Commonwealth trawl and scalefish-hook sectors

Main features

**STATUS**

Eight stocks, species or species-groups—blue warehou (eastern stock), deepwater sharks (upper slope species), eastern gemfish, orange roughy [except Cascade Plateau], redfish, silver trevally, smooth oreo dory [except Cascade Plateau] and other oreo dories—classified overfished; overfishing continues for eastern gemfish, orange roughy (eastern and western zones), redfish and silver trevally, and possibly the eastern blue warehou stock.

Ten stocks or species—blue-eye trevalla, blue grenadier, blue warehou (western stock), deepwater sharks (midslope species), eastern school whiting, jackass morwong, orange roughy (Cascade stock), pink ling, spotted warehou and tiger flathead—classified not overfished; overfishing is occurring at current catch levels for orange roughy (Cascade stock), pink ling and tiger flathead.

Seven stocks, species or species-groups—John dory, mirror dory, ocean perch, ribaldo, royal red prawn, smooth oreo dory (Cascade stock) and western gemfish—classified uncertain.

Of the 14 species or species-groups for which the Australian Fisheries Management Authority has set a trawl catch-rate reference level, 12 did not meet the criterion during 2004: blue-eye trevalla, blue warehou, eastern school whiting, jackass morwong, John dory, mirror dory, pink ling, ocean perch, redfish, silver trevally, spotted warehou and western gemfish. 2004 catch rates for six of these species were the lowest on record.

Quota management was introduced in 2005 for two additional scalefish species—ribaldo and smooth oreo dory—together with a ‘basket’ total allowable catch (TAC) for other oreo dory species. Ribaldo have yet to be formally assessed and are classed as uncertain. The catch histories for oreos indicate stocks to be overfished except on the Cascade Plateau.

CONTINUED OVER THE PAGE
MAIN MANAGEMENT OBJECTIVE

For most major species, the reference biomass-level targets and limits are now designated. However, these have yet to be integrated into formal harvest strategies with binding decision rules. For most TAC species, as an interim measure, management seeks to ensure catch rates are maintained above the lowest annual mean rate between 1986 and 1994 levels. No decision rules have yet been formally agreed on for any species, although a harvest strategy based on fishing mortality rates was trialled during the 2004–05 stock-assessment process.

MANAGEMENT METHODS

TACs, individual transferable quotas, limited entry, area restrictions and some gear restrictions.
Highlights

- The Commonwealth trawl and scalefish-hook sectors supply most of the fresh fish to the markets of New South Wales, Victoria and Tasmania. There is a limit on the total allowable catch (TAC) of each of the 22 species or species groups that provide the bulk (>80%) of landings. The remaining landings of around 100 commercial species are unrestricted.

- The principal hook species are blue-eye trevalla and pink ling. A shift to autolonglining technology has led to increased pink ling catches by this sector and a marked rise in effort during 2002–2004.

- The 2005 TAC for eastern gemfish remained at 100 t, to allow for bycatch only. Blue grenadier, flathead, orange roughy (Cascade Plateau), pink ling and redfish TACs for 2005 were reduced. The 2005 TACs for mirror dory and spotted warehou were increased. All other TACs remained at their 2004 levels.

- In 2005 TACs were introduced for four additional species or species groups: deepwater sharks, smooth oreo dory, ‘other’ oreo species and ribaldo.

- The number of active trawlers has decreased since 1992, but total fleet capacity and horsepower have increased. The annual trawl-fishing effort in 2004 (117 569 bottom-time hours) was 11% higher than in 2003 and was the highest on record. Danish-seine effort has remained more or less constant over the past decade, with the 2004 total (8224 shots) being the lowest since 1995.

- Total landed catch weight in 2004 was 7% less than in 2003. Rising fuel prices and relatively static fish prices greatly reduced fishers’ profit margins.

- Discarding of some species at sea, particularly in shelf waters, remains a major issue. Actions to reduce unwanted bycatch and discarding are slowly being developed.

Background

Before 1996, the South East Fishery (SEF) consisted solely of the multispecies trawl and Danish-seine fishery and was commonly called the South East Trawl Fishery. However, in 1996, Australian Government-managed non-trawl demersal fishing was included, giving rise to trawl and non-trawl (now scalefish-hook) sectors. The Commonwealth trawl sector stretches from Sydney southwards around Tasmania to Cape Jervis in South Australia and is adjoined to the north by the East coast deepwater sector that extends to 24°30’S off Queensland. The scalefish-hook sector extends from the same boundary off Queensland to the South Australia–Western Australia border. Some of the species and stocks involved extend beyond the fisheries’ boundaries and are managed by other State or Australian Government fisheries. However, under Offshore Constitutional Settlement (OCS) arrangements, the pertinent States have largely ceded control of Southern and Eastern Scalefish and Shark Fishery (SESSF) quota-managed species to the Australian Government. Thus, in most instances, the catches in State waters by Australian Government-endorsed vessels are debited against the respective SESSF total allowable catch (TAC) limits. However, New South Wales retains jurisdiction over non-trawl fishers out to 80 n.mile along its entire coastline and over trawl fishers for the same distance offshore north of Sydney.

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11 Many fishers in the scalefish-hook sector operate in the shark gillnet and shark hook sectors. Quotas applying in those sectors also apply to scalefish-hook sector operations, but sharks are discussed in the Shark gillnet and hook sectors chapter.
History of the fishery

Trawl sector

The trawl sector has changed considerably since it began in the early 1900s with trawlers fishing continental-shelf species in depths of less than 200 m. Before 1930, tiger flathead was the main trawl species caught, but from the late 1940s stock declines led to increasing capture of jackass morwong and redfish. The SEF fleet was dominated by steam trawlers from 1915 to 1950, by Danish-seiners from the early 1950s to the early 1970s, and by modern trawlers since then. In the virtual absence of management restrictions, the Danish-seine fleet based in New South Wales expanded southwards in the 1950s to waters off Victoria. Trawlers began fishing in deeper and more southerly waters during the 1970s. By the early 1980s the New South Wales fleet had increased to 130 vessels, almost double that of 1970. Before 1985 there was a limit on the number of trawlers over 32 m long permitted to enter the fishery, but there were no regulations controlling the number of smaller vessels. Despite the introduction of several management measures aimed at limiting fleet expansion, both fishing capacity and effort continued to increase. The fishery was seen to be in a worsening economic state, with the decline of stocks such as eastern gemfish exacerbating the situation. The discovery and development of the deepwater orange roughy fishery in the late 1980s and early 1990s led to further increases in fleet capacity and fishing effort.

TACs were introduced for eastern gemfish in 1988 and orange roughy in 1990. TACs and individual transferable quotas for another 15 important commercial species or species groups taken by the fishery were introduced in 1992. The sector takes more than 100 commercial species, but the quota-managed species or species-groups comprise more than 80% of the recorded weight of landed catch. About 140 vessels were active in the trawl sector in 1991. Vessel numbers declined after the introduction of quotas. In 1997 there were 108 active vessels, although a further 42 fishing permits were held by inactive fishers at the start of the year. During 1997 an Australian Government-funded adjustment scheme removed 27 permits from the fishery. Nonetheless, annual fishing effort (hours bottom-time) doubled between 1992 and 2001 and has remained at high levels. There were 75 trawlers and 16 Danish seiners active in 2004.

Landings from New South Wales and eastern Bass Strait waters dominated the total trawl catch until the mid-1980s, when targeting of orange roughy, and to a lesser extent blue grenadier, in waters around Tasmania markedly increased in Tasmanian and Victorian landings. The downturn in the orange roughy fishery saw effort shift back into shallower waters, with Eden (New South Wales) the main landing port in 1996 and 1998. Increased landings of blue grenadier, spotted warehou and remote zone orange roughy then resulted in Hobart again becoming the main landing port for three years, but Eden has since dominated.

Scalefish-hook sector

This sector incorporates all waters outside a line 80 n.mile off the New South Wales coast and all waters outside State internal water boundaries of Victoria, Tasmania and South Australia (see map). The number of active Australian Government-endorsed SESSF hook vessels in 2004 was 49. The most commonly used hook methods are droplines and demersal longlines, with many fishers using both methods. In the past three years there has been a marked increase in automatic-longline effort. The main quota species targeted are blue-eye trevalla and pink ling. Five trap permits have been granted, with the main target species also being ling. Shark gillnetting also catches scalefish bycatch. Whereas blue warehou once constituted a major target species for ‘shark’ gillnetters, a marked stock decline has ended targeted gillnet fishing for this species.

Entry to the Australian Government-managed non-trawl sector has been limited since the mid-1980s. More stringent entry criteria were introduced in 1996. However, until 1997 there were no constraints on catch
weights (other than trip limits for eastern gemfish since 1991). In 1997 a TAC of 250 t was introduced for blue warehou. ‘Global’ TACs, encompassing all commercial fishing methods in Australian Government-managed SEF waters, started in 1998 for blue-eye trevalla, blue warehou and pink ling. Such global TACs were extended to all SEF quota species in 2001.

Prior to 2002 there was only one auto-longline permit in the non-trawl sector. In early 2002 a further 14 ‘trial’ permits were issued. Concerns over possible overfishing and perceived inequities in the allocation of permits led to a moratorium in October 2002 on the issue of further permits. This is still in place. Due to the efficiency of these additional auto-longliners, SESSF hook effort rose sharply during 2002 to 2004. Effort increased by 352% (from 665 000 to 3 007 229 hooks set) from 2001 to 2002, then by a further 30% (to 3 920 472 hooks-set) in 2003, and a further 117% (to 8 504 902 hooks-set) in 2004.

OCS arrangements for quota species have now been reached with every relevant State; however, the agreement between New South Wales and the Australian Government impedes effective management because some stocks—including overfished stocks—subject to total catch limits in the Australian Government-managed component of the fishery are not subject to limits in the New South Wales-managed component.

The 2004 fishery

The Commonwealth trawl and scalefish-hook sectors continue to be an important component of the Australian fishing industry, taking the largest marketed tonnage and supplying most of the fresh fish for Sydney and Melbourne. The 2004 value of the sectors was around A$60m. This value is derived from ABARE fish-market prices, with a 21% deduction for marketing costs. Onboard value-adding by freezer-trawlers in the winter blue-grenadier fishery is not adequately represented in these Gross Value of Production estimates.

Trawl sector

The available trawl TAC—i.e. the TAC allocated to the trawl sector plus that transferred from the non-trawl sector—in 2004 totalled 25 917 t. This total includes the Cascade Plateau orange roughy fishery, but excludes (bycatch) shark species managed under the Commonwealth shark hook and shark gillnet sectors TAC system. This overall TAC was 16% less than that for 2003, largely because of a 3216 t reduction in the blue grenadier TAC. The trawl sector recorded landings (including orange roughy from the Remote Zone, but excluding shark sector landings) of 21 145 t of quota species in 2004, which was 11% less than the 2003 total of 23 727 t. This decline was mainly due to smaller landings of blue grenadier, lower redfish catches and a greater proportion of the pink ling catch being taken by the non-trawl sector. Non-TAC species landings (excluding those of small pelagic species) were 4551 t in 2004, close to those in 2003 (4491 t).

Orange roughy landings from the continental slope management zones (eastern, southern and western) continued to decline, with an overall total of 1069 t in 2004, 13% less than in 2003. 2004 landings from the Cascade Plateau (1420 t) remained steady and 46 t were taken from the northeastern remote zone. Orange roughy catches from the South Tasman Rise, just outside the Australian Fishing Zone (AFZ), are described in the South Tasman Rise Trawl Fishery chapter.
The 2004 landings of six quota species were close to those in 2003. Comparative landings of nine species declined, with pronounced falls for blue grenadier, eastern school whiting, pink ling and redfish. Catches of blue-eye trevalla, western zone orange roughy, silver trevally and spotted warehou increased. Overall landings in 2004 declined despite trawl effort reaching a new recorded peak of 117 569 h bottom time, a 10% increase on that for 2003 (105 984 h). The ongoing increase in trawl effort continues to threaten the sustainability of the fishery and confound attempts to rebuild overfished stocks. Fleet horsepower and technological efficiency have also increased in recent years, so the increase in effective effort over the past decade (if it could be standardised) is much greater than indicated by hours of bottom time. Danish-seine effort again remained comparatively steady, with the 2004 total (8224 shots) being the lowest annual total since 1995.

For 2005, the recommended trawl-sector TACs for quota-managed species totalled 22 818 t, a decrease of 10% from 2004 (25 421 t) and the lowest since ITQ management began in 1992. The final allocated trawl-sector TACs will depend on the limited availability of carry-over quota and transfers between the trawl and non-trawl sectors during 2005. These totals include Cascade Plateau orange roughy, but not bycatches of school shark, gummy shark, elephant fish and saw shark—species that are subject to individual transferable quota (ITQ) management in the shark sectors of the SESSF.

Scalefish-hook sector
In 2001, the quota-management system was extended to include non-trawl catches of all SEF TAC species. Non-trawl quota allocations were low for most species other than blue-eye trevalla, blue warehou and pink ling. The available 2004 scalefish-hook TACs (excluding shark sector species, as in the trawl sector) totalled 1831 t, which included transfers between the trawl and scalefish-hook sectors. Landings of quota species in 2004 totalled 1529 t, 38% higher than in 2003. This increase was largely attributable to higher pink ling landings by auto-longliners, with nearly half the total 2004 catch of ling being taken by this method. As noted above, hook effort doubled from 2003 to 2004, with much of this increased effort occurring west of Bass Strait. A further 456 t of species not controlled by TACs were landed. These non-quota totals almost certainly include some bycatch from the shark sectors, as a common logbook is used.

The recommended 2005 scalefish-hook TACs (excluding shark sector species) totalled 1043 t, but the eventual allocated total will undoubtedly be much higher because of quota transfers from the trawl to the non-trawl sector.

Current monitoring and assessment
Since October 1985 it has been compulsory for fishers in the Commonwealth trawl sector to complete a shot-by-shot logbook. An equivalent logbook for the non-trawl sector was introduced in 1997. Previously this sector completed State logbooks, but the fishing-effort and catch-rate data are inconsistent and of limited use in analyses.

As many stocks are shared with adjacent State fisheries, all relevant catch data are included in the stock assessments where possible. However, in some instances data are not available in time, or are incompatible with the Commonwealth trawl logbook database.

Since 1994, detailed information on the composition of both the retained and discarded catch of trawl and non-trawl vessels has been collected by the Integrated Scientific Monitoring Programme (ISMP), which places scientific observers on a sample of fishing trips to gather data on species, size- and age-composition, and information on fishing practices. The ISMP also takes length samples of the catch at the main landing ports and the Melbourne and Sydney fish markets. An industry levy now recovers 80% of the
ISMP operating costs. The Central Ageing Facility at Queenscliff, Victoria, determines the age composition of selected species.

The establishment of the SEF Assessment Group (SEFAG) in 1993 and increased scientific monitoring of the fishery, particularly at sea and at landing ports, were major steps towards improving assessments. The success of the Eastern Gemfish Assessment Group (EGAG), formed in 1996, led to the creation of species assessment groups for blue grenadier, blue warehou, orange roughy, redfish and blue-eye trevalla under the SEFAG ‘umbrella’. In 2001, EGAG was disbanded and the Blue Warehou Assessment Group’s activities expanded to include spotted warehou assessment.

With the advent of the SESSF structure in 2003, SEFAG was disbanded and a Southern and an Eastern Scalefish and Shark Fishery Assessment Group (SESSFAG) created. Single (SEF) species assessment groups were replaced by three multi-species assessment groups—the Shelf Assessment Group; the Slope Assessment Group and the Deepwater Assessment Group. Another SESSFAG assessment group is responsible for shark species across the fishery.

**Status of stocks**

**Previous assessments**

The heavily fished status of some SESSF stocks has been known for many years. In 1989 a subcommittee of the Australian Fisheries Council reported there were ‘a number of species under severe biological stress and ... there was concern for a number of other specific stocks and little potential for increased total catches’.

The Demersal and Pelagic Fish Research Group, with State and Australian Government members, was prominent in SEF research issues and helped improve cooperation between agencies until it was disbanded in 1993. Before quota management began in 1992, the group concluded there was sufficient information on only four species (blue grenadier, flathead, jackass morwong and redfish) to estimate their sustainable yields. Judgments on the status of other quota species were based mainly on historical catch-and-effort data.

From 1993 to 2003, SEFAG provided a greater focus for assessments and reporting of results to fishery managers and the industry. Periodic SEFAG assessment reports formed the basis of annual TACs. In 1994, SEFAG produced stock-assessment reports for every quota species. It then developed a strategic plan for stock assessment, largely based on the then South East Trawl Management Advisory Committee priorities, and subject to regular review. In any given year, stock-assessment reports were prepared for the priority species at the time. Even so, whereas the triggering of a management reference-point (such as catch-rate; see below) should theoretically have set a priority for assessing a species, limited resources usually prevented it. Most quantitative assessment work was on the few species for which assessment groups existed. Thus, in each annual assessment cycle, most quota species were not subject to formal assessment, but instead were briefly reviewed at a SEFAG plenary meeting using available catch-rate and ISMP information.

The formation of multi-species assessment groups for shelf, slope and deepwater species has seen an improvement in the number of species assessed in a given year. However, species of lesser economic value (e.g. John dory, mirror dory, ocean perch, royal red prawn and western gemfish) have still not had a formal quantitative assessment since ITQ management began in 1992.

**Management reference points**

AFMA specifies different management-performance criteria from species to species. For the main species, target biomass levels and limit levels have been adopted as reference levels against which performance can be judged. These reference levels are usually expressed as a percentage of the unfished biomass. However, for many species the stock biomass levels are not known, so as an interim measure, AFMA uses catch per
unit effort (CPUE) as an index of relative abundance for most species and seeks to maintain trawl catch-rates above a reference rate—the lowest annual mean CPUE between 1986 and 1994. CPUE is usually expressed as the mean weight of fish per hour of trawl bottom-time for shots containing the species in question. There are many variables to consider when interpreting a CPUE time-series, but attempts to standardise CPUE values have been hampered by changes in fishing practice.

Whereas harvest strategies are being developed for the main species, there are not as yet formally ratified decision rules for any quota species stating what actions will be taken when a reference point is triggered. A research programme aimed at developing an appropriate harvest strategy framework for the SESSF is currently trialling, for each quota species, target and limit fishing-mortality rates, together with the adoption of a minimum biomass level below which fishing ceases (see box: Harvest strategy framework). A basic precautionary tenet of this strategy is that target exploitation rates will decrease as uncertainty about stock status increases. However, initial trials during the 2005 stock assessment process indicated that, in many instances, this tenet was not being met by the strategy used. The minimum (i.e. limit) biomass level of 20% of unfished biomass, adopted as an interim measure by this programme, is likely to be too low for many SESSF species and a more precautionary figure will need to be adopted.

Of the 14 species or species-groups for which a CPUE reference rate has been used, 12 would not have met this criterion in 2004—the catch rates for blue-eye trevalla, blue warehou, eastern school whiting, jackass morwong, John dory, pink ling, mirror dory, ocean perch, redfish, silver trevally, spotted warehou and western gemfish were below their reference point.
A harvest strategy is a set of rules or plans for the exploitation of a fish stock, which specify how management targets are to be achieved. They can vary from the simple to the very complex. Well-managed fisheries have an unambiguous (explicit and quantitative) harvest strategy, robust to the unpredictable biological fluctuations to which the stock may be subject. The harvest strategy will state how the catch will be adjusted from year to year depending on: the size of the stock; the economic or social conditions of the fishery; conditions of other interdependent stocks; and the uncertainty regarding biological knowledge of the stock.

The main management tool for managing the Southern and Eastern Scalefish and Shark Fishery (SESSF) is the setting of annual total allowable catches (TACs), implemented as individual transferable quotas. Since TACs were introduced in the SESSF, the manner of setting them has varied across species and sectors. A more rigorous and consistent approach using reference points and clear decision rules is needed.

In 2005, the Australian Fisheries Management Authority (AFMA) began trialling a harvest strategy framework for the SESSF intended to provide greater clarity in the setting of TACs. In this approach a maximum exploitation rate which defines overfishing and a target exploitation rate which defines optimum fishing levels are specified. The strategy also defines a minimum biomass level of a stock, below which fishing would cease. The structure of the framework has four tiers based on the amount and type of information available to assess stock status for a species. A species assigned to the highest tier would have the highest quality of information available and hence a robust quantitative assessment. At the lowest tier there would be no reliable information on current biomass or current exploitation rate and any assessment would be based on current catch levels and catch rates. Increasing uncertainty in the assessment (i.e. assignment of a species to a lower tier) would result in more precautionary or lower exploitation rates. Conversely, increasing investment in research leading to a robust assessment could lead to higher target exploitation rates.

The development of this harvest strategy approach was tested through AFMA’s assessment groups for the SESSF. The result of the approach is a recommended biological catch (RBC) for each species and this RBC is then the primary input for the setting of the TAC for the following year. Good progress was made in developing this harvest strategy framework in 2005, and estimated RBCs were considered in setting TACs for 2006. A number of issues are yet to be resolved with the framework, including some inconsistencies in the results; for example, the methodology resulted in higher RBCs for some species when assigned to a lower tier. A lower tier indicates more uncertainty and a precautionary outcome should result in a lower RBC. Application of the framework will also need further research including establishing agreed catch-histories for species to be assessed as well as agreed stock boundaries.

The recently announced A$220 million fisheries-restructure package requires AFMA to build on the work undertaken in 2005 to develop a world’s-best-practice Commonwealth Harvest Strategy Policy to apply to all fisheries it manages. A number of reference points were accepted as appropriate in the short term. In summary, these require that:

- exploitation rates of target stocks will not exceed those giving maximum sustainable yield;
- reductions in the exploitation rate and catch are to be implemented immediately when breeding stocks are assessed to be below 40% of pre-fished levels;
- targeted fishing is to cease when breeding stocks are assessed to be below 20% of pre-fished levels;
- the objective of avoiding overfishing and avoiding overfished stocks must be achieved with at least 80% probability.
A best-practice harvest-strategy policy is being developed in 2006 to be put in place by 1 January 2007.

As an initial response to the need for structural adjustment, AFMA released new catch limits for 2006 and projected catch limits for 2007 for the SESSF (source AFMA):

<table>
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<tr>
<th>SPECIES</th>
<th>2006 TAC (t)</th>
<th>PROJECTED 2007 TAC (t)</th>
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<tr>
<td>Alfonsino</td>
<td>500</td>
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<td>Bight redfish, GAB</td>
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<td>Blue-eye trevalla</td>
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<td>Blue grenadier</td>
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<td>Blue warehou</td>
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<td>Deepwater shark, western ‘basket limit’ (bycatch)</td>
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<td>Eastern school whiting</td>
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<td>Spotted (silver) warehou</td>
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<td>3300</td>
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**TAC** total allowable catch  
**(t)** tonnes  
**CT** Commonwealth trawl sector  
**GAB** Great Australian Bight trawl sector
**Carryover**

AFMA revised the quota ‘carryover’ provision in 2002. For most species, fishers had been allowed to carryover, from one year to the next, up to 20% credit because of under-caught quota or make-up a 20% debit because of over-caught quota. From 2003 onwards, no carryover of either type was permitted for blue grenadier, blue warehou, eastern gemfish, orange roughy (southern and western zones), redfish and silver trevally. A 10% ‘uncaught’ carryover quota is permitted for eastern school whiting, flathead, jackass morwong, John dory, pink ling, mirror dory, ocean perch, orange roughy (eastern and Cascade zones), royal red prawn, spotted warehou and western gemfish. A 20% ‘uncaught’ carryover is permitted only for blue-eye trevalla.

Note that TACs for individual quota species are set annually by the AFMA Board and are indicated in the following species summaries as the ‘recommended TAC’. However the actual TAC for a species (indicated in the species summaries as the ‘allocated TAC’) includes leases during the year between the trawl and non-trawl sectors, and carryover. Following AFMA’s revision of the carryover provision, there has been comparatively little carryover of uncaught quota (except for blue-eye trevalla) from 2003 onwards. The 2005 TAC allocated totals are those at the start of the year and do not include any cross-sector leasing that may occur during 2005. The 2004 catch totals include catches from State waters by the Commonwealth trawl sector.

**Stock status in 2004**

During 2004–05, quantitative assessments of blue grenadier, blue warehou, eastern school whiting, flathead, jackass morwong, pink ling, orange roughy (Cascade Plateau), silver trevally and spotted warehou were made. Assessments of the remaining quota species were limited to reviews of additional fisheries data and updates by the appropriate Assessment Group.
A genetic study indicated a common stock in Australian waters from mid-New South Wales to southwestern Western Australia. More recent otolith shape/microchemistry and mitochondrial DNA studies were ambiguous, but found no significant differences between fish on offshore seamounts and the continental slope. Blue-eye trevalla can live for about 40 years, and grow to 120 cm long. They are found in slope waters, mainly in depths of 300–550 m. The bulk of the Australian catch is taken by the scalefish-hook sector, traditionally by hook fishing with droplines but more recently by auto-longlining. The proportion taken by longline has increased from 8% by weight in 1998 to over 60% in 2004. An expansion of longline effort into Great Australian Bight waters saw 25% of the 2004 catch come from there. New South Wales still has jurisdiction over the hook fishery in coastal waters out to 80 n.mile, but does not permit auto-longlining.

Trawl catches of blue-eye trevalla are mainly a bycatch, but some target fishing in 1990 led to conflict with the hook sector and a TAC was introduced for the trawl sector to prevent its catches increasing. Before non-trawl sector ITQ management was introduced in 1998, Tasmanian non-trawl landings increased substantially to almost 700 t in 1997, largely because of increased effort. Trawl and dropline catch mostly young, immature fish, with larger, mature fish becoming vulnerable to line fishing when forming seasonal spawning aggregations. Length-frequency distributions are frequently multi-modal, containing three size groups (fish around 50 cm, 55–70 cm and above 70 cm), with the relative proportions of these groups varying by gear, area and season.

No quantitative assessment has so far been completed, as several attempts to use conventional stock-assessment models have proven unsuccessful. Available data do not adequately represent the spatial/temporal structuring of the fishery and growth and gear-selectivity parameters. Also, there is a lack of contrast in catch-rate data. Concern has been expressed at comparatively high estimates of fishing mortality, but catch-curve analyses are largely confounded by gear selectivity. Despite the lack of a quantitative assessment, all indicators suggest that the stock is fully fished. The unstandardised trawl catch-rate has declined since 2001. The suitability of such a reference point has been disputed, as the trawl sector takes less than 20% of the SESSF blue-eye trevalla catch. However, the widespread, bycatch nature of most trawl catches means that catch rates are probably a useful comparative abundance indicator; they suggest that population abundance has declined. It is uncertain whether there is overfishing. The recommended TAC for 2004 was reduced by 10% and remained at that level in 2005.

Blue grenadier

*Macruronus novaezelandiae*

**STATUS:** At present classified **not overfished**, but further TAC reductions are needed to maintain spawning biomass at target reference point until adult recruitment occurs.

**REFERENCE POINT:** Target biomass—maintain stock biomass at or above 40% of the average 1978 to 1988 spawning biomass.

- **2004:** Recommended combined TAC 7000 t. Allocated TAC 7000 t (6984 t trawl; 16 t non-trawl). Catch 6402 t (6392 t trawl, 10 t non-trawl). Discards 27 t
- **2005:** Recommended combined TAC 5000 t. Allocated combined TAC 5403 t
Genetic studies suggest there is a single breeding population in Australia, distributed from mid-New South Wales to southern Western Australia, and mainly in depths of 300–600 m. Blue grenadier spawn mainly off western Tasmania, in dense aggregations in winter. They mature at 4–5 years, can live for about 25 years, and grow to 110 cm long. The fishery has two distinct trawl-sector components: a year-round fishery on non-spawning fish throughout the fishery, and a winter-spawner fishery off western Tasmania. Initially, the development of the orange roughy fishery diverted effort from blue grenadier, but catches were boosted by the entry of large, chartered freezer-trawlers that are allowed to target the winter-spawner fishery only. Three such vessels fished in 1999 and two from 2000 onwards.

Catch rates in the non-spawning fishery declined from 1991 to 1997 because a series of weak year-classes entered the fishery. The recruitment of strong 1994 and 1995 year-classes raised catch rates again, but not without extremely high discarding of one- and two-year-olds in 1996 and 1997 until they became fully recruited in 1999. Catch rates then declined again after these cohorts passed through the fishery.

Catch rates in the winter-spawner fishery have been variable. Estimated fishing mortality levels have generally been below 10%. The spawning biomass is estimated to have declined continuously from 1979, but increased sharply in 2000 and peaked in 2001 when the strong 1994 and 1995 year-classes matured. There were no strong year-classes between 1996 and 2002 and spawning biomass has declined from 2001 onwards as the two strong cohorts pass through the stock.

Annual catches of blue grenadier increased steadily during the late 1990s as freezer-trawlers harvested the winter spawning fishery. Landings peaked in 1999 (9326 t) and
remained at around 8000–9000 t during 2000–2003. TACs and catches have since been reduced.

A 1998 assessment developed an age-structured ‘integrated analysis’ model. Catch-rate data were standardised to remove some of the impact of changes in fishing practices and fleet composition. The 1999 assessment improved the model and made a risk analysis of the impacts of different future harvest levels on the spawner and non-spawner fisheries. The assessment concluded that a TAC of 10 000 t for 20 years had a low risk of reducing the spawning biomass to below 40% of the reference biomass—the average spawning biomass between 1978 and 1988. However, the results of the 1998 assessment, and the projections, were extremely sensitive to whether earlier biomass estimates derived from egg surveys were measures of absolute or relative abundance.

The 2000–01 assessment noted that the fish in the two strong year-classes had grown more slowly than usual; however, this did not significantly change the risk analysis. The 2001–02 assessment improved the age-structured ‘integrated-analysis’ model, but was less optimistic, indicating that the strength of the 1994 cohort was not as great as previously estimated. As the 2002 estimate of female spawning biomass indicated it to be nearing AFMA’s 40% target level, the TAC was stepped downwards to 7000 t in 2004 with no quota carryover permitted. The recommended TAC for 2005 was 5000 t. A winter closure to fishing of the Pieman Canyon, a major spawning ground, was also proposed as a conservation measure. However, such a closure would have hindered the industry-based acoustic survey and was abandoned after the freezer-trawler companies voluntarily agreed to a 20% reduction (against quota) in their landings.

The 2004–05 assessments estimated the 2004 female spawning biomass to be at 44% of the reference level. Industry/CSIRO acoustic surveys of the west Tasmania spawning grounds, begun during the 2002 winter, aimed to develop a comparative abundance index for spawning biomass. Acoustic estimates of spawning biomass during the 2003 and 2004 winters were included in the 2005 assessment as a sensitivity test.

ISMP data indicate that a stronger 2003 cohort has entered the fishery. The strength of this cohort is currently unknown and a general increase in codend mesh size since 1996–1997 (when high juvenile discarding occurred) confounds comparisons with ISMP data for those years. However, the 2003 cohort will not mature until 2008 and further TAC reductions may be needed to maintain the spawning biomass at target level. Paradoxically, the 2003 cohort will reach marketable size in 2005–06 and more quota will probably be required to cover catches from the multi-species non-spawning fishery and prevent discarding.
Blue warehou

Seriolella brama

**STATUS:** Western stock: Not overfished. Eastern stock Overfished; overfishing may still be occurring.

A recent (2002) stock-structure study indicated that there are two stocks—one east and one west of Bass Strait. However, a common TAC is currently still in place and spatial management is needed. Blue warehou mature at 3–4 years, can live for about 10 years, and grow to 65 cm long. They have a similar distribution to spotted warehou (see below), but usually live in shallower waters (50–300 m). SEF trawl catches rose until 1991 (about 1300 t), but catches and catch rates have generally declined since then. Landings from a gillnet fishery for blue warehou peaked at about 1700 t in 1990, but then declined sharply. Only 2 t were landed by the non-trawl sector in 2004 and most of the non-trawl quota is leased to the trawl sector. There are also significant landings from Tasmanian State waters.

In the absence of yield estimates for blue warehou, there was concern in 1996 that catches might be unsustainable. Declines in trawl and gillnet catch rates from 1990 to 1996, and a significant reduction in the proportion of larger (>40 cm length) fish in trawl catches, were thought to signal overfishing. Consequently, the agreed 1997 trawl TAC was reduced to 700 t from the 1996 TAC of 1000 t. However, the ‘global’ TAC introduced for both sectors in 1998 allocated over 2000 t, which was considerably more than recent catches. Despite reductions in agreed TACs in 1999 (1750 t) and 2000 (1430 t), the absence of proportionate reductions in carryover saw about 2000 t being allocated in both years, although catches had continued to decline.

The status of blue warehou was thought to have improved during 1998–99 when Virtual Population Analysis (VPA) was applied to catch-at-age and standardised fishing-effort data. However, the use of ‘integrated analysis’ as the basis for the 1999 assessment showed that the VPA results were less reliable than previously thought. Preliminary genetic studies indicated the fishery could not be modelled as one stock, so east and west of Bass Strait were modelled separately, with the assessment for the west thought to be less

**2004:** Recommended combined TAC 300 t. Allocated TAC 298 t (281 t trawl; 17 t non-trawl). Catch 264 t (262 t trawl; 2 t non-trawl). Tasmanian catch 29 t. Discards 381 t.

**2005:** Recommended combined TAC 300 t. Allocated combined TAC 300 t, plus 200 t for assessment surveys.

**REFERENCE POINTS:** CPUE; and target biomass (stock biomass rebuilt to 30% of the unfished biomass).
reliable. In 2001–02, the Blue Warehou Assessment Group revised methods of standardising catch rates. New analyses found the decline in catch rates to be more pronounced than indicated by earlier analyses and more consistent with trends in recorded catch levels. Both east and west of Bass Strait, biomasses were estimated to be below AFMA’s limit reference level of 30% of the unfished biomass, and the stocks were classed as overfished. In 2002–03 the assessment group continued to refine data inputs for the increasingly complex model. The confirmation of the two-stock hypothesis necessitated a restructuring of age–length keys, and a formal assessment was not made in 2003.

The 2003 catch was the lowest on record and 2004 landings were only 10 t greater. The unstandardised trawl catch-rate has been below AFMA’s catch-rate reference level since 1995. Catches and catch rates from the western stock improved in 2004 after good recruitment to the fishery. However, limited quota availability resulted in about half the western catch being discarded. The 2004–05 assessments estimated the western stock to be above 40% of unfished biomass, so this stock was removed from the overfished category. Assessments of the eastern stock remain highly uncertain, but do not indicate any recovery. The combined (excluding the Tasmanian ‘domestic’ component) TAC for 2005 remained at 300 t with no carryover, but an additional 200 t was made available for trawl surveys to assist stock assessment. However, this TAC covers two stocks; distinct management strategies, including separate TACs for each stock, are needed. In the meantime, fishing mortality on the eastern stock may still be excessive.

### Deepwater sharks

**Various spp.**

**STATUS**: Upper slope species **overfished**; uncertain if overfishing is occurring. Mid slope species **not overfished**; uncertain if overfishing is occurring

**2005**: Upper slope—trip limits for *Centrophosus harrisoni*, *C. moluccensis* and *C. ugato*. Mid slope—basket quota of 200 t for dogfish, 92 t assigned to eastern zone and 108 t to western zone

Sharks tend to be more susceptible to overfishing than scalefish and invertebrates because sharks are commonly long-lived, often mature at a later age and produce relatively small numbers of young. There has been particular concern over several species of deepwater sharks or dogfish (Squalidae) taken in the SESSF. About 20 species can be taken, predominantly by the Commonwealth trawl sector, but also by the other sectors in the SESSF. There has been poor recording of the species taken as they can be difficult to identify and there has been confusion over common names used. Changes have been made to improve data quality, including the preparation of species-identification sheets.

Deepwater dogfish taken in the SESSF can be split into two ecological groups: upper-slope species taken in depths of 200 m to 650 m and mid-slope species taken in depths of 650 m to 1200 m. The taxonomy and distribution of many of the species is uncertain.

In the 1990s, upper-slope species were targeted by shark fishers for their livers. Catch rates in this period declined markedly and targeting by this sector ceased. However, these species continue to be taken as byproduct by the various sectors of the
SESSF. Trawl surveys of upper-slope waters off southern New South Wales in 1976–77 and again in 1996–97 suggested considerable declines of these species over that time period. Three species of gulper sharks—Harrison’s dogfish (*Centrophorus harrissoni*), Endeavour dogfish (*C. moluccensis*) and Southern dogfish (*C. uyato*) have been nominated and are being evaluated for listing as threatened species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Available information indicates these species have been overfished. Ongoing bycatch and the low productivity of the species will make recovery difficult.

Catches of these three shark species in the SESSF are restricted by trip limits. Indications are that another upper-slope species, the greeneye dogfish (*Squalus mitsukurii*) has also been depleted in waters off New South Wales but is thought to be more abundant in western regions of the SESSF.

Mid-slope dogfish sharks, initially taken predominantly as a bycatch of trawling for orange roughy, are also likely to be vulnerable to overfishing but as yet have not been impacted to the same extent as *Centrophorus* spp. Until recently, catches of these species were unregulated and they were largely discarded until the mid-1990s when the relaxation of mercury laws increased the ability for carcasses to be marketed. Increasing catches suggested they were being targeted or taken in conjunction with increased fishing for oreo dories. Autolongliners also have the potential to take a bycatch of deepwater dogfish. A CSIRO study concluded that available data does not provide evidence of these species having been depleted. In 2005, quota was introduced for deepwater dogfish, implemented as a basket quota covering the catch of several species. A deepwater working group recommended that there were potential differences between stocks east and west of Tasmania, so 92 t was allocated to an eastern zone and 108 t to a western zone. This overall quota was less than-average annual catches in recent years. Reported catches of deepwater sharks in 2005 were 66.2 t in the east and 101.2 t in the west. Information on discards will be important for monitoring of catch trends for these species.

The same quotas are in place for 2006. The species included in the basket quota are brier shark (*Deania calcea*), longsnout dogfish (*D. quadrispinosa*), bareskin dogfish (*Centroscyllium kamoharai*), Portuguese dogfish (*Centroscymnus coelolepis*), golden dogfish (*C. crepidater*), Owston’s dogfish (*C. owstonii*), Plunket’s dogfish (*C. plunketi*), black shark (*Dalatias licha*), smooth lanternshark (*Etmopterus bigelowi*), short-tail lanternshark (*E. brachyurus*), pink lanternshark (*E. dianthus*), lined lanternshark (*E. dislineatus*), blackmouth lanternshark (*E. evansi*), pygmy lanternshark (*E. fuscus*), southern lanternshark (*E. granulosus*), blackbelly lanternshark (*E. lucifer*), Moller’s lanternshark (*E. molleri*) and slender lanternshark (*E. pusillus*).
There are three main stocks in the SESSF: from Jervis Bay in New South Wales to Portland in Victoria; to the west of Portland; and around Tasmania. Their precise boundaries are unknown. Eastern school whiting live in inner-shelf waters. They mature at two years, can live for seven years, and grow to 22 cm long. Recruitment is thought to be variable. Most SESSF quota catches of eastern school whiting are from the Jervis Bay–Portland stock and are taken by Danish-seiners using Lakes Entrance as their port. High catches of school whiting are also taken by State fishers. All sector landings from all stocks totalled 1719 t in 2004.

Catch rates by Danish-seiners are extremely variable, being influenced by market demand for whiting and the amount of fleet effort directed at flathead. Eastern school whiting catches in all years except 1993 have been much lower than the TAC, but catch statistics suggest that annual catches of whiting and flathead are inversely related, and in recent years the Danish-seine effort in flathead depths has increased.

The 2004 assessment indicated that the spawning biomass of the Jervis Bay–Portland stock declined from 1993 to 2000. Stronger recruitment has since seen biomass increase, but there is considerable uncertainty about the strength of recent recruitment. However, the current spawning biomass is estimated to be well above the 1991 level and the current TAC of 1500 t is sustainable in the short to medium term.

**2004**: Recommended TAC 1500 t trawl. Allocated TAC 1598 t trawl. Catch 631 t trawl. Discards 26 t

**2005**: Recommended TAC 1500 t trawl. Allocated TAC 1659 t trawl

**REFERENCE POINT**: CPUE only before 2005, but now the 1991 spawning biomass
Flathead

*Neoplatycephalus* spp. *Platycephalus* spp.

**STATUS:** At present classified **not overfished**, but **overfishing** if annual landings in excess of 3000 t continue

Tiger flathead (*N. richardsoni*) is the main species caught, but toothy flathead (*N. aurimaculatus*), sand flathead (*P. bassensis*), bluespot flathead (*P. caeruleopunctatus*) and southern flathead (*P. speculator*) comprise a significant proportion of the ‘flathead’ catch and are included in the TAC. In the absence of specific stock-discrimination studies, tiger flathead in the trawl sector are assumed to be a single stock. However, industry has postulated that flathead off eastern Tasmania are a distinct stock.

Flathead are caught mainly in depths of 50–250 m, mature at 4–5 years, can live to 15 years, and grow to 80 cm long. They have always been a large component of SEF trawls, with annual landings rising to over 5000 t in 1928–29, and then declining. Since the establishment of the South East Trawl Fishery in 1984, annual Commonwealth landings have ranged between 1650 t (1984) and 3680 t (1999). The bulk of the catch is taken off New South Wales, eastern Victoria and Bass Strait, but from 2002 onwards a significant proportion has been taken off eastern Tasmania.

Catch rates for both trawl and Danish-seine declined from 1989 to 1994, particularly in the eastern Bass Strait grounds. There was also a decrease in the proportion of larger, older tiger flathead (seven years or more) there and in southern New South Wales’ catches. Estimates of fishing mortality obtained from the age composition of catches were relatively high. These results indicated that tiger flathead abundance in the eastern Bass Strait area had been declining, both in number and biomass, from the late 1980s. However, trawl catch rates have remained comparatively stable since 1995, and Danish-seine catch rates have improved from 1996 onwards. Nevertheless, estimates of fishing mortality were high, and the flathead TAC remained above previous estimates of long-term sustainable yield.

A stock-assessment workshop for flathead held in June 2001 developed a preliminary assessment model. Indicators of stock status across the fishery appeared stable. However, the decline in numbers of large fish in catches off New South Wales was of concern.

Quantitative ‘integrated analysis’ assessments in 2004–05 estimated the current spawning biomass of the New South Wales–Victoria–Bass Strait stock to be about 40% of the unfishable (1915) level and noted that recent

**2004:** Recommended combined TAC 3500 t. Allocated TAC 3631 t (3629 t trawl; 2 t non-trawl). Catch 3603 t (3602 t trawl; 1 t non-trawl). Discards 228 t

**2005:** Recommended combined TAC 3150 t. Allocated combined TAC 3354 t

**REFERENCE POINT:** CPUE and spawning biomass

![Graph showing catch rates for flathead](image-url)
catch levels over 3000 t were not sustainable in the long term. Long-term sustainable-yield estimates ranged between 2200 and 2800 t per annum, depending on the natural mortality value used in their calculation. There also appear to be significant annual changes in flathead availability that may not be related to stock size; environmental factors are the probable cause.

Targeting of flathead has increased in recent years, with more use of ‘flathead gear’ by the trawl sector and higher catches by the Danish-seine fleet. Catch rates for otter trawling and Danish-seining have remained generally above AFMA’s reference catch rate. Annual catches gradually increased, reaching the agreed TAC in 1999. The 2004 catch again exceeded the recommended TAC.

**Gemfish, eastern**

*Rekea solandri*

**Status:** Overfished; probable overfishing through bycatch mortality. There are no signs of stock recovery

Genetic research indicates that the eastern stock of gemfish, extending from Cape Moreton in southern Queensland to the western edge of Bass Strait, is distinct from the western stock that extends across the Great Australian Bight to Geraldton in Western Australia. Gemfish are found at depths of 100–700 m. Females mature later (4–6 years of age), live longer (up to 17 years), and can grow to a greater length (116 cm) than males (age at maturity 3–5 years, longevity up to 13 years, and maximum length 106 cm). The eastern stock migrates up the east coast to spawn off central and northern New South Wales during a short period in early- to mid-August. The bulk of the catch used to be taken during the late spawning run from June to early August.

In the 1970s, the eastern gemfish catch increased from less than 200 t to more than 5000 t and became a significant proportion of the total SEF catch. This level of catch was not sustained, however, and reported landings fluctuated between 3000 t and 4000 t until 1987, when catches began to decline. In response to concerns over declining catch rates and the smaller fish being caught, a trawl-sector TAC of 3000 t for the winter fishery was imposed in 1988, and ITQs were introduced in 1989. This was the first quota-managed SEF stock. Concerns about levels of recruitment to the stock led to successive reductions in the TAC, resulting in a zero TAC in 1993, which remained in place through 1993–96. Despite trip limits to allow for unavoidable bycatch of eastern gemfish, discarding is believed to have been a serious problem during this period. An experimental-fishing programme, carried out with industry cooperation, provided catch-rate data for the 1996 spawning run, which were incorporated into a new assessment. The 1997 TAC for the trawl sector was then set at 1000 t, with the expectation of a reduction in 1998. However, the 1997 catch of 393 t was well below the TAC.

Assessments of the eastern gemfish stock were based on a long time-series of size and age data. These data were first analysed in
using cohort analysis. Analyses were subsequently updated and extended as additional information and newer modelling techniques became available. By 1995 there were a number of different assessments, agreeing broadly on overall trends, but differing in details such as estimates of current biomass. It became apparent that modelling was handicapped by the absence of an adequate index of abundance from the fishery after 1992, when the TAC for target fishing was zero.

In 1996 there was a special effort to coordinate work by different researchers, leading to the formation of the Eastern Gemfish Assessment Group (EGAG) and the initiation of research surveys with chartered commercial fishing vessels. Catch-rate data were collected in 1996, 1997 and 1998. The assessments that used the 1996 experimental data were in broad agreement with previous assessments that the biomass had declined in the early 1980s, and a succession of weak year-classes had been spawned in the late 1980s. The EGAG’s ‘standard’ 1999 model estimated the spawning biomass at the end of the 1999 winter fishery to be between 5% and 26% of the 1979 biomass, which was well below AFMA’s target reference level of 40% of the 1979 biomass. However, the results from a modified model (a ‘mortality model’ that better fitted the length-frequency data for recent years) were markedly lower than from the standard model: a winter 2000 biomass range of <1% to 4% of the 1979 biomass. All scenarios examined by the EGAG showed the spawning stock to be well below the AFMA limit reference level (20% of 1979 biomass).

The range of values for biomass and depletion reflected the uncertainties, including historic catch levels, the form of the stock–recruitment relationship, the possibility of density-dependent selectivity and catch-rate standardisations.

There has been no quantitative assessment since 2000, principally because few new data are available. A monitoring and assessment strategy needs to be developed. The stock is certainly still well below AFMA’s limit reference biomass and is showing little evidence of recovery. Unstandardised (by)catch rates remain at a low level. Significant numbers of adults and juveniles continue to be taken as bycatch, jeopardising rebuilding of the stock. More stringent management measures to protect spawning aggregations and juvenile fish are required.

Since 1998 the agreed TACs have been theoretically zero (i.e. no targeted fishery), but catch allocations continued to be allocated to trawl quota holders to manage bycatch. This tonnage was reduced progressively from 300 t in 1998 to 100 t in 2002. Landings have been well below these TACs, despite some evidence of limited targeting by a few operators. It is also known that substantial quantities of gemfish (mainly juveniles) have been, and are being, discarded (83 t in 2004). New South Wales applies a 50 kg/day trip limit for all fishing methods.

2004 landings (80 t) were higher than those for 2003 (76 t) and 2002 (62 t), leading to industry claims that the stock is recovering. However, the size composition of the spawning population showed most fish to be 35–75 cm fork length, with very few fish aged above five years, whereas a ‘recovered’ population would contain mainly 65–95 cm fish aged five to ten years. The recommended 2005 (bycatch) TAC remained at 100 t.
A genetic study showed the western gemfish to be a single stock distributed from western Bass Strait across the Great Australian Bight to about Geraldton, Western Australia, in depths of 250–500 m. The biology of western gemfish appears to be similar to that of eastern gemfish, except they are thought to spawn in summer rather than winter. Unlike eastern gemfish, spawning fish aggregations are not targeted.

The Commonwealth trawl and scalefish-hook sectors are located at the eastern boundary of western gemfish distribution; they are taken almost exclusively by the trawl sector. Annual catches from 1992 to 1995 never exceeded 50% of the 300 t TAC. Standardised catch rates were stable from 1991 to 2000, but have since declined. The 2004 value was the lowest on record. However, it is not clear whether catch rates relate to overall abundance. An increase in fishing effort west of Bass Strait saw landings of western gemfish generally increase during the 1990s until, in 2000, they exceeded the TAC (336 t). However, landings for 2002 to 2004 have been less than 200 t.

Quotas do not apply in the adjacent Great Australian Bight trawl sector, where recent annual landings have risen significantly to 384 t in 2004. Urgent consideration should be given to complementary management controls in the two fisheries and the appropriateness of a global TAC in that context. No formal assessments of western gemfish have been made, nor are there yield estimates, so it is not known whether current catches are sustainable. It is uncertain whether overfishing is occurring.
Stock-structure studies have been ambiguous and a single common stock off southeastern Australia is assumed for management purposes. Jackass morwong live mainly at depths of 50–250 m and are taken predominantly by the trawl sector. They are long-lived (35 years), and grow to a length of 50 cm. Annual recruitment is highly variable.

The jackass morwong TAC was 1500 t through 1992–99, but was never reached. However, this TAC was partly based on yield estimates derived from parameters calculated from whole-otolith ageing. Sectioned-otolith ageing data showed morwong to have greater longevity (35 years) and lower natural mortality rates than were previously reported, implying a less-productive resource (so fishing rates should, likewise, be lower). The TAC was reduced to 1200 t in 2000 and to 960 t from 2002 onwards. Although annual landings have been comparatively stable at around 800 t since 1997, catch rates have declined.

A quantitative assessment was conducted in 2004, using the software package Coleraine. The assessment modelled the impact of five historical and current fishing fleets on the morwong population. The base-case model estimated current spawning biomass to be 37% of the unfished (1915) biomass. A more recent re-run incorporating 2003–04 catch data increased this estimate to 44%. However, there are concerns that the assessment may be optimistic; the decline in catch rates may have been under-estimated, because of new fishing grounds being accessed. The assessment indicates the stock to be not overfished and recent catch levels to be sustainable.
John dory

Zeus faber

**STATUS:** Uncertain

John dory is widely distributed in the temperate latitudes of the world, mainly in depths of less than 200 m. Little is known of its biology and life-history in Australia. The Australian distribution is from southern Queensland to the central west coast of Western Australia, but it is not common around Tasmania and to the west of Bass Strait. The stock structure in the AFZ is unknown, and a common stock is assumed for management purposes. John dory is largely taken as a bycatch of fishing for other shelf species. Thus, the size of the John dory catch largely depends on how much fishing effort is directed at the depth strata they occupy. It is therefore very unlikely that changing the John dory TAC would affect its fishing mortality. Also, a significant proportion of John dory landings in southeastern Australia comes from non-SESSF fisheries, particularly the trawl fishery north of Barranjoey Point near Sydney, and a sizeable recreational fishery.

It is not known whether overfishing is occurring. The annual catch exceeded the TAC in 1993 and 1994, declined to a historic low of 103 t in 1997, but increased thereafter. Unstandardised catch rates have declined since the late 1980s, and have been below AFMA’s reference point since 1995. However, catch-curve analyses indicated fishing-mortality rates to be less than natural-mortality rates and no long-term trends in the size structure of the catch are apparent. No formal assessments of John dory have been made, so there are no yield estimates and the status of the fishery remains uncertain.

2004: Recommended combined TAC 240 t. Allocated TAC 258 t (257 t trawl; 1 t non-trawl). Catch 166 t trawl. Discards 1 t

2005: Recommended combined TAC 240 t. Allocated combined TAC 260 t

**REFERENCE POINT:** CPUE only
Mirror dory

*Zenopsis nebulosus*

**STATUS:** Uncertain

The stock structure is unknown, but age compositions and growth rates differ east and west of Bass Strait. A common stock across the fishery is assumed for management purposes. Mirror dory are found from southern Western Australia to northern New South Wales, most commonly in depths of 300–500 m. Preliminary ageing data suggest that mirror dory can live for about 12 years and grow to 70 cm long. Little is known of their biology. Changes in the size compositions of annual catches, and annual fluctuations in SESSF landings, suggested that their recruitment is variable. However, these fluctuations may be associated with environmentally-driven shifts in their availability to fishers.

Early mirror dory landings were largely taken as a bycatch of unrestricted fishing for eastern gemfish. With the decline of the eastern gemfish stock, the shift away from gemfish trawling resulted in a drop in mirror dory catch-rates and landings. Annual landings fell to a low of 208 t in 2000, but have since improved. Landings in 2003 exceeded the TAC and the 2004 TAC was increased mid-season to prevent discarding of marketable fish because of limited quota availability. Landings appear to be driven by the cyclic availability of larger (>40 cm) fish. Discarding of small mirror dory is common east of Bass Strait.

No formal quantitative assessments have been conducted. Standardised catch rates have been stable over the past six years and catch-curve analyses indicate fishing mortality to be less than natural mortality. The stock’s status is uncertain. The recommended TAC was reduced from 800 t in 2001 to 576 t in 2003 and 2004, but was increased to 700 t in 2005.

**2004:** Recommended combined TAC 640 t. Allocated TAC 638 t* (603 t trawl). Catch 566 t trawl. Discards 170 t (*Increased from 576 t mid-season)

**2005:** Recommended combined TAC 700 t. Allocated combined TAC 736 t

**REFERENCE POINT:** CPUE only
Ocean perch
*Helicolenus* spp.

**Status:** Uncertain

The TAC includes two distinct species: an inshore species *Helicolenus percoides* (also known as coral cod); and an offshore species *H. barathri* (which dominates landings). Catch data are separated by the 200 m depth contour to distinguish between them. *H. barathri* can grow to 44 cm long and live more than 60 years, but few fish older than 15 years have been recorded in landings east of Bass Strait.

Trawl surveys by the FRV *Kapala* in 1976–77 and 1979–81 indicated that the abundance of *H. barathri* had declined significantly over that period on the trawl grounds off New South Wales. Later surveys suggested a further decline in abundance between 1979–81 and 1996–97, and a significant decline since 1976–77 in the representation of larger length groups in the species length-composition. The reasons for this are uncertain. However, ISMP data show little evidence of a decrease in the size of *H. barathri* in recent commercial catches. Catch rates for *H. percoides* have declined steadily over the past decade and ISMP data also indicate a decrease in size over the past five years. About 90% of *H. percoides* in catches are too small to market.

Trawl landings have been relatively stable since 1993 and thus considerably lower than the TAC since its increase in 1994. Since 2002, an increasing proportion of the catch is being taken by the non-trawl sector, largely by auto-longlining. Unstandardised trawl catch-rates for both ocean perch species remain well below AFMA’s minimum reference rate. No quantitative assessments have been made, and it is not known whether current catches are sustainable. The status of both species is uncertain. Because much of the ocean perch catch is below marketable size and discarded, particularly that of *H. percoides*, actual catches have often reached or exceeded recent TACs. The high level of discarding is of concern.

**2004:** Recommended combined TAC 500 t. Allocated TAC 535 t (428 t trawl; 107 t non-trawl). Catch 22 t inshore species, 352 t offshore species, totalling 374 t (298 t trawl; 85 t non-trawl). Discards (trawl only) 194 t inshore species, 41 t offshore species

**2005:** Recommended combined TAC 500 t. Allocated combined TAC 542 t

**Reference Point:** CPUE only
Orange roughy are widely distributed within the temperate latitudes of the world. In Australia, they occur from central New South Wales, southwards around Tasmania and across the Great Australian Bight to southwest of Western Australia. They also occur on seamounts and ocean ridges off southern Australia and on the South Tasman and Lord Howe rises. Orange roughy are most common between depths of 800 m and 1000 m. Within the Commonwealth trawl sector there are four management zones where quota management applies—eastern, southern, western and Cascade Plateau—and a northeastern remote zone beyond them.

Despite considerable research, the stock structure in the SESSF remains uncertain. Industry observations, geography and biological information, suggest there are two stocks in the southern management zone. Of these, the Maatsuyker Island stock appears to be independent of other eastern and southern management-zone stocks, but the Pedra Branca Island stock probably extends into the eastern management zone. Geography and biological information indicate that orange roughy on the Cascade Plateau are a distinct stock.

Orange roughy live for well over 100 years and mature when aged 20–30 years. Fecundity is low, rarely exceeding 90 000 eggs per female. They can grow to about 55 cm. Natural mortality is very low at less than 5% per annum. The aggregating behaviour of orange roughy makes them very vulnerable to fishing. They form spawning aggregations between mid-July and late August. St Helens Hill, a seamount off eastern Tasmania, is the only known major spawning site in the SESSF, although spawning has been confirmed in other areas—off St Patrick’s Head (south of St Helens) and at least three sites in the southern management zone. A regular spawning aggregation on the Cascade Plateau has been fished since 1996.

Within the SESSF, the orange roughy catch is taken entirely by trawling. The first substantial quantities were taken in the late 1980s when several non-spawning aggregations were discovered off western Victoria and western Tasmania. The discovery of the large spawning aggregation at St Helens Hill in 1989, together with non-spawning aggregations on seamounts south of Tasmania, resulted in a marked increase in landings. The combined catch from these two areas is estimated at about 34 000 t in 1989, taking into account losses from nets bursting, other gear damage and discarding. Despite a catch limit of 12 000 t each for the eastern and southern management zones, the estimated catch rose to a peak of about 53 000 t in 1990. In 1992, TACs totalling about 18 000 t and allocated as ITQs were adopted for the eastern, southern and western management zones collectively. However, the quota monitoring system was inadequate and some operators substantially under-declared their catches. The total 1992 catch was subsequently estimated to have been about 31 000 t. As SEF stocks became fished down, catches have declined.

AFMA’s stated management strategy for orange roughy within the SEF, adopted in 1994, was ‘to maintain the spawning biomass above 30% of pre-fishing levels as at 1988. If there is a greater than 50% probability that the stock is below 30% of the pre-fishing biomass, then the TAC is set such that the biomass reaches 30% by 2004’.

In other words, the intention was to rebuild to the target level within 5–10 years. AFMA also specified that ‘Where there is greater than 50% probability that the stock is below 20% of the 1988 spawning biomass, [in other words, the limit level], then the TAC will be zero and remain at zero until there is a greater than 50% probability that the spawning biomass exceeds 20% B_{88} [i.e. 20% of the 1988 biomass].’
Industry endorsed the harvest strategy and it was adopted in 1994. However, although TACs were reduced sequentially, they did not constrain catches in the southern and western management zones. The zero-catch strategy was not implemented formally when assessments indicated that the biomass had fallen below the limit reference point. TAC levels were too high, with uncaught quota carried over to the following year. Consequently, in both these zones, TACs have ‘chased’ catches down. Recent stock-rebuilding projections allow for a much longer ‘recovery’ time for overfished stocks, with a continuing low level of fishing. Long-term harvest strategies have yet to be formally agreed on. The appropriateness of such low target and limit reference points for such a long-lived species also warrants scrutiny.

Only in the eastern management zone, in which good catches continued to be made from the St Helens Hill and St Patrick’s Head spawning aggregations, did TACs limit catches.

Since 1997, the Cascade Plateau fishery has been a valuable component of southeastern landings, with a TAC of 1600 t in place since 1998. Before 2001, the TAC was split into four annual quarters to spread fishing effort and gain information on the developing fishery. The TAC was then allocated as ITQs and now extends throughout the year. Industry currently observes a voluntary closure during the buildup and peak of the spawning aggregation to ensure that annual acoustic surveys can proceed undisturbed.

Considerable resources have been directed towards orange roughy assessment since the fishery began. Assessments have been based on a combination of fishery-independent surveys and fishery-dependent data such as catch and effort. External reviewers concluded that this approach was as good as the best methods used elsewhere in the world. Fishery-independent acoustic surveys, which provided snapshot estimates of biomass, were carried out at St Helens Hill each year from 1990 to 1993 and in 1996 and 1999, and in the southern management zone in 1992 and 1994. An egg survey at St Helens Hill in 1992 also provided an absolute estimate of biomass. Because of the high cost of using a dedicated research vessel, commercial vessels with hull-mounted transducers made the recent acoustic surveys in the eastern management zone and have done so on the Cascade Plateau since 1999. Generally, these surveys have not provided quantitative biomass estimates, but this is changing as industry vessels upgrade their sounders to ones compatible with scientific-survey techniques.

Since 1989, there have been several groups and organisations involved with orange roughy assessments. A dedicated Orange Roughy Assessment Group (ORAG) was formed in 1997 and carried out all detailed assessments until 2004, when it was replaced by a Deepwater Assessment Group. ORAG’s assessment methods and results were again externally reviewed in 2002, with the overseas reviewers agreeing that best practice was being used. There is now an extensive literature on orange roughy research and assessment, but only key assessment findings are cited below.
A joint CSIRO–industry acoustic survey of the spawning aggregations in 1999 on St Helens Hill and the nearby St Patrick’s Head ground found the biomass on St Helens Hill to be about 7% of the estimate for 1990. This rose to about 19% if the St Patrick’s Head estimate—higher than expected—was included in the ‘St Helens’ biomass. In 1999 and 2000, more fish were caught from St Patrick’s Head than from St Helens Hill. It was not known whether these fish were a common stock, although size–age data suggested distinct populations. Hence, the 2001 assessment examined three scenarios: (1) a single stock and a single fishery; (2) a single stock and two fisheries; and (3) two stocks and two fisheries. Also, all age-composition data were used to arrive at a single natural mortality rate, thus removing earlier conflicting advice based on two natural mortality rates. Scenario 2 did not fit the model well so was not examined in detail. For scenarios 1 and 3, there was a 68–99% probability that the current biomass was less than AFMA’s target biomass. Furthermore, there was a 51–86% probability that this target could not be reached if the 2002 to 2004 catches were zero. As these results showed that the assessments are extremely sensitive to the inclusion of age-composition data, ORAG arranged for further ageing work to be carried out.

Otoliths collected from the 2001 spawning event resolved the sensitivity to age-composition data in the 2002 assessment. The current biomass was estimated at 7–13% of pre-fishery biomass. In view of AFMA’s limit reference point of 20% of pre-fishery biomass, continuing to harvest, albeit much less, still constitutes overfishing. In all cases, and with future catch levels set at 1600 t, 800 t and 0 t (slightly higher for scenarios including Pedra Branca fish), the probability that the biomass in 2004 would have been less than 30% of the 1988 biomass was greater than 50% (range 75 to >99%). Thus, AFMA’s performance criterion for this fishery could not have been met, even with zero catch.
In summary, the results of the major 1997, 2000 and 2001 assessments were in conflict, although all indicated the need to reduce catches. The 1997 and 2000 assessments concluded AFMA’s target reference point could be met if the TAC were reduced to between 500 t and 1000 t (lower rate of natural mortality), or with no change in TAC (higher rate of natural mortality). The TAC remained at 2000 t from 1997 to 2000. The 2001 TAC was reduced to 1800 t. In the 2001 assessment, most scenarios indicated that the reference point could be met only if the TAC was reduced to between 0 t and 500 t. However, two scenarios that used only part of the available age-composition data indicated that the reference point could be met with no change to the TAC. Overall, the 2001 assessment was that it was increasingly unlikely that AFMA’s reference point could be reached without a substantial reduction in the TAC. Incorporating additional age-composition data, the 2002 assessment concluded that it would take between 5 and 16 years to reach AFMA’s reference point with a zero catch, and between 8 and 26 years with an 800 t catch.

There was no 2003 assessment, as ORAG concentrated on developing feasible long-term monitoring strategies that could measure any recovery of the stock biomass. Under a three-year monitoring plan, St Helens Hill was closed to fishing in 2003 and 2004. This closure became mandatory in 2005. Industry-based surveys were conducted during the 2004 and 2005 spawning seasons to check for changes in spawning time, dynamics or school size. A multi-frequency towed-body acoustic survey is planned for 2006.

Irrespective of survey results, AFMA’s current management objectives and performance indicators cannot be met for this stock. New objectives and indicators urgently need to be developed. In the meantime the 2005 TAC remained at 720 t, with an additional 100 t being allocated for the winter survey work.

All assessment scenarios in 2000 indicated that AFMA’s target reference point could not be met even with a zero TAC for the southern zone. Standardised catch-per-shot abundance indices (using data only from vessels that had regularly fished this zone) estimated the abundance in 2001 to be about 7% of that in 1989. The 2003 catch was slightly higher than in 2002 (167 t), but demonstrated the low remaining biomass. However, a 2004 update of the abundance indices incorporating the limited (32 shots only) 2003 catch data was more optimistic. A consistent upward trend of catch per shot from 2001 to 2003 indicates that rebuilding is probably occurring. This fishery is now effectively closed, with the TAC of 100 t being essentially a ‘bycatch’ TAC to allow targeting of other deepwater species.
Western Zone

**STATUS:** Overfished and overfishing is occurring

2004: Recommended TAC 450 t trawl. Allocated TAC 450 t trawl. Catch 321 t trawl

2005: Recommended TAC 450 t trawl. Allocated TAC 487 t trawl

An initial attempt to provide an assessment in 1997 for the western management zone was unsuccessful because of difficulties in interpreting the catch-and-effort data, the only data available on relative abundance between years. The first assessment was made in 1999. The ORAG used 1985—the year before significant commercial fishing began—as the reference year for AFMA’s management strategy. The abundance index was catch-per-shot, for shots of one hour or less, from vessels that had been in the fishery for at least five years and had fished for at least two of the last four years. An assessment was presented for the entire western management zone (assessments for smaller areas were unreliable). The probability that the biomass in 2004 would have been less than 30% of the 1985 biomass was greater than 90%, even with a zero catch. The probability that the 1999 biomass was less than 20% of the 1985 biomass was 97%. Thus, were AFMA’s management strategy to be implemented, there was strong evidence for adopting a zero TAC.

Assessments have been hampered by speculation over stock structure and possible links with orange roughy populations in the Great Australian Bight fishery. The establishment of a spatial closure in a possible spawning area was used to justify the 2005 TAC remaining at 450 t. However, no significant spawning is known to occur in the region. Comparison between otoliths collected in 1994–96 and 2004 showed a marked change in modal age indicative of a heavily fished stock, but it is uncertain whether all the otoliths came from the same “stock” of fish. Despite uncertainty about current stock status, there is little doubt that it is overfished and overfishing is occurring under the current non-restrictive TAC. As with the eastern zone, new management objectives and indicators urgently need to be developed.
At-sea observations during the 2001 survey suggested that the 2001 spawning biomass was larger than that in 2000, and that there may be annual variability in spawning. The 2002 survey estimated a spawning biomass similar to that in 2000. More recent (2003 and 2004) surveys suggest a decline in peak biomass. However, these estimates from acoustic surveys are based on school area, with limited knowledge of the density of fish within the school. Thus, these surveys are considered to be poor estimators of absolute orange roughy biomass.

An integrated assessment model with an age- and sex-structured population-dynamics model was used in the 2004 assessment. The pre-fishery (1989) population was not estimated to be large (between 20 000 and 38 000 t). Over all the scenarios used in sensitivity analyses, the 2003 biomass was estimated to be between 36 and 60% of pre-fishery biomass. Given the comparatively low productivity of Cascade fish compared with orange roughy in mainland slope waters, the sustainable long-term yield for this fishery is well below current catch levels and is probably between 200 and 400 t. However, the 2005 TAC was only reduced by 200 t, from 1600 t to 1400 t. The Deepwater Assessment Group recommended that an appropriate management target for this fishery “is that the biomass 10 years in the future (2015) should be greater than 30% of pre-fishery biomass, with a probability greater than 90%”. Most modelling scenarios indicate that an annual catch of 400 t or less is required to attain this target.

Cascade orange roughy are considerably larger and older than fish of this species in the other management zones and have a very low (0.02) estimated natural mortality. There was no formal stock assessment for this fishery before 2004 because of an inadequate time-series of data. The Cascade Plateau has now been fished consistently since 1996. Total reported catches to the end of 2004 are 15 367 t. No trend was observed in the catch-per-shot data from 1997 to April 2001, due to the large differences between vessels and changes in management regulations. This catch series ended with the change from a competitive TAC to ITQs in 2001.

Industry-led surveys in 1999, 2000 and 2001 described the dynamics of the spawning aggregation and the fishery. Acoustic estimates for 2000 suggested the spawning biomass was in the range of 5000–15 000 t.
**Oreo dories**

Oreo dories are usually caught as a bycatch of orange roughy targeting, but have been targeted in some localities. Quotas were introduced for oreo dories in 2005.

**Smooth oreo dory**

*Pseudocyttus maculatus*

**Status:** Uncertain on Cascade Plateau; overfished elsewhere

Smooth oreos occur in depths 650–1500 m. Unvalidated age estimates indicate smooth oreos to be slow-growing and long-lived. In New Zealand they reach a maximum age of about 90 years, mature at around 25 years at a length of about 34 cm and do not appear to have a distinct spawning season. There are no biomass estimates for Australian stocks, but a marked reduction in recent landings and catch rates indicates smooth oreo to be overfished except on the Cascade Plateau, where catches and catch rates have remained relatively stable. In the eastern and southern orange roughy management zones, significant but unquantified discarding of oreos occurred during the ‘boom’ orange roughy catch period of 1989 to 1992. It is not known whether current TAC levels are sustainable, but the low ‘combined’ TAC of 50 t should prevent target fishing occurring in 2005.

**Other oreo dories**

Spiky oreo (*Neocyttus rhomboidalis*)

Black oreo (*Allocyttus niger*)

Warty oreo (*A. verrucosus*)

Ox-eyed oreo (*Oreosoma atlanticum*)

**Status:** Overfished

**2004:** Catch: Cascade Plateau 101 t, Elsewhere 120 t

**2005:** Recommended and allocated Cascade TAC 100 t. Recommended and allocated TAC for combined eastern, southern and western management zones 50 t

**2004:** Catch 202 t

**2005:** Recommended and allocated TAC for combined Cascade, eastern, southern and western management zones 200 t
Australian catches of other oreos have been dominated by spiky oreo, with small landings of the other three species. The following comments refer only to spiky oreo. Little is known of their biology but, like smooth oreo, they are long-lived and slow-growing. There are no biomass estimates for Australian stocks, but a marked reduction in recent landings and catch-rates indicates spiky oreo to be overfished. Although Cascade Plateau catch rates have remained relatively stable, only a small proportion of the catch (e.g. 11 t in 2004) is caught there. In the eastern and southern orange roughy management zones, significant (but unquantified) discarding of oreos occurred during the ‘boom’ orange roughy catch period of 1989 to 1992. It is doubtful whether the current TAC level is sustainable, as it is close to recent depressed catch levels.

**Pink Ling**

*Genypterus blacodes*

**STATUS:** Not overfished but overfishing occurring

**2004:** Recommended combined TAC 1800 t. Allocated TAC 2001 t (1111 t trawl; 890 t non-trawl). Catch 1610 t (1133 t trawl; 477 t non-trawl). Discards 1 t

**2005:** Recommended combined TAC 1400 t. Allocated combined TAC 1400 t

**REFERENCE POINT:** CPUE only
Pink ling are found from southern Western Australia to central New South Wales, mostly in depths of 300–550 m. They mature at 5–7 years, can live for about 30 years, and grow to 130 cm long. A genetic and morphometric study was unable to distinguish the stock structure, so a common stock has been assumed for management purposes. However, there are clear and persistent differences in catch compositions between areas. Annual trawl sector landings rose until 1997, but have since declined. Trawl catch rates have been below AFMA’s reference point since 2000. Non-trawl catches increased sharply during the early 1990s, but were then limited by the global TAC introduced in 1998. However, recent non-trawl landings have risen sharply with the increased transfer of quota from the trawl sector and auto-longline effort increasing and expanding westwards into the Great Australian Bight. About half the 2004 catch was taken by the non-trawl sector. As the sizes and ages of fish taken by the non-trawl sector are much greater than those in the trawl sector, auto-longlining is almost certainly having a greater impact than trawling on the spawning biomass. Ling aggregate to spawn in distinct areas and regional/seasonal spawning closures to fishing were introduced in 2005 as a precautionary measure.

Whereas a 1996–97 survey by FRV Kapala off southern New South Wales indicated that pink ling abundance had not decreased since 1976–77, catches and standardised catch rates east of Bass Strait have declined since 2000. West of Bass Strait, standardised trawl catch rates are relatively stable but show a gradual decline since the mid-1990s. The size compositions of trawl and non-trawl catches have been stable in recent years.

Early stock assessments could not reconcile the standardised catch-per-unit-effort series with the catch-at-age and length-frequency data. Whereas size–age data indicated a heavy fishing mortality, catch rates had remained comparatively stable. Catch rates have since declined. The fishery has had a greater impact on eastern pink ling populations: the mean size of fish caught has declined and there appears to be growth overfishing. A mesh-selectivity study showed current trawl codends have a 50% selectivity for pink ling of about 45 cm length, which is sub-optimal from a yield-per-recruit perspective. Modelling projections in a 2004–05 quantitative assessment indicated that catches of 1200 to 1400 t were sustainable, but catches over 1600 t were not. This was consistent with projections made in 2003. However, the current assessment is not robust enough to provide reliable abundance estimates. Recent annual landings have exceeded 1600 t and overfishing has been occurring. The reduced 2005 TAC of 1400 t should limit catches, but growth overfishing remains a problem in the east.
Tagging studies suggest a common redfish stock off New South Wales, but growth studies suggest there may be some north–south stock structuring. Redfish commonly occur from northern New South Wales to eastern Bass Strait. They are long-lived (over 35 years) and slow-growing (to 40 cm long), with the bulk of the catch being fish aged 3–10 years. A study of their reproductive biology is currently underway.

Redfish is caught almost exclusively by the trawl sector, with over 90% caught off New South Wales. Small catches are also taken north of the Sydney, but few redfish are caught west of Bass Strait. Catch data suggest that the stock has cyclic fluctuations in availability, possibly related to the Southern Oscillation Index. Landings declined from 1760 t in 1984 to 730 t in 1989, causing concern about the stock. TACs of 600 t were set in 1992 and 1993 to limit catches and allow stock to rebuild. However, from 1992 to 1994 there were substantial overruns, with fishers claiming that the bulk of their catch was taken from State waters where no quota applied. The introduction of State trip limits in 1994 subsequently closed this loophole, but annual catch totals (including discards) exceeded 3000 t from 1993 to 1995.

Results from a preliminary cohort analysis in 1998 were consistent with the 1993 stock assessment suggesting that the recruited biomass of redfish declined significantly between 1970 and 1990. The 1998 assessment also suggested that an

**Redfish**

*Centroberyx affinis*

**Status:** Overfished; and growth overfishing occurring

**2004:** Recommended combined TAC 1575 t. Allocated TAC 1570 t (1563 t trawl; 7 t non-trawl). Catch 539 t (538 t trawl; 1 t non-trawl). Discards 377 t

**2005:** Recommended combined TAC 1300 t. Allocated combined TAC 1454 t

**Reference Point:** CPUE only
improvement in recruitment during the early 1990s had contributed to increased catch rates and higher biomass levels during this period. However, it has since been suggested that improved catch rates were largely attributable to the increasing use of bobbin gear, which opened up previously unfished areas. Nevertheless, there were indications that both recruitment and biomass may have declined since that time. This trend in recruited biomass between the mid-1970s and the mid-1990s was consistent with the findings of the FRV Kapala re-survey of the continental slope grounds off New South Wales. However, the validity of the cohort-analysis estimates of biomass for the most recent years was uncertain, and the estimates were not consistent with industry’s perceptions of continued high availability of redfish throughout the fishery off New South Wales. The high fishing-mortality estimates for recent years were also queried by the then SEF assessment group as being unrealistic.

A 2001 assessment centred on developing a dynamic ‘integrated analysis’ population model and understanding factors that may influence redfish catch-rates. Major problems with model specifications include the lack of any age-composition data before 1991 and uncertainty about a possible north–south stock structure off New South Wales. Despite the uncertainty with assessments, the evidence of ‘growth overfishing’ (taking too many small fish) of redfish is strong, and this problem still needs to be tackled. There was also strong evidence that the adult biomass has fallen to an estimated 25% of the unexploited level, but this estimate should be viewed with caution—the assessment model did not fit the trend in catch size-composition from 1975 to 1990. There has been no formal assessment since 2001, although a 2004–05 study evaluated harvest strategies using larger mesh, or square mesh, codends.

Size-composition data show a continuing increase in the proportion of small (17–19 cm fork length) fish in catches from Ulladulla, a trend that has been evident since observations began in 1993. No discernible trend is apparent in the size compositions of catches by vessels working from Eden.

There is significant at-sea discarding of redfish. Whereas the discarded portion of the catch was low (6% by weight) in 1999, it rose to 23% in 2000 after the closure of a surimi (fish-mince) plant and continued to rise in 2001 (40%) and 2002 (52%). Discards in 2003 and 2004 were still high at 36%. Most of these discards were small fish, which emphasises the problem of growth-overfishing in this fishery. Recent catches have been well below the TAC and 2004 landings were less than a quarter of the most recent peak landing of 2071 t in 1993. Catch rates continue to fall, with the 2004 catch rate being the lowest recorded. Although there are large uncertainties about the current biomass levels of redfish stocks, there is little doubt that they remain overfished. The recommended 2005 TAC was reduced by 17% to 1300 t.

<table>
<thead>
<tr>
<th>Year</th>
<th>Catch (thousand tonnes)</th>
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<tbody>
<tr>
<td>2001</td>
<td>101 t trawl, 138 t non-trawl</td>
</tr>
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<td>2002</td>
<td>100 t</td>
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**Ribaldo**

*Mora moro*

**STATUS:** Uncertain

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2004: Catch 239 t (101 t trawl, 138 t non-trawl)

2005: Recommended combined TAC 100 t. Allocated combined TAC 100 t
Ribaldo occur throughout SESSF slope waters and are most common at depths of 500–1000 m. They reach lengths of about 75 cm for females and 65 cm for males. Little is known of their life cycle and behaviour, but they do not appear to form spawning aggregations and are usually caught as a bycatch of targeting other deepwater species. No information on their age, growth and natural mortality is available. Annual trawl landings were typically comparatively low (<50 t) before 2002, but have since grown to about 100 t. The advent of auto-longlining has also seen annual hook catches increase to around 100 t from 2002 onwards. The overall 2004 landings of 239 t were the highest on record, but the precautionary 100 t TAC, introduced in 2005, should prevent further rapid development of this fishery. Nothing is known of resource size and productivity, so the appropriateness of this TAC level currently cannot be determined.

**Royal red prawn**

*Haliporoides sibogae*

**STATUS:** Uncertain

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**2004:** Recommended TAC 500 t trawl. Allocated TAC 553 t trawl. Catch 172 t trawl (plus 49 t from New South Wales waters). Discards 43 t

**2005:** Recommended TAC 500 t trawl. Allocated TAC 554 t trawl

**REFERENCE POINT:** CPUE only
Reproductive studies suggest there is a common stock of royal red prawn along the entire New South Wales coastline in depths of 350–550 m. Catches are taken exclusively by the trawl sector, and almost all from New South Wales. The New South Wales-managed fishery to the north of Barranjoey Point is not subject to quota control.

Catch levels have fluctuated with market demand, which has been low since 2002. Landings peaked at 485 t, just below the TAC, in 2000. The 2004 catch was the lowest since 1992, but the 2004 catch rate was above AFMA’s reference point. Unstandardised catch rates have been relatively stable over the past decade. However, industry are limiting their catches to suit processing demand, confounding the usefulness of catch rates as a crude indicator of stock abundance. No formal assessments have been made since 1994, and no sustainable yield estimates are available. Carapace-length–frequency distribution in annual catches has remained stable and there is minimal discarding. Despite recent catch rates suggesting that catches at the 500 t TAC level are sustainable, it is still not certain whether this catch level can be maintained. The recommended TAC for 2005 remained at 500 t.

**Silver trevally**

*Pseudocaranx dentex*

**STATUS:** Overfished, and overfishing is occurring

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2004: Recommended combined TAC 320 t. Allocated TAC 319 t (286 t trawl; 33 t non-trawl). Catch 465 t (463 t trawl including 324 t from State waters; 2 t non-trawl). Discards 41 t

2005: Recommended combined TAC 320 t. Allocated combined TAC 320 t

**REFERENCE POINT:** CPUE only
Silver trevally are widespread, having a distribution southwards from North West Cape in Western Australia, around to northern Queensland, usually in depths of less than 200 m. A pilot stock-structure study suggests there is a common stock across the fishery.

Little is known of the biology of silver trevally. They grow to 60–70 cm long, appear to mature at two years of age off New South Wales, and reach an age of over 46 years in New Zealand (the Australian estimate is 25–30 years). Although the bulk of the silver trevally catch is taken by trawling, significant catches are made by non-trawl and recreational fishers. Most landings occur in New South Wales, where catches peaked at about 1800–2000 t in the mid-1980s and then started to decline. Unstandardised trawl catch-rates fell below AFMA's reference point in 1998 and have remained there, despite improving slightly in 2003 and 2004.

Size-composition data for the early years of the fishery are inadequate, but strongly suggest the mean size of trevally in both commercial and recreational catches has dropped significantly since the late 1980s. In recent years, the modal size of trevally in commercial catches has been 20–25 cm, which is very small for a fish that can grow to around 60 cm long. The data from the fishery suggest that the trevally stock is being growth-overfished, with too many fish being caught well below their optimum size. Significant increases in yield (per recruit) would be obtained from increasing the size at first capture at current exploitation rates. However, there is a market preference for ‘plate-sized’ fish and larger fish are less vulnerable to trawling, as their greater swimming speed enables them to escape capture. Introducing a minimum size limit (New South Wales is contemplating a 30-cm limit) would result in a large proportion of the catch being discarded.

Commercial landings are less than half those of the mid-1980s and have been well below the TAC until the recent TAC reduction. An age-structured ‘integrated analysis’ assessment was carried out in 2004–05 using fisheries data extending back to 1945. Estimates of current biomass are sensitive to assumed natural mortality values, but all scenarios indicate that the stock is below 20% of its 1945 level (noting that fishing occurred before then) and is overfished. The model indicated that recruitment has remained relatively stable since 1985. The recommended TAC has been reduced from 500 t in 2001 to 400 t in 2002 and 320 t in 2003, and has remained at 320 t thereafter. The slight increases in landings and catch rates from 2000 onwards have probably resulted from increased targeting of this species in coastal waters and not from any increase in their comparative abundance.

Management is complicated by the multi-jurisdictional and multi-sectoral nature of the fishery. Almost 70% of the 2004 catch reported against quota was taken by dual-endorsed SESSF vessels from waters under State jurisdiction. Hence the 2001 to 2004 TACs were exceeded. AFMA's reductions in the SESSF TAC have not limited and cannot control catches. The total 2004 catch of silver trevally from all sectors, which includes the 465 t reported against quota and the catch from the New South Wales fishery, was 913 t. A revised OCS arrangement with New South Wales and/or complementary management measures are needed to effectively reduce the fishing mortality of silver trevally.
**Spotted warehou**

*Seriolella punctata*

**STATUS:** Not overfished

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**2004:** Recommended combined TAC 4039 t. Allocated TAC 4479 t (4391 t trawl; 88 t non-trawl). Catch 3313 t (3311 t trawl; 2 t non-trawl). Discards 1183 t

**2005:** Recommended combined TAC 4400 t. Allocated combined TAC 4400 t

**REFERENCE POINTS:** CPUE; target stock biomass—at or above 40% of the unfished biomass (i.e. average spawning biomass between 1986 and 1988); limit stock biomass—20% of unfished biomass

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A recent stock-structure study indicated a single stock east and west of Bass Strait. A common stock had previously been assumed for management purposes. Spotted warehou mature at 3–4 years, live for about 11 years and grow to 65 cm long. They occur throughout the SESSF in depths to 500 m. Their schooling behaviour often results in large catches being taken, mainly by the trawl sector, although non-trawl (gillnet) fishers occasionally target them. Annual recorded landings have risen from 600 t in 1984 to a peak of 4100 t in 2002, mainly because of increased catches west of Bass Strait. In recent years, a large proportion of the catch has been taken as a bycatch of the winter fishery off western Tasmania for spawning blue grenadier.

An age-structured ‘integrated analysis’ assessment model was developed during 2001–02. The biomass trajectory estimated by the base-case model indicated a decline since 1997. Recruitment to the fishery is variable and strong year-classes had entered the fishery in 1993 and 1994. Thus, a biomass decline would have occurred in the absence of fishing as these two cohorts passed through the fishery. The model estimated that the female spawning biomass in 2001 was about half its unfished biomass. Standardised catch rates show a slow decline in recent years. However, there is complex spatial variability with catch rates. For example, catch rates of spotted warehou by the blue grenadier spawner fishery off western Tasmania have doubled since 1991–92. Because of these inconsistencies, AFMA’s nominal-catch-rate performance criterion appears inappropriate for the species.

Industry has expressed no concern about the status of the stock. Marketing of the species remains a problem and is largely responsible for relatively high levels of discarding. More recent (2004) modelling results indicate that the fishery is now impacting on the stock, but current biomass levels are about 60% of the unfished biomass. Future projections indicate that annual catches, including discards, of around 5500 t
over five years would lead to a 50% probability of stock biomass falling below the target reference level. Confidence levels around current and reference biomass estimates are wide, but the 2004 assessment is more optimistic than that in 2002. The fishery is classified as not overfished, but requires careful monitoring.

Catches exceeded the agreed TAC between 1993 and 1997, except for 1995. Because the abundance of spotted warehou appeared to be high in 1997, the 1998 trawl sector TAC was increased to 3500 t, then progressively to 4488 t by 2002. The 2002 trawl landings of 4101 t were the highest on record, but catches have since been lower. Poor market prices again resulted in significant discarding (21%) in 2004. The recommended TAC for 2005 was 10% higher than in 2004, returning to its 2002–03 level.

**Reliability of the assessments**

Fishery-independent biomass estimates are available for only two fisheries: the eastern zone orange roughy and the winter blue grenadier fishery. Annual acoustic/trawl surveys of the spawning biomass of orange roughy on the Cascade Plateau are also providing some quantitative information on that fishery. Biomass estimates, where available, for the other species are derived from fishery-dependent data. The ISMP is providing detailed catch-composition data for many species, and age-composition estimates for some are regularly made. Both sets of data cover around a decade, although longer time-series are available for a few species. Age-structured modelling has been undertaken, or is underway, for blue grenadier, blue and spotted warehou, eastern gemfish, eastern school whiting, flathead, jackass morwong, pink ling and redfish. ‘Integrated analysis’ models are now the preferred tool of assessment groups. However, for less commercially significant quota species, the main means of assessment is examination of catch and effort trends and catch composition (sex, size, age) data. Comprehensive biological data are available for very few species.

Assessments relying principally on catch rates as an indicator of abundance are affected by such factors as improvements in horsepower and gear technology (for example, global positioning systems and plotters), and environmental variability. When fishing power increases, the use of unstandardised catch rates leads to optimistic assessments. Fishing behaviour and targeting practices have also changed since the introduction of ITQ management, making interpretation of catch rates even more difficult. Statistical techniques to standardise fishing effort are being used, but such factors as changes in fishing behaviour cannot usually be covered adequately. A generic standardisation technique has not been developed, and the techniques used vary between assessment groups. The influence of environmental factors on catchability is poorly understood, but is being investigated. Thus there is a real possibility that catch rates do not reliably indicate relative stock abundance. Nevertheless, a consistent decline in catch rates is a useful indicator that the species concerned warrants further investigation and a cautious management regime. In the absence of more precise indicators, AFMA still specifies management performance for most species in terms of maintaining catch rates above a target level.

Logbook data, from which catch and catch-rate trends are estimated, are largely not validated. When the logbook became linked with quota monitoring, there were some problems with data quality. For example, there was significant misreporting of catch positions and landings after ITQs were introduced in 1992. Misreporting is now less common, particularly since the introduction of satellite monitoring of the orange roughy fleet and OCS arrangements or State trip-limits for most quota species.

Improved size–age data for many quota species and the continuation of programs such as the ISMP will reduce uncertainties, and longer time-series of data will facilitate more definitive assessments. The formation of individual assessment groups for blue
The basic data used by trawl- and non-trawl-sector management are catch and catch rates (from logbook and landings), catch composition (collected by ISMP) and economic. These should be collected regularly and routinely. Additional data will also be needed to improve stock assessment and management. For example, most SESSF stock-assessment models lack adequate biological information. Limited resources continue to hamper refinement of assessments. For most non-quota species, some of which have been increasingly targeted, very little information is available.

Descriptive information on changes in fishing practices and effort is essential to interpret changes in catches and catch rates. Stock assessment relies predominantly on fishery-dependent data and can be confounded by changes in fishing practices. Despite attempts to quantify such changes and their impacts, the standardisation of catch rates for most species remains a problem. A high priority should be given to collecting fishery-independent data and developing comparative-abundance indices by using commercial vessels for scientific surveys. In some orange roughy fisheries, industry is already conducting acoustic and trawl surveys during the spawning season.

Whereas the stock structure of some species (e.g. blue warehou) has recently been resolved, the assessments of some quota species (e.g. flathead, ling and redfish) are being hampered by the lack of such information. Stock-structure studies are needed for some key species.

Ideally, the setting of a TAC should take into account the probable trends in abundance and size-composition with different catch levels. However, such projections are very sensitive to the stock–recruitment relationship for a species, and there is currently no robust information of this kind for any SESSF species. Several quota species appear to have large fluctuations in recruitment or catchability or both. Analyses of environmental influences on stocks are required. They should take into account not only environmental data but also industry experience. The single-species assessment process has, to some extent, overshadowed the need for multi-species studies; more holistic, fishery-wide assessments are needed. Promulgation of the EPBC Act has heightened the need to assess more thoroughly the effects of fishing on the SESSF ecosystem. The shift to multi-species assessment groups should assist this process.

Environmental issues

The ISMP has shown that bycatch, and subsequent discarding, of both commercial and non-commercial fish species is a major issue for the SESSF. Observed discard rates since the mid-1990s are about 45–50% by weight of the total catch off New South Wales and eastern Victoria and around 35% west of Bass Strait. The ecological and economic implications of such discard rates are not
known, and fishery-independent data on the comparative abundances of discard species are scarce. The FRV Kapala surveys indicated that the abundance of some shark species taken as bycatch had declined dramatically off New South Wales between 1976–77 and 1996–97. A gear-selectivity study in the trawl sector demonstrated that an increase in codend mesh size and/or having square-mesh escape panels will reduce bycatch. As part of the National Policy on Fisheries Bycatch, a Bycatch Action Plan has been developed for the SESSF.

Industry has actively promoted a code of fishing practice aimed at minimising wildlife interactions and bycatch. However, a continuing rise in fur seal populations is also leading to significant seal–fishery interactions in some areas of the SESSF. A monitoring programme to assess the extent of such interactions began in 2005. In contrast, the ISMP recorded a low trawl bycatch of marine birds and reptiles. A research programme has assessed the effectiveness of seal-exclusion devices in mid-water trawls.

The lack of regulations governing the size of footrope gear such as rollers has led to some concern that habitat damage may still be occurring. The use of such gear in previously inaccessible areas has been encouraged, to some extent, by the development of satellite navigation aids. The nature and extent of possible habitat damage within the SESSF are unquantified and little studied. As a precautionary measure, AFMA and the Biodiversity Group of the Department of Environment and Heritage have designated a Marine Protected Area to protect a group of seamounts off southern Tasmania from demersal trawling. The possibility of using such refuges as a management tool for the fishery has yet to be examined in detail.

However, mapping of trawl effort indicates that a comparatively small proportion of the shelf–upper slope area within the SESSF boundary is intensively trawled. Most fishing effort is still confined to historic established grounds. CSIRO has undertaken detailed habitat mapping of some of the major trawl grounds. The EPBC Act came into force in July 2000, with important implications for the SESSF. Management must now formally assess and review environmental and ecological issues, such as the impact of fishing, to fulfil the requirements of this Act.

Small pelagic species such as blue and jack mackerel and red bait are not managed as part of the SESSF. However, they constitute important food items for some quota species and wildlife. In recent years there has been increased harvesting of these pelagic species by midwater trawling. The trophic implications for the SESSF of such increased harvesting should be assessed to ensure that ‘ecosystem overfishing’ does not occur. Cetacean bycatch has also been an issue with this fishery.

The SESSF and state fishing-fleets produce debris, largely of pieces of fishing gear (lost or discarded trawl nets, gillnets, traps, hooks and lines), which may continue to ‘ghost’ fish, litter foreshores or entangle seals and birds. A survey in the waters of Bass Strait and southern Tasmania by the Tasmanian Parks and Wildlife Service found that 1.5–2% of Australian fur seals became entangled in fishing debris. Trawl-net material formed most of the ‘neck collars’. However, it should be noted that the study period (1989–93) encompassed the ‘boom’ years for the orange roughy fishery, when many trawl nets were lost or burst. In June 1995, SETMAC and the South East Trawl Fishing Industry Association endorsed the Trawl Industry Code of Conduct for Responsible Fishing. It contains provisions covering international agreements on the disposal of nets and plastics at sea, in acknowledgment of the need to reduce such debris.

As noted above, the introduction of the EPBC Act has heightened the need to assess more fully the impacts of fishing on SESSF habitats and their fauna and flora. Biodiversity issues are now prominent. The South East Trawl Fishing Industry Association has since revised its Code of Conduct to take into account wider
environmental aspects of fishing activities and is actively promoting more responsible fishing practices. A project entitled Ecological Risk Assessment of Commonwealth Fisheries is currently considering the ecological impacts of fishing on target, byproduct, bycatch and protected species, habitats and ecological communities in the SESSF and other fisheries. A SESSF Ecological Advisory Group has also been established to examine these issues.

Further reading


Management performance

Management performance for the fishery has been poor. In the 12 years since these status reports began, catches have declined, fishing effort has more than doubled and the number of stocks classed as overfished has increased. Management performance has been greatly hampered by conflicting statutory socio-economic and resource-sustainability objectives. Whereas communication and cooperation between industry, managers and scientists have been greatly improved by the creation of management advisory committees, stock assessment groups and the like over this period, management advice and decisions have been insufficiently precautionary.

Assessments that show a decline in the fishery have frequently been disputed by industry, particularly at the management-advisory-committee level. Consequently, catches have generally remained at too high a level and stocks have declined. The major challenge for management is to ensure long-term-sustainability strategies and rebuilding of stocks in an environment of growing socio-economic demand for fish.

Biological management reference points, based on estimates of the current spawning biomass relative to its unfished level, are now used for an increasing number of quota species. However, decision rules (i.e. agreed responses that management must make in defined circumstances) for when a target or limit reference point is reached have yet to be formally adopted and enforced. For example, although some orange roughy stocks have been below their limit reference points for some years, AFMA has not applied its stated “zero TAC” strategy (see orange roughy, above) to aid stock recovery, and overfishing continues. Despite numerous debates about the need to control catches of non-quota species of commercial value, little has been done about it since ITQs were introduced in 1992. Ribaldo and oreo dories now have catch controls, but several other non-quota species are still being actively targeted. In the absence of controls on fishing effort (see...
below), these species should be brought into the ITQ management system, albeit belatedly. Oreodories are already overfished.

Whereas AFMA’s catch rate performance criterion is being increasingly replaced by biological reference points, it still technically applied to 14 quota species in 2004. A decline in catch rate below the criterion should theoretically be a trigger to examine the status of the stock more closely. In 2004, 12 species did not meet their catch-rate criterion, but SESSFAG’s limited resources resulted in only six of these species being quantitatively assessed during the 2004–05 assessment period.

Given uncertainties in the assessments, the TACs for the SESSF are still based in many instances on inadequate information. Discarding at sea is still at high levels for some quota species and such discards are currently not debited against the TAC. In many instances the risks to sustainability associated with current TAC levels are unknown. It will still be some years before the status of most quota species relative to the management objective of long-term sustainability can be assigned with any confidence. Progress is being made in developing risk assessments and harvest strategies to cope with assessment uncertainty. However, the results from 2004–05 trials of a harvest strategy using fishing-mortality rates as reference points were inconsistent (see box: Harvest strategy framework).

Although the number of active vessels has fallen by about a quarter since ITQ management began, annual trawl effort (hours bottom-time) in the fishery continues to increase, and hit a new peak in 2004. Part of this effort increase can be attributed to a shift away from target fishing to ‘mixed-species’ quota fishing because of individual quota restrictions or market demands and increased targeting of non-quota species. However, declining catch rates are indicative of an overall decline in fish abundance and there is little doubt that fishers are ‘fishing harder and catching less’. The effective effort in a ‘bottom-time hour’ is undoubtedly much greater in 2004 than in 1992 because of improved technology. The increasing use of large midwater trawls and the recent permitting of twin-rig trawl gear and pair trawling are exacerbating the increase in effective effort. In the scalefish-hook sector, several input controls have been relaxed or abolished, nominally “to maximise economic efficiency”, since ITQ management was introduced. AFMA’s decision to issue further auto-longlining permits has led to a marked increase in demersal-longline effort in areas of the fishery previously experiencing comparatively little fishing pressure. Increased fishing effort is almost certainly impacting on many SESSF fish stocks, particularly bycatch species, but such impacts remain largely unquantified. The absence of specific management controls, other than the generic limited-entry and TAC controls, to limit effort in the fishery has to be rectified. Fishing effort has to be reduced if stocks are to be rebuilt to optimal levels.

More spatial management is needed. A stock-structure study of blue warehou indicates that there are two stocks, one east and one west of Bass Strait. Both stocks are managed under a common TAC. A high priority should be given to establishing separate management areas and TACs for each stock. Similar stock-structure studies for pink ling were ambiguous, but did not rule out the possibility of separate stocks on either side of Bass Strait. Other quota species may also require separate stock-management arrangements when their stock structures are better known. The closure of St Helens Hill to protect spawning orange roughy and the introduction of spatial spawning closures for pink ling are steps in the right direction.

OCS issues between the Australian Government and New South Wales have still to be resolved. The Australian Government has reached agreement with all other States on acceptable jurisdictional arrangements for the SESSF. Complementary management measures for stocks shared with the Great Australian Bight trawl fishery are also needed.