



Australian Government

Australian Fisheries Management Authority



Orange Roughy (*Hoplostethus atlanticus*) Stock Rebuilding Strategy

2014

Executive Summary

This *Orange Roughy Rebuilding Strategy 2014* (the Strategy) replaces the *Orange Roughy Conservation Program 2006* (ORCP). The objective of the ORCP was to conserve Orange Roughy to ensure its long term survival in nature and recover the species to ecologically sustainable levels.

Recognising progress made under the ORCP, the primary objective of this Strategy is to return all Orange Roughy stocks to levels where they can be harvested in an ecologically sustainable manner consistent with the *Commonwealth Fisheries Harvest Strategy Policy 2007* (HSP) and ultimately maximise the economic returns to the Australian community.

The Eastern Zone Orange Roughy stock was re-assessed in 2014. The results indicate that stock has rebuilt to a level of about 25 percent of the unfished biomass, above the level where a rebuilding strategy would usually be required.

In line with, and guided by HSP, management actions set out in this Strategy maintain low fishing mortality to support rebuilding while continuing to monitor and assess the stocks. This will be done through:

- deep water closures within the Southern and Eastern Scalefish and Shark Fishery (SESSF) to protect on Orange Roughy and some other deep water species while providing access and flexibility to industry for species that are commercially sustainable
- allowing targeted fishing for Orange Roughy stocks that are above the limit reference point of 20 per cent of the unfished spawning biomass
- restricting effort by limiting entry to existing fisheries. This means that no new fishing concessions are created and, in order to fish in a fishery, an existing concession must be leased or purchased
- research and monitoring to support stock assessments and to ensure the Strategy meets its objectives.

The Slope Resource Assessment Group (SlopeRAG) annually reviews Orange Roughy stocks and recommends biologically appropriate catches based on the most recent stock assessment and fishing mortality information. This Strategy will be reviewed by AFMA, in consultation with SlopeRAG, Great Australian Bight Resource Assessment Group (GABRAG), South East Management Advisory Committee (SEMAC) and Great Australian Bight Management Advisory Committee (GABMAC) after five years.



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Introduction

This *Orange Roughy Rebuilding Strategy 2014* (the Strategy) outlines measures to rebuild stocks of Orange Roughy occurring in the SESSF.

This Strategy replaces the ORCP which was implemented in 2006 when Orange Roughy was listed as 'Conservation Dependent' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A listing in this category means that a fish species is 'the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long-term survival in nature are maximised'.

Accordingly, in line with the EPBC Act the objective of the ORCP was to conserve Orange Roughy to ensure its long term survival in nature and recover the species to ecological sustainable levels. Recognising the progress made under the ORCP, the primary objective of this Strategy is to return all Orange Roughy stocks to levels where they can be harvested in an ecologically sustainable manner under the *Commonwealth Fisheries Harvest Strategy Policy 2007* (HSP) and ultimately maximise the economic returns to the Australian community.

When last reviewed by Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), the biomass of Orange Roughy was below its limit reference point (20 per cent of unfished biomass) in the Southern and Western Zones and South Tasman Rise, uncertain in the Eastern Zone and Great Australian Bight (GAB), and above its target reference point (60 per cent of unfished biomass) on the Cascade Plateau. Consequently, the *ABARES Fishery status reports 2013-14* (Georgeson et al. 2014) classified Orange Roughy as **overfished** in the Southern and Western Zones and South Tasman Rise; **uncertain if overfished** in the Eastern Zone and GAB; and **not overfished** on the Cascade Plateau. However, because of existing management arrangements, all zones were classified as **not subject to overfishing**. Note the Eastern Zone stock has been subsequently assessed as being above the limit reference point.

Objectives

The primary objective of this Strategy is to rebuild Orange Roughy stocks to levels where they can be harvested in an ecologically sustainable manner consistent with the *Commonwealth Fisheries Harvest Strategy Policy 2007* (HSP) and ultimately maximise the economic returns to the Australian community.

Specific objectives of the Strategy¹ are:

1. to rebuild Orange Roughy stocks (except Eastern Zone and Cascade Plateau that are assessed as having rebuilt) in the area of the SESSF to the limit reference biomass point (B_{LIM}) of 20 per cent of the unfished spawning biomass within a biologically reasonable time frame; being one mean generation time (56 years) plus 10 years (66 years) from the start of the ORCP. That is, to reach B_{LIM} by no later than 2072;

¹ The limit and target reference points for managing Orange Roughy stocks were recommended by SlopeRAG at its meeting on 30 October 2014. The reference points are consistent with the default reference points in the *Commonwealth Fisheries Harvest Strategy Policy 2007*.



2. having reached B_{LIM} , rebuild these stocks to the maximum sustainable yield biomass level of 40 per cent of the unfished spawning biomass (B_{MSY}) using the harvest control rules outlined in the SESSF Harvest Strategy Framework. These harvest control rules provide for a restricted TAC to allow limited fishing whilst rebuilding from B_{LIM} to B_{MSY} ; and
3. once B_{MSY} is reached, pursue the default maximum economic yield biomass level of 48 per cent of unfished spawning biomass (B_{MEY}).

Background

Stock distribution and structure

Orange Roughy is a deepwater fish widely distributed in southern Australian waters from New South Wales, south around Tasmania and west to southern Western Australia. The species also occurs off New Zealand, southern Africa and in the Atlantic Ocean and Mediterranean Sea.

Orange Roughy mainly occur between the depths of 700-1400 m where the water temperature is cold. They form dense spawning and feeding aggregations over rugged topographic features such as the edge of the continental shelf and seamounts. They can also disperse more widely over smooth and rough bottom. The species is benthopelagic, generally occurring on the bottom but at times rising 50-100 m off the bottom to feed or spawn (Kailoloa et al. 1993, Branch 2001, Gomon et al. 2008).

The stock structure of Orange Roughy in Australian waters is uncertain. A recent genetic study (Goncalves da Silva et al. 2012) found low but statistically significant genetic differences between stocks from the North Atlantic, western Africa, Chile and Australia/New Zealand. However, within Australian waters only low levels of genetic differentiation were found suggesting that Australian Orange Roughy form a single genetic stock. However loci were found to have signatures of natural selection suggesting three separate areas: Albany/Esperance; Hamburger Hill (in the GAB); and south-eastern Australia. There were no meaningful divisions found within the south east Australian stock.

However, the authors point out that genetics is not the sole determinant of stock structure and the results do not resolve the question of whether the locations in question are demographically isolated. It was noted that the amount of genetic exchange needed to maintain genetic homogeneity is much less than the amount needed to have demographic homogeneity, and that residency or slow migration may result in separate demographic units despite genetic similarity (Morison et al 2013). The available evidence suggests that fish from the eastern and western coasts of Tasmania appear to be distinct from each other, and from those on the Cascade Plateau and South Tasman Rise (Hordyk, 2009)

Genetically similar stocks can still be demographically separate and may require separate management (Goncalves da Silva et al. 2012, SlopeRAG 2013b, Prince and Hordyk 2009). Accordingly, within the SESSF Orange Roughy are managed in nine zones (Figure 1 and Figure 2):

1. Eastern Zone (Commonwealth South East Trawl Sector (SET) - quota)
2. Cascade Plateau (SET - quota)
3. Southern Zone (SET - quota)
4. Western Zone (SET - quota)



5. Southern Remote Zone (SET)
6. North-eastern Remote Zone (SET)
7. South Tasman Rise (SET)
8. East Coast Deepwater Trawl Zone (ECDWT)
9. GAB: far west, west, central west, central east, east.

Life history

Orange Roughy is a high-value, deep water fish that occurs in southern Australian waters, often associated with steep topographical features such as seamounts. The species underwent significant decline during the early to mid-1990's as a result of heavy fishing pressure by demersal trawl operators.

Orange Roughy are slow growing to a maximum size of ~ 50 cm (Gomon et al. 2008), slow to mature (~ 30 years), have a mean generation time of about 56 years (J. Upston, pers. comm.) and long lived (> 100 years) (Kailola et al. 2003). They are synchronous spawners (Pankhurst et al. 1987) with spawning events occurring annually although individuals may not spawn every year (Bell et al. 1992). Males appear to spawn over a 1-2 week period and females spawn for up to one week producing between 10 000 and 90 000 large (2.0 – 2.5 mm diameter) eggs (Pankhurst et.al. 1987).

These traits, combined with the predictability of spawning events in both space and time, make this species particularly vulnerable to overfishing.

Key threats to recovery

The key threat to the recovery of Orange Roughy stocks in Australian waters is commercial trawl fishing in the SESSF.

Orange Roughy is primarily caught in the SESSF by the otter trawl method between 700 metres and 1200 metres. Most fishing occurs on winter spawning grounds (mid-July to late August), but fishing can also occur during the summer months when Orange Roughy disperse more widely across flat bottom and mix with deep water sharks and Oreo species.

The first substantial quantities of Orange Roughy were taken in the late 1980's with the discovery of large aggregations off western Tasmania and western Victoria. Catches increased significantly in 1989 with the discovery of a large spawning aggregation at St Helen's Hill, a seamount off eastern Tasmania, and other non-spawning aggregations in waters adjacent to Maatsuyker and Pedra Branca Islands off southern Tasmania. The reported catch of Orange Roughy peaked in 1990 at around 50 000 tonnes with large quantities estimated to have been unreported (Hordyk 2009, SlopeRAG 2011).

In the early 1990's, catch limits and individual transferable quotas were implemented followed by a formal harvest strategy in 1994. The intent of the harvest strategy was to maintain the biomass above 30 per cent of pre-1988 levels. If the stock fell below 30 per cent it was to be rebuilt to this level by 2004. Despite the Total Allowable Catch (TAC) being sequentially reduced to rebuild stocks, operators could not catch the TAC and the TAC reductions failed to halt the decline in biomass.



In 2006, with the implementation of the ORCP, the SESSF was closed to targeted Orange Roughy fishing except on the Cascade Plateau where the stock remained above the Cascade Plateau target biomass of 60 per cent of unfished levels.

Orange Roughy has also been caught in the Commonwealth-managed Western Deepwater Trawl Fishery off the coast of Western Australia. However, apart from what appears to be a one-off large catch of 150 tonnes in 2001, annual catches are generally less than 4 tonnes with no catch reported since 2005. An annual catch limit of 100 tonnes currently applies.

Status of resource

Recovery of the stock may be impacted by changes in the proportion of fish spawning annually and by changes in their reproductive potential. Orange Roughy do not mature until approximately 28 years of age so recruitment would have remained at pre-fishery levels for many years after fishing commenced. Current recruitment is from the Orange Roughy stock prior to commercial fishing commencing in the late 1980s and is the main factor in the relatively rapid rebuilding of the Eastern Australian stock. This same factor should have helped other Australian stocks to rebuild. However due to the relatively short history of Orange Roughy fisheries it is unclear what the effects of commercial fishing will be on future recruitment to the fishery.

Orange Roughy are very-long lived and so their populations will naturally be resilient to long periods of low recruitment. Conversely, the great longevity and low natural mortality of Orange Roughy indicate that even relatively low levels of fishing pressure are likely to lead to stock declines, which will affect future recruitment. Surveys have shown an increase in reproductive capability following declines in the stocks (Koslow et al. 1995, Pitman et al. 2013) and there may also be changes to growth rates and age at maturity that act to rebuild stocks faster than would otherwise be predicted.

Orange Roughy aggregate to spawn and such aggregations are targeted by fisheries. Orange Roughy exhibit an avoidance reaction to trawls and other towed objects and fishing may therefore disrupt spawning behaviour and reduce future recruitment to an extent that is underestimated by the reduction in biomass. The stock-recruitment relationship for Orange Roughy (like most species) is poorly known. Steepness is assumed to be 0.75 but if this is higher than the true value, recruitment would have been reduced by more than the amount predicted in assessments.

Orange Roughy is assessed as being above its limit reference point of 20 per cent of unfished biomass in the Eastern Zone (Upston and Punt, 2014), below its limit reference point in the Southern and Western Zones and South Tasman Rise, uncertain in the GAB, and above its target reference point (60 per cent of unfished biomass) on the Cascade Plateau. Consequently, the *ABARES Fishery status reports 2013-14* (Georgeson et al. 2014) classified Orange Roughy as overfished in the Southern and Western Zones and South Tasman Rise; uncertain in the Eastern Zone² and GAB; and not overfished on the Cascade Plateau. However, because of existing management arrangements, no zone is considered subject to continued overfishing. Table 1 provides a summary of stock status by zone.

² The ABARES assessment of the Eastern Zone occurred prior to the completion of the most recent stock assessment showing that it has rebuilt to 26% of unfished biomass.



Eastern Zone

Since 2006, four acoustic surveys have been conducted in the St Patricks and St Helens Hill areas off eastern Tasmania, most recently in 2013. These surveys aim to estimate the size of the spawning stock in the Eastern Zone and assess changes in the biology of the species including age, length, weight and spawning potential. An attempt to update the stock assessment in 2011 was not successful because of conflicting signals from available data.

In 2014, an updated quantitative stock assessment was prepared which incorporated results from the recent Acoustic Optical Survey in 2013. The assessment estimated that the female spawning biomass in 2015 has rebuilt from previous low levels and is between 23 percent and 28 percent (median estimate 26 percent) of the unfished biomass (Upston et al. 2014). The stock structure hypothesis used in the 2014 base case model is the same as that specified in the 2006 and 2011 base case models, i.e. combined stock from the Eastern Zone and Pedra Branca area in the southern zone.

Cascade Plateau

Cascade Plateau is managed as a separate zone. It was previously suggested that there may be some mixing between the Cascade and south-east populations during larval and juvenile stages³ and that the Cascade Plateau may have played a role in recovery of depleted populations⁴. For this reason, a target reference point of 60 per cent of unfished biomass was adopted for this stock under the ORCP. At its December 2014 meeting, the Slope Resource Assessment Group (SlopeRAG) noted there was no scientific evidence that a separate target was appropriate for the Cascade stock and recommended the HSP proxy be adopted, that is, 48 per cent of unfished biomass.

The last formal stock assessment for Orange Roughy on the Cascade Plateau was in 2009 using revised data to 2005. Based on this assessment the biomass of Orange Roughy in 2011 is estimated to be at 63 per cent of unfished levels. SlopeRAG has advised that, due to recent low effort and limited data, it is unlikely that a new stock assessment can be undertaken until effort increases. Due to low fishing effort it is unlikely that the stock has declined to below 60 per cent of unfished biomass. This stock is classified in the *ABARES Fishery status reports 2013-14* (Georgeson et al. 2014) as not overfished and not subject to overfishing.

Southern Zone

The last formal stock assessment for the Southern Zone in 2000 estimated the biomass to around 7 per cent of 1989 levels. The 2004 and 2006 updates of abundance indices and observations of possible spawning aggregations (from acoustic surveys) indicated that rebuilding may be occurring. Catches are extremely low therefore overfishing is unlikely to be occurring. This stock is classified in the *ABARES Fishery status reports 2013-14* (Georgeson et al. 2014) as overfished but not subject to overfishing.

Substantial portions of the two main historical catching areas in the Southern Zone are now within Commonwealth Marine Reserves. Future research and monitoring in the Southern Zone is likely to be informed by work on the stock structure of the Eastern Zone.

³ ORCP page 7.

⁴ ORCP page 2.



Western Zone

The last updated stock assessment for the Western Zone was in 2002. This assessment estimated the biomass had a 50 per cent chance of being less than 30 per cent of the biomass that existed in 1985. This stock is classified in the *ABARES Fishery status reports 2013–14* (Georgeson et al. 2014) as overfished but not subject to overfishing.

Southern Remote Zone

There are no known spawning aggregations in the Southern Remote Zone. Catches have been low and there is no stock assessment for Orange Roughy in this area. This stock is not classified in the *ABARES Fishery status reports 2013–14* (Georgeson et al. 2014).

North East Remote Zone

There are no known spawning aggregations in the North East Remote Zone. Catches are very low with the highest recorded catch since 1998 being 78 tonnes in 2003. There is no stock assessment for Orange Roughy in this area and the stock is not classified in the *ABARES Fishery status reports 2013–14* (Georgeson et al. 2014).

South Tasman Rise

The South Tasman Rise (STR) is an undersea ridge that extends south of Tasmania and into the Southern Ocean, straddling the Australian Fishing Zone and the high seas. In 2000 Australia established a Memorandum of Understanding (MOU) with New Zealand to manage the STR cooperatively. This MOU expired in 2007 and the STR is current closed to fishing both within the Australian Fishing Zone and on the high seas.

The STR Orange Roughy fishery began in 1997. It has been anecdotally reported that very large catches were taken by illegal vessels in 1999 but very little catch was taken in subsequent years. An assessment in 2003 of the STR fishery indicated the original stock was not large and had been reduced dramatically since 1997 although no biomass estimates are available. No assessment work has been done on the STR Orange Roughy population since the fishery was closed and the current biomass and population trends are unknown. This combined with less than 10 per cent of the TAC being taken in years when fishing was permitted (2001-2006), lack of spawning aggregations and the life history of Orange Roughy resulted in a classification of overfished in the *ABARES Fishery status reports 2013–14* (Georgeson et al. 2014). However, given the fact the STR is currently closed, it is not classified as subject to overfishing.

The East Coast Deepwater Trawl Sector

Limited fishing has occurred in this fishery; some exploratory fishing for Orange Roughy was undertaken during the early 1990's, mainly around the Lord Howe Rise. In 2003, 300 kg of Orange Roughy was reported with zero catch since then. There is no stock assessment for Orange Roughy in this area and the stock is not classified in the *ABARES Fishery status reports 2013–14* (Georgeson et al. 2014).

Great Australian Bight Trawl Sector (GABT)

There is no formal stock assessment for Orange Roughy in the GAB because catches and consequently data are sporadic and spatially scattered (Knuckey et al. 2010). Since 1990 catches have primarily come from the Albany/Esperance area with catches peaking in 1993 at 425 tonnes off Albany, and in 1999 at 650 tonnes off Esperance. No large aggregations have



been reported since 1990 and the species is believed to have declined in the GAB as it had in other parts of the SESSF (Woodhams et al. 2011). Orange Roughy in the GAB is classified in the *ABARES Fishery status reports 2013–14* (Georgeson et al. 2014) as uncertain but, however, due to zero catches and area closures under the GABT Deepwater Management Strategy (GABIA 2007a), is not subject to overfishing.

Rebuilding timeframes

The guidelines to the HSP recognise that there are a number of alternative time paths to rebuild a stock and that in determining the appropriate time to rebuild a stock, consideration should be given to the loss in profits in the short term and the speed at which the stock should be rebuilt to B_{MEY} .

The guidelines provide that typically recovery times are the minimum of:

- the mean generation time plus 10 years; or
- three times the mean generation time.

Recognising the biology of Orange Roughy, Management Strategy Evaluation of harvest control rules (see below under Monitoring and Evaluation) and the timeframe required for management measures to take effect, this Strategy has adopted the rebuilding timeframe to the limit reference point of one mean generation time plus 10 years. With a mean generation time of 56 years, the objective of this Strategy is to rebuild all stocks to the limit reference point within 66 years from the commencement of management measures under the ORCP (2006), that is, by or before 2072.

Management actions to achieve the objectives

Management arrangements implemented under the ORCP and continuing under this Strategy fit into five broad categories.

1. Catch limits - Targeted fishing for Orange Roughy has been prohibited in the SESSF, excluding the Cascade Plateau, since 2006. Consistent with the HSP, targeted fishing will not re-commence for a stock until it is at least above its limit reference point.

TACs in the Southern, Eastern, Western and GAB Zones are set at levels which cover the minimum incidental catch while targeting other species. For the 2015/16 season, the incidental TACs for these zones have been set at: 31 tonnes Southern zone; 60 tonnes Western Zone; and 50 tonnes Albany/Esperance (GABT). Catches have remained below the incidental TACs primarily because many areas where Orange Roughy are targeted are closed to fishing (see below).

A commercial TAC of 500 tonnes has been set for the Cascade Plateau for the 2015/16 season.

Catch limits for the Eastern Zone and Pedra Branca area in the Southern Zone have been changed for the 2015/16 season as these areas will be re-opened for commercial fishing. Management arrangements for these areas are outlined below.



2. Closures - Spatial closures have been implemented in deep water areas within the SESSF except where targeted Orange Roughy fishing is allowed or specific management arrangements are in place to target other deep water species.
3. Effort restrictions - Limiting entry to existing fisheries by not granting any new fishing concessions. This means that to fish in a fishery, an existing concession must be leased or purchased
4. Reporting and monitoring – Catches are reported by operators and monitored by AFMA in accordance with the logbook provisions of the fishery. Catch, discard and ageing data are collected through AFMA's observer program and Acoustic Optical Surveys.
5. Assessment – Conducting stock assessments under the SESSF Harvest Strategy Framework. The stock assessment for the Eastern Zone is being updated in 2014.

Eastern Zone and Pedra Branca

The 2015/16 TAC for the Eastern Zone is 465 tonnes. The TAC for the whole Southern Zone is 66 tonnes of which 35 tonnes will apply to the Pedra Branca area leaving 31 tonnes incidental catch for the remainder of the Southern Zone.

Management arrangements that will apply to the Eastern Zone and Pedra Branca areas in 2015/16 include:

1. real time monitoring of fishing on aggregations using 100 percent observer coverage during the peak winter spawning period
2. minimum quota holdings to enter and remain fishing during the peak winter spawning period
3. accounting for all Orange Roughy taken, including discards
4. stop fishing trigger limits and undercatch provisions on quota that minimise the incentive to fish to the limit of quota holdings thereby reducing the risk of catching more than the TAC.

South Tasman Rise (STR)

The STR is currently closed to fishing by Australian boats within the Australian Fishing Zone. The STR is also currently closed to fishing by Australian and New Zealand boats on the high seas under the measures of the South Pacific Regional Fisheries Management Organisation (SPRFMO).

Great Australian Bight

The current arrangements for Orange Roughy in the GAB include:

- no commercial targeting of Orange Roughy in the GAB unless an accepted stock assessment is in place and the objectives of this Strategy are met
- nine spatial closures over recognised Orange Roughy seamounts: Albany; Bremmer; Humdinger West; Humdinger / Magic; Lomvar Gully; United Nations; The Knob;



Racetrack /Hamburger; and Kangaroo Island Hill. These areas have produced 90 per cent of historical catch in the GAB (see Figure 2 below)

- for areas outside the closures and outside the Albany and Esperance quota zones, an incidental catch trigger of 10 tonnes per deepwater management zone: far west; west; central west; central east; and east (see Figure 2 below), applies. If catches of Orange Roughy in any zone exceed the bycatch TAC or trigger limit, management measures to cease all catches of Orange Roughy will be implemented.
- a TAC 50 tonnes has been set to cover incidental catches in the Albany and Esperance quota zones. This has been set based on the GAB Resource Assessment Group's advice that incidental take of this amount would present little risk to the stock.

Commonwealth Marine Reserves

The Department of Environment is responsible for the implementation of marine protected areas and, while not an AFMA process, marine reserves have been implemented on the South Tasman Rise, in the Southern Remote Zone and in the GAB that close large areas to demersal trawling.

Monitoring and evaluation

Stock assessments and data collection

Stock assessments monitor stock status and the recovery of Orange Roughy. Not all areas are assessed because of limited fishing effort, catch data and costs of assessment. For example, acoustic surveys can provide indices of abundance for Orange Roughy and are a key source of data for stock assessments in the Eastern Zone and Cascade Plateau. However, to be effective, the surveys require information on spawning aggregations collected by fishermen. Therefore, their use is limited to only some areas within the Australian Fishing Zone where aggregations are reasonably well known.

Eastern Zone

An updated quantitative stock assessment for the Eastern Zone was completed for AFMA in 2014. Following the assessment, SlopeRAG is responsible for providing advice on the ongoing monitoring program for this zone.

Management Strategy Evaluation

Management Strategy Evaluation (MSE) tests harvesting rules to ensure they meet management objectives.

In 2009 an MSE model was developed for the SESSF and the Tier 1 harvest control rules from the SESSF Harvest Strategy Framework were tested for three types of species: a short-lived, highly productive species with high recruitment variability (whiting); a very long-lived species with low natural mortality (Orange Roughy); and a species between these two extremes (flathead) (Wayte 2009). The MSE demonstrated that the control rules implemented in the SESSF Harvest Strategy Framework are consistent with the requirements of the HSP. In the MSE completed in 2009, recovery of the Eastern Zone stock to the limit reference point was predicted to occur before 2030, while recovery to the target level took almost 70 years. The MSE suggested recovery would slow for a period after 2030. This was attributed to the



reduction in spawning biomass due heavy fishing and subsequently lowered recruitment up to 1990, and the MSE assumption of the age at which 50 per cent of fish mature of 38 years.

Research / future work

A number of research needs were identified during a workshop held in May 2014.

- Develop and document criteria for the selection of acoustic survey biomass estimate snapshots that are suitable to be used in the stock assessment model for the Eastern Zone.
- Improve ageing estimates. A change in the otolith (transition zone) occurs when Orange Roughy reach sexual maturity. A key question for the accuracy of the age estimates is how the transition zone has been identified. The workshop recommended that 1000 Eastern Zone otoliths are re-aged to determine if errors in identifying the transition zone are apparent.
- Document the provenance of otoliths.
- Investigate if the current age groups used in the model are appropriate or should be extended.
- Consider alternative harvest strategies for Orange Roughy accounting for the biology of the species.

Integrated Scientific Monitoring Program (ISMP)

The ISMP is a data collection program which places observers on commercial fishing vessels to collect independent and verifiable information on fishing operations, catch and discards in the SESSF. The program has provided information on the quantity, size and age composition of quota species, including Orange Roughy, caught in some sectors of the SESSF since 1994. The data is then used to monitor the status of fish stocks and set sustainable TACs.

The sampling design of the ISMP was reviewed in 2009 (Bergh et al. 2009) and updated in 2014 to ensure that data collection is representative of fishing effort and supports AFMA's ecosystem-based approach to fisheries management. The new sampling regime was implemented on 1 July 2014.

Electronic monitoring systems (cameras and sensors) have been in use in the SESSF gillnet sector since 2010 and have proven effective at monitoring catch and detecting threatened, endangered and protected species bycatch events. The systems automatically record fishing activity as the catch is brought on board. AFMA is investigating the capability of the systems for use in the Commonwealth Trawl Sector, including whether it is possible for the systems to provide estimated size and species composition of catch.

EPBC Act and reporting to the Department of the Environment

AFMA reports annually on the status of Orange Roughy and performance against the objectives of this Strategy to the Department of Environment. AFMA also reports on the level of observer coverage and industry compliance with this Strategy.



Reviewing the Strategy

SlopeRAG annually reviews Orange Roughy stocks and recommends biologically appropriate catches based on the most recent stock assessment and fishing mortality information.

This Strategy will be reviewed by AFMA, with input from SlopeRAG and South East Management Advisory Committee (SEMAC), every five years.

Impacts of the Strategy

Consultation

This Strategy has been developed with the assistance of:

- the Department of Agriculture and the Department of the Environment
- SlopeRAG, GABRAG, SEMAC and GABMAC. Membership of MACs and RAGs includes industry, scientific, government, environmental and recreational representatives
- the South East Trawl Fishing Industry Association (SETFIA), the Great Australian Bight Industry Association (GABIA) and individual operators
- key stakeholders including environmental non-government organisations, recreational fishers and the public through AFMA's website.

Economic impact

The main costs associated with the recovery process for Orange Roughy are from monitoring, research and the stock assessment process. There has been an additional cost to industry in terms of lost catch because of the closures implemented. However, these costs may be outweighed in the longer term from catches once Orange Roughy stocks have rebuilt and commercial fishing can re-commence.

Management costs are apportioned between industry and the Australian Government under AFMA's Cost Recovery Impact Statement (CRIS) which reflects the Australian Government's Cost Recovery Guidelines.

Environmental impacts

Environmental impacts from the implementation of this Strategy are anticipated to be positive. The broad objective of the Strategy of returning Orange Roughy stocks to ecologically sustainable levels is consistent with the threat abatement and recovery of the species.



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Southern and Eastern Scalefish and Shark Fishery

Orange Roughy Zones

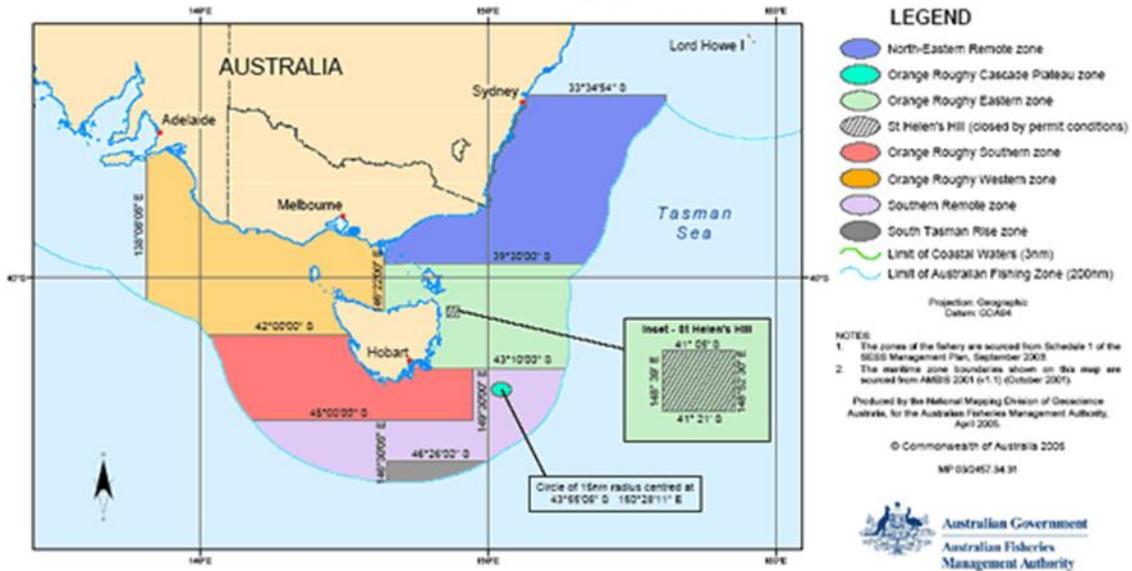


Figure 1: Map of Orange Roughy Zones in the South East Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery and the South Tasman Rise.

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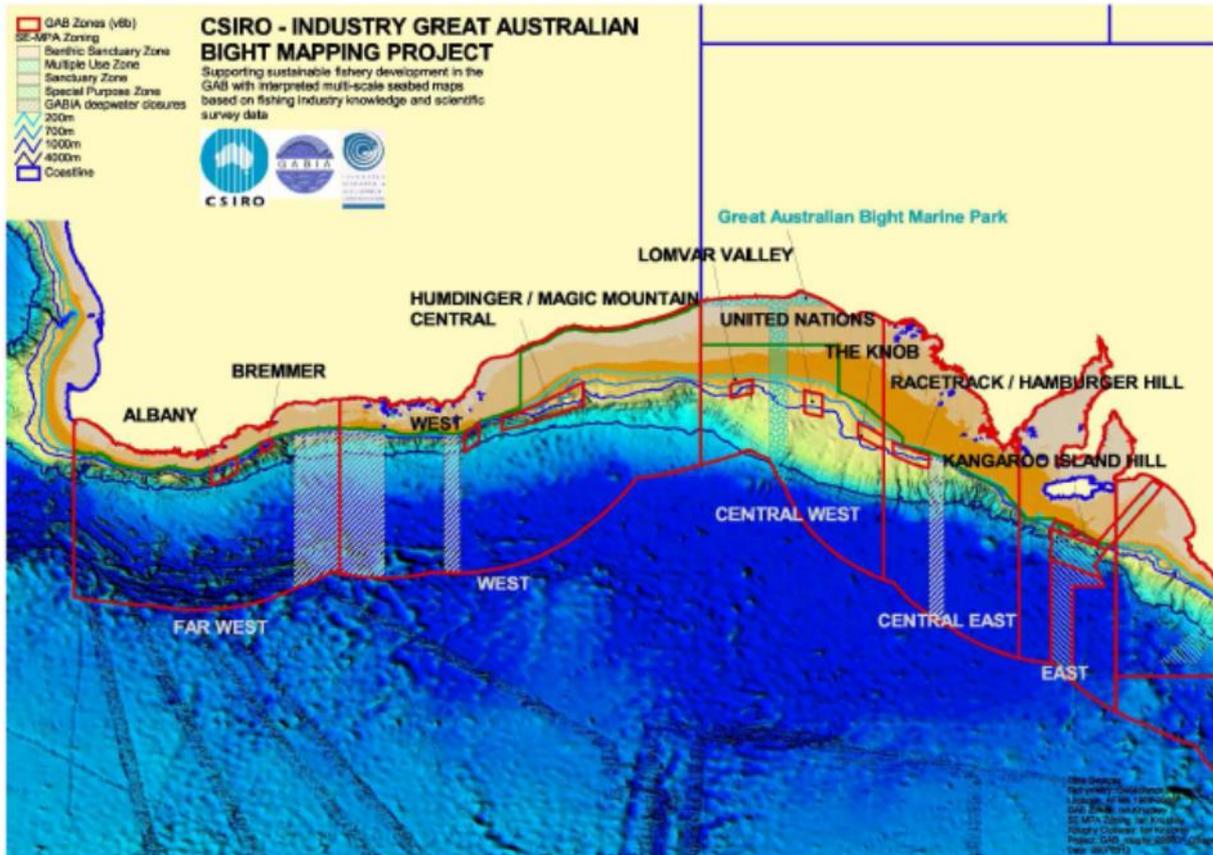


Figure 2: Map of Orange Roughy Zones in the Great Australian Bight Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery. Source: Management strategy for sustainable deepwater fishing in the GABTS including proposed arrangements that conform to the Orange Roughy Conservation Program (GABIA 2007a).

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Table 1: Orange Roughy management zone, most recent stock assessment, management arrangement and stock status in Commonwealth waters.

Management zone	SESSF sector	Most recent assessment	Management arrangement	Status (ABARES Fishery Status Report, 2013)
East Coast Deep Water Trawl Sector	ECDWTS	No formal stock assessment	No targeted fishing for Orange Roughy Incidental TAC 50 tonnes Targeting of Alfonsino and limited effort has meant no take of Orange Roughy in recent years.	Zero catch, Not assessed.
North-east remote zone	SET	Not assessed	No targeted fishing for Orange Roughy, significant spatial closures	Not assessed
Eastern Zone	SET	New assessment undertaken in 2014 estimated stock to be at B_{26}	Catch subject to quota, significant spatial closures	Biomass uncertain Not subject to overfishing
Southern Zone	SET	Last formal stock assessment 2000 estimated stock B_7	Incidental catch subject to quota, TAC in Pedra Branca area subject to quota, significant spatial closures	Overfished Not subject to overfishing
Western Zone	SET	Last formal stock assessment 2002 estimated stock at less than B_{30}	Incidental TAC 60 t, all catch subject to quota, significant spatial closures	Overfished Not subject to overfishing
Southern Remote Zone	SET	Not assessed	No targeted fishing for Orange Roughy	Not assessed



Management zone	SESSF sector	Most recent assessment	Management arrangement	Status (ABARES Fishery Status Report, 2013)
Cascade Plateau	SET	Assessment conducted 2004 with update in 2009 estimates stock at B_{63} in 2011.	TAC 500 t (2014/15), all catch subject to quota	Biomass higher than target Not overfished Not subject to overfishing
GAB	GABTS	Not assessed, review of historical catches suggests decline has occurred.	<ul style="list-style-type: none"> • 9 targeted spatial closures encompass > 90% historical catch, • 5 Deepwater Management Zones, 10 t trigger limit each zone • Bycatch TAC of 50t for Albany / Esperance 	Biomass uncertain Not subject to overfishing
South Tasman Rise	SET	No biomass estimate, basic assessment in 2003 concluded stock significantly depleted	Fishery closed since 2007. High Seas component managed through SPRFMO	Overfished Not subject to overfishing

