



Australian Government

Australian Fisheries Management Authority

Upper-Slope Dogfish Management Strategy

AFMA-managed Fisheries

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Executive Summary

Four species of upper-slope dogfish have undergone significant declines in south eastern Australia as a result of fishing pressure: Harrison's Dogfish, Southern Dogfish, Endeavour Dogfish and Greeneye Spurdog. AFMA's Ecological Risk Assessment process for the Commonwealth Trawl and Auto-Longline Sectors of the Southern and Eastern Scalefish and Shark Fishery (SESSF), together with Conditions on the Wildlife Trade Operation for the SESSF, identified the need for specific management measures for these species. In addition, Harrison's Dogfish, Southern Dogfish and Endeavour Dogfish have been nominated for listing as threatened species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). While a decision not to list Endeavour Dogfish has been made, the Threatened Species Scientific Committee is yet to consider the listing of Harrison's Dogfish and Southern Dogfish.

AFMA has implemented management measures for upper-slope dogfish in stages. Catch limits were first introduced in the early 2000's, spatial closures in 2007 and additional spatial closures and revised catch limits were implemented in 2010, under the original Upper-Slope Dogfish Management Strategy (original Strategy). Currently, a network of seven targeted spatial closures, covering more than 4738 km² between the depths of 200m to 650m is closed. AFMA notes that the Musick Review (2011) of these measures indicates that the decline in biomass of both species has been halted and more needs to be done to rebuild it.

This Upper-Slope Dogfish Management Strategy has been developed by AFMA, in consultation with the fishing industry, scientific experts, conservation NGOs and other stakeholders. The Strategy seeks, in particular, to ensure that the management requirements to satisfy a Conservation Dependent listing under the EPBC Act for Harrison's Dogfish and Southern Dogfish are in place. The objective of the original Strategy was to stop the decline of, and support the recovery of Harrison's Dogfish and Southern Dogfish so that their chances of long term survival in nature are maximised. The original Strategy would also help to mitigate the impact of fishing on Endeavour Dogfish and Greeneye Spurdog.

The management actions contained in the new Strategy are designed specifically to rebuild the populations of Harrison's Dogfish and Southern Dogfish above a limit reference point (B_{LIM}) of B_{25} (25% of unfished biomass), in line with the Commonwealth Fisheries Harvest Strategy Policy. Given the multi-species nature of the fishery it may be that the biomass does not reach B_{TARG} (50% of unfished biomass). This outcome is consistent with the Commonwealth Fisheries Harvest Strategy Policy. In the absence of biomass estimates for these species a habitat proxy has been used for biomass. These settings are in excess of the defaults required for commercial species under the HSP in recognition that these species are long lived and characterised by low biological productivity. These characteristics, and in particular late age of maturity, also dictate that recovery periods will be protracted. The recovery time to B_{25} is estimated at around 86 years for Harrison's Dogfish, and 62 years for Southern Dogfish.

The Strategy relies on a new network of spatial closures supplemented by a range of operational measures including regulated handling practices, 100% monitoring, move-on provisions and no retention of gulper sharks. The Strategy also outlines options to access



some shallower waters through a possible night time closure. The details of these operational measures will be implemented through various legislative instruments prior to mid-February 2013.

The development of the new network of spatial closures involved three main steps:

1. locate the most prospective general areas (Candidate Areas) within the distributional range of each species;
2. identify options for closures (Area Options) in each Candidate Area that contrast a range of conservation and socio-economic objectives; and
3. evaluate the collective properties of sets of Area Options as a network (Closure Network).

The relative contribution of the identified Area Options to protection and recovery of Harrison's Dogfish and Southern Dogfish was then assessed on the basis of habitat area as a proxy for biomass, and also habitat area weighted by carrying capacity (the habitat area's ability to support dogfish populations). Both of these proxies can be used to inform the level of protection being afforded to the upper-slope dogfish. The assessment has resulted in a new network of closures to be implemented under this Strategy that involves the extension of four existing closures, the addition of three new closures and the revision of three closures.

A summary of protection afforded to Harrison's Dogfish and Southern Dogfish by existing and new closures based on habitat area weighted by carrying capacity is provided in Table 1. New, extended and revised closures are identified by an asterisk. The new Closure Network will provide protection, across the depth range, of 25% of the carrying capacity weighted core habitat of the continental slope stock of Harrison's Dogfish, 16.2% of the east stock of Southern Dogfish and 24.3% of the central stock of Southern Dogfish, in AFMA-managed waters. This closure network also protects 25% for Harrison's Dogfish, 25.9% for eastern Southern Dogfish, and 20.1% for central Southern Dogfish of core habitat area. A further 8.6% of central Southern Dogfish core habitat area is outside of the GAB Trawl Sector allowed area of waters and is not included in the protection figures. While this area does not cover the entire depth range of the species (between 200 – 900m for Southern Dogfish), it is effectively closed to GAB trawl offering protection to central Southern Dogfish.

While this closure network only protects 16.2% of the carrying capacity habitat area for eastern Southern Dogfish, areas that may have provided higher protection have been determined to not hold viable populations for rebuilding, which was one of the criteria in selecting candidate areas. Noting that over 25% of core habitat is closed across the stocks depth range. Further protection to these species is afforded through closures that do not cover the species whole depth range, temporal closures and complementary management arrangements. In addition, the SESSF allows multiple gear types and therefore some closures are designed for certain gear types only. This means that even if those closures cover the required depth range they do not fully protect the species. AFMA considers the complementary arrangements for line vessels (monitoring program, interaction limits and move-on provisions) will provide an equivalent level of protection in those closure areas.



Table 1: Protection of core habitat (carrying capacity weighted) in Commonwealth managed waters area under the new closure network (%)

Closures	Harrisson's Dogfish	Southern Dogfish	
	Continental Slope	East	Central
Harrisson's Gulper closure	1.70	1.01	
*Babel Island closure	<i>Inc. in Extended Flinders Research Zone closure</i>	<i>Inc. in Extended Flinders Research Zone closure</i>	
*Cape Barren closure	<i>Inc. in Extended Flinders Research Zone closure</i>	<i>Inc. in Extended Flinders Research Zone closure</i>	
St Helens Hill closure	0.64³		
700 m closures	10.21³	12.57³	5.69³
Area 1			5.26
Area 2			0.43
Area 3	0.71		
*Area 4	<i>Inc. in Extended Flinders Research Zone closure</i>	<i>Inc. in Extended Flinders Research Zone closure</i>	
Area 5	0.23	0.24	
Area 6	0.38	0.59	
Area 7	6.40	9.83	
Area 8	1.01	0.77	
Area 9	<i>Inc. in Extended Endeavour Dogfish Closure</i>	<i>Inc. in Extended Endeavour Dogfish Closure</i>	
Sydney Cable North	2.16	1.66	
Sydney Cable South	2.49	1.91	
60 mile closure (GAB and shark hook)			8.17
Current Endeavour Dogfish closure	4.92	3.78	
Current Port MacDonnell closure			0.75
Racetrack/Hamburger Orange Roughy closure			0.46
Kangaroo Hill closure			4.67
*Extended Flinders Research Zone closure	6.85	3.56	
*Extension to Endeavour Dogfish Closure off Sydney	7.08	5.44	
*Extension to Port MacDonnell Closure			1.59
* Murray Dogfish closure (GABT and CTS)			7.54¹

¹ Closures apply for trawl gears only while still allowing line fishing. However due to the complementary management arrangements for line fishing, AFMA considers these closures will provide equivalent protection to the species. The 700 m closures apply to trawl gear only, however it should also be noted that historically line fishing does not occur deeper than 600m.



Closures	Harrisson's Dogfish	Southern Dogfish	
	Continental Slope	East	Central
Existing Commonwealth Marine Reserves	0.65 ³	0	6.27 ²
Total	35.22	28.79	35.14³
Total across depth range⁴	25.00	16.22⁵	24.31

Populations of Endeavour Dogfish, Harrisson's Dogfish and, to a lesser extent, Southern Dogfish are also within waters managed by NSW. Actions under this Strategy will be complemented by actions of NSW which has previously implemented a possession limit for dogfish species as a group, and is considering further spatial closures and other management arrangements for Harrisson's and Southern dogfish. It should be noted that the NSW actions are not under AFMA's control.

There is also a western stock of Southern Dogfish that is primarily under the jurisdiction of Western Australia. However, there is limited data for this stock and no assessment of depletion has been made. Up to 33% of the habitat will be subject to closures for some or all fishing methods for this stock, creating large areas of protection, noting some of these rely on proposed Commonwealth Marine Reserves⁶.

This Strategy will be subject to review to ensure the objectives are being met and to consider any new information that may become available through research projects and ongoing monitoring. AFMA will consider the need to review the Strategy following the conclusion of the Commonwealth Marine Reserve Network process and will formally review it after five years.

² Closures across the depth range of the species need to be considered as the only closures providing 100% protection to the stocks. Other closures will provide some level of protection but is hard to quantify.

³ A further 8.6% protection is offered to this stock by the Great Australian Bight Trawl sector area of waters not covering some shallow areas of the core habitat of the Southern Dogfish central stock.

⁴ Closures across the depth range of the species need to be considered as the only closures providing 100% protection to the stocks. Other closures will provide some level of protection but is hard to quantify.

⁵ The closures do not rank as high for the eastern stock of Southern Dogfish as they are positioned close to the edges of their core distribution, therefore not scoring a high carrying capacity. However, the proposed closures have been chosen in areas where there are known populations of Southern Dogfish, increasing the likelihood of rebuilding in these areas. Whilst there may be areas with a higher carrying capacity for eastern Southern Dogfish, the populations in these areas are not sufficient to support any rebuilding.

⁶ See www.environment.gov.au/coasts/mbp/reserves/index.html for a summary of the proposed Commonwealth Marine Reserves.



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Introduction

This Upper-Slope Dogfish Management Strategy (the Strategy) is designed primarily to strengthen AFMA's management arrangements for two species of gulper sharks: Harrison's Dogfish (*Centrophorus harrissoni*) and Southern Dogfish (*C. zeehaani*). The management actions outlined in the Strategy will also provide some protection for other dogfish species including Endeavour Dogfish (*C. moluccensis*) and Greeneye Spurdog (*Squalus chloroculus*). The Strategy applies to Commonwealth waters managed by AFMA, with New South Wales, (NSW), Western Australia (WA) and other jurisdictions responsible for their own actions.

Background

The Ecological Risk Assessment (ERA) process for the Commonwealth Trawl Sector and Auto-Longline Sector of the Southern and Eastern Scalefish and Shark Fishery (SESSF) identified three species of upper-slope dogfish (Harrison's Dogfish, Southern Dogfish and Greeneye Spurdog) at high risk from fishing. It should be noted that the Great Australian Bight Trawl Fishery did not pose such a risk based on its ERA outcomes.

In 2009, Harrison's Dogfish and Southern Dogfish, along with Endeavour Dogfish were nominated for listing as threatened species under the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act). A condition relating to management of Harrison's Dogfish, Southern Dogfish, Endeavour Dogfish and Greeneye Spurdog was attached to the then Minister for the Environment, Heritage and the Arts' accreditation of the SESSF as a Wildlife Trade Operation (WTO) in February 2010.

AFMA had begun developing an Upper-Slope Dogfish Management Strategy in 2009. Stage 1 of the Management Strategy, including reduced catch limits, a number of spatial closures and improved handling practices, was implemented in mid-2010. Stage 2, involving the development of a network of closures across the SESSF, was introduced in December that year. Currently, a network of seven targeted spatial closures covering more than 4738 km² between depths of 200 m to 650 m is closed from the Great Australian Bight to eastern south Australia, eastern Bass Strait and off the coast of NSW.

In July 2011, the Minister for Sustainability, Environment, Water, Population and Communities decided that Endeavour Dogfish was not eligible for listing under the EPBC Act and extended the timeframe for consideration of listing of Harrison's Dogfish and Southern Dogfish until July 2012. A review (the Musick Review 2011) commissioned by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) concluded that AFMA's existing Management Strategy may have stopped the species declines but was inadequate to enable their recovery. AFMA then initiated an extensive process to revise and strengthen the management measures. In recognition of the research, consultation and management considerations underway to achieve this, the timeframe for consideration of the listing nomination was further extended until 28 February 2013.

On 20 July 2011 the Gulper Shark Inter-Departmental Committee met and agreed to use the principles of the Commonwealth Fisheries Harvest Strategy Policy (HSP), to use habitat (or alternative) as a spatial proxy to achieve these objectives, and to form a scientific group to



provide expert advice on specific scientific questions in the development of the revised Strategy. The Upper-Slope Dogfish Scientific Working Group (SWG) was formed and determined that the most appropriate figure for B_{MSY} is 50% (B_{50}), therefore giving a limit reference point of B_{25} . The SWG also agreed that habitat as a proxy, with the incorporation of metrics of abundance, could be used as a proxy for biomass.

Purpose and objectives

This Strategy is a response to the findings of AFMA's ERA process, to the Condition relating to upper-slope dogfish attaching to the WTO accreditation of the SESSF, and to the nomination for listing of Harrison's Dogfish and Southern Dogfish under the EPBC Act. It has been developed in accordance with the objectives of the *Fisheries Management Act 1991* and with the principles of the HSP (Department of Agriculture, Fisheries and Forestry (DAFF), 2007).

The objective of the Strategy is to promote the recovery of Harrison's Dogfish and Southern Dogfish. The Strategy will also help to mitigate the impact of fishing on Endeavour Dogfish and Greeneye Spurdog.

Species description and life history

Biology

Upper-slope species within families Centrophoridae and Squalus, along with sharks in general, when compared with bony (teleost) fishes, have a slower growth rate, later onset of sexual maturity and lower fecundity. These life history characteristics place them at higher risk of rapid stock depletion and, subsequently, make their recovery protracted once depleted (Daley *et al.*, 2002; Simpfendorfer and Kyne, 2009).

Harrison's Dogfish reach lengths up to 114 cm. Males mature at around 83 cm and females at around 98 cm. Females typically give birth to one to two pups on a reproductive cycle that is likely to be longer than one year (Daley *et al.*, 2002; McLaughlin and Morrissey, 2005). An estimate of mean generation time for Harrison's Dogfish has been established as 28.5 years based on dorsal spine bands (Whitely, 2004). Until 2008, the Western Gulper Shark *Centrophorus westraliensis*, that occurs from Shark Bay to Cape Leeuwin in Western Australia, was believed to be conspecific with Harrison's Dogfish but has now been formally separated (White *et al.* 2008).

Southern Dogfish reach lengths up to 103 cm. Males mature at around 80 cm and females at around 96 cm. Females invariably give birth to one pup on a reproductive cycle that is likely to be longer than one year (Daley *et al.*, 2002; McLaughlin and Morrissey, 2005). An estimate of mean generation time for Southern Dogfish has been established as 20.5 years based on dorsal spine bands (Whitely, 2004).

Endeavour Dogfish reach lengths up to 100 cm. Males matures at about 70 cm and females at around 85 cm. Females typically give birth to two pups on a reproductive cycle that is likely to be longer than one year (Daley *et al.*, 2002; McLaughlin and Morrissey, 2005).



Little is known about the biology of Greeneye Spurdog except that it reaches a length of around 99 cm with males maturing by 68 cm (Last and Stevens, 2009).

Distribution

Distributional and depth ranges for Harrison’s Dogfish and Southern Dogfish have been established with a high degree of confidence, although some uncertainty remains about the western distributional range endpoint of Southern Dogfish (Williams *et al.*, 2012a, Part 1).

Range

Harrison’s Dogfish is distributed in the waters off eastern Australia from southern Queensland to south eastern Tasmania. Its distribution includes seamounts off northern NSW, including Lord Howe Island, and southern Queensland. Its core distribution extends from northern NSW to the south east coast of Tasmania. Core and extra-limital⁷ areas of the species’ ranges are identified in Figure 1.



Figure 1: The distribution of Harrison’s Dogfish. (1) core continental margin habitat; (2) core seamount habitat; (3 & 4) northern and southern extra-limital distribution on margin; (5) Fraser seamount extra-limital distribution on seamounts. Source: Williams *et al.*, 2012a, Part 1.

⁷ Extra-limital areas are at the range end-points where abundance is relatively low and/or are areas where the species is represented only by vagrants.



Southern Dogfish is endemic to southern Australia from Shark Bay in Western Australia to Forster in NSW. The species' core distribution extends from Port Stephens in NSW to Flinders Island off Tasmania, and from western Bass Strait to south of Ceduna in the eastern Great Australian Bight (GAB), with a gap in distribution over the Ceduna Terrace. However the distributional status of Southern Dogfish from the western GAB to Bunbury remains uncertain, largely due to a lack of reliable species-specific identification in commercial catch data in that region (Williams *et al.*, 2012a, Part 2). Core and extra-limital areas of the species' ranges are identified in Figure 2.

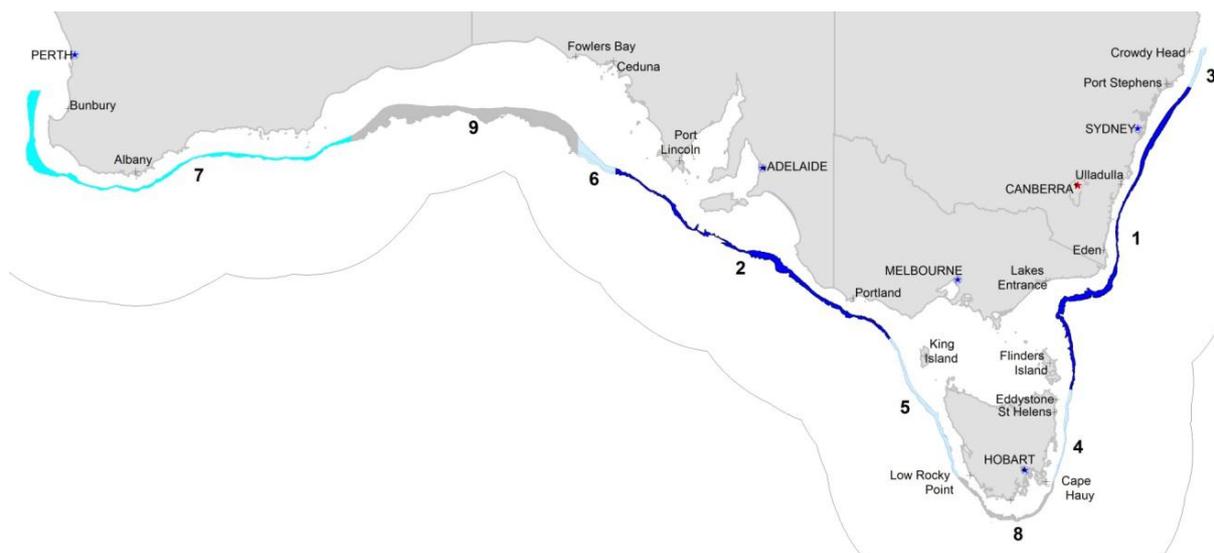


Figure 2: The distribution of Southern Dogfish. (1) core eastern habitat; (2) core eastern GAB habitat; (3) northeastern extra-limital distribution; (4 & 5) eastern and western Tasmanian extra-limital distribution; (6) eastern GAB extra-limital distribution; (7) southwestern area with insufficient data to determine distributional status; (8 & 9) apparent gaps in distribution off southern Tasmania and Head of Bight. Source: Williams *et al.*, 2012a Part 1.

Endeavour Dogfish is more widespread than Harrison's Dogfish and Southern Dogfish, occurring in the western Indian Ocean off South Africa and western Pacific around the Philippines, Indonesia, Taiwan, Japan and Australia. Within Australia, Endeavour Dogfish occurs along the west and east coasts but is uncommon off the south coast of Australia.

Greeneye Spurdog is restricted to waters of south eastern Australia from Jervis Bay in NSW to Eucla in Western Australia (Last *et al.*, 2009).

Depth range and movement

Research has shown Gulper Sharks undertake day-night (diel) migrations across their depth range from relatively deep daytime residence depths (to 1000 m), to shallower night time feeding depths (to 200 m) (Williams *et al.* 2012b).

The depth range of Harrison's Dogfish is considered to be 180 to 1000 m, with a core range of 200 to 900 m. For Southern Dogfish, the depth range is considered to be 180 to 900 m with a core range of 200 to 800 m. (Williams *et al.*, 2012a Part 1).



Endeavour Dogfish has a range of around 150 to 650 m and a core depth of 200 to 550 m (Williams *et al.*, 2012b). Greeneye Spurdog occurs within the depths 216 to 1360 m (Last *et al.*, 2009).

Information on along-slope movement of gulper sharks has been measured by acoustic tracking and conventional tagging. Acoustic tracking detected most (35-45/59) individual sharks within the '60-mile closure' (off South Australia) in any given month. Of nine conventionally tagged Southern Dogfish recaptured after 4 years, seven (75%) had moved 50 km or less (Daly *et al.*, 2012).

Stock structure and separation

Southern Dogfish

The currently available information suggests that there are likely to be three distinct stocks of Southern Dogfish: one along the east coast of Australia down to eastern Tasmania (the eastern stock); one from western Tasmania through the GAB (the central stock); and one from the western GAB to southern Western Australia (western stock). This is based on:

- apparent gaps in the distribution off southern Tasmania, through Bass Strait and Ceduna Terraces demonstrated by the absence of Southern Dogfish in the records from surveys and commercial fishing in these areas;
- differences in the physical characteristics of the seafloor in the upper-slope area off southern Tasmania and on the Ceduna Terrace; and
- limited along-slope movement of the species based on acoustic tagging data from the CSIRO research in the GAB (Upper-slope Dogfish Scientific Working Group (SWG), 2012).

Harrisson's Dogfish

There is less certainty relating to the stock structure of Harrisson's Dogfish. A key uncertainty is the relationship between the populations on the continental margin down the east coast and those on offshore seamounts of northern NSW and southern Queensland, including Lord Howe Island. Based on the available information on stock structure, and noting that there are no specific genetic or tagging studies that directly address stock structure in this species, it is considered that:

- the population of Harrisson's Dogfish that occurs on the continental margin is likely to be a separate stock to that which occurs on the offshore seamounts, based on the large distance and substantial break in habitat (deep water) between these two areas; and
- the populations occurring on the offshore seamounts should be considered as a single stock based on the strong sex-bias in the dogfish that occur at some offshore seamounts which would require movement between seamounts for reproduction (SWG, 2012).



Fishing history

The primary threat to upper-slope dogfish in Australian waters is commercial fishing within Commonwealth and State (primarily NSW) managed fisheries. A summary of the areas and percentages of the different populations of Harrison’s and Southern dogfishes, by fishery and jurisdiction is provided in Table 2. The need for complementary management arrangements between the Commonwealth and NSW is paramount for the success of this Strategy. AFMA understands that this Strategy, together with the Strategy being developed by NSW, will be assessed as the “plan of management” for the purposes of the Threatened Species Scientific Committee’s (TSSC) consideration of the nomination for listing of Harrison’s Dogfish and Southern Dogfish under the EPBC Act.

Table 2: Habitat areas as a percentage of the stocks of Harrison’s Dogfish and Southern Dogfish by fishery/region

Fisheries/Sector/jurisdiction	Harrison’s Dogfish			Southern Dogfish		
	Total area (km ²)	% Continental slope stock	% Seamounts stock	Total area (km ²)	% East stock	% Central stock
Total core area (km²)		19,674	3091		11,980	10156
SESSF (GAB)	n/a			3732		37
SESSF – ‘west’	n/a			6424		63
SESSF – ‘east’	8441	43		6052	51	
SESSF – CTS ‘east’+NSW line methods	5062	26		4596	38	
NSW Fisheries (all gears)	6172	31		1329	11	
SESSF – ‘seamounts’	3091		100	n/a		

Source: Williams *et al.*, 2012a, Part 3.

Commonwealth fisheries

Historically the gillnet method in the SESSF has been known as a key threat to these species, while management arrangements implemented in the last decade have mitigated against these interactions, the Hook method of the Gillnet, Hook and Trap (GHAT) sector and the Commonwealth Trawl Sector (CTS) still are known to interact with these species. Two other Commonwealth fisheries occur within the range of these species. The Coral Sea Fishery (CSF) potentially interacts with the Endeavour Dogfish, and the Western Deepwater Trawl Fishery (WDWTF) potentially interacts with both Endeavour Dogfish and Southern Dogfish. However, given the small number of operators and low, sporadic effort in these fisheries⁸, the impact on these species is considered low. Consequently, this Strategy focuses on reducing the impact of the SESSF on these species.

The SESSF covers nearly half of the waters within the Australian Fishing Zone off mainland Australia and Tasmania, extending from Fraser Island in Queensland and south and west to Cape Leeuwin in Western Australia. It is a multi-species, multi-gear fishery and some sectors of the fishery have operated for more than 85 years. The fishery catches over 80 species of commercial value and is the main provider of fresh fish to the Sydney and Melbourne

⁸ For example, there is only one active operator in the WDWTF and 0 kg of dogfish was reported in the 2011-12 fishing season.



markets. Major ports include Ulladulla, Eden, Lakes Entrance, Portland and Hobart. The SESSF is managed under the *Southern and Eastern Scalefish and Shark Fishery Management Plan 2003* (the Plan) and is divided into four principal sectors (See Figure 3):

1. CTS⁹ which uses predominantly otter trawl and Danish seine methods and some mid-water trawling;
2. East Coast Deepwater Trawl (ECDWT) sector which uses both demersal and mid-water trawl;
3. GAB Trawl (GABT) sector which uses predominantly otter trawl with some mid-water trawl; and
4. GHAT sector which uses primarily scalefish hook and shark hook, shark gillnets and fish traps. Within the GHAT only scalefish hook (including auto-longlines) is now used on the upper-slope areas as shark gillnets and shark hook are restricted to depths shallower than 183 m.

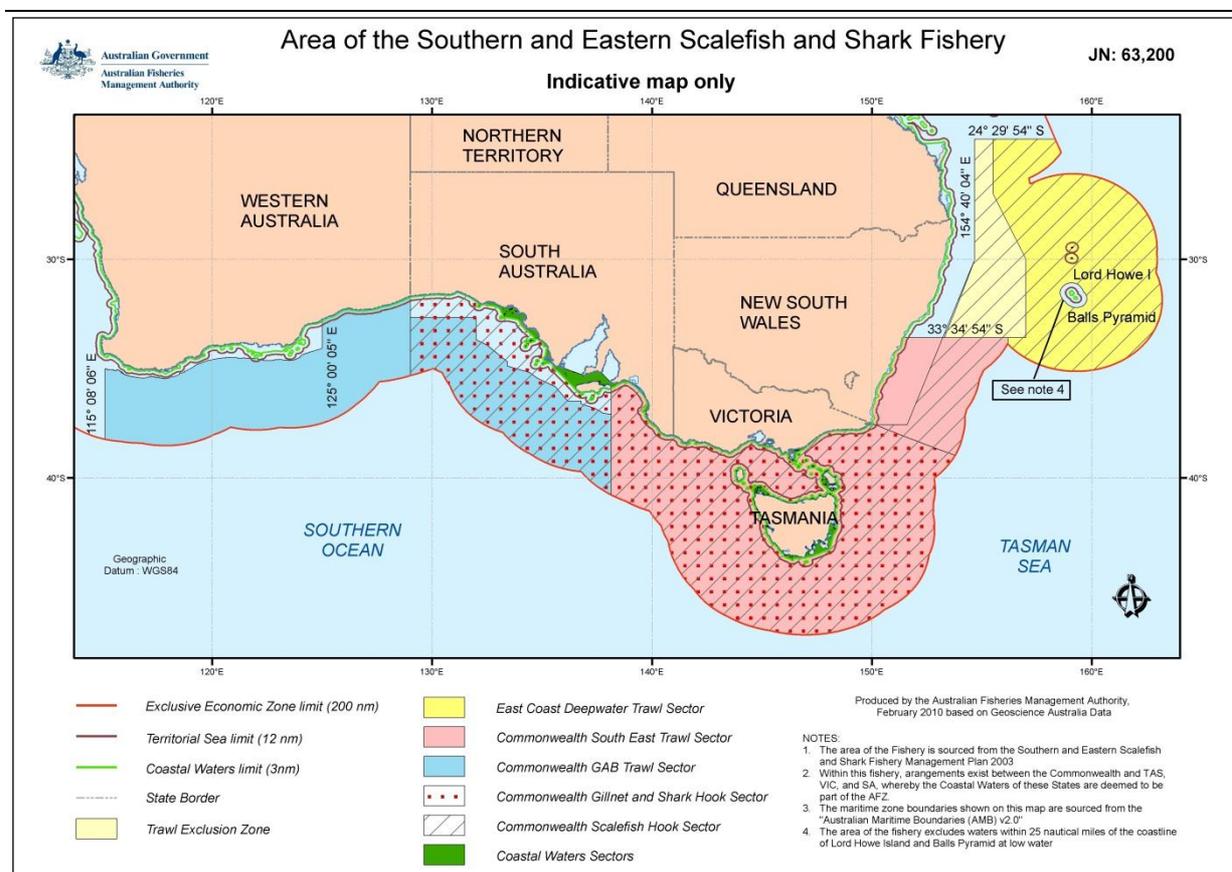


Figure 3: Area of the SESSF and primary sectors.

Of the SESSF sectors, the CTS and auto-longline sector of the GHAT Fishery are currently the most likely to interact with upper-slope dogfish as key fishing grounds and methods overlap significantly with the habitat of these species. However, taxonomic confusion that was not clarified until 2008 (White *et al.*, 2008), combined with the similarity of different species

⁹ For the purposes of the Strategy, CTS refers to the trawl method, not Danish Seine, as the latter does not fish deeper than 200 m.



has meant that accurate catch data from fishing operations on dogfish have only started becoming available since that time. The historic data that is available includes a larger species assemblage than Harrison's Dogfish, Southern Dogfish, Endeavour Dogfish and Greeneye Spurdog (Wilson *et al.*, 2009). For example, catches of Harrison's, Southern and Endeavour dogfish were typically recorded as 'Endeavour Dogfish'. Similarly, catches of Greeneye Spurdog have been recorded along with numerous other species under the generic category 'dogfish'.

Historically, upper-slope dogfish of the genus *Centrophorus* were targeted by some operators in the CTS and shark sector of the GHAT as these have the highest liver squalene (oil) content relative to other dogfish species (Daley *et al.*, 2002). The annual catch recorded under the generic category of 'dogfish', which included *Centrophorus* and *Squalus* spp., among other species, peaked in the SESSF at around 500 t in 1992 (Daley *et al.*, 2002, Walker and Gason, 2005). After this time, catches of upper-slope species declined and operators increasingly began to target mid-slope species (Daley *et al.*, 2002). Further reductions in effort through the Australian Governments 'Securing our Fishing Future' package has seen effort reduced by almost 50% in the CTS and hence reduced the fishing pressure on upper-slope dogfish.

Since the late 1990s, upper-slope dogfish have been taken as incidental bycatch in the SESSF, primarily in the CTS and the auto-longline sector of the GHAT. Trip limits of 150 kg for Harrison's Dogfish, Southern Dogfish and Endeavour Dogfish (as a group) were implemented in the SESSF in 2002/03. This trip limit was subsequently revised in May 2010 to include Greeneye Spurdog, and reduced to a 15 kg daily limit or 90 kg in total for trips exceeding six days in length. The combined landed catch for all gulper sharks (upper-slope dogfish from the family Centrophoridae but interpreted to mainly represent Harrison's, Southern and Endeavour dogfishes) in the SESSF was less than 4.5 t in 2011. In 2010, catch disposal records indicated that approximately 3 t of gulper sharks had been landed and observer reports indicate that a further 0.5 t was discarded (Stobutzki *et al.*, 2011).

State fisheries

New South Wales

Around 31% of the continental slope stock of Harrison's Dogfish and 11% of the east stock of Southern Dogfish overlap with the area of NSW fisheries (see Table 2). Significant catches of *Centrophorus* species have been taken in the NSW Ocean Trap and Line Fishery and the Ocean Trawl Fishery. Annual catches from these fisheries peaked at around 250 t in 1992/93 (Scandol *et al.*, 2008). As in the SESSF, these catches have not been identified to species level and are likely to contain significant catches of species other than Harrison's Dogfish, Endeavour Dogfish and Southern Dogfish. In 2010/11 6.8 tonnes of dogfish were caught in NSW fisheries. 'Dogfish' incorporates *Squalus*, *Centrophorus* and *Deania* sp. It is unknown how much of this catch can be attributed to Harrison's or Southern dogfish, however it is likely to be a small percentage of this total dogfish catch (NSW pers comms).

NSW has undertaken a risk assessment of both commercial and recreational fishing on deepwater sharks and has found, in relation to Harrison's Dogfish and Southern Dogfish, that:



- Harrison's Dogfish is at high risk from dropline and setline/trotline fishing, at medium risk from handline and Royal Red Prawn trawl fishing, and at low or no risk from all other methods; and
- Southern Dogfish is at high risk from dropline and setline/trotline fishing, at medium risk from handline fishing and at low risk from all other methods (NSW Department of Primary Industries, 2012).

The NSW Department of Primary Industries has developed a complementary strategy to assist with the rebuilding of Harrison's Dogfish and Southern Dogfish populations. Their strategy proposes:

- a suite of measures that apply to all recreational, charter and commercial fishing methods to all waters under NSW jurisdiction including
 - zero retention of Harrison's Dogfish and Southern Dogfish, unless for scientific purposes as agreed by Fisheries NSW; and,
 - the development of an education kit for commercial fishers to improve identification, handling techniques and reporting.
- Restricting certain methods that have been identified under their risk assessment as posing increased risks to Harrison's Dogfish and Southern Dogfish. This will be based on depth and area.

NSW have calculated that their strategy protects 25.8% of area weighted by carrying capacity (26.8% unweighted) for Harrison's Dogfish and 21.5% of area weighted by carrying capacity (21.7% unweighted) for the eastern stock of Southern Dogfish.

Western Australia

It is likely that Southern Dogfish were taken in the WA shark fishery that targeted dogfishes for their livers during the 1990s. However, lack of accurate species identification in catch data and taxonomic changes means that the extent of the catch of Southern Dogfish is uncertain. While White *et al.* (2008) have confirmed that Southern Dogfish exist in the western GAB, its abundance in this area is not known (Daley *et al.*, 2002; White *et al.*, 2012a Part 2).

Resource status

Dogfish, and all deepwater sharks in general, have been described by the International Union for Conservation of Nature (IUCN) Shark Specialist Group as being more vulnerable to over-exploitation than perhaps any other marine species group. In Australian waters, while fishers' logbook data and market data indicate clear declines for deepwater dogfish, accurate data on individual species is limited for a range of reasons. These include: taxonomic confusion, difficulty in fishers identifying different species, and catches being reported under generic categories such as 'dogfish' or 'Endeavour Dogfish'. Consequently, methods for assessing the status of individual species are also limited.

To date, the primary source of data that demonstrates significant declines to the species level for upper-slope dogfish is from the fishery independent trawl surveys undertaken by the NSW *FRV Kapala* over a 20-year period. Trawling was undertaken on the upper-slope habitat (200



to 650 m depth) off NSW using the same vessel (FRV *Kapala*), trawl gear and similar sampling protocols in 1976/77 (during the early years of commercial exploitation) and again in 1996/97. This research provided an analysis of the relative abundances of 15 species (or species groups) of sharks (including dogfish) and rays on the NSW upper-slope from the two survey periods between 1976 and 1997. The results described changes in relative abundance after 20 years of trawling on previously lightly unexploited stocks (Graham *et al.*, 2001) based on a dramatic decline in the catch rate of dogfish (*Centrophorus* spp. and *Squalus* spp.):

- In the 1976/1977 surveys the mean catch per unit effort for *Centrophorus* was reported as 139 kg/hr (126.3 kg/hr for Harrison's Dogfish and Southern Dogfish combined and 12.3 kg/hr for Endeavour Dogfish). For Greeneye dogsharks (*Squalus* spp.) a catch rate of 45.2 kg/hr was reported.
- In the 1996-97 surveys, catch per unit effort for *Centrophorus* spp. was reported as 0.6 kg/hr (0.4 kg/hr and 0.2 kg/hr for Harrison's Dogfish, Southern Dogfish and Endeavour Dogfish respectively). This equates to declines in the relative abundances from the upper-slope of NSW between 1976/77 and 1996/97 of between 98.4–99.7%.
- Similarly, the reported catch rate for Greeneye dogsharks (*Squalus* spp.) in 1996-97 was 1.9 kg/hr, a decline of 95.8 per cent since 1976-77.

Wilson *et al.* (2009) conducted a review of all available information on upper-slope dogfish caught in the area of the SESSF, including the *Kapala* surveys and other relevant studies. This review confirmed previous reports of a decline greater than 90% in upper slope dogfish, in particular in Harrison's Dogfish, Endeavour Dogfish, Southern Dogfish and Greeneye dogsharks, over the past few decades.

Based primarily on the results of the *Kapala* surveys, the IUCN (2012) has listed Harrison's Dogfish as Critically Endangered, Endeavour Dogfish as Data Deficient and Greeneye Spurdog as Near Threatened. Southern Dogfish has not been assessed by the IUCN since its taxonomy has been clarified.

While targeted by some operators in the SESSF until the late 1990's, upper-slope dogfish are now a relatively minor bycatch species in Commonwealth fisheries. Consequently, there is currently no quantitative stock assessment for upper-slope dogfish species. Nonetheless, the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), in its annual status report on Commonwealth fisheries, assessed gulper sharks (upper-slope), which includes Harrison's and Southern dogfishes, as overfished and subject to overfishing in the SESSF. Gulper sharks (upper slope) have been considered as overfished since 2005 when they were first included in the status reports and subject to overfishing since 2008 (Woodhams *et al.*, 2011).

Management actions to maintain and recover the stocks

Actions prior to this Strategy

Throughout the history of the SESSF, management arrangements have been implemented that are likely to have had an impact on upper-slope dogfish, either directly or indirectly. Such arrangements include general area closures, depth closures of mid-slope habitat,



establishment of marine reserves, such as the Great Australian Bight Marine Park, and fleet structural adjustment programmes that have removed fishing effort from the SESSF.

However, in 2001/02, in recognition of the declines reported for dogfish, specific catch limits to prevent targeting of Harrison's Dogfish, Southern Dogfish and Endeavour Dogfish were introduced in the SESSF. Following the Ministerial Direction of 2005 to recover overfished stocks and manage the broader environmental impacts of fishing, a large number of area closures were implemented in the SESSF. These closures resulted in 7%¹⁰ of the upper-slope habitat within the area of the SESSF being closed to all forms of fishing, providing direct protection to upper-slope dogfish species (Wilson *et al.*, 2009). In summary, these closures include:

- Endeavour Dogfish Closure, 507 km² closed off Sydney (closed to all Commonwealth fishing methods);
- Harrison's Dogfish Closure, 1231 km² (345 km² of upper slope habitat) closed in eastern Bass Strait (closed to all fishing methods);
- Southern Dogfish Closure (the 60 mile closure), 1339 km² closed off South Australia (closed to all fishing methods); and
- a prohibition on shark gillnetting in waters deeper than 183 m (except in eastern Bass Strait) which immediately halted a significant source of gulper shark mortality.

Further closures dedicated to the protection of upper-slope dogfish were implemented by December 2010 which resulted in 9.5% of the upper slope closed to all demersal fishing methods:

- extension to the Endeavour Dogfish Closure;
- Port MacDonnell Closure (closed to all fishing methods);
- Babel Island and Cape Barren Closures (closed to all fishing methods);
- Barcoo and Taupo Seamounts Closure (closed to all fishing methods);
- shark hook method prohibited from fishing deeper than 183 m;
- extension of the prohibition on gillnet fishing in waters deeper than 183 m to include eastern Bass Strait; and
- extension of the GAB Far West Deepwater closure.

The following closures, which overlap in part with the distribution and depth range of upper-slope dogfish, also offer some secondary protection to these species:

- St. Helens Hill (closed to all trawl methods);
- East Coast Deepwater Trawl Exclusion Zone (closed to all trawl methods);
- West Coast of Tasmania Shark Hook and Shark Gillnet Depth Closure (closed to shark fishing);
- CTS 700 m Depth Closure (closed to all trawl methods);

¹⁰ The upper-slope habitat defined by Wilson *et al.*, 2009 differs to the upper-slope habitat as defined by Williams *et al.*, 2012a Part 1.



- GAB Deepwater Closures (Central West Zone, Salisbury Canyon) (closed to demersal otter trawl);
- Pink Ling Closures (temporal closures closed to all fishing methods);
- Commonwealth Marine Reserves (CMR) (closed to demersal trawl methods) including East Gippsland, Flinders, Freycinet, Zeehan and Murray; and
- Northern and Southern Sydney (Submarine Cable) Protection Zones (closed to all trawl methods and demersal longline).

Taken together, the closures currently in place already protect significant components of core habitat of Harrison's Dogfish and Southern Dogfish stocks. The level of core habitat of each stock protected under these current closures is summarised in Table 3. The western stock has not been included in this analysis as there is limited data available for this stock and it is already covered by an extensive network of existing and proposed closures, and managed fishery research zones that collectively regulate around 33% of the upper habitat. Full evaluation of the total area and effectiveness of the closures for protecting this stock of Southern Dogfish has been deferred pending determination of the final boundaries of the CMRs, whether or not fishery research zones are permanent and which fishing gears are restricted under the CMRs. It should also be noted that line and gillnet fishing methods are under WA jurisdiction. AFMA will continue to monitor Commonwealth fishing effort in this area and implement management measures if required.

Table 3: Total percentage of Core Habitat closed (not carrying capacity weighted) under existing closures.

Species/Stock	Core habitat closed (%)	Core habitat closed in Commonwealth jurisdiction (%)
Southern Dogfish		
Eastern stock	23.35	25.6
Central stock	21.43	21.43
Harrison's Dogfish		
Continental slope stock	18.4	26.64
Seamount stock	25.7	25.7

Source: AFMA 2012

In addition to these spatial closures the following management arrangements for upper-slope dogfish are also currently in place:

- a catch limit of 15 kg daily (retained and discarded), with a trip limit of 90 kg for any trip over six days in length, for all species combined, in the SESSF and CSF;
- An annual trigger limit of 4.5 t for Harrison's Dogfish, Southern Dogfish and Endeavour Dogfish (combined) in the SESSF;

These measures are supported by an auto-longline Code of Practice (SETFIA, 2006) related to handling of dogfish and education programmes for fishers aimed at improving identification and reporting of dogfish.



New Methodology

In response to the nomination to list Southern Dogfish, Harrison's Dogfish and Endeavour Dogfish under the EPBC Act, AFMA sought to strengthen its existing management arrangements for upper-slope dogfish. During this process AFMA referred to the TSSC's *Guidelines for Assessing the Conservation Status of Native Species According to the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act) and the EPBC Regulations 2000* to improve our understanding of the process.

A three step process to identify options for a network of spatial closures was adopted:

1. locate the most prospective general areas (Candidate Areas) within the distributional range of each species;
2. identify options for closures (Area Options) in each Candidate Area that contrast a range of conservation and socioeconomic objectives; and
3. evaluate the collective properties of sets of Area Options as a network (Closure Network).

Evaluation of the options was conducted against the objective to promote the recovery of Harrison's Dogfish and Southern Dogfish in the wider context of AFMA's legislative objectives, including ecologically sustainable development, economic efficiency and cost-effective management.

The application of this process to Harrison's Dogfish and Southern Dogfish required a considerable amount of new information and analysis. The key requirements were:

- establishment of limit and target reference points using a habitat proxy;
- estimation of depletion by species, stock and fishery sub-regions;
- establishment of rebuilding timeframes;
- identification of candidate areas for closures;
- identification of Area and Network options using a management strategy evaluation (MSE) approach; and
- determination of the extent of overlap of existing fishery closures and marine reserves with the distribution of Harrison's Dogfish and Southern Dogfish.

Each of these is discussed below.

Limit/Target reference points

The management actions contained in the Strategy are designed specifically to rebuild the populations of Harrison's Dogfish and Southern Dogfish above a limit reference point (B_{LIM}) of B_{25} (25% of unfished biomass). Given the multi-species nature of the fishery it may be that the biomass does not reach the target reference point (B_{TARG}) of B_{50} (50% of unfished biomass), consistent with the Commonwealth Fisheries Harvest Strategy Policy (HSP). These reference points are in excess of the default levels required for commercial species under the HSP in recognition that, in comparison to teleost fishes, these species are long lived and characterised by low biological productivity.



In the absence of biomass estimates for these species, a habitat proxy has been applied as a proxy for biomass. This approach was suggested by Musick (2011) in reviewing the original Upper-Slope Dogfish Management Strategy. That review suggested that “habitat” could be used as a proxy for population biomass when defining a target for protection and assessing the strategy’s performance. While there are a number of issues associated with the use of habitat as a proxy, the SWG initially considered that it was the best available method for determining adequate protection and recovery of the species. Subsequent to this the SWG suggested the habitat area weighted by carrying capacity (the habitat area’s ability to support dogfish populations) was a more appropriate proxy to use and should be considered in line with the other available information.

The relative contribution of proposed spatial closures to achieving B_{LIM} was evaluated based on area (km^2) and pre-fishery carrying capacity (K) of the area. Both of these estimates provide information on the level of protection offered to Harrison’s and Southern Dogfish under the Strategy.

Depletion estimates and pre-fishery carrying capacity

Williams *et al.*, (2012a, Part 4) have estimated pre-fishery carrying capacity for Harrison’s Dogfish and Southern Dogfish in each habitat segment in the species’ core ranges, both directly and indirectly, and have estimated depletion (the proportion of carrying capacity remaining) and current biomass values for each segment. The resultant depletion estimates for the stocks were:

- **Harrison’s Dogfish** 21% (range 11%-31%)
 - **Continental slope stock:** 11% (range 4%-20%)
 - **Seamount stock:** 75% (range 50%-100%)
- **Southern Dogfish** 13% (range 7% - 25%)¹¹
 - **Eastern stock:** 11% (range 6%-19%)
 - **Central stock:** 16% (range 8%-33%)
 - **Western stock:** estimation not possible.

The depletion rates show that both the continental slope stock of Harrison’s Dogfish and the eastern stock of Southern Dogfish are substantially depleted south of Sydney. While the central stock of Southern Dogfish, east of Kangaroo Island, is also substantially depleted. These results highlighted the need for recovery of these three stocks south of Sydney and east of Kangaroo Island.

Rebuilding timeframes

Given the life history characteristics of gulper sharks, the recovery times for these species from low levels of depletion are likely to be long (multiple decades). Factors influencing recovery times will include:

¹¹ Note these figures do not include the western stock of Southern Dogfish due to the stocks uncertainty and limited data due to limited fishing effort.



- the level of depletion at the start of the management strategy;
- the time taken to colonise previously depleted areas from areas where the species are currently more abundant; and
- any ongoing fishing mortality arising during the recovery phase.

Until further research has been completed it is not feasible to set definitive timeframes for recovery. In the interim, three mean generation times has been adopted as the most appropriate recovery time period for these species. This compares to the one generation plus ten years recovery period prescribed in the HSP. The HSP setting is not considered appropriate for these species as the calculation of the recovery time in the HSP is based on teleost species for which recruitment processes are much different to those of upper-slope dogfish. The low reproductive rates of dogfish means that stocks below B_{LIM} would be unlikely to recover within the standard HSP timeframe, even with complete protection (SWG, 2012).

Based on estimates of age at maturity of 23 years for female Harrison's Dogfish and 14 years for female Southern Dogfish (Whitely, 2004), and using a standard demographic approach, the mean generation time for Harrison's Dogfish is estimated at 28.5 years and 20.5 years for Southern Dogfish. Using these estimates at three mean generation times, the recovery time to B_{25} is estimated at around 86 years for Harrison's Dogfish, and 62 years for Southern Dogfish (SWG, 2012).

Candidate areas

Candidate areas for spatial closures are habitat areas with potential to meet the management objectives of mitigating fishing impacts on upper-slope dogfish and supporting their recovery. These areas were established through the identification of 113 Habitat Segments each of which is a short section of upper continental slope habitat within the distributional ranges of Harrison's Dogfish and Southern Dogfish. They are demarcated by coarse scale attributes including seabed hardness, seabed slope, width of slope and feature type (e.g. canyon, rocky terraces, sediment flats, seamounts). A total of 66 Habitat Segments were identified in the range of Harrison's Dogfish (58 in its core distribution) and 91 Segments in the range of Southern Dogfish (66 in its core distribution).

The Habitat Segments were screened on the basis of: gulper shark abundance; breeding potential; proximity to remaining populations; and habitat condition. In addition, fishery catch and effort were used to assist with the screening process. Candidate Areas (individual Habitat Segments or groups of Segments) were then identified using the Segment information.

Area and network closure options

Based on the Candidate Areas identified, Management Strategy Evaluation (MSE) was used to assess Area Options and Network Options. MSE is a decision support tool to assist in choosing between alternative courses of action where there are conflicting objectives and where there is significant scientific uncertainty in predicting outcomes.

Ten attributes were used to score areas of the upper slope in the process to identify a closure network: abundance of existing populations; breeding success; habitat proximity; habitat



condition; areas of occupancy (length and size of protected areas); extent of occurrence (geographical range of protected populations); number of closures (genetic diversity); boundary requirements (depth); catch value; and fishing effort.

Overlap of closures/reserves with distribution

All existing and proposed closures that were found to overlap some of the core range distributions of the populations of Harrison’s and Southern Dogfish were identified (Williams *et al.*, 2012a Part 3).

Table 4: Summary of existing and proposed closures that overlap core depth and distributional ranges of Harrison’s and Southern Dogfish (%).

Closure Type	Harrison’s Dogfish		Southern Dogfish	
	Continental slope stock	Seamount stock	Eastern stock	Central stock
Fully closed to all gears (encompassing most of species depth range)	7.7	25.6	8.7	6.1
Closed to some gears (encompassing most of the species depth range or gulper shark research zone)	3.9	74.4	4.0	2.7
Marine Reserve Zoning regulates some fishing gears (encompassing most of species depth range)	1.3	0.0	0.0	3.7
Proposed Marine Reserve (final location, zoning and boundaries to be determined)	4.1	0.0	3.0	2.7
Managed fishery areas with partial covering of species core depth range and/or complementing other closures	3.1	0.0	3.9	3.1
Managed fishery area with limited coverage of species depth range not complementing other closures	8.1	0.0	11.0	7.8

Includes closures in NSW Fisheries.
Source: Williams *et al.*, 2012a Part 3

Actions to support recovery of the species

The Strategy relies primarily on many of the steps already taken by AFMA and industry and by enhancing these with an expanded network of spatial closures accompanied by a range of complementary management arrangements. The expanded Closure Network is shown in Appendix A and is based on the methodology described above. Further to the closure network, handling practices will be mandatory for line fishing operations in the fishery. The Network builds on the current closures by implementing three new closures, extending four existing closures and revising three existing closures. Details of these changes are identified in Table 5. Where required, complementary management arrangements are identified.



Table 5: Description of the changes to closures under this Strategy.

Spatial closures	Details	Complementary management arrangements where fishing is permitted inside closures
Extended closures		
Extended Endeavour Dogfish Closure off Sydney (Appendix A, Figure 5)	Extended closure to all methods of fishing across the core depth range	Fishing is not permitted so complementary measures are not applicable.
Extended closure in the Flinders Research Zone (Appendix A, Figure 6)	<p>Extended closure to range from 200m to 1000m for all methods. The extended FRZ will incorporate the existing Babel Island and Cape Barren Closures and one area of the existing 700m line closure</p> <p>Negotiation will continue with industry, and SEWPAC if necessary, with regard to possible trawl fishing between 200 to 300 m in daylight hours</p>	If night time closures are negotiated in future, all fishing will be subject to 100% monitoring*
Extended Port MacDonnell Closure (Appendix A, Figure 7)	Extended closure to all methods of fishing across the core depth range	Fishing is not permitted, so complementary measures are not applicable.
New closures		
Murray Dogfish closure (Appendix A, Figure 8)	<p>New closure</p> <p>Closed to trawling</p> <p>Open to hook methods</p>	<p>Line fishing subject to regulated handling practices, interaction limit per boat and 100% monitoring*</p> <p>Vessel interaction limit of three¹² gulper sharks which if reached the closure will be closed to that boat for 12 months</p>
Derwent Hunter Seamount (Appendix A, Figure 9)	Closed to all fishing methods	Fishing is not permitted, so complementary measures are not applicable.
Queensland and Britannia Guyots (Appendix A, Figure 9)	<p>Closed to demersal longline (including trotline and auto-longline)</p> <p>Open to hydraulic hand reel droplining¹³ only</p>	<p>Line fishing subject to regulated handling practices, interaction limit per boat and 100% monitoring*</p> <p>Vessel interaction limit of three gulper sharks which if reached the closure will be closed to that boat for 12 months</p>

¹² An interaction limit has been developed as a conservative number by AFMA reviewing the possible boats to fish in the closure as the maximum gulper sharks that AFMA consider should be taken from an area.

¹³ Hydraulic hand reel droplining is defined as the individual droplines staying attached to the boat, a maximum soak time of 90 minutes and no more than 25 hooks per individual line.



Spatial closures	Details	Complementary management arrangements where fishing is permitted inside closures
Revised closures		
Barcoo Seamount and Taupo Seamount (Appendix A, Figure 10)	Will remain closed to all trawl methods Will be open to line fishing	Line fishing subject to regulated handling practices and 100% monitoring* Vessel interaction limit of three gulper sharks and if reached the closure area will be closed to that boat for 12 months
Harrisson's Dogfish Closure (Appendix A, Figure 4)	Will remain closed to all fishing methods in an amended depth range (200 m to 1000 m) which reflect the depth range of Harrisson's Dogfish and Southern Dogfish.	Fishing is not permitted, so complementary measures are not applicable.

*100% monitoring by an approved AFMA method

Options for spatial closures for the continental slope stock of Harrisson's Dogfish and the east and central stocks of Southern Dogfish were developed based on this approach. The risk of interactions by AFMA managed fisheries with gulper sharks is considered low in the far west, given the nature and extent of current fishing and proposed marine reserves in these areas. As a result, no additional spatial closures are proposed under this Strategy in relation to the Western stock of Southern Dogfish. In relation to the seamount stock of Harrisson's Dogfish, proposals for CMRs will encompass the current AFMA closures on Barcoo Seamount and Taupo Seamount. In addition the depletion rate analysis suggests that the stock is healthy. While AFMA will apply closures on the Derwent Hunter Seamount, the Queensland Guyot and Britannia Guyot (see Table 5) the aim of this Strategy is to maintain the seamount stock above B_{LIM} and around B_{TARG} , in line with the Commonwealth Fisheries Harvest Strategy Policy.

Further to the new closure network, fishing will also require 100% monitoring (electronic or observer), interaction limits and move-on provisions while fishing in any closure where line fishing is allowed. This includes the areas marked with foot note 13 in table 6 (St Helens Hill closure, Murray Dogfish closure, Murray Commonwealth Marine Reserve and the Freycinet Commonwealth Marine Reserve).

The initial process to identify and evaluate the potential of spatial closures to protect gulper sharks initially used a metric of plan area (km^2) to define a quantitative management target and measure the contribution of various area options towards the target. However, measures of plan area do not differentiate the relative potential value of individual areas in terms of their gulper shark carrying capacity or the level of depletion of gulper shark populations within them. To address this, area-specific estimates for pre-fishery relative carrying capacity (K) were applied to determine the relative conservation value of both existing and potential Area Options (Williams *et al.*, 2012c). The incorporation of carrying capacity has resulted in the estimates of the protection afforded stocks of Harrisson's and Southern Dogfish by closures selected on the basis of area alone, either increasing or decreasing. In particular, the percentage of core habitat of the east stock of Southern Dogfish is reduced from 25.9% to 16.2%, across the depth range, using the revised approach. This reflects that the closures are at the outer edges of the core distribution of this stock therefore protection based on carrying



capacity is lower than when based on area. However, the selected closures relate to initial candidate areas where there are known populations of dogfish (Williams et al., 2012c), so there is a higher chance of rebuilding in these areas within a reasonable time frame compared to areas of higher carrying capacity, but lower populations, in the middle of the core range.

A summary of the level of protection afforded Harrison’s Dogfish and Southern Dogfish by existing and new closures based on carrying capacity is provided in Table 6. New, extended and revised closures are identified by an asterisk. The new Closure Network will provide protection of 25% of the core habitat of continental slope stock of Harrison’s Dogfish, 16.2% of the east stock of Southern Dogfish and 24.3% of the central stock of Southern Dogfish, in AFMA-managed waters. This closure network also protects 25% for Harrison’s Dogfish, 25.9% for eastern Southern Dogfish, and 20.1% for central Southern Dogfish of core habitat area. A further 8.6% of central Southern Dogfish core habitat area is outside of the GAB Trawl Sector boundary and is not included in the protection figures. While this area does not cover the entire depth range of the species it is effectively closed to trawl methods and offers protection to central Southern Dogfish.

While this closure network only protects 16.2% of the carrying capacity habitat area for eastern Southern Dogfish, areas that may have provided higher protection were determined to not hold viable populations for rebuilding (Williams et al. 2012b), which was one of the criteria in selecting candidate areas (Williams et al., 2012a Part 1) . Noting that over 25% of core habitat is closed across the stocks depth range. The SESSF allows for multiple gear types and therefore some closures are designed for certain gear types only. This means that even if those closures cover the required depth range they do not fully protect the species to all types of gear. Complementary arrangements (monitoring program, interaction limits and move-on provisions) will be implemented in all parts of the fishery where closures do not apply to all methods. AFMA considers that these arrangements will provide the equivalent level of protection as the closures that apply to all methods. Further protection to these species is afforded through closures that do not cover the species whole depth range, temporal closures and complementary management arrangements.

Table 6: Protection of core habitat (carrying capacity weighted) in Commonwealth managed waters under the new closure network (%).

Closures	Harrison’s Dogfish	Southern Dogfish	
	Continental Slope	East	Central
Harrison’s Gulper closure	1.70	1.01	
*Babel Island closure	Inc. in Extended Flinders Research Zone closure	Inc. in Extended Flinders Research Zone closure	
*Cape Barren closure	Inc. in Flinders Research Zone closure	Inc. in Extended Flinders Research Zone closure	
St Helens Hill closure	0.64 ¹⁴		
700 m closures	10.21 ¹⁴	12.57 ¹⁴	5.69 ¹⁴
Area 1			5.26
Area 2			0.43
Area 3	0.71		
*Area 4	Inc. in Extended Flinders Research Zone closure	Inc. in Extended Flinders Research Zone closure	



Closures	Harrisson's Dogfish	Southern Dogfish	
	Continental Slope	East	Central
Area 5	0.23	0.24	
Area 6	0.38	0.59	
Area 7	6.40	9.83	
Area 8	1.01	0.77	
Area 9	<i>Inc. in Extended Endeavour Dogfish Closure</i>	<i>Inc. in Extended Endeavour Dogfish Closure</i>	
Sydney Cable North	2.16	1.66	
Sydney Cable South	2.49	1.91	
60 mile closure (GAB and shark hook)			8.17
Current Endeavour Dogfish closure	4.92	3.78	
Current Port MacDonnell closure			0.75
Racetrack/Hamburger Orange Roughy closure			0.46
Kangaroo Hill closure			4.67
*Extension to Flinders Research Zone closure	6.85	3.56	
*Extension to Endeavour Dogfish Closure off Sydney	7.08	5.44	
*Extension to Port MacDonnell Closure			1.59
*Murray Dogfish closure (GABT and CTS)			7.54¹⁴
Existing Commonwealth Marine Reserves	0.65¹⁴	0	6.27¹⁴
Total	35.22	28.79	35.14
Total across depth range	25.00	16.22¹⁵	24.31

The western stock of Southern Dogfish will also be provided considerable protection by the proposed CMRs but due to the uncertain nature of the stock from limited fishing effort, catch data and research these figures were calculated.

¹⁴ Closures apply to trawl gears only while still allowing line fishing. However due to the complementary management arrangements for line fishing, AFMA consider these closures will still provide equivalent protection to the species. The 700 m closures apply to trawl gear only, however it should be noted that historically line fishing does not occur deeper than 600m.

¹⁵ The closures do not rank as high for the eastern stock of Southern Dogfish as the closures are positioned close to the edges of their core distribution, therefore not scoring a high carrying capacity. However, the proposed closures have been chosen in areas where there are known concentrations of Southern Dogfish, increasing the likelihood of rebuilding in these areas. Whilst there may be areas with a higher carrying capacity for eastern Southern Dogfish, the populations in these areas are not sufficient to promote rebuilding within reasonable timeframes.



Economic Impact of closures

The closures implemented under the original Upper-Slope Dogfish Management Strategy represented 0.17% of the total SESSF area. A further 0.09% will be closed under this revised Strategy. In developing new spatial closures under the Strategy, AFMA has focused on core areas of the species' distribution combined with areas of least fishing effort, with a view to maximising opportunities for recovery of the species while minimising the economic impact on operators. To support this approach AFMA analysed fishing data for the period 2008 to 2011 in the areas to be closed under this Strategy and evaluated it against data from the total fishing areas (within the depth range) adjacent to the closures. Overall, AFMA is of the view that it has reduced the economic impact on the overall fishery while meeting the recovery objectives for Harrison's Dogfish and Southern Dogfish.

Role of complementary management arrangements

The Closure Network implemented under this Strategy will be complemented by a range of operational measures that will apply including:

- fishing and handling practices will be implemented across the whole fishery in order to reduce the potential for interactions with upper-slope dogfish (e.g. through changes to soak time) and to minimise post-release mortality (line fishing methods);
- 100% monitoring through AFMA approved methods (electronic monitoring or observer) when fishing in closures to ensure compliance with operational management measures e.g. arrangements to minimise post-release mortality and interaction limits. Closures which allow limited fishing methods and are subject to 100% monitoring include the:
 - St Helens Hill closure
 - Murray Dogfish closure
 - Murray Commonwealth Marine Reserve
 - Freycinet Commonwealth Marine Reserve
 - Taupo and Barcoo Seamount closures
 - Queensland and Britannia Seamount closures; and,
 - possible future night time trawl closure between 200-300m in the Flinders Research Zone.
- move-on provisions with vessel interaction limits for upper-slope dogfish when fishing inside a closure, associated with a 12 month ban from the closure for the vessel reaching the limit; and
- no retention of gulper sharks implemented across the whole fishery to remove any incentive to target the species.

The application of these measures are summarised in Table 5. The details of these measures will be implemented through legislative instruments, including conditions on statutory fishing rights and closure directions.



This Strategy outlines a possible night time closure in shallower waters reflecting the movement of upper-slope dogfish into shallower night-time feeding depths, which may reduce economic impact on trawl vessels (Flinders Research Zone closure between 200-300m). This measure will be available by negotiation if requested in the future and would require offsets elsewhere if there was any reduction in protection for the species.

Compliance risk assessment

AFMA undertakes a risk-based compliance and enforcement program as part of the National Compliance and Enforcement Policy.

In the 2011-12 compliance risk assessment process it was identified that fishing/navigating in closed areas against regulation should be dealt with as a prioritised risk. As such, this risk was assigned to a specific Compliance Risk Management Team (CRMT). The CRMT is responsible for:

- assessing, monitoring and reporting on the locations of boats with regard to closed areas;
- providing routine reports listing all possible breaches, including an analysis of all breaches;
- providing a set of recommended courses of action to the project team and the Operational Management Committee for decision;
- deciding on an appropriate course of action in dealing with breaches identified; and
- continually reviewing the spatial analysis process to allow for the efficient and accurate generation of reports highlighting activity in closed areas.

Operators of boats whose Vessel Monitoring System activity is consistent with fishing or navigating in closed areas are sent a letter from the National Intelligence Unit noting the suspected breach and offering the operator a chance to “show cause”. Serious breaches are referred to National Compliance Operations for further analysis and/or action.

The CRMT also continue to focus on the following as prioritised risks:

- failure to report interaction/retention of protected or prohibited species
- quota evasion and avoidance including:
 - unreported take of quota species and/or misreporting in Catch Disposal Records (CDRs) to avoid quota decrementation
 - non-completion of CDRs by concession holders fishing solely on minor line boat Statutory Fishing Rights.

In order to ensure the general deterrence/presence role is maintained a series of inspections and patrols designed to target identified high risk ports, boats and fish receivers occur throughout the program. AFMA is continuing a risk based compliance and enforcement program in 2012–13 and plans to continue with this program in the longer term (AFMA, 2011).



Role of the Commonwealth Marine Reserves process

In addition to the fishery specific management arrangements being developed by AFMA for upper-slope dogfish, DSEWPaC is currently engaged in marine bioregional planning, and has announced final proposals for a network of CMRs. While these reserves are not designed as fisheries management tools, there is the potential for overlap with AFMA's new spatial closures adjacent to WA and at the Tasmantid Seamounts, and they may provide supplementary protection for upper-slope dogfish species. The boundaries and zoning of these marine reserves have not yet been finalised and proclamation of the network will take some time. This Strategy will, therefore, be implemented in advance of completion of the marine bioregional planning process. AFMA will consider the need to review the Strategy when that process has been finalised.

Implementation plan

Process of implementing instruments to give effect to the revised strategy

The implementation of the management arrangements in this Strategy will require the use of various pieces of legislation. These management arrangements will include:

- spatial closures (with exceptions allowing line fishing in the Murray Dogfish closure, the Barcoo and Taupo Seamount closures, and the Queensland and Britannia Seamount closures)
- 100% monitoring (electronic or observer) on all line boats while in closures that allow line fishing
- An interaction limit on gulper sharks for line fishing methods (while in closures that allow line fishing) with temporal move on provisions if interaction limits are reached
- no commercial retention of dogfish for all fishing methods across the fishery
- not allowing gulper sharks to be taken through auto-longline de-hooking rollers or spiking them with a gaff.

AFMA may give directions to implement partial closures in a fishery under section 41A of the *Fisheries Management Act 1991* (the Act). This section of the Act requires that the South East Management Advisory Committee has been consulted and at least seven days prior to the direction taking effect, AFMA must notify holders of fishing concessions, in writing, about the direction. AFMA plans to implement spatial closures using a direction.

Other non-spatial management arrangements will be implemented under conditions placed on an operator's statutory fishing concession or permit, consistent with sections 22 and 32 of the Act.

OBPR, MAC and Commission approval

The process for the approval of this Strategy has included many steps prior to finalisation. AFMA has held numerous meetings involving scientific working groups, general stakeholders



and government departments. AFMA also conducted port visits to consult on draft management options developed by AFMA.

Once the final management arrangements were developed AFMA consulted with the Office of Best Practise Regulation (OBPR) regarding the expansion and addition of closures. It should be noted the OBPR are only interested in the effect of the most recent changes made to the industry. The OBPR's role is to promote the Government's objective of improving the effectiveness and efficiency of regulation, and do so by assessing whether a regulation impact statement (RIS) is required. In this case the OBPR have provided AFMA an exemption from developing a RIS.

Once the Strategy was finalised it was presented to the South East Management Advisory Committee for comment prior to being presented to the AFMA Commission. The Commission is required to approve the strategy and the legislative instruments that bring it into effect.

Monitoring and evaluation

AFMA will develop a research and monitoring plan for this Strategy within 12 months of the Strategy's implementation. The plan will be developed through the relevant Management Advisory Committees and Resource Assessment Groups, and will be subject to approval by the AFMA Commission. It will consider matters previously raised by the TSSC and others, including:

- Identification of reference sites in areas open and closed to fishing, and those of current and historic abundance, to be sampled through time (nominally every 5 years) to monitor population recovery or decline
- Identification of baseline numbers of individuals in reference sites described above to aid in long-term monitoring of upper slope dogfish populations
- Genetic analysis to define stocks of both Southern and Harrison's dogfish
- Comprehensive life history analysis, particularly age and growth, to refine generation time and recovery potential
- Definition of the extent of movement of Harrison's Dogfish similar to research conducted on Southern Dogfish to define movement of that species.

The plan will also consider the usefulness of existing data collection programs (described below).

AFMA plans to consult on the development of this research and monitoring plan with NSW in order to gain insight into the rebuilding on stocks across their habitat ranges.

Dogfish identification project

Dogfish identification keys and field guides have been produced and industry identification cross checked against genetic samples for accuracy (Koopman *et al.*, 2011). Outputs from this project are assisting industry members and AFMA observers with correctly identifying and reporting dogfish catches. AFMA intends to educate industry on the identification of these



species on an ongoing basis. Upper-slope dogfish identification and the use of these identification keys was part of the AFMA observer training workshop in March 2010 and training in dogfish identification will be an ongoing high priority for the observer program.

To further improve data collection and consequently, monitoring, all SESSF documentation, including the annual Guide to Management Arrangements Booklet, the GABT Boat Operating Procedures Manual and fishing concession conditions, have been updated with the correct species names for Harrison's Dogfish, Southern Dogfish and Endeavour Dogfish. The SESSF Management Arrangements Booklet for 2012 and GABT Boat Operating Procedures Manual also include sections on the management of upper-slope dogfish, highlighting the importance of correct identification and reporting requirements. These sections will be included on an ongoing basis.

An industry initiative to improve the identification of dogfish by skippers in the CTS is the South East Trawl Fishing Industry Association (SETFIA) managed project that aims to train senior crew. This initiative has been supported by the Fisheries Research and Development Corporation (FRDC). The Improved Environmental Work Practices course is nationally accredited through the East Gippsland TAFE. The course includes general modules on society's expectations of the wild catch sector and the importance of reporting threatened, endangered and protected species (TEPS) as well as a specific module pertaining to the identification and reporting of upper-slope dogfish. There has been very strong support for the course, with some oversubscribed. An annual refresher course is planned for late 2012.

The NSW Department of Primary Industries introduced species-specific reporting of shark catches in September 2008 in the Ocean Trap and Line Fishery and in all other NSW commercial fisheries in July 2009. These measures will improve the data collected on dogfish caught by NSW commercial operators.

Dogfish identification by both AFMA observers and fishing operators will be important for ongoing monitoring in areas open to fishing as catch rates from the Integrated Scientific Monitoring Program (ISMP) and commercial catch and effort data are two sources of information that will be monitored.

Observer coverage and the Integrated Scientific Monitoring Program

The ISMP collects information on the quantity, size and age composition of target species for stock assessments and monitors bycatch species as well as interactions with TEPS caught in the SESSF.

This program has varied in its implementation across the sectors of the SESSF in terms of when it was introduced, the level of coverage and different objectives of the program for each of the sectors. For these reasons, a consultant was contracted to undertake a full review of the ISMP sampling design for all sectors for the SESSF in 2009. This review identified a range of coverage options for the SESSF. One of the requirements of the review was to ensure that the program is representative, effective and statistically robust in relation to the monitoring of interactions between SESSF operations and TEPS and high risk species (as identified through the ERA process). AFMA implemented a new sampling regime in July 2010.



It is envisaged that catch rates derived from the revised ISMP sampling design could provide an annual index of abundance for upper-slope dogfish in areas open to fishing.

Fishery Independent Surveys

Fishery Independent Surveys (FIS) provide a time series of abundance indices for target, non-target and recovering species and are becoming increasingly important in the SESSF. In closed areas FISs such as auto-longline surveys and Baited Remote Underwater Video will be the primary method of monitoring. Additionally, there are two FISs in the SESSF that occur in areas open to fishing which may provide some level of monitoring in these areas over time.

The GAB Trawl Sub-fishery FIS, on the main shelf areas of the fishery, has been successfully conducted annually from 2005 to 2011. One of the main objectives of this survey is to determine a relative abundance index of main by-product and incidental catch species in the current shelf fishery. It is intended that this survey now be undertaken on a biennial basis. The frequency of this survey will be reviewed periodically depending on the data requirements of the fishery.

In the CTS, a five-year FRDC funded (with AFMA levy component) trawl fishery independent survey is being undertaken. The survey contributes to the development of independent indices of abundance for CTS species, including upper-slope dogfish. The survey has been conducted annually between 2008 and 2012. The frequency of future surveys will be discussed by the SESSF Resource Assessment Group (SESSFRAG) in 2012/13.

Monitoring frequency

Areas open to fishing will be monitored annually, primarily through the observer program with some data potentially derived from FISs and commercial catch and effort data. Correct species identification by both observers and fishers will be important for monitoring in these areas.

SlopeRAG currently conducts scientific stock assessments for key commercial species inhabiting the upper-slope within the SESSF. SlopeRAG will review new information as it becomes available in relation to the targets and rebuilding timeframes of Harrison's Dogfish and Southern Dogfish, and assess the effectiveness of the Strategy in achieving its objective.

The AFMA Commission is ultimately responsible for the implementation of the Strategy and will perform an ongoing oversight role in its implementation, review and subsequent modification as required¹⁶.

Performance indicators

A relative index of abundance such as catch rate (catch per unit effort) is considered the most realistic performance indicator available.

- Inside closed areas catch rates will have to be derived from fishery independent surveys using, for example, auto-longline surveys and possibly baited remote underwater video.

¹⁶ DSEWPaC will be consulted where necessary during these processes.



- In areas open to fishing, catch rates derived from the observer program could provide an annual index of abundance for both trawl and automatic longline methods. The current management regime in place that is aimed at reducing the catch of these species does add complexity in using this data set. However the ISMP managed by AFMA's observer program has been redesigned to achieve statistically robust coverage of high risk and threatened species. The redesign will improve the power of this data set for monitoring these species into the future. The current SESSF Fishery Independent Trawl Survey may also provide some level of information along with commercial catch and effort data.

Other indicators of performance assessment that could assist experts in monitoring the species but require further work (some of which is under way through the CSIRO project 'Mapping the distribution and movement of gulper sharks, and developing a non-extractive monitoring technique, to mitigate the risk to the species within a multi-species fishery region off southern and eastern Australia') in order to derive targets include:

- Expanded areas of occupancy (within the original ranges of individual species, new records in areas where they are currently believed to be absent).
- Sex ratio (occurrence of mature individuals of both sexes in the same locations confirms and ability to reproduce).
- Size composition (records the distribution of mature and juvenile sharks respectively, indicating locations / distributions of breeding individuals and recruits).
- Genetic measures of connectivity and stock structure (genetic techniques may have potential to measure the degree of mixing between populations, and habitat fidelity at fine spatial scales, but these are exploratory techniques and un-validated for upper-slope dogfish at present).

In time, information from these indicators could be used by Resource Assessment Groups to provide additional evidence of the status of these species and assess if new or modified measures are necessary.

It is unlikely that the full impact of the measures previously implemented and implemented as part of this management strategy will be measurable for a number of years. The biennial review of the management strategy will monitor the performance of management arrangements against its objectives. Management arrangements may also be changed where ongoing monitoring or other information shows a significant change in catch rates or interactions with upper slope dogfish. This may include the expansion or relocation of current closures, addition or deletion of closures, modifications to fishing methods and enhanced monitoring.

Five-year review

While the annual review of the available data will be the principal method of monitoring performance of this management strategy against its objectives, the management strategy itself will be reviewed at the end of its fifth year.

AFMA will report annually on the available data and performance against the goals of the management strategy to DSEWPaC.



Consultation

AFMA's broad-based consultative framework, including through the South East Management Advisory Committee and the SlopeRAG has underpinned the development of this Strategy. A range of additional consultative processes has been implemented to supplement the framework in development of this Strategy:

- Stakeholder meetings and workshops have been held regularly to update members on the current available information, process and timelines. Meetings have included members from industry, researchers, conservation groups, NSW Government and AFMA. AFMA has also held a series of port visits and teleconferences with these groups to discuss options for implementation under this Strategy.
- The Upper-Slope Dogfish Scientific Working Group was formed to provide expert scientific advice on specific scientific questions to inform management and recovery of upper-slope dogfish species. This group meets on an as needs basis.
- A Gulper Shark Inter-Departmental Committee, consisting of members from AFMA, ABARES, DAFF and DSEWPaC. This Committee met regularly during the development of this Strategy.



References

- AFMA (2011). *Domestic Compliance and Enforcement Program 2011-12*. Available at: www.afma.gov.au/wp-content/uploads/2010/09/Domestic-Compliance-and-Enforcement-Program-2011-12.pdf.
- AFMA (2012). *Upper-Slope Dogfish Management Strategy Consultation Document: Commonwealth-managed fisheries*
- DAFF (2007). *Commonwealth Fisheries Harvest Strategy Policy and Guidelines*. DAFF, Canberra.
- Daley, R.K., Stevens, J.D. and Graham, K.J. (2002). *Catch analysis and productivity of the deepwater dogfish resource in southern Australia*. FRDC Final Report 1998/108. Fisheries Research and Development Corporation, Canberra.
- Daley, R. Smith, T and Williams, A. (2012). Gulper shark movements. 27 April 2012
- Graham, K.J., Andrew, N.L. and Hodgson, K.E. (2001). Changes in relative abundance of sharks and rays on Australian South East Fishery trawl grounds after twenty years of fishing. *Marine and Freshwater Research* 52:549-561.
- IUCN (2012). *IUCN Red List of Threatened Species. Version 2012.1*. www.iucnredlist.org. accessed 13 September 2012.
- Koopman, M., Knuckey, I and Daley, R. (2011). *Industry monitoring and sampling of gulper shark catches in the SESSF*. FRDC Project 2009/023
- Last, P.R. and Stevens, J.D. (2009). *Sharks and Rays of Australia*. Second Edition CSIRO Australia.
- McLaughlin, D, M. and Morrissey, J, F. (2005). Reproductive biology of *Centrophorus cf. uyato* from the Cayman Trench, Jamaica. *J. Mar. Biol. Ass. U.K.* 85: pp 5027/1-8.
- Musick, J.A.. Unpublished report to SEWPAC, *An evaluation of the Australian Fisheries Management Authority (AFMA) Upper-Slope Dogfish Management Strategy – Commonwealth-managed Fisheries – 6 June, 2011*.
- NSW Department of Primary Industries (2012). NSW Strategy to assist with the rebuilding of Harrison's and southern dogfish populations. Draft for Consultation, August 2012. Available at: www.dpi.nsw.gov.au/fisheries/commercial/info/gulper-shark.
- Scandol, J., Rowling, K and Graham, K. (2008) (Eds). *Status of Fisheries Resources in NSW 2006/07*, NSW Department of Primary Industries, Cronulla, 334 pp.
- Scientific Working Group (2012). *Interim Report of the Upper-Slope Dogfish Scientific working Group*. Agenda Item 4.1 SEMAC 9.
- SETFIA (2006). Code of Practice for Automatic Longline Operators Encountering Gulper Sharks. Available at: www.afma.gov.au/wp-content/uploads/2010/07/code_of_practice.pdf.
- Simpfendorfer, C.A., and Kyne, P.M. (2009). Limited potential to recover from overfishing raises concerns for deep-sea sharks, rays and chimaeras. *Environmental Conservation* 36, 97-103.
- Walker, T.I. and Gason, A.S. (2005). *GHATF monitoring database management 2004/05*. Final report to Australian Fisheries Management Authority Project No. R02/1113 and R03/1383. December 2005. Primary Industries Research Victoria: Queenscliff, Victoria, Australia.
- White, W.T., Ebert, D.A and Compagno, L.J.V. (2008). Description of two new species of gulper sharks, genus *Centrophorus* (Chondrichthyes: Squaliformes: Centrophoridae) from Australia, pp. 1-21. *In*: P.R. Last, W.T. White & J.J. Pogonoski (eds). Descriptions



of new Australian Chondrichthyans. *CSIRO Marine and Atmospheric Research Paper 022*, 358 pp.

- Whitely, R. (2004). *Using dorsal spines to age the Australian dogfish Centrophorus harrissoni and Centrophorus uyato*. University of Wales, Bangor, UK.
- Williams, A., Althaus, F., Smith, T., Daley, R., Barker, B. and Fuller, M. (2012a). *Developing and applying a spatially-based seascape analysis (the "habitat proxy" method) to inform management of gulper sharks: A compendium of discussion papers*. Report to AFMA. CSIRO, Australia. 188pp
- Williams, A., Daley, R., Green, M., Barker, B and Knuckey, I. (2012b). *Mapping the distribution and movement of gulper sharks, and developing a non-extractive monitoring technique, to mitigate the risk to the species within a multi-sector fishery region off southern and eastern Australia*. FRDC Final Report 2009/024. Available at: www.frdc.com.au/research/Documents/Final_reports/2009-024-DLD.pdf.
- Williams, A., Althaus, F., Smith, T., Daley, R., Barker, B. and Fuller, M. (2012c). *Harrisson's and Southern Gulper Sharks: metrics indicating the recovery potential represented by areas under management or being considered for management*, September 3 2012. Supplementary document to: Williams, A., Althaus, F., Smith, T., Daley, R., Barker, B. and Fuller, M. (2012) *Developing and applying a spatially-based seascape analysis (the "habitat proxy" method) to inform management of gulper sharks: A compendium of discussion papers*. Report to AFMA. CSIRO, Australia. 188pp
- Wilson, D.T., Patterson, H.M., Summerson, R. and Hobsbawn, P.I. (2009). *Information to support management options for upper-slope gulper sharks (including Harrisson's Dogfish and Southern Dogfish)*. Final Report to the Fisheries Research and Development Corporation Project No. 2008/65. Bureau of Rural Sciences, Canberra.
- Woodhams, J, Stobutzki, I, Vieira, S, Curtotti, R & Begg, GA (eds) 2011, *Fishery status reports 2010: status of fish stocks and fisheries managed by the Australian Government*, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.



Appendix A

Indicative maps of closures

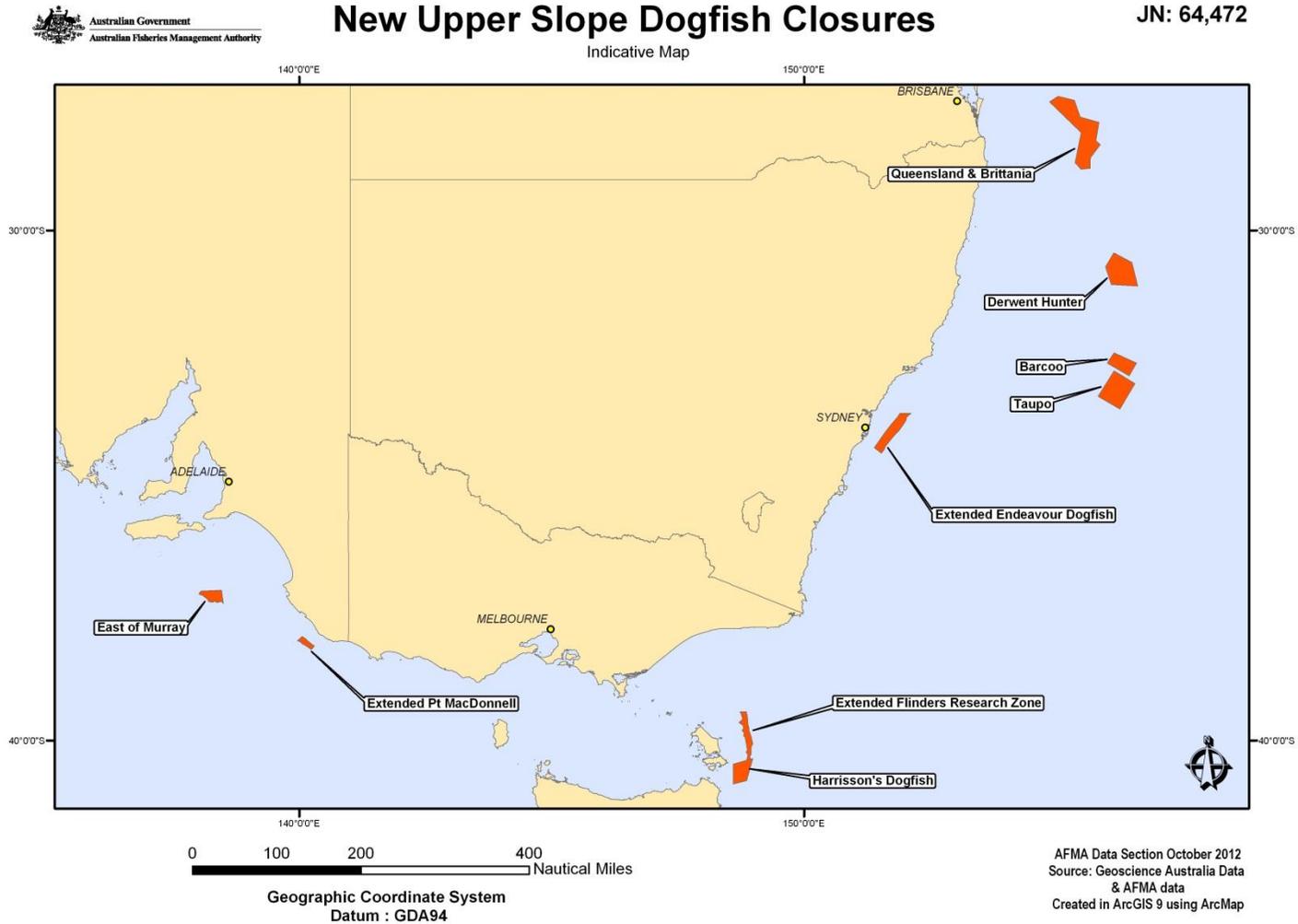


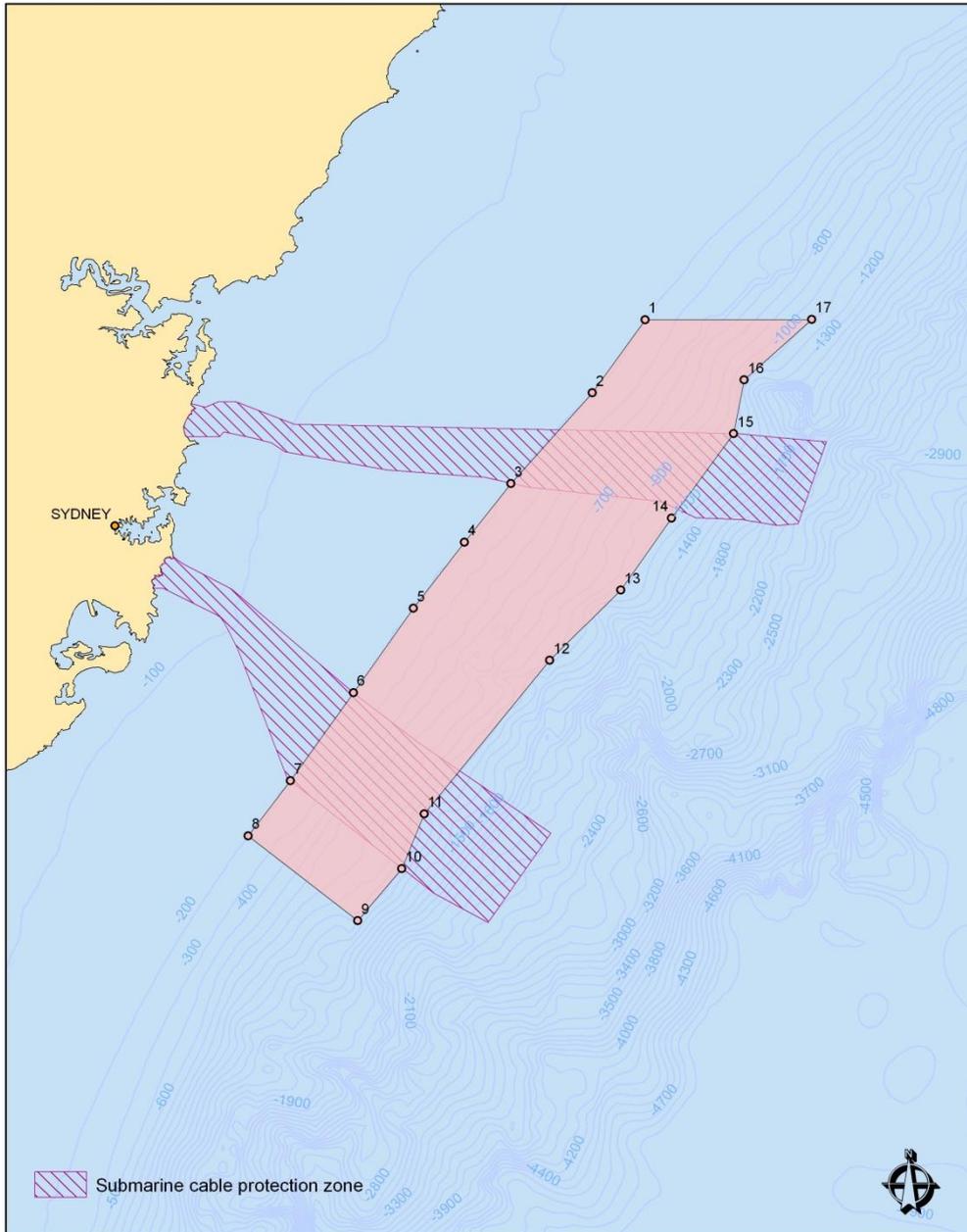
Figure 4: Map of all the Extended, New and Revised closures under the Strategy.



Sydney Closure

(Indicative map only)

JN: 64,466



0 5 10 20 Nautical Miles
Geographic Coordinate System
Datum : GDA94

AFMA Data Section September 2012
Source: Geoscience Australia Data
& AFMA data
Created in ArcGIS 9 using ArcMap

Figure 5: The Extended Endeavour Dogfish closure off Sydney.



Flinders Research Zone Extension

JN: 64,466

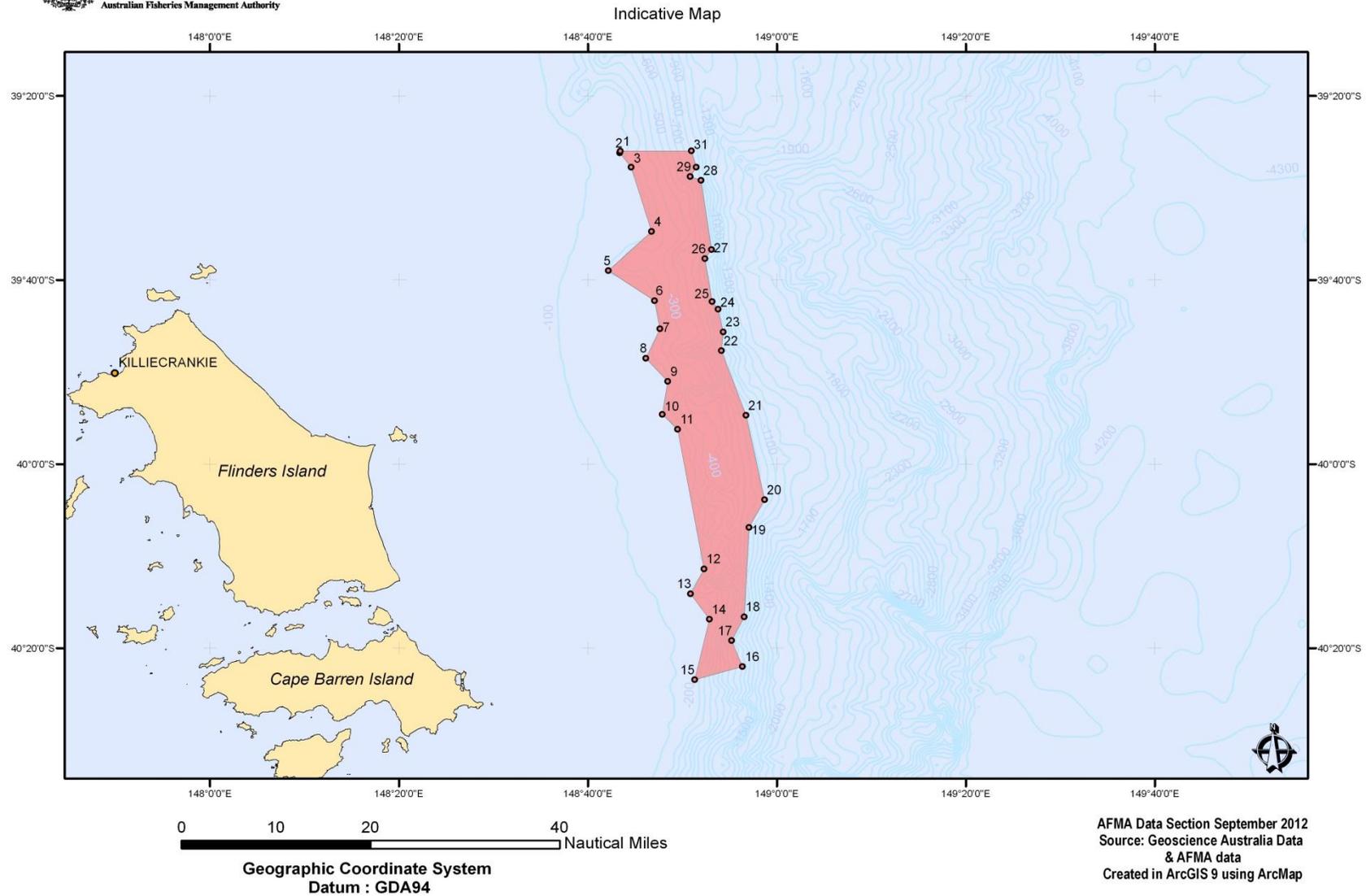


Figure 6: The Extended Flinders Research Zone.



Port MacDonnell Closure Extension

JN: 64,466

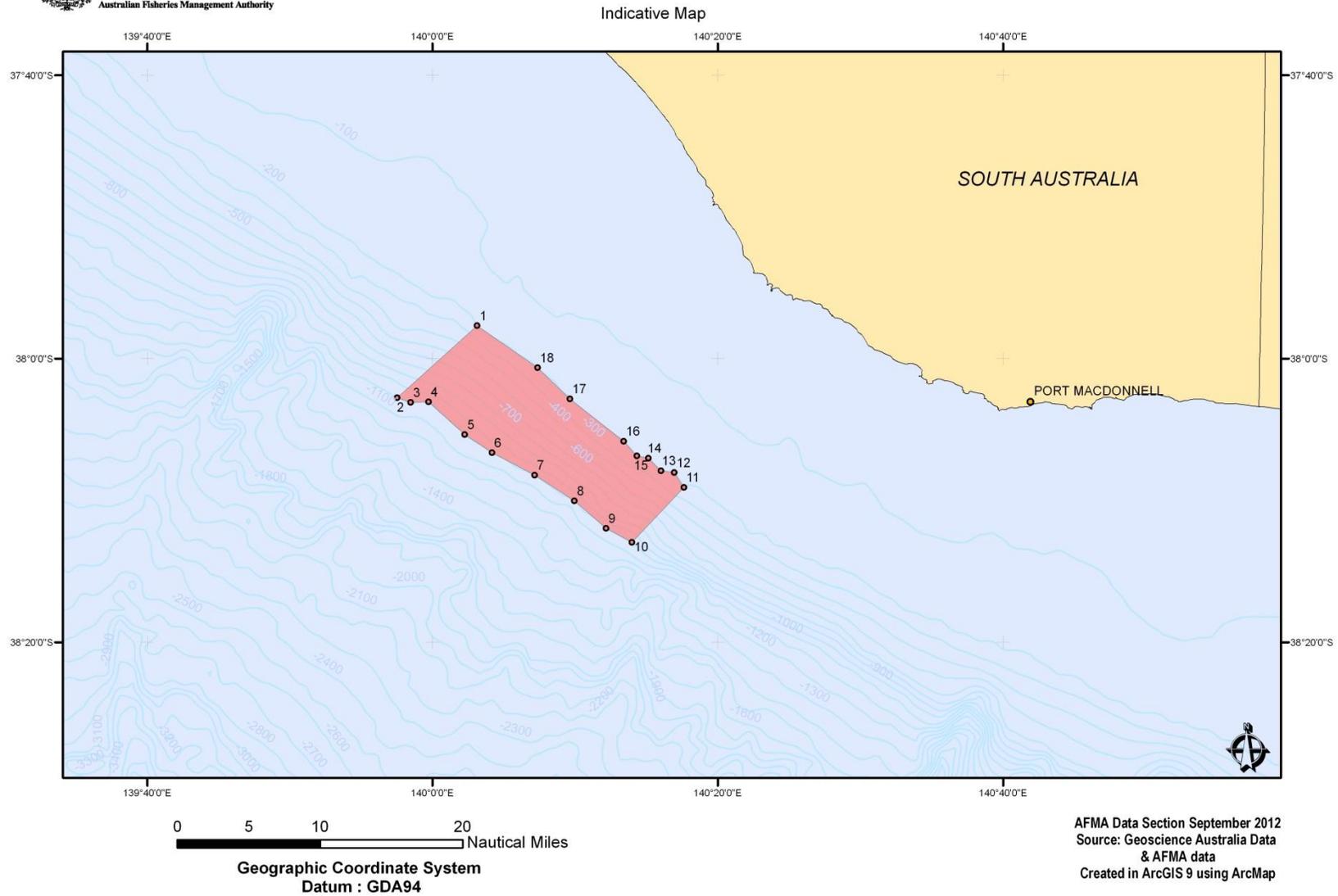


Figure 7: The Extended Port MacDonnell closure.



Murray Closure

JN: 64,466

Indicative Map

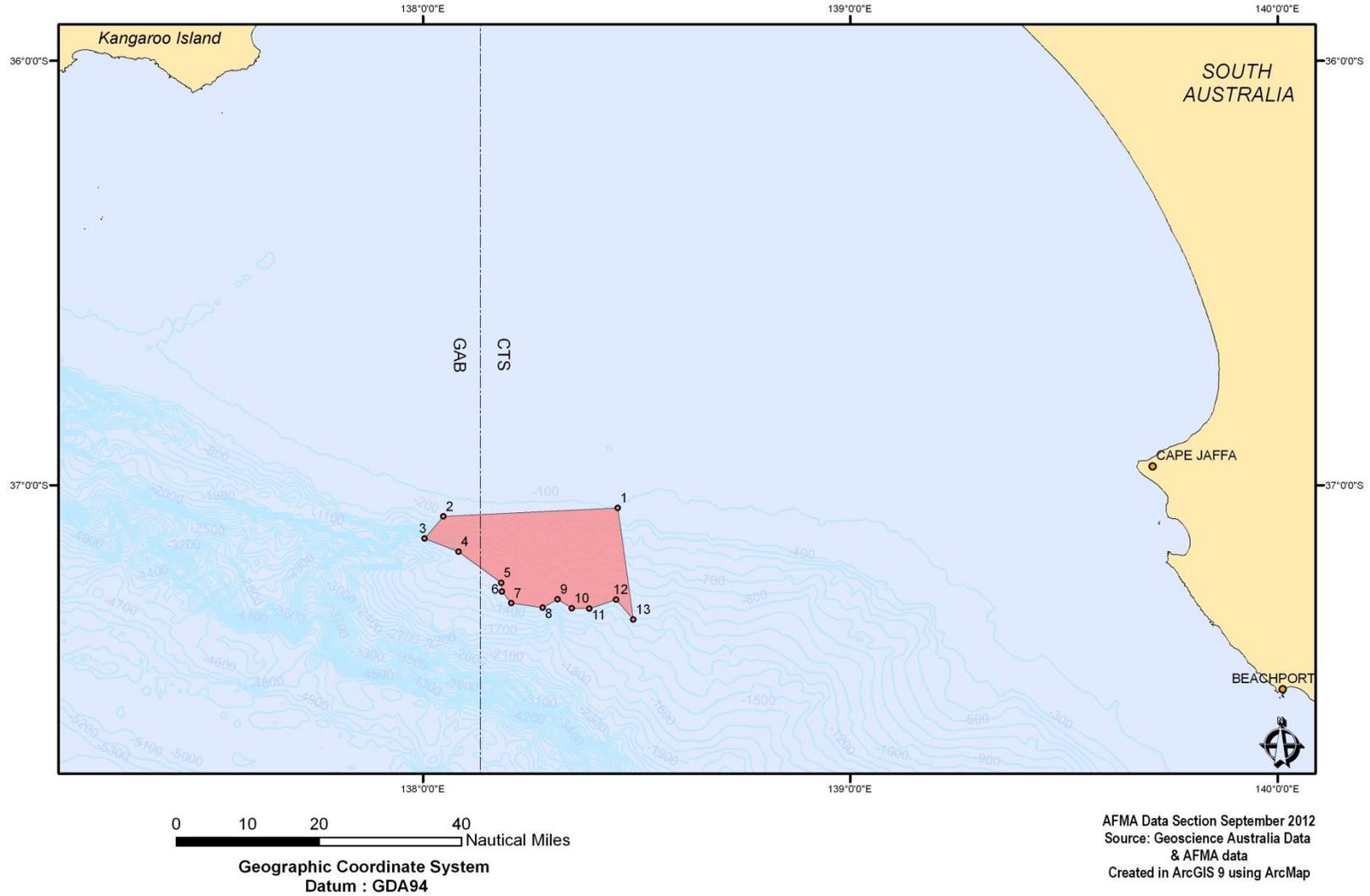


Figure 8: The Murray Dogfish closure.



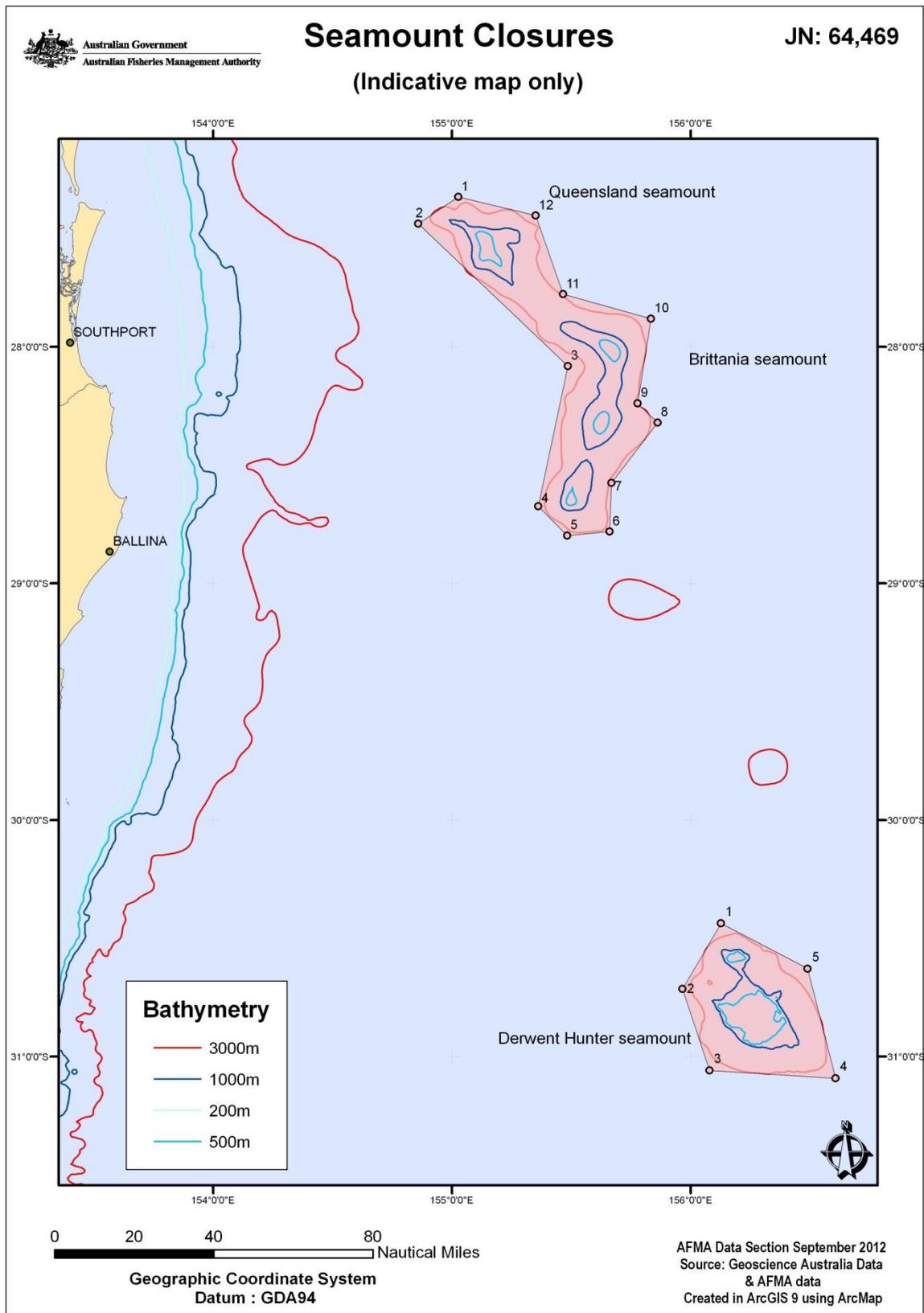


Figure 9: Queensland, Britannia and Derwent Hunter seamounts closures.



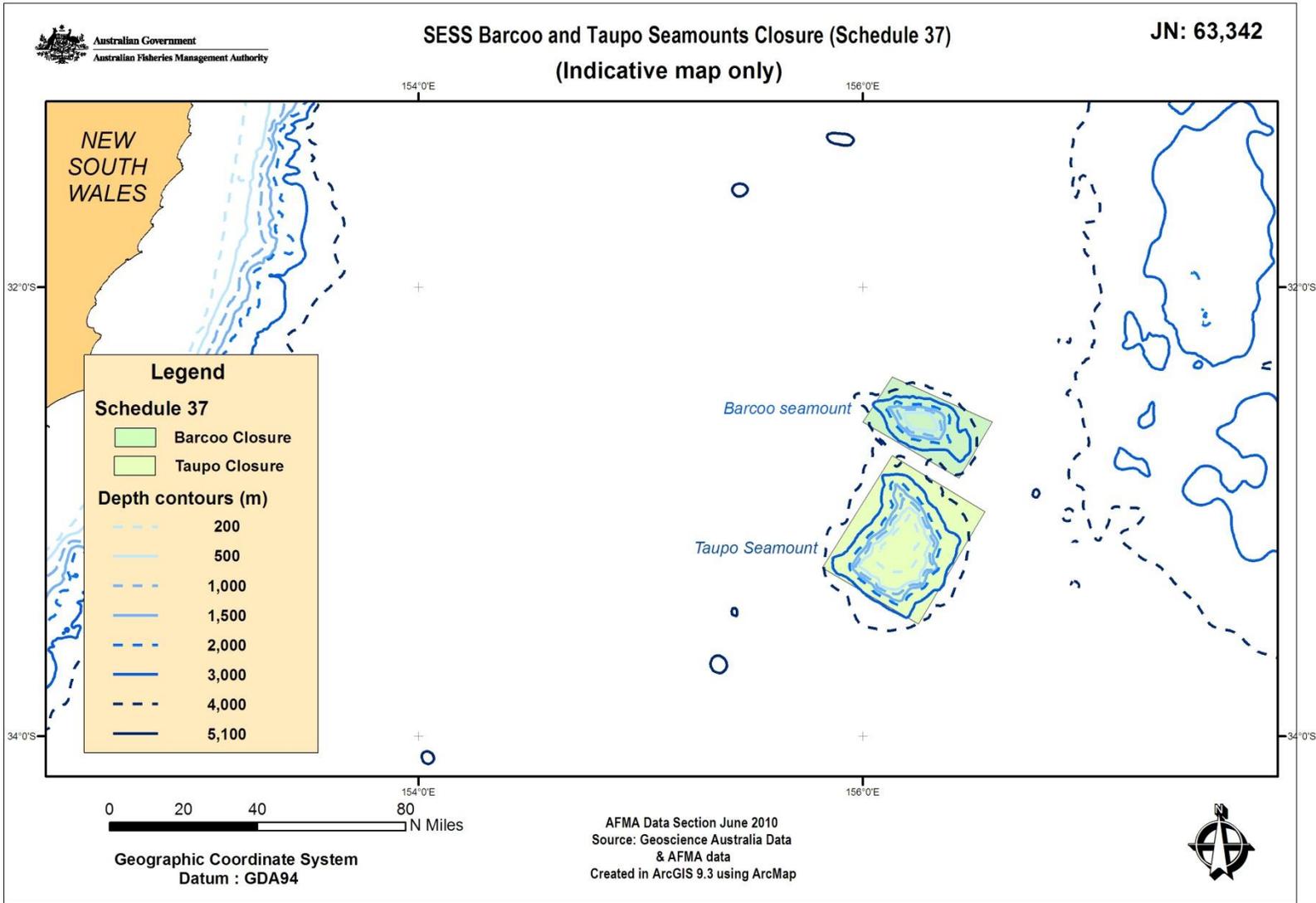


Figure 10: Barcoo and Taupo seamounts closure.

