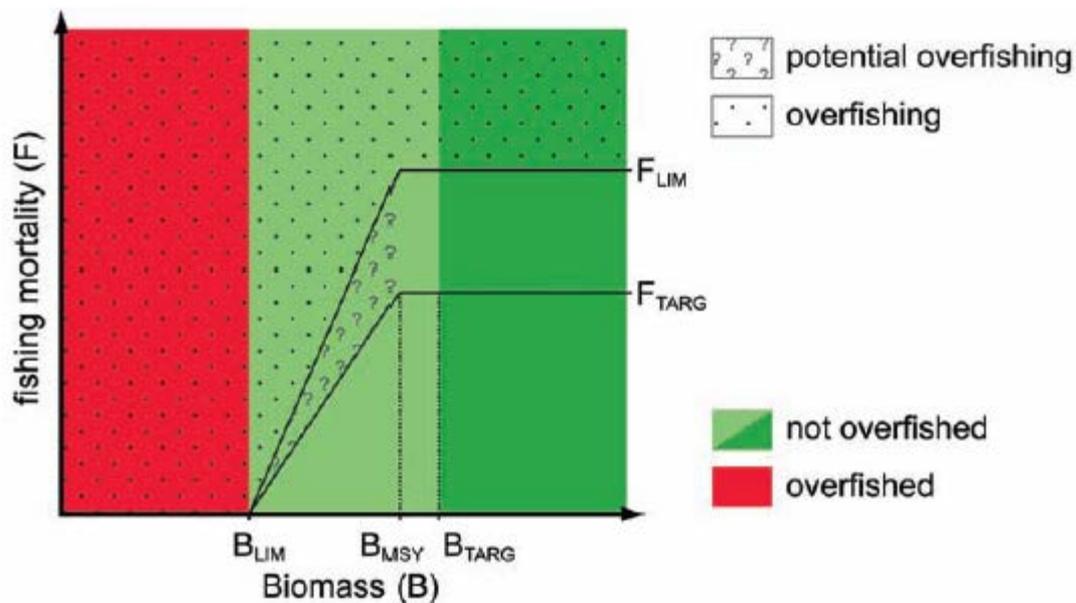


Figure 1. Schematic representation of a harvest control rule, showing key reference points (Source: ABARES Fishery Status Report 2007).

6.3. Determining RBCs using harvest control rules (HCRs)

6.3.1. Tier 1

The Tier 1 HCR applies to species and/or stocks where there is a robust quantitative assessment that provides estimates of current biomass levels (B_{CUR}) and where estimates are available for B_{35} , B_{20} and F_{48} . The formula for calculating F_{TARG} is as follows:

F_{TARG}	Biomass level
$F_{TARG} = F_{48}$	where $B_{CUR} > B_{35}$
$F_{TARG} = F_{48} * (B_{CUR}/B_{20} - 1)$	where $B_{35} > B_{CUR} > B_{20}$
$F_{TARG} = 0$	where $B_{CUR} < B_{20}$

The RBC is calculated by applying F_{TARG} to the current biomass B_{CUR} to calculate the total catch (including discards) in the next year, using the agreed base case assessment model:

$$RBC = \text{Catch}[F_{TARG} \rightarrow B_{CUR}]$$

At Tier 1, $B_{LIM} = B_{20}$, the maximum value for $F_{TARG} = F_{48}$ and the breakpoint in the HCR occurs at B_{35} . Alternative reference points may be adopted for some stocks to better pursue the objective of maximising economic returns across the fishery as a whole.

6.3.2. Tier 3

The Tier 3 HCR applies to species and/or stocks that do not have a quantitative stock assessment, but where estimates of fishing mortality and other biological information are available.

Yield per recruit calculations are used to calculate F values that will reduce the spawning biomass to 20% (F_{20}), 40% (F_{40}) and 48% (F_{48}) of the unexploited level. The relationship given in Figure 2 is then used to assign a value for F_{RBC} using F_{CUR} . This relationship has properties similar to the Tier 1 harvest control rule, with the default proxies of F_{20} as the limit and F_{48} as the target fishing mortality rate.

The following formula, which adjusts the current catch C_{CUR} according to the ratio of the intended and current exploitation rates, is then used to calculate the recommended biological catch C_{RBC} :

$$C_{RBC} = \frac{(1 - e^{-F_{RBC}})}{(1 - e^{-F_{CUR}})} C_{CUR}$$

where F_{CUR} is the estimated current fishing mortality, and F_{RBC} is the selected F for the recommended biological catch from the control rule. The estimate of fishing mortality is limited to be no less than 0.1 of natural mortality.

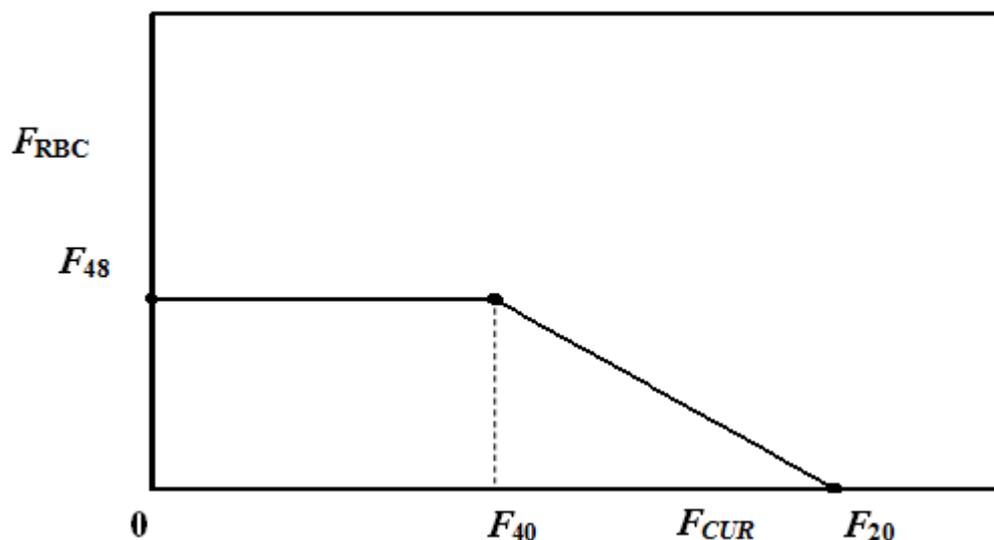


Figure 2. Method for selecting F_{RBC} based on F_{48} target and estimated F_{CUR}

6.3.3. Tier 4

The Tier 4 HCR applies to species and/or stocks where there is no reliable information available on either the current biomass or current exploitation rate. It is assumed that there is information available on current catch levels and trends in catch rates.

The Tier 4 control rule is of the form:

$$RBC = C^* \max\left(0, \frac{\overline{CPUE} - CPUE_{lim}}{CPUE_{targ} - CPUE_{lim}}\right)$$

where:

- $CPUE_{targ}$ is the target catch per unit effort (CPUE) for the species
- $CPUE_{lim}$ is the limit CPUE for the species
- \overline{CPUE} is the average CPUE over the most recent m years
- C^* is a catch target derived from a historical period that has been identified as a desirable target in terms of CPUE, catches and status of the fishery

The form of the rule is shown in Figure 3. Because this linear form can result in large catches at high CPUE levels which could deplete the stock very quickly, a maximum catch level C_{max}

is imposed when the CPUE is above the target level, and the multiplier is set to zero when the CPUE is below the limit.

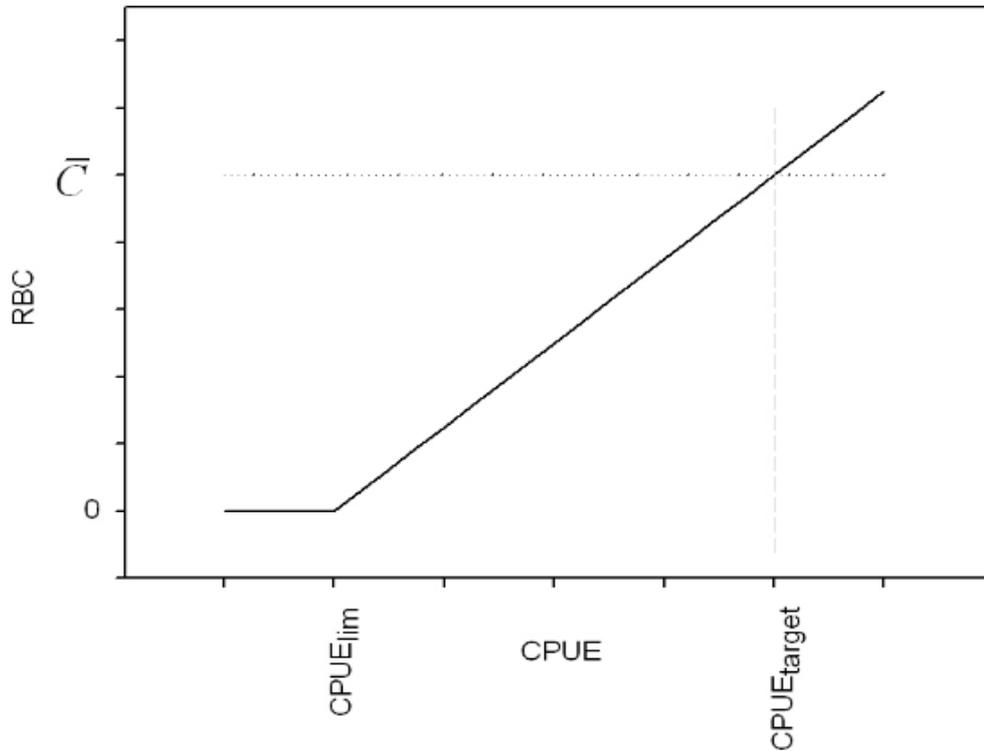


Figure 3. Graphical representation of the Tier 4 harvest control rule. \bar{C} is the average catch over the most recent m years.

6.4. Determining TACs from RBCs

The following metarules are applied to the RBCs that are derived from the application of the Harvest Control Rules. The metarules for discount factors, state catch, discards, research catch allowance and the large change limiting rule are applied in the order below. The other metarules may be applied in the circumstances described. On the basis of the RBCs, TACs may be reduced to support stock recovery and prevent stocks from becoming overfished in the future. Note that the TACs for Bight Redfish and Deepwater flathead are set using the decision rules outlined in section 6.5 under co-management arrangements with the Great Australian Bight Fishing Industry Association.

6.4.1. Discount Factor

Consistent with the HSP, which establishes a more precautionary approach to harvest control rules for species for which assessments are more uncertain, it is considered appropriate to apply a discount factor to the RBCs derived from Tier 3 and 4 assessments. The discount factors to be applied are 5% for Tier 3 and 15% for Tier 4. These values take account of the relative uncertainties in the assessments and reference points at each of these Tier levels.

The application of the rule can be shown as follows:

$$\text{Tier 3:} \quad RBC_{DISC} = RBC \left(1 - \frac{5}{100} \right)$$

$$\text{Tier 4:} \quad RBC_{DISC} = RBC \left(1 - \frac{15}{100} \right)$$

- The application of the discount factor is to be determined on an individual species basis but will be applied unless RAGs advise that alternative equivalent precautionary measures are in place. At its meeting on 4-5 March 2014, SESSFRAG recommended to the AFMA Commission that a discount factor should apply unless: equivalent or additional precaution is provided by other measures, such as but not limited to:
 - spatial closures
 - market controls.

6.4.2. State catch, discards and research catch allowance

Other sources of mortality arising from discarded catch, catch taken by other jurisdictions (e.g. State and recreational sectors) or research catch allowance, are subtracted from the RBC to produce a Commonwealth TAC.

For discards the following formula is used, which weights the discard rate within a stratum according to the size of catches:

$$\bar{D}_{si} = \frac{\sum_{j=1}^k d_{sij}}{\sum_{j=1}^k (d_{sij} + r_{sij})} \times 100$$

where d_{sij} is the discarded catch for species s , stratum i , and trip j , and r_{sij} is the corresponding retained catch. The mean annual discard rate \bar{D}_{si} for species s in stratum i is weighted using SETF logbook retained catches by:

$$\bar{D}_s = \frac{\sum_{i=1}^n \bar{D}_{si} \times L_{si}}{\sum_{i=1}^n L_{si}}$$

where L_{si} is SETF logbook catch for species s and stratum i .

The discard rate for species s is then converted to a discard weight as follows:

$$W_s = \frac{\bar{D}_s / 100 \times C_s}{1 - (\bar{D}_s / 100)}$$

where W_s is the discarded weight for species s and C_s is the total annual Commonwealth landed catch for the species from catch disposal records.

The discarded catch is generally estimated for the following fishing season using a four year weighted average. Discard estimates are weighted in the ratio of 8:4:2:1 for the most recent four years, with most weight given to the most recent year.

State catches are estimated as a simple average of the four most recent years. When estimating State catch, the impact of management changes in State fisheries (e.g. new spatial closures) are to be considered to forecast the State catch in the following year.

Where appropriate, the methods used to estimate future discards and State catches may be varied if an alternative method is expected to provide a more reliable estimate. This may be appropriate if there are management changes in State fisheries.

To ensure consistency between the RBCs derived through stock assessment models and the resultant TAC, where a stock assessment model is used to estimate a future discard rate, this estimate should be used in determining the TAC.

For Gummy Shark, under the Memorandum of Understanding with relevant states, state catches are not deducted from the RBC but a proportion of the RBC is allocated to relevant state sectors.

Research catch allowance is deducted from the RBC as determined by the Commission in accordance with AFMA's *Research Catch and Effort Allowance Policy 2007*.

6.4.3. Latest CPUE Multiplier Rule

This rule is no longer applied.

6.4.4. Large Change Limiting Rule

This rule is designed to limit large changes (up or down) in the TACs from year to year. It is applied last in the sequence of rules and compares the recommended TAC derived after applying the first three rules, with the actual TAC for the previous fishing year.

To limit excessive changes from season to season in the TACs, an override may be applied for some species in setting TACs for the next fishing season, such that the TACs will not change up or down by more than 50% from the previous fishing season where this will not pose a significant risk to stock status. For multi-year TACs, the large change limiting rule may be applied for each year of the period until the RBC is achieved.

6.4.5. Multi-year TACs

Multi-year TACs are to be applied for all Tier 1, Tier 3 and Tier 4 species where suitable. In determining whether a multi-year TAC applies, the following criteria should be considered:

- if the current biomass (BCUR) is higher than the maximum sustainable yield (BMSY) OR if Bcur is below BMSY but higher than the biomass limit (BLIM) and BCUR does not show a decreasing trend over a time period relevant for that species
- if fishable biomass (Tier 1) or a proxy (Tier 3 and Tier 4) can be predicted at an acceptable precision for the multiyear TAC period
- if the fishery is expected to be stable in terms of the level, method and spatial distribution of effort for the multi-year TAC period.

For Tier 1 species, multi-year TACs should be set using Tier 1 assessment projections and probability estimates after considering break out rules.

Multi-year TACs for Tier 3 and Tier 4 species are to be determined on a per species basis by the individual RAGs. Breakout rules for multi-year TACs are to be applied as appropriate to identify fundamental changes from the understanding of the stock at the time of the assessment. Break out rules are to be set having regard to any one or more of the following:

- changes in CPUE (from logbooks and FISs). The CPUE method should be the same as used in the last assessment, either standardised or unstandardised and, if standardised, using the same standardisation parameters as used in the assessment
- changes to economic factors
- changes in total fishing mortality (from total catches, discards, catches in other fisheries or jurisdictions)
- changes in size and age compositions
- interactions with TEP species, for example where a quota species is listed as conservation dependent under the *Environment Protection and Biodiversity Conservation Act 1999* or where catches of a quota species impact TEP species (eg companion species)

- changes to companion species TACs
- changes to abundance indexes derived from FISs.

In setting a multi-year TAC, the multi-year RBC is applied for each year in the period, with updated state catches, discards and research catch allowance to be deducted annually for the purposes of determining the TAC.

6.4.6. Step up or step down TACs

A different TAC to that produced by applying the HCR and the metarules above may be adopted in limited circumstances. This may occur where there is a step up or step down in the TAC to achieve the RBC over a number of years. . A step up or step down TAC may be set to reduce the economic impact of a significant change in RBC and allow fishers time to adjust their operations where the:

- TAC best pursues AFMA's objectives and the objectives of the HSP
- RAG provides advice on the biological risk to the stock of adopting a step up or step down TAC.

6.4.7. Setting a TAC outside the Tier 1 Harvest Control Rule

In some circumstances it may be appropriate to set a TAC different to that produced by the Tier 1 HCR, for example, where the Tier 1 HCR produces a TAC below the incidental bycatch of the species. A TAC different to that produced by the Tier 1 HCR may be set where the:

- stock is estimated to be above B_{LIM} but below B_{TARG}
- probability of the stock being below B_{LIM} , both at the date of the assessment and in future years, is assessed to meet the HSP objective of ensuring that the stock stays above B_{LIM} at least 90% of the time (i.e. less than a 1 in 10 year risk that stocks will fall below B_{LIM})
- relevant RAG considers that the time that the stock is estimated to take to rebuild to B_{TARG} under the proposed TAC is appropriate given the HSP and biology of the stock.

6.4.8. Incidental bycatch TACs where the RBC is zero

Where the RBC is zero, an incidental bycatch TAC may be set after considering:

- the impact of incidental catches on rebuilding of the stock
- non-targeted catch based on:
 - landed catch
 - logbook discards
 - ISMP estimates of discards
- RAG or MAC advice on whether the incidental bycatch TAC should be adjusted to account for any inefficiency in the quota market for that stock
- RAG or MAC advice on their understanding of the level of targeting and the ability of operators to avoid catching the stock
- whether other management arrangements (including those in the relevant Rebuilding Strategy) have been, or are proposed to be, implemented to prevent targeting.

6.4.9. Other Provisions

Other provisions in addition to those above may be considered, including:

- agreed transition rules for TAC setting in the next fishing year, where harvest strategy rules have been revised
- companion species TACs (rules still to be determined).

Table 6 shows the current or suggested Tier levels for species/stocks in the SESSF.

Table 6: Suggested Tier levels for SESSF species and stocks (2011)

Species/stocks	Tier level	Comments
Alfonsino	3	Was assessed as Tier 4 in 2007, than as Tier 3 in 2008 with the availability of ageing data
Blue Eye Trevalla	4	
Blue Grenadier	1	
Blue Warehou	4	
Tiger Flathead	1	For the 2013 assessment, Shelf RAG agreed that the default RBC for tiger flathead is calculated under a 20:35:40 strategy
Eastern Gemfish	1	
Western Gemfish	1	
Jackass Morwong	1	The 20:35:48 harvest control rule was applied in the 2008 assessment
John Dory	4	The first formal assessment was undertaken in 2008
Mirror Dory	3	
Ocean Perch	4	Potentially 3, if additional information on growth and age composition is available
Pink Ling	1	
Redfish	1	Formal quantitative assessments have been conducted in the past, however, have too many uncertainties.
Royal Red Prawn	4	Potentially 3, if size information is available to reflect different growth rates of male and female
School Whiting	1	
Silver Trevally	4	
Spotted (Silver) Warehou	1	
Orange Roughy east	1	
Orange Roughy south	1	
Orange Roughy west	1	

Species/stocks	Tier level	Comments
Orange Roughy Cascade	1	
Bight Redfish	1	
Deepwater Flathead	1	
School Shark	1	
Gummy Shark	1	
Elephant Fish	4	
Saw Shark	4	
Ribaldo	4	
Smooth Oreo	4	
Other Oreo	4	
Deepwater sharks	4	

6.5. GABTS Decision Rules

The GABTS operates under a different set of decision rules to the other sectors of the SESSF. These separate arrangements have been agreed to under co-management arrangements. The FIS and the collection of age and frequency data as well as the monitoring of catch and effort information obtained will be analysed and presented to the RAG each year prior to the date at which a decision on the TAC for the next year is made.

- When the FIS has been conducted in two consecutive years, the catch rates from the first leg of the survey will be the indicator of abundance used to make any adjustment to the default TAC.
- In a year when the FIS has not been conducted in two consecutive years, the standardised commercial catch rate for the period July to February inclusive is the indicator of abundance used to make any adjustment to the default TAC.
- If there is a change of $\geq 20\%$ to the indicator of abundance, a 10% (increase or decrease) to the default TAC will occur.
- If the RAG is concerned with any indicators over the period between stock assessments (length frequency distributions, standardised commercial catch rates, age distributions etc.), then it can decide to undertake a full assessment in that year.
- Multi-year TACs have been agreed to using the same rules outlined in section 6.4.5.

The GABTS has a development strategy for species not currently under a TAC, with actions occurring at specified catch triggers (**Appendix 1**). This strategy is designed to improve the data collected and the knowledge of these species as catch increases.

- The initial catch triggers (set at 400 t for blue grenadier and gemfish, and 100 t for pink ling, blue-eye trevalla, ribaldo and hapuku) require data collection and analysis, and the development of an assessment plan.
- Exceeding the second trigger level requires that fishing for that species cease.

- The third trigger level applies to total catches across the three most recent years and requires a formal stock assessment.

6.6. Evaluation of reference points and decision rules

The HSF expresses the objectives of the Harvest Strategy in the form of quantifiable reference points based on the HSP. These reference points are used to guide management decisions, which are pre-agreed actions linked directly to the status of the fishery relative to those reference points.

The reference points and harvest control rules have been tested and refined through a management strategy evaluation (MSE) project conducted by CSIRO during 2006 and 2007. The MSE evaluated the choice of targets and thresholds for all Tier levels of the HSF. A key result of the project was improvements to the Tier 3 and Tier 4 rules, which now have well defined target harvest levels analogous to those used in the Tier 1 assessments for the major commercial species, recognising that Tier 3 and Tier 4 assessments are based on less information than Tier 1.

A copy of the final report “Evaluation of new harvest strategies for SESSF species” is available at:

<http://www.afma.gov.au/wp-content/uploads/2010/06/HSE-AFMA-Report-June20091.pdf>.

Currently, climate change is not explicitly considered in the HS. However, changes in the status, composition and population dynamics of the stock is reflected in the data collected – for example, age and length frequencies, catch and effort, stock recruitment, mortality and biomass data and trends.

Both biological and economic targets have been explicitly considered in developing the reference points and decision rules. However, while biological indicators and parameters have been included, economic indicators and parameters are still under development.

Evidence that the decision rules will maintain or move the stock to the biomass targets (or equivalent proxy) within a reasonable timeframe, and that the HSF will ensure that the stocks stay above the limit biomass level (or equivalent proxy) at least 90% of the time, have been provided by MSE testing.

For stocks below B_{LIM} , rebuilding strategies have been implemented in accordance with the HS. The strategies outline measures for rebuilding the stocks to above B_{LIM} (or equivalent proxy), and then additional measures to rebuild the stocks to B_{TARG} (or equivalent proxy) and monitor and maintain the stocks at the target level. The rebuilding strategies include an objective to ensure that the stocks stay above the limit biomass level (or equivalent proxy) at least 90% of the time.

7. REVIEW

Under certain circumstances, it may be necessary to amend harvest strategies between reviews. These circumstances may arise if:

- there is new information that substantially changes the status of a fishery, leading to improved estimates of indicators relative to reference points; or
- drivers external to management of the fishery increase the risk to fish stock/s; or
- it is clear the strategy is not working effectively and the intent of the HSP is not being met.

Further explanation can be found in section 15 of the HSP Guidelines. The consultative and technical processes for amending harvest strategies are set out in the HSP Guidelines in section 2.5.

The SESSF Harvest Strategy Framework underwent a management strategy evaluation (MSE) by CSIRO in 2006-2007. The project identified problems with the initial implementation of the HSF, developed improvements to the TAC setting procedures, and

then tested these using the MSE approach. A MSE procedure was developed and used to test each Tier rule of the HSF.

A final report on the outcomes of the MSE was produced in 2009, entitled "Evaluation of new harvest strategies for SESSF species". Key outcomes of the project were:

- a discussion paper with nine recommendations for modifications to the HSF
- demonstration that the HSF is consistent with, and meets the requirements of, the Commonwealth Harvest Strategy Policy
- demonstration that the Tier 1 rule achieves its aims for a range of species with differing life histories
- improvements to the Tier 3 and Tier 4 harvest control rules. The revised rules were presented to and approved by the RAGs during 2008, and applied (where appropriate) to setting the RBCs for 2009
- an evaluation of proposed rules for changing the TAC in response to the most recent year's catch per unit effort (CPUE).

The MSE testing framework developed in the project is available for further testing of any future proposed revisions to elements of the HSF.

8. APPENDIX

8.1. GABTS Trigger limits

SPECIES	TRIGGER TO COLLECT BIOLOGICAL DATA	TRIGGER FOR DATA COLLECTION AND DEVELOPMENT OF ASSESSMENT PLAN	CEASE FISHING FOR THAT SPECIES	COMMENCE STOCK ASSESSMENT
Gemfish	Currently collected	400t	500t/year	1000t/3 years
Blue Grenadier	Currently collected	400t	500t/year cease fishing. If a spawning aggregation is found, trigger an acoustic survey (500t) and operator collects 100 whole fish.	1000t/3 years
Ling	Currently collected	100t	250t	250t
Blue-eye Trevalla	Currently collected	100t	250t	–
Ribaldo	Currently collected	100t	250t	–
Hapuka	Currently collected	100t	250t	–
Gulper sharks	Code of practice by industry to not target these species in addition to area closure.	–	2t	–
Deepwater sharks (Black/Brier)	Code of practice by industry to not target these species in addition to area closure.	–	–	–
Chinamen Leatherjacket	Management measures on Bight Redfish and Deepwater Flathead influences catch.	–	–	–
Angel Shark	Management measures on Bight Redfish and Deepwater Flathead influences catch.	–	–	–
Jackass Morwong	Management measures on Bight Redfish and Deepwater Flathead influences catch.	–	–	–