

**Advice to the Minister for the Environment and Heritage from the Threatened Species
Scientific Committee (TSSC) on Amendments to the list of Threatened Species under the
*Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)***

1. Scientific name, common name

Hoplostethus atlanticus (Orange Roughy)

2. Description

The Orange Roughy is a marine fish that has a reddish upper body, orange fins and tail, a large bony head and relatively large eyes. An adult Orange Roughy is on average 30-40 centimetres in length and weighs around 1.5 kilograms, although the species can grow to a maximum size of approximately 50cm and 3.6kg. This species is also sometimes called sea perch or deep-sea perch.

Orange Roughy are a long-lived, slow maturing species. They can live up to 150 years, and reach sexual maturity between 20 and 40 years of age. Fecundity (rate of reproduction) is low, with a typical female carrying only 22,000 eggs per kilogram of body weight, which is less than 10% of the average for other fish species. These characteristics (long-lived, slow maturing and low fecundity), coupled with the species' habit of forming very large aggregations at spawning, make Orange Roughy particularly vulnerable to, and slow to recover from, over-exploitation by commercial fishing.

Orange Roughy are predators that will consume a range of food types, including a wide variety of fish, squids and crustaceans, depending on whatever is most available in the area at the time. During the spawning season, they appear to starve themselves as most fish caught at this time have empty stomachs. Natural mortality is very low and is estimated to be 4 - 6% per annum.

The species normally occurs at a sea depth of between 700 and 1500 metres, although they have been recorded to a depth of 1800 metres. Spawning in Australian waters occurs once each year between late June and early August although not all of the adult population will spawn each year. Orange Roughy form very large and dense aggregations at spawning (schooling in the millions), predominantly around deep ocean seamounts, hills and plateaus.

There is some evidence that males and females are segregated within these spawning aggregations, with females occurring deeper in the water and males assembling around and above female aggregations. The fish are synchronous spawners; that is, they release eggs into the water at the same time. The fertilised eggs gradually rise in the water column to a depth of about 200 metres. The eggs develop rapidly at this depth and then sink back to the ocean floor, where they hatch (eight to nine days after spawning). The juvenile fish begin feeding after about one month. It is not known where the juveniles live, as the fish are not usually encountered again until they are caught as adults by commercial fishers.

While there is some debate about the age at which Orange Roughy mature, it is generally agreed, and published data suggest, that between 20 and 40 years is accurate. It is also generally agreed that the species can live for around 150 years. Assuming that Orange Roughy breed from maturity until death, the generation length is calculated to be around 90 years.

3. National Context

Orange Roughy are found worldwide in temperate regions of the Atlantic, Indian and west Pacific oceans, and are fished commercially off New Zealand, Australia, Namibia and Chile. Other (more sporadic) fisheries include the North-East Atlantic and the Southern Indian Ocean.

In Australia, Orange Roughy occur in deep waters from offshore of Fraser Island in Queensland, southwards around Tasmania, and across the Great Australian Bight to the North West Shelf region of Western Australia. They also occur on seamounts and ocean ridges east of Lord Howe Island, and south of Tasmania in the South Tasman Rise, which straddles the Australian Exclusive Economic Zone (EEZ) and extends into high seas, and in the Indian Ocean west of Western Australia. The species is fished commercially throughout its range. Although there is ongoing debate about the structure of the Australian Orange Roughy population, there is evidence to show that besides spawning movements, Orange Roughy are sedentary with little movement between each of the known Orange Roughy sites. It is therefore believed that the Australian Orange Roughy population is comprised of a number of discrete sub-populations. Genetic research also indicates a distinction between the New Zealand and Australian Orange Roughy populations.

The main fishing season is from June to August, during the spawning season, when fish come together in large, dense aggregations and are easier to catch. However, the species is also fished at other times of the year when individuals form smaller feeding aggregations. Orange Roughy are caught by demersal trawling in waters of typically 700-1200 m depth, corresponding to “mid slope” regions between the continental shelf and deep ocean waters off southern Australia.

Australian Government-managed fisheries which target the species are the Southern and Eastern Scalefish and Shark Fishery (SESSF), the South Tasman Rise Fishery (STRF), and the Western Deepwater Trawl Fishery (WDWTF). The SESSF was established in December 2003 by the Australian Fisheries Management Authority (AFMA), and is comprised of the former South East Trawl Fishery (SETF), the Great Australian Bight Trawl Fishery and the Gillnet Hook and Trap Fisheries. These fisheries now make up management sectors within the SESSF. Orange Roughy is not targeted in, and is very infrequently caught in any State-managed fisheries. It has been occasionally caught in New South Wales-managed fisheries north of the SESSF.

The Bureau of Rural Sciences’ (BRS) Fishery Status Reports review the status of fish stocks managed by the Australian Government, and describe trends in the status. The reports contribute to the evaluation of the performance of Australian Government fisheries management, and are based on the most recent assessments carried out by research bodies, including State and Territory agencies, CSIRO and BRS. Information is also gathered from unpublished reports from fishery assessment meetings and workshops organised by the Australian Fisheries Management Authority (AFMA) and other agencies with involvement in fisheries research, such as the Fisheries Research and Development Corporation (FRDC).

Through the Fishery Status Reports, BRS aims to make fishery status and trends information available to government, industry and the community. The reports, first published in 1992, provide a means to monitor whether strategies are succeeding in sustaining the resources on which each fishery is based.

The BRS Reports (from 1992 to 2004) are used in this advice to assess the current conservation status of Orange Roughy against the threatened species listing criteria of the EPBC Act. These reports are publicly available. These assessments have been used because they provide

authoritative information on the status of the species that has been consistently assessed, and is comparable from year to year.

4. How judged by TSSC in relation to the EPBC Act criteria.

TSSC judges the species to be **eligible** for listing as **endangered** under the EPBC Act. The justification against the criteria is as follows:

Criterion 1 – It has undergone, is suspected to have undergone or is likely to undergo in the immediate future a very severe, severe or substantial reduction in numbers.

The Orange Roughy appears to have undergone a severe reduction in numbers following heavy initial exploitation by commercial fishing in certain areas since 1986.

The 2004 Bureau of Rural Sciences annual Fishery Status Reports list Orange Roughy as ‘overfished’ (a fish stock in which the amount of fishing is excessive or for which the catch depletes the biomass too much; or a stock that still reflects the effects of previous excessive fishing) in all fishery management zones in which it is targeted, except the Cascade Plateau and Great Australian Bight Trawl zones of the SESSF, and the Western Deepwater Trawl Fishery, where it is classified as ‘uncertain’ because of a lack of formal stock assessments in these sectors. Additionally, the 2004 BRS Reports advise that overfishing for Orange Roughy continues.

Relevant Biology

As detailed at page 1, it is generally agreed and suggested by published data that Orange Roughy mature at between 20 and 40 years. It is also generally agreed that the species can live for around 150 years. Assuming that Orange Roughy breed from maturity until death, the generation length is calculated to be around 90 years. Natural mortality is very low and is estimated to be 4 - 6% per annum.

Decline in catches

In the SESSF (incorporating the previous SETF and GABTF), catches of Orange Roughy have declined significantly over the past decade. Following peak landings in 1990, catches have decreased by over 90%.

A large non-spawning aggregation was discovered off western Tasmania in 1986, where the first substantial catches of Orange Roughy were taken. Between 1986 and 1988 catches ranged between 4,600 and 7,000 tonnes per year. The discovery of the St Helen’s Hill spawning aggregation in 1989 led to Orange Roughy catches totalling over 26,000 tonnes, and over 40,000 tonnes in 1990. In 1992, Total Allowable Catches (TACs) totalling about 18,000 tonnes were adopted for the Eastern, Southern and Western management zones of the SETF sector of the SESSF. However, the 1994 and 1997 BRS Fishery Status Reports note that the quota monitoring system was inadequate and it is acknowledged that some operators substantially under-declared their catches. The total 1992 catch was subsequently estimated to have been about 31,000 tonnes. By 1997, catches had declined to just over 5,000 tonnes, and to around 4,000 tonnes by 1998. TACs have generally (in most management sectors) been reactively reduced in response to the declining catches and have not constrained catches.

Based on currently available stock assessment data, it is believed that the SETF (now part of the SESSF) contains a number of discrete Orange Roughy stocks.

In the Great Australian Bight Trawl Fishery (GABTF – part of the SESSF since December 2003) the Orange Roughy catch has decreased from a 1989 peak of 4,139 tonnes to 323 t in 1997. Catches have increased to 820 t in 1999. However, catches of Orange Roughy in the GABTF have not exceeded 1000 tonnes since 1990, despite a greatly increased fishing effort compared to the early 1990's. This equates to a decline of between 80% and 92% in catches since the initial peak landings of over 4,000 tonnes.

The Western Deepwater Trawl Fishery (WDWTF) is located in deep water off Western Australia. Principally a finfish trawl fishery, species diversity is considerable. Orange Roughy catches peaked at 237 tonnes in 1994–95, remained at less than 20 t for the next five years, then increased to 104 t in 2001–02. It is believed that the fish encountered within the WDWTF may be of the same stock as those within the neighbouring GABTF. Orange Roughy has not been targeted in this fishery since 2001.

Table 1 shows catch data from the SETF, GABTF and WDWTF over the past decade, and where available, since the commencement of commercial fishing for Orange Roughy. Catch data for the South Tasman Rise Fishery are detailed in a separate table (Table 2) as this fishery developed more recently and catches are assessed seasonally (eg 1997-1998) rather than by calendar year (eg 1999).

Table 1 This table incorporates catch data from fishery assessments for the SETF, GABTF (both now part of the SESSF), and the WDWTF. All figures sourced from BRS annual Fishery Status Reports.

Year	SETF (tonnes)	GABTF (tonnes)	WDWTF (tonnes)
1989	26,000	4,139	
1990	44,000	1,050	
1991	22,000	<1,000 [^]	
1992	31,000 ^{**}	<1,000 [^]	Fishing commenced
1993	10,670	<1,000 [^]	
1994	7,740	68	156
1995	5,203	345	237
1996	5,155	359	<20 [*]
1997	4,047	323	<20 [*]
1998	4,140	648	<20 [*]
1999	4,064	819	<20 [*]
2000	4,033	378	Not available [*]
2001	3,483	239	104
2002	3,543	375	Not targeted, data not available
2003	2,808	251	Not targeted, data not available

^{**}Total estimated catch after consideration of estimated under-reporting.

[^] No further data are reported in the relevant BRS Fishery Status Reports

^{*}Indicates that the catch data for these years has been kept confidential by AFMA, as publishing catches would result in individual vessels being identifiable due to the small fleet that operated in the fishery at these times.

Although the South Tasman Rise Fishery (STRF) is relatively new, declining catches are indicating that, similar to the trend in other Orange Roughy management sectors, one or two seasons of heavy, unregulated fishing of spawning aggregations have had a marked effect on catches in subsequent years.

All available scientific evidence indicates that the current South Tasman Rise Orange Roughy fishery is based on a single discrete population that straddles the Australian Exclusive Economic Zone (EEZ) and extends into the high seas. The fishery is currently managed under a Memorandum of Understanding between Australia and New Zealand.

Fishing on the South Tasman Rise developed strongly in 1997 with total Australian and New Zealand catches of 2,100 tonnes. Concern was expressed that uncontrolled fishing by both fleets would swiftly decimate the Orange Roughy population. Fisheries officials from both countries agreed in late 1997 to establish a precautionary Total Allowable Catch (TAC) for Orange Roughy within a proclaimed area of international waters. The TAC was based on the verified 1997 catch (2100 t) and apportioned between the two countries accordingly (80 percent Australia, 20 percent New Zealand). The fishing year was split into two six-month periods, each with half the TAC, to encourage fishing over a longer period to obtain more information on the extent of the fishery. In 1999 AFMA closed the fishery to Australian vessels when catches reached 1,723 tonnes (43 t over the Australian TAC). The New Zealand Government did not close the fishery to New Zealand vessels until New Zealand catches reached approximately 1,900 tonnes (approximately 1480 t over the New Zealand TAC). During this time negotiations between Australia and New Zealand were held to discuss longer-term management arrangements for the STR fishery, but no agreement was reached until 1 March 2000, when a Memorandum of Understanding between the two countries was put in place.

BRS Fishery Status Reports (2000-2001) state that during this management hiatus, foreign vessels fished the STR and diplomatic efforts were unable to stop them for several weeks. Log books from one of these vessels showed that 750 tonnes of Orange Roughy were taken, however anecdotal reports from Australian and New Zealand fishing ports claim that close to 5000 tonnes were taken. If this is accurate, then up to 10,000 tonnes of Orange Roughy were taken from the STR in the 1999 calendar year alone. Experts consider that this fishery has now become commercially unviable.

Table 2 Catches in the STRF since its development in 1997

Year	Total Allowable Catch (tonnes)	Actual Catch (tonnes)	Percentage of TAC caught
1997-1998	N/A	2,100	
1998-1999	2,100	At least 4,300*	
1999-2000	N/A		
2000-2001	2,400	830	34.5%
2001-2002	2,400	188	7.8%
2002-2003	1,800	103	5.7%
2003-2004	800	3	<1%

*This table includes reported catches from Australian and New Zealand vessels, plus the catch recorded in the logbook of one of the foreign vessels that fished the STRF in winter 1999. However, fishing industry members claim that the catch by the foreign vessels was closer to 5,000 tonnes. This means that the 1999 catch for the STRF could have been in the vicinity of 4,300 – 10,000 tonnes.

Estimates of Biomass

As noted previously, accurate and precise estimates of biomass are very difficult to obtain for Orange Roughy, and methods used to estimate biomass are subject to many sources of uncertainty. Biomass estimates in Australia have been conducted since the early 1990's, after initial peak catches of Orange Roughy began to decline. Biomass estimates have been obtained using trawl surveys, egg and larval surveys and catch-per-unit-of-effort (CPUE) results, and in more recent years, CPUE results combined with acoustic surveys of Orange Roughy aggregations.

Integrated stock assessments that combine catch data and acoustic survey data are currently the primary method of stock assessment and are used by BRS in the development of its annual Fishery Status Reports. Acoustic methods rely on measuring the reflected echoes from fish in the water. Since Orange Roughy form dense aggregations, this method can provide direct measurements of the numbers of fish in the aggregations. Acoustic surveys have been used as a primary biomass estimation tool in New Zealand, Australia and Namibia in recent years. Methods are improving all the time, but significant problems still occur in interpreting acoustic estimates. Measurement of the 'target strength' (the intensity of the reflected echo) is made difficult by the depth at which Orange Roughy live, and also because they reflect much less than most fish because their swim bladder is oil-filled and not gas-filled. Species composition in the aggregations is also problematic, since it is difficult to ensure that all the reflected echo comes from Orange Roughy and not from a few, more reflective, fish of other species. Combining acoustic surveys with trawling surveys partly addresses this problem, but trawls can only catch fish near the ocean floor, whereas acoustic methods can measure the echo from many metres above the ocean floor. Although acoustic methods have problems with measuring fish that are very close to the ocean floor, (this zone is known as the "acoustic dead zone"), some of these problems have been partially solved in recent times. Deep-towed acoustic transducers reduce the "dead zone". In addition, simultaneous transmission on several frequencies can be used to distinguish between different species.

While there are still sources of uncertainty in the methods used to estimate biomass, the margins of error are becoming better defined. In the absence of data that may have been collected over several decades, as for some other commercially-fished species, the estimates of biomass for Orange Roughy that are based on current acoustic, trawl and CPUE techniques provide a better indication of relative abundance than was previously possible. Additionally, given that fish taken in Orange Roughy fisheries tend to be approximately even in size, a decline in biomass reflects a decline in numbers of mature individuals.

It is not possible at this time to provide estimates of pre-1988 biomass across all sectors of Australian Orange Roughy fisheries. This is due to the lack of consistent assessment in some sectors and a lack of any assessment in others. Biomass estimates have been conducted throughout the Eastern and Southern SETF zones for just over the last 10 years, although there has been significant debate about results from year to year. Biomass estimates have been conducted in the Cascade Plateau sector and the South Tasman Rise Fishery since 2000. Stock assessments have not been completed for other zones and sectors of the SESSF or other Orange Roughy fisheries.

Formal management targets for Orange Roughy have only been established to date in certain zones of the SESSF. In 1994, AFMA adopted a management target for the SETF (now part of the SESSF) of reaching, by 2004, a spawning biomass (mature, breeding adults) for Orange Roughy of 30% of the estimated biomass prior to the commencement of significant fishing activities (1988), through total allowable catches. This management target was not achieved. As recent (1999-2002) catches in many of the management sectors of Orange Roughy fisheries have not been able to fulfil quotas, and fishing effort has remained fairly constant, or increased in different sectors, it may suggest that this strategy is failing to maintain the species at a sustainable level. While the data available on pre-1988 biomass contain elements of uncertainty, they provide some estimate of abundance that previously was not available.

Based on an assessment conducted in 1996 by CSIRO Marine Research for the South East Fishery Stock Assessment Group, pre-fishery (pre-1988) biomass for Orange Roughy in the Eastern and Southern zones of the SETF (combined, based on the assumption that this is single stock) was estimated at 166,000 to 191,000 tonnes. It was also found that at that time, there was an 82 to 86% probability that the biomass was below AFMA's target reference point of 30% of pre-fishery biomass, and a 49 to 61% probability of being below the limit reference point of 20% of pre-fishery

biomass (at which point a zero TAC was to be implemented to recover the stock, which to date has not occurred).

Eastern zone assessments conducted in 2001 estimated the effects of a zero catch, and a catch of 800 tonnes, on the spawning biomass if the spawning aggregations at St Helen's Hill and St Patrick's Head were regarded as the same stock or separate stocks (which is still subject to debate). Analyses found that, in both stock scenarios, the probability that the current biomass was beneath AFMA's limit reference point (of 20% of pre-1988 biomass) was at least 60%, and possibly greater than 90%. Even with zero-catches, the probability of not attaining the target reference point by 2004 was 75% or higher. Incorporating additional age-composition data, another assessment in 2002 concluded that it would take between 5 and 16 years to reach AFMA's target reference point with a zero catch, and between 8 and 26 years with an 800 tonne catch in the eastern management sector. The recommended TAC for 2003 was subsequently set by AFMA at 748 tonnes. The 2003 catch for this zone was 772 t.

In the southern and western management zones of the SESSF, TACs have continually been reduced in response to declining catches, but to date have not constrained catches. In the southern zone, stock assessments have not been updated since 2000, when the probability of the biomass being below AFMA's limit reference point was estimated at 57–95%. In the western zone, assessments have also not been updated since 2000, when analysis of catches indicated the biomass to be well below AFMA's target level. Even under a zero-catch scenario, the analysis suggested it would take 11 years to attain a 50% probability of reaching the 30% target. Recent landings continue to be considerably below TAC levels: the recommended TAC for 2003 for the southern zone was 340 t with a 210 t catch; and for the western zone a 450 t TAC was allocated, with a catch of 243 t.

There is no formal stock assessment for the Cascade Plateau sector of the SESSF. The sector has been fished consistently since 1996 and remains the only sector in which Orange Roughy TACs continue to be fulfilled.

Conclusion

Orange Roughy is a long-lived species with low natural mortality and a long period to maturity (between 20 and 40 years).

Although Orange Roughy has been taken commercially in Australia for just over 20 years, assessments of catches of the species have only been undertaken in the last 10-15 years, and in some cases, in only the past 6-7 years. With an estimated single generation time of about 90 years, the data on catches span only 5% to 16% of the length of a single Orange Roughy generation. However, despite the relatively small dataset for this species, catch data have been historically used for many commercially targeted fish species as an indirect measure of trends in relative population abundance over time, and while they are not an absolute measure, catches can indicate a suspected decline of a species.

In 1994, AFMA adopted a management strategy for the SETF eastern, southern and western zones, of reaching by 2004 a spawning biomass for Orange Roughy of 30% of the estimated biomass prior to the commencement of significant fishing activities (1988), through total allowable catches. This target was not achieved and Orange Roughy taken from this sector of the SESSF is currently classified by BRS as 'overfished' and BRS additionally notes that overfishing for Orange Roughy is occurring (BRS 2004).

The current AFMA management strategy for Orange Roughy (in the SESSF) allows for the 'fishing down' of the species to 30% of the pre-fishery biomass, and assessments conducted over the past several years indicate a very high probability that the species' current biomass is below this level in

all Orange Roughy management sectors, apart from the Cascade Plateau and GABT sectors of the SESSF, and the Western Deepwater Trawl Fishery, where it is considered 'uncertain'. This infers a decline of over 70% has occurred in the Orange Roughy stocks that occur within these sectors, and under current fishing management practices, declines are likely to continue. Catch rates of Orange Roughy support this likelihood. Data for Orange Roughy show an overall decline in catch rate by around 90% since peak landings between 1989 and 1992 (BRS 2004).

Therefore, the species is **eligible** for listing as **endangered** under Criterion 1.

Criterion 2 – Its geographic distribution is precarious for the survival of the species and is very restricted, restricted or limited.

Orange Roughy is found worldwide in temperate regions of the Atlantic, Indian and west Pacific oceans, and is fished commercially off New Zealand, Australia, Namibia and Chile. Other (more sporadic) fisheries include the North-East Atlantic and the Southern Indian Ocean.

In Australia, Orange Roughy may occur in waters from offshore of Fraser Island in Queensland, southwards around Tasmania, and across the Great Australian Bight to the North West Shelf region of Western Australia. They also occur on seamounts and ocean ridges east of Lord Howe Island, and south of Tasmania in the South Tasman Rise, which straddles the Australian Exclusive Economic Zone (EEZ) and extends into high seas, and in the Indian Ocean west of Western Australia.

The geographic distribution of the Orange Roughy is neither precarious for the survival of the species, nor is it very restricted, restricted or limited.

Therefore, the species is **not eligible** for listing under this criterion.

Criterion 3 – The estimated total number of mature individuals is limited to a particular degree and: (a) evidence suggests that the number will continue to decline at a particular rate; or (b) the number is likely to continue to decline and its geographic distribution is precarious for its survival.

As discussed under Criterion 1, it is not possible to measure precisely the total number of mature individuals of a deep-sea species such as the Orange Roughy. While there is some evidence to indicate that the population is continuing to decline, there is insufficient information to enable the rate of this continuing decline to be determined. In addition, the geographic distribution of Orange Roughy is not considered to be precarious for the survival of the species (see Criterion 2).

Therefore, the species is **not eligible** for listing under this criterion.

Criterion 4 – The estimated total number of mature individuals is extremely low, very low or low.

There are insufficient quantitative data available on the number of mature individuals in the Orange Roughy population, and therefore there is insufficient information available to assess the species against this criterion.

Criterion 5 - Probability of extinction in the wild

There are no quantitative data available to assess the species against this criterion.

5. CONCLUSION

Although Orange Roughy has been taken commercially in Australia for just over 20 years, assessments of catches of the species have only been undertaken in the last 10-15 years, and in some cases, in only the past 6-7 years. With an estimated single generation time of about 90 years, the data on catches span only 5% to 16% of the length of a single Orange Roughy generation. However, despite the relatively small dataset for this species, the available assessments indicate significant declines have occurred. Catch data have been historically used for many commercially targeted fish species as an indirect measure of trends in relative population abundance over time, and while they are not an absolute measure catches can indicate a suspected decline of a species.

In 1994, AFMA adopted a management strategy, for the SETF eastern, southern and western zones, of reaching by 2004 a spawning biomass for Orange Roughy of 30% of the estimated biomass prior to the commencement of significant fishing activities (1988), through total allowable catches. This target was not achieved and Orange Roughy taken from this sector of the SESSF is currently classified by BRS as 'overfished' (a fish stock in which the amount of fishing is excessive or for which the catch depletes the biomass too much; or a stock that still reflects the effects of previous excessive fishing) and BRS additionally notes that overfishing is occurring (2004).

The current AFMA management strategy for Orange Roughy (in the SESSF) allows for the 'fishing down' of the species to 30% of the pre-fishery biomass, and assessments conducted over the past several years indicate a very high probability that the species' current biomass is below this level in all Orange Roughy management sectors, apart from the Cascade Plateau and GABT sectors of the SESSF, and the Western Deepwater Trawl Fishery, where it is considered 'uncertain'. Therefore, an inferred decline of over 70% has occurred in the Orange Roughy stocks that occur within these sectors, and under current fishing management practices, declines are likely to continue. Catch rates of Orange Roughy support this likelihood. Data for Orange Roughy show an overall decline in catch rate by around 90% since peak landings between 1989 and 1992 (BRS 2004).

Therefore, the species is **eligible** for listing as **endangered** under Criterion 1.

6. Recommendation

TSSC recommends that the list referred to in section 178 of the EPBC Act be amended by adding to the **endangered** category:

Hoplostethus atlanticus (Orange Roughy)

Associate Professor Robert J.S. Beeton

Chair

Threatened Species Scientific Committee

Publications used to assess the nomination

Bax, N. (1999) *Stock Assessment Report 1999 Orange Roughy (Hoplostethus atlanticus)* CSIRO Marine Research, Hobart

Bureau of Rural Resources (1992) *Fishery Status Report South East Trawl: Orange Roughy 1992* Canberra

Caton, A. (ed) *Fishery Status Reports 2000-2001*, Bureau of Rural Sciences, Canberra

Caton, A., McLoughlin, K., and Staples, D. (eds) (1997) *Fishery Status Reports 1997* Department of Primary Industries and Energy, Bureau of Resource Sciences, Canberra

Caton, A., and McLoughlin, K. (eds) (2000) *Fishery Status Reports 1999*, Bureau of Rural Sciences, Canberra

Caton, A., and McLoughlin, K. (eds) (2004) *Fishery Status Reports 2004*, Bureau of Rural Sciences, Canberra

Caton, A., McLoughlin, K., and Staples, D. (eds) (1998) *Fishery Status Reports 1998*, Bureau of Rural Sciences, Canberra

Honkalehto, T. and Ryan, T. (2003) *Analysis of industry acoustic observations of Orange Roughy (Hoplostethus atlanticus) spawning aggregations on the Cascade Plateau off south eastern Tasmania in June and July 2003*, CSIRO Marine Research, Australia

McLoughlin, K., Wallner, B., and Staples, D. (eds) (1995) *Fishery Status Reports 1994* Department of Primary Industries and Energy, Bureau of Resource Sciences, Canberra

Pogonoski, J.J., Pollard, D.A., and Paxton, J.R. (2002) *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes (2002)* Environment Australia, Canberra

Prince, J. and Diver, G. (2001) *Industry Survey of the Orange Roughy Stocks on the South Tasman Rise Fishery 2000* Australian Fisheries Management Authority Project R2000/0172, Biospherics Pty Ltd

Southern and Eastern Scalefish and Shark Fishery Management Plan. Australian Fisheries Management Authority, 2003

South East Trawl Fishery Management Arrangements. Australian Fisheries Management Authority, 2002

Species Summary: Hoplostethus atlanticus (Orange roughy), Fishbase.org, Retrieved March 2004, <http://www.fishbase.org/Summary/SpeciesSummary.cfm?genusname=Hoplostethus&speciesname=atlanticus>

Orange Roughy Assessment Group: The Fishery, Orange Roughy Assessment Group web site, retrieved March 2004, <http://www.marine.csiro.au/orag/fishery/index.htm>