Volume 3

Appendices

This is the third of four volumes

of the

Environmental Impact Statement

on the

Ocean Trawl Fishery

Note: The NSW Department of Primary Industries, incorporating NSW Fisheries, was established on 1 July 2004. Any reference in this document to NSW Fisheries is a reference to the NSW Department of Primary Industries.

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Appendix B1.1 Bycatch Reduction Devices used in OTF

Ocean Prawn Trawl Bycatch Reduction Devices (BRD's)

BRD's are a requirement in the OPT fishery in accordance with a closure notice prepared under s8 of the *Fisheries Management Act 1994.*

BRD	**Specification**
Square Mesh Panel	Attachment 1
Nordemore Grid	Attachment 2
Blubber Chute	Attachment 3
Composite Square Mesh Panel	Attachment 4
Diamond BRD	Attachment 5
V-Cut	Attachment 6
Fish Eye	Attachment 7
Big Eye	Attachment 8

Note: Discussions re taking place on alternative management arrangements and possibly new trawl gear for fishers that target whiting. It is intended that the BRDs in the prawn fishery will be further improved — for example, phase out the current square mesh panel and refine other BRDs.

Attachment 1

SPECIFICATIONS FOR THE SQUARE MESH PANEL

The position of the panel

The square mesh panel must be positioned in the top of the anterior (front) section of the cod-end and the base of the panel must be either,

1. within 40 meshes of the cod-end drawstring, or
2. within 40 meshes of any restriction that is placed around the cod-end during trawling, or
3. within 3 meshes of the line in the cod-end where the number of meshes is increased (ie, 3 meshes above the start of the bell).

NB. If more than one drawstring is used, the drawstring closest to the tail of the cod-end is taken to be that referred to in these specifications.

The minimum size of the panel

The minimum size of the panel (surface area) of a square mesh panel will depend upon the number of panels and the size of mesh used. To ensure that panels are of an appropriate shape (ie. A square or rectangle) a minimum width also applies, and the length of a panel must be greater than the width. No more than four panels are permitted.

Table 1 For panel(s) with mesh smaller than 75mm

	Minimum Total Area	Minimum width of each panel
1 Panel	450cm^2	18cm
2 Panels	600cm^2	17cm
3 Panels	750cm^2	15cm
4 Panels	900cm^2	15cm

Table 2 For panel(s) with mesh greater than 75mm

	Minimum Total Area	Minimum width of each panel
1 Panel	450cm^2	18cm
2 Panels	550cm^2	16cm
3 Panels	650cm^2	14cm
4 Panels	750cm^2	13cm

Material that may be used to construct the panel

Netting (ie. Typical trawl net) or rigid mesh (ie. Plastic or metal) may be used to construct the square mesh panel. Netting inside a rigid frame may also be used. The netting that formes the BRD must be hung so that the meshes are open and square shaped (ie. Not a diamond — hung on the bar)

If netting is used to construct a panel, the netting must be of 55mm mesh size or greater (ie. Measured via conventional means — on the diagonal with a weighted measuring device). If a rigid mesh is used, the minimum length for each side of the mesh is 27mm (40mm between diagonal corners — measured via vernier callipers). Note: Guide only.

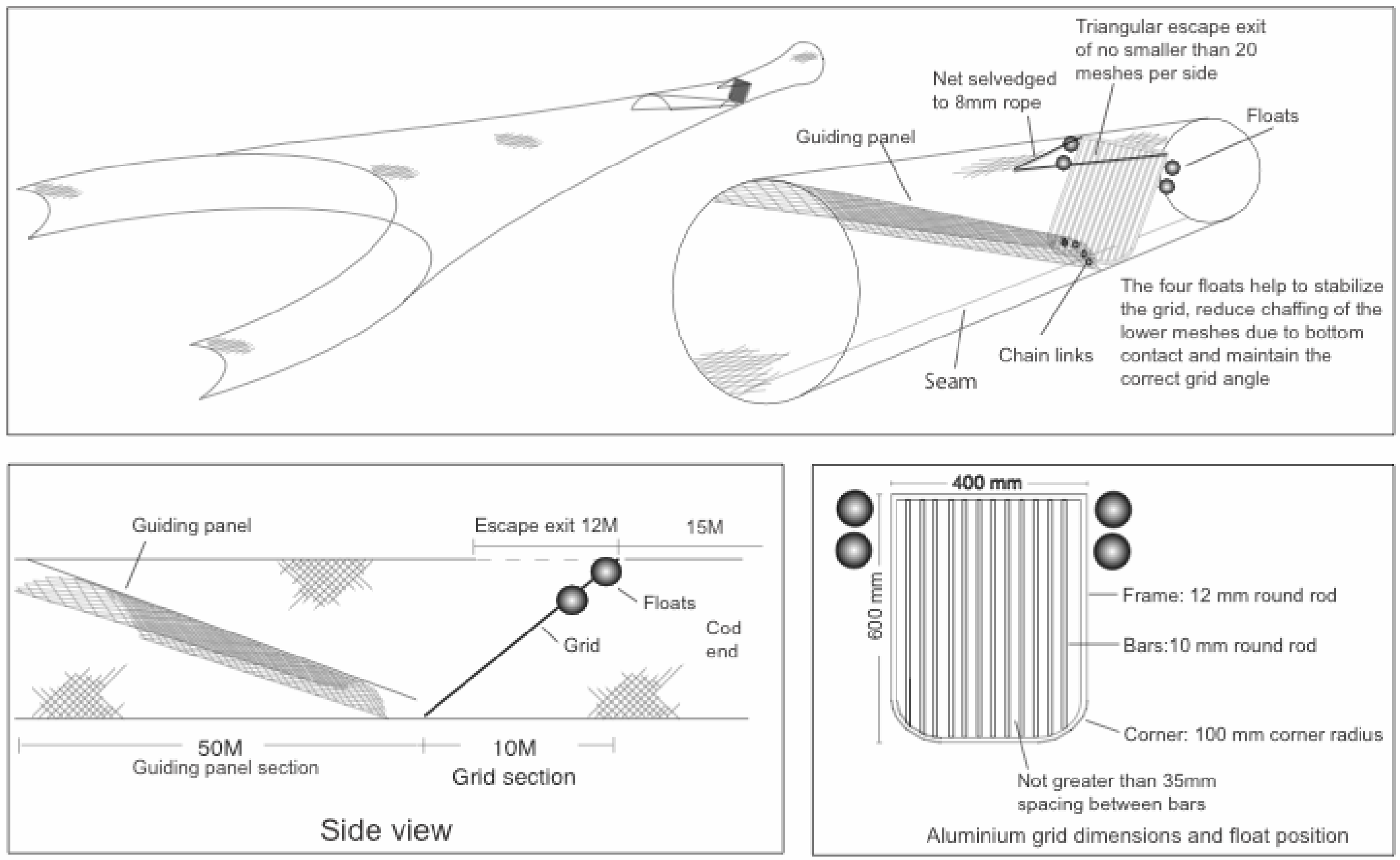
Other conditions

The mesh panel must not be covered, tied up, or restricted in any manner (ie. Fish must be able to freely escape). A single piece of rope may however be used to stop the trawl net distorting.

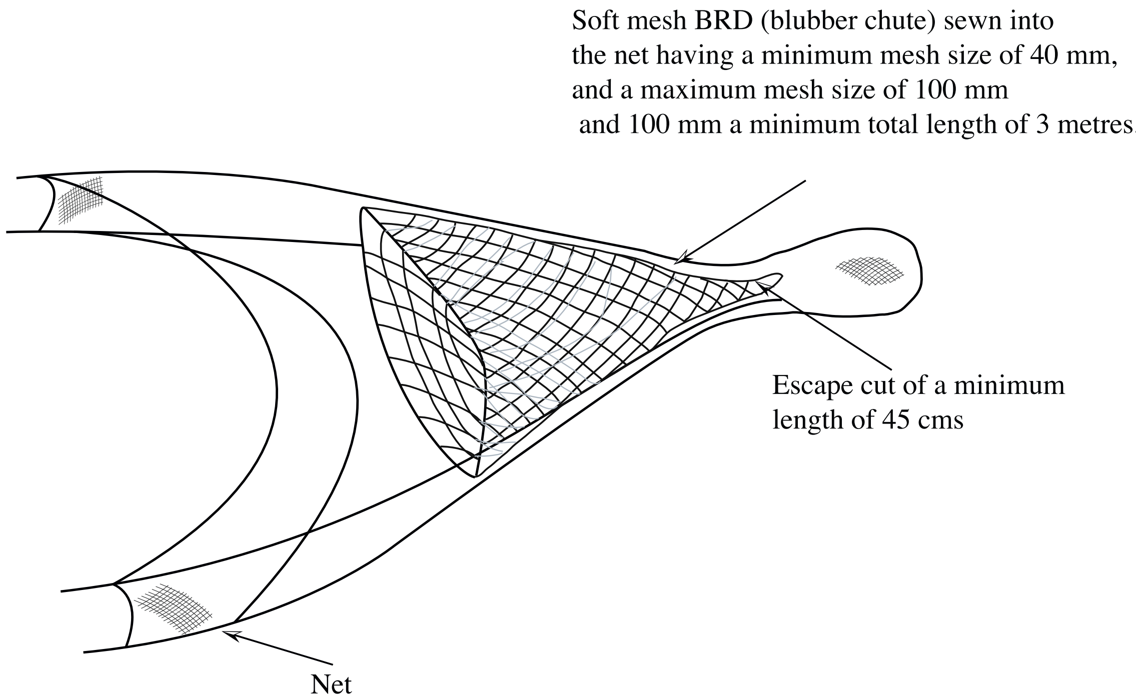
- To ensure that the mesh in a netting panel remains open, ‘minimum bating rates’ apply as follows (ie. This does not apply to rigid mesh panels)
  - 55mm—60mm mesh must be at least 2 points to each bar on the panel
  - 60mm—75mm mesh must be at least 3 points to each bar on the panel
  - >75mm mesh must be at least 4 points to each bar on the panel
- A ‘point’ is defined as the corner of a mesh that attaches to the square mesh panel.
- A ‘bar’ is defined as the side of a single mesh within the panel, to which the ‘points’ of the trawl net are attached.

Attachment 2

Oceanic Nordmore Grid



Attachment 3



Attachment 4

Composite Square Mesh Panel Bycatch Reduction Device

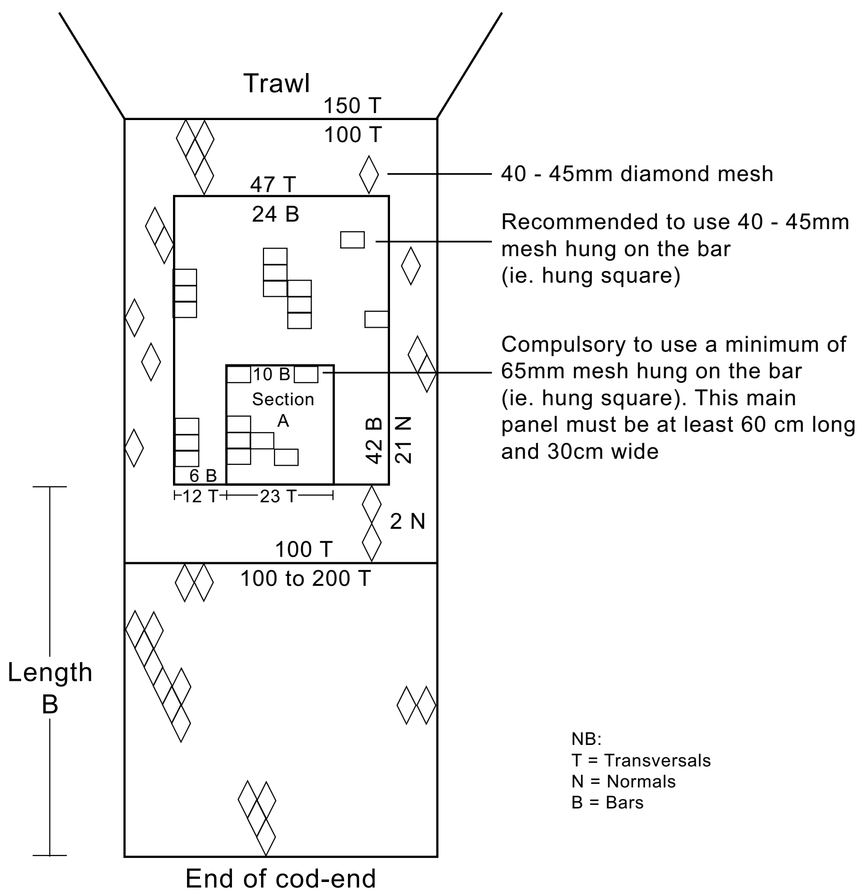
Compulsory aspect of the diamond BRD:

1. The panel is sewn into the top of the net, with its base a maximum length (length B) of 1.2m forward of the cod-end drawstring.

2. The dimensions of section A (the main square mesh panel) must be a minimum of 60cm long by 30cm wide with a minimum of 65cm mesh hung on the bar (ie. hung square).

3. The larger panel surrounding section A must consist of 40mm to 50mm mesh hung on the bar.

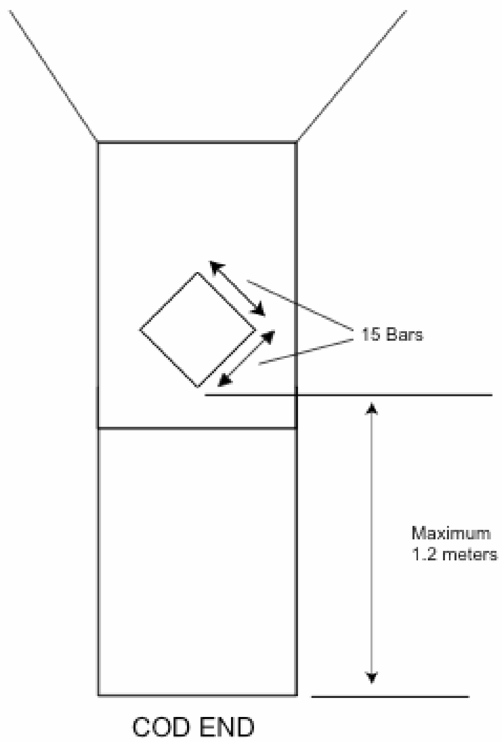
4. The panels must be sewn into the net in accordance with the bating rates (transversals to bars, normals to bars) detailed in the diagram below.



Attachment 5

V-Cut bycatch reduction device

Compulsory aspect of the diamond BRD:
1. Each side of the diamond must be a minimum of 15 bars long.
2. The base of the diamond must be within 1.2m of the cod-end drawstring
3. The diamond escape hole must not be covered by netting or otherwise be obstructed.

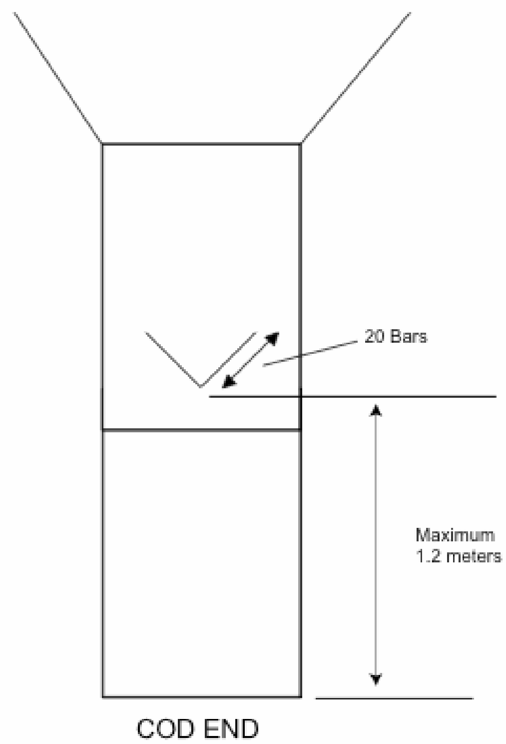


Attachment 6

V-Cut bycatch reduction device

Compulsory aspect of the V-cut BRD:

1. Each of the V-cut must be a minimum of 20 bars long.
2. The apex of the V must be within 1.2m of the cod-end drawstring
3. The flap created when cutting the V into the cod-end must be removed and the escape holemust not be otherwise obstructed

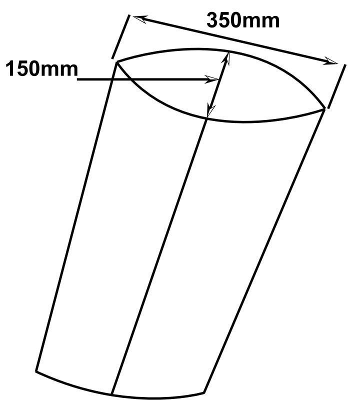


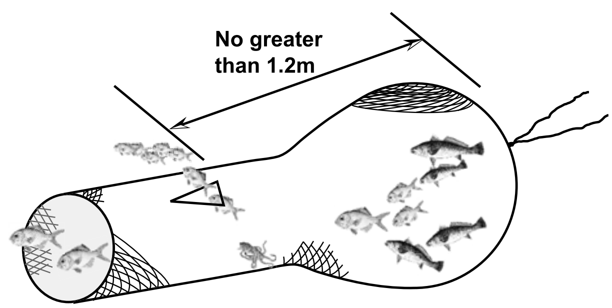
Attachment 7

FISH EYE BYCATCH REDUCTION DEVICE

Compulsory aspect of the fish-eye BRD

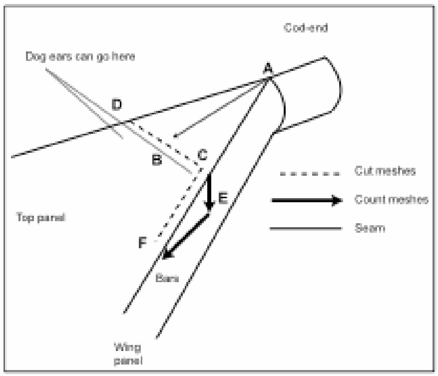
1. The opening of the fish-eye must be a minimum of 150mm by 350mm
2. The base of the fish-eye (part closest to the cod-end drawstring) must be within 1.2m of the codend drawstring
3. The opening (escape hole) of the fish-eye must not be covered with netting or otherwise obstructed.





Attachment 8

CONSTRUCTION OF A BIG-EYE BRD IN A 4 SEAM NET



Compulsory aspects of the BRD are:
1. Mesh A must be within 1.2m of the cod-end drawstring
2. Mesh B must be a minimum of 20 meshes forward of mesh A
3. Mesh E must be not less than 40% of the depth of the wing panel below mesh C

Step 1. Find the centre mesh of the top of the net within 1.2m of the cod-end drawstring (mesh A). Count forward a minimum of 20 meshes (mesh B). Note: The further forward you count the bigger the completed opening will be.

Step 2. From this mesh (mesh B) follow the points of the top of the panel all the way to the seam(mesh C and mesh D). Make a transversal cut across the top panel in the net all the way to the seams (ie. cut betwen mesh C and D).

Step 3. Calculate 40% of the wing panel depth. Example: for a 50 mesh deep wing panel; 40% equals 20 meshes. From mesh C measure down the wing panel 20 meshes to find mesh E (40% of panel depth).

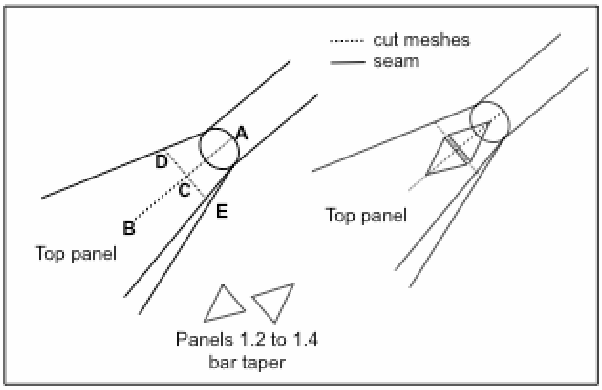
Step 4. From mesh E follow the bars of the wing panel forward and upward back to the seam where the top panel joins the wing panel (mesh F).

Step 5. Cut the seam between mesh F and mesh C. The tapered top panel betwen mesh E and mesh C is then to be sewn to the bars of the wing panel between mesh F and mesh E.

Step 6. Repeat steps 1 to 5 on the other side of the net.

Step 7. Finish the Big Eye BRD with selvedging, floats and weights as explained below.

CONSTRUCTION OF A BIG-EYE BRD IN A 2 SEAM NET



Compusory aspects of the BRD are:

1. Mesh A must be within 1.2m of the cod-end drawstring.
2. Mesh B must be not less than 30 meshes from mesh A.
3. The transversal cut between mesh D and E should be not less than 10 meshes / transversals.

Step 1. Find the centre mesh on the top of the net within 1.2m of the cod-end drawstring (mesh A). Cut the meshes forward fo a minimum of 30 meshes to mesh B. Note: the further forward you cut the larger the opening will be.

Step 2. Find the middle mesh between meshes A and B (mesh C). Make a transversal cut of at least 5 meshes each side towards the side seam to meshes D and E. The finished cut following steps 1 and 2 should look like a cross.
Note: the transverse cut must be at least 5 meshes / transversals either side of the centre but the entire cut should be no more than the width of the top panel.

Step 3. Cut two identical triangular panels from some spare netting. Their length should be equal to the number of meshes minus one, between meshes A and B or B and C.
Note: Tthe steeper the taper of the triangular panels the more slack mesh will be created resulting in a larger opening. A 1:2 — 1:4 bar taper is suitable.

Step 4. Sew one of the triangular panels of mesh into the fore / aft cut between mesh B and mesh C. Sew the other triangular panel from mesh A to mesh C.

Step 5. Finish the Big Eye BRD with salvaging, floats and weights as explained below.

FINISHING THE BIG-EYE BRD IN 4 AND 2 SEAM NETS
(SELVEDGING, FLOATS AND WEIGHTS)

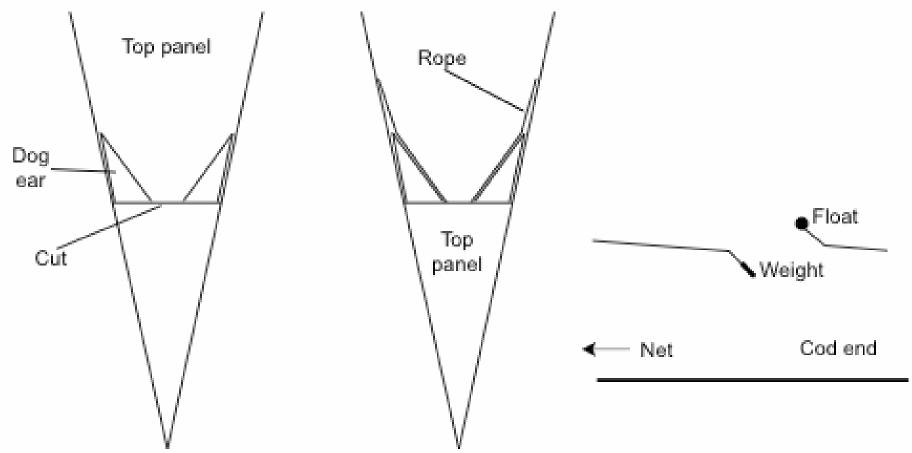


Figure 3a Figure 3b Figure 3c

Step 1. Strengthen the corners of the horizontal cut by fitting dog ears(10 meshes by 10 meshes by 20 bars)—see Figure 3a.

Step 2. Selvedge a rope around the extremities of the opening to further strengthen the device—see Figure 3b

Step 3. Add floats to the rope selvedged to the rear panel—see Figure 3c

Step 4. Add weight to the rope selvadged to the forward panel of the device — see Figure 3c. Note: the weight mut not consist of linls of chain that mat rattle or will spook fish attempting to escape.

Appendix B1.2 Vessel Capacity Rules

1.0 Calculation of hull, engine and net units

1.1 Hull units = $\frac{\text{Length x Breadth x Depth x 0.6}}{2.83}$

1.2 Engine units = the published continuous (brake kilowatt) rating for the engine or hydraulic motor. If an engine or hydraulic motor is not rated for continuous application, the continuous (brake kilowatt) rating is to be estimated by the Director-General, NSW Fisheries, in consultation with the engine manufacturer or an authorised representative.

1.3 Total units = Hull units + Engine units

1.4 Net units = 0.275 x total units, for the first 100 total units, plus

0.183 x total units for between 101 and 200 total units, plus

0.092 x total units for each total unit over 200.

2.0 Controls on hull capacity

2.1 Any vessel shall not be larger in capacity than the hull units allocated, except in the case of an existing licensed vessel that was subject to a survey and an original allocation of hull units and a new survey certificate is provided which demonstrates a larger hull capacity than the hull units allocated.

2.2 A vessel less than 20 metres in length must not be replaced or modified to become greater than 20 metres in length.

2.3 A vessel greater than 20 metres in length must not be replaced or modified to become greater than its current length.

2.4 The length, depth and breadth of a vessel is determined in accordance a survey certificate for the vessel which has been prepared in accordance with the Uniform Shipping Laws Code.

3.0 Controls on engine power

3.1 The continuous (brake kilowatt) power rating of an engine or hydraulic motor must not exceed the original engine unit allocation by more than 10%, unless:

a) the engine unit allocation is the result of an amalgamation in which case the 10% tolerance does not apply, or
b) the vessel is licensed with an offshore prawn trawl endorsement and the engine in the vessel was upgraded between 5 November 1986 and 1 November 1994, in which case the power rating of an engine or hydraulic motor must not be greater than the power rating of the engine fitted in the vessel as at 1 November 1994.

4.0 Consent required before replacing or modifying a vessel or engine

4.1 The Director-General, NSW Fisheries', written consent is required before the engine, (or propulsive hydraulic pump) or hull of a vessel authorised to operate in the Ocean Trawl Fishery is modified or replaced.

4.2 If a vessel is used in other NSW commercial fisheries, any replacement boat or engine must be within the vessel capacity restrictions for those fisheries (if applicable) for the business to remain endorsed in those fisheries. Conditions may also be applied to prevent increases in effort within a fishery.

5.0 Controls on net length

5.1 For each net unit the vessel may tow 1 metre of headrope (to one decimal place), unless allocated less than 33 net units in which case the vessel may tow up to 33 metres of net.

5.2 The maximum allowable headrope length for a prawn trawl net is 60 metres.

5.3 The maximum allowable headrope length for a fish trawl net is 60 metres.

5.4 The maximum allowable headrope length for prawn and fish trawl nets will be reduced to 55 metres upon any engine or vessel replacement or upon transfer or amalgamation of the boat licence.

6.0 Upgrading a trawler – increasing units

6.1 Boat licences endorsed in the ocean trawl fishery may be amalgamated for the purpose of increasing engine unit and net unit allocations provided:

a) the fishing businesses are allocated the same type of ocean trawl endorsements, or
b) where the fishing businesses are allocated more than two types of ocean trawl endorsements, the businesses must have at least two of the same type of endorsement, and
c) the boat licence is not subject to an offshore prawn trawl P2, P3 or P4 endorsement type, and
d) the amalgamation of boat licences or fishing businesses is approved by the Director-General, NSW Fisheries, taking account of any transfer rules that apply generally to fishing businesses or to other fisheries. Conditions may also be applied to prevent increases in effort within a fishery.

6.2 Hull units cannot be amalgamated.

6.3 Upon amalgamation of two or more boat licences, all hull units and 50% of the engine units are forfeited from the licence with the lesser total unit holding – unless the owner requests that the forfeiture apply to the licence with the greater total unit holding. The new engine unit holding will be used to re-calculate the new total units and net units in accordance with the formulas outlined in 1.3 and 1.4 above.

6.4 It is permissible for more than one fishing business owner to apply to transfer a licence and ocean prawn trawl endorsement for the purposes of sharing the associated engine units. In this case, the 50% forfeiture of engine units (see 6.3 above) still applies, and the remaining engine units can be divided amongst the transferors. The acquired boat licence and any validated catch history associated with that licence will be surrendered. The new engine unit holdings will be used to re-calculate the new total units and net units for the transferors in accordance with the formulas outlined in 1.3 and 1.4 above.

7.0 General provisions relating to the vessel capacity controls

7.1 A breach of any provision of the vessel capacity controls may result in the suspension or cancellation of the ocean trawl endorsement(s) associated with the fishing business.

These controls may be varied or amended by the Director-General, NSW Fisheries, from time to time.

Appendix B2.1 Summary of biological characteristics of used to determine resilience for primary, key secondary and secondary species of the OTF

Species that make up 99% of landings (2000/01)	Species Type - P, K2, S	Fecundity level (no. eggs, 1000's)	Reproductive/Life history strategy	Geographic distribution	Habitat specificity	Stock/pop size
Fish						
Whiting, School	P	30-110	Larvae and eggs pelagic	Morten Bay Q to SA including Tas	seabed, sandy substrate, to 80m	
Flathead, Tiger	P	1.5-2.5 mill	Larvae and eggs pelagic	Endemic; Coffs Harbour to Portland V, including all Tas	seabed mud & sand, pelagic at night to feed; 10-400m, 200m av	
Flathead, Sand	P	unknown	Larvae and eggs pelagic	Endemic; Nth NSW to Sth WA above Perth incling all Tas	shallow inshore to 100m; substrate sand, shell grit & mud;	
Trevally, Silver	P	30-100 220 mod.	Larvae and eggs pelagic	Mid Q to Nth Cape WA, including all Tas	J: estuaries, bays, shallow Cont Sh Ad: Cont Sh, inshore reefs, open sand or gravel, large bays, inlets	
Shark, Fiddler	P	low, 3 embryos	Live bearing	Sth Q & NSW	sand burrowing; coastal bays, seagrass	
Latchet / Gurnard	K2	unknown	Larvae and eggs pelagic, family level	Sth NSW - SA including Tas	J: inshore Latchet - mid-outer Sh, 20-220m	
Dory, John	K2	unknown	eggs adhesive, demersal	Morten Bay Q to Cape Cuvier WA, including Tas	5-360m, seabed; Cont Sh	
Shark, Angel	K2	unknown	Live bearing	NSW - SA, WA	seabed, inshore to 256m, Cont Sh & Sl 130-400m	
Flounder (all species)	K2	unknown	pelagic eggs & larvae	Sth Q - SA including Tas	estuaries, mud & sand bottom to 150m	
Mullet, Red	K2	unknown	pelagic eggs & larvae	NSW - SA including Tas, WA	school on sand & rocky substrate to 100m	
Redfish	K2	unknown	pelagic eggs & larvae, J. form schools often entering estuaries	Morten Bay Q to West Bass Strait including Nth east Tas	J: estuaries shallow coastal Ad: reefs, muddy substrate Cont Sh to Cont Sl to 450m	
Leatherjacket (mixed spp)	K2	700-2000	batch spawner	NSW - SA, WA	2-200m, seabed, Cont Sh & Sl to 360m	

Appendix B2.1 cont'd**.**

Species that make up 99% of landings (2000/01)	**Species Type -P, K2, S**	**Growth rate**	**Longevity**	**Size or Age at maturity**	**Diet specificity**
Fish					
Whiting, School	P	nth - fast sth slower	Short	2y; 14-16cm	A: crustaceans, prawns; J: polychaete,amphipods
Flathead, Tiger	P	M slower than F	Medium	30-36 cm; 3-5y	A: small fish J: crustaceans, krill
Flathead, Sand	P	slow, variable > 4 yr	Medium ?	22 cm	small fish, crabs and prawns, small octopus & squid; change seasonally crustaceans Oc-Mar & fish during winter
Trevally, Silver	P	slow	Long	26-28cm 18-26 cm	polychaetes, molluscs, crustaceans, amphipods
Shark, Fiddler	P		Long ?	N/A	benthic invertebrates & fish
Latchet / Gurnard	K2		Medium ?	20-24cm; 2-3y	
Dory, John	K2	rapid	Medium	F:5yr M: 4yr	fish, crustaaceans, molluscs
Shark, Angel	K2		Long ?	N/A	benthic invertebrates
Flounder (all species)	K2	unknown	Medium ?	N/A	
Mullet, Red	K2	rapid	Short	F:1 yr M:2yr	
Redfish	K2	slow	Long	4-6y 20-25 cm	small fish, crustaceans & molluscs
Leatherjacket (mixed sp	K2		Mostly medium ?	F:3-4.5y; <37cm	salps, gastropods, crustaceans, fish; small schools when feeding

Appendix B2.1 cont'd.

Species that make up 99% of landings (2000/01)	Species Type - P, K2, S	Fecundity level (no. eggs, 1000's)	Reproductive/Life history strategy	Geographic distribution	Habitat specificity	Stock/pop size
Yellowtail	S		Larvae and eggs pelagic	Sth Q - SA	pelagic	
Perch, Ocean	K2	150-200 (30cm)	internal fertilization, eggs pelagic, viv- & ovoviv	Coffs Harbour NSW to Shark Bay WA, including Tas	inshore & offshore forms; inshore: most 300m range 50-750m offshore: Cont Sh >750m	
Shark, Saw	K2	unknown	internal fertilization, live bearers	Sth NSW - SA including Tas, Sth WA	Cont Sh & Sl 40-140m	
Stingray	S	unknown	internal fertilization, live bearers	NSW - SA including Tas, Sth WA	estuaries, off beaches, Cont Sh to 175m	
Shark, Gummy	S	1-38 young (14 av)	ovovivip., gestation 11-12 months	Endemic, Nth NSW to Shark Bay WA including all Tas	outer Cont Sh, upper Cont Sl, seabed 120-400m	
Sole, mixed	K2	10 - 100,000's	Pelagic eggs, larvae, brooder	V - SA (Tas)	inshore- Cont Sh 80m	
Dory, Mirror	K2	unknown	eggs adhesive, demersal	Botany Bay NSW to NW Shelf WA including Tas	50-600m, seabed	
Tarwhine	S		Larvae and eggs pelagic			
Morwong, Rubberlip	K2	unknown	Larvae and eggs pelagic	Morten Bay Q to Wilsons Promotory V & Strom Bay Tas	10-400m reefs 10-100m	
Flathead, Dusky	S	unknown	Larvae and eggs pelagic	Endemic, Carins Q to Gippsland V.	shallow inshore; bays substrates sand, mud, silt, gravel, seagrass to 30m in NSW estuaries J: <12m coastal bays & shallow mangrove, mudflats, seagrass	
Shark, Dogfish Greeney	S	4-9 pups	ovovivi., gestation up to 2yr ?	Sth Q - SA including Tas, WA	Cont Sh & Sl 150-700m	
Bream, Black and Yello	S	unknown	Larvae and eggs pelagic		coastal & estuaries, rocky inshore reefs, seabed, sand, mud, rocky; Blackfin: estuaries only sand, mud, rocky	
Shark, Carpet	S	unknown	Live bearing, ovovivip.			
Moonfish	K2	unknown	Larvae and eggs pelagic			
Boarfish	K2	unknown	Pelagic eggs & larvae Brooder	Sth NSW - SA including Tas, WA	Cont Sh & Sl from 30-500m	

Appendix B2.1 cont'd.

Species that make up 99% of landings (2000/01)	Species Type -P, K2, S	Growth rate	Longevity	Size or Age at maturity	Diet specificity
Yellowtail	S		Medium	F:20cm*; M:22cm*	
Perch, Ocean	K2	slow	Long	unk at least 44cm	squid, royal red prawns, cardinal fish
Shark, Saw	K2		Long-very long ?		
Stingray	S		Unknown		
Shark, Gummy	S	fast	Med 16y	85-130cm 4-5y	non-selective demersal feeders, sandy-rocky, mostly squid & octopus; bony fish of other commercial fisheries
Sole, mixed	K2	unknown	unknown	unknown	
Dory, Mirror	K2	unknown	Medium	30-40cm, 4-7y	fish, crustaceans, molluscs
Tarwhine	S				
Morwong, Rubberlip	K2	unknown	Unknown	3y; 25cm*	polychaetes, molluscs, echinoderms, crustaceans
Flathead, Dusky	S	medium	Medium	F: 38cm, M:32cm, 2-3y	small fish, crabs and prawns, small octopus & squid; foragers & ambush
Shark, Dogfish Greeney	S				
Bream, Black and Yello	S		Medium	24cm*,2-5y	crabs, prawns, molluscs, small fish, plants
Shark, Carpet	S				
Moonfish	K2				
Boarfish	K2				

Appendix B2.1 cont'd.

Species that make up 99% of landings (2000/01)	Species Type - P, K2, S	Fecundity level (no. eggs, 1000's)	Reproductive/Life history strategy	Geographic distribution	Habitat specificity	Stock/pop size
Ling	S	unknown	spawn My-Oc, unknown	Sth coast Australia	seabed 20-800m, most common 300-550m, soft sand & mud burrow into, rocky reef too.	
Shark, Dogfish Endeavo	S	2 pups	ovovivi., internal fertilisation			
Silver biddy	S	unknown	Larvae and eggs pelagic			
Trumpeter	S	unknown	eggs pelagic, larvae not specialised for pelagic life			
Crustaceans						
Prawn, Eastern King	P	800	pelagic larvae, eggs develop on female	MacKay Q to Nth east Tas & Lord Howe Island	1-220m J: bare & vegetated substrate in estuaries & oceanic embayments A: oceanic environment moving northwards to spawn	
Prawn, School	P		pelagic larvae, eggs develop on female	Tin Can Bay Q to Corner Inlet V	1-55m J: estuaries, fine to medium sandy substrate A: mostly oceanic, turbid waters from estuarine discharge	
Prawn, Royal Red	P	58-140	pelagic larvae, eggs develop on female	Cairns Q to Lakes Entrance V	100-1500m, common 365-550m, mud	
Crab, Blue Swimmer	K2	651-761	spawn in estuaries Oc-De, larvae pelagic	All Australian states except Tas & V	inshore- Cont Sh; substrate - mud & sand; algae, seagrass to 50m, burrow when not feeding	
Bug, Balmain	P	55-37	pelagic larvae, eggs develop on female	Eastern Aust	<80m up to 150m, sand, mud, gravel	

Appendix B2.1 cont'd.

Species that make up 99% of landings (2000/01)	Species Type -P, K2, S	Growth rate	Longevity	Size or Age at maturity	Diet specificity
Ling	S		Medium-long		crustaceans, royal red prawns, fish - gemfish, blue grenadier
Shark, Dogfish Endeavour	S		Long-very long		
Silver biddy	S			23cm	
Trumpeter	S				
Crustaceans					
Prawn, Eastern King	P	fast	Med - long, 3y	42mm CL	opportunistic omnivores, small crustaceans, polychaetes, bivalves, foraminifers
Prawn, School	P	fast	Short, 12-18mo	25 & 23mm CL (Hunter River) sizes vary along coast	opportuistic omnivores, bottom omnivores, crus, polychaetes, bivalves, foraminifers
Prawn, Royal Red	P	slower than other prawns	long for prawns	F: 30.8mm CL M: 25.8mm CL	small molluscs, crustaceans, polychaetes
Crab, Blue Swimmer	K2	fast	Short	1y; 90mm CL	bottom carnivore/scavengers - sessile invertebrates, bivalves, crustaceans, polychaetes
Bug, Balmain	P	F>M, medium	Short	F:49.7-54.9ML, 2y M:55.2ML	

Appendix B2.1 cont'd.

Species that make up 99% of landings (2000/01)	Species Type - P, K2, S	Fecundity level (no. eggs, 1000's)	Reproductive/Life history strategy	Geographic distribution	Habitat specificity	Stock/pop size
Molluscs						
Octopus	P	low	lay demersal eggs	Sth east Australia	seagrass to coastal reefs, Cont Sh to 500m; rocky reef during breeding (Su), soft sediment rest	
Cuttlefish	P	Unknown	lay demersal eggs		coastal to 35m	no. of discrete stocks
Calamari, Southern *Sepioteuthis australis*	P	variable	lay demersal eggs	Sth east Australia	coastal, inshore <100m	
Squid - broad &bottle *Photololigo* spp.	K2	Unknown			school on seabed day; disperse night; estuaries to ocean depth 500m, common 50-200m	
Shells	S					

Appendix B2.1 cont'd.

Species that make up 99% of landings (2000/01)	Species Type -P, K2, S	Growth rate	Longevity	Size or Age at maturity	Diet specificity
Molluscs					
Octopus	P	fast	Short-medium	150cmML	Active predators, crustaceans, gastropods, bivalves, soft sediment oragnisms
Cuttlefish	P	fast	Short		demersal - fish & crustaceans
Calamari, Southern Sepioteuthis australis	P	fast	Short 6-10mth	1y; 16ML	prawns & fish, aggregates
Squid - broad &bottle Photololigo spp.	K2	fast	Short	M:22cm; F:30cm ML	night feeders, pelagic crustaceans, fish, squid
Shells	S				

Key:

P - primary
K2 - key secondary
S - secondary
F - female
M - male
Ad - adult; J - juvenile
Short - <10y
Medium - 10-20y
Long - 20-50y
Very long - <50y

ML - mantle length
CL - carapace length
viv - viviporpous
ovoviv - ovoviviporous
nth - north
sth - south
av - average
Cont Sl - continental slope
Cont Sh - continental shelf

Sources:

Kailola *et al*, (1993)
Morison and Rowling (2001)
Rowling and Raines (2000)
Anderson (1997, 1999)
Jackson and Yeatman (1995)
Pecl (2001)
Stewart and Kennelly (1997, 2000)
Stewart *et al.* , (1997)
Baelde (1991, 1992)
Last and Stevens (1994)
Neira *et al* . (1998)
Dunn (2001)
Yoneda et al. (2002)
Simpfendorfer et al. (2001)
Jordan (2001a,b,c)

Appendix B2.2 Decision rules for determining resilience for primary, key secondary and secondary species of the OTF

Biological Characteristics		**Risk Averse**	**Risk Prone**	
Category	**Character**	A	P	PP
Life history	Fecundity	100-500,000 to 1-3million eggs	large eggs (>=2mm) &/or <50,000	< 10 pups (live bearers)
	Life history strategy	pelagic eggs; internal fertilisation or mouth brooders	egg cases &/or parental care; demersal eggs	live bearing
Distribution & abundance	Geographic distribution	widespread in NSW & adjacent juristications common	restricted range	
	Habitat specificity	broad habitat requirements; narrow habitat requirements but larger area of available habitat	narrow haditat requirements but small area of available habitat	
	Stock/ population size	large size	small size	
Other	Growth rate	relatively fast	relatively slow	
	Longevity	short - medium (< 10yr - 10-20yr)	long (20 - 50yr)	
	Age at maturity	1-2 years	>5 years	
	Diet specificity	broad diet requirements; narrow diet requirements but larger area of available diet	narrow diet requirements but small area of available diet	

Appendix B2.3 Summary of fishery impact factors of used to determine the fishery impact profile for primary, key secondary and secondary species of the OTF

Species that make 99% of catch	Species Type - P, K2, S	Catch level & trends	CPUE trends	% Discarded	Stock Assessment adequacy	Exploitation Status NSW Status Report	OTF fishery targets aggregations
Fish							
Whiting, School	P	General increase in catches from early '90 but declining in last 3 years due BRD introduction in pawn trawl to < 50% of former peak	50% drop in catch rate since 1999 due to the introduction of BRD		inadequate	unknown	yes
Flathead, Tiger	P	80-100t stable since late 1980s, sharp decline in '99-'01				fully fished	no
Flathead, Sand	P	120t; peaked in mid '80s and late '90s; has declined to approximately half of its peak			inadequate	fully fished	no
Trevally, Silver	P	100t declining; steady decline since mid 1980s to approximately 10% of its peak in mid 1980s to < 50t in 2000/2001				growth overfished	yes
Shark, Fiddler	P	70t peak in mid '90s, then declined			inadequate		no
Latchet / Gurnard	K2	Relatively stable but high annual variability in fish trawl			none		no
Dory, John	K2	Caught primarily as bycatch, therefore catch depends on fishing effort for other species; general decline in catches since mid 1980s of approximately 25% of catches in 2000/01			inadequate	unknown, uncertain (SEF)	unknown
Shark, Angel	K2	stable for approximately 9 years since late 1980s, declining since 1999					no
Flounder (all species)	K2	substantial increase in catches from late 1980s to mid 1990s then stable, but large annual variability			inadequate	unknown	no
Mullet, Red	K2	Large peak in catches in late 1990s then declining by approximately 50% in 2000/01			inadequate	unknown	no

Appendix B2.3 cont'd

Species that make 99% of catch	Species Type - P, K2, S	Gear selectivity	BRD used to exclude undersized species	Proportion OTF of total %	Species identification problem	[1] Marketability	Refuge availability
Fish							
Whiting, School	P	inappropriate	yes	61.27	no	***	Moderate
Flathead, Tiger	P	undersized, < LL c. 23cm		[2]7.42	no	***	Low
Flathead, Sand	P	undersized, < LL c. 23cm		see Tiger Flathead	no	***	Low
Trevally, Silver	P	very bad, too small		23.56	no	***	Low
Shark, Fiddler	P	NA		97.16	no	**	Moderate - Low
Latchet / Gurnard	K2	NA		28.49	yes	***	Moderate - Low
Dory, John	K2	NA		18.64	no	****	Moderate - Low
Shark, Angel	K2	NA		44.36	no	**	Moderate - Low
Flounder (all species)	K2	NA		85.65	yes	***	Unknown
Mullet, Red	K2	uncertain		74.07	no	***	Unknown

[1] Based on Appendix I in Hutchins and Swainston (1986)

[2] Based on all flathead species

Appendix B2.3 cont'd

Species that make 99% of catch	Species Type - P, K2, S	Catch level & trends	CPUE trends	% Discarded	Stock Assessment adequacy	Exploitation Status NSW Status Report	OTF fishery targets aggregations
Redfish	K2	Declining since mid 1980s to approximately 98% of peak in mid 1980s; steady decline in fish trawl catches since mid '80s to 25% of former peak in mid '90s				growth overfished	yes
Leatherjacket (mixed spp)	K2	Large annual variability in fish trawl, declining in fish trawl since late '90s but steady increase in prawn trawl for last 10 years			inadequate	unknown	no
Yellowtail	S	Low steady catches from 84-96, decline since 98 but within previous fluctuations			inadequate	unknown	unknown
Perch, Ocean	K2	Large fluctuations since 92/93; decline in Ptsince 95/96, larger decline in FT since 99/00			inadequate	fully fished	no
Shark, Saw	K2	Large fluctuations since 94/95. Decreasing since 00/01					no
Stingray	S	Large fluctuaitons, peaked in 92/93, overall decline since then					no
Shark, Gummy	S	Steady but variable catches in FT; PT peaked in 98/99 declining since					juv only
Sole, mixed	K2	large increase from 96/97-98/99; declining since			inadequate	unknown	no
Dory, Mirror	K2	Large fluctuations since 87/88; probably due variable effort as spp. Caught as bycatch			inadequate	unknown	unknown
Tarwhine	S	Since 84/85 two large peaks characterised by sharp rises and declines; declingin since 98/99					unknown
Morwong, Rubberlip	K2	gradual decline 84/85-94/95 peaked in 97/98 to 84/85 level; decling overall since					unknown
Flathead, Dusky	S	very low catches, PT increase since 97/98				fully fished	no
Shark, Dogfish	S	decline since large peak in 91/92 to < 5t					no
Bream, Black and Yellowfin	S	Very low catches since 92/93				fully fished	yes

Appendix B2.3 cont'd

Species that make 99% of catch	Species Type - P, K2, S	Gear selectivity	BRD used to exclude undersized species	Proportion OTF of total %	Species identification problem	Marketability [1]	Refuge availability
Redfish	K2	very bad, too small		2.51	no	***	Low
Leatherjacket (mixed spp)	K2	NA		7.36	yes	***	Low
Yellowtail	S	bycatch in prawn		4.12	no	**	High
Perch, Ocean	K2	too small		4.90	no	***	Moderate - Low
Shark, Saw	K2	NA		23.27	no	***	Moderate
Stingray	S	NA		76.51	yes	**	Unknown
Shark, Gummy	S	NA		13.24	no	***	Mod
Sole, mixed	K2	NA		96.80	yes	****	Unknown
Dory, Mirror	K2	NA		3.24	no	****	Moderate
Tarwhine	S	no problem		11.05	no	***	Moderate - Low
Morwong, Rubberlip	K2	inappropriate		5.24	no	***	Low
Flathead, Dusky	S	no problem		23.02	no	***	Low
Shark, Dogfish Greeneye	S	NA			no	**	Moderate
Bream, Black and Yellowfin	S	some too small		1.11	yes	***	Moderate - Low

Appendix B2.3 cont'd

Species that make 99% of catch	Species Type -P, K2, S	Catch level & trends	CPUE trends	% Discarded	Stock Assessment adequacy	Exploitation Status NSW Status Report	OTF fishery targets aggregations
Shark, Carpet	S	Low catches fluctuating from 92/93-97/98; declining since to < 4t					no
Moonfish, pink tile fish	K2						no
Boarfish	K2	Very low catches < 4t on average					no
Shark, Black Tip	S	Large fluctuations					no
Ling	S	Large varaibility, decline since 98/99				unknown	no
Shark, Dogfish	S	Large variability, catches < 10t					no
Silver biddy	S	Very low catches < 2t			inadequate	unknown	yes
Trumpeter	S	Very low catches, decline since 97/98			inadequate	unknown	no
Crustaceans							
Prawn, Eastern King	P	Steady with fluctuation between 500t-800t from 85-97/98; increase since 96/97 to c. 1000t in 00/01	catch rate stable between 84/85 to 96/97, increased since.	2:1 but highly variable	none recent	fully fished	yes
Prawn, School	P	Peaked in 88/89, sharp decline next 2yr, then fluctuate at 25% of peak of about 100t, increase in 00/01 to 400t	Variable since 84/85 with peak in 89/90, declined since	2:1 but highly variable	none	unknown	yes
Prawn, Royal Red	P	From 85/86 to 88/89 steady at 200t, then increase in 89/92 to 400-500t, large fluctuations c. 300-500t until 96/97, large decline to < 200t & fluctuated at this level since	Large fluctuations but overall remained stable	unknown	none	unknown	yes
Crab, Blue Swimmer	K2	Peaked in 91/92 30t then fell to steady at 15-20t, increase from 98/99 to 35t in 2000/01			inadequate	unknown	no
Bug, Balmain	P	increase from 89/90, peaked in 96/97 at c.150-160t, declined since to c.50t since			none	unknown	no

[1] Based on Appendix I in Hutchins and Swainston (1986)

Sources: NSW Fisheries (2001), Caton, (2001), National Recreational Survey

P - primary; K2 - key secondary; S - secondary; blank = unknown; LL - legal length

Appendix B2.4 Decision rules for determining fishery impact profile for primary, key secondary and secondary species of the OTF

		Decision Rules	
Factor	**Measure of factor**	**Averse**	**Prone**
What's caught	Species identification problem	No	Yes
	Marketability	<= **	> **
Where fished	Refuge availability	High, Mod	Low
How is it fished	OTF fishery targets aggregations	No	Yes
	Gear selectivity	OK or NA	Too small
	BRD used to remove juveniles of species	effective in precluding undersized fish	ineffective in precluding undersized fish
How much caught	Catch level & trends	stable for 5yr or greater,	decline for 5 yr or more or highly variable
	CPUE trends	stable for last 5 yr	decrease in last 5 yr
	Discard rate/% discarded	<10%	>10%
	Stock assessment adequacy	Adequate information, i.e. CPUE, age & length	Inadequate information
	NSW exploitation status	Under fished	Fully, overfished or unknown
How many fishers	Proportion OTF of total catch	< = 50%	> 50%

Note: Shaded box indicates factor not used because of lack of information

Appendix B2.5 Stock assessment classes proposed to be used in determining stock assessments of primary, key secondary and secondary species of the OTF

Class	Characteristics
1	-ÊCredible time series of an index of abundance (survey or "clean" fishery dependent cpue). -ÊBiomass estimate with errors. - Risk analysis of managerial strategies. -ÊUse of standard fishery reference points as trigger points (e.g. $F_{0.1}$, B/B_0). - Time series of a recruitment index. - Externally reviewed or published. - Eastern king prawns will be subject to Class 1 assessment after the PhD-based research project has been completed (Dec 2005)
2	- Credible time series of cpue. - Local data on individual growth and total mortality. - Some information on adult movement from tagging studies. - Indicator/trigger points based upon landings, cpue, age/length structure. - Primary species would initially be subject to Class 2 assessment.
3	- Representative time series of landings. - Time series of cpue would have mixed credibility. - Local data on individual growth and total mortality. - Indicator/trigger points based upon landings, cpue and length structure. - Key secondary and some secondary species would initially subject to Class 3 assessment.
4	- Time series of landings only (possibly unrepresentative because of species identification issues). - Several similar species may be confounded within a complex. - Data on individual growth and total mortality from other sources if any (e.g. FishBase). - Indicator/trigger points based upon landings only. - Some secondary species will be subject to Class 4 assessment.
5	- Species not landed but known to undergo fishing mortality. - Data on individual growth and total mortality from other sources if any (e.g. FishBase). - No stock status trigger points defined, or only used within indicators of discarding.

Appendix B2.6 List of non-commerncial species caught by fishery independent surveys using ocean fish and prawn trawl gear

Note: Percentage is the percentage frequency of occurrence of a species across all trawls

Non-commercial bycatch species of OTF - Ocean fish trawl shelf sector					
Fish			**Fish**		
Family	**Species**	**%**	**Family**	**Species**	**%**
HEXANCHIDAE	*Heptranchias perlo*	0.4	CARANGIDAE	*Carangoides equula*	1.9
HETERODONTIDAE	*Heterodontus portusjacksoni*	20.1	CARANGIDAE	*Decapterus macrosoma*	1.1
PARASCYLLIIDAE	*Parascyllium collare*	17.7	SCORPIDIDAE	*Atypichthys strigatus*	1.1
SCYLIORHINIDAE	*Asymbolus rubiginosus*	29.6	CHAETODONTIDAE	*Chelmonops howensis*	5.9
SCYLIORHINIDAE	*Cephaloscyllium* sp.A	2.8	PENTACEROTIDAE	*Zanclistius elevatus*	33.8
NARCINIDAE	*Narcine tasmaniensis*	26.8	SPHYRAENIDAE	*Sphyraena africana*	1.2
HYPNIDAE	*Hypnos monopterygium*	4.3	PINGUIPEDIDAE	*Parapercis allporti*	59.8
TORPEDINIDAE	*Torpedo macneilli*	2.4	PINGUIPEDIDAE	*Parapercis macrophthalma*	2.0
RAJIDAE	*Raja australis*	73.8	BEMBROPSIDAE	*Bembrops aethalea*	0.4
UROLOPHIDAE	*Trygonoptera testaceus*	4.3	URANOSCOPIDAE	*Uranoscopus* sp.1	6.7
UROLOPHIDAE	*Urolophus bucculentus*	86.5	CALLIONYMIDAE	*Callionymus moretonensis*	26.9
UROLOPHIDAE	*Urolophus paucimaculatus*	5.4	ARIOMMIDAE	*Ariomma* sp.	0.8
UROLOPHIDAE	*Urolophus sufflavus*	78.6	BOTHIDAE	*Lophonectes gallus*	24.8
UROLOPHIDAE	*Urolophus viridis*	91.3	PLEURONECTIDAE	*Plagiopsetta glossa*	1.1
OPHICHTHYIDAE	*Ophisurus serpens*	1.6	OSTRACIIDAE	*Anoplocapros inermis*	23.6
AULOPIDAE	*Aulopus curtirostris*	40.4	OSTRACIIDAE	*Trioris reipublicae*	1.1
HARPADONTIDAE	*Saurida filamentosa*	5.6	OSTRACIIDAE	*Kentrocapros flavofasciatus*	4.7
PARAULOPIDAE	*Paraulopus nigripinnis*	64.1	TETRAODONTIDAE	*Lagocephalus cheesemani*	4.8
ATELEOPIDAE	*Ateleopus* sp.	0.4	TETRAODONTIDAE	*Sphoeroides pachygaster*	59.9
GONORYNCHIDAE	*Gonorynchus greyi*	6.0	TETRAODONTIDAE	*Arothron firmamentum*	1.1
LOPHIIDAE	*Lophiomus setigerus*	7.0	TETRAODONTIDAE	*Lagocephalus sp.*	5.4
ANTENNARIIDAE	*Antennarius striatus*	1.1	DIODONTIDAE	*Allomycterus pilatus*	73.9
OGCOCEPHALIDAE	*Halieutia brevicauda*	32.8	**Invertebrates**		
MORIDAE	*Physiculus therosideros*	1.5	SQUILLIDAE	*Kempina mikado*	12.1
MORIDAE	*Pseudophycis breviuscula*	11.4	MAJIDAE	*Leptomithrax waitei*	60.5
TRACHICHTHYIDAE	*Aulotrachichthys novaezelandiae*	14.6	DIOGENIDAE	*Trizopagurus strigimanus*	16.1
TRACHICHTHYIDAE	*Optivus* sp. cf. *elongatus*	1.1	DIOGENIDAE	*Dardanus arrosor*	36.3
HOLOCENTRIDAE	*Ostichthys japonicus*	0.8	VOLUTIDAE	*Ericusa sowerbyi*	2.4
MONOCENTRIDAE	*Cleidopus gloriamaris*	2.2	RANELLIDAE	*Charonia lampas rubicunda*	3.2
CAPROIDAE	*Antigonia rubicunda*	15.2	BUCCINIDAE	*Penion maxima*	4.8
FISTULARIIDAE	*Fistularia petimba*	29.4			
CENTRISCIDAE	*Macroramphosus gracilis*	36.8			
CENTRISCIDAE	*Macroramphosus scolopax*	83.7			
SYNGNATHIDAE	*Solegnathus spinsissimus*	14.0			
SCORPAENIDAE	*Maxillicosta whitleyi*	0.4			
SCORPAENIDAE	*Neosebastes thetidis*	1.1			
SCORPAENIDAE	*Neosebastes incisipinnis*	35.5			
TRIGLIDAE	*Lepidotrigla argus*	8.0			
TRIGLIDAE	*Lepidotrigla grandis*	28.5			
TRIGLIDAE	*Lepidotrigla modesta*	70.4			
TRIGLIDAE	*Lepidotrigla mulhalli*	83.6			
TRIGLIDAE	*Lepidotrigla* sp.	10.1			
PERISTEDIIDAE	*Satyrichthys welchi*	1.2			
PLATYCEPHALIDAE	*Bembras japonicus*	0.4			
HOPLICHTHYIDAE	*Hoplichthys ogilbyi*	16.8			
DACTYLOPTERIDAE	*Dactyloptena papilio*	1.1			
SERRANIDAE	*Lepidoperca brochata*	13.6			
SERRANIDAE	*Lepidoperca pulchella*	16.8			
PRIACANTHIDAE	*Priacanthus macracanthus*	1.1			
ACROPOMATIDAE	*Apogonops anomalus*	47.5			
ACROPOMATIDAE	*Synagrops japonicus*	10.1			
CARANGIDAE	*Carangoides equula*	1.9			

Non-commercial bycatch species of OTF - Ocean prawn trawl deepwater sector, cont'd

Fish			**Fish**		
Family	**Species**	**%**	**Family**	**Species**	**%**
MYXINIDAE	*Eptatretus cirrhatus*	9.5	PARALEPIDIDAE	*Lestidium nudum*	12.6
HEXANCHIDAE	*Heptranchias perlo*	41.3	PARALEPIDIDAE	*Stemonosudus rothschildi*	1.0
HETERODONTIDAE	*Heterodontus portusjacksoni*	0.5	PARALEPIDIDAE	*Lestrolepis* sp.x	0.5
SCYLIORINIDAE	*Apristurus* sp.G	2.1	PARALEPIDIDAE	*Lestidiops* sp.x	0.5
SCYLIORINIDAE	*Cephaloscyllium* sp.A	23.0	ATELEOPIDIDAE	*Ateleopus* sp.1	6.3
SCYLIORINIDAE	*Asymbolus rubiginosus*	4.7	LOPHIIDAE	*Lophiodes naresi*	10.4
SCYLIORINIDAE	*Galeus boardmani*	30.4	LOPHIIDAE	*Lophiodes mutilus*	24.6
SQUALIDAE	*Etmopterus lucifer*	24.7	LOPHIIDAE	*Lophiomus setigerus*	2.1
SQUALIDAE	*Squaliolus aliae*	0.5	CHAUNACIDAE	*Chaunax endeavouri*	23.1
SQUALIDAE	*Dalatias licha*	5.2	CHAUNACIDAE	*Chaunax penicillatus*	37.7
OXYNOTIDAE	*Oxynotus bruniensis*	8.4	OGCOCEPHALIDAE	*Halieutaea brevicauda*	6.8
NARCINIDAE	*Narcine tasmaniensis*	21.9	OGCOCEPHALIDAE	*Malthopsis ?lutea*	2.1
TORPEDINIDAE	*Torpedo macneilli*	10.4	OGCOCEPHALIDAE	*Halicmetus reticulatus*	4.7
RAJIDAE	*Pavoraja nitida*	22.0	OGCOCEPHALIDAE	*?Dibranchus* sp.1	0.5
RAJIDAE	*Raja australis*	7.3	MORIDAE	*Trypterophycis gilchristi*	28.9
RAJIDAE	*Raja gudgeri*	22.1	MORIDAE	*Gadella macrura*	0.5
RAJIDAE	*Raja* sp.B	35.7	MORIDAE	*Notophycis marginata*	1.6
RAJIDAE	*Raja* sp.C	25.1	MORIDAE	*Euclichthys* sp.A	20.5
RAJIDAE	*Raja* sp.I	1.0	MELANONIDAE	*Melanonus zugmayeri*	0.5
RAJIDAE	*Raja* sp.J	11.0	OPHIDIIDAE	*Monomitopus* sp.	14.7
RAJIDAE	*Raja polyommata*	0.5	OPHIDIIDAE	*Hoplobrotula* sp.1	0.5
RAJIDAE	*Pavoraja sp.* F	1.1	OPHIDIIDAE	*Glyptophidium* sp.	1.1
UROLOPHIDAE	*Urolophus bucculentus*	11.0	OPHIDIIDAE	*Homostolus acer*	3.7
UROLOPHIDAE	*Urolophus viridis*	11.0	OPHIDIIDAE	*Neobythites pallidus*	0.5
UROLOPHIDAE	*Urolophus sufflavus*	5.8	BYTHYTIDAE	*Diplacanthopoma* sp.1	2.1
CHIMAERIDAE	*Hydrolagus* sp.B	1.0	CARAPIDAE	*Pyramodon punctatus*	1.1
CONGRIDAE	*Bassanago bulbiceps*	20.0	MACROURIDAE	*Caelorinchus parvifasciatus*	44.1
CONGRIDAE	*Bassanago hirsutus*	1.1	MACROURIDAE	*Caelorinchus mirus*	29.3
CONGRIDAE	*Gnathophis macroporis*	1.1	MACROURIDAE	*Caelorinchus innotabilis*	14.6
OPHICHTHIDAE	*Ophisurus serpens*	1.6	MACROURIDAE	*Caelorinchus maurofasciatus*	42.5
OPHICHTHIDAE	*Muraenichthys breviceps*	0.5	MACROURIDAE	*Lucigadus nigromaculata*	35.6
NEMICHTHYIDAE	*Nemichthys curvirostris*	1.1	MACROURIDAE	*Malacocephalus laevis*	32.1
NOTACANTHIDAE	*Notacanthus sexspinus*	3.7	MACROURIDAE	*Lepidorhynchus denticulatus*	60.8
ARGENTINIDAE	*Argentina australiae*	6.8	MACROURIDAE	*Hymenocephalus longibarbis*	29.4
OPISTHOPROCTIDAE	*Opisthoproctus grimaldii*	0.5	MACROURIDAE	*Ventrifossa nigrodorsalis*	18.9
PHOTICHTHYIDAE	*Photichthys argenteus*	5.2	MACROURIDAE	*Lucigadus microlepis*	4.7
PHOTICHTHYIDAE	*Polymetme corythaeola*	2.1	POLYMIXIIDAE	*Polymixia* sp.	8.9
CHAULIODONTIDAE	*Chauliodus sloani*	3.1	DIRETMIDAE	*Diretmus argenteus*	1.6
STERNOPTYCHIDAE	*Argyropelicus aculeatus*	1.1	DIRETMIDAE	*Diretmoides parini*	0.5
STERNOPTYCHIDAE	*Argyrypnus iridescens*	0.5	TRACHICHTHYIDAE	*Hoplostethus intermedius*	40.3
ASTRONESTHIDAE	*Astronesthes indicus*	0.5	PARAZENIDAE	*Parazen pacificus*	3.7
IDIACANTHIDAE	*Idiacanthus fasciola*	0.5	ZENIONTIDAE	*Zenion japonicum*	33.6
AULOPIIDAE	*Aulopus curtirostris*	5.2	ZEIDAE	*Cyttus novaezelandiae*	2.6
PARAULOPIDAE	*Paraulopus nigripinnis*	69.7	ZEIDAE	*Cyttopsis roseus*	6.3
CHLOROPHTHALMIDAE	*Chlorophthalmus* sp.2	32.1	GRAMMICOLEPIDIDAE	*Grammicolepis brachiusculus*	2.1
CHLOROPHTHALMIDAE	*Chlorophthalmus* sp.3	1.6	GRAMMICOLEPIDIDAE	*Xenolepidichthys dalglieshi*	23.1
CHLOROPHTHALMIDAE	*Chlorophthalmus* sp.4	1.1	TRACHIPTERIDAE	*Trachipterus jacksonensis*	3.1
CHLOROPHTHALMIDAE	*Chlorophthalmus* sp.5	1.1	FISTULARIIDAE	*Fistularia petimba*	0.5
NEOSCOPELIDAE	*Neoscopelus macrolepidotus*	2.6			
NEOSCOPELIDAE	*Neoscopelus microchir*	1.6			

Non-commercial bycatch species of OTF - Ocean prawn trawl deepwater sector					
Fish			**Invertebrates**		
Family	**Species**	**%**	**Family**	**Species**	**%**
CENTRISCIDAE	*Centriscops humerosus*	41.4	SOLENOCERIDAE	*Haliporoides cristatus*	6.3
CENTRISCIDAE	*Notopogon xenosoma*	3.7	CHIROSTYLIDAE	*Uroptichus* sp.	2.1
CENTRISCIDAE	*Macroramphosus gracilis*	0.5	DIOGENIDAE	*Dardanus arossor*	39.6
CENTRISCIDAE	*Macroramphosus scolopax*	11.5	DIOGENIDAE	*Trizopagrus strigimanus*	20.8
SCORPAENIDAE	*Setarches guentheri*	0.5	PAGURIDAE	*Pagurus investigatoris*	58.3
SCORPAENIDAE	*Phenacoscorpius megalops*	1.1	PARAPAGURIDAE	*Parapagurus bouvieri*	18.8
SCORPAENIDAE	*Setarches longimanus*	6.3	ENOPLOTEUTHIDAE	*Abralia astrolineatus*	10.4
TRIGLIDAE	*Lepidotrigla modesta*	3.7	ENOPLOTEUTHIDAE	*Enoploteuthis galaxias*	31.3
TRIGLIDAE	*Lepidotrigla mulhalli*	8.3	HISTIOTEUTHIDAE	*Histioteuthis* sp.	2.1
PERISTEDIIDAE	*Peristedion liorhynchus*	25.2	OCTOPODIDAE	*Eledone palari*	4.2
PERISTEDIIDAE	*Peristedion* sp.2	1.1	OCTOPODIDAE	*Octopus* sp. (MoV #2040)*	4.2
PERISTEDIIDAE	*Satyrichthys* sp.3	4.2	EUGONATONOTIDAE	*Eugonatonotus crassa*	2.1
HOPLICHTHYIDAE	*Hoplichthys haswelli*	78.1	OPISTHOTEUTHIDAE	*Opisthoteuthis ?pluto*	10.4
HOPLICHTHYIDAE	*Hoplichthys filamentosus*	1.1	SEPIIDAE	*Sepia cultrata*	77.1
HOPLICHTHYIDAE	*Hoplichthys citrinus*	1.6	SEPIOLIDAE	*Rossia australis*	50.0
COTTIDAE	*Antipodocottus elegans*	3.2	BUCCINIDAE	*Penion mandarina*	8.3
PSYCHROLUTIDAE	*Psychrolutes marcidus*	0.5	FASCIOLARIIDAE	*Fusinus annae*	4.2
SERRANIDAE	*Lepidoperca brochata*	9.4	FASCIOLARIIDAE	*Pleuroploca australasia*	2.1
SERRANIDAE	*Ostracoberyx* sp.	11.0	RANELLIDAE	*Fusitriton retiolus*	37.5
PRIACANTHIDAE	*Priacanthus* sp.1	0.5	TROCHIDAE	*Calliotropus glyptus*	6.3
EPIGONIDAE	*Epigonus denticulatus*	31.0	TURBINELLIDAE	*Columbarium pagodoides*	4.2
EPIGONIDAE	*Epigonus robustus*	2.1	PANDALIDAE	*Heterocarpus sibogae*	10.4
ACROPOMATIDAE	*Synagrops japonicus*	52.4	VOLUTIDAE	*Ericusa papillosa*	2.1
ACROPOMATIDAE	*Apogonops anomalus*	51.3	PECTINIDAE	*Chlamys challengeri*	2.1
ACROPOMATIDAE	*Howella brodiei*	0.5	PANDALIDAE	*Plesionika martia*	41.7
BRAMIDAE	*Brama* sp.	0.5	POLYCHELIDAE	*Stereomastis phosphorus*	4.2
BATHYCLUPEIDAE	*Bathyclupea* sp.	4.7	GONEPLACIDAE	*Carcinoplax victoriensis*	6.3
PENTACEROTIDAE	*Pentaceros decacanthus*	32.0	HOMOLIDAE	*Homolochunia kular*	6.3
PENTACEROTIDAE	*Zanclistius elevatus*	6.3	HOMOLIDAE	*Latreillopsis petterdi*	41.7
PINGUIPEDIDAE	*Parapercis allporti*	16.2	PORTUNIDAE	*Ovalipes molleri*	22.9
CHAMPSODONTIDAE	*Champsodon sp.*	15.2			
CALLIONYMIDAE	*Foetorepus phasis*	0.5			
GEMPYLIDAE	*Rexea prometheoides*	1.1			
GEMPYLIDAE	*Nealotes tripes*	0.5			
GEMPYLIDAE	*Rexichthys johnpaxtoni*	7.3			
TRICHIURIDAE	*Benthodesmus elongatus*	20.4			
NOMEIDAE	*Cubiceps squamiceps*	26.2			
ARIOMMATIDAE	*Ariomma* sp.2	1.6			
BOTHIDAE	*Chascanopsetta lugubris*	29.9			
BOTHIDAE	*?Laeops* sp.	2.6			
PLEURONECTIDAE	*Azygopus pinnifasciatus*	36.8			
PLEURONECTIDAE	*Nematops macrochirus*	4.2			
CYNOGLOSSIDAE	*Symphurus australis*	3.7			
TRIACANTHODIDAE	*Macrorhamphosodes uradoi*	8.9			
TRIACANTHODIDAE	*Bathyphylax bombifrons*	4.7			
TRIACANTHODIDAE	*Triacanthodes ethiops*	3.7			
TRIACANTHODIDAE	*Halimochirargus alcocki*	0.5			
OSTRACIIDAE	*Lactoria fornasini*	0.5			
TETRAODONTIDAE	*Sphoeroides pachygaster*	20.9			
DIODONTIDAE	*Allomycterus pilatus*	2.6			

Non-commercial bycatch species of OTF - Ocean prawn trawl shelf sector					
Fish			**Fish**		
Family	**Species**	**%**	**Family**	**Species**	**%**
HETERODONTIDAE	*Heterodontus galeatus*	2.2	FISTULARIIDAE	*Fistularia commersonii*	1.1
HETERODONTIDAE	*Heterodontus portusjacksoni*	22.6	FISTULARIIDAE	*Fistularia petimba*	18.7
BRACHAELURIDAE	*Brachaelurus waddi*	0.6	CENTRISCIDAE	*Macroramphosus gracilis*	4.2
PARASCYLLIIDAE	*Parascyllium collare*	1.1	CENTRISCIDAE	*Macroramphosus scolopax*	11.2
SCYLIORHINIDAE	*Asymbolus rubinosus*	1.7	SYNGNATHIDAE	*Euleptorhamphus longirostris*	0.3
HYPNIDAE	*Hypnos monopterygium*	41.9	SYNGNATHIDAE	*Filicampus tigris*	0.3
RAJIDAE	*Raja australis*	6.4	SYNGNATHIDAE	*Hippocampus abdominalis*	0.3
DASYATIDIDAE	*Dasyatis fluviorum*	0.6	SYNGNATHIDAE	*Hippocampus tristis*	0.3
DASYATIDIDAE	*Dasyatis kuhlii*	9.5	SCORPAENIDAE	*Apistus carinatus*	2.5
UR0LOPHIDAE	*Trygonoptera testaceus*	37.2	SCORPAENIDAE	*Centropogon australis*	22.9
UR0LOPHIDAE	*Urolophus bucculentus*	3.1	SCORPAENIDAE	*Dendrochirus brachypterus*	1.4
UR0LOPHIDAE	*Urolophus paucimaculatus*	0.8	SCORPAENIDAE	*Dendrochirus zebra*	1.7
UR0LOPHIDAE	*Urolophus sufflavus*	0.6	SCORPAENIDAE	*Erosa erosa*	8.7
UR0LOPHIDAE	*Urolophus viridis*	1.7	SCORPAENIDAE	*Maxillacosta whitleyi*	59.5
UR0LOPHIDAE	*Urolophus* sp.A	25.1	SCORPAENIDAE	*Minous versicolor*	0.3
MURAENOSOCIDAE	*Oxyconger leptognathus*	0.8	SCORPAENIDAE	*Neocentropogon aeglefinis*	0.3
NETTASTOMATIDAE	?*Saurenchelys* sp.	0.3	SCORPAENIDAE	*Neosebastes incisipinnis*	15.6
CONGRIDAE	*Gnathophis longicaudus*	48.3	SCORPAENIDAE	*Notesthes robusta*	6.7
CONGRIDAE	*Gnathophis umbrellabius*	7.8	SCORPAENIDAE	*Pterois miles*	0.3
CONGRIDAE	*Gnathophis grahami*	34.4	TRIGLIDAE	*Lepidotrigla argus*	76.8
CONGRIDAE	*Poeciloconger kapala*	2.5	TRIGLIDAE	*Lepidotrigla mulhalli*	0.6
CONGRIDAE	*Uroconger lepturus*	2.5	TRIGLIDAE	*Lepidotrigla papilio*	21.5
OPHISURIDAE	*Ophisurus serpens*	0.6	TRIGLIDAE	*Lepidotrigla umbrosa*	10.9
CLUPEIDAE	*Etrumeus teres*	1.1	APLOACTINIDAE	*Aploactis adspersa*	1.4
CLUPEIDAE	*Hyperlophus vittatus*	4.5	PATAECIDAE	*Pataecus fronto*	1.1
ENGRAULIDIDAE	*Engraulis australis*	4.5	PLATYCEPHALIDAE	*Platycephalus longispinis*	85.2
SYNODONTIDAE	*Trachinocephalus myops*	18.2	PLATYCEPHALIDAE	*Suggrundus jugosus*	29.1
HARPADONTIDAE	*Saurida filamentosa*	17.6	DACTYLOPTERIDAE	*Dactyloptena orientalis*	1.7
HARPADONTIDAE	*Saurida undosquamis*	18.7	DACTYLOPTERIDAE	*Dactyloptena papilio*	14.2
PARAULOPIDAE	*Paraulopus nigripinnis*	0.3	SERRANIDAE	*Caesioperca lepidoptera*	0.3
GONORYNCHIDAE	*Gonorynchus greyi*	33.8	SERRANIDAE	*Hypoplectrodes maccullochi*	0.6
PLOTOSIDAE	*Cnidoglanis macrocephalus*	1.4	SERRANIDAE	*Lepidoperca pulchella*	1.1
PLOTOSIDAE	*Euristhmus lepturus*	1.7	SERRANIDAE	*Triso dermopterus*	0.6
PLOTOSIDAE	*Plotosus lineatus*	4.7	ACROPOMATIDAE	*Apogonops anomalus*	19.3
BATRACHOIDIDAE	*Batrachomeus dubius*	17.9	ACROPOMATIDAE	*Synagrops japonicus*	0.3
LOPHIIDAE	*Lophiomus setigerus*	5.3	TERAPONTIDAE	*Pelates quadrilineatus*	21.8
ANTENNARIIDAE	*Antennarius striatus*	36.3	TERAPONTIDAE	*Terapon jarbua*	0.3
ANTENNARIIDAE	*Kuiterichthys furcipilis*	0.6	PRIACANTHIDAE	*Priacanthus macracanthus*	39.7
OGCOCEPHALIDAE	*Halieutea brevicauda*	1.4	PRIACANTHIDAE	*Pristigenys niphonia*	4.2
MORIDAE	*Lotella rhacina*	0.6	APOGONIDAE	*Apogon ellioti*	2.5
MORIDAE	*Pseudophycis breviuscula*	33.8	APOGONIDAE	*Apogon fasciatus*	6.1
OPHIDIIDAE	*Neobythites* sp.	0.3	APOGONIDAE	*Apogon nigripinnis*	21.8
OPHIDIIDAE	*Ophidion* sp.	2.2	DINOLESTIDAE	*Dinolestes lewini*	5.0
BELONIDAE	*Ablennes hians*	1.4	CARANGIDAE	*Alepes* sp.	2.8
TRACHICHTHYIDAE	*Aulotrachichthys novaezelandiae*	0.3	CARANGIDAE	*Carangoides chrysophrys*	1.4
TRACHICHTHYIDAE	*Optivus* cf *elongatus*	33.8	CARANGIDAE	*Carangoides equula*	2.0
TRACHICHTHYIDAE	*Trachichthys australis*	0.3	CARANGIDAE	*Carangoides malabaricus*	0.6
MONOCENTRIDAE	*Cleidopus gloriamaris*	4.5	CARANGIDAE	*Trachurus declivis*	4.2
HOLOCENTRIDAE	*Ostichthys japonicus*	4.2	LEIOGNATHIDAE	*Equulites mortoniensis*	23.2
CAPROIDAE	*Antigonia rhomboidea*	0.3	NEMIPTERIDAE	*Nemipterus theodorei*	16.5
CAPROIDAE	*Antigonia rubicunda*	5.9	HAEMULIDAE	*Diagramma pictum*	1.1
VELIFERIDAE	*Velifer multiradiatus*	1.4	MULLIDAE	*Upeneus filifer*	2.8

Non-commercial bycatch species of OTF - Ocean prawn trawl shelf sector

Fish			**Fish**		
Family	**Species**	**%**	**Family**	**Species**	**%**
MULLIDAE	*Upeneus moluccensis*	1.7	MONACANTHIDAE	*Acanthaluteres vittiger*	1.4
MONODACTYLIDAE	*Schuettea scalaripinnis*	0.6	MONACANTHIDAE	*Arotrolepis filicauda*	12.3
PEMPHERIDIDAE	*Pempheris affinis*	0.3	MONACANTHIDAE	*Brachaluteres jacksonianus*	0.8
PEMPHERIDIDAE	*Pempheris analis*	5.9	MONACANTHIDAE	*Cantheschenia longipinnis*	1.1
PEMPHERIDIDAE	*Pempheris compressa*	4.2	MONACANTHIDAE	*Chaetoderma penicilligera*	0.6
PEMPHERIDIDAE	*Pempheris multiradiatus*	2.0	MONACANTHIDAE	*Paramonacanthus lowei*	13.1
SCORPIDIDAE	*Atypichthys strigatus*	8.1	MONACANTHIDAE	*Paramonacanthus otisensis*	10.1
SCORPIDIDAE	*Microcanthus strigatus*	2.8	MONACANTHIDAE	*Thamnaconus harpargyreus*	0.3
SCORPIDIDAE	*Scorpis lineolatus*	0.3	OSTRACIIDAE	*Anoplocapros inermis*	65.6
CHAETODONTIDAE	*Chaetodon guntheri*	0.6	OSTRACIIDAE	*Lactoria cornuta*	0.3
CHAETODONTIDAE	*Heniochus diphreutes*	0.8	OSTRACIIDAE	*Lactoria diaphana*	0.8
ENOPLOSIDAE	*Enoplosus armatus*	5.0	OSTRACIIDAE	*Trioris reipublicae*	67.6
PENTACEROTIDAE	*Zanclistius elevatus*	0.8	TETRAODONTIDAE	*Arothron aerostaticus*	0.3
POMACENTRIDAE	*Chromis abyssicola*	0.3	TETRAODONTIDAE	*Arothron firmamentum*	0.3
APLODACTYLIDAE	*Crinodus lophodon*	1.7	TETRAODONTIDAE	*Canthegaster callisterna*	0.6
CHEILODACTYLIDAE	*Cheilodactylus vestitus*	0.3	TETRAODONTIDAE	*Lagocephalus cheesemani*	28.5
CEPOLIDAE	*Cepola australis*	1.1	TETRAODONTIDAE	*Lagocephalus inermis*	0.3
SPHYRAENIDAE	*Sphyraena africana*	11.7	TETRAODONTIDAE	*Lagocephalus sceleratus*	0.6
LABRIDAE	*Choerodon frenatus*	5.3	TETRAODONTIDAE	*Reicheltia halsteadi*	25.1
LABRIDAE	*Suezichthys gracilis*	0.3	TETRAODONTIDAE	*Tetractenos glaber*	0.6
OPISTOGNATHIDAE	*Opistognathus jacksonensis*	0.3	TETRAODONTIDAE	*Tetractenos hamiltoni*	0.8
PINGUIPEDIDAE	*Parapercis allporti*	5.0	TETRAODONTIDAE	*Torquigener altipinnis*	26.5
PINGUIPEDIDAE	*Parapercis binivirgata*	2.2	TETRAODONTIDAE	*Torquigener pleurogramma*	0.6
PINGUIPEDIDAE	*Parapercis nebulosa*	17.6	TETRAODONTIDAE	*Torqigener tuberculiferus*	0.6
PINGUIPEDIDAE	*Parapercis* sp.A	1.4	DIODONTIDAE	*Allomycterus pilatus*	5.0
URANOSCOPIDAE	*Ichthyscopus nigripinnis*	1.1	DIODONTIDAE	*Chilomycterus reticulatus*	0.3
URANOSCOPIDAE	*Uranoscopus ?terraereginae*	4.7	DIODONTIDAE	*Dicotylichthys punctulatus*	18.2
CHAMPSODONTIDAE	*Champsodon* sp.	12.0	DIODONTIDAE	*Diodon holocanthus*	1.1
BLENNIIDAE	*Petroscirtes lupus*	1.7	DIODONTIDAE	*Diodon hystrix*	0.3
BLENNIIDAE	*Xiphasia setifer*	1.1			
CLINIDAE	*Cristiceps aurantiacus*	0.6			
CALLIONYMIDAE	*Callionymus calcaratus*	57.5			
CALLIONYMIDAE	*Callionymus limiceps*	1.7			
CALLIONYMIDAE	*Callionymus japonicus*	17.9			
CALLIONYMIDAE	*Callionymus macdonaldi*	0.3			
CALLIONYMIDAE	*Callionymus moretonensis*	0.8			
CALLIONYMIDAE	*Synchiropus calauropomus*	26.5			
BOTHIDAE	*Arnoglossus fisoni*	3.6			
BOTHIDAE	*Crossorhombus ?valderostratus*	4.5			
BOTHIDAE	*Engyprosopon grandisquama*	20.9			
BOTHIDAE	*Engyprosopon ?bleekeri*	2.2			
BOTHIDAE	*Engyprosopon maculipinnis*	4.2			
BOTHIDAE	*Grammatobothus pennatus*	1.1			
BOTHIDAE	*Lophonectes gallus*	83.5			
PLEURONECTIDAE	*Samaris cristatus*	0.3			
SOLEIDAE	*Aesopia cornuta*	1.4			
SOLEIDAE	*Aesopia microcephala*	2.2			
SOLEIDAE	*Synclidopus macleayanus*	47.8			
SOLEIDAE	*Synclidopus* sp.2	0.3			
SOLEIDAE	*Pardachirus hedleyi*	13.7			
SOLEIDAE	*Zebrias scalaris*	64.5			
CYNOGLOSSIDAE	*Cynoglossus maculipinnis*	11.2			

Non-commercial bycatch species of OTF - Ocean prawn trawl shelf sector					
Invertebrates			**Invertebrates**		
Family	**Species**	**%**	**Family**	**Species**	**%**
SQUILLIDAE	*Belosquilla laevis*	31.8	SEPIIDAE	*Sepia limata*	15.1
SQUILLIDAE	*Anchisquilloides mcneilli*	17.0	SEPIOLOIDIDAE	*Sepioloidea lineolata*	38.5
SQUILLIDAE	*Kempina mikado*	3.4	OCTOPODIDAE	*Hapalochlaena fasciata*	1.7
SQUILLIDAE	*Oratosquilla* cf. *imperialis*	2.0	OCTOPODIDAE	*Octopus* sp. (MoV #2040)*	1.4
SQUILLIDAE	*Oratosquilla woodmasoni*	3.1	OCTOPODIDAE	*Octopus* sp. (MoV #1462)*	3.6
HARPIOSQUILLIDAE	*Harpiosquilla melanura*	0.6	OCTOPODIDAE	*Octopus* sp. (MoV #1463)*	5.9
LYSIOSQUILLIDAE	*Lysiosquilla* sp.	0.8	ARCHITECTONIDAE	*Architectonica perspectiva*	0.3
ODONTODACTYLIDAE	*Odontodactylus japonicus*	0.3	BUCCINIDAE	*Penion maxima*	7.8
SOLENOCERIDAE	*Solenocera ?choprai*	13.4	BUCCINIDAE	*Fusinus novaehollandiae*	2.0
SOLENOCERIDAE	*Solenocera* sp.2	5.9	CASSIDAE	*Cassis nana*	0.6
PENAEIDAE	*Metapenaeopsis ?mogiensis*	1.1	CASSIDAE	*Phalium bisulcatum*	1.7
PENAEIDAE	*Metapenaeopsis novaeguineae*	11.2	CASSIDAE	*Phalium thomsoni*	5.3
PENAEIDAE	*Trachypenaeus curvirostris*	70.7	CYMATIIDAE	*Cymatium vespaceum*	1.1
SICYONIDAE	*Sicyona cristata*	7.5	CYMATIIDAE	*Mayena australasiae*	2.5
PANDALIDAE	*Plesionika ortmani*	6.7	FICIDAE	*Ficus subintermedia*	3.6
PANDALIDAE	*Plesionika spinipes*	3.4	MITRIDAE	*Mitra solida*	0.6
SCYLLARIDAE	*Scyllaris sordidus*	1.1	OLIVIDAE	*Ancillista velesiana*	15.9
DIOGENIDAE	*Trizopagurus strigimanus*	5.6	OVULIDAE	*Volva volva*	0.6
DIOGENIDAE	*Dardanus arrosor*	22.9	STROMBIDAE	*Strombus vittatus*	0.3
DIOGENIDAE	*Dardanus ?crassimanus*	7.0	TROCHIDAE	*Astele speciosa*	1.7
PARAPAGURIDAE	*Paragiopagurus diogenes*	9.5	VOLUTIDAE	*Amoria undulata*	0.3
CALAPPIDAE	*Calappa lophus*	2.5	VOLUTIDAE	*Cymbiolista hunteri*	7.8
CALAPPIDAE	*Calappa philargius*	2.5	VOLUTIDAE	*Zebramoria zebra*	0.3
CALAPPIDAE	*Matuta planipes*	0.6	XENOPHORIDAE	*Xenophora indica*	11.7
CALAPPIDAE	*Mursia curtispina*	3.1	XENOPHORIDAE	*Xenophora peroniana*	7.5
CORYSTIDAE	*Jonas luteanus*	2.0	GLYCIMERIDAE	*Glycimeris flamma*	5.6
DORIPPIDAE	*Dorippe quadridens*	0.3	GLYCIMERIDAE	*Glycimeris holoserica*	9.2
DROMIIDAE	Dromiid sp.	0.3	LIOCONCHIDAE	*Callista diemenensis*	0.6
GONOPLACIDAE	*Carcinoplax meridionalis*	3.9	MACTRIDAE	*Mactra contraria*	0.3
GONOPLACIDAE	*Ommatocarcinus macgillivrayi*	5.6	PECTINIDAE	*Annachlamys flabellatus*	0.3
GONOPLACIDAE	*Psopheticus cf insignis*	2.0	PECTINIDAE	*Mesopeplum fenestratum*	1.1
HOMOLIDAE	*Homola orientalis*	2.2	TRIGONIDAE	*Neotrigonia lamarkii*	1.7
LATREILLIDAE	*Latreillia philargium*	3.6	VENERIDAE	*Placamen placidum*	1.4
LEUCOSIIDAE	*Arcania undecimspinosa*	2.8			
LEUCOSIIDAE	*Ebalia undecimspinosa*	0.3			
MAJIDAE	*Ephippias endeavouri*	0.6			
MAJIDAE	*Leptomithrax tuberculatus*	25.1			
MAJIDAE	*Leptomithrax waitei*	2.8			
MAJIDAE	*Naxioides robillardi*	1.7			
MAJIDAE	*Phalangipus australiensis*	3.9			
PARTHENOPIDAE	*Eumedonus villosus*	0.8			
PORTUNIDAE	*Charybdis bimaculata*	39.7			
PORTUNIDAE	*Charybdis miles*	31.3			
PORTUNIDAE	*Charybdis natator*	17.3			
PORTUNIDAE	*Charybdis granulosus*	17.9			
PORTUNIDAE	*Lupocyclas* sp.	2.8			
PORTUNIDAE	*Portunus argentatus*	21.2			
PORTUNIDAE	*Portunus orbitosinus*	2.5			
PORTUNIDAE	*Portunus rubromarginatus*	28.5			
PORTUNIDAE	*Portunus* sp.A	2.0			
PORTUNIDAE	*Thalamita sima*	1.7			
RANINIDAE	*Lyreidus tridentatus*	6.4			

Non-commercial bycatch species of OTF - Ocean fish trawl shelf, Wreck Bay and Tathra inshore grounds

Fish

Family	Species	%
HETERODONTIDAE	*Heterodontus portusjacksoni*	64.1
HETERODONTIDAE	*Heterodontus galeatus*	5.5
ODONTASPIDIDAE	*Eugomphodus taurus*	0.8
PARASCYLLIIDAE	*Parascyllium collare*	26.6
BRACHAELURIDAE	*Brachaelurus waddi*	2.3
SCYLIORHINIDAE	*Asymbolus analis*	57.0
SCYLIORHINIDAE	*Cephaloscyllium laticeps*	43.8
HYPNIDAE	*Hypnos monopterygium*	1.6
TORPEDINIDAE	*Torpedo macneilli*	0.8
RAJIDAE	*Raja australis*	24.2
UROLOPHIDAE	*Trygonoptera testacea*	38.3
UROLOPHIDAE	*Trygonoptera* sp.B	16.4
UROLOPHIDAE	*Urolophus bucculentus*	24.2
UROLOPHIDAE	*Urolophus cruciatus*	46.1
UROLOPHIDAE	*Urolophus paucimaculatus*	81.3
UROLOPHIDAE	*Urolophus sufflavus*	12.5
UROLOPHIDAE	*Urolophus viridis*	17.2
UROLOPHIDAE	*Urolophus* sp.A	71.9
SYNODONTIDAE	*Trachinocephalus myops*	14.8
PARAULOPIDAE	*Paraulopus nigripinnis*	2.3
GONORYNCHIDAE	*Gonorynchus greyi*	47.7
ANTENNARIIDAE	*Antennarius striatus*	0.8
MORIDAE	*Pseudophycis breviuscula*	3.9
TRACHICHTHYIDAE	*Optivus* sp. cf. *elongatus*	19.5
TRACHICHTHYIDAE	*Paratrachichthys* cf. *trailli*	0.8
MONOCENTRIDIDAE	*Cleidopus gloriamaris*	2.3
CAPROIDAE	*Antigonia rubicunda*	0.8
VELIFERIDAE	*Velifer multiradiatus*	5.5
FISTULARIIDAE	*Fistularia petimba*	40.6
CENTRISCIDAE	*Macroramphosus gracilis*	1.6
CENTRISCIDAE	*Macroramphosus scolopax*	40.6
SYNGNATHIDAE	*Solegnathus spinsissimus*	7.8
SCORPAENIDAE	*Centropogon australis*	10.2
SCORPAENIDAE	*Maxillicosta whitleyi*	79.7
SCORPAENIDAE	*Neosebastes incisipinnis*	14.1
SCORPAENIDAE	*Neosebastes scorpaenoides*	35.9
SCORPAENIDAE	*Scorpaena ergastulorum*	1.6
TRIGLIDAE	*Lepidotrigla argus*	64.8
TRIGLIDAE	*Lepidotrigla modesta*	3.9
TRIGLIDAE	*Lepidotrigla mulhalli*	65.6
TRIGLIDAE	*Lepidotrigla papilio*	53.9
TRIGLIDAE	*Lepidotrigla vanessa*	50.8
PLATYCEPHALIDAE	*Platycephalus longispinis*	91.4
TERAPONTIDAE	*Pelates quadrilineatus*	2.3
PRIACANTHIDAE	*Priacanthus macracanthus*	0.8
DINOLESTIDAE	*Dinolestes lewini*	13.3
ACROPOMATIDAE	*Apogonops anomalus*	8.6
PEMPHERIDAE	*Pempheris compressus*	2.3
PEMPHERIDAE	*Pempheris multiradiatus*	3.9
SCORPIDIDAE	*Atypichthys strigatus*	14.1
ENOPLOSIDAE	*Enoplosus armatus*	2.3

Fish

Family	Species	%
PENTACEROTIDAE	*Zanclistius elevatus*	7.8
PINGUIPEDIDAE	*Parapercis allporti*	1.6
CALLIONYMIDAE	*Callionymus calcaratus*	29.7
CALLIONYMIDAE	*Synchiropus calauropomus*	26.6
BOTHIDAE	*Lophonectes gallus*	16.4
SOLEIDAE	*Zebrias scalaris*	15.6
MONACANTHIDAE	*Meuschenia venusta*	0.8
MONACANTHIDAE	*Thamnaconus degeni*	10.9
OSTRACIIDAE	*Anoplocapros inermis*	86.7
OSTRACIIDAE	*Aracana aurita*	1.6
OSTRACIIDAE	*Lactoria diaphana*	0.8
OSTRACIIDAE	*Trioris reipublicae*	42.2
TETRAODONTIDAE	*Arothron firmamentum*	18.0
TETRAODONTIDAE	*Lagocephalus cheesemani*	4.7
TETRAODONTIDAE	*Omegophora armilla*	3.9
DIODONTIDAE	*Allomycterus pilatus*	73.4
DIODONTIDAE	*Dicotylichthys punctulatus*	4.7
DIODONTIDAE	*Diodon nicthemerus*	42.2

Invertebrates

MAJIDAE	*Leptomithrax tuberculatus*	3.1
DIOGENIDAE	*Trizopagurus strigimanus*	28.9
DIOGENIDAE	*Dardanus arrosor*	28.1
OCTOPODIDAE	*Octopus* sp. (MoV #1462)	0.8
OCTOPODIDAE	*Octopus* sp. (MoV #1463)	0.8
OCTOPODIDAE	*Octopus* sp. (MoV #2040)	1.6
VOLUTIDAE	*Amoria undulata*	6.3
VOLUTIDAE	*Ericusa sowerbyi*	14.1
CASSIDIDAE	*Semicassis pyrum*	3.1
BUCCINIDAE	*Penion maxima*	3.9
BUCCINIDAE	*Pleuroploca australasia*	3.9
BUCCINIDAE	*Fusinus novaehollandiae*	1.6
BUCCINIDAE	*Fusinus undulatus*	1.6
UMBRACULIDAE	*Umbraculum umbraculum*	0.8
PINNIDAE	*Atrina tasmanica*	6.3
PECTINIDAE	*Mesopeplum fenestratum*	2.3

Sources: Fish - Compiled from Kapala Cruise Reports No's 114 (Graham *et al*., 1995), 115 (Graham *et al*., 1996) and 117 (Graham *et al*., 1997); Prawn - Compiled from Kapala Cruise Reports No's 110 (Graham *et al*., 1993a); 112 (Graham *et al*., 1993b); and 116 (Graham and Wood, 1997).

Note: Only includes species found in NSW waters (any species found only in SEF grounds were deleted)

Appendix B2.7 Risk Assessment of non-commercial species of the OTF)

FIP - fishery impact profile, P - prone, PP - double prone, Y - yes, TT - trawl trauma, B - baratrauma, I-H - intermediate to high, I-L - intermediate to low .

Non-commercial Bycatch Finfish Species												
Family	**Species**	Obs	Survival	Survival Risk potential	Depth overlap Risk potential	**FIP**	Life history Risk potential	Mode of life Risk potential	Habitat Assoc. risk potential	Depth range Risk potential	**Resilience**	**Risk**
HETERODONTIDAE	*Heterodontus portusjacksoni*	✓	*Y*	A	P	**Low**	P	P	P	A	**Low-Mod**	**I-L**
HETERODONTIDAE	*Heterodontus galeatus*	✓	*Y*	A	P	**Low**	PP	P	P	P	**Low**	**I-L**
HEXANCHIDAE	*Heptranchias perlo*	✓	*TT*	PP	PP	**High**	PP	P	P	A	**Low-Mod**	**H**
PARASCYLLIIDAE	*Parascyllium collare*	✓	*Y*	A	P	**Low**	P	P	A	A	**Mod**	**L**
SCYLIORHINIDAE	*Asymbolus rubiginosus*	×	*Y*	A	PP	**Low**	P	P	U	A	**Mod**	**L**
SCYLIORHINIDAE	*Asymbolus analis*	✓	*Y*	A	PP	**Low**	P	P	U	A	**Mod**	**L**
SCYLIORHINIDAE	*Cephaloscyllium laticeps*	✓	*Y*	A	P	**Low**	P	P	U	A	**Mod**	**L**
SCYLIORHINIDAE	*Cephaloscyllium sp.A*	✓	*Y*	A	PP	**Low**	P	P	U	A	**Mod**	**L**
SCYLIORINIDAE	*Galeus boardmani*	✓	*TT*	PP	PP	**High**	P	P	U	A	**Mod**	**H**
NARCINIDAE	*Narcine tasmaniensis*	✓	*TT*	PP	P	**High**	P	P	P	A	**Low-Mod**	**H**
SQUALIDAE	*Etmopterus lucifer*	✓	*TT*	PP	PP	**High**	P	A	U	A	**Mod-High**	**I-H**
RAJIDAE	*Raja sp.B*	✓	*TT*	PP	PP	**High**	P	P	P	A	**Low-Mod**	**H**
RAJIDAE	*Raja sp.C*	×	*TT*	PP	PP	**High**	P	P	P	A	**Low-Mod**	**H**
RAJIDAE	*Raja gudgeri*	✓	*TT*	PP	PP	**High**	P	P	P	A	**Low-Mod**	**H**
RAJIDAE	*Pavoraja nitida*	✓	*TT*	PP	PP	**High**	P	P	P	A	**Low-Mod**	**H**
RAJIDAE	*Raja australis*	✓	*TT*	PP	P	**High**	P	P	P	A	**Low-Mod**	**H**
UROLOPHIDAE	*Urolophus viridis*	×	*TT*	PP	PP	**High**	PP	P	P	A	**Low-Mod**	**H**
UROLOPHIDAE	*Urolophus bucculentus*	✓	*TT*	PP	PP	**High**	PP	P	P	A	**Low-Mod**	**H**
UROLOPHIDAE	*Urolophus sufflavus*	×	*TT*	PP	PP	**High**	PP	P	P	A	**Low-Mod**	**H**
UROLOPHIDAE	*Urolophus paucimaculatus*	✓	*TT*	PP	P	**High**	PP	P	P	A	**Low-Mod**	**H**
UROLOPHIDAE	*Urolophus sp.A*	×	*TT*	PP	P	**High**	PP	P	P	A	**Low-Mod**	**H**
UROLOPHIDAE	*Urolophus cruciatus*	✓	*TT*	PP	P	**High**	PP	P	P	A	**Low-Mod**	**H**
UROLOPHIDAE	*Trygonoptera testacea*	✓	*TT*	PP	P	**High**	PP	P	P	P	**Low**	**H**
UROLOPHIDAE	*Trygonoptera sp.B*	✓	*TT*	PP	P	**High**	PP	P	P	A	**Low-Mod**	**H**
AULOPIDAE	*Aulopus curtirostris*	✓	*B*	PP	P	**High**	A	P	A		**Mod-High**	**I-H**
HARPADONTIDAE	*Saurida filamentosa*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**I-H**
PARAULOPIDAE	*Paraulopus nigripinnis*		*TT*	PP	U	**High**	P	P	P		**Low-Mod**	**I-H**
SYNODONTIDAE	*Trachinocephalus myops*	✓	*B*	PP	PP	**High**	A	P	P		**Mod**	**H**
GONORYNCHIDAE	*Gonorynchus greyi*		*TT*	PP	U	**High**	P	P	P	P	**Low-Mod**	**I-H**
LOPHIIDAE	*Lophiodes mutilus*	✓	*B*	PP	PP	**High**	A	P	U		**Mod-High**	**I-H**

Appendix B2.7 cont'd

Non-commercial Bycatch Finfish Species												
Family	**Species**	Obs	Survival	Survival Risk potential	Depth overlap Risk potential	**FIP**	Life history Risk potential	Mode of life Risk potential	Habitat Assoc. risk potential	Depth range Risk potential	**Resilience**	**Risk**
LOPHIIDAE	*Lophiomus setigerus*	×	*TT*	PP	PP	**High**	A	P	U		**Mod-High**	**L**
OGCOCEPHALIDAE	*Halieutia brevicauda*	✓	*B*	PP	PP	**High**	P	P	U	A	**Mod**	**H**
TRACHICHTHYIDAE	*Aulotrachichthys novaezelandiae*	×	*B*	PP	PP	**High**	A	P	A	A	**Mod-High**	**I-H**
TRACHICHTHYIDAE	*Optivus sp. cf. elongatus*	×	*B*	PP	PP	**High**	A	P	A	A	**Mod-High**	**I-H**
TRACHICHTHYIDAE	*Hoplostethus intermedius*	✓	*B*	PP	PP	**High**	A	P	A	A	**Mod-High**	**I-H**
MORIDAE	*Pseudophycis breviuscula*		*B*	PP	U	**High**	P	P	A	P	**Low-Mod**	**I-H**
MORIDAE	*Trypterophycis gilchristi*		*B*	PP	U	**High**	P	P	A	P	**Low-Mod**	**I-H**
MORIDAE	*Euclichthys sp.A*		*B*	PP	U	**High**	P	P	A	P	**Low-Mod**	**I-H**
CONGRIDAE	*Bassanago bulbiceps*		*B*	PP	U	**High**	P	P	A	P	**Low-Mod**	**I-H**
VELIFERIDAE	*Velifer multiradiatus*	✓	*B*	PP	P	**High**	P	P	U	A	**Mod**	**H**
FISTULARIIDAE	*Fistularia petimba*		*TT*	PP	U	**High**	PP	P	P	P	**Low**	**I-H**
CAPROIDAE	*Antigonia rubicunda*		*B*	PP	U	**High**	A	P	P	P	**Low-Mod**	**I-H**
CENTRISCIDAE	*Macroramphosus scolopax*		*TT*	PP	U	**High**	A	P	P	P	**Low-Mod**	**I-H**
CENTRISCIDAE	*Macroramphosus gracilis*		*TT*	PP	U	**High**	A	P	P	P	**Low-Mod**	**I-H**
CENTRISCIDAE	*Centriscops humerosus*		*B*	PP	U	**High**	A	P	P	P	**Low-Mod**	**I-H**
SYNGNATHIDAE	*Solegnathus spinsissimus*	✓	*B*	PP	P	**High**	PP	P	P	A	**Low-Mod**	**H**
SCORPAENIDAE	*Neosebastes incisipinnis*	✓	*B*	PP	PP	**High**	A	P	P		**Mod**	**H**
SCORPAENIDAE	*Maxillicosta whitleyi*	×	*B*	PP	PP	**High**	A	P	P		**Mod**	**H**
SCORPAENIDAE	*Neosebastes scorpaenoides*	✓	*B*	PP	P	**High**	A	P	P	A	**Mod**	**H**
SCORPAENIDAE	*Centropogon australis*	✓	*B*	PP	P	**High**	A	P	A	P	**Mod**	**H**
TRIGLIDAE	*Lepidotrigla mulhalli*	✓	*B*	PP	P	**High**	A	P	P	A	**Mod**	**H**
TRIGLIDAE	*Lepidotrigla modesta*	✓	*B*	PP	P	**High**	A	P	P	A	**Mod**	**H**
TRIGLIDAE	*Lepidotrigla grandis*	×	*B*	PP	P	**High**	A	P	P	A	**Mod**	**H**
TRIGLIDAE	*Lepidotrigla sp.*	×	*B*	PP	P	**High**	A	P	P	A	**Mod**	**H**
TRIGLIDAE	*Lepidotrigla argus*	✓	*B*	PP	PP	**High**	A	P	P		**Mod**	**H**
TRIGLIDAE	*Lepidotrigla papilio*	✓	*B*	PP	P	**High**	A	P	P	P	**Low-Mod**	**H**
TRIGLIDAE	*Lepidotrigla vanessa*	×	*B*	PP	P	**High**	A	P	P	P	**Low-Mod**	**H**
PLATYCEPHALIDAE	*Platycephalus longispinis*	✓	*B*	PP	P	**High**	A	P	P	P	**Low-Mod**	**H**
CHLOROPHTHALMIDAE	*Chlorophthalmus sp.2*		*TT*	PP	U	**High**					**High**	**I-H**
HOPLICHTHYIDAE	*Hoplichthys haswelli*	✓	*TT*	PP	PP	**High**	A	P	P	A	**Mod**	**H**
HOPLICHTHYIDAE	*Hoplichthys ogilbyi*	×	*TT*	PP	PP	**High**	A	P	P	A	**Mod**	**H**
DINOLESTIDAE	*Dinolestes lewini*		*TT*	PP	U	**High**	P	A	P	P	**Low-Mod**	**I-H**
ACROPOMATIDAE	*Synagrops japonicus*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**I-H**
ACROPOMATIDAE	*Apogonops anomalus*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**I-H**
SERRANIDAE	*Lepidoperca pulchella*	×	*B*	PP	P	**High**	A	P	A	A	**Mod-High**	**I-H**

Appendix B2.7 cont'd

Non-commercial Bycatch Finfish Species													
Family	**Species**	Obs	Survival	Survival Risk potential	Depth overlap Risk potential	**FIP**	Life history Risk potential	Mode of life Risk potential	Habitat Assoc. risk potential	Depth range Risk potential	**Resilience**	**Risk**
SERRANIDAE	*Lepidoperca brochata*	✓	*B*	PP	P	**High**	A	P	A	A	**Mod-High**	**I-H**
SCORPIDIDAE	*Atypichthys strigatus*	✓	*B*	PP	P	**High**	A	A	A	P	**Mod-High**	**I-H**
PENTACEROTIDAE	*Zanclistius elevatus*	✓	*B*	PP	P	**High**	A	P	U	A	**Mod-High**	**I-H**
PENTACEROTIDAE	*Pentaceros decacanthus*	✓	*B*	PP	P	**High**	A	P	P	A	**Mod**	**H**
CALLIONYMIDAE	*Callionymus moretonensis*	✓	*TT*	PP	PP	**High**	A	P	P		**Mod**	**H**
CALLIONYMIDAE	*Callionymus calcaratus*	✓	*TT*	PP	PP	**High**	A	P	P		**Mod**	**H**
CALLIONYMIDAE	*Synchiropus calauropomus*	×	*TT*	PP	PP	**High**	A	P	P		**Mod**	**H**
CHAETODONTIDAE	*Chelmonops howensis*	✓	*B*	PP	P	**High**	A	P	A	P	**Mod**	**H**
BOTHIDAE	*Chascanopsetta lugubris*	✓	*TT*	PP	PP	**High**	A	P	P	A	**Mod**	**H**
BOTHIDAE	*Lophonectes gallus*	✓	*TT*	PP	P	**High**	A	P	P	A	**Mod**	**H**
SOLEIDAE	*Zebrias scalaris*		*TT*	PP	U	**High**	A	P	P	A	**Mod**	**I-H**
PINGUIPEDIDAE	*Parapercis allporti*	✓	*B*	PP	PP	**High**	A	P	P	A	**Mod**	**H**
CHAUNACIDAE	*Chaunax penicillatus*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
CHAUNACIDAE	*Chaunax endeavouri*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
MONACANTHIDAE	*Thamnaconus degeni*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
OSTRACIIDAE	*Anoplocapros inermis*	✓	*B*	PP	P	**High**	A	P	U	A	**Mod-High**	**H**
OSTRACIIDAE	*Kentrocapros flavofasciatus*	✓	*B*	PP	PP	**High**	A	P	U	P	**Mod**	**H**
OSTRACIIDAE	*Trioris reipublicae*	×	*B*	PP	PP	**High**	A	P	U	P	**Mod**	**H**
URANOSCOPIDAE	*Uranoscopus sp.1*		*TT*	PP	U	**High**	U	P	P	P	**Low-Mod**	**H**
TETRAODONTIDAE	*Sphoeroides pachygaster*	✓	*B*	PP	PP	**High**	P	P	A	A	**Mod**	**H**
TETRAODONTIDAE	*Lagocephalus cheesemani*	✓	*B*	PP	PP	**High**	P	A	P		**Mod**	**H**
TETRAODONTIDAE	*Arothron firmamentum*	×	*B*	PP	PP	**High**	P	A	P		**Mod**	**H**
DIODONTIDAE	*Allomycterus pilatus*	✓	*B*	PP	P	**High**	P	P	U	A	**Mod**	**H**
DIODONTIDAE	*Diodon nicthemerus*	✓	*B*	PP	P	**High**	P	P	P	P	**Low-Mod**	**H**
DIODONTIDAE	*Dicotylichthys punctulatus*	✓	*B*	PP	P	**High**	P	P	A	P	**Low-Mod**	**H**
MACROURIDAE	*Lepidorhynchus denticulatus*	✓	*B*	PP	PP	**High**	A	P	P	A	**Mod**	**H**
MACROURIDAE	*Caelorinchus parvifasciatus*	✓	*B*	PP	PP	**High**	A	A	P	A	**Mod-High**	**H**
MACROURIDAE	*Caelorinchus maurofasciatus*	✓	*B*	PP	P	**High**	A	A	P	A	**Mod-High**	**H**
MACROURIDAE	*Lucigadus nigromaculata*	×	*B*	PP	P	**High**	A	A	P	A	**Mod-High**	**H**
MACROURIDAE	*Malacocephalus laevis*	×	*B*	PP	P	**High**	A	A	P	A	**Mod-High**	**H**
MACROURIDAE	*Hymenocephalus longibarbis*	×	*B*	PP	A	**High**	A	A	P	A	**Mod-High**	**H**
MACROURIDAE	*Caelorinchus mirus*	✓	*B*	PP	PP	**High**	A	P	P	A	**Mod**	**H**
MACROURIDAE	*Ventrifossa nigrodorsalis*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
ZENIONTIDAE	*Zenion japonicum*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
GRAMMICOLEPIDIDAE	*Xenolepidichthys dalglieshi*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
PERISTEDIIDAE	*Peristedion liorhynchus*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
EPIGONIDAE	*Epigonus denticulatus*		*TT*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
TRICHIURIDAE	*Benthodesmus elongatus*	✓	*B*	PP	PP	**High**	A	A	P	A	**Mod-High**	**H**
NOMEIDAE	*Cubiceps squamiceps*		*B*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**
PLEURONECTIDAE	*Azygopus pinnifasciatus*		*TT*	PP	U	**High**	P	P	P	P	**Low-Mod**	**H**

Appendix B2.7 cont'd

Non-commercial Bycatch Invertebrate Species										
Family	**Species**	**Obs**	**Survival after handling**	**Survival Risk potential**	**FIP**	**Life hist Risk potential**	**Habitat Assoc. risk potential**	**Resilience**	**Risk**
MAJIDAE	*Leptomithrax tuberculatus*		Mod-Low	P	I-H	P	PP	Low	High
MAJIDAE	*Leptomithrax waitei*		Mod-Low	P	I-H	P	PP	Low	High
PAGURIDAE	*Pagurus investigatoris*		Mod-Low	P	I-H	P	PP	Low	High
PANDALIDAE	*Plesionika martia*		Mod-Low	P	I-H	P	PP	Low	High
PENAEIDAE	*Trachypenaeus curvirostris*		Mod-Low	P	I-H	P	PP	Low	High
PINNIDAE	*Atrina tasmanica*		Mod-Low	P	I-H	P	PP	Low	High
PORTUNIDAE	*Ovalipes molleri*		Mod-Low	P	I-H	P	PP	Low	High
PORTUNIDAE	*Portunus argentatus*		Mod-Low	P	I-H	P	PP	Low	High
PORTUNIDAE	*Portunus rubromarginatus*		Mod-Low	P	I-H	P	PP	Low	High
PORTUNIDAE	*Charybdis bimaculata*		Mod-Low	P	I-H	P	PP	Low	High
PORTUNIDAE	*Charybdis granulosus*		Mod-Low	P	I-H	P	PP	Low	High
PORTUNIDAE	*Charybdis miles*		Mod-Low	P	I-H	P	PP	Low	High
PORTUNIDAE	*Charybdis natator*		Mod-Low	P	I-H	P	PP	Low	High
RANELLIDAE	*Fusitriton retiolus*		Mod-Low	P	I-H	P	PP	Low	High
BUCCINIDAE	*Penion maxima*		Low	PP	H	P	P	Int-Low	High
ENOPLOTEUTHIDAE	*Enoploteuthis galaxias*		Low	PP	H	P	P	Int-Low	High
SEPIIDAE	*Sepia cultrata*		Low	PP	H	P	P	Int-Low	High
SEPIOLIDAE	*Rossia australis*		Low	PP	H	P	P	Int-Low	High
SEPIOLOIDIDAE	*Sepioloidea lineolata*		Low	PP	H	P	P	Int-Low	High
SQUILLIDAE	*Belosquilla laevis*		Low	PP	H	P	P	Int-Low	High
SQUILLIDAE	*Kempina mikado*		Low	PP	H	P	P	Int-Low	High
VOLUTIDAE	*Amoria undulata*		Low	PP	H	P	P	Int-Low	High
VOLUTIDAE	*Ericusa sowerbyi*		Low	PP	H	P	P	Int-Low	High
DIOGENIDAE	*Dardanus arrosor*		Mod	P	I-H	P	PP	Low	High
DIOGENIDAE	*Trizopagrus strigimanus*		Mod	P	I-H	P	PP	Low	High
HOMOLIDAE	*Latreillopsis petterdi*		Mod	P	I-H	P	PP	Low	High

Appendix B2.8 Detailed information supporting risk assessment for threatened species

This appendix provides the detail behind the risk levels given for threatened and protected species in section B2.4.

Risks to species listed under the Fisheries Management Act (FM Act)

Endangered species

Grey nurse shark (*Carcharius taurus*)

Conservation status: The grey nurse shark is listed as Endangered under the FM Act and the east coast population is considered Critically Endangered under the EPBC Act.

Distribution and decline: In Australia, the grey nurse shark occurs from Mooloolaba, southern Queensland to Shark Bay, Western Australia, but is less common on the south coast of the continent (Hutchins and Swainston, 1986).

Key threatening processes: Hook and line fishing, shark meshing (FM Act), and harmful marine debris (EPBC Act) pose a threat to the grey nurse shark.

Other threatening processes: Recreational and commercial fishing, shark finning and excessive ecotourism activity may threaten the grey nurse shark (Pogonoski *et al.*, 2002).

Habitat: Warm temperate and subtropical waters from rocky inshore reefs down to 200 m on the continental shelf. In NSW the species is commonly seen in or near sandy-bottomed gutters or rocky caves around inshore islands or reefs between 15 and 25 m (Otway and Parker, 1999).

Recovery plans: A national recovery plan for the grey nurse shark has been adopted by Environment Australia (Environment Australia, 2002a). The national plan calls for reduction of the impacts of commercial fishing, recreational fishing, shark finning and shark control activities, management of ecotourism impacts, elimination of impacts from aquaria, establishment of conservation areas, development of research and population models to assist recovery, promotion of community education and development of a quantitative framework to assess recovery of the species. A draft recovery plan for the species has been prepared by NSW Fisheries (NSW Threatened Species Recovery Planning Program, 2002). A range of recovery actions is proposed in the NSW draft plan, including reducing the impact of commercial fishing (primarily line fishing), declaration of critical habitat, increasing compliance, improved data collection on interactions with fishing, and minimising the effect of shark meshing. Community consultation is ongoing, with a discussion paper on further protection for the species released in July 2003.

Assessment of risk to the grey nurse shark

Biological characteristics: The grey nurse shark is ovoviviparous, bearing one or two pups (rarely four) per litter. Gestation lasts 9-12 months. Males reach sexual maturity at 190-195 cm and four years of age, while females mature at 220-230 cm and six years of age. Individuals reproduce every two years (Otway and Parker, 1999). Based on this information, the resilience of the species is considered to be low.

Overlap and interaction with fishery: Grey nurse sharks have been recorded occasionally in trawl nets. One individual was caught off Ulladulla in 1994 in a trawl survey over two years (Graham *et al.*, 1996). Generally the species congregates in reef habitats that are unsuitable for trawling. In other parts of the world, the species is migratory, generally undergoing pole-ward migrations in summer and equatorial migrations in winter (Compagno, 1984). The limited information available suggests that the species may undergo similar migrations in NSW (Otway and Parker, 2000) so it may migrate across trawl grounds from time to time. The draft recovery plan for the grey nurse shark lists fishing methods including demersal gill nets, drop lines and other line fishing gear as threats, but trawling is not listed as a threat to the grey nurse shark (NSW Threatened Species Recovery Planning Program, 2002).

Risk: Low. Given the negligible overlap with the fishery and infrequent capture of the species in trawl nets the risk to the species is considered to be Low.

Green sawfish (*Pristis zijsron*)

Conservation status: The green sawfish is listed as endangered under the FM Act.

Distribution and decline: Green sawfish have been recorded in the tropical Indo-West Pacific from eastern Australia and Papua New Guinea through to western India, with a disjunct population off Mozambique and eastern South Africa. In Australia, the species occurs mainly in the tropics from Broome to southern Queensland, with individuals found as far south as Sydney and a single record from Glenelg, South Australia. In NSW, specimens have been collected from Byron Bay in the north to Parramatta River in the south, plus an unofficial record from Jervis Bay. Green sawfish have suffered a serious population decline in NSW, however it remains common in the north of its range (Last and Stevens, 1994). Prior to 1972, the species was regularly found in the shallow waters at the mouths of the Tweed, Clarence and Richmond Rivers and on outside ocean beaches such as Yamba. The last specimen from the Sydney region was taken in 1926.

Key threatening processes: None of the currently listed KTP apply to the green sawfish.

Other threatening processes: Bycatch in shallow water prawn trawling, and other netting methods in shallow water pose a threat to the species, as they would rarely be returned to the water alive. The species is also targeted harvest for flesh, fins and saws. The fins command a high price in the shark fin trade and the saws are used in traditional medicine and were sold as curios. Habitat degradation may also threaten this species.

Habitat: The green sawfish inhabits muddy bottom habitats and enters estuaries (Allen, 1997), and is frequently found in shallow waters (Last and Stevens, 1994).

Recovery plans: There is no recovery plan for the green sawfish.

Assessment of risk to the green sawfish

Biological characteristics: Little information is available about the reproductive biology of the green sawfish. All sawfishes are ovoviviparous (live bearers), which have long gestation periods and tend to give birth to small numbers of relatively large pups. On the basis of this information, the green sawfish is considered to have low resilience to fishing pressure.

Overlap and interaction with fishery: Historically, the species has been encountered in inshore trawling operations. If caught, individuals are unlikely to survive.

Risk: Low-medium. The species is now rare in NSW (although it is still common in the tropical part of its range), therefore unlikely to be encountered in trawling operations, however, any capture is unlikely to impede the recovery of the species.

Vulnerable Species

Black cod (*Epinephelus daemelii*)

Conservation status: The black cod is listed as vulnerable under the FM Act.

Distribution and decline: The black cod inhabits warm temperate and subtropical waters of the southwestern Pacific including southeast Australia, Lord Howe Island, Norfolk Island, the Kermadec Islands and the north island of New Zealand (Heemstra and Randall, 1993). In Australia the species occurs from Townsville to Cape Conran, Victoria (Hutchins and Swainston, 1986). A decline in the species around Sydney was noted as early as 1916 (Roughley 1916, cited in Pogonoski *et al*., 2002), and was attributed to overfishing and increased shipping. Increased popularity in spear fishing in the early 1970s also led to noticeable declines, prompting the total protection of the species in NSW in 1983 (Pogonoski *et al*., 2002).

Key threatening processes: Hook and line fishing threatens the black cod.

Other threatening processes: Commercial and recreational fishing in Queensland (where the species is not protected) and illegal capture in NSW also threaten the black cod (Pogonoski *et al*., 2002).

Habitat: Coastal reefs, estuaries and deeper offshore reefs. Juveniles are found in rock pools (Hutchins and Swainston, 1986). The species is aggressively territorial, and may occupy a particular cave for life (Heemstra and Randall, 1993).

Recovery plans: A recovery plan for the black cod has not yet been prepared.

Assessment of risk to the black cod

Biological characteristics: There is little information on the biology of this species. Observations suggest that the species is slow growing (Leadbitter, 1992). It is a protogynous hermaphrodite, meaning that small individuals are all females and some become males once they reach a certain size (around 100-110 cm in length) (Francis, 1996). Species with this life history tend to have sex ratios that are naturally biased towards females, but this bias can be artificially increased by selective fishing of the larger fish (males) (Coleman *et al*., 1996). This feature of the life history makes such species particularly susceptible to overfishing, because the loss of large males through selective fishing may limit the reproductive success of the population, especially where fishers target spawning aggregations (Coleman *et al*., 1996). This effect may be reduced if the transition of large females to males occurs rapidly enough to compensate for the loss of males (Huntsman and Schaaf, 1994). It is not known whether such compensation can occur for black cod, or whether the species has spawning aggregations. Like many large groupers, the species has a low natural mortality rate, reaches maturity and maximum size slowly, is inherently rare, move little as adults, may aggregate to spawn and is protogynous (Huntsman *et al*., 1999), which are all factors that contribute to a low-medium resilience to fishing pressure.

Overlap and interaction with fishery: Despite trawling taking place within the broader geographic range of black cod, their habitat preference for rocky reefs with caves, gutters and bomboras is likely to preclude them from capture by trawlers. They are far less likely to be found on the low profile, low complexity hard ground that can be trawled under the current operation of the fishery. Even if they were, this is unlikely to change the very limited potential for interaction with the fishery.

Risk: Low-medium. Given the limited potential for interaction, the risk to this species is considered to be low-medium.

Great white shark (*Carcharodon carcharias*)

Conservation status: The great white shark is listed as vulnerable under the FM Act and the EPBC Act.

Distribution and decline: The species occurs in all seas in both hemispheres. It is most commonly found in inshore cool to warm temperate waters. It is most frequently observed in cool to warm temperate continental waters of the Western north Atlantic, Mediterranean Sea, Southern Africa, southern Australia, New Zealand and the Eastern North Pacific. In NSW there has been a decline in the number and size of individuals caught in beach meshing operations over the last 50 years, and a similar pattern has been observed in Queensland.

Key threatening processes: Hook and line fishing and shark meshing are key threatening processes for the great white shark.

Other threatening processes: Commercial fishing, recreational fishing, trade in shark products such as fins and jaws, tourism and possible adverse effects of tagging programs are considered to be threats to the great white shark (Environment Australia, 2002b).

Habitat: The great white shark generally occurs in inshore temperate waters, often around rocky reefs and islands, and in the vicinity of seal colonies (Environment Australia, 2002b).

Recovery plans: A national recovery plan for the great white shark has been adopted under the EPBC Act (Environment Australia, 2002b). The recovery plan calls for monitoring and reduction of the effects of commercial fishing, shark meshing and trade in shark products, investigation into the effects of recreational fishing and tourism, development of research programs towards the conservation of the species, identification and protection of critical habitat, promotion of community awareness and development of a quantitative framework to assess recovery of the species.

Assessment of risk to the great white shark

Biological characteristics: The great white shark is a live bearer, producing litters of 2 - 11 pups every 2-3 years. Females reach maturity at 4-5 m in length and 12-14 years of age, while males mature between 3.5 and 4.1 m long and 9-10 years of age. Females may reach an age of 23 years (Compagno *et al.*, 1997). Based on this information, the great white shark is considered to have low resilience to fishing pressure.

Overlap and interaction with fishery: Commercial fishing is considered a threat to the species, however most of the catch of great white sharks comes from line fishing operations. Great white sharks have been taken occasionally by prawn trawlers in South Australia (Environment Australia, 2002b). Two great white sharks were captured during observation of 590 commercial fish trawl tows made between 1993-1995 in waters north of Sydney (NSW Fisheries, unpublished data). None were observed in similar studies done south of Sydney.

Risk: Low. Given the small number of sharks captured in NSW trawling operations, the risk to the species is considered to be low.

Whale shark (*Rhincodon typus*)

Conservation status: The whale shark is listed as vulnerable under the EPBC Act.

Distribution and decline: The species occurs in tropical to warm temperate seas worldwide, in both oceanic and coastal waters. Individuals are commonly observed feeding close to the surface. Whale sharks undertake very long distance migrations (e.g. trans-Pacific), which are possibly timed to coincide with blooms of the planktonic organisms on which they feed. Catches in the Taiwanese whale shark fishery apparently declined dramatically during the 1980s (Pogonoski *et al.*, 2002).

Key threatening processes: None of the listed KTP thought to affect the whale shark.

Other threatening processes: Targeted fishing of this species in South East Asia is thought to be the main cause of decline (Pogonoski *et al.*, 2002) and is probably the main threat to the future of the species.

Habitat: Whale sharks occur in oceanic and coastal waters from the tropics to warm temperate waters. They are generally encountered near the surface.

Recovery plans: A recovery plan for the whale shark has not yet been prepared.

Assessment of risk to the whale shark

Biological characteristics: Little is known about the biology of this species. It was recently discovered that the species is a livebearer with an ovoviviparous mode of reproduction, when a pregnant female containing 300 embryos in its uteri was caught off Taiwan (Joung *et al.*, 1996). Individuals probably do not reach sexual maturity until they reach nine metres in length. The Taiwanese whale shark fishery has undergone a decline recently, probably due to fishing pressure (Joung *et al.*, 1996). Based on this information the species considered to have low resilience to fishing pressure.

Overlap and interaction with fishery: Whale sharks have not been recorded in any scientific surveys of trawl bycatch. Juveniles (minimum recorded size = 55 cm) may be susceptible to capture, but adults are probably too large to be captured in the trawl nets used in NSW. Furthermore, the species spends much of the time at or near the surface, so is unlikely to come into contact with operational trawl nets.

Risk: Low. Given the small probability of interaction with the fishery, the risk to the whale shark is considered to be low.

Protected species (section 19)

Giant Queensland groper (*Epinephelus lanceolatus*)

Conservation status: The giant Queensland groper is protected under section 19 of the FM Act.

Distribution and decline: This species occurs throughout the tropical waters of the Indo-Pacific region and extends into some warm temperate waters. In NSW, the species generally occurs in the northern half of the State, from about Hawkesbury River (Heemstra and Randall, 1993). Over its range, the species is naturally rare, and has been extirpated from heavily fished areas. Due to its large size (up to 3m and 600kg), the species was sought after by line and spear fishers, before becoming a protected species in the early 1980s (Pogonoski *et al*., 2002).

Key threatening processes: n/a

Other threatening processes: Commercial and recreational line fishing practices are potential threats to this species (Pogonoski *et al*., 2002).

Habitat: The species occurs at depths down to 100m, but is more common at shallower depths. It is commonly seen on coral reefs, in caves and around wrecks.

Recovery plans: A recovery plan is not required for this species.

Assessment of risk to the giant Queensland groper

Biological characteristics: There is little information on the biology or reproduction of this species. Like many large groupers, the species probably has a low natural mortality rate, reaches maturity and maximum size slowly, is inherently rare, moves little during the adult stage, forms spawning aggregations to spawn (may be targeted by fishers) and is protogynous (Huntsman *et al*., 1999), which are all factors that contribute to a low-medium resilience to fishing pressure.

Overlap and interaction with the fishery: Despite trawling taking place within the broader geographic range of giant Queensland groper, their habitat preference for coral reefs, wrecks and estuaries (as juveniles) is likely to preclude them from capture by trawlers. They are far less likely to be found on the low profile, low complexity hard ground that can be trawled under the current operation of the fishery. Even if they were, this is unlikely to change the very limited potential for interaction with the fishery.

Risk: Low-medium. Given the low interaction, the risk to this species is considered to be low-medium.

Estuary cod (*Epinephelus coioides*)

Conservation status: The estuary cod is protected under section 19 of the FM Act.

Distribution and decline: The estuary cod is a widespread tropical Indo-West Pacific species. In Australia, it is most common in Queensland, Northern Territory and Western Australian waters. In NSW, the species is known to occur as far south as Sydney.

Key threatening processes: n/a

Other threatening processes: Commercial and recreational line fishing are potential threats to this species (Pogonoski *et al*., 2002).

Habitat: The estuary cod occurs from lower estuaries to offshore reefs. Juveniles are found inshore and adults are usually found along the bases of small drop-offs associated with large caves, or in shipwrecks, but they also occur offshore to depths of 100m (Kuiter, 1996; Heemstra and Randall, 1993).

Recovery plans: A recovery plan is not required for this species.

Assessment of risk to the estuary cod

Biological characteristics: Like many large groupers, the species has a low natural mortality rate, reaches maturity and maximum size slowly, is inherently rare, moves little in the adult stage, forms spawning aggregations (which may be targeted by fishers) and is protogynous (Huntsman *et al*., 1999), which are all factors that contribute to a low-medium resilience to fishing pressure. Juveniles (sexually immature females) occur in estuaries and move out onto offshore reefs at around 40-50 cm in length (Sheaves, 1995). Individuals in estuaries appear to move little, indicating high site fidelity and relatively small home ranges (Sheaves, 1993).

Overlap and interaction with the fishery: Despite trawling taking place within the broader geographic range of estuary cod, their habitat preference for estuaries and reefs is likely to limit their interaction with trawlers. Pogonoski *et al*. (2002) suggest that they are caught sporadically by demersal fish trawlers, although they have not been recorded in Kapala surveys. It is possible that during flood events, some estuary cod move into nearshore waters where they may come into contact with trawlers, although numerous closures exist along estuaries and during floods to limit trawling during floods. Overall, there is very limited potential for interaction with the fishery.

Risk: Low-medium. Given a low interaction, the risk to this species is considered to be low-medium.

Elegant wrasse (*Anampses elegans*)

Conservation status: The elegant wrasse is protected under section 19 of the FM Act.

Distribution and decline: In Australia, the elegant wrasse is known from southern Queensland, NSW, Elizabeth and Middleton Reefs, Lord Howe Island, Norfolk Island and the Kermadec Islands. In NSW, it is thought to occur as far south as Montague Island. It is also occurs in New Zealand, New Caledonia and Rapa, Mangareva, Pitcairn and Easter Islands (Pogonoski *et al*., 2002). There is no evidence of a decline in the distribution or abundance of this species.

Key Threatening Processes: No Key Threatening Processes are considered likely to affect elegant wrasse.

Other threatening processes: None identified.

Habitat: Juveniles are found in coastal bays and harbours, and larger juveniles and females in aggregations on coastal rocky reefs down to 10m (Kuiter, 1993; Francis, 1993). Adult males usually occur in deeper water to about 30m, particularly around coral and rocky reefs and over rubble (Francis, 1993).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the elegant wrasse

Biological characteristics: Elegant wrasse grow to approximately 30cm in length. Juveniles and females aggregate in small, fast-moving groups that pause only to browse on the seabed for their food, which consists of crustaceans and worms (Ayling and Cox, 1982; Francis, 1993). Adult males are much less common, are territorial and solitary animals that move from one group of females to another.

Overlap and interaction with the fishery: The limited information suggests that elegant wrasse have significant spatial overlap with the fishery, but that there are unlikely to be any interactions, as elegant wrasse are protected from fishing and thus can't be retained, and the fishery does not target the preferred food of elegant wrasse. Incidental capture is highly unlikely by either traps or hook and line methods.

Risk: Low-moderate, on the basis that the little that is known of the biology and distribution of the species suggests that it probably has a moderate resilience and very low degree of interaction with the fishery.

Eastern blue devil (*Paraplesiops bleekeri*)

Conservation status: The eastern blue devil is protected under section 19 of the FM Act.

Distribution and decline: The eastern blue devil primarily occurs from southern Queensland to Montague Island, but is most common in NSW from Sydney southwards to Ulladulla (Kuiter, 1993). Museum records include specimens from as far south as Queenscliff, Victoria (Pogonoski *et al*., 2002). It is a secretive species for which there is no evidence of decline.

Key Threatening Processes: No Key Threatening Processes are considered likely to affect eastern blue devil.

Other threatening processes: The main threat to this species would be collection for the aquarium trade (Pogonoski *et al*., 2002).

Habitat: Occurs in shallow waters in estuaries, and around Sydney it occurs in the more saline parts of estuaries, along the rocky coastline and around offshore islands (Pogonoski *et al*., 2002; Kuiter, 1993), usually in caves. Also recorded offshore to depths of up to 40m (Pogonoski *et al*., 2002).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the eastern blue devil

Biological characteristics: Eastern blue devils grow to about 40cm. It is a shy, secretive fish that breeds in the warmer months from October to March. Larvae have been taken in the coastal waters off Sydney from November to May (Gray, 1995), and although the eggs of *P. bleekeri* have not been described, those of *P. alisonae* are tightly bound together and deposited onto the substratum and guarded by the male. Males are thought to be solitary and territorial, and like *P. alisonae*, are probably responsible for guarding eggs and rearing juveniles. There is no information on the diet of eastern blue devil.

Overlap and interaction with the fishery: The limited information suggests that there is likely to be significant spatial overlap with the fishery, but its secretive nature and territoriality suggest that it is unlikely to interact with traps or baited lines.

Risk: Low-moderate, on the basis that nothing is really known about its degree of interaction with the fishery and a presumably low-moderate resilience based on the very limited biological information.

Ballina angelfish (*Chaetodontoplus ballinae*)

Conservation status: The Ballina angelfish is protected under section 19 of the FM Act.

Distribution and decline: The Ballina angelfish is known to occur in northern NSW (Coffs Harbour, Ballina and North Solitary Islands) and the Balls Pyramid area of Lord Howe Island. There are also sight records from divers near Kingscliff, Flat Rock and Seal Rocks (Pogonoski *et al*., 2002). This species may be naturally rare and as yet there is no evidence of a decline in distribution or abundance.

Key Threatening Processes: No Key Threatening Processes are considered likely to affect Ballina angelfish.

Other threatening processes: Angelfishes are much sought after in the aquarium trade, which could be a serious potential threat given its difficulty to collect in the wild.

Habitat: Inhabits coral and rocky reefs in depths between 25-123m. Specimens collected from Balls Pyramid were associated with a large rocky pinnacle that rose to within 12m of the surface and was encrusted with hard corals of *Acropora* spp., *Porites* spp., and *Pocillopora damicornis* (Parker, 1994).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the Ballina angelfish

Biological characteristics: Nothing is known about the biological characteristics or population size of this species, other than that pairs of fish appear to establish large territories (~2500m^2) (Parker, 1994). Its apparent rarity may indicate that it is not highly resilient to fishing pressure, but as yet there is no evidence to support that theory.

Overlap and interaction with the fishery: The limited information about the species suggests that it is restricted to the north coast of NSW, minimising its spatial overlap with this fishery. It is also thought to be rare, further restricting opportunities for interaction. At the smaller scale, however, its apparent preference for deep coral and rocky reefs is likely to bring it into contact with the fishery, as evidenced by the original Australian Museum specimen, which was collected in a deepwater fish trap off Ballina in the late 1950s. Another specimen was collected from a deep trawl by the Research Vessel Kapala off Evans Head in 123m of water in 1978.

Risk: Low-medium. Although rare, given that nothing is known of its resilience and that it is likely to occupy habitats utilised by the fishery, the risk to this species is considered to be low-medium.

Herbst's nurse shark

Conservation status: Herbst's nurse shark is listed as protected from fishing under Section 19 of the FM Act.

Distribution and decline: Records show an irregular distribution throughout most of the world's oceans. In Australia it has been recorded off NSW (Pogonoski *et al.*, 2002). Trawl surveys by the research vessel Kapala and an observer study (Liggins, 1996) of commercial trawling suggest that numbers have declined dramatically off NSW since the mid 1970s (Fergusson *et al.*, 2003). The decrease in abundance suggests that trawling is having an adverse effect on the population (Fergusson *et al.*, 2003).

Key threatening processes: No key threatening processes are considered likely to affect Herbst's nurse shark.

Other threatening processes: Incidental capture by commercial fishing activities is considered a potential threat to this species in NSW (Pogonoski *et al.*, 2002).

Habitat: The species lives on or closely associated with the bottom in deep waters along continental and insular shelves and upper slopes (Last and Stevens, 1994). It has been recorded at depths of depths 150 to 850 m in NSW (Fergusson *et al.*, 2003). It is occasionally found in shallower water (Last and Stevens, 1994).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to Herbst's nurse shark

Biological characteristics: The size of this species at birth is over 1 m and the species reaches at least 3.6 m (Last and Stevens, 1994). Overseas studies have found that size at maturity is large, around 2.75 m for males (Compagno, 1984). Other aspects of the species' reproductive biology are thought to be similar to those of the grey nurse shark (Pogonoski *et al.*, 2002). Based on this information, the resilience of Herbst's nurse shark is considered to be low.

Overlap and interaction with fishery: Commercial fishing is considered to be the main threat the Herbst's nurse shark (Pogonoski *et al.*, 2002). Trawling is the only fishing method by which the species is likely to be caught (K. Graham, NSW Fisheries, pers. comm., 2003). In 1993-1997, the average catch of Herbst's nurse shark from trawl grounds off Ulladulla was one every 32 tows (Fergusson *et al.*, 2003). It is estimated that during the 1990s about 20-40 Herbst's nurse sharks were caught each year between Ulladulla and Newcastle (Fergusson *et al.*, 2003), however given that most of these sharks are caught at depths of >500m (G. Liggins, NSW Fisheries, unpublished data), it is likely that most captures south of Sydney would have been made by in the Commonwealth South East Fishery and not the NSW Ocean Trawl.

Risk: Low-medium. Given the low resilience of this species to fishing pressure, the frequency of capture by trawlers, and its apparent decline in NSW the species is considered to be at some risk from trawling. However, it appears that most of the risk arises from the operation of the Commonwealth South East Trawl fishery and not the NSW Ocean Trawl fishery. More information about the distribution of this species and its interactions with trawlers is needed, particularly in the area north of Barrenjoey Headland.

Pegasidae, Solenostomidae and Syngnathidae

All members of the families Pegasidae, Solenostomidae and Syngnathidae that occur in NSW waters will be protected under section 19 of the FM Act from 1 July 2004. As such, species descriptions are provided for all of the species within each of those three families that are thought to occur in NSW waters. For brevity, these descriptions will not include conservation status, KTP, or recovery plans as per other species, because:

1) they are all protected under s19 of the FM Act and s248 of the EPBC Act
2) none of the currently listed KTP apply to any of the pegasids, solenostomids or syngnathids, although at a broader level, habitat loss and poor water quality are likely to affect the majority of species and some of the estuarine and nearshore species could be affected by collecting for the aquarium and or Traditional Chinese Medicine (TCM) trade. Where applicable, these will be discussed under other threatening processes and resilience to fishing pressure will be considered in terms of the fishery, not hand collecting
3) no pegasids, solenostomids or syngnathids are listed as vulnerable or endangered under the FM Act or EPBC Act and thus recovery plans do not apply to these species.

It is important to note that the following assessments of risk are made based on almost no information about the distribution and abundance of most species, and what little information there is usually comes from a very limited number of specimens retained in museums. Very few have been studied in the field, and those studied are unlikely to include those that could be encountered in this fishery. Specimens have often been caught in trawlers, which by itself may suggest considerable interaction, but in the absence of information about what proportion of the population or habitat those specimens represent, it is difficult if not impossible to draw any rigorous conclusions. Despite these obvious limitations, what information is available will be presented and an attempt made to assess the risk of the current operation of the fishery, although there is considerable uncertainty attached to the assessments.

Family Pegasidae

Slender seamoth (*Pegasus volitans*)

Distribution and decline: Widespread tropical Indo-West Pacific, with juveniles expatriating into subtropical regions. In Australian waters, known from Queensland, WA and as far south as Bermagui in NSW (Kuiter, 1993 and 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified.

Habitat: Adults mainly found in muddy estuaries or shallow sandy bays, often in the vicinity of seagrass beds and in current-prone areas, where they pair, but also sometimes found floating at the surface. They are primarily benthic fishes, but have pelagic larval and early juvenile stages. Usually in shallow depths of about 3-6m, but also reported to 73m and a larval specimen from 110m (Kuiter, 1993 and 2003a; Australian Museum Ichthyology Collection Database).

Assessment of risk to slender seamoth

Biological characteristics: Grows to about 14cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Limited potential overlap with the fishery, particularly as a proportion of its potential geographic range, and its preference for estuaries and similar sheltered waters with seagrass beds.

Risk: Low.

Little dragonfish (*Eurypegasus draconis*)

Distribution and decline: Widespread Indo-West Pacific, expatriating into subtropical waters with pelagic young, as far south as Sydney on the east coast (Kuiter, 1993 and 2003a).

Threatening processes: None identified.

Habitat: Common short-bodied species in sheltered bays in coastal waters, on fine sand with sparse rubble and with adults usually in pairs on muddy substrata (Kuiter, 2003a).

Assessment of risk to little dragonfish

Biological characteristics: Grows to about 9cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Limited potential overlap with the fishery, particularly as a proportion of its potential geographic range, and its preference for estuaries and similar sheltered waters.

Risk: Low.

Family Solenostomidae

Ornate ghost pipefish (*Solenostomus paradoxus*)

Distribution and decline: Widespread tropical Indo-West Pacific, from Red Sea and all of Indian Ocean to West and Central Pacific, and ranges into sub-tropical zones. In Australia, it is known from Queensland and NSW (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: Mostly pelagic until settling on substratum for breeding. Usually settles along reef edges in current-prone areas where they pair of form small groups of several individuals. Mostly occurs in sheltered coastal waters and estuaries in channels to about 35m depth, but known to a depth of 46m (Australian Museum Ichthyology Collection Database; Kuiter, 2003a).

Assessment of risk to ornate ghost pipefish

Biological characteristics: Grows to about 11cm in length. Feeds mostly on mysids but also targets small benthic shrimps (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, particularly as a proportion of its potential geographic range, its predominantly pelagic lifecycle, and when it does settle to the substratum the species is predominantly found on reefs and similar complex habitat in sheltered coastal waters and estuaries. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds, which were within the broader geographic range of this species.

Risk: Low.

Robust ghost pipefish (*Solenostomus cyanopterus*)

Distribution and decline: Widespread tropical Indo-West Pacific, expatriating to sub-tropical zones. In Australia, it is known mostly from NSW, as well as Queensland and WA (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: Mostly pelagic until settling on substratum for breeding. Primarily associates with vegetation, taking on colours of various algaes or seagrasses, from bright green to brown or black.

Known to depths of approximately 30m (Australian Museum Ichthyology Collection Database; Kuiter, 2003a).

Assessment of risk to robust ghost pipefish

Biological characteristics: Grows to about 15cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, particularly as a proportion of its potential geographic range, its predominantly pelagic lifecycle, and when it does settle to the substratum the species is predominantly found amongst vegetation. FRV Kapala recorded the species during one (off Clarence River) of about 700 scientific trawls on northern NSW prawn grounds, which were within the broader geographic range of this species. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low.

Delicate ghost pipefish (*Solenostomus leptosomus*)

Distribution and decline: Widespread tropical Indo-West Pacific, known from Japan and Australia and also from Mauritius in the West Indian Ocean (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Mostly pelagic until settling on substratum for breeding at almost maximum size. Usually settles along reef edges, bordering on open sandy substrata, usually in depths of 15m or more (Kuiter, 2003a).

Assessment of risk to delicate ghost pipefish

Biological characteristics: Grows to about 10cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, particularly as a proportion of its potential geographic range, its predominantly pelagic lifecycle, and when it does settle to the substratum the species is predominantly found on reefs and reef-edges. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds, which were within the broader geographic range of this species.

Risk: Low.

Rough-snout ghost pipefish (*Solenostomus paegnius)*

Distribution and decline: Widespread tropical Indo-West Pacific (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Mostly pelagic until settling on substratum for breeding at almost maximum size. Usually settles on algae-rubble reef and soft-bottom substrata, usually in depths of 10m or more (Kuiter, 2003a).

Assessment of risk to rough-snout ghost pipefish

Biological characteristics: Grows to about 12cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, particularly as a proportion of its potential geographic range, and its predominantly pelagic lifecycle. When it does settle to the substratum, however, it prefers algae-rubble reef and soft substrata, which could place it within trawlable grounds. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds, which were within the broader geographic range of this species, suggesting that they prefer the shallower inshore areas to those of the fishery or that they are able to seek refuge from trawlers. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low.

Family Syngnathidae

All members of the family Syngnathidae will be protected under section 19 of the FM Act from 1 July 2004. Syngnathids includes animals commonly referred to as seahorses, seadragons, pipefish and pipehorses. These unusual fishes have a unique reproductive method, whereby the male incubates the eggs in a pouch or ventrally on the tail or belly, with or without a skin cover. Hatchlings are usually well developed and resemble their parents.

Of the approximately 120 syngnathid species that occur in Australian waters, approximately 29 species have been recorded in NSW waters, including several endemic species (Kuiter, 2000), with more species being revealed following revisions of previous taxonomic work and further field surveys (Kuiter, 2001; Kuiter, 2003a). Worldwide, syngnathids occupy almost all aquatic habitats, including freshwater rivers, estuarine seagrass beds, inshore waters, offshore rocky reefs and soft substrata in deepwater.

White's seahorse (*Hippocampus whitei*)

Distribution and decline: Appears to be endemic to NSW waters and is common in the large estuaries between Sydney and Forster, although the northern extent of its range is uncertain (Kuiter, 2001; Kuiter, 2003a). There is no evidence of any declines in this species (Pogonoski *et al*., 2002).

Threatening processes: None identified

Habitat: Shallow (< 25m) inshore areas, particularly in seagrass or algal beds in estuaries, but also found in sponge-reef and kelp forests in nearshore waters, as well as under jetties and other man-made structures. Common in *Posidonia* beds and particularly abundant in Sydney Harbour (Pogonoski *et al*., 2002).

Assessment of risk to White's seahorse

Biological characteristics: White's seahorses grow to approximately 10cm and are thought to be very site specific and generally monogamous, forming pairs for life and establishing home and feeding ranges. They can breed year round, although there is a peak in spring and summer. Gestation is approximately 22 days and they are reasonably fecund, with a brood of generally between 60-250 young. They mature early, at about six months but sexes can be differentiated at three months. These factors suggest that they have a medium resilience to fishing pressure.

Overlap and interaction with fishery: Despite trawling taking place within their broader geographic range, the majority of their preferred habitat (seagrass and kelp beds in Sydney Harbour and other central coast estuaries) is outside the primary operating area of the fishery. They have not been recorded in research trawls conducted by NSW Fisheries (Graham *et al*., 1993a and b - note that references to *H. whitei* in those reports were misidentifications of *H. tristis*), although they are taken as bycatch from the Commonwealth's South East Trawl Fishery (AFMA, 1999). Those incidental catches in the SETF and any that may occur in this fishery are unlikely to significantly affect the population and overall this probably represents limited interaction with the fishery.

Risk: Low. Given the limited interaction and medium resilience, the risk to this species is considered to be low.

Eastern pot-belly seahorse (*Hippocampus abdominalis*)

Distribution and decline: Primarily in NSW waters from Newcastle to Eden but probably ranges into Victoria (Kuiter, 2003a). It is also widespread on the north and south islands of New Zealand and has been recorded from Three Knights Island, Stewart Island, the Snares and the Chatham Islands. There is no evidence of any declines in this species (Pogonoski *et al*., 2002).

Threatening processes: Overcollecting for the aquarium and Traditional Medicine trades are the greatest potential threats to the species (Pogonoski *et al*., 2002)

Habitat: Occurs in large estuaries, harbours and protected coastal bays on shallow low reef with kelp, and in nearshore waters in sponge habitats in depths generally between 20-40m (Pogonoski *et al*., 2002; Kuiter, 2003a).

Assessment of risk to Eastern pot-belly seahorse

Biological characteristics: Eastern pot-belly seahorses are thought to grow to approximately 18cm, although the largest recorded specimen was 165mm. In New Zealand, they spawn in spring and summer and young are released after approximately 30 days and are pelagic. The brood size is thought to be several hundred individuals. They mature at about 12 months but sexes can be differentiated at six months. They reach their maximum size after two years of age and these factors suggest that they have a medium resilience to fishing pressure.

Overlap and interaction with fishery: Despite trawling taking place within their broader geographic range, the majority of their preferred habitat (kelp-covered reef in coastal bays and estuaries) is outside the primary operating area of the fishery. Although eastern pot-belly seahorses occur offshore in sponge habitat and have been recorded in research trawls (Graham *et al*., 1993a and b), such incidental catches are unlikely to significantly affect the population and overall this probably represents limited interaction with the fishery.

Risk: Low. Given the limited interaction and medium resilience, the risk to this species is considered to be low.

Collared seahorse (*Hippocampus jugumus*)

Known from a single specimen that was collected in 1925 from Lord Howe Island (Kuiter, 2003a). It was 44mm long. No other details are known about the species, but is considered a low risk.

Sad seahorse (*Hippocampus tristis*)

Distribution and decline: The actual extent of its range is uncertain. It is known to occur in a fairly narrow range from southern Queensland to at least Iluka on the NSW north coast, and also Lord Howe Island (Pogonoski *et al*., 2002; Kuiter, 2003a). There is no evidence of any declines in this species (Pogonoski *et al*., 2002).

Threatening processes: Commercial trawling operations in southern Queensland and northern NSW are thought to be potential threats to this species (Pogonoski *et al*., 2002).

Habitat: Probably occurs in a variety of habitats as it has been captured in trawling operations in south-east Queensland and northern NSW waters in depths generally between 18-59m (Kuiter, 2001; Graham *et al*., 1993a and 1993b).

Assessment of risk to the sad seahorse

Biological characteristics: Sad seahorses grow to approximately 23cm, and are thought to be carnivorous, feeding on small crustaceans, but nothing else is known about the species (Pogonoski *et al*., 2002; Kuiter, 2001). As such the resilience is unknown.

Overlap and interaction with fishery: Although there is limited biological information about this species, almost all specimens known to date have been taken in trawlers on the northern NSW coast and southern Queensland coast, or have been found washed up on beaches and are also thought to be trawl discards. This suggests that for northern NSW waters, which probably represent a significant proportion of their range and their southern limit, there are likely to be interactions with the fishery, although we don’t know the significance of those interactions in terms of the population.

Risk: Medium. Until there is better information about the distribution and abundance of this species and of its preferred habitat, its currently restricted distribution and known capture by trawlers suggest that there is a risk from trawling in northern NSW waters.

Zebra seahorse (*Hippocampus zebra*)

Distribution and decline: Only known from a few specimens from Cape York to northern NSW (Kuiter, 2003a). There is no evidence of any declines in this species (Pogonoski *et al*., 2002).

Threatening processes: None identified

Habitat: The known specimens have all been trawled or dredged in waters of between 20-80m depth and are thought to be associated with soft bottom habitat, probably black-coral fans or gorgonians (Kuiter, 2001; Kuiter, 2003a).

Assessment of risk to zebra seahorse

Biological characteristics: Zebra seahorses grow to approximately 9cm, and are thought to be carnivorous, feeding on small crustaceans, but nothing else is known about the species (Pogonoski *et al*., 2002; Kuiter, 2001). As such the resilience is unknown.

Overlap and interaction with fishery: Despite trawling taking place at what could be the southern limit of the species’ range, it appears to represent a minute amount of potential habitat given its known distribution from Cape York, northern Queensland south to Tweed Heads. Against such a wide distribution, albeit not in NSW waters, the overlap with this fishery appears to be very limited.

Risk: Low. Given the limited potential overlap compared to its known distribution, the risk to this species is considered to be low.

Bullneck seahorse (*Hippocampus minotaur*)

Distribution and decline: Only known from southern NSW, mostly off Eden, to the Bass Strait region (Kuiter, 2001; Kuiter 2003a). There is no evidence of any declines in this species (Pogonoski *et al*., 2002).

Threatening processes: None identified

Habitat: Only known from trawled specimens recorded from depths of between 60-110m, on fine sandy or hard substrata, possibly in association with gorgonian corals (Pogonoski *et al*., 2002; Kuiter, 2003a).

Assessment of risk to the bullneck seahorse

Biological characteristics: Unknown. Collected specimens to 45mm in height.

Overlap and interaction with fishery: Owing to the apparent depth requirements of this species, greater than 60m, there is likely to be very limited potential for overlap with this fishery. In the southern part of the State, this fishery is confined to waters within 3nm, and whilst in some areas that would include waters to and in excess of 60m, it is likely to represent a very small proportion of such waters and habitat. Waters beyond the 3nm limit are the responsibility of the Commonwealth under the SETF, which has a syngnathid monitoring program in place. Overall there is very limited potential for interaction with the OTF.

Risk: Low. Given the limited potential overlap compared to its known habitat distribution, the risk to this species is considered to be low.

Coleman's pygmy seahorse (*Hippocampus colemani*)

Distribution and decline: This species is only known from Lord Howe Island and Milne Bay, PNG (Kuiter, 2003a; Kuiter, 2003b).

Threatening processes: None identified.

Habitat: It was discovered in Lord Howe Island's main lagoon and its habitat there comprises coarse sand with sparse *Zostera* and *Halophila* seagrass that have fine filamentous algae on their leaves (Kuiter, 2003a; Kuiter, 2003b).

Assessment of risk to Coleman's pygmy seahorse

Biological characteristics: Unknown. Collected specimens up to 22mm in height.

Overlap and interaction with fishery: The fishery does not operate in the waters of Lord Howe Island lagoon and given its apparent habitat requirement for *Zostera* and or *Halophila* seagrass, there would be no interaction with the fishery.

Risk: Zero.

Sydney's pygmy pipehorse (*Idiotropiscis lumnitzeri*)

Distribution and decline: Appears to be endemic to NSW, as it is only known from central to southern NSW (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Occurs on semi-exposed open coast reefs in 6-30m depth amongst red algae (Kuiter, 2003a).

Assessment of risk to Sydney's pygmy pipehorse

Biological characteristics: Grows to 55mm in height and feeds on small crustaceans. Males have a relatively large pouch and an estimated 60 eggs per brood. It has been observed solitary, in pairs and in small groups at night. Individuals appear to live on the same small section of reef for long periods, often in excess of eight months (Kuiter, 2003a).

Overlap and interaction with fishery: There are no records of any interactions between this species and the fishery and its preference for inshore rocky reefs probably means that there is very little potential for such interactions to occur.

Risk: Low. Given the limited potential overlap compared to its known habitat distribution, the risk to this species is considered to be low.

Hardwick's pipehorse (*Solegnathus hardwickii*)

Distribution and decline: Known from tropical and sub-tropical Australia, the South China Sea and Japan (Pogonoski *et al*., 2002; Kuiter, 2003a). It is likely to be very uncommon in NSW waters, with only one record from near the Tweed River and two unconfirmed (specimens lost) records from Kempsey. A recent study of Solegnathus bycatch in the Queensland trawl fishery indicated that export rates (and presumably catches) were 70% lower in 2000 than in 1998, down from 238kg/month to

70kg/month, although it was emphasised that the decrease did not necessarily reflect a declining CPUE or that the effect was due to fishing (Connolly *et al*. 2001).

Threatening processes: Commercial trawl fishing and scallop dredging are thought to be potential threats to the survival of the species in Queensland waters (Pogonoski *et al*., 2002).

Habitat: In Queensland waters, the species has only been caught at depths of greater than 25m, primarily in, on or proximate to seabeds with a high carbonate fraction, indicative of coral-derived substratum. It has also been recorded from depths of up to 180m. (Pogonoski *et al*., 2002).

Assessment of risk to the Hardwick's pipehorse

Biological characteristics: The species breeds throughout the year, with a peak in the proportion of pregnant males from mid-winter to spring. Males become mature at about 320mm and grow to at least 510mm and approximately five years of age, although this estimate requires further validation. Growth rates of 1.2mm/day for juveniles and 0.3-0.5mm/day for adults have been calculated and males can carry in excess of 200 eggs. Density estimates range from 0-128 individuals/km^2, with an average of 3/km^2 (Connolly *et al*., 2001).

Overlap and interaction with fishery: There are very few records of the species within NSW waters, and the principal range for the species appears to be off the Queensland coast between Innisfail and Mooloolaba. Its preference for areas of coral reef and or loose sediments derived from coral substrata also limits its potential occurrence in NSW. It has not been recorded in any scientific trawls off the NSW coast (> 150 surveys), although anecdotal reports suggest that there are occasional catches of pipehorses, but these are likely to be Duncker's (*S. dunckeri*) or Australian spiny pipehorse, discussed below. Given that significant quantities (approximately 19 000 individuals) of Hardwick's pipehorse were exported in 2000 following capture in trawls off the Queensland coast, any captures by NSW trawlers are likely to represent a minute proportion of the population. Overall there appears to be very limited potential for interaction with the OTF.

Risk: Low. Given the limited potential overlap compared to its known habitat distribution, the risk to this species is considered to be low.

Duncker's pipehorse (*Solegnathus dunckeri*)

Distribution and decline: Endemic to eastern Australia, it has been recorded from Lord Howe Island and southern Queensland to Forster on the NSW north coast (Pogonoski *et al*., 2002). There is no evidence of any declines in this species (Pogonoski *et al*., 2002).

Threatening processes: Commercial trawl fishing is thought to be a potential threat to the survival of the species in Queensland and NSW waters (Pogonoski *et al*., 2002).

Habitat: It has a benthic species occurring in continental shelf waters and has been recorded from depths of between 29-137m. (Pogonoski *et al*., 2002).

Assessment of risk to Duncker's pipehorse

Biological characteristics: The species probably breeds throughout the year, with a peak in the proportion of pregnant males from mid-winter to spring. Males can carry in excess of 100 eggs, are mature at 33cm and are thought to grow to approximately 50cm (Connolly *et al*., 2001; Pogonoski *et al*., 2002).

Overlap and interaction with fishery: There appears to be significant overlap between the geographical range of this species and the fishery, with both fish and prawn trawlers operating across the southern half of its range and prawn trawlers across the northern half, in addition to Queensland trawlers north of the border. Although it is not known how much further offshore they occur, current information about its distribution suggests that there is significant overlap, and that if it did occur further offshore, those areas are unlikely to provide refuge as they are probably fished by the SETF. The species has also been recorded in scientific trawls off the NSW coast (Graham *et al*., 1993b), and there are anecdotal reports of captures of pipehorse in this fishery.

Risk: Medium-high. Given the extensive overlap with its known habitat distribution, and the fact that pipehorses are occasionally captured in this fishery, the risk to Duncker's pipehorse is considered to be medium-high, thus warranting some form of management response in the draft FMS. The lack of information about syngnathids in general, but the *Solegnathus* species in particular, indicates that inclusion in an observer program and or retaining specimens may help address some of these information gaps.

Queensland's spiny pipehorse (*Solegnathus* sp.1)

Distribution and decline: An undescribed species that was previously included with *S. hardwickii*. Known from off Queensland and northern NSW waters (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Trawled from between 100-170m depth (Kuiter, 2003a).

Assessment of risk to Queensland's spiny pipehorse

Biological characteristics: Grows to 50cm in height (Kuiter, 2003a). Nothing else known about the species.

Overlap and interaction with fishery: There are no records of any interactions between this recently described species and this fishery, and the fact that it has been confused with *S. hardwickii* suggests that, as its name implies, it is probably far more common in Queensland waters than NSW waters. This suggests that there is little potential for interactions between this species and the OTF.

Risk: Medium. This level is largely precautionary as next to nothing is known about this species, but it does appear to overlap with the fishery, it is confused with other similar species and has been captured in trawls. Any management response designed to address *S. denckeri* would also be able to address this species.

Australian spiny pipehorse (*Solegnathus spinosissimus*)

Distribution and decline: Occurs in southeastern Australia along the coasts of Victoria, Tasmania, New South Wales and southern Queensland, and also in New Zealand (Pogonoski *et al*., 2002; Kuiter, 2003a). There is no evidence of any declines in this species (Pogonoski *et al*., 2002).

Threatening processes: Commercial fish and prawn trawling are thought to be potential threats to this species (Pogonoski *et al*., 2002).

Habitat: Occurs on soft substrata, usually of mud or rubble adjacent to invertebrate-rich platform reefs. Known from depths ranging from 2-640m, but is more common over 30-250m. It is found at shallow depths in the southern part of its range, particularly Derwent Estuary, Tasmania, where waters are shaded or darkened by tannins (Pogonoski *et al*., 2002; Kuiter, 2003a).

Assessment of risk to Australian spiny pipehorse

Biological characteristics: Grows to 49cm in height (Kuiter, 2003a). The young are benthic and have no pelagic stage (Pogonoski *et al*., 2002). They anchor themselves to seaweed or sea fans to feed on planktonic crustaceans (Pogonoski *et al*., 2002).

Overlap and interaction with fishery: There appears to be significant overlap between the geographical range of this species and the fishery, with both fish and prawn trawlers operating in the south of the State and prawn trawlers in the north, in addition to Queensland trawlers north of the border. Although it is not known how much further offshore they occur, current information about its distribution suggests that there is significant overlap, and that if it did occur further offshore, those areas are unlikely to provide refuge as they are probably fished by the SETF as they are in the southern half of NSW. They are a byproduct species in the SETF and are sold locally and overseas for the TCM trade. The species has also been recorded in scientific trawls off the NSW coast (Graham *et al*., 1993a), and there are anecdotal reports of captures of pipehorse in this fishery.

Risk: Medium. *S. spinosissimus* is more widespread than the related *S. dunckeri*, hence the lower risk level. However, there is still extensive overlap between its distribution in NSW and this fishery, pipehorses are occasionally captured in this fishery and have been recorded in scientific trawls, so the risk to the Australian spiny pipehorse is considered to be medium, thus warranting some form of management response in the draft FMS. Any management response designed to address *S. dunckeri* would also be able to address this species.

Weedy seadragon

Conservation status: The weedy seadragon is listed as protected under section 19 of the FM Act.

Distribution and decline: Occurs in southern Australia from Port Stephens in NSW to Geraldton in Western Australia and around Tasmania (Edgar, 1997). There is no evidence for decline of this species. It is infrequently trawled and is not caught by line fishers (Pogonoski *et al.*, 2002).

Key threatening processes: None of the listed KTP are thought to affect the weedy sea dragon.

Other threatening processes: Excessive collection for the marine aquarium trade has the potential to threaten this species (Pogonoski *et al.*, 2002).

Habitat: The weedy sea dragon is found in estuaries and offshore reefs to depths of 50 m. Juveniles are most common along the sandy margins of reefs near the mouths of bays, while adults occur amongst larger algae on exposed reefs and occur relatively deeper in the northern parts of the range (Edgar, 1997). The species may also be associated with sponge habitats (Baker 2000a).

Recovery plans: A recovery plan is not required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the weedy seadragon

Biological characteristics: The weedy seadragon breeds annually, starting in early summer. The clutch size is around 250 eggs, which are carried by the male until they hatch. Some individuals breed in their first year, but most do not breed until their second year (Kuiter, 1993). Natural mortality of seadragons due to unfavourable weather conditions washing them ashore is probably the largest source mortality for the species (Baker 2000a). Given this information, the resilience of the species is considered to be medium.

Overlap and interaction with fishery: The species generally occurs in rocky reef habitats, which are unsuitable for trawling. However, it may also be associated with sponge habitats (Baker 2000b), which may occasionally be subject to trawling. There are no records of capture of this species in trawl surveys.

Risk: Low-medium. The probability of capture for this species is low, as suggested by the absence of reported captures, however there is potential for it to be caught in the fishery. Therefore a low-medium risk is assigned and the monitoring of catches of the species is recommended.

Sawtooth pipefish (*Maroubra perserrata*)

Distribution and decline: Widespread along Australia's south coast from northern NSW to southern Western Australia, including Tasmania (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Occurs on semi-exposed to open ocean rocky shore reef habitat. It is found in the back of narrow crevices, often behind urchins, and usually occurs in pairs or small aggregations (Kuiter, 2003a).

Assessment of risk to sawtooth pipefish

Biological characteristics: Grows to 85mm in height. In aquaria, they live for about 2 years and breed within the first year from birth. They produce a brood about every month for several months in summer time. Eggs are comparatively large and number about 60 on fully-grown individuals, hatching after 22 days of incubation. These characteristics would give it medium-high resilience (Kuiter, 2003a).

Overlap and interaction with fishery: There are no records of any interactions between this species and the OTF, and its preference for more complex rocky reefs that are inhabited by urchins probably means that there is very little potential for such interactions to occur. Even if the occasional interaction were recorded, which is unlikely, there are likely to be significant areas of its habitat that are not available to trawling, hence making any interactions insignificant in terms of the NSW population.

Risk: Low. Given the limited potential overlap compared to its known habitat distribution, the risk to this species is considered to be low.

Eastern upside-down pipefish (*Heraldia nocturna*)

Distribution and decline: Endemic to NSW, only known from Seal Rocks to Jervis Bay, but may occur further north or south (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Sheltered coastal coves and harbours. It lives secretively in rocky reefs to about 20m depth, and usually only seen at night when shining a light into caves, where it typically swims upside down on the ceiling (Kuiter, 2003a).

Assessment of risk to eastern upside-down pipefish

Biological characteristics: Grows to 80mm in height (Kuiter, 2003a).

Overlap and interaction with fishery: There are no records of any interactions between this species and the OTF, and its preference for nearshore, complex rocky reefs with caves probably means that there is very little potential for such interactions to occur. Even if the occasional interaction were recorded, which is unlikely, there are likely to be significant areas of its habitat that are not available to trawling, hence making any interactions insignificant in terms of the NSW population.

Risk: Low. Given the limited potential overlap compared to its known habitat distribution, the risk to this species is considered to be low.

Girdled pipefish (*Festucalex cinctus*)

Distribution and decline: Only known from eastern Australia, probably restricted from central NSW to central Queensland (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Found on rubble substratum with short algaes and sponges in 10-20m depth (Kuiter, 2003a).

Assessment of risk to girdled pipefish

Biological characteristics: Grows to 16cm in height (Kuiter, 2003a).

Overlap and interaction with fishery: There are no records of any interactions between this species and the OTF, however its preference for nearshore, low relief substrata means that there is potential for such interactions to occur. Its restricted distribution in NSW is entirely overlapped by the area of the fishery, indicating that there are unlikely to be significant areas of its habitat that are not available to trawling, hence probably making any interactions significant in terms of the NSW population.

Risk: Medium-high. Given the extensive spatial overlap, the risk to this species is considered to be medium-high.

Bend stick pipefish (*Trachyrhamphus bicoarctatus*)

Distribution and decline: Widespread Indo-West Pacific, but probably comprises several similar species that are distributed over the area. Known to at least as far south as Sydney Harbour in NSW (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Occupy a variety of habitats, from seagrass beds in estuaries to sand and mud areas in nearshore waters to about 25m depth (Kuiter, 2003a), but has been recorded at between 43-59m (Graham *et al*., 1993b).

Assessment of risk to bend stick pipefish

Biological characteristics: Grows to 40cm in height (Kuiter, 2003a).

Overlap and interaction with fishery: Has been recorded at depths of between 43-59m during research trawls on FRV Kapala (Graham *et al*., 1993b). It also appears to have considerable overlap with the fishery, although there are also numerous estuarine areas that would also provide suitable habitats for the species. Given its large size, it is probable that if it were regularly caught in the fishery, then there would be anecdotal reports of its capture. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low. Despite the potential overlap, the risk to this species is considered to be low because of the extensive area of equally suitable habitat in non-trawled areas and its apparent rarity in the fishery.

Tiger pipefish (*Filicampus tigris*)

Distribution and decline: Sub-tropical waters on the east and west coasts of Australia. Common in Sydney Harbour (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Often in shallow depths along the edges of seagrass beds, and in Sydney Harbour commonly found in sheltered bays on sand and muddy substrata adjacent to tidal channels where they feed on massing mysids. Found to at least 30m depth (Kuiter, 2003a; Graham *et al*., 1993a).

Assessment of risk to tiger pipefish

Biological characteristics: Grows to 30cm (Kuiter, 2003a).

Overlap and interaction with fishery: There appears to be limited potential overlap with the fishery, as the species is predominantly found in estuaries, particularly adjacent to seagrass beds. The species was a very rare capture in the 700 scientific trawls on northern NSW prawn grounds by FRV Kapala. (Graham *et al*., 1993a). Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low. The risk to this species is considered to be low because there is limited overlap with the fishery, the extensive area of equally suitable habitat in non-trawled areas and its apparent rarity in the fishery.

Mother-of-pearl pipefish (*Vanacampus margaritifer*)

Distribution and decline: Widespread in southern Australian waters, ranging into cooler coastal waters of southern Queensland (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Occurs on rubble-algae reefs in harbours and estuaries, and often on muddy substrata. Usually found to about 10m depth (Kuiter, 2003a).

Assessment of risk to mother-of-pearl pipefish

Biological characteristics: Usually grows to about 16cm, but grows larger in southern waters, sometimes to 20cm (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in harbours and estuaries. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low.

Port Phillip pipefish (*Vanacampus phillipi*)

Distribution and decline: Several populations along Australia's south coast, from east to west coast including Tasmania (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Primarily an estuarine species that is highly localised, occupying algae reefs and seagrass beds, depending on the area. In NSW, it is mainly found in intertidal seagrass beds (Kuiter, 2003a).

Assessment of risk to Port Phillip pipefish

Biological characteristics: Grows to 20cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in seagrass beds in estuaries. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low.

Red pipefish (*Notiocampus ruber*)

Distribution and decline: Only known from a few specimens ranging from Sydney to southern Western Australia and Tasmania (Kuiter, 2003a).

Threatening processes: None identified

Habitat: Primarily an estuarine species that is highly localised, occupying algae reefs and seagrass beds, depending on the area. In NSW, it is mainly found in intertidal seagrass beds (Kuiter, 2003a).

Assessment of risk to red pipefish

Biological characteristics: Grows to 17cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in seagrass beds in estuaries. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low.

Javelin pipefish (*Lissocampus runa*)

Distribution and decline: Widespread on Australia's south coast, with specimens recorded predominantly from NSW, South Australia, Western Australia and Tasmania, as well as a recent record from Queensland (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: Reported from reefs and tidepools amongst algae-rubble reef, with most records from less than 5m, but also known to a depth of 18m (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Assessment of risk to javelin pipefish

Biological characteristics: Grows to 10cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in shallow fringing reefs and tidepools. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low.

Brigg's crested pipefish (*Histiogamphelus briggsii*)

Distribution and decline: Mainly found in the Bass Strait region, but range extends to Seal Rocks in NSW (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: Occurs along reefs and off beaches with loose weeds on sand and appears to be on the move most of the time. It is also often seasonal in certain areas, probably indicating migratory behaviour. Usually in depths greater than 10m off beaches, but shallower in estuaries when in sand channels (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Assessment of risk to Brigg's crested pipefish

Biological characteristics: Grows to 25cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in shallow water adjacent to beaches and reefs. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds, some of which were within the range of this species. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low.

Lord Howe's pipefish (*Cosmocampus howensis*)

Distribution and decline: Appears to be widespread in the south Pacific, including waters of Lord Howe Island and the NSW mainland (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: Mostly known from depths of less than 10m, but also known from 23m (Australian Museum Ichthyology Collection Database).

Assessment of risk to Lord Howe's pipefish

Biological characteristics: Grows to about 12cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in shallow water and predominantly from Lord Howe Island.

Risk: Low.

Booth's pipefish (*Halicampus boothae*)

Distribution and decline: Southern West Pacific, eastern Australia and the Coral Sea, including waters of Lord Howe Island, Norfolk Island and the NSW mainland, and Queensland (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: Known from depths of less than 10m (Australian Museum Ichthyology Collection Database), but also thought to occur on rocky reefs with algae-rich habitats (Kuiter, 2003a).

Assessment of risk to Booth's pipefish

Biological characteristics: Grows to about 16cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in shallow water on or adjacent to rocky reefs.

Risk: Low.

Madura pipefish (*Hippichthys heptagonus*)

Distribution and decline: Widespread Indo-West Pacific from east African coast to Solomon Islands, and tropical Japan to tropical eastern Australia, including Queensland and NSW waters (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: Known from brackish reaches of estuaries, including mangroves, the lower reaches of freshwater streams and sometimes in lakes, generally in depths of less than 1m (Australian Museum Ichthyology Collection Database; Kuiter, 2003a).

Assessment of risk to Madura pipefish

Biological characteristics: Grows to about 15cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in very shallow water in estuaries or freshwater.

Risk: Low.

Hairy pipefish (*Urocampus carinirostris*)

Distribution and decline: Common in marine estuaries of NSW, ranging into southern Queensland, Tasmania and scattered population along the south coast, west to the Perth region. Also reported from Papua New Guinea and Japan, although these latter records are likely to represent different species (Kuiter, 2003a; Australian Museum Ichthyology Collection Database). No evidence of decline, as usually common where found.

Threatening processes: None identified

Habitat: A predominantly estuarine species that is usually associated with *Zostera* and other seagrass beds, and is also found on sheltered rubble-algae mixed sparse reefs to about 5m depth, but has been recorded from depths of greater than 200m. Adults may also travel with loose weed on the bottom (Australian Museum Ichthyology Collection Database; Kuiter, 2003a).

Assessment of risk to hairy pipefish

Biological characteristics: Grows to about 10cm in length. Hatchlings are non-pelagic and settle in vicinity of parents (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in very shallow water in estuaries, particularly in seagrass beds. FRV Kapala did not record the species in any of about 700 scientific trawls on northern NSW prawn grounds, which were within the broader geographic range of this species. Has been recorded from 200m and 650m, but these are likely to represent very rare occurrences and may have been swept out to sea amongst seaweed or seagrass. Overall, any interactions between this species and the fishery are unlikely to be significant in terms of the NSW population.

Risk: Low.

Spotted pipefish (*Stigmatopora argus*)

Distribution and decline: Widespread along Australia's south coast, from central NSW west to Shark Bay, WA, including Tasmania (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: A predominantly estuarine species that usually occurs in small groups associated with *Zostera* and other seagrass beds in sheltered habitats to about 5m depth, but may also get washed out to sea with loose seagrass or seaweed (Australian Museum Ichthyology Collection Database; Kuiter, 2003a).

Assessment of risk to spotted pipefish

Biological characteristics: Grows to about 28cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in very shallow water in estuaries, particularly in seagrass beds.

Risk: Low.

Wide-bodied pipefish (*Stigmatopora nigra*)

Distribution and decline: Widespread along Australia's south coast, from southern Queensland west to Shark Bay, WA, including Tasmania, and New Zealand (Kuiter, 2003a; Australian Museum Ichthyology Collection Database).

Threatening processes: None identified

Habitat: A predominantly estuarine species that usually occurs in small to large groups in *Zostera* beds and algal-reef habitats in sheltered bays and estuaries. Sometimes with loose seagrass or seaweed on otherwise bare substrata (Australian Museum Ichthyology Collection Database; Kuiter, 2003a).

Assessment of risk to wide-bodied pipefish

Biological characteristics: Grows to about 28cm in length (Kuiter, 2003a).

Overlap and interaction with fishery: Very limited potential overlap with the fishery, as the species is predominantly found in very shallow water in estuaries, particularly in seagrass beds.

Risk: Low.

Protected species (section 20)

Blue groper

Conservation status: The blue groper is protected from commercial fishing under section 20 of the FM Act.

Distribution and decline: Occurs from Hervey Bay, Queensland, to Wilsons Promontory in Victoria (Hutchins and Swainston, 1986).

Key threatening processes: Hook and line fishing may pose a threat to the blue groper, especially in areas where local fishing pressure is high (Pogonoski *et al.*, 2002).

Other threatening processes: Illegal spearfishing also poses a threat to the blue groper (Pogonoski *et al.*, 2002).

Habitat: Juveniles inhabit seagrass beds until they reach about 10 cm in length, when they move to rocky reefs. Adults may range over large areas of reef in estuaries and offshore to depths of at least 60 m. (Gillanders, 1995a; Kuiter, 1996)

Recovery plans: A recovery plan is not required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the blue groper

Biological characteristics: The blue groper is a protogynous hermaphrodite, commencing life as a female, with some individuals changing to males after 8-18 years. Females are mature at 1-2 years. The sex ratio is heavily biased toward females, (1:6.8 - 1:62 (Gillanders, 1995b). The reproductive characteristics of the species make it particularly susceptible to overfishing of large males (Gillanders, 1995b). Based on this information, the resilience of the species is considered to be intermediate (2 prone characteristics - long lived, large age at maturity (for males)).

Overlap and interaction with fishery: Although it is primarily a reef dweller, this species has been caught by estuarine prawn trawlers. It has not been recorded in Ocean Trawl observer studies (Geoff Liggins, NSW Fisheries, pers. comm., 2003).

Risk: Low. Given the low probability of interaction with the fishery, the risk from trawling is considered to be low.

Risks to species listed under the Threatened Species Conservation Act (TSC Act) and Environment Protection Biodiversity Conservation Act (EPBC Act)

Endangered species

Birds

Gould's petrel

Conservation status: The Gould's petrel, *Pterodroma leucoptera leucoptera*, is listed an Endangered under the TSC Act and the EPBC Act.

Distribution and decline: Cabbage Tree Island, near Port Stephens (NSW), was thought to be the only breeding site for this endemic species, but some nesting birds were also found on nearby Boondelbah Island in 1995 (NSW NPWS, 2000a). The species distribution during its non-breeding season (May – October) is unknown, but it is thought to forage predominantly in the Tasman Sea (NSW NPWS, 2000a). Beach washed specimens and sightings at sea extend from the Queensland border to Eyre on the south coast of Western Australia (NSW NPWS, 2000a). Between 1970 and 1993, a decline in the population on Cabbage Tree Island has been documented, estimated numbers decreased from 2,000 to between 1,150 and 1,500 birds (Priddel and Carlile, 1997). The lowest number of breeding pairs recorded on Cabbage Tree Island was 122 in 1990, this increased to 425 pairs in 1995 and has increased each year since (Priddel and Carlile, 1997; NSW NPWS, 2000a).

Key Threatening Processes: This species is listed as being under threat from the activity of feral rabbits (Environment Australia, 1999). Recovery planning for this species under state legislation has successfully implemented the objectives of the threat abatement plan for feral rabbits prepared by Environment Australia and eliminated the identified threat of rabbits to this isolated endangered species. This species is also particularly affected by the ingestion of or entanglement in harmful marine debris (Threatened Species Scientific Committee, 2003).

Other threatening processes: A successful rabbit eradication program conducted on Cabbage Tree Island has eliminated the previously listed threat of nesting habitat degradation by rabbit grazing activity (NSW NPWS, 2000a). Bird-lime trees have not yet been fully removed from Cabbage Tree Island, and the species is still threatened from entanglement in the sticky fruit of this tree (NSW NPWS, 2000a). The species is also currently threatened by predation from avian predators, such as ravens and currawongs, and noise disturbance from military jet aircraft activity (NSW NPWS, 2000a).

Habitat and ecology: This pelagic species occasionally occurs offshore and is rarely observed less than 10 km from its breeding islands (Marchant and Higgins, 1990). It feeds off squid, but their diet is otherwise unknown (Marchant and Higgins, 1990). Like other members of the gadfly group of petrels, the Gould's petrel is also likely to feed on surface fish and krill (NSW NPWS, 2000a). Adult birds begin arriving on Cabbage Tree Island from mid to late September, and the fledglings depart the island from late March to early May, and are thought to then remain at sea for several years (NSW NPWS, 2000a). Breeding pairs produce one egg per clutch (Marchant and Higgins, 1990).

Recovery plans: The NSW NPWS initially prepared a draft recovery plan for the Gould's Petrel in 1996. The five-year life span of this plan has passed and in 2000 a new draft recovery plan for this species was prepared (NSW NPWS, 2000a). The implementation of the initial draft recovery plan has reduced some of the main threats to this species and a corresponding increase in its population and survival has resulted (NSW NPWS, 2000a). None of the recovery actions listed in the current draft recovery plan relate to fishing activities. An action to study the dietary and energetic requirements of this species should identify its marine food resources. This could have future consequences for the fishing industry if the petrel is found to have a reduced reproductive success from limited food resources that are also landed by fishers. Another recovery action, to recommend the declaration of Cabbage Tree Island as a Critical Habitat under the TSC Act, may also have potential consequences for future fishing activity in the vicinity.

Assessment of risk to Gould's petrel

Biological characteristics: The information provided above shows that the Gould's petrel has a restricted geographic range and the small population is restricted to breeding on two islands. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the Gould's petrel is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF, especially closer to Port Stephens during its breeding season (September to May). The OTF could interact with both breeding and non-breeding individuals of this species only when they are foraging. Breeding birds of this species are thought to forage some distance from their breeding islands, probably greater than 10km away. As the OTF predominantly harvests demersal species it is not likely to reduce the availability of this surface feeding petrels' natural prey. There are no records of interactions between this species and the OTF. The Gould's petrel is not known to actively follow fishing vessels and feed on their discards. As its breeding population is currently increasing and the draft recovery plan does not list fishing related activities as a threat to this species (NSW NPWS, 2000a) it seems that if the species does actively feed from trawl discards, is disturbed by the noise or light emitted from the trawlers or is killed by severely colliding with the trawling equipment, that these interactions either occur infrequently and/or are having a negligible effect on the species. While this species is listed as being affected by marine debris, the OTF does not significantly contribute to this problem (see previous discussion under section B2.4). In all, any interactions between the Gould's petrel and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Northern royal albatross

Conservation status: The northern royal albatross, *Diomedea sanfordi*, is listed as Endangered under the EPBC Act and is protected under the NPW Act.

Distribution and decline: The species has a circumpolar distribution over the Southern Ocean from 36°S to at least 52°S (Environment Australia, 2001a), and is most common in New Zealand and South American waters (Marchant and Higgins, 1990). It breeds biennially at Chatham Island and Taiaroa Head on New Zealand's South Island, from November to September (Gales, 1998). Non-breeders of all age groups of this species appear to wander widely between breeding seasons (Environment Australia, 2001a). In Australia, the species is generally found offshore in south-eastern waters from Coffs Harbour in the east to Eyre Peninsula in the west, especially in Tasmanian and South Australian waters (Environment Australia, 1998a). The infrequent records of this species in NSW (Environment Australia, 2001a) are from off Coffs Harbour to Bellambi (Pizzey and Doyle, 1985). The total breeding population of this species is 8,500, and there are possibly 34,000 individuals of this species in total (Environment Australia, 2001a). The breeding populations on the Chatham Islands, the main breeding location for this species, are decreasing (Environment Australia, 2001a).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: When on their breeding islands in New Zealand, northern royal albatrosses are threatened by illegal chick harvesting, nesting habitat degradation and climatic changes which are either drying nests or damaging them through storms (Gales, 1998). When at sea, the species is threatened from fishing activities, the previously mentioned longlining activity and the cables and warps used on trawlers, with which the species can collide (Gales, 1998).

Habitat and ecology: This pelagic species breeds every two years in colonies among grass tussocks and feeds on squid, fish and crustaceans (Marchant and Higgins, 1990; Gales, 1998). It begins breeding after nine years of age and has lived for at least 61 years in the wild (Robertson, 1998). One egg is produced per clutch (Environment Australia, 2001a).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to northern royal albatross

Biological characteristics: The information provided above shows that the northern royal albatross is a long lived species that reaches maturity at greater than nine years of age, uses eggs requiring parental care to reproduce and has a low reproductive output, producing one egg per clutch. Its breeding habitat is restricted and current population is small. Subsequently, the resilience level of the northern royal albatross is low.

Overlap and interaction with fishery: Only the OTF activities occurring south of Coffs Harbour could potentially interact with this species. As this species has only been recorded infrequently in this area and is known to be more common in other waters around Australia and the world, the OTF could potentially affect only a small number of individuals. As the foraging distance of breeding individuals at their New Zealand colonies is not known, it will be assumed that the fishery could encounter both breeding and non-breeding individuals. The fishery could only interact with this species when it is foraging. As the larger albatrosses are generally surface feeders (Commonwealth of Australia, 2003), their natural prey is probably composed of pelagic species. As the fishery predominantly harvests demersal species it is not likely to directly reduce the natural prey availability of this species. Although there are no records of any interactions between this species and the OTF, it could feed on the fishery’s discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages its breeding cycle (see discussion under section B2.4). The OTF may kill or injure individual birds that severely collide with the trawling equipment, however given the occurrence of this species in the area, such mortality would be infrequent and only have a negligible impact on the population as a whole. While this species is listed as being affected by marine debris, the OTF does not significantly contribute to this problem (see previous discussion under section B2.4). In all, any interactions between the northern royal albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only a small number of northern royal albatrosses occur off NSW, south of Coffs Harbour. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Southern giant-petrel

Conservation status: The southern giant-petrel, *Macronectes giganteus*, is listed as Endangered under the TSC Act and the EPBC Act.

Distribution and decline: The southern giant-petrel has a circumpolar pelagic range from Antarctica to approximately 20^{o}S (Marchant and Higgins, 1990). During the species' breeding season, in summer, it is mostly found in Antarctic waters (Marchant and Higgins, 1990). In winter, its range extends into subtropical waters and it is mostly found north of 50^{o}S (Marchant and Higgins, 1990). The species is a common visitor off the entire NSW coast. The global population of this species reduced approximately 17% between 1985 to 2001 (NSW Scientific Committee, 2001a). The estimated 5,000 breeding pairs in Australian territory represents a reduction of approximately 50% since the middle of the last century (Marchant and Higgins, 1990).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003). The species is also affected by predation by cats on breeding islands (Garnett and Crowley, 2000).

Other threatening processes: Other identified threats include human disturbance, the accumulation of chemical contamination, predation from rats, habitat degradation from introduced animals and on some breeding islands, hunting (Marchant and Higgins, 1990; Garnett and Crowley, 2000). Within NSW waters, the species is potentially threatened by the loss of southern cuttlefish populations, illegal longline fishing operations and oil spills (NSW Scientific Committee, 2001a).

Habitat and ecology: Found in Antarctic to subtropical waters, this marine species occurs over both pelagic and inshore waters (Marchant and Higgins, 1990). Over summer, it nests annually on Antarctic and subantarctic islands, including Heard and Macquarie Islands, Antarctica and South America, with about 30% of the potential breeding population not attempting to breed each year (Marchant and Higgins, 1990). Males first breed at 4-6 years of age and females at 7-8 years (Marchant and Higgins, 1990). A single chick is raised (Marchant and Higgins, 1990). Adults are present around Antarctic breeding colonies all year, while immature birds disperse north during winter (Marchant and Higgins, 1990). The species is an opportunistic scavenger and predator and feeds mostly on smaller seabirds, cephalopods, krill, fish and animal carcasses, from the surface of the sea and sometimes on land (Marchant and Higgins, 1990). Very occasionally, the species will dive to shallow depths to capture their prey (Harper, 1987). The species regularly attends fishing vessels (NSW Scientific Committee, 2001a).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to southern giant-petrel

Biological characteristics: The information provided above shows that the southern giant-petrel generally reaches maturity at greater than five years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Its current population is much smaller than it was historically. Subsequently, the resilience level of the southern giant-petrel is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF, over both pelagic and inshore waters, mostly during winter. The fishery is not likely to have a significant impact upon this species' breeding success as it is only likely to encounter immature individuals. The reason being that the OTF operates some distance from the nearest breeding colony at Macquarie Island, and adults tend to remain near their colonies throughout the year. As this species feeds from the waters surface and by shallow diving, its natural prey is likely to comprise only of pelagic species. As the OTF predominantly harvests demersal species it is not likely to directly reduce the availability of this species' natural prey. There are no interactions between this species and the OTF. The discards from the OTF may be providing a foodsource for this species that is known to regularly feed on fishing discards. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. While this species is listed as being affected by marine debris, the OTF does not significantly contribute to this problem (see previous discussion under section B2.4). In all, any interactions between the southern giant-petrel and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Wandering albatross

Conservation status: The wandering albatross, *Diomedea exulans*, is listed as Endangered under the TSC Act and as Vulnerable under the EPBC Act.

Distribution and decline: The wandering albatross has a southern circumpolar distribution over the Antarctic, subantarctic and subtropical waters of the Atlantic, Pacific and Indian Oceans (Marchant and Higgins, 1990). The species can be found in southern Australian waters throughout the year (Marchant and Higgins, 1990). It has been recorded along the entire coast of NSW (NSW Scientific Committee, 1996) and is most abundant here from mid-June to mid-September (Marchant and Higgins, 1990). All populations of this species that have been monitored have decreased over the past 20 years (NSW Scientific Committee, 1996). The most recent global population estimate of this species is 55,000 individuals, with around 8,500 pairs breeding annually (Gales, 1998). At last report, fewer than ten pairs breed annually on Macquarie Island (Gales, 1998), a maximum of 44 annual breeding pairs have recorded on this island (Environment Australia, 2001a).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: The species is shot for bait or to prevent them from scavenging bait from drop line fishing gear (Garnett and Crowley, 2000). On Macquarie Island, it is affected by an elevated number of Antarctic skuas and human disturbance (Garnett and Crowley, 2000). The accumulation of chemical contaminants and human disturbance may also pose risks to this species (Garnett and Crowley, 2000).

Habitat: In the Australasian region, this highly dispersive marine species occurs inshore, offshore and in pelagic waters, regularly feeding in sheltered harbours and straits, and have been recorded as gathering at sewage outfalls (Marchant and Higgins, 1990). The species breeds every two years on about nine subantarctic and Antarctic islands, including Macquarie Island, during summer (Marchant and Higgins, 1990). Birds first breed at 7-16 years of age (Environment Australia, 2001a). One egg is produced per clutch (Marchant and Higgins, 1990). They feed mostly on cephalopods and fish by scavenging, seizing food from the surface, shallow plunging or pursuit plunging, and do most of their hunting at night (Marchant and Higgins, 1990). The species frequently attends fishing vessels for food (Brothers, 1991).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to wandering albatross

Biological characteristics: The information provided above shows that the wandering albatross generally reaches maturity at 7-16 years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. The breeding habitat of this currently small population is restricted to around nine islands. Subsequently, the resilience level of the southern giant-petrel is low.

Overlap and interaction with fishery: This species can occur throughout the whole area of operation of the OTF, including inshore, offshore and deeper water, throughout the year but mostly from mid-June to mid-September. As the species is highly dispersive, the fishery may encounter both breeding birds from distant breeding colonies and non-breeding birds. The fishery can only interact with this species while it is foraging. As the larger albatrosses are generally surface feeders (Commonwealth of Australia, 2003), their natural prey is probably composed of pelagic species. As the fishery predominantly harvests demersal species it is not likely to directly reduce the natural prey availability of this species. There are no records of interactions between this species and the OTF. The discards from the OTF may be providing a food source for this species that is known to follow vessels for food. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the wandering albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Mammals

Unless otherwise specifically referenced, the following information on mammals was obtained from *The Action Plan for Australian Cetaceans* (Bannister *et al.,* 1996).

Blue whale

Conservation status: The blue whale, *Balaenoptera musculus*, is listed as Endangered under the TSC Act and the EPBC Act.

Distribution and decline: Occurring throughout the world's oceans, blue whales migrate between warm water breeding grounds in tropical and subtropical waters and cold water feeding grounds in polar and subpolar waters. There are three subspecies of blue whale, the spatially disjunct northern and southern 'true' blue whale and the pygmy blue whale (Clapham *et al.*, 1999). In the southern hemisphere, 'true' blue whales occur between 20^{o}S and 60-70^{o}S. Pygmy blue whales only occur in the southern hemisphere, particularly in the Indian Ocean, and migrate to north of 50^{o}S in summer. Blue whales have been recorded from all Australian states. Recent strandings in Australia have mostly been pygmy blue whales. Their migration paths are widespread and do not obviously follow coastlines or oceanographic features.

The waters off the far south coast of NSW, and the adjacent waters off Victoria, are one of only three recognised aggregation areas for blue whales in Australia (Environment Australia, 2001b). Blue whales have been sighted in NSW waters on a number of occasions mostly between Bermagui and Green Cape, mostly in October and November (Smith, 2001). While there are no confirmed records of pygmy blue whales in NSW waters, it is likely that some NSW sightings of blue whales may have been this species as it is the more common subspecies in adjacent Victorian waters (NSW Scientific Committee, 2002a).

The population of 'true' blue whales dramatically declined during historical whaling operations that fully ceased in the early 1970s. The current southern hemisphere population of 'true' blue whales has been estimated at 610 and pygmy blue whales at 4,300 (Butterworth *et al.*, 1995). This is only a small proportion of the original population.

Key Threatening Processes: Ingestion of or entanglement in harmful marine debris affects this species (Threatened Species Scientific Committee, 2003). Human induced climate change also threatens this species (NSW Scientific Committee, 2002a).

Other threatening processes: The numbers of blue whales have been so severely depleted that the species vulnerability to other threats is exacerbated (NSW Scientific Committee, 2002a). The species is threatened by seismic operations, collision with large vessels, entanglement in fishing gear, defence operations, and pollution leading to the accumulation of toxic substances in body tissues (NSW Scientific Committee, 2002a).

Habitat and ecology: Blue whales mostly occur along the edges of continental shelves and along ice fronts, and also in both deep oceanic waters and shallow inshore zones (Leatherwood and Reeves, 1983). 'True' blue whales reach a maximum age of 80-90 years and a maximum length of 30.5m. 'True' blue males reach sexual maturity at 22 m and females at 23-24 m (5-10 years of age). They give birth to a single calf every two to three years in the tropical open ocean in winter after a 10-11 month gestation period (Rafic, 1999). They mate in winter. Pygmy blue whales reach a maximum age of less than 50 years and a maximum length of 24.4 m. Pygmy blue whales calve every two to three years in tropical open oceans in winter after a 10-11 month gestation period. They mate in winter. 'True' blue whales feed almost exclusively on one species of krill in Antarctic waters. Pygmy blue whales feed further north on smaller krill, and have been reported feeding off southern Australia. They exhibit both shallow and deep diving behaviour, and can dive for up to 30 minutes. In one day they may consume two to four tonnes of food.

Recovery plans: A draft recovery plan for blue whales in Australian waters, prepared by Environment Australia, recommends the protection of identified critical habitat, programs to reduce human-induced mortality, maintenance of the stranding and sightings database, continued cooperation with international conservation programs and research to achieve these management goals and increase knowledge of this population (Rafic, 1999).

Assessment of risk to blue whale

Biological characteristics: The information provided above shows that both the 'true' and pygmy blue whales have a small population size, live a long time, reach maturity at greater than five years of age and produce a single offspring every two to three years that, like all other mammals, requires some parental care. Consequently, the resilience level of 'true' and pygmy blue whales is low.

Overlap and interaction with fishery: There is little overlap between the ocean trawl fishery and the blue whales. Blue whales primarily occur well offshore from the southern part of NSW (Environment Australia, 2001b), where the fishery operates within three nautical miles of the coast. There have been no reports of blue whales coming into contact with trawlers in NSW (Rafic, 1999).

Risk: Low. Given the low probability of trawlers coming into contact with blue whales, the risk is considered to be low.

Dugong

Conservation status: The dugong, *Dugong dugon*, is listed as Endangered under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The dugong occurs in the Indian and western Pacific Oceans, between about 27^{o}N and 27^{o}S (Smith, 2001). It is now found in small relict populations separated by large areas where it is close to extinction (Smith, 2001). The resident populations around the northern shoreline of Australia from Shark Bay (WA) to Moreton Bay (Qld) support most of the current world population of the species (Smith, 2001). Dugongs usually only occur in NSW as occasional stragglers usually in waters north of Jervis Bay, although they have been reported as far south as Twofold Bay (Smith, 2001). In 1992-93, there was an influx of dugongs (many of them dying) from Hervey Bay into NSW waters. This was due to a large loss of habitat following floods and a cyclone (Smith, 2001). NSW waters act as a refuge area for Queensland's dugongs (NSW Scientific Committee, 2002b). The minimum size of the Australian population of dugongs was estimated to be 85,000 (Smith, 2001). Populations in the southern Barrier Reef and Hervey Bay area have declined in recent years (Smith, 2001).

Key Threatening Processes: This species could be affected by human induced climate change (Threatened Species Scientific Committee, 2001).

Other threatening processes: Dugongs are threatened by coastal development, poor catchment management leading to siltation and the loss of seagrass beds, traditional hunting, collision with boats, and incidental mortality in gillnets and shark protection nets. Isolated dugong populations are vulnerable to local extinction following stochastic events such as floods or cyclones (NSW Scientific Committee, 2002b).

Habitat and ecology: Dugongs are found in the shallow coastal parts of tropical and subtropical waters. They feed on a wide variety of seagrass species and algae, although usually only in very small amounts if seagrasses are abundant. They live for up to 70 years, reach sexual maturity after ten years and produce a single calf every three to five years (Marsh *et al.*, 1984).

Recovery plans: A recovery plan for the dugong in NSW has not been prepared, but there is a recovery plan for Queensland (Queensland Parks and Wildlife Service, 1999).

Assessment of risk to dugong

Biological characteristics: The information provided above shows that the dugong is long lived, reaches sexual maturity after ten years and produces a single calf (twins are rare) every three to five years that, like all other mammals, requires some parental care. Its global population is much smaller than it was historically. Subsequently, the resilience level of the dugong is low.

Overlap and interaction with fishery: Dugongs generally occur in shallow inshore waters that are unlikely to be trawled. Furthermore, in NSW, dugongs generally only occur as rare vagrants, with the exception of the influx in 1993 described above. There are no observer records of dugongs being caught by trawlers in New South Wales (Graham *et al*., 1995, 1996, 1997, Liggins, 1996), and trawling is not considered to be a threat to the species in the dugong recovery plan (Queensland Parks and Wildlife Service, 1999).

Risk: Low. Given the small probability of a dugong coming into contact with trawlers in NSW, the risk is considered to be low.

Southern right whale

Conservation status: The southern right whale, *Eubalaena australis*, is listed as Endangered under the EPBC Act and as Vulnerable under the TSC Act.

Distribution and decline: Southern right whales occur across the southern hemisphere between around 30^{o} and 60^{o}S. They feed in summer in the higher latitudes of their range (between about 45^{o}S and 55^{o}S) and generally move to the lower latitudes for breeding in winter. They approach coasts in winter. In Australia, the species is a winter-spring visitor, occurring around the southern coastline from Perth (WA) to Sydney (NSW), including Tasmania. Their Australian range is possibly extending further north as sightings have been reported from Shark Bay and North West Cape (WA) and Byron Bay (NSW).

The species is regularly observed close to shore along the NSW coast between May and November, and there are a couple of January records (Smith, 2001). The species has mostly been sighted in southern and central NSW (south of Newcastle), although there are some records further north, the furthest from Byron Bay (Smith, 2001). New-born calves are regularly sighted in NSW waters (Smith, 2001). After calving in NSW waters, the population perhaps moves offshore before migrating to more southerly waters in summer (Smith, 2001).

The population of southern right whales dramatically declined during historical whaling operations that ceased in the 1960s. Population estimates are difficult for this species, given its irregular movement and calving cycle. The numbers of southern right whales off southern Western Australia have increased since 1977 at around 10% per year. The Australian population remains small compared with its likely size before exploitation (Smith, 2001). The numbers of southern right whales that visit NSW in any one year is probably less than ten (Warneke, 1996).

Key Threatening Processes: Ingestion of or entanglement in harmful marine debris affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: Southern right whales are threatened by direct disturbance, especially when they are close to the coast. The disturbance can result from whale watching activities, recreational and research related boating activities, collision with large vessels, swimmers, divers, low-flying aircraft, coastal industrial activity, defence operations, entanglement in fishing gear and pollution leading to the accumulation of toxic substances in body tissues.

Habitat and ecology: In summer, southern right whales are pelagic and feed in the open Southern Ocean. In winter, they occur close to the coast, particularly calving females. Consistent calving locations in Australia in recent years have been at Doubtful Island Bay and east of Israelite

Bay (WA), the head of the Great Australian Bight (SA), and off the South Australian gulfs and Warrnambool (Victoria). They live to a maximum of 50+ years and reach a maximum length of 17.5 m. Sexual maturity is reached around nine to ten years / 12-13 m. They generally calve every three years in preferred onshore localities during June-August after an 11-12 month gestation period. They mate from July-August. The data implies that there is no feeding near the coast in winter, calving females effectively fast for a little over four months. These baleen whales feed mainly on smaller plankton and copepods, taken primarily in the open ocean, presumably south of 40^{o}S, in summer at or near the surface. Near shore, their swimming speeds are generally slow, however they are capable of reaching 15+ km / hr over short distances.

Recovery plans: The draft recovery plan for southern right whales in Australian waters, prepared by the Commonwealth, recommends minimising human induced threats, the identification and protection of critical and/or preferred habitats, continued cooperation with international conservation programs and research (Burnell and McCulloch, 2001).

Assessment of risk to southern right whale

Biological characteristics: The information provided above shows that the southern right whale is long lived, reaches sexual maturity after nine to ten years and produces a single calf at a time that like all other mammals require some parental care. Its population is much smaller than it was historically. Subsequently, the resilience level of the southern right whale is low.

Overlap and interaction with fishery: The species is frequently seen in inshore areas along the New South Wales coast in winter (Smith, 2001). The draft recovery plan for the species identifies Twofold Bay and coastal waters 5 km north and south as an area of frequent use by the species, however the plan acknowledges that other areas may become important as the population recovers (Burnell and McCulloch, 2001). Data from South Africa indicates that over the winter, females with calves generally occur in shallow waters, sometimes less than 5 m deep, and that all whales generally occur within 1.85 km of the shore (Best, 1990). Given this distribution, interaction with trawlers seems likely to occur. Such interactions may include acoustic disturbance, collision with vessels and entanglement in fishing gear. Competition with the OTF is unlikely because the species feeds on krill in Southern Ocean feeding grounds. Collision with vessels rarely occurs and is considered not to pose a threat to this species (Burnell and McCulloch, 2001). Entanglement in demersal trawl gear is unlikely, because such gear is deployed on the bottom, and is rarely lost, and if it were lost, would most likely sink. Acoustic disturbance from fishing boats is possible, and would constitute the greatest risks in near shore aggregation areas (Burnell and McCulloch, 2001). Short-term effects of disturbance from boats may vary from apparently little change to avoidance of rapidly moving vessels (Richardson *et al.* 1995). The long-term impacts of repeated disturbance may include the abandonment of critical habitats, which could have a long-term negative impact on the population (Burnell and McCulloch, 2001), however there is no evidence of this occurring in NSW. The recovery plan calls for the exclusion of commercial fishing from preferred and/or critical habitats of the species between May and October, but it is not clear whether this refers to the Twofold Bay area (Burnell and McCulloch, 2001).

Risk: Low-medium. There is a small probability of negative interactions with the Ocean Trawl fishery. More data on interactions between this species and the fishery is needed to ensure no impediments to ongoing recovery of the species, particularly in the event of new areas being used by an increasing population of southern right whales. The risk to the species is considered to be low-medium.

Reptiles

Unless otherwise specifically referenced, the following information on turtles was obtained from the *Draft Recovery Plan for Marine Turtles in Australia* (Environment Australia, 1998b).

Conservation status: The loggerhead turtle, *Caretta caretta*, is listed as Endangered under the TSC Act and the EPBC Act.

Distribution and decline: Loggerhead turtles are found worldwide, inhabiting tropical and warmer temperate waters, often straying into higher latitudes (Cogger, 2000). In Australia, loggerhead turtles live year round in coastal waters from southern Western Australia, through the Northern Territory and Queensland to southern New South Wales. Breeding is largely restricted to areas north of 27^{o}S (Cogger, 2000), and they are most abundant within 1000 km of their nesting beaches. In NSW coastal waters, they occur in moderate numbers in the far north and are far less numerous in the southern parts of the State (Cogger, 2000). The eastern Australian population of loggerhead turtles is in severe decline, it has reduced by 86% over the past 23 years to less than 500 breeding females (C. Limpus, NPWS, pers. comm.).

Key Threatening Processes: Trawling north of 28°S, harmful marine debris, predation by foxes and imported fire ants pose threats to the loggerhead turtle.

Other threatening processes: The species is threatened by fishing interactions, ingestion of synthetic materials, boat strike, predation of eggs at rookeries, disease, coastal development, tourism, indigenous harvesting. Fishing interactions include incidental capture in trawling, gill netting, pelagic long line and shark meshing gear and entanglement in float lines from traps.

Habitat and ecology: Loggerhead turtles occur within continental shelf waters and forage over coral reef, rocky reef, bay or estuarine habitats. They also forage on the deeper soft-bottomed habitats throughout the coastal waters of the continental shelf. Adult and large immature turtles eat shellfish and crabs, while immature turtles eat sea urchins, jellyfish and sea anemones. They do not form obvious social groups and feed as individuals. They feed off the substrate surface, from within the water column, and at or near the surface on floating prey and discarded trawl bycatch (Limpus, in prep.). They reach sexual maturity at about 30 years or more and grow to an average of one metre in size. On average, 127 eggs per clutch are laid. Loggerhead turtles migrate 2,600 km from feeding grounds in the Northern Territory, New South Wales and Queensland to traditional nesting sites on the eastern and western Australian coastlines. Some nesting turtles also migrate from as far as Indonesia, Papua New Guinea, Solomon Islands and New Caledonia. Australian nesting populations are genetically distinct from those in other countries. The southern Great Barrier Reef and adjacent mainland near Bundaberg is the breeding centre of the eastern Australian population. Successful breeding events have been recorded in far northern NSW (NSW NPWS, 2002b). Mating occurs from late October to early December, followed by nesting from late October to early March. Breeding and nesting occurs on average every 2-5 years.

Recovery plans: The recovery plan for marine turtles in Australia, prepared by Environment Australia, recommends specific actions that seek to reduce mortality, monitor populations, manage factors affecting nesting, protect critical habitats, educate stakeholders and support, maintain and develop international conservation programs (Environment Australia, 2003). No NSW fisheries are listed as having an impact upon marine turtles (Environment Australia, 2003).

Assessment of risk to loggerhead turtle

Biological characteristics: The information provided above shows that the loggerhead turtle is long lived, reaches sexual maturity at 30 years, uses eggs to produce offspring and lays an average of

127 eggs at a time. Its current population is very small. Subsequently, the resilience level of the loggerhead turtle is low.

Overlap and interaction with fishery: The observer study by NSW Fisheries found that turtles (unspecified species) were captured in 3 of 590 tows (0.51%) north of Newcastle, and none were caught further south. Many of the turtles caught in trawls can be successfully revived and returned to the water (Ocean Watch Australia, 2003).

Risk: Low-medium. Given the apparently low incidence of capture and lower incidence of mortality of turtles in NSW, the risk to the loggerhead turtle from the Ocean Trawl fishery is considered to be low.

Endangered populations

Little penguin population

Unless otherwise specifically referenced, the following information on the endangered little penguin population at Manly was obtained from the recovery plan for this population (NSW NPWS, 2000b).

Conservation status: The little penguin population (*Eudyptula minor*) in the Manly Point area is listed as an Endangered Population under the TSC Act.

Distribution and decline: Little penguins, found only in Australia and New Zealand, once ranged from Swan River in Western Australia through Tasmania and up to Moreton Bay in Queensland, and may still occasionally venture that far. They are relatively common in the waters of southern Australia, breeding mainly on offshore islands. They generally breed from Port Stephens in NSW along the eastern and southern coasts, including around Tasmania, and as far north as Fremantle on the west coast. The little penguin population at Manly represents only a small percentage of the State’s population, however it is of importance as it is the only breeding site on mainland NSW. This population was formerly more extensive, covered a greater area in Sydney Harbour and was more numerous. The population contained 75 breeding pairs in the 2001/02 breeding season (NSW NPWS, 2002a).

Key Threatening Processes: Predation by cats and foxes are a threat to this population.

Other threatening processes: Listed threats to this population include loss of suitable habitat, disturbance, predation by dogs, pollution and commercial fishing activities that harvest the penguins food resources and restrict their access to burrows.

Habitat and ecology: The main habitat of this Manly population (including aquatic areas extending 50m out from the high water mark) has been listed as a Critical Habitat under the TSC Act. Little penguin nesting habitat normally consists of burrows built in sand dunes, rockpiles, sea caves, and occasionally under buildings. At Manly, a range of nest types are utilised, including under rocks on the foreshore, rock falls under seaside houses, garages, under stairs, in wood piles and under overhanging vegetation.

Little penguins at Manly generally breed from July through to February each year, although this can very between seasons. While little penguins lay two eggs per clutch, usually only one chick hatches, although it is not uncommon for two chicks to hatch at Manly. It is also not uncommon for the penguins at Manly to rear two consecutive clutches in a season.

Once fledged young penguins return to the colony annually to moult until they are ready to breed at three to four years of age. It is not known if young birds spend most of this time at sea or disperse to other colonies. Adult little penguins tend to remain centred on their breeding colony throughout the year, although they may leave for 2-3 months during the non-breeding season. When feeding their young, they generally do not disperse far from their colonies and their daily foraging range is usually between 10 – 30 km.

Little penguins appear to be opportunistic feeders, foraging in relatively shallow waters. Their diet consists mainly of small schooling fish, like anchovies (*Engraulis australis*), pilchards (*Sardinops neopilchardus*), squid (Order Teuthida) and to a lesser extent krill. When swimming in search of food, little penguins are unlikely to swim faster than 6km/h.

Recovery plans: The recovery plan for this population aims to ameliorate current threats, protect the population and maintain it at current levels and increase the limits of potential habitat, continue community education and involvement, better understand the ecology of this population. Specific management actions in the plan related to fishing in offshore waters include the collection of data on commercial fishing effort and baitfish catches in the ocean adjacent to Sydney Harbour.

Assessment of risk to endangered little penguin population

Biological characteristics: The information provided above shows that little penguins use eggs requiring parental care to reproduce and have a low reproductive output producing 1-4 chicks a year. These biological prone characters of the penguins themselves combined with the prone characters of the population itself, i.e. restricted breeding habitat and small population size, results in a low resilience level for the little penguin population at Manly.

Overlap and interaction with fishery: The OTF is an offshore fishery that does not operate in or adjacent to the critical habitat area declared for this population. Only when the OTF vessels working off Sydney Harbour do so reasonably close to shore within 30km of the colony during the breeding period can the fishery encounter foraging breeding adults from this population. Disturbances from commercial fishing, including activities adjacent to the colony, have not been reported to prevent adults from returning to their fledglings at the colony with food. Such disturbance has been noted at a colony offshore from Wollongong. Immature and non-breeding adult birds from the colony disperse more widely when foraging and may overlap with a larger area of the OTF. As little penguins naturally feed on pelagic species, the harvesting of predominantly demersal species by the OTF should not reduce the natural prey availability of the little penguin population at Manly. This population is not likely to be adapted to feeding on the discards from the OTF as its members have not been recorded feeding from the discards of any fishing vessels, including those that operate adjacent to the population. Also, as no little penguins have been recorded captured in the trawls operating in Sydney Harbour itself, and as penguins feed in pelagic waters and the OTF works in demersal waters, any capture of penguins from this population by the OTF would be an extremely rare event. While disturbance is listed as a threat to this population, this listing largely concerns the disturbances adjacent to the breeding colony. Any disturbance from the noise and light emitted from this fishery to individuals from this population whilst they are foraging at sea is likely to have negligible effects on the population (see section B2.4). In all, it appears that any interactions between the OTF and the endangered population of little penguins at Manly should only have a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low. The OTF operates some distance from the listed critical habitat of this population. Any disturbances to individuals of this population from the fishery should only have negligible consequences both for the species and the population.

Vulnerable species

Birds

Unless otherwise specifically referenced, the following information on birds was obtained from the *Handbook of Australian, New Zealand and Antarctic Birds* (Marchant and Higgins, 1990, 1993; Higgins and Davies, 1996).

Antipodean albatross

Conservation status: The antipodean albatross, *Diomedea antipodensis*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The antipodean albatross only breeds in New Zealand, on Antipodes and Campbell Island (Garnett and Crowley, 2000). It occurs across the southern Pacific Ocean, east to the coast of Chile and west to eastern Australia (Garnett and Crowley, 2000). This albatross regularly occurs in small numbers off the New South Wales south coast from Green Cape to Newcastle during winter where they feed on cuttlefish (NSW Scientific Committee, 2001b). Population trends of this species could not be determined due to a lack of historical population data (Garnett and Crowley, 2000). The annual breeding population of this species is relatively small and has been estimated at 5,154 pairs (Gales, 1998).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: Along with drowning in longline fishing gear this species may also suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998). Shooting to protect bait also threatens the species (Garnet and Crowley, 2000). Within NSW waters, potential threats to the species are the loss of the southern cuttlefish populations, illegal longline fishing and oil spills (NSW Scientific Committee, 2001b).

Habitat and ecology: This species breeds every two years, mostly on Antipodes Island, with a small number of breeding pairs on Campbell Island. Egg laying begins in January (Antipodes Island) and February (Campbell Island), and chicks usually fledge the following year in January and March (Gales, 1998). This pelagic species feeds on squid, fish and crustaceans (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to antipodean albatross

Biological characteristics: The information provided above shows that the population of the antipodean albatross is small and only breeds on only two islands. The species uses eggs requiring parental care to reproduce, and like all other albatross species produces one egg per clutch. Subsequently, the resilience level of the antipodean albatross is low.

Overlap and interaction with fishery: Only the OTF activities occurring south of Coffs Harbour could potentially interact with this species. As the foraging range of this species when breeding is not known, it will be assumed that the OTF may encounter both breeding and non-breeding individuals. This fishery is only likely to encounter this species when foraging. By predominantly harvesting demersal species, it is not likely to directly reduce the natural prey availability of this species, which is likely to be only composed of pelagic species. Although there are no records of any interactions between this species and the OTF, it, like other albatross species, may feed on the discards from the OTF and be indirectly disturbed from the noise and light emitted from a vessel. As mentioned in section B2.4, such interactions would not negatively affect the species, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality from any trawl fishery should only be infrequent, and should only have a negligible impact on the population as a whole. While this species is listed as being affected by marine debris, the OTF does not significantly contribute to this problem (See previous discussion under section B2.4). In all, any interactions between the antipodean albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only the trawling activities occurring south of Coffs Harbour could interact with this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Black-browed albatross

Conservation status: The black-browed albatross, *Diomedea melanophris*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The black-browed albatross has a circumpolar distribution over the southern oceans. The species forages around its Antarctic and subantarctic breeding islands during its summer breeding season and moves further north when not breeding. In Australia, it occurs along the southern coast from Brisbane to Perth. The species regularly migrates to waters off the continental shelf from May to November and is regularly recorded off the coast of NSW during this time (NSW NPWS, 1999a). Sub-adults are observed in Australian waters all year round (Environment Australia, 2001a). Decreases in the numbers and/or recruitment rates at many breeding colonies of this species have been recorded (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Predation by cats at breeding colonies could also affect this species (Garnett and Crowley, 2000).

Other threatening processes: Other threats to the species include predation by skuas at breeding colonies and pollution (Garnett and Crowley, 2000; NSW NPWS, 1999a).

Habitat and ecology: This generally pelagic species inhabits Antarctic, subantarctic and subtropical marine waters. It breeds annually on Antarctic and subantarctic islands between September and December and begins breeding at around 11 years of age. One egg is produced per clutch. It feeds on fish, krill, crustaceans, cephalopods and offal, and often forages in flocks with other seabirds. Prey are usually seized from the surface or just below while swimming or landing, and also by submerging themselves by plunging from heights and by scavenging behind fishing vessels. Feeding usually occurs during the day, and occasionally at night.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to black-browed albatross

Biological characteristics: The information provided above shows that the black-browed albatross first breeds at around 11 years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Populations of this species on Antarctic and subantarctic islands are small (Environment Australia, 2001a). Subsequently, the resilience level of the black-browed albatross is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF, especially between May to November. The fishery could only interact with individual birds when they are foraging. As the foraging distance of breeding birds is not known, it will be assumed that the fishery could interact with both breeding and non-breeding individuals. This species can feed from the surface and by diving to unknown depths. When diving this species has been recorded staying under water for periods of 20 seconds (Harper, 1987), and like most albatross species it would probably not be able to reach great depths. Subsequently its diet would predominantly be composed of pelagic species. As the OTF predominantly harvests demersal species it is not likely to reduce they natural prey availability of this species. There are no records on interactions between this species and the OTF. The discards from the OTF may be providing a food source for this species that is known to feed on fishing discards or be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle. Considering that mortality resulting from the collision with or entanglement in trawl gear is likely to be rare (see discussion in section B2.4), especially as this is not listed as a threat to this species, such mortality from any trawl fishery should only be infrequent, and should only have a negligible impact on the population as a whole. In all, any interactions between the black-browed albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Black-winged petrel

Conservation status: The black-winged petrel, *Pterodroma nigripennis*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The black-winged petrel occurs in the north Tasman Sea and southwest Pacific Ocean during its summer breeding season, and moves eastwards into the central Pacific Ocean when not breeding. Within Australia, the species has been sighted in scattered areas along the southern Queensland and NSW coastline. In NSW, they have been observed ashore at Muttonbird Island, Byron Bay, Lord Howe Island, Norfolk Island, Newcastle, Cronulla, Batemans Bay, Solitary Island, Wollongong and Eden (NSW NPWS, 1999b). The breeding range of this species appears to be expanding (Garnett and Crowley, 2000).

Key Threatening Processes: This species is mainly threatened from predation by cats, activity from feral pigs and goats could also affect this species.

Other threatening processes: The introduced brown rat could also affect this species.

Habitat and ecology: This pelagic seabird occurs over subtropical and tropical waters and also over warm currents in cool seas. It breeds during summer on tropical and subtropical islands and inlets in the southwestern Pacific Ocean, including Norfolk and Lord Howe Islands, although nesting events on Lord Howe Island have never been successful (Garnet and Crowley, 2000). It lays one egg per clutch. They are thought to mainly feed on squid and prawns, which they catch by seizing from the surface or shallow diving, often in association with a number of other birds.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to black-winged petrel

Biological characteristics: The information provided above shows that the black-winged petrel has a restricted range in Australia. There is limited population information on this species, however considering it is listed as threatened it will be assumed to be small. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the black-winged petrel is low.

Overlap and interaction with fishery: This species may be found scattered throughout the area of operation of the OTF. The fishery could potentially interact with both breeding and non-breeding individuals, only when they are foraging. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this surface feeding and shallow diving species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The species, including breeding birds, may potentially feed on the fishery's discards or be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not be negatively affecting the species especially as the discards from the fishery would be available to the species throughout the year and the various stages of its breeding cycle. Considering that mortality resulting from the collision with or entanglement in trawl gear is likely to be rare (see discussion in section B2.4), especially as this is not listed as a threat to this species, such mortality from any trawl fishery should only be infrequent, and should only have a negligible impact on the population as a whole. In all, any interactions between the black-winged petrel and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Buller's albatross

Conservation status: The Buller's albatross, *Thallassarche bulleri*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: The Buller's albatross generally occurs near its breeding sites on Snares and Solander Islands, New Zealand. It may cross the Tasman Sea, even when breeding and also regularly visits Chile and Peru during the non-breeding season. This pelagic species is found off south-eastern Australia, between Coffs Harbour and Eyre Peninsula (Gales, 1998). In this area the species was formerly regarded as rare but there have been more frequent sightings recently. The number of breeding pairs on Snares Island increased between 1969-1992 and on Solander Island decreased between 1986-1996 (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species may also suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998).

Habitat and ecology: In Australia, this species occurs over inshore, offshore and pelagic waters. Adult birds arrive at the breeding colony in December and chicks fledge the colony during late August (Gales, 1998). One egg per clutch is laid. The species mostly feeds on squid and some fish, krill and tunicates and takes its food from or just below the water's surface. The species has been observed in association with fishing boats in New Zealand.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to Buller's albatross

Biological characteristics: The information provided above shows that the Buller's albatross uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. It is restricted to breeding on two islands and, given that it is listed as threatened, its population is probably small. Subsequently, the resilience level of the Buller's albatross is low.

Overlap and interaction with fishery: Only the OTF activities occurring south of Coffs Harbour could potentially interact with this species. The fishery could potentially interact with both breeding and non-breeding individuals, only when they are foraging. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this surface feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. It may feed on the fishery's discards, as provisioning activity has been observed in New Zealand waters, or be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not be negatively affecting the species, especially as the discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality should only be infrequent, especially as the species does not appear to occur in large numbers off the NSW coast, and should only have a negligible impact on the population as a whole. In all, any interactions between the Buller's albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only the trawling activities occurring south of Coffs Harbour could interact with this species. It seems that only a small number of this species occurs off the NSW coast. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Campbell albatross

Conservation status: Campbell's albatross, *Thallassarche impavida*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: This species only breeds on Campbell Island, New Zealand. It can be found foraging around New Zealand when breeding and over the temperate shelf waters of New Zealand, southern Australia and the central and western Pacific Islands when not breeding (Environment Australia, 2001a; Gales, 1998). In Australia, it occurs from the NSW/Qld border in the east to Ceduna South Australia in the west (Environment Australia, 1998a). This population has significantly decreased in recent decades (Environment Australia, 2001a).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). High capture rates of this species have been recorded from longliners operating off New Zealand and southern Australia (Gales, 1998).

Other threatening processes: This species may suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998). Predation from other seabirds on the breeding island also threatens this species (Gales, 1998).

Habitat and ecology: This annual breeder returns to its breeding colony in August and successful breeders and chicks depart in April-May (Gales, 1998). One egg is laid per clutch (Environment Australia, 2001a). It feeds pelagically on squid, fish and crustaceans and also follows boats to retrieve offal (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to Campbell's albatross

Biological characteristics: The information provided above shows that the Campbell's albatross uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Its geographic range is restricted and its current population is significantly smaller than it was historically. Subsequently, the resilience level of the Campbell's albatross is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF. As breeding individuals tend to remain near their distant breeding colonies, the OTF is only likely to encounter non-breeding individuals of this species. The fishery could only interact with these birds when they are foraging. Like other albatross species, this species is probably mostly feeds from the surface or just below. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The species could be feeding on the fishery's discards, or be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not be negatively affecting the species. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality should only be infrequent, and should only have a negligible impact on the population as a whole. In all, any interactions between the Campbell's albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Flesh-footed shearwater

Conservation status: The flesh-footed shearwater, *Puffinus carneipes*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The flesh-footed shearwater is a trans-equatorial migrant, widely distributed across the southern Indian Ocean and southeastern Pacific Ocean in the breeding season. They are a breeding and non-breeding visitor to the coastal and pelagic waters of southern Australia, where they are locally common in all months of the year. In NSW, the species is fairly common from September-May mostly in the north east of the state, with breeding birds foraging around Lord Howe Island from August to May. It is scarce at other times of the year and in the south east of the state.

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Predation by cats and foxes at breeding colonies also threatens this species.

Other threatening processes: At its breeding colonies, predation by raptors and skinks, human disturbance and destruction of nesting sites also threaten the species.

Habitat and ecology: This pelagic species occurs in subtropical waters mainly over the continental shelves and slopes and occasionally inshore. It breeds from late September to May on islands in the Australasian region and Indian Ocean, including Norfolk and Lord Howe Islands. Their diet is poorly known but probably includes fish and cephalopods. They feed mostly during the day by seizing from the surface or plunging or diving to about five metres below, often from behind fishing vessels.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to flesh-footed shearwater

Biological characteristics: The flesh-footed shearwater uses eggs requiring parental care to reproduce. Its clutch size has not been specified, but like most other species in this family it is likely to be one. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened shearwater will be assumed to be low.

Overlap and interaction with fishery: It is the OTF activities off north-east NSW that are most likely to interact with this species, mostly from September to May, and mainly in shelf and slope waters and occasionally inshore. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As the fishery predominantly harvests demersal species from deep water, it is not likely to directly reduce the natural prey availability of this species that is probably mostly composed of pelagic species as it feeds from the surface to a depth of around five metres. There are no records of interactions between this species and the OTF. The species, including foraging breeding birds, may feed on the discards from the OTF as it is known to follow fishing vessels. It may also be disturbed by noise or light emitted from the fishery. As mentioned in section B2.4, these interactions should not negatively affect the species, especially as the OTF discards are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the flesh-footed shearwater and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. The trawling off north-east NSW is most likely to interact with this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Gibson's albatross

Conservation status: The Gibson's albatross, *Diomedea gibsoni*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The Gibson's albatross breeds on three islands around New Zealand and in the subantarctic Auckland Island group. Non-breeding birds are usually found between 30° and 50°S. Males and females of this species forage in different areas, females in the Tasman Sea around 40°S and males further south or in the mid-Pacific Ocean. This species regularly occurs off the NSW coast usually between Green Cape and Newcastle. (NSW Scientific Committee, 2001c). About 6,200 pairs of this species breed annually (Environment Australia, 2001a).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003). This species could potentially be affected from predation by cats and the activity of pigs if they were introduced to its breeding islands (NSW Scientific Committee, 2001c).

Other threatening processes: This species may also suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998). Within NSW waters, the species is potentially threatened from the loss of southern cuttlefish populations, illegal longline fishing and oil spills (NSW Scientific Committee, 2001c).

Habitat and ecology: This species breeds every two years, with most eggs laid between December and January and chicks fledging the following year in January to February (Gales, 1998). One egg is laid per clutch (Environment Australia, 2001a). It feeds pelagically on squid, fish and crustaceans (Garnett and Crowley, 2003).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to Gibson's albatross

Biological characteristics: The information provided above shows that the Gibson's albatross uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. This small population only breeds on three islands. Subsequently, the resilience level of the Gibson's albatross is low.

Overlap and interaction with fishery: This species regularly occurs throughout the area of operation of the OTF, especially south of Newcastle. The fishery may interact with breeding and non-breeding individuals, only when they are foraging. Like other albatross species, this species probably mostly feeds from the surface or just below. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. It may feed on the fishery's discards, or be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not be negatively affecting the species, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality should only be infrequent, and should only have a negligible impact on the population as a whole. While this species is listed as being affected by marine debris, the OTF does not significantly contribute to this problem (see discussion under section B2.4). In all, any interactions between the Gibson's albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. It is the trawling south of Newcastle that is most likely to interact with this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Grey ternlet

Conservation status: The grey ternlet, *Procelsterna cerulea,* is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The grey ternlet occurs through much of the tropical Pacific Ocean from Australia east to Hawaii and San Felix and San Ambrosio Islands off the east coast of Chile. In

Australia, the species occurs off the east coast between the Tropic of Capricorn and Bass Strait and is occasionally beachcast during stormy weather. Individuals are usually recorded off the east coast between December and March soon after the breeding season, and it is thought that some individuals may disperse to the east coast of Australia from breeding grounds on Lord Howe and Norfolk Islands. There is no information on the population trends of this species (Garnett and Crowley, 2000).

Key Threatening Processes: None of the Key Threatening Processes listed under the EPBC Act and the TSC Act would affect this species.

Other threatening processes: Threats to the species include intensive fishing operations in feeding grounds, cyclonic weather and development of roosting and breeding islands. This species is also vulnerable to predation from rats and birds on breeding islands (Garnett and Crowley, 2000).

Habitat and ecology: The grey ternlet mainly occurs on isolated tropical or subtropical islands on which they breed and roost and their surrounding nearshore waters and is occasionally found in the pelagic zone. They produce one egg per clutch. They usually forage from the surface of the sea during the day and feed on small crustaceans, fish and squid.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to grey ternlet

Biological characteristics: The information provided above shows that the grey ternlet has a restricted range in Australian waters. There is limited population information on this species, however considering it is listed as threatened it will be assumed to be small. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the grey ternlet is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF, usually between December to March. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As the fishery predominantly harvests demersal species from deep water, it is not likely to directly reduce the natural prey availability of this surface feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The species, including foraging breeding birds, may feed on the discards from the OTF. It may also be disturbed by noise or light emitted from the fishery. As mentioned in section B2.4, these interactions should not negatively affect the species, especially as the OTF discards are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the grey ternlet and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. It is mostly the trawling activity between December-March that is most likely to interact with this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Indian yellow-nosed albatross

Conservation status: The Indian yellow-nosed albatross, *Thalassarche carteri*, is listed as vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: This species occurs over both pelagic and inshore waters between 15°S and 50°S (Environment Australia, 2001a). It breeds on five islands in the Indian Ocean and is mostly found in the southern Indian Ocean where it is particularly abundant off Western Australia (Garnett and Crowley, 2000). It is the most common albatross in the Great Australian Bight and central Bass Strait and also occurs east off Tasmania and along the east coast of the mainland as far north as Coffs Harbour (Environment Australia, 2001a). The main breeding colony of this species has reduced by about 30% since the early 1980s, with the decline continuing (Garnett and Crowley, 2000).

Key threatening processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species may also suffer from colliding with the cables and warps used on fishing trawlers (Garnett and Crowley, 2000).

Habitat and ecology: This species breeds annually over an eight month period, beginning in mid-August (Environment Australia, 2001a). Pairs travel to distant, subtropical feeding sites while rearing chicks (Environment Australia, 2001a). It feeds on fish and squid (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to Indian yellow-nosed albatross

Biological characteristics: The information provided above shows that the Indian yellow-nosed albatross uses eggs requiring parental care to reproduce, and like other albatross species, it probably has a low reproductive output producing one egg per clutch. Its breeding habitat is restricted to five islands. Its current population is much smaller than it was historically. Subsequently, the resilience level of the Indian yellow-nosed albatross is low.

Overlap and interaction with fishery: Only the OTF activities occurring south of Coffs Harbour could interact with this species. As the distribution of foraging breeding adults can be some distance away, it will be assumed that this fishery could interact with both breeding and non-breeding individuals of this species, only when they are foraging. Like other albatross species, this species probably mostly feeds from the surface or just below. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The species, like other albatross species, may feed on fishing discards, including those from the OTF. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species, especially as trawl discards are available to the species throughout the year and the various stages of its breeding cycle. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality from any trawl fishery should only be infrequent, and should only have a negligible impact on the population as a whole. In all, any interactions between the Indian yellow-nosed albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only the trawling occurring south of Coffs Harbour could interact with this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Kermadec petrel (western)

Conservation status: The Kermadec petrel (western population), *Pterodroma neglecta neglecta*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The Kermadec petrel occurs in the Pacific Ocean between 20 and 35°S, dispersing to the central North Pacific. Breeding colonies are located in the South Pacific Ocean, between 25-35°S, from off Lord Howe Island to Juan Fernandez Island. Non-breeding petrels migrate trans-equatorially, with individuals recorded as far north as 28°N in the central Pacific Ocean and 21°N in the eastern Pacific Ocean. The species is present around Kermadec Island throughout the year and is a vagrant to the east coast of Australia. Breeding birds from the small colony off Lord Howe Island can be found in the waters off eastern Australia. Only three single beachcasts of the species have been recorded from the NSW coastline at Kingscliff, Tuggerah Beach and Jervis Bay in the 1970s. The population trend of this species in Australian territory is not known. The petrel is now extinct on Lord Howe Island (Garnett and Crowley, 2000).

Key Threatening Processes: The species is threatened by predation from cats and rabbits on breeding islands and its breeding habitat is sensitive to the impacts of introduced rabbits and goats.

Other threatening processes: Harvesting activity egg collecting by humans could also threaten the species.

Habitat and ecology: This marine species is found in tropical and subtropical waters. It breeds during either summer-autumn or spring-summer. Breeding locations include Ball’s Pyramid off Lord Howe Island and Phillip Island near Norfolk Island. It produces one egg per clutch. Very little is known about its diet, it probably feeds on squid and crustaceans. It forages far from its breeding islands and feeds on or just below the water’s surface by seizing or dipping.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to Kermadec petrel

Biological characteristics: The information provided above shows that the Kermadec petrel has a restricted geographic range in Australian waters. There is limited population information on this species, however considering it is listed as threatened it will be assumed to be small. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the Kermadec petrel is low.

Overlap and interaction with fishery: Only the OTF activities north of around Jervis Bay could potentially interact with this species. The fishery is only likely to encounter a small number of individuals of this species, either breeding birds from the small colony on Lord Howe Island or vagrant individuals. It could only interact with this species when it is foraging. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this surface feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. While this petrel species is not known to feed on fishing discards it may, like other petrels, feed on fishing discards including those from the OTF. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle. Any mortality resulting from the collision with or entanglement in the OTF trawl gear is likely to be rare, especially considering the small numbers of this species off NSW, and should only have a negligible impact on the population as a whole. In all, any interactions between the Kermadec petrel and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only a small number of this species are found off NSW, only north of Jervis Bay. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Little shearwater

Conservation status: The little shearwater, *Puffinus assimilis*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The little shearwater has a circumpolar distribution across the Atlantic, Pacific and southern Indian Oceans, generally north of the Antarctic Convergence and reaching 40^{o}N in the northern hemisphere. As the species tends to remain in seas near breeding colonies throughout the year, it is reasonably common in seas off southwest and southeast Australia, Kermadec Island and far southeast New Zealand and less common elsewhere in the Australasian region. In the Australian region the species breeds on subtropical and subantarctic islands off south western Australia and New Zealand, including near Lord Howe and Norfolk Islands. In NSW, the little shearwater has been recorded along the coast and in breeding colonies on islands off Lord Howe Island and near Norfolk Island (NSW NPWS, 1999c). The breeding distribution of this species in the Tasman Sea has declined, it is now extinct from both Lord Howe and Norfolk Islands, both once breeding localities for this species (Garnett and Crowley, 2000).

Key Threatening Processes: None of the Key Threatening Processes listed under the EPBC Act and the TSC Act currently affect this species.

Other threatening processes: Disturbances on breeding islands by visitors and human habitation and the accidental introduction of feral animals, such as rats, cats and dogs to existing breeding refuges threaten the species. The species is also vulnerable to the loss of nesting habitat from development and erosion.

Habitat and ecology: This pelagic species frequently occurs on continental shelf waters in subantarctic, subtropical and occasionally tropical seas. It produces one egg per clutch. It forages far out to sea and feeds on cephalopods, krill and small fish both from the surface and by plunge diving.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to little shearwater

Biological characteristics: The little shearwater uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened shearwater will be assumed to be low.

Overlap and interaction with fishery: This species is reasonably common throughout the area of operation of the OTF. While the species will tend to remain near its breeding colonies around Lord Howe and Norfolk Islands throughout the year, the fishery could still interact with both breeding and non-breeding individuals, only when they are foraging. This species can feed from the surface and by diving to unknown depths. The maximum depths this species can dive to may be quite deep, as some shearwaters, for example the sooty shearwaters, can dive to depths of 70m (Commonwealth of Australia, 2003). Thus, in comparison to other seabird species, this species may feed from a greater area of the water column and its natural prey may include deeper species that may be more likely to be harvested by this demersal trawl fishery. Subsequently, potential for the harvesting activities of the

OTF to reduce the natural prey availability of this species may be greater than that for the other threatened seabirds. There are no records of interactions between this species and the OTF. Like other shearwaters, this species, including foraging breeding birds, may feed on the discards from the OTF as it is known to follow fishing vessels. It may also be disturbed by noise or light emitted from the fishery. As mentioned in section B2.4, these interactions should not negatively affect the species, especially as the OTF discards are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the little shearwater and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Northern giant-petrel

Conservation status: The northern giant-petrel, *Macronectes halli*, is listed as vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: The northern giant-petrel is found over the southern oceans generally north of the Antarctic convergence between 30 and 64^{o}S. In summer, the species is usually found south of 40-45^{o}S. Breeding occurs on subantarctic islands, including Macquarie Island in summer. Juveniles disperse widely and adults are present at colonies and adjacent seas throughout winter. It is a regular winter visitor to Australian waters, and occurs offshore in southern waters from Fraser Island in the east to Shark Bay in the west (Environment Australia, 1998a). The population of this species on nearly all of its breeding islands, including Macquarie Island, has increased, while a decrease in this population at sea has been observed (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003). Predation by cats at breeding islands also affects this species (Garnett and Crowley, 2000).

Other threatening processes: This species is threatened from predation by rats and skuas on breeding islands and the accumulation of chemical contaminants (Garnett and Crowley, 2000).

Habitat and ecology: This species occurs mainly in subantarctic, Antarctic and also subtropical waters in winter-spring. Predominantly pelagic, it can also occur on inshore waters. Breeding pairs raise a single chick, and each year only around 70% of the population breed (Voisin, 1988). The species begins breeding at 9-11 years of age (Voisin, 1988). They are an opportunistic scavenger and predator, and commonly follow ships. Males generally feed on the carcasses of penguins, seals and cetaceans, while females obtain live prey at sea including cephalopods, small seabirds and fish. They feed on or near the surface of the sea and dive to depths of 2 m.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to northern giant-petrel

Biological characteristics: The information provided above shows that the northern giant-petrel first breeds at 9-11 years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Considering this species is listed as threatened, its population can be assumed to be small. Subsequently, the resilience level of the northern giant-petrel is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF, over both pelagic and inshore waters, mostly during winter. As breeding birds tend to remain near their distant breeding colonies throughout the year, the fishery is not likely to have a significant impact upon this species' breeding success as it is only likely to encounter immature individuals. The fishery could only interact with this species when it is foraging. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this surface and shallow diving feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. This species is known to follow ships for food and it may be feeding on the OTF discards. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the northern giant-petrel and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Of all the interactions that may occur between this species and the OTF, the one that could negatively affect the species has a very low chance of occurring.

Providence petrel

Conservation status: The providence petrel, *Pterodroma solandri*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The species is mainly subtropical in the southwest Pacific Ocean, including the Tasman Sea, however some birds migrate to the north Pacific and Bering Seas. The species can be observed in moderate numbers in the waters off the eastern Australian coast between Fraser Island and southeast Tasmania during its breeding season, from March to November. It may also be observed in this area during December to February, although it is generally rare or absent. In NSW, the species occurs along the entire coast, however, it has been recorded most often off the north coast. The species currently breeds at only two locations, Lord Howe Island and Phillip Island (near Norfolk Island). It also historically bred on Norfolk Island.

Key Threatening Processes: The species is threatened from predation by cats and it may be sensitive to the impact of feral pigs and goats.

Other threatening processes: None.

Habitat and ecology: This pelagic species occurs on subtropical and tropical waters of the south-west Pacific and in colder waters in the North Pacific. Breeding occurs during winter in burrows or rock crevices. It produces one egg per clutch. It feeds on fish, cephalopods, crustaceans and offal, and favoured feeding grounds are located within the Tasman Sea and along the edge of the continental shelf off the east coast of Australia. Like other members of the gadfly family, this species probably feeds from the water's surface. It has been observed feeding at night and near fishing boats.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to providence petrel

Biological characteristics: The information provided above shows that the providence petrel has a restricted geographic range in Australian waters. It is restricted to breeding on two islands. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the providence petrel is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF, mostly off the northern NSW coast, mostly from March to November. The fishery is likely to interact with breeding individuals from nearby colonies and perhaps also non-breeding individuals, only when they are foraging. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this surface feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. As this species is known to feed near fishing vessels, it may be feeding on the OTF discards. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species, especially as the discards are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the providence petrel and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. It is the trawling activities occurring off northern NSW from March-November that are most likely to interact with this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Red-tailed tropicbird

Conservation status: The red-tailed tropicbird, *Phaethon rubicauda*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The red-tailed tropicbird occurs in the tropical parts of the Indian and Pacific Oceans between 40°N and 40°S. It nests on numerous islands throughout its range, including Norfolk and Lord Howe Islands off NSW. In Australia, the species is found between November-March along the western and northern coasts and in the Coral Sea area, with scattered records along the east and south coasts to around Yorke Peninsula (SA). In NSW, the species has been recorded along the whole coast as far south as Montague Island and occasionally inland.

Key Threatening Processes: Predation by cats on breeding islands threatens this species.

Other threatening processes: Predation by rats, dogs and other birds, human interference (including harvesting outside of the Australian Territory), urban development and mining activity on breeding islands affect this species. On Christmas Island the yellow crazy ant also threatens this species.

Habitat and ecology: This pelagic, tropical and subtropical species breeds on islands between October and April. It produces one egg per clutch. When foraging it ventures hundreds of kilometres away from breeding sites. It mostly feeds on fish and cephalopods by deep plunging vertically into the water from a height of 6-10 m. When diving, they remain underwater for an average of 26.6 seconds. They follow ships from the air at an average height of around 40 m.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to red-tailed tropicbird

Biological characteristics: The red-tailed tropicbird uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened shearwater will be assumed to be low.

Overlap and interaction with fishery: It is the OTF activities that occur north of Montague Island that could potentially encounter scattered numbers of this species. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. This species feeds by diving to unknown depths. The maximum depths this species can dive to are not known, but it can remain underwater for an average of 26.6 seconds. In comparison to surface feeding seabirds, this species may feed from a greater area of the water column and its natural prey may include deeper species that may be more likely to be harvested by this demersal trawl fishery. Subsequently, potential for the harvesting activities of the OTF to reduce the natural prey availability of this species may be greater than that for the other threatened seabirds. There are no records of interactions between this species and the OTF. The discards from the OTF may be providing a food source for this species that is known to follow ships. It may also be disturbed by noise or light emitted from the fishery. As mentioned in section B2.4, these interactions should not negatively affect the species, especially as the OTF discards are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the red-tailed tropicbird and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only trawling activities north of Montague Island could encounter scattered individuals of this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring..

Salvin's albatross

Conservation status: The Salvin's albatross, *Thalassarche salvini*, is listed as vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: This species breeds on three islands south of New Zealand and one island in the Indian Ocean (Garnett and Crowley, 2000). It forages over most of the southern Pacific Ocean, especially off South America, in the Indian Ocean (in small numbers) and sometimes in the South Atlantic Ocean (Garnett and Crowley, 2000). It is abundant throughout the year on all continental shelf areas around New Zealand and roams widely in winter (Environment Australia, 2001a). Small numbers of non-breeding adults regularly fly across to south-east Australian waters (Environment Australia, 2001a).

Key threatening processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species may also suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998).

Habitat and ecology: This species breeds annually, eggs are laid in October and chicks fledge in March-April (Environment Australia, 2001a). Breeding adults forage over shelf waters around colonies (Environment Australia, 2001a). They probably feed on fish and squid and commonly follow fishing boats (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to Salvin's albatross

Biological characteristics: The information provided above shows that the Salvin's albatross uses eggs requiring parental care to reproduce, and like other albatross species, it probably has a low reproductive output producing one egg per clutch. Its breeding habitat is restricted to four islands. As it is listed as a threatened species, its population is assumed to be small. Subsequently, the resilience level of the Salvin's albatross is low.

Overlap and interaction with fishery: As the distribution of this species in the Tasman Sea is poorly known, it will be assumed that all of the OTF trawling off NSW could interact with this species. The fishery is not likely to impact upon breeding individuals of this species as they tend to forage in waters some distance from the OTF. Like other albatross species, this species probably mostly feeds from the surface or just below. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. As this species is known to follow fishing vessels presumably to feed, it may also feed on the discards from this fishery. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality from any trawl fishery should only be infrequent, and should only have a negligible impact on the population as a whole. In all, any interactions between the Salvin's albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low – Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Shy albatross

Conservation status: The shy albatross, *Thalassarche cauta,* is listed as vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The shy albatross is endemic to Australia (Environment Australia, 2001a). Information on its at-sea distribution is confounded by its recent separation from other closely related taxa. It appears to occur in Australian waters below 25°S from south-west Western Australia to Queensland, mostly around Tasmania and south-eastern Australia, where it can be found year round (Environment Australia, 2001a). Although uncommon north of Sydney, the species is commonly recorded off south-east NSW, particularly between July and November. Some juvenile and immature individuals can be found in most sub-Antarctic to subtropical waters and have also been recorded in the northern hemisphere (Environment Australia, 2001a). It breeds on three islands in Australian territory (Environment Australia, 2001a). The population of this species was greatly reduced in the late 18th Century, and it has been increasing through the 20th Century (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species is shot off Tasmania to reduce bait stealing and for bait and food in South African waters (Garnett and Crowley, 2000). Trawl fisheries could also threaten the species if collides with cables or gets trapped in nets (Garnett and Crowley, 2000). Disturbance by introduced predators at breeding colonies, pollution from plastics, oils and chemicals and avian pox virus also threaten the species (Garnett and Crowley, 2000; NSW NPWS, 1999d). Commercial overexploitation of food reserves near breeding colonies in Bass Strait could threaten this species in the future (Gales, 1998).

Habitat and ecology: Found mainly in subantarctic and subtropical waters, this species feeds over continental shelf waters, including in bays and harbours. Adults seldom venture more than 600 km from their breeding colonies (Environment Australia, 2001a). It breeds annually between September and December. It first breeds at five to six years of age. One egg is produced per clutch. It feeds on fish, squid, crustaceans and offal using a variety of techniques, including seizing prey from the surface, diving and scavenging behind fishing vessels.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to shy albatross

Biological characteristics: The information provided above shows that the shy albatross first breeds at five to six years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. The breeding activity of this species is restricted to only three islands. Subsequently, the resilience level of the shy albatross is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF, in shelf and inshore waters, mostly off southeast NSW and uncommonly north of Sydney, especially between July and November. As breeding birds tend to remain near their distant breeding colonies throughout the year, the fishery is not likely to have a significant impact upon this species' breeding success as it is only likely to encounter juvenile and immature individuals. The fishery could only interact with this species when it is foraging. As this species feeds from the surface and by plunge diving to depths of about 3m, its natural prey is probably composed of pelagic species. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this species. There are no records of interactions between this species and the OTF. The discards from the OTF may be providing a food source for this species that is known to feed on fishing discards. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality from any trawl fishery should only be infrequent, and seems to be having have a negligible impact on the population as a whole as the population of this species has been increasing. In all, any interactions between the shy albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. It is the trawling activities south of Sydney between July and November that are most likely to encounter this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring..

Sooty albatross

Conservation status: The sooty albatross, *Phoebetria fusca*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: This species breeds on islands in the southern Indian and Atlantic Oceans and forages south of 30°S, between southern NSW and Argentina. The species has not been recorded in the Pacific Ocean. In Australian waters the sooty albatross occurs off the south coast from Tasmania to Western Australia. Occasionally, the species is recorded off the NSW coast, north to Grafton (NSW NPWS, 1999e). Individuals are generally recorded in Australian waters in winter (NSW NPWS, 1999e). A decrease of 50% in the population size of one breeding site has been recorded, but not at the other sites (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species may also suffer from colliding with the warps and cables used on fishing trawlers (Garnett and Crowley, 2000). Disturbance on breeding islands from frequent fires and predation by rats and pollution from plastics, oils and chemicals also threaten the species (NSW NPWS, 1999e).

Habitat and ecology: This pelagic species inhabits subantarctic and subtropical marine waters, and is occasionally observed over inshore waters. It breeds every two years on small, isolated, subantarctic islands between August and December. The species first breeds at 12 years of age, on average (Environment Australia, 2001a). One egg is laid per clutch. The species feeds on fish, crustaceans, offal and squid by seizing prey from the surface while swimming or by landing on top of prey. It possibly feeds at night and may follow fishing vessels for short periods.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to sooty albatross

Biological characteristics: The information provided above shows that the sooty albatross first breeds at an average of 12 years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Considering this species is listed as threatened, its population is assumed to be small. Subsequently, the resilience level of the sooty albatross is low.

Overlap and interaction with fishery: This species may occasionally be found off the NSW coast as far north as off Grafton, generally during winter. Considering this species' breeding islands are some distance away, and the species generally occurs off NSW during the non-breeding season, it will be assumed that the OTF will be only likely to encounter juvenile or immature individuals. The fishery could only interact with this species when it is foraging. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this surface feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The discards from the OTF may be providing a food source for this species that is known to follow vessels for food. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality from any trawl fishery should only be infrequent, and should only have a negligible impact on the population as a whole. In all, any interactions between the sooty albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only the trawling activities south of Grafton are most likely to encounter this species. Of all the interactions that may occur between this species and the OTF, the one that could negatively affect the species has a very low chance of occurring.

Sooty tern

Conservation status: The sooty tern, *Sterna fuscata*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The sooty tern is found within the tropical and subtropical waters and islands of the Indian, Pacific and Atlantic Oceans. In Australia, individuals are widespread in the tropics and occasional sightings occur along the west and east coasts, from Perth in Western Australia to Bermagui on the south coast of NSW, although in NSW they are more common off the north coast. There are breeding colonies of this species on Lord Howe and Norfolk Islands and their offshore islets.

Key Threatening Processes: Predation by cats on breeding islands threatens this species (NSW NPWS, 1999f)

Other threatening processes: Threats to the species include disturbance to breeding colonies, egg collecting, ticks and predation of eggs and chicks by rats and other birds, particularly silver gulls (NSW NPWS, 1999f).

Habitat and ecology: This species occurs in offshore and pelagic zones and is almost never found inshore. Usually one and occasionally two eggs are laid per clutch. They are active during day and night, mainly feeding on fish, squid, crustaceans and hydrozoans taken from or just below the water's surface and occasionally by diving through the crests of waves. Food may also be scavenged from the aerial pursuits of other birds and by hawking for cicadas over forests.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to sooty tern

Biological characteristics: The sooty tern uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg and occasionally two eggs per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened tern will be assumed to be low.

Overlap and interaction with fishery: As the sooty tern is almost never found in inshore waters and is more common off northern NSW, it is the OTF activities north of Barrenjoey Headland that work further offshore that are more likely to potentially interact with this species. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As the fishery predominantly harvests demersal species from deep water, it is not likely to directly reduce the natural prey availability of this surface feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The species, including foraging breeding birds, may feed on the discards from the OTF. It may also be disturbed by noise or light emitted from the fishery. As mentioned in section B2.4, these interactions should not negatively affect the species, especially as the OTF discards are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the sooty tern and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only the trawling activities north of Barrenjoey Headland are most likely to encounter this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Southern royal albatross

Conservation status: The southern royal albatross, *Diomedea epomophora*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: This species is found across the Southern Oceans, from 36°S to 55°S (Environment Australia, 2001a). It breeds on four islands around New Zealand (Gales, 1998). It is found off southern Australia at all times of the year, especially between July and October, from Byron Bay to south-western Western Australia (Environment Australia, 2001a). In NSW, the species has mostly been recorded around the central coast from Coffs Harbour to Bellambi (Pizzey and Doyle, 1985). There are around 13,000 breeding pairs of this species, and 50,000 individuals in total (Environment Australia, 2001a).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: The species may also suffer from colliding with the warps and cables used on fishing trawlers (Gales, 1998).

Habitat and ecology: Around Australia, this species has mostly been recorded over the continental slope areas (Environment Australia, 2001a). The species breeds every two years and lays its eggs in November-December and chicks fledge October-November (Gales, 1998). It begins to breed at nine years of age (Environment Australia, 1998a). One egg is produced per clutch (Environment Australia, 1998a). It feeds pelagically, primarily on squid and fish (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to southern royal albatross

Biological characteristics: The information provided above shows that the southern royal albatross first breeds at nine years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Its breeding habitat is restricted to four islands. Subsequently, the resilience level of the southern royal albatross is low.

Overlap and interaction with fishery: OTF activities south of Byron Bay could potentially interact with this species, especially between July to October. As the species has mostly been recorded over Australia's continental slope, it is the OTF activities between Byron Bay and Barrenjoey Headland operating over this habitat, that are most likely to encounter this species. As the foraging distance of breeding individuals of this species is not known, it will be assumed that the fishery could interact with both breeding and non-breeding individuals. As the larger albatrosses are generally surface feeders (Commonwealth of Australia, 2003), their natural prey is probably composed of pelagic species. As the fishery predominantly harvests demersal species it is not likely to directly reduce the natural prey availability of this species. There are no records of interactions between this species and the OTF. The species, like other albatross species, may feed on fishing discards, including those from the OTF. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species, especially as the discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality from any trawl fishery should only be infrequent, and should only have a negligible impact on the population as a whole. While this species is listed as being affected by marine debris, the OTF does not significantly contribute to this problem. In all, any interactions between the southern royal albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only the trawling activities between Byron Bay and Barrenjoey Headland could encounter this species, especially between July to October. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

White tern

Conservation status: The white tern, *Gygis alba*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The white tern occurs transglobally throughout tropical and sub-tropical oceans. It breeds on numerous islands across the Indian and south-west Pacific Oceans, including Norfolk and Lord Howe Islands. Individuals may occasionally visit the east coast of Australia between Cape York Peninsula and Sydney and generally only come ashore as a result of stormy weather. Within NSW, they are regularly recorded off the coast at Ballina and occasionally off Sydney and Wollongong. They are present on Lord Howe Island from September to June, dispersing when the winter gale arrives.

Key Threatening Processes: Predation by cats on breeding islands threatens this species.

Other threatening processes: Threats to the species include stochastic events impacting upon small colonies, strong winds dislodging their eggs that are laid singly on horizontal branches, predation by kestrels, owls and currawongs, and the introduced black ant.

Habitat and ecology: The white tern is found on isolated tropical islands and their nearshore waters. They are also recorded in the pelagic zone, especially off Australia. The species feeds both inshore and offshore from the surface of the water on fish, squid and less frequently crustaceans and insects. Dawn and dusk are probably important feeding times for the species.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to white tern

Biological characteristics: The white tern uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened tern will be assumed to be low.

Overlap and interaction with fishery: It is the OTF activities north of Sydney, especially those off the state's far north, which could potentially interact with this species. The fishery could only interact with this species when it is foraging, and while it is not known if breeding birds on nearby Lord Howe and Norfolk Islands forage off NSW, it will be assumed that the fishery could encounter both breeding and non-breeding birds. As the fishery predominantly harvests demersal species from deep water, it is not likely to directly reduce the natural prey availability of this surface feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The species, including foraging breeding birds, may feed on the discards from the OTF. It may also be disturbed by noise or light emitted from the fishery. As mentioned in section B2.4, these interactions should not negatively affect the species, especially as the OTF discards are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the white tern and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only the trawling activities north of Sydney could encounter this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

White-bellied storm petrel

Conservation status: The white-bellied storm petrel, *Fregatta grallaria grallaria*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The distribution of the white-bellied storm petrel is poorly understood. The species is found in the subtropical and highly saline tropical Pacific, Atlantic and Indian Oceans, to 42^{o}S. It breeds on islands and stacks close to the Subtropical Convergence in the southern Atlantic and Pacific Oceans, including the Lord Howe Island group. This is the only area where the species breeds around Australia. In Australia, the species is thought to occur in the Tasman and Coral Seas between May-October. The continental margin of north and central NSW may be a favoured feeding area of Lord Howe Island breeding birds. In NSW, the species has been recorded on continental shelf waters between Wolli and Nambucca Heads, off Coffs Harbour and off Wollongong. The species has been extinct from Lord Howe Islands since 1913, but continues to breed on nearby islands (Garnett and Crowley, 2000).

Key Threatening Processes: Predation by cats on breeding islands threatens this species (NSW NPWS, 1999g).

Other threatening processes: It is also vulnerable to the accidental introduction of rats to their breeding colonies (Garnett and Crowley, 2000).

Habitat and ecology: This pelagic species breeds from December to February and migrates to the tropics during the non-breeding season. It produces one egg per clutch. During the non-breeding season it is found near the edge of Australia's continental shelf 10 km to 25 km offshore. It feeds on cephalopods and crustaceans from or just below the surface, by dipping.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to white-bellied storm petrel

Biological characteristics: The white-bellied storm petrel uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. It has a restricted geographic range in Australia. This species' longevity and age at maturity is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened tern will be assumed to be low.

Overlap and interaction with fishery: It is the OTF activities north of Wollongong, especially those occurring over the continental margins, which are most likely to potentially interact with this species. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As the fishery predominantly harvests demersal species from deep water, it is not likely to directly reduce the natural prey availability of this surface feeding species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The species, including foraging breeding birds, may feed on the discards from the OTF. It may also be disturbed by noise or light emitted from the fishery. As mentioned in section B2.4, these interactions should not negatively affect the species, especially as the OTF discards are available to the species throughout the year and the various stages of its breeding cycle. Considering that any mortality from the collision with or entanglement in trawl gear is likely to be rare (see discussion under section B2.4), and that this interaction is not listed as a threat to this species, such interactions with the OTF should only have a negligible impact on the species as a whole. In all, any interactions between the white-bellied storm-petrel and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Only the trawling activities north of Wollongong, especially those occurring over the continental margins could encounter this species. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

White-capped albatross

Conservation status: The white-capped albatross, *Thalassarche steadi*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: The white-capped albatross breeds on five islands in the Auckland and Antipodes Island groups off New Zealand and is generally forages in nearby waters (Gales, 1998). Adults are found in New Zealand and south-east Australian waters throughout the year whilst immatures commonly occur off south-east Australia and South Africa (Environment Australia, 2001a). In Australia, the species is especially found in waters around Tasmania (Environment Australia, 1998a). There is little information on the occurrence of this species in waters off NSW.

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Predation of chicks by pigs on one of its breeding islands also threatens this species (Croxall and Gales, 1998).

Other threatening processes: The species can be affected by colliding with the cables and warps used on fishing trawlers (Gales, 1998).

Habitat and ecology: The species breeds annually, egg laying starts mid November and young fledglings leave their nests in mid August (Gales, 1998). Off Australia, it is found in offshore pelagic waters (Garnett and Crowley, 2000). The diet of this species has never been studied, but it is probably composed of squid and fish (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001a).

Assessment of risk to white-capped albatross

Biological characteristics: The information provided above shows that the white-capped albatross uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Its geographic range seems somewhat restricted and its breeding habitat is restricted to five islands. Subsequently, the resilience level of the white-capped albatross is low.

Overlap and interaction with fishery: While the distribution of this species off NSW is poorly known, it will be assumed that all OTF activities occurring in offshore waters could potentially interact with this species. The fishery could interact with both adult and immature individuals, only when they are foraging. Like other albatross species, this species is probably mostly feeds from the surface or just below. As the fishery predominantly harvests demersal species, it is not likely to directly reduce the natural prey availability of this species, which is probably composed of pelagic species. There are no records of interactions between this species and the OTF. The species, like other albatross species, may feed on fishing discards, including those from the OTF. It may also be disturbed by noise or light emitted from the fishery, however as mentioned in section B2.4, such interactions would not negatively affect the species, especially as trawl discards are available to the species throughout the year and the various stages of its breeding cycle. Mortality resulting from the collision with or entanglement in trawl gear is listed as a threat to this species, however as discussed in section B2.4, such mortality from any trawl fishery should only be infrequent, and should only have a negligible impact on the population as a whole. In all, any interactions between the white-capped albatross and the OTF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Mammals

Unless otherwise specifically referenced, the following information on fur-seals was obtained from *The Action Plan for Australian Seals* (Shaughnessy, 1999) and that on whales from *The Action Plan for Australian Cetaceans* (Bannister *et al.,* 1996).

Australian fur-seal (*Arctocephalus pusillus*)

Conservation status: The Australian fur-seal, *Arctocephalus pusillus*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The Australian fur-seal breeds on five Bass Strait islands, and a small breeding colony is becoming established at Wright Rock. Their range extends to South Australia, south Tasmania and New South Wales and several haul-out sites are known in each state. The species once bred more widely with breeding colonies at Seal Rocks in NSW and southern Tasmania. In NSW, Montague Island is the main site for the species. The species hauls-out on the northern side of the island, throughout the year, but mostly during winter (July to October) when the highest numbers are found (Shaughnessy *et al.*, 2001). A maximum of 540 Australian fur-seals were recorded on Montague Island in October 1998 (Shaughnessy *et al.*, 2001). Although it is generally thought that only male fur-seals haul-out on Montague Island, there are indications that the island is also used by female fur-seals (Shaughnessy *et al.*, 2001). The colonies of Australian fur-seals on the island are non-breeding, although there are records of odd unsuccessful breeding events, the vicinity lacks important features of other breeding colonies, and any fur-seal pups born on the island would probably not survive the weaning period (Shaughnessy *et al.*, 2001). Steamers Beach and Green Cape are other sites in NSW where Australian fur-seals regularly haul-out. Seals also come ashore irregularly at other sites all along the coast from Nadgee Nature Reserve to Tweed Heads. This occurs throughout the year, but most frequently between July and November (Smith, 2001).

The Australian fur-seal population was dramatically reduced from commercial sealing activities. In 1991, the total population size for Australian waters was estimated at between 47,000 and 60,000, with pup production estimated at 13,335. Despite some recent increases, the overall population level in Australia is likely to be much lower now than it was historically.

Key Threatening Processes: The entanglement in and ingestion of plastic debris is a threat to this species (NSW Scientific Committee, 2002c).

Other threatening processes: The species is threatened by reduced prey item availability from fishing operations, illegal shooting of seals that compete with fishing activities and entanglement in fishing gear debris (NSW Scientific Committee, 2002c).

Habitat and ecology: Australian fur-seals prefer rocky parts of islands with flat, open terrain. At sea, they remain mainly within continental shelf waters (Smith, 2001). On average, females reach a maximum length of 157 cm and males 216 cm. The maximum age for females is >21 years and males >19 years. After females reach sexual maturity at three to six years (males reach sexual maturity at around five years) they breed annually between October to December, producing a single pup after an eight to nine month gestation period. They principally feed on fish and cephalopods, and also seabirds. In Tasmanian waters, they predominantly feed on adult fish, such as redbait, leatherjackets and jack mackerel, in winter and adult squid, primarily Gould's squid, in summer. Australian fur-seals also feed at fishing boats.

Recovery plans: A recovery plan for the Australian fur-seal has not been prepared.

Assessment of risk to Australian fur-seal

Biological characteristics: The information provided above shows that the Australian fur-seal is long lived, reaches sexual maturity at three to six years and produces a single calf that, like all other mammals, requires some parental care. Its breeding habitat is restricted. Although its Australian population is increasing, it is much smaller than it was historically. Subsequently, the resilience level of the Australian fur-seal is low.

Overlap and interaction with fishery: The Australian fur seal is likely to interact with the Ocean Trawl fishery. Potential interactions include capture or contact with fishing gear, entanglement in lost fishing gear or discarded material, competition and illegal shooting by fishers. There is little information on competition with the fishery, or on the impacts of discarding on seal populations. Seals are attracted to fishing vessels and will follow vessels while they are fishing, feeding on fish that pass through the net. There are few published records of seals being caught in trawling operations, however, there are many anecdotal reports of capture. Observer studies in 1993-97 found that two of 897 (0.22%) commercial trawl shots off Ulladulla and 27 of 1109 (2.43%) of commercial shots off Eden caught seals (species were not recorded). These figures are relatively small compared to some other areas, but they are nevertheless cause for concern. The mortality rates of these captures are not known. Rates of entanglement in debris, including fishing gear, for this species are high in Tasmania and Victoria, and in NSW, Shaughnessy *et al.* (2001) reported seven Australian fur-seal pups around Montague Island with human debris around their necks, including rope, strap and trawl net portions. Illegal shooting by fishers occurs, but there is no information on mortality rates.

Risk: Low-medium. Despite the sources of mortality described above, the population of Australian fur seals is increasing slowly. It is not known whether these sources of mortality would prevent full recovery of the population to pre-harvest levels, therefore ongoing collection of information on interactions of the fishery with seals is needed. Should evidence of impediment to recovery become apparent, measures to reduce the mortality of seals in trawl nets (such as the development of seal exclusion devices) might be needed.

Humpback whale (*Megaptera novaeangliae*)

Conservation status: The humpback whale, *Megaptera novaeangliae*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: Humpback whales occur throughout the world's oceans. Northern and southern hemisphere populations are distinct, because of seasonal migration separation. Humpback whales are found off coastal Australia in winter and spring and are recorded from all states, except the Northern Territory. They migrate annually between warm water breeding grounds in winter, at around 15-20^{o}S, to cold water (Antarctic) feeding grounds in summer, to 60-70^{o}S. Off Australia, wintering animals off the west coast (Group IV population) are shown to be distinct from those off the east coast (Group V population). The latter is more closely related to those wintering off Tonga. Humpback whales may occur close to the coast on migration. Not all animals migrate south each year, there are some summer sightings in the Coral Sea. There is a reported sex ratio bias towards males in the east coast migration, perhaps not all females migrate north each year.

Humpback whales are regularly sighted in NSW waters when migrating (Smith, 2001). They generally pass close to the coast (rarely venturing >10 km from shore) (Bryden, 1985), mainly between June and November on their northward migration (peaking in June-July) and September and November on the southward migration (Smith, 2001).

The humpback whale population has been greatly reduced by historical whaling activities that ceased in 1963. Recent estimates of the population migrating along the east coast (Group IV) were between 3,000-4,000 and that along the west coast (Group V) were between 14,000-19,000. Australian populations of the species are increasing at a rate of around 10% per year.

Key Threatening Processes: Ingestion of or entanglement in harmful marine debris affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: Humpback whales are more likely to be directly disturbed when they are closer to human activities on their migration and in breeding areas. Whale watching, research and pleasure vessels, aircraft, swimmers, divers, coastal seismic activity, defence operations, collision with large vessels, entanglement in fishing gear or shark nets, and pollution leading to the accumulation of toxic substances in body tissues can all directly disturb humpback whales.

Habitat and ecology: Humpback whales are pelagic and are found in Antarctic waters during summer and temperate-subtropical / tropical coastal waters in winter. Key localities for the east coast population are the south coast of New South Wales, off Coffs Harbour, Cape Byron, Stadbroke Island, Hervey Bay, and islands in the Great Barrier Reef, especially the Whitsunday passage area. The exact location of breeding grounds is unknown, although much breeding of the east coast population occurs in central Great Barrier Reef area. However, there is probably a wide range of opportunity for breeding, over several degrees of latitude on each coast. There is evidence that some animals calve in northern NSW waters when migrating north (Smith, 2001). They live to a maximum of 50 years and reach a maximum length of 18 m. Males reach sexual maturity at 11.6 m and females at 13.7 m (4-10 years of age). They calve every two to three years, sometimes twice every three years, or even annually. They calve in tropical coastal waters between June-October after an 11 – 11.5 month gestation period, producing a single calf. Mating occurs between June-October. Feeding areas are concentrated in Antarctic waters, where they almost exclusively feed on Antarctic krill. There is some evidence of them feeding on fish and plankton swarms in warmer waters, for example off Eden in

NSW. Feeding behaviour off Eden has been repeatedly observed in recent years during the southward migration (Warneke, 1996). Only negligible amounts of food are taken while in NSW waters (Chittleborough, 1965). Feeding in subtropics off north-west Western Australia and eastern Australia is uncertain, however it is unlikely. The species exhibits both shallow and deep diving behaviour, and can dive for up to 15 minutes.

Recovery plans: A recovery plan for the humpback whale has not been prepared.

Assessment of risk to humpback whale

Biological characteristics: The information provided above shows that the humpback whale is long lived, reaches sexual maturity after 4-10 years and produces a single calf every 1 to 3 years, which like all other mammals, requires some parental care. Its population is much smaller than it was historically. Therefore, the resilience level of the humpback whale is considered t be low.

Overlap and interaction with fishery: Key areas for the species in NSW are the south coast of New South Wales, off Coffs Harbour and Cape Byron. In addition, the entire coast constitutes a migration route for the species, and the species may approach close to the coast during migration. Given this information, interactions with fishing vessels operating in the OTF are likely to occur. Risks from fishing include noise, entanglement and collision with vessels. Fertl and Leatherwood (1997) cite a report of two humpback whales feeding behind trawl nets in, however in NSW, the species consumes negligible amounts of food (Chittleborough, 1965), generally feeding in high latitudes and fasting during migration and calving. There is one record of two humpback whales caught in a trawl net in the northwest Atlantic (Fertl and Leatherwood, 1997), however this was most likely a mid-water trawling operation, which are faster, use larger nets and target depths and habitats that are more likely to contain cetaceans compared to the demersal trawls used in the Ocean Trawl fishery. Humpback whales may respond to noise from approaching vessels by reducing the proportion of time at the surface, diving for longer, changing direction and moving away. Responses have been measured as far away as several kilometres. Despite these short-term reactions, humpback whales are known to return to areas that experience heavy boat traffic. They seem less responsive to disturbance when feeding than when resting at the surface. The long-term effects of vessel noise on humpback whales are unknown (Richardson *et al.,* 1995).

Risk: Low-medium. Given the small probability of negative interactions with the fishery, the risk to the humpback whale is considered to be low.

New Zealand fur-seal (*Arctocephalus forsteri*)

Conservation status: The New Zealand fur-seal, *Arctocephalus forsteri*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: In Australia, New Zealand fur-seals breed in southern Australia on the south coasts of Western Australia, South Australia and on Maatsuyker Island (Tasmania). They have recently been reported breeding on a couple of islands in north-eastern Bass Strait (Arnould *et al.,* 2000). They also breed in New Zealand and Macquarie Island. There are >30 breeding populations in Australian waters. Non-breeding New Zealand fur-seals are occasionally reported from the west coast of Western Australia, Victoria, Bass Strait, New South Wales (mainly Montague Island), Queensland (south of Fraser Island) and New Caledonia. Montague Island is the only known regular haul-out site for New Zealand fur-seals in NSW. Here the species hauls-out on the northern side of the island, where the highest numbers occur between July to October (Shaughnessy *et al.*, 2001). Although considered a non-breeding colony a New Zealand fur-seal pup was born on Montague Island over the summer of 1999/2000, and survived for at least four months (Shaughnessy *et al.,* 2001). It is suspected that both male and female fur-seals haul-out on the island (Shaughnessy *et al.*, 2001).

Outside of Montague Island, there are scattered records of New Zealand fur-seals hauling-out along the NSW coast north to Yamba (Smith, 2001). They generally do not stay at such locations for extended periods (Smith, 2001). Animals on the east coast of Australia may have moved there from New Zealand or from South Australia. Seals tagged at Kangaroo Island have been reported at Tathra, Montague Island, Jervis Bay and Sydney.

New Zealand fur-seals in Australian waters suffered a severe decline in numbers from commercial sealing operations in the late 18th and early 19th centuries. Their former range used to extend to the Furneaux Group in eastern Bass Strait where it was quite abundant. New Zealand fur-seals in Australian waters were recently estimated to number 34,700 in the early 1990s. The population of this species in Australian waters is increasing, however it is probably still lower now than it was historically. The recolonisation of Bass Strait breeding sites illustrates the increasing population of this species (Arnould *et al.*, 2000).

Key Threatening Processes: The entanglement in and ingestion of plastic debris is a threat to this species (NSW Scientific Committee, 2002d).

Other threatening processes: This species is threatened by reduced prey item availability from fishing operations, the illegal shooting of seals that interact with commercial and recreational fishing gear, and their entanglement or capture in fishing gear, such as nets used in tuna farming and deep water trawl nets (from the hoki fishery in New Zealand, and perhaps also the Australian south east trawl fishery) (NSW Scientific Committee, 2002d).

Habitat and ecology: New Zealand fur-seals prefer rocky parts of islands with mixed terrain and boulders. At sea, they seem to occur only within continental shelf waters. They reach a maximum length of 100-150 cm (females) or 150-250 cm (males). After females reach sexual maturity at six years, they produce a single pup every year after an eight to nine month gestation period. Their breeding season is from November-January. They principally feed on fish and cephalopods, and also seabirds. They also feed at fishing boats.

Recovery plans: A recovery plan for the New Zealand fur-seal has not been prepared.

Assessment of risk to New Zealand fur-seal

Biological characteristics: The information provided above shows that the New Zealand fur-seal is long lived, reaches sexual maturity at six years and produces a single pup each year that, like all other mammals, require some parental care. Although its Australian population is increasing, it is much smaller than it was historically. Consequently, the resilience level of the New Zealand fur-seal is low.

Overlap and interaction with fishery: New Zealand fur seals are not abundant in NSW, having major population centres in New Zealand, the south coast of Australia and some Subantarctic islands. It is thought that individuals observed in NSW have migrated from either New Zealand or South Australia. Possible interactions with Ocean Trawl vessels include capture or contact with fishing gear, entanglement in lost fishing gear or discarded material, competition and illegal shooting by fishers. Substantial numbers of seals (e.g. ~ 800 per year) are caught in one New Zealand deep-water trawl fishery. Small numbers are caught in the South East trawl fishery (Commonwealth), reflecting their low abundance in that area. Rates of entanglement are lower for this species than for the Australian fur seal. There are no data on the impact of competition or on mortality rates resulting from illegal shooting.

Risk: Low-medium. It seems very likely that the mortality rate of seals is increased by fishing activity in the Ocean Trawl fishery, but the proportion of the population affected by operation of the

Ocean Trawl fishery operations is very small. The New Zealand fur seal population is increasing slowly in spite of the fishing pressure. It is not known, whether the population can recover to pre-harvest levels under the existing regime, however it seems unlikely that the Ocean Trawl Fishery would prevent this.

Sperm whale (*Physter catodon*)

Conservation status: The sperm whale, *Physter catodon*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: Sperm whales are found throughout the world's oceans in deep water off the continental shelf, i.e. in water >200 m deep. Females and young males are restricted to warmer waters north of around 45^{o}S in the southern hemisphere, and adult males travel to and from colder waters. In Albany (WA), the species is concentrated in a narrow area only a few miles wide at the shelf edge and move westward throughout the year. Similar concentrations are known elsewhere. Off the west coast of Western Australia, where the shelf slopes less steeply, sperm whales are less concentrated close to the shelf edge and are more widely dispersed offshore. In the open ocean, sperm whales in the southern hemisphere generally move southwards in summer and northwards in winter. Northern hemisphere sperm whales have a separate migration that consists of similar seasonal movements to those in the south. They occur in all Australian states. Key localities for the species in Australia are near the continental shelf between Cape Leeuwin and Esperance (WA), south-west of Kangaroo Island (SA), off Tasmania's west and south coasts, off New South Wales (including Wollongong), and off Stradbroke Island (Queensland). The sperm whales off eastern Australia (Division 6 stock) are said to be a separate stock than those off western Australia (Division 5 stock) (Smith, 2001).

Sperm whales are commonly sighted off NSW out to the edge of the Australian Exclusive Economic Zone (Smith, 2001). These sightings mostly occurred between August and April (Smith, 2001), however this may represent a bias towards the tuna fishing season as most observations were made on these vessels (Paterson, 1982). The species rarely occurs within the 5 km limit of NSW waters. Small groups of the species have been sighted twice in such waters, off Eden and Broken Bay (Atlas of NSW Wildlife, 02/01/2003). The species has stranded 22 times along most of the coast of NSW, the most recent in March 2000 (Smith, 2001).

The population of sperm whales dramatically declined during historical whaling operations that ceased in 1978. The current number of sperm whales is unknown, however the 'Australian' population of the species is likely to be in the tens of thousands.

Key Threatening Processes: None of the Key Threatening Processes listed under the EPBC Act or the TSC Act would affect this species.

Other threatening processes: The species is currently threatened from direct disturbances such as collision with large vessels on shipping lanes beyond the edge of the continental shelf, seismic operations in this area, net entrapment in deep-sea gill-nets, and pollution leading to accumulation of toxic substances in the body.

Habitat and ecology: Sperm whales are pelagic and are found offshore only in deep water only. Their population is centred in temperate or tropical waters where breeding / nursing schools and groups of young males occur. They concentrate in areas where the seabed rises steeply from great depth, this is probably associated with concentrations of their major food source in areas of upwelling. They reach a maximum age of around 60 years and a maximum length of 18.3 m (males) or 12.5 m (females). Males are sexually mature at 18-21 years / 11.0-12.0 m while females are sexually mature at 7-13 years / 8.3-9.2 m. They calve every four to six years between November – March after a 14-15 month gestation period. They feed mostly on oceanic cephalopods that are taken at depth, and some deep-sea angler fish and mysid shrimps are also eaten. At the surface, their swimming speed rarely exceeds 7.5 km / hr, however they can swim to 30 km / hr when disturbed. They are deep divers and can do so for over 60 minutes. Maximum diving depths between 1135 m to 3195 m have been recorded, although the mean diving depth is much shallower. They probably use echolocation. Breeding schools of sperm whales include females of all ages and immature and younger pubertal males. Large, socially mature males accompany schools only during the breeding season, and then for short periods of possibly only a few hours. The average school size of such a group is 25 animals, although they have been reported to number up to the low thousands. Bachelor schools of sperm whales consist of older pubertal males and sexually, but not socially, mature males, all of similar size and age. Socially mature males leave such schools to associate with breeding schools, either alone or in small groups of usually less than six animals.

Recovery plans: A recovery plan for the sperm whale has not been prepared.

Assessment of risk to sperm whale

Biological characteristics: The information provided above shows that the sperm whale is long lived, reaches sexual maturity at 7-21 years and produces a single calf every four to six years that, like all other mammals, require some parental care. Its population is much smaller than it was historically. Consequently, the resilience level of the sperm whale is low.

Overlap and interaction with fishery: Given that the species rarely occurs within the 3 nautical mile limit, interactions with the fishery are unlikely to occur in the south of the state where the fishery only operates out to 3 nautical miles. Interactions are possible in the north of the state, where the fishery extends beyond 3 nautical miles. In a review of interactions between mammals and trawlers, Bannister *et al.* (1996) found one record of a sperm whale being captured by a trawler, but this was most likely a mid-water trawling operation, which are faster, use larger nets and target depths that are more likely to contain cetaceans compared to the demersal trawls used in the Ocean Trawl fishery. The main potential impact of the Ocean Trawl fishery is collision with large vessels in shipping lanes beyond the continental shelf (Bannister *et al.*, 1996). It is not known how frequently collisions occur, but the relatively small trawlers operating in the Ocean Trawl fishery are far less likely to have an impact than large container ships. Competition with trawlers for food is unlikely because the sperm whale consumes deep-sea cephalopods, which are not generally targeted by trawling operations.

Risk: Low. Given the limited potential for interactions with the trawl fishery, the risks to the sperm whale are considered to be low.

Reptiles

Unless otherwise specifically referenced, the following information on turtles was obtained from the *Draft Recovery Plan for Marine Turtles in Australia* (Environment Australia, 1998b).

Green turtle (*Chelonia mydas*)

Conservation status: The green turtle, *Chelonia mydas*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: Green turtles occur worldwide and are found in tropical and subtropical waters, with vagrants extending to higher latitudes (Cogger, 2000). In Australia, green turtles live year round in coastal waters from central Western Australia, through Northern Territory and Queensland to central New South Wales. Breeding is largely restricted to areas north of 27^{o}S (Cogger, 2000), and they are most abundant within 1000 km of their nesting beaches. In NSW, they are found in small numbers in coastal waters (Cogger, 2000). The species is the most frequently recorded marine reptile (112 records) on the NPWS Atlas of NSW Wildlife (20/02/2003). It is probably relatively common in northern NSW waters, from where there are records of mostly unsuccessful nestings (Cogger, 2000). A nesting record, near Coffs Harbour was successful (NSW NPWS, 2002b).

Green turtles have been hunted intensively in the past, except in Australia where it was, and continues to be hunted in relatively small numbers by indigenous communities (Cogger, 2000). Recent downward trends in nesting rates for the Queensland stock may be the result of intense hunting pressure in non-Australian waters (Cogger, 2000).

Key Threatening Processes: Trawling north of 28°S, harmful marine debris, predation by foxes and imported fire ants pose threats to the green turtle.

Other threatening processes: Green turtles are taken as bycatch in trawl fisheries, gill nets, shark meshing operations and can become entangled in trap ropes. Other influences include boat strike, disease, tourism activities, indigenous harvesting and ingestion of fishing line.

Habitat and ecology: Green turtles inhabit subtidal and intertidal seagrass beds and coral reefs with a good cover of seaweed. Adult turtles feed on seaweeds and seagrasses, whereas immature turtles feed on jellyfish, small molluscs, crustaceans and sponges. They do not form obvious social groups and feed as individuals. Green turtles are long-lived species that become sexually mature after 50 years when they are generally between 91.5 – 122.5cm CCL. Adult females breed about every six years. On average, 115 eggs are laid in a clutch. They may migrate up to 2,600 km from feeding grounds in Indonesia, Papua New Guinea, New Caledonia, Fiji, Queensland, Northern Territory, Western Australia and New South Wales to breed and nest in southern and northern Great Barrier Reef, northwest Northern Territory, Gulf of Carpentaria, Western Australia, Coral Sea and Ashmore Reef. Nesting generally occurs from late November to January and earlier in the Northern Territory from July to December. The Australian nesting populations are genetically distinct from those in neighbouring countries. Some green turtles that feed in Australia are part of stocks that breed in other countries and vice versa.

Recovery plans: The recovery plan for marine turtles in Australia, prepared by Environment Australia, recommends specific actions that seek to reduce mortality, monitor populations, manage factors affecting nesting, protect critical habitats, educate stakeholders and support, maintain and develop international conservation programs (Environment Australia, 2003). No NSW fisheries are listed as having an impact upon marine turtles (Environment Australia, 2003).

Assessment of risk to green turtle

Biological characteristics: The information provided above shows that the green turtle is long lived, reaches sexual maturity after 50 years, uses eggs to produce offspring and lays an average of 115 eggs at a time. Its current population is very small. Subsequently, the resilience level of the green turtle is low.

Overlap and interaction with fishery: Observer study by NSW Fisheries found that turtles (unspecified species) were captured in 3 of 590 tows (0.51%) north of Newcastle, and none were caught further south. Many of the turtles caught in trawls can be successfully revived and returned to the water (Ocean Watch Australia, 2003).

Risk: Low-medium. Given the apparently low incidence of capture and lower incidence of mortality of turtles in NSW, the risk to the green turtle from the Ocean Trawl fishery is considered to be low-medium.

Hawksbill turtle (*Eretmochelys imbricata*)

Conservation status: The hawksbill turtle, *Eretmochelys imbricata*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: Hawksbill turtles occur worldwide and are found in tropical and warm temperate waters and often extend to higher latitudes (Cogger, 2000). In Australia, they are most abundant within tropical waters of Western Australia, Northern Territory and Queensland. Breeding areas in Australia are restricted to north of 26^{o}S (Cogger, 2000). They can be found in small numbers in NSW coastal waters (Cogger, 2000). There is possibly one or more resident communities in far northern NSW and no breeding has been recorded in this area (Cogger, 2000). Julian Rocks near Byron Bay is one such location (L. Tarvey, NSW NPWS, pers. comm., 2003). Hawksbill turtles were intensively harvested in the past. Australia may have globally significant stocks of this species, considering the pressures in faces in the Asia / Pacific region. The breeding population on Millman Island (Qld) has declined.

Key Threatening Processes: Trawling north of 28°S, harmful marine debris, effects of feral pigs and imported fire ants pose threats to the hawksbill turtle.

Other threatening processes: The hawksbill turtle is threatened by fishing interactions, boat strike, predation at rookeries and indigenous harvesting. Fishing interactions include incidental capture in trawling and gill netting gear and ghost fishing by lost nets.

Habitat and ecology: Hawksbill turtles inhabit mostly subtidal and intertidal coral and rocky reef habitats of the continental shelf. They use a parrot-like beak to feed on sponges, seagrasses, algae, soft corals, shellfish, sea squirts and molluscs. They do not form obvious social groups and feed as individuals. Their average shell length is 80 cm. They reach sexual maturity after about 40 years. On average, 130 eggs are laid at a time. Breeding females migrate up to 2,400 km from feeding grounds in New South Wales, Northern Territory, Queensland, Western Australia, Indonesia and Papua New Guinea to traditional breeding and nesting sites in tropical Northern Australia. In addition, many migrate to breeding sites in neighbouring countries including Papua New Guinea, Vanuatu, and the Solomon Islands. The Australian nesting populations are genetically distinct from those in other countries. Breeding occurs year round in the Northern Territory population, between January – April in the Torres Strait and the northern Great Barrier Reef populations and between August - November in Western Australia.

Recovery plans: The recovery plan for marine turtles in Australia, prepared by Environment Australia, recommends specific actions that seek to reduce mortality, monitor populations, manage factors affecting nesting, protect critical habitats, educate stakeholders and support, maintain and develop international conservation programs (Environment Australia, 2003). No NSW fisheries are listed as having an impact upon marine turtles (Environment Australia, 2003).

Assessment of risk to hawksbill turtle

Biological characteristics: The information provided above shows that the hawksbill turtle is long lived, reaches sexual maturity after 40 years, uses eggs to produce offspring and lays an average of 130 eggs at a time. Its current global population is much small. Subsequently, the resilience level of the hawksbill turtle is low.

Overlap and interaction with fishery: Observer study by NSW Fisheries found that turtles (unspecified species) were captured in 3 of 590 tows (0.51%) north of Newcastle, and none were caught further south. Many of the turtles caught in trawls can be successfully revived and returned to the water (Ocean Watch Australia, 2003).

Risk: Low-medium. Given the apparently low incidence of capture and lower incidence of mortality of turtles in NSW, the risk to the hawksbill turtle from the Ocean Trawl fishery is considered to be low.

Leatherback turtle (*Dermochelys coriacea*)

Conservation status: The leatherback turtle, *Dermochelys coriacea*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: Leatherback turtles occur across the world's tropical waters and adults are frequently recorded from higher latitudes (Cogger, 2000). In Australia, adult and large immature leatherback turtles are most regularly encountered in temperate waters of Queensland and Western Australia and in New South Wales, Victoria and Tasmania. Small numbers are found in coastal NSW waters (Cogger, 2000). There are possibly one or more resident communities in far northern NSW (Cogger, 2000). Breeding events in NSW have been recorded near Ballina in 1993 (Tarvey, 1993) and near Forster in 1995, the latter was unsuccessful (NSW NPWS, 2002b). The population of this species is declining in international waters. In Australia, the species may have always occurred in small numbers.

Key Threatening Processes: Trawling north of 28°S, harmful marine debris, predation by foxes and imported fire ants pose threats to the leatherback turtle.

Other threatening processes: The leatherback turtle has been incidentally caught in trawling, gill netting and offshore long line fishing gear. They are also occasionally entangled in trap buoy-lines. Predation at rookeries and some indigenous harvesting also threaten the species.

Habitat and ecology: Leatherback turtles are the largest of the marine turtles, with shells averaging 1.6 metres in length and with a total weight of up to 500 kg. They may reach sexual maturity at around 10 years of age and produce on average 90 eggs per clutch. They are oceanic and feed on jellyfish and other soft bodied invertebrates within the water column. The major breeding and nesting sites in the Asia / Pacific occur in Indonesia, Malaysia, Papua New Guinea and the Solomon Islands. Animals from these nesting aggregations use the continental waters of Australia to feed and migrate to temperate waters where they feed within the water column. Leatherback turtles rarely nest in Australian waters, there are perhaps fewer than 40 nesting records in total (NSW NPWS, 2002b). Annual nesting attempts in eastern Australia occur near the Bundaberg coastline and sporadic nesting occurs at other widely scattered sites in Queensland, New South Wales and the Northern Territory.

Recovery plans: The recovery plan for marine turtles in Australia, prepared by Environment Australia, recommends specific actions that seek to reduce mortality, monitor populations, manage factors affecting nesting, protect critical habitats, educate stakeholders and support, maintain and develop international conservation programs (Environment Australia, 2003). No NSW fisheries are listed as having an impact upon marine turtles (Environment Australia, 2003).

Assessment of risk to leatherback turtle

Biological characteristics: The information provided above shows that the leatherback turtle is long lived, reaches sexual maturity after 10 years, uses eggs to produce offspring and lays an average of 90 eggs at a time. Only small numbers of this species occur in Australian waters. Its current global population is much smaller than it was historically. Subsequently, the resilience level of the leatherback turtle is low.

Overlap and interaction with fishery: Observer study by NSW Fisheries found that turtles (unspecified species) were captured in 3 of 590 tows (0.51%) north of Newcastle, and none were caught further south. Many of the turtles caught in trawls can be successfully revived and returned to the water (Ocean Watch Australia, 2003).

Risk: Given the apparently low incidence of capture and lower incidence of mortality of turtles in NSW, the risk to the leatherback turtle from the Ocean Trawl fishery is considered to be low.

Appendix B2.9 Determination of risk averse and risk prone characteristics for habitats affected by the Ocean Trawl Fishery

Habitats	**Where are the habitats?**	**Where does the fishing occur?**	**What overlap is there between the area in which the fishery operates and the distribution of habitat types?**	**Do habitats have adequate protection (refuge) from fishing impacts?**	**Is the use of "high-impact" fishing gear currently permitted in the fishery?**
Geological habitats					
Hard-ground substratum (High vertical relief >2m)	Prone	Prone	Prone	Averse	Averse
Hard-ground substratum (Low vertical relief <2m)	Prone	Prone	Prone	Prone	Prone
Soft-ground substratum (sands, muddy sediments, gravels)	Prone	Prone	Prone	Prone	Averse
Biogenic habitats					
Biota of hard-ground substratum (High vertical relief >2m)	Prone	Prone	Prone	Prone	Prone
Biota of hard-ground substratum (Low vertical relief <2m)	Prone	Prone	Prone	Prone	Prone
Biota of soft-ground substratum (sands, muddy sediments, gravels)	Prone	Prone	Prone	Prone	Prone
Water Column	Averse	Averse	Averse	Averse	Averse

APPENDIX D1 Implementation table for the Ocean Trawl Fishery Management Strategy

The following implementation table outlines the time periods within which each management response detailed in the Fishery Management Strategy is scheduled to be implemented. The table also provides information relating to the head of power for implementation and who has the lead responsibility for carrying out the action(s). A general description of the terms used in the table with respect to timeframes follows:

Term	**Description**
Immediate	Upon the date of approval of the strategy
Short Term	Within one year of the date of approval of the strategy
Medium Term	Within 3 years of the date of approval of the strategy
Long term	In excess of three years of the date of approval of the strategy
As required	Whenever the circumstances warrant action
Ongoing	Continuing into the future

Goal 1. Manage the Ocean Trawl Fishery in a manner that promotes the conservation of biological diversity in the marine environment					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
1.1 Mitigate the impact of trawling in NSW ocean waters on ecosystem integrity (species, populations, and ecological communities)	a) Define and map the extent of 'trawling grounds' and determine the intensity of trawling on each of these grounds	1, 2, 7	Medium term	NSW Fisheries OT Fishers	-
	b) Implement a series of closures to trawling to protect a range of ocean habitats and associated biodiversity, including closure of all reefs and depths greater than 1100 metres	1, 2, 4, 7	Depths >1100m - Immediate; Reefs and other areas - Medium term	NSW Fisheries	Regulatory
	c) Continue the prohibition on using fish trawl nets north of Smoky Cape, and implement additional Bycatch Reduction Device requirements for prawn trawl nets south of Smoky Cape (to minimise the incidental catch of fish in prawn trawl nets used in this area)	1, 2, 4, 6	North of Smoky Cape - Ongoing; South of Smoky Cape - Short term	NSW Fisheries	Regulatory
	d) Promote research and collaborate with research institutions to improve our understanding of ecosystem functioning and how it is affected by trawling	1, 2, 7	Long term	NSW Fisheries OT MAC	-
1.2 Mitigate the impact of the ocean trawl fishery on non-retained species	a) Design and implement an industry funded scientific observer program to document the degree of interaction of commercial designated fisheries, including the ocean trawl fishery, with non-retained and threatened species and to collect information on the use and effectiveness of Bycatch Reduction Devices	1, 2, 3, 4, 5, 6, 7	Short term	NSW Fisheries OT MAC	Regulatory
	b) Refine and improve methods for reducing incidental catches, including the introduction of more effective BRDs for prawn trawl nets, and modification of the 'square-mesh panel' BRD	1, 4, 5, 6	Short term [consistent with school whiting gear timeframe]	NSW Fisheries OT fishers	Regulatory
	c) Investigate alternative handling practices to improve survival of incidental species that are to be returned to the water	2, 4, 6	Ongoing	NSW Fisheries OT fishers	Regulatory
	d) Develop a Code of Conduct for ocean trawl fishers	1, 2, 3, 4, 6	Medium term	NSW Fisheries OT Fishers	Various
	e) Identify areas and/or times of problem incidental catch to target catch ratios and restrict trawling appropriately. In particular, implement closures to trawling around river entrances during times of high river discharge in accordance with the program described in Appendix D2	1, 2, 4, 6	Short term, then ongoing	NSW Fisheries	Regulatory

Goal 1. Manage the Ocean Trawl Fishery in a manner that promotes the conservation of biological diversity in the marine environment					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
1.3 Mitigate the impact of the ocean trawl fishery on ocean habitats and their associated biota	a) Require the use of trawl gear designs that minimise impacts on habitats and associated biota	1, 2, 4	Ongoing	NSW Fisheries	Regulatory
1.4 Prevent the introduction and translocation of marine pests and diseases by fishing activities	a) Implement, in consultation with the relevant MACs, measures required in accordance with any marine pest or disease management plans	1, 2, 3	As required	NSW Fisheries	Various

Goal 2. Maintain stocks of primary and key secondary species harvested by the Ocean Trawl Fishery at sustainable levels					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
2.1 Prevent overfishing of the stocks of primary and key secondary species by ocean trawl fishers	a) Monitor the quantity, length and/or age and sex composition of the primary and key secondary species taken by commercial designated fishing activities, including the ocean trawl fishery, as part of the overall stock assessment system	2, 5, 6, 7	Short term, then ongoing	NSW Fisheries	-
	b) Develop a system for and conduct stock assessments for each of the primary and key secondary species taken by commercial designated fishing activities, including the ocean trawl fishery, and review the assessments at least every three years thereafter	2, 4, 5, 7	Medium term	NSW Fisheries	-
	c) Monitor the annual landings of primary and key secondary species, for comparison against "reference" levels set out in Appendix D6, as part of the overall stock assessment system	2, 4, 5, 7	Short term, then ongoing	NSW Fisheries	-
	d) Monitor the commercial landings of all secondary species (other than the key secondary species) taken in the fishery annually for comparison against an historical range for each of those species or groups of species, as part of the overall stock assessment system	2, 4, 5, 7	Short term, then ongoing	NSW Fisheries	-
	e) Ensure that the selectivity of the gear used in the fishery (apart from gear used in designated whiting areas - see provisions in Appendices D3 and D5) is appropriate in relation to the biology of the species being targeted. In particular: i) restrict prawn trawl net cod-ends to a maximum of 150 meshes round (hanging ratio of 1:1), constructed with single twine of maximum 4 mm diameter, with mesh size between 40 and 50 mm ii) restrict fish trawl net cod-ends to a maximum of 100 meshes round (hanging ratio of 1:1), constructed with single twine of maximum 6 mm diameter and with a mesh size of at least 90 mm iii) review and modify the restrictions applying to prawn trawl and fish trawl nets on the basis of research results on the selectivity of trawl nets, including assessment of mesh size and shape	2, 5, 7	(i) and (ii) Short term (iii) Ongoing	NSW Fisheries	Regulatory
	f) Maintain and enhance the effectiveness of the "juvenile king prawn" closures, and in particular: i) modify the juvenile king prawn closure off South West Rocks . ii) make all juvenile king prawn closures year-round closures, and iii) investigate the need to extend juvenile prawn closures to be adjacent to the mouths of all major estuaries along the NSW coast	1, 2, 4, 5, 6	(i) to (iii) - Short term (iv) Medium term	NSW Fisheries	Regulatory

Goal 2. Maintain stocks of primary and key secondary species harvested by the Ocean Trawl Fishery at sustainable levels					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
	g) Develop strategies to establish 'refuge' areas and spawning closures for species targeted by trawling	2, 4, 5, 7	Medium term	NSW Fisheres OT MAC	-
	h) Investigate the cost effectiveness of using fishery independent surveys to provide abundance indices and other information for stock assessment of the primary species taken in the ocean trawl fishery	2, 5, 6, 7	Medium term	NSW Fisheries	-
	i) Review the efficacy of minimum size limits for fish species taken in the ocean trawl fishery, including the need for minimum legal sizes to be implemented for additional species, and the regulations pertaining to fish with a minimum legal length that are captured in prawn trawl nets south of Smoky Cape	2, 5, 7	Medium term	NSW Fisheries	Regulatory
	j) Utilise onboard observers to collect additional biological information, including size at maturity and fecundity/brood size data, for the important elasmobranch species taken by the fishery	1, 2, 4, 5, 6	Short term, then ongoing	NSW Fisheries	-
2.2 Promote the recovery of overfished species	a) Where the ocean trawl fishery is a major harvester of a species determined as overfished in NSW (recruitment overfished or growth overfished) develop and implement a recovery program for that species as detailed in the harvest strategy	2, 4, 5	Trevally - short term Other species - as required	NSW Fisheries	Various
	b) Where the fishery is a minor harvester of an overfished species, contribute to the development of any recovery programs for that species, and adopt any measures required by a recovery program	2, 4, 5	As required	NSW Fisheries OTL MAC	-

Goal 3. Promote the conservation of threatened species, populations and ecological communities likely to be impacted by the operation of the Ocean Trawl Fishery					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
3.1 Identify and minimise or eliminate any impacts of fishing activities on threatened species, populations, ecological communities and habitats (including mammals, birds, reptiles, finfish, shellfish and other invertebrates, and vegetation) and promote their recovery	a) Modify, in consultation with the Ocean Trawl MAC, the mandatory reporting arrangements to enable collection of information on interactions with or sightings of threatened or protected marine species, and gear interactions with other threatened or protected species	3, 6, 7	Medium term	NSW Fisheries OT MAC	Policy
	b) Implement, in consultation with the Ocean Trawl MAC, the provisions of any relevant threatened species recovery plan or threat abatement plan, including the protection of identified 'critical habitat' areas	3, 6	As required	NSW Fisheries OT MAC	Various
	c) Using the code of conduct, promote the use of fishing techniques that avoid the capture of or interaction with protected fish and fish protected from commercial fishing	3, 4	Medium term	NSW Fisheries	Regulatory
	d) Determine, through the on-board observer program, the level of interaction between the fishery and marine turtles and seals (protected under the *Threatened Species Conservation Act 1995*) and assess the need to introduce Turtle or Seal Excluder Devices, or other measures to minimise impacts on these species	3, 5, 7	Medium term, then ongoing	OT MAC	-

Goal 4. Appropriately share the resource and carry out fishing in a manner that minimises negative social impacts					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
4.1 Provide for appropriate access to the fisheries resource by other stakeholders (eg. recreational, Indigenous), acknowledging the need of seafood consumers to access quality shellfish and finfish	a) Estimate the total catch of 'primary' and 'key secondary' species in the ocean trawl fishery, taking account of the recorded commercial catch and estimates of recreational, Indigenous and illegal catch	2, 4, 5, 7	Ongoing	NSW Fisheries	-
4.2 Provide for fair and equitable sharing of the fisheries resources with other commercial fisheries (NSW, interstate and Commonwealth)	a) Monitor management arrangements and the annual landings of key ocean trawl species in fisheries that are outside NSW jurisdiction but which impact on stocks shared with the NSW ocean trawl fishery, as part of the stock assessment system	2, 4, 5, 7	Ongoing	NSW Fisheries	-
	b) Monitor the annual landings of all secondary species within each sector of the ocean trawl fishery, as part of the stock assessment system	1, 4, 6, 7	Ongoing	NSW Fisheries OT MAC	-
	c) Use cross-fishery and cross-jurisdictional consultation to discuss and then manage issues relating to, but not limited to, the multiple use of specific fishing grounds, collaborative research, fair and equitable access to stocks, complementary management arrangements and other interactions between fishing sectors	1, 2, 4, 5, 7	Ongoing	NSW Fisheries OT MAC	-
4.3 Provide for the fair and equitable sharing of the fisheries resource within the ocean trawl fishery	a) Limit operations of 'offshore' prawn trawlers to depths less than 150 fathoms (275 m), and limit operations of 'deepwater' prawn trawlers to depths between 200 and 600 fathoms (365 to 1100 m), and close depths between 150-200 fathoms to prawn trawling	1, 2, 6	Immediate	NSW Fisheries	Regulatory
	b) Respond to information about significant changes in relative catches of the primary and key secondary species taken in each of the major sectors of the ocean trawl fishery	2, 4, 5, 7	Ongoing	NSW Fisheries OT MAC	Various
	c) Manage the multiple use of trawl grounds within the ocean trawl fishery and minimise adverse interactions	4, 5, 7	Ongoing	NSW Fisheries OT MAC	Various

Goal 4. Appropriately share the resource and carry out fishing in a manner that minimises negative social impacts					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
4.4 Identify and mitigate any negative impacts of the ocean trawl fishery on Aboriginal, cultural or other heritage	a) Manage the ocean trawl fishery in a manner consistent with the Indigenous Fisheries Strategy and Implementation Plan	4, 7	As required	NSW Fisheries	Various
	b) Modify the activity, where relevant, in response to new information about areas or objects of cultural significance in order to minimise the risk from fishing or fishing activities	4, 5, 7	As required	NSW Fisheries OT Fishers	Various
4.5 Provide for resolution of conflicts between the ocean trawl fishery and other community interests	a) Modify the activity, in consultation with the Ocean Trawl MAC, to respond appropriately to conflicts that arise between ocean trawl operators and other members of the community	1, 2, 3, 4, 6	As required	NSW Fisheries OT Fishers	Various

Goal 5. Promote a viable Ocean Trawl Fishery, consistent with ecological sustainability					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
5.1 Manage the harvesting of the primary and key secondary species to achieve the best outcome in terms of optimising biological yield and maximising economic return	a) Determine and implement arrangements to optimise the biological yield for the primary and key secondary species taken in the fishery	2, 4, 5, 7	Long term	NSW Fisheries OT MAC	-
	b) Identify and implement strategies to maximise the economic return to the fishery, taking into account the conditions required to optimise the biological yield for the range of species taken	2, 4, 5, 7	Medium term	NSW Fisheries OT MAC	-
	c) Implement suitable gear, area and operational specifications for targeting school whiting, and define appropriate minimum and maximum annual catch levels that will trigger a review of management arrangements (see specific controls in Appendix D5 and catch triggers in Appendix D6)	1, 2, 4, 5, 7	Short term [consistent with BRD and gear selectivity timeframes]	NSW Fisheries	Regulatory

Goal 5. Promote a viable Ocean Trawl Fishery, consistent with ecological sustainability					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
5.2 Establish a level of fishing effort to achieve a fishery that is commercially viable (and ecologically sustainable) over the longer term	a) Manage fishing effort in the ocean trawl fishery by: (i) limiting the number of each endorsement type so as to minimise the potential activation of latent fishing effort (ii) maintaining the hull capacity, engine power and net length restrictions that apply to the offshore sector of the Ocean Prawn Trawl Fishery and extend these rules to the other sectors of the ocean trawl fishery (iii) establishing a maximum level of fishing effort for each sector of the ocean trawl fishery to be achieved within 10 years of the commencement of the share management plan (iv) investigating the efficacy of limiting the number of days/nights each boat may work in the prawn trawl and fish trawl sectors of the fishery	1, 2, 3, 4, 5, 6	(i) Medium term (ii) Ongoing (iii) Medium term (iv) Medium term	NSW Fisheries	Various
	b) Maintain the prohibition on trawling south of Byron Bay for vessels with a P4 offshore prawn trawl endorsement	1, 2, 4	Ongoing	NSW Fisheries	Regulatory
5.3 Promote the economic viability of the ocean trawl fishery, and assess the economic benefits of the fishery to the community	a) Refine the performance indicator for monitoring trends in the commercial viability of fishing businesses within each designated fishing activity, so as to be based on net returns	5, 7	Medium term	NSW Fisheries OT MAC	-
	b) Investigate the data available to assess the economic multiplier (flow-on) effects of commercial fishing, including the ocean trawl fishery, to the broader community, and develop strategies to improve the quality / usefulness of such data	5, 7	Short term	NSW Fisheries OT MAC	-
	c) Identify and promote post-harvest practices which will ensure the best return in dollars per kilogram for product of the fishery	5,6	Medium term	OT MAC	-
	d) Develop a cost recovery framework, in consultation with the MAC and the Ministerial advisory body relating to commercial fishing	4, 5, 6	Short term	NSW Fisheries OT MAC	Regulatory
5.4 Provide secure fishing entitlements for ocean trawl fishers	a) Implement the share management provisions of the *Fisheries Management Act 1994* for the prawn trawl sector of the fishery and the fish trawl sector north of Barrenjoey Pt	2, 4, 5	Ongoing	NSW Fisheries	Regulatory
5.5 Manage food safety risks in the harvesting of shellfish and finfish in the fishery	a) Co-operate with Safe Food Production NSW in the development and implementation of food safety programs relevant to the fishery	5, 6, 7	Ongoing	OT Fishers	FP Act

Goal 6. Facilitate effective and efficient compliance, research and management of the Ocean Trawl Fishery					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
6.1 Promote and maximise compliance with the provisions contained in the Ocean Trawl Fishery Management Strategy	a) Develop, implement and monitor a compliance plan for commercial designated fishing activities, including the ocean trawl fishery	1, 2, 3, 5, 6	Short term	NSW Fisheries	Policy
	b) Review developments in electronic vessel monitoring systems (VMS) and associated catch and effort reporting systems, with a view to implementing a cost-effective VMS system for the fishery	1, 2, 5, 6, 7	Medium term	NSW Fisheries OT MAC	-
	c) Implement a penalty points scheme (incorporating endorsement suspension and share forfeiture for serious offences and habitual offenders)	1, 2, 3, 5, 6	Medium term	NSW Fisheries	Regulatory
	d) Develop strategies to support appropriate practices and behaviour in commercial fisheries, including development of training and accreditation courses in core competencies and the introduction of fit and proper person requirements	1, 2, 3, 4, 5, 6	Long term	NSW Fisheries OT MAC	Regulatory
6.2 Identify research priorities required to provide for the sustainable operation of the ocean trawl fishery	a) Develop and implement a Research Strategic Plan for designated commercial fishing activities including the ocean trawl fishery, taking account of the priorities for research outlined in the harvest strategy	1, 2, 3, 4, 5, 6, 7	Short term	NSW Fisheries	Policy
6.3 Ensure effective and efficient management of the ocean trawl fishery	a) Develop and implement the fishing business (skipper) card system	5, 6	Medium term	NSW Fisheries OT MAC	Regulatory
	b) Modify the arrangements for trawling in the area south of Barrenjoey Pt (within 3 nautical miles) to achieve greater complementarity with the management of the adjacent Commonwealth Southern and Eastern Scalefish and Shark Fishery and to manage fish stocks in State waters on a sustainable basis and minimise other environmental impacts, as provided for in Appendix D3	1, 2, 3, 4, 5, 6, 7	Short term	NSW Fisheries	-
	c) Rationalise the areas closed to trawling (as outlined in this management strategy) taking account of the combined effect of fishing closures, addressing the environmental risks identified in the EIS, and the implications for trawling operations at a regional level	1, 2, 3, 4, 5, 6	Medium term	NSW Fisheries OT MAC	Various

Goal 6. Facilitate effective and efficient compliance, research and management of the Ocean Trawl Fishery					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
6.4 Provide effective and efficient communication and consultation mechanisms in relation to management of the ocean trawl fishery	a) Establish the Ocean Trawl Management Advisory Committee, with the services of an 'independent' Chairperson, as the primary consultative body for issues affecting the fishery	4, 5, 6	Short term	NSW Fisheries	Regulatory
6.5 Implement this strategy in a manner consistent with related Commonwealth and State endorsed programs aimed at protecting aquatic environments and achieving the objectives of ecological sustainable development	a) Manage the ocean trawl fishery consistently with other jurisdictional or natural resource management requirements, such as the marine parks program, aquatic biodiversity strategy, threatened species program, Indigenous Fisheries Strategy, compliance and other relevant strategies	1, 3, 4, 5, 6	Ongoing	NSW Fisheries	Policy
	Provide for the issue of permits under Section 37 of the *Fisheries Management Act 1994* authorising the use of modified fishing practices to assist research programs or for purposes consistent with the vision and goals of this management strategy	1, 2, 3, 5, 6, 7	Ongoing	NSW Fisheries	Regulatory

Goal 7. Improve knowledge about the Ocean Trawl Fishery and the resources on which it relies					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
7.1 Improve the community's understanding and public perception of the ocean trawl fishery	a) Promote awareness of the ocean trawl fishery as part of the overall communication strategy across all commercial designated fishing activities	4, 6, 7	Medium term, then ongoing	NSW Fisheries OT MAC	-
7.2 Promote scientific research to collect relevant information about the biology of the primary and key secondary species, the impact of trawling on other species and the environment, and the status of the fishery as a whole, including economic and social factors	a) Promote and support targeted research projects	1, 2, 3, 4, 5, 6, 7	Short term and ongoing	NSW Fisheries OT MAC	-
	b) Implement targeted surveys of endorsement holders to obtain more accurate information on the economic and social status of commercial fisheries, including the ocean trawl fishery	4, 5, 6, 7	Medium term	NSW Fisheries OT Fishers	-
7.3 Improve the quality of the catch and effort information collected from endorsement holders	a) Periodically review the mandatory catch and effort return forms submitted by ocean trawl fishers	2, 3, 6, 7	Ongoing	NSW Fisheries OT MAC	Regulatory
	b) Assess the accuracy of the current catch recording system, and species identification in catch records, and provide advice to industry to make needed changes	2, 3, 6, 7	Medium term	NSW Fisheries	-

APPENDIX D2 Supporting Policy for Ocean Trawl Bycatch Reduction and Prawn Yields

This policy aims to ensure that ocean trawlers do not operate in areas and at times when bycatch levels are likely to be high, such as after flooding events, and to help improve the yield of regional prawn fisheries. The intent is to encourage commercial fishers to take greater responsibility for their environmental performance.

This approach would involve the establishment of joint industry/NSW Fisheries regional working groups to review and advise on the need for closures to trawling when the conditions so warrant, in order to meet the targets for bycatch reduction and prawn yields outlined in this policy. Peer influence would be used to encourage local trawl operators to avoid areas where the levels of bycatch or small prawns are likely to be high. The working groups would be empowered to request NSW Fisheries to close an area in the event that some operators did not comply. NSW Fisheries would implement the closures in circumstances where a working group is not established or not achieving the aim of the policy.

Consistent with the intent to rationalise area closures, this policy will support many of the existing fishing closures that exist around the mouths of estuaries. In areas where permanent closures that extend to the beach already apply this policy would not need to apply.

The effectiveness of the policy and its application will be monitored on an ongoing basis. NSW Fisheries, in consultation with the MAC, will review and amend the arrangements at a coast wide or regional level in light of practical experience, the implementation of more effective bycatch devices or more selective trawl gear, and the findings from the scientific observer program.

The following arrangements will provide guidance as to the circumstances under which trawling in certain areas or at certain times should be avoided.

Area of interest

Temporary closures introduced under this policy will in most cases be located in ocean waters adjacent to the rivers as detailed in Table 1 attached. GPS co-ordinates will be used to define the boundaries. NSW Fisheries and regional fisher representatives can examine the option of dividing the closures into pre-defined sections.

Triggers for adopting temporary closures

Triggers include, but are not restricted to:

- Notifications from the Bureau of Meteorology that the river adjacent to the closure area is in flood (Moderate or Major), or.
- A ‘trial’ or a trawl shot that produces in excess of 2 parts bycatch to 1 part retained catch in the case of prawn trawl, or the case of fish trawl 1 part bycatch to 1 part retained catch, or.
- A ‘trial’ or a trawl shot that produces prawns smaller than a count of 50 prawns per ½ kilogram in the case of king prawns or 100 prawns per ½ kilogram in the case of school prawns.

Consultation with regional industry representatives

The working group and regional Ocean Trawl MAC members will be consulted if the above triggers are reached. Ocean Trawl MAC members from adjacent regions should also be informed.

Notification of areas to be avoided by trawlers

Notices of areas to avoid or formal closures should be placed in the Fishermen's Co-operatives closest to the port and directly adjacent ports where the fishing closure applies, and in a prominent location at the wharf from which the majority of endorsed vessels operate. A radio broadcast to fishing vessels should also be made. The notice and broadcast should specify the relevant area, the date(s) and the methods of trawling affected. The notices should provide information on any new or expiring closures.

Time period

The time periods relevant to each closure event are detailed in Table 1 and are subject to early lifting if conditions warrant a change. The period that closures would apply have been determined having regard to the size of the river catchment and the severity of flooding (ie. 'major' or 'moderate' floods).

Any closures that is invoked following a 'trial' should apply for a minimum of one week, or a longer period if agreed by the relevant working group.

Early lifting of a closure

During the period of a closure, regional Ocean Trawl MAC members may request that a 'trial' be undertaken to determine if the closure, or part thereof, should be lifted early. A closure can be lifted if the results fall within the triggers listed above and in the case of a closure introduced for the purposes of improving prawn yields, the prawns caught exhibit hard shells.

Other relevant factors

The following factors should also be observed with respect to this policy:

- A 'trial' should not to be undertaken within 7 days of another 'trial'.
- A Fisheries Officer or duly authorised observer should be present during the trial.
- A 'trial' is to be conducted at no cost to NSW Fisheries other than the time spent preparing for, observing and follow-up by a Fisheries Officer or duly authorised observer.
- The vessel to be used during the trial must be fitted with a BRD of the following specifications, unless the relevant working group otherwise agree – square mesh panel at the minimum allowable dimensions of 450cm^2 and consisting of 55mm mesh.
- A closure may be lifted to specified methods of trawling (ie. fish or prawn trawling or with specified BRDs installed) if deemed appropriate.
- Where a closure under this program overlaps one of the existing juvenile king prawn closures, the juvenile king prawn closure or parts thereof may also be opened subject to the criteria above. The juvenile king prawn closure will be reinstated on a date determined by NSW Fisheries in consultation with regional industry representatives, but not exceeding two (2) weeks from its opening.

- Despite closure of waters to trawling under this program, trawling would be permitted by the vessel(s) approved by NSW Fisheries for the purpose of undertaking a trial in accordance with this program.

River	Area of closure	Period of Closure	Comments
Tweed	From the intersection of mean high water mark and 28º10ÕS, then north east to the point 28¡08.100ÕS, 153¡36.360ÕE, then south to 28¡15.ÕS, 153¡36.360ÕE, then west to the mean high wa mark, then generally north along the mean high water mark to the point of commencement.	Major: 3 weeks Moderate: 2 weeks	The same area as the Tweed Heads juvenile king prawn closure (offshore boundary is approx 2 _ nautical miles to sea).
Brunswick	From the mean high water mark 2 nautical miles north of the northern break wall, east 1.2 nautical miles, then generally south 1.2 nautical miles off the mean high water mark for 7 nautical miles, then due west to the mean high water mark, the generally north along the mean high water mark (and across the river entrance) to the point of commencement.	Major: 3 weeks Moderate: 2 weeks	The same area as the Brunswick Heads juvenile king prawn closure extended inshore to the mean high water mark (offshore boundary is approx 1 _ nautical miles to sea).
Richmond	From the intersection of the mean high water mark and 28º48.42Õs, east to 28º48.42Õs, 153º37.10Õ then east to the point 28¼48.432Õ S and 153¼437.836Õ E, then south to the point 28¼452.154Õ S and 153¼437.836Õ E, then south west to the point 28¼453.580Õ S and 153¼437.360Õ E, then south west to point 28¼457.530Õ S and 153¼433.420Õ E, then south west to the point 29¼400.000Õ S and 153¼430.9 then due west to the mean high water mark, then generally north along the mean high water mark (and across the river entrance) to the point of commencement.	Major: 4 weeks Moderate: 2 weeks	The same area are the Ballina juvenile king prawn closure extended inshore to the mean high water mark from the northern and southern extremities (offshore boundary is approx 1 _ nautical miles to sea).
Evans	From the intersection of the mean high water mark and the eastern most extremity of Joggly Point (Evans Head), due north for a distance of 2km, then due west to the mean high water mark on Airforce Beach, then generally south along the mean high water mark (and across the river entrance) to the point of commencement.	Major: 3 weeks Moderate: 2 weeks	The same area as the closure directly off the river entrance and first introduced during the 2001 floods (ie. not the juvenile king prawn closure to the south). Note this closure applies for 12 months of the year (offshore boundary is approx 1 nautical mile from the river entrance).
Clarence	The intersection of the mean high water mark and 29¡22.4Õ S then east to a point 3 nautical miles from WOODY HEAD at 29¡22.4Õ S and 153¡25.87Õ E, then south to a point 3 nautical miles east of YAMBA POINT at 29¡26.48Õ E and 153¡25.78Õ E, then south to a point 3 nautical miles east of ANGOURIE POINT at 29¡29.2Õ S and 153¡25.5Õ E, then south to a point 3 nautical miles east of BROOMS HEAD at 29¡36.8Õ S and 153¡23.8Õ E, then west to Mean High Water Mark at BROOMS HEAD at 29¡36.8Õ S and 153¡20.4Õ E, then along the Mean High Water Mark (and across the river entrance) to the point of commencement at WOODY HEAD.	Major: 4 weeks Moderate: 2 weeks	The same area are the Angourie Point juvenile king prawn closure extended inshore to the mean high water mark from the northern and southern extremities (offshore boundary is approx 3 nautical miles to sea).

River	Area of closure	Period of Closure	Comments
Bellinger Nambucca Hastings Clyde Moruya	From the mean high water mark 2 nautical miles north of the northern bank of the river entrance (or northern breakwall), then due east for 2 nautical miles, then due south to a point 2 nautical miles south of the river entrance (or southern breakwall), then due west to the mean high water mark, then generally north along the mean high water mark (and across the river entrance) to the point of commencement.	Major: 3 weeks Moderate: 2 weeks	New closures
Macleay Manning Hunter Hawkesbury Shoalhaven	From the mean high water mark 3 nautical miles north of the northern bank of the river entrance (or northern breakwall), then due east for 3 nautical miles, then due south to a point 3 nautical miles south of the river entrance (or southern breakwall), then due west to the mean high water mark, then generally north along the mean high water mark (and across the river entrance) to the point of commencement.	Major: 4 weeks Moderate: 2 weeks	New closures

APPENDIX D3 Arrangements for trawling in waters south of Barrenjoey Headland (and within 3 nautical miles)

The following arrangements will apply with respect to trawling activities in waters south of Barrenjoey Headland and within 3 nautical miles of the coast:

(1) A minimum of 75% of the total area of State waters will be closed to trawling, taking account of closures implemented under management response 1.1b

(2) A limited number, location and size of whiting trawl grounds are to be identified and boundaries specified

(3) The catch of the primary and key secondary species taken by fish trawling and the catch of whiting by fish and/or prawn trawling of each fishing business is to be capped (by weight). The limits will be calculated using the average of each businesses best two years of catch between the years 1999 to 2003 and adjusted annually in line with the total allowable catches set for the Commonwealth's Southern and Eastern Scalefish and Shark Fishery

(4) The movement of all trawl vessels operating in that area are to be monitored through a vessel monitoring system (VMS). This would depend on making a link with an existing (eg. AFMA or Queensland) VMS.

(5) A new single gear trawl net for catching whiting to be designed and introduced [see point (7) below] and in the interim:

- Allow fishers to use the existing lawful cod ends (including double braided 90 mm cod ends) on the mapped whiting trawl grounds only
- Require cod ends used anywhere else to be made from (max.) 6 mm single twine, with a maximum of 100 meshes round (hanging ratio of 1:1), with a 90 mm minimum mesh size

(6) A new triple gear trawl net for catching prawns and whiting to be designed and introduced [see point (7) below] and in the interim:

- Require prawn trawl cod ends to be made from (max.) 4 mm single twine, with a maximum of 150 meshes round (hanging ratio of 1:1), with a 40-50 mm mesh size
- Require the use of a square mesh panel BRD (constructed as per the requirements outlined in point (i) below) or another approved BRD on prawn trawl nets,

(i) the square mesh panel is to be constructed as a single panel with:

- the base of the panel positioned in the top of the anterior of the cod end either within 40 meshes of the cod end drawstring or within 3 meshes above the start of the bell (ie. where the number of meshes is increased)

- a minimum 65 mm mesh size and minimum surface area of 770 square cm, or a minimum 75 mm mesh size and minimum surface area of 650 square cm, and

- a bating rate of at least 3 points to each bar located on the anterior and posterior end of a panel made of 65-75 mm mesh and at least 4 points to each bar located on the anterior and posterior end of a panel made of >75 mm mesh (where 'points' refers to the corner of a mesh that attaches to the panel, and 'bar' means the side of a single square mesh within the panel to which the points of the trawl net are attached)

(7) A research project funded by fishing businesses with entitlements in the ocean trawl fishery will be conducted over the next three years, with industry input in the form of a working group to oversee the project, to:

- finalise the design of a triple trawl for catching prawns and whiting at optimum sizes and to minimise bycatch (Ideally, one new trawl design will be developed. Alternatively, it may be necessary to specify a design range that allows fishers to target their preferred species)
- design a single trawl for catching whiting at optimum sizes and to minimise bycatch
- assess the species biology of trawl whiting to identify the best sizes and times for harvest, and
- recommend any other management arrangements for whiting (eg. lunar closures, day versus night time fishing, byproduct trip limits, need for daily catch and effort reporting).

Note: Opportunities for supplementary funding through external sources will be explored.

Implementation timetable for these arrangements

Points (1) – (3)	Short term
Point (4)	Short term for vessels already carrying VMS equipment; medium term for the installation of VMS on vessels without VMS equipment
Points (5) – (7)	Medium term

APPENDIX D4 Relative catches of Primary and Key Secondary Species by Ocean Trawl Fishery Sector

Management response 4.3(b) requires information on the relative catches of the primary and key secondary species by each of the major sectors in the ocean trawl fishery (fish trawl, prawn trawl and royal red prawn trawl).

The table below sets out this information for the period 1997/98 to 2002/03. For each sector the mean annual catch of each species (in tonnes) is given, followed by the range of annual catches reported by fishers in that sector during this period.

Primary Species	**Fish Trawl**	**Prawn Trawl**	**Royal Red Trawl**
Bug, Balmain	3.8 (2.6 to 6.5)	44.3 (25.4 to 61.6)	0.3 (0.01 to 1.6)
Calamari, Southern	74.0 (46.5 to 130.8)	10.5 (5.4 to 13.7)	n/a
Cuttlefish	57.6 (39.9 to 72.7)	182.4 (136.6 to 250.3)	0.7 (0.4 to 1.2)
Flathead, Sand	67.3 (60.7 to 80.5)	71.1 (44.2 to 114.1)	n/a
Flathead, Tiger	164.2 (104.8 to 208.5)	4.6 (1.5 to 10.8)	n/a
Octopus	16.7 (10.7 to 29.9)	459.5 (236.9 to 701.8)	0.6 (0.01 to 1.9)
Shark, Fiddler	76.8 (68.6 to 87.8)	21.9 (17.4 to 28.0)	n/a
Trevally, Silver	184.3 (121.0 to 235.2)	1.0 (0.19 to 3.3)	n/a
Key Secondary Species			
Crab, Blue Swimmer	4.1 (1.9 to 7.5)	35.1 (20.1 to 50.7)	n/a
Boarfish	4.4 (1.9 to 7.5)	3.8 (2.2 to 5.8)	n/a
Dory, John	23.9 (16.1 to 33.7)	5.6 (4.2 to 6.9)	n/a
Flounder	10.6 (8.5 to 13.8)	18.5 (17.0 to 19.9)	n/a
Latchet + Gurnard	31.1 (27.1 to 39.7)	2.0 (1.7 to 2.5)	0.4 (0.0 to 1.4)
Moonfish	1.6 (0.5 to 3.1)	1.2 (0.3 to 3.8)	n/a
Morwong, Rubberlip	12.3 (8.8 to 19.5)	0.3 (0.1 to 0.5)	n/a
Mullet, Red	5.2 (2.9 to 9.4)	23.6 (17.5 to 37.9)	n/a
Redfish	47.4 (22.4 to 66.7)	2.3 (1.0 to 4.4)	n/a
Shark, Angel	23.3 (18.0 to 27.0)	6.9 (5.9 to 7.7)	0.1 (0.03 to 0.2)
Sole	1.2 (0.8 to 2,4)	7.4 (5.3 to 11.1)	n/a
Squid	18.9 (6.3 to 30.1)	48.8 (36.1 to 59.5)	1.3 (0.4 to 2.3)

Data are not presented in the table for:

- the three prawn species (school and eastern king prawns are taken almost exclusively by the prawn trawl sector, while royal red prawns are taken exclusively by the royal red prawn trawl sector);
- school whiting (which are to be the target of new gear types to be introduced under the FMS);
- leatherjackets and ‘mixed’ sharks, where the species composition of catches needs to be better determined before any useful data on catch by sector could be summarised.

APPENDIX D5 Arrangements relating to the management of trawling for school whiting

The following arrangements will apply with respect to trawling activities for the targeting of school whiting. Different arrangements apply to the areas between Barrenjoey Headland to Smoky Cape and Smoky Cape north, as outlined below.

Waters between Barrenjoey Headland and Smoky Cape

(1) A new triple gear trawl net for catching prawns and whiting to be designed and introduced [see point (5) below] and in the interim:

- Require prawn trawl cod ends to be made from (max.) 4 mm single twine, with a maximum of 150 meshes round (hanging ratio of 1:1), with a 40-50 mm mesh size
- Require the use of a square mesh panel BRD (constructed as per the requirements outlined in point (i) below) or another approved BRD on prawn trawl nets,

(i) the square mesh panel is to be constructed as a single panel with:

- the base of the panel positioned in the top of the anterior of the cod end either within 40 meshes of the cod end drawstring or within 3 meshes above the start of the bell (ie. where the number of meshes is increased)
- a minimum 65 mm mesh size and minimum surface area of 770 square cm, or a minimum 75 mm mesh size and minimum surface area of 650 square cm, and
- a bating rate of at least 3 points to each bar located on the anterior and posterior end of a panel made of 65-75 mm mesh and at least 4 points to each bar located on the anterior and posterior end of a panel made of >75 mm mesh (where ‘points’ refers to the corner of a mesh that attaches to the panel, and ‘bar’ means the side of a single square mesh within the panel to which the points of the trawl net are attached).

(2) A new single gear trawl net for catching whiting to be designed and introduced [see point (5) below] and in the interim:

- Require cod ends used in waters deeper than 55 m to be made from (max.) 6 mm single twine, with a maximum of 100 meshes round (hanging ratio of 1:1), with a 90 mm minimum mesh size
- Provide for the use of existing lawful cod ends (including double braided 90 mm cod ends) for targeting whiting on grounds less than 55 m in depth

(3) Require all fishing businesses with entitlements in the Commonwealth Southern and Eastern Scalefish and Shark Fishery to provide information from their vessel monitoring system (VMS) to NSW Fisheries. This would depend on making a link with an existing (eg. AFMA or Queensland) VMS.

Waters north of Smoky Cape

(4) A new triple gear trawl net for catching prawns and whiting to be designed and introduced [see point (5) below] and in the interim:

- Require prawn trawl cod ends to be made from (max.) 4 mm single twine, with a maximum of 150 meshes round (hanging ratio of 1:1), with a 40-50 mm mesh size

- Require the use of a square mesh panel BRD (constructed as per the requirements outlined in point (1)(i) above) or another approved BRD on prawn trawl nets

All waters north of Barrenjoey Headland

(5) A research project funded by fishing businesses with entitlements in the ocean trawl fishery will be conducted over the next three years, with industry input in the form of a working group to oversee the project, to:

- finalise the design of a triple trawl for catching prawns and whiting at optimum sizes and to minimise bycatch (Ideally, one new trawl design will be developed. Alternatively, it may be necessary to specify a design range that allows fishers to target their preferred species)
- design a single trawl for catching whiting at optimum sizes and to minimise bycatch
- assess the species biology of trawl whiting to identify the best sizes and times for harvest
- identify all primary trawl whiting areas, and
- recommend any other management arrangements for whiting (eg. lunar closures, day versus night time fishing, byproduct trip limits, need for daily catch and effort reporting).

Note: Opportunities for supplementary funding through external sources will be explored.

Implementation timetable for these arrangements

Points (1) – (2)	Medium term
Point (3)	Short term
Points (4) - (5)	Medium term

APPENDIX D6 Using changes in commercial landings as an indicator of stock status

A system to detect undesirable changes in landings will be used while stock assessments are being developed for primary and key secondary species. This primary monitoring tool is also likely to be in place for an extended period for the many species of lower value (and/or catch) that do not have better estimates of stock status. As biological reference points become available from stock assessments, monitoring based solely on landings will be phased out.

Monitoring systems based on landings such as those outlined in this management strategy are rarely formalised, and published examples of such systems could not be found. However, the large number and relatively low commercial value of species caught in most NSW fisheries means that some species must remain a relatively low priority for stock assessment. For these species, monitoring landings is the only practical choice.

A more sophisticated treatment of catch data often used in stock assessments is catch per unit effort (or CPUE) analysis. However, caution must be taken in analysing CPUE information for the reasons described in the box below.

Note on the use of catch per unit effort as an indicator of relative abundance

It is tempting to consider that there is a simple relationship between fish stock abundance and catch which has been scaled by units of fishing effort (known as catch per unit of effort or CPUE). Most stock assessment models assume that CPUE is directly proportional to stock abundance. This can only be the case if fishing effort is randomly distributed, and we know that this is seldom the case. Some fisheries target aggregations of fish, which can mean that CPUE stays high, even as total abundance drops because the remaining fish continue to aggregate.

The correct use of fishing effort data requires a good knowledge of the biology of each species that it is applied to, so that its spatial distribution can be adequately considered. Information about fishers' behaviour and gear is also important so that effort units can be standardised and changes over time can be accounted for.

An index of relative abundance based on CPUE is likely to be biased when applied to a range of species, even when caught by the same gear (Richards and Schnute, 1986). This means the application of CPUE information from commercial catch records would need to be adjusted for each species.

Finally, CPUE series need to take account of changes in reporting (see Pease and Grinberg, 1995) or other changes that may have changed catchability. The difficulties as they relate to the NSW Estuary General Fishery were discussed by Scandol and Forrest (2001). For these reasons, CPUE has not been used in the development of initial performance indicators and trigger points in this management strategy.

The aim of trigger points based on changes in landings is to force a review of a species' circumstance (i.e. status) when landings go beyond a reasonable expected range. Trigger points must be set at a level where they are sensitive enough to be likely to register a real problem but not so sensitive that they constantly trigger when there is no need for a review.

Trigger points will be set in a precautionary manner relative to known levels of variation in annual landings levels. That is, trigger levels will be set to be within the known range of past landings variation, leading to the expectation of "false alarms". This is desirable insurance that ensures reviews will be done when management action is needed.

There are a number of factors that must be considered when selecting a trigger level based on performance of fishery or species landings:

- level of variation in recorded historic landings
- management changes over time that may affect landings levels
- changes in the catch recording system that limit interpretation of landings data
- relevant environmental events
- changes in activities by important harvesters of that species.

All these factors have and will continue to influence how changes in catch can be interpreted.

The landings-based trigger points are designed to measure different types of changes in catch of the primary and key secondary species.

Trigger points based upon commercial landings have been calibrated to cause a review of a species' status when landings vary by an uncommon amount. The change that triggers a review is not an unprecedented change but rather a change that was well within the normal range of variation, but expected infrequently (perhaps once every five to ten years). The triggers are based on the variation in year-to-year changes in the historical landings data. The trigger points are set at a level of change that occurs less than 20% of the time. In other words, changes that are within the largest 20% of historical changes will trigger a review. This level of change is chosen to ensure that there will be a review if there is a dramatic change in the circumstances of a species over a short period. Setting the trigger points this way means accepting the inevitable "false alarms" when the performance indicator is at the edge of its natural range. The review will aim to determine if trigger breaches are "false alarms" or whether they indicate a need to change the species' status. The reference level for this short-term trigger system will be the landings during the previous year.

There are many potential improvements that could be made to these simple trigger points using commercial landings (Scandol 2003; Scandol in press). The most important limitation of the current trigger points is that they do not take into account information about upward or downward 'trends' in landings. Unfortunately any scheme that attempts to capture trends in the landings data requires additional parameters to be specified. For example, moving averages of the landings data can capture trends but requires the window of averaging years to be defined.

Several schemes are being investigated to interpret trends in landings or, for that matter, any indicator. A particularly promising method is the CUSUM, or cumulative sum control chart. Such methods are not, however, as easy to interpret as the simple interval-based trigger points. There is an important trade-off between the introduction of methods for interpreting indicators (and defining trigger points) that improve robustness but also have the potential to reduce transparency. It is likely that these statistically sophisticated methods for interpreting stock-status indicators would be most beneficially applied to indicators that are more robust than commercial landings.

As the stock assessment process is developed there will be careful consideration of appropriate indicators and trigger points for each species, and incorporating information about trends will be a priority when developing stock-status indicators. In cases where credible indices of abundances can be derived from catch per unit effort data, then these will be used as performance indicators. In most cases, more robust indicators of stock sustainability, such as the fraction of commercial catch that is immature, will be developed. Definition, evaluation, consultation and implementation of these indicators and trigger points will be the primary objective of the stock assessment strategy outlined above. Trigger points associated with stock-status indicators will always be specified in a precautionary manner.

How trigger points based on landings will be applied

The simple landings-based trigger is explained in the example shown in Figure 1. This example shows how the trigger points will work with a hypothetical starting point (five years ago), trigger levels and existing catch data.

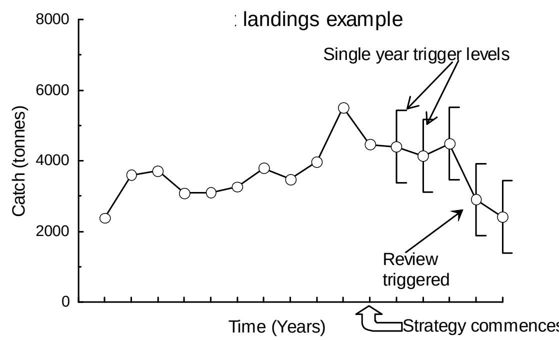


Figure 1. Hypothetical example of use of trigger levels for an ocean trawl species.

Table 1. Levels of trigger points for primary and key secondary species in the ocean trawl fishery that will be used to assist in determining a species' status.

Note: These levels will apply for the first year of the management strategy only. At each annual assessment the trigger levels for the next year will be calculated, using the most recent year of catch data as the new reference level. All values in the table are in tonnes. Silver trevally will be subject to a 'recovery program' and review will occur irrespective of whether the catch triggers are breached or not. Please note that reference to 'CI' in the average annual change column refers to 'confidence interval'.

Primary Species	**Reference Level (t) (2001/02 catch)**	**Average Annual Change (+80% CI)**	**First Upper Year Trigger**	**First Lower Year Trigger**
Eastern King Prawn	988.8	143.8	1132.6	845.0
School Prawn	489.7	325.2	814.9	164.5
Royal Red Prawn	133.8	62.2	196.0	71.6
Balmain Bug	56.9	30	86.9	26.9
Octopus	415.9	176.6	592.5	239.3
Cuttlefish	218.5	63	281.5	155.5
Southern Calamari	51.0	32.6	83.6	18.4
School + Stout Whiting	1243.7	142.6	1386.3	1101.1
Tiger Flathead	104	52.4	156.4	51.6
Sand Flathead	117.6	22.55	140.2	95.1
Silver trevally	297.1	63.9	361.0	233.2
Fiddler Shark	110.8	15.7	126.5	95.1
Key Secondary Species	**Reference Level (t) (2001/02 catch)**	**Average Annual Change (+80% CI)**	**First Upper Year Trigger**	**First Lower Year Trigger**
Blue Swimmer Crab	132.5	44.1	176.6	88.4
Squid + Arrow squid	68.5	39.27	107.8	29.2
Latchet + Gurnard	33.6	7.01	40.6	26.6
John Dory	22.5	13.49	36.0	9.0
Angel Shark	29.3	6.95	36.3	22.4
Flounder (mixed species)	26.7	5.4	32.1	21.3
Red Mullet	22.2	10.8	33.0	11.4
Redfish	45.2	29.85	75.1	15.4
Leatherjacket (mixed species)	241.5	28.6	270.1	212.9
Ocean Perch	34.6	34.5	46.1**	23.1**
Mirror Dory	10.2	27.8	13.6**	6.8**
Sole (mixed species)	7.3	3.23	10.5	4.1
Morwong, Rubberlip	65	32	97.0	33.0
Moonfish $	3.3	2.94	4.4**	2.2**
Boarfish	9.8	3.43	13.2	6.4
"Sharks" (mixed species*)	277.3	91.1	368.4	186.2

** Trigger catches set at 2/3 and 4/3 of Reference Level (to avoid near-zero lower trigger).

* 'Mixed species' includes whalers, hammerhead, tiger, dogfish, gummy, carpet, ghost, saw and unspecified sharks.

$ Moonfish (preferred common name pink tilefish) are currently recorded as "opah" on the catch database.

Appendix D7 Species Synopses for the Primary and Key Secondary Species

Analyses of landings data identified 28 species or species groups that could be considered ‘primary’ or ‘key secondary’ species for trawling in ocean waters off NSW.

This appendix presents a summary of the level of interaction of the ocean trawl fishery with each of these species or species groups, and provides a brief description of what is currently known of the distribution, biology and status of each species. Information has been drawn from a wide variety of sources, including published and unpublished papers and reports, landings data held by NSW Fisheries, and reference texts. (Note that individual references are not given in the text for the sake of brevity.)

The following summary table has been prepared for the ‘primary’ species in the ocean trawl fishery.

Summary Table for Primary Species

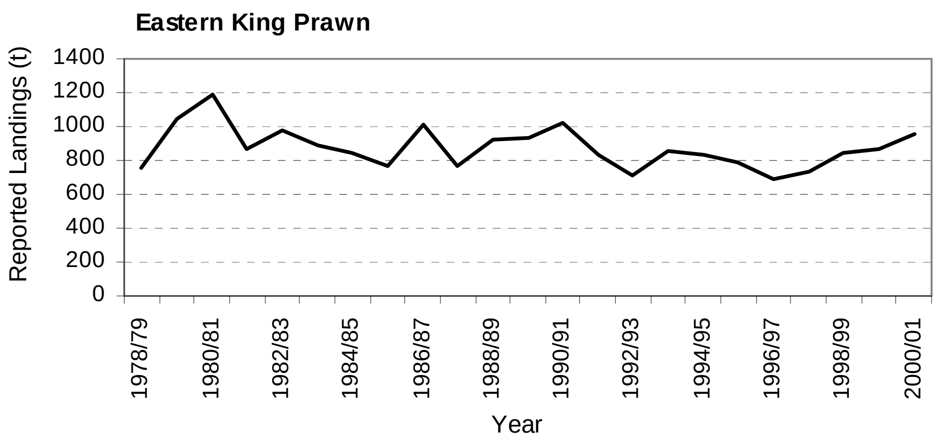
Species	**NSW O/Trawl annual catch and trend**	**Other significant fisheries**	**Biological Knowledge**	**Stock Assessment**	**Issues**
Eastern King Prawn	900 – 1000 t stable	Qld EC trawl Est Gen, Vic, Recreational	Good	Preliminary	Size at first capture Need to ensure adequate recruitment
School Prawn	100 – 300 t reduced	Est Prawn Trawl Est Gen	Reasonable	Very Preliminary	Size at first capture Current research project
Royal Red Prawn	200 t reduced	SEF	Reasonable	NO	SEF overlap Incidental catches
Balmain Bugs	40 t recent decline	SEF, Qld EC trawl	Reasonable	NO	Species identification Slow growth rate
Octopus	250 - 450 t reduced	SEF Qld EC trawl.	Poor	NO	Species identification Lack of biol. knowledge
Cuttlefish	150-250 t reduced.	SEF Qld EC trawl.	Poor	NO	Species identification Lack of biol. knowledge
Southern Calamari	80 – 100 t stable	All southern states	Poor	NO	Targeted Lack of monitoring data
School Whiting	800 – 1000 t stable?	Qld trawl SEF	Reasonable	NO	Two species New gear to be implemented
Tiger Flathead	80 – 100 t stable	SEF	Good	Preliminary	Potential overfishing in SEF Species identification
Sand Flathead	100 – 140 t recently stable	Recreational	Poor	NO	Poor biological knowledge Lack of monitoring data
Silver Trevally	100 t long-term decline	SEF Trap & Line Recreational	Good	Preliminary	Multiple sectors Growth overfished Trawl gear selectivity
Fiddler Shark	100 – 120 t stable	Recreational	Poor	NO	Common names and identification of sharks Lack of biological knowledge

Eastern King Prawns *Penaeus plebejus*

Distribution

Estuarine and continental shelf waters from southern Queensland to north-eastern Tasmania (22º to 42º S latitude). Spawning is known to occur in ocean waters off northern NSW and southern Queensland. Juveniles and immature adults occur in estuarine and near shore waters.

Catch trend in NSW Ocean Trawl



Annual landings of eastern king prawns from NSW ocean waters have been relatively stable at 800-1000 t since the early 1980s. During the mid 1990s there was a series of years when catches were at the lower end of this range, but in 2000/01 a relatively high catch was recorded.

Catches by other fisheries / jurisdictions

Significant numbers of small eastern king prawns are taken by both commercial and recreational fishers in NSW estuaries. Commercial landings from NSW estuaries range between 50 and100 t per annum, and recreational catches are estimated to be around 30% of the commercial catch. Trawling in ocean waters off southern Queensland accounts for 1700 – 2000 t of eastern king prawns annually. The majority of these are large, mature prawns. An additional 150 – 200 t of eastern king prawns are trawled from Moreton Bay each year. Eastern king prawns are also targeted by trawlers off eastern Victoria.

Biological characteristics / level of knowledge

There is reasonably good information available about the life history, growth, migration and reproductive biology of eastern king prawns. The population off NSW is considered a unit stock, with individuals shown to potentially migrate the full length of the NSW coast. Stock structure off southern Queensland is uncertain. Yield per recruit and optimum size at first capture have been estimated for the NSW fishery, and a 'compartmental' population model has been developed for the stock off NSW.

Stock status - Growth overfished

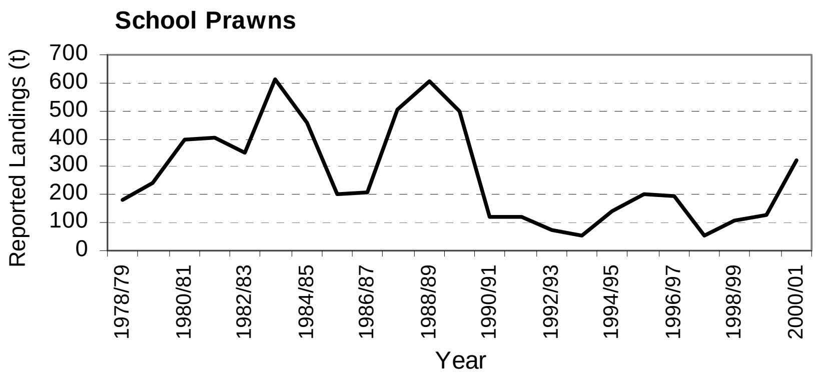
A formal assessment for the eastern king prawn stock has not been published, but there has been considerable analysis of the available data and the stock is considered to be fully fished. In Queensland there is some concern that abundance of juvenile king prawns in inshore nursery grounds has declined over the past 3 decades. In NSW, if catches by all fisheries are taken into account then the stock can be considered to be growth overfished, and an appropriate size at first capture needs to be implemented for the relevant fisheries.

School Prawns *Metapenaeus macleayi*

Distribution

Estuarine and near-shore coastal waters from southern Queensland to eastern Victoria (25º to 38º S latitude). School prawns occur mainly in estuarine waters as juvenile and young adults. Mature prawns are found mainly at sea, in coastal waters near the mouths of large estuaries, where spawning occurs. The population of school prawns from within a given estuary might be considered a separate unit stock to those from other estuaries (while apparently being genetically similar).

Catch trend in NSW Ocean Trawl



Annual landings of school prawns from ocean waters apparently exceeded 1000t in the early 1970s. School prawn catches since the mid 1980s suggest cyclical peaks in availability. During the 1990s school prawns were generally less available in ocean waters than during the preceding decade. The ocean waters catch improved in 2000/01, but was still well below historic levels.

Catches by other fisheries / jurisdictions

Significant quantities (600 to 900 t per annum) of school prawns are landed from NSW estuarine waters by commercial fishers in both the Estuary Prawn Trawl and Estuary General fisheries. Catches of school prawns by recreational fishers are low. School prawns form part of the "Bay" prawn harvest in southern Queensland, which produces 300-600 t per annum, and small catches are landed from the Gippsland Lakes in eastern Victoria. School prawns taken in estuaries comprise mainly juvenile and immature prawns, which are on average considerably smaller than school prawns taken in ocean waters.

Biological characteristics / level of knowledge

Only limited information is available on the biology, life history and population dynamics of school prawns. Discrete 'stocks' have been proposed within the species' range, but little study has been directed at this issue. Description of the portion of the stock(s) exploited by the different fishery sectors is rudimentary, and based on some historic studies. A 3-year FRDC funded research project commenced in July 2003 and will study growth and mortality rates of school prawns in NSW waters.

Stock status - Growth overfished

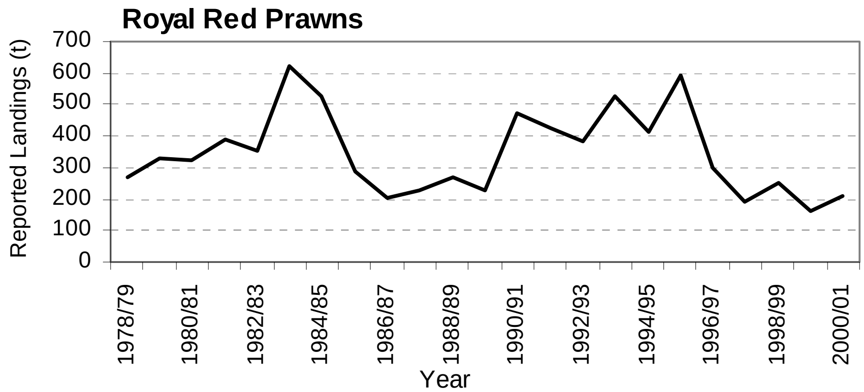
An adequate stock assessment is not available for the school prawn resource. Preliminary analyses of the available data suggest that in some areas school prawns can be considered to be growth overfished, but further study is required to confirm this assessment. Results from the current FRDC-funded research project will contribute to an improved stock assessment for school prawns in coming years.

Royal Red Prawns *Haliporoides sibogae*

Distribution

Continental slope waters at depths of 220 to 820 m. Widely distributed off eastern, southern and western Australia, and New Zealand.

Catch trend in NSW Ocean Trawl



Reported landings of royal red prawns from ocean waters off NSW (north of Barrenjoey Pt, approx. 33º 35'S latitude) have fluctuated between 200 and 600 t annually. Reported landings suggest a cyclical trend in availability, with peaks in the mid 1980s and the mid 1990s. Landings in recent years have been at the lower end of the range, around 200 t per annum. The market price received by fishers for royal red prawns has shown little increase since the 1980s, and market factors can influence the degree of targetting.

Catches by other fisheries / jurisdictions

Off eastern Australia, trawlers fishing in the Commonwealth-managed South East Trawl Fishery catch significant quantities of royal red prawns. In the SETF, royal red prawns are subject to an annual TAC of 500 t, with recorded landings of 200 – 300 t in recent years, except for 2000 when 434 t were landed. There is no recreational catch of royal red prawns, nor are they taken by any other NSW commercial fishery.

Biological characteristics / level of knowledge

Growth rates and reproductive biology of royal red prawns have been studied for prawns caught in the South East Trawl Fishery area, south of Sydney, but there is little recent information available on trends in catch composition, which would allow an assessment of the current status of the resource. Little research relevant to the resources north of Sydney has been conducted.

Stock status - Moderately Fished

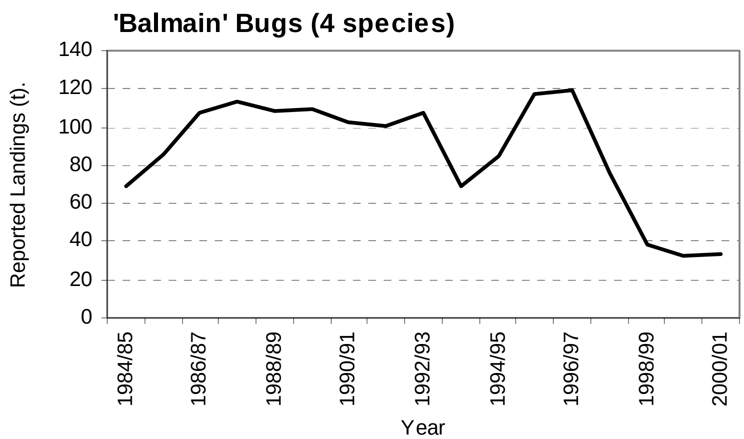
No stock assessment is available for royal red prawns off eastern Australia.

Balmain Bugs *Ibacus* species (also known as shovelnosed lobsters)

Distribution

Trawlers off NSW catch four species of ‘bugs’. The Balmain bug *Ibacus peronii* occurs on inshore grounds (<80 m deep) along the length of the NSW coast, and off other southern Australian states. The ‘smooth’ bug, *I. chacei,* generally occurs on deeper grounds (50 to 150 m) off the north coast of NSW and southern Queensland, and is the predominant bug caught by prawn trawls in this area. A less common species, Bruce’s bug, *I. brucei*, also occurs in small quantities in prawn trawls on deeper continental shelf grounds off northern NSW. These three species of ‘Balmain’ bugs are not differentiated in catch returns. The smaller deepwater bug, *I. alticrenatus*, occurs at depths of 200 to 400 m off southern Australia, and is caught off NSW by trawlers targeting fish or prawns at these depths.

Catch trend in NSW Ocean Trawl



Landings of bugs were generally stable at around 80 - 120 t per annum until the mid 1990s, but declined in 1998/99. In June 1999 a Minimum Legal Size of 100 mm (carapace width) was introduced for ‘Balmain’ bugs (excluding the deepwater bug), based on the average size at maturity of female bugs. Annual landings have since been around 30 - 40 t per annum.

Catches by other fisheries / jurisdictions

Balmain bugs are taken as an incidental catch by other trawl fisheries off southern Australia. Smooth bugs are a significant by-catch (about 5% of total bug catch) of prawn trawlers operating off southern Queensland (the majority of ‘bugs’ reported by Queensland trawlers are ‘Moreton Bay Bugs of the genus *Thenus*). Small quantities of bugs are caught incidentally in spanner crab traps. There is no recreational fishery for bugs in NSW.

Biological characteristics / level of knowledge

Targeted research conducted during the past decade has revealed distinct differences in life history between the Balmain and smooth bugs. Growth rates and maximum age (>10 years) appear similar for both species. However, tagged smooth bugs showed a distinct northward movement pattern that was not evident for tagged Balmain bugs. Studies of reproductive biology suggest smooth bugs move to warmer waters off Queensland to spawn, whereas Balmain bugs spawn throughout their range off NSW. Less is known about the biology of Bruce’s bugs and deepwater bugs. Sexed size composition data are available for bugs caught in research trawls by FRV Kapala and from sporadic monitoring of the size composition of commercial landings.

Stock status - Fully Fished (but several similar species need to be separately identified)

No detailed stock assessments are available for any of the 'bug' species taken by trawlers off NSW. In Queensland, the fact that bugs are relatively long-lived crustaceans, with low fecundity and relatively low population densities has led to concern that they may be vulnerable to overexploitation.

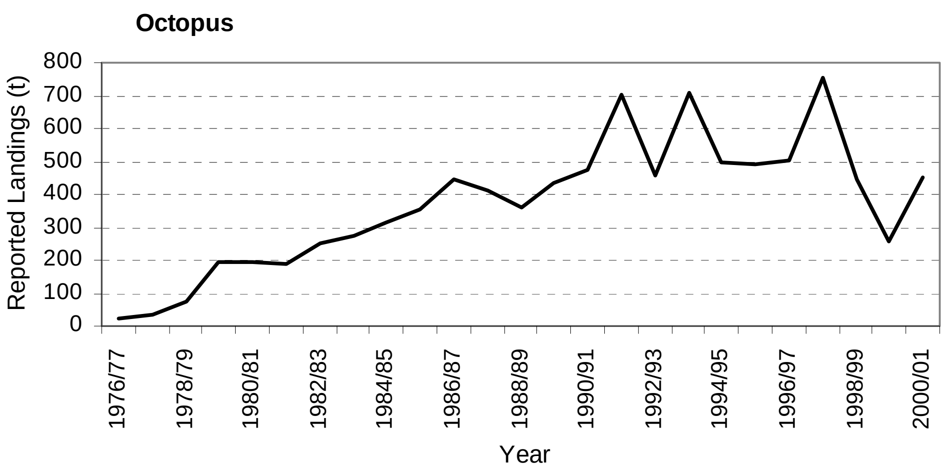
Octopus *Octopus* species

Distribution

At least ten species of octopus are taken in ocean trawls off NSW, but there is little information on the relative occurrence of the various species in commercial trawls. The following information is based on observations from research catches made by FRV Kapala.

Large octopus in trawl catches were generally the Sydney octopus (*O. tetricus*) or, on southern grounds, the Maori octopus (*O. maorum*). Small octopus in trawl catches were mainly the hammer octopus (*O. australis*), and in southern areas the pale octopus (*O. pallidus*). A number of other small, thin octopus were also recorded in trawl catches, but were unlikely to be marketed in significant quantities (these included the southern white-spot octopus *O. bunurong*, the southern keeled octopus *O. berrima*, the club pygmy octopus *O. warringa* and the southern sand octopus *O. kaurna*).

Catch trend in NSW Ocean Trawl



Reported landings of octopus increased to about 500-600t in the early 1990s. Landings declined to 250 in 1999/2000 but increased to 450t in 2000/01.

Catches by other fisheries / jurisdictions

Octopus species comprise an important incidental catch in other demersal trawl fisheries, and off southern Australia there is a small targeted 'trap' fishery for octopus. Small quantities of octopus are landed by recreational fishers.

Biological characteristics / level of knowledge

The level of biological knowledge of octopus in the wild could be said to be very poor. Correct identification of the various species is difficult, and has not generally been encouraged in the past. Some species have only recently been formally described.

Stock status - Uncertain **(species composition of catches needs to be determined)**

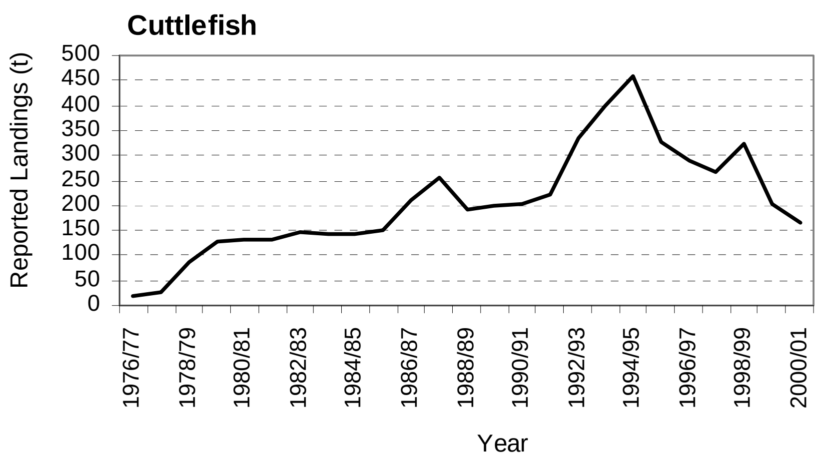
No stock assessments are available for any octopus species in NSW.

Cuttlefish *Sepia* species

Distribution

At least 11 species of cuttlefish are known to occur in trawl catches off NSW, but as for octopus, there is little information about the relative levels of occurrence of the different species in commercial trawl catches. Apart from the giant cuttlefish (*S. apama*) which grows to more than 5kg in weight, the other species of cuttlefish trawled off NSW are small animals, reaching a maximum length of about 20 cm and weight of about 250 g. Data from trawl catches by FRV Kapala suggested that the most commonly encountered species which were likely to be commercially important were *S. rozella* and *S. opipara* in prawn trawls and *S. rozella, S. rex* and *S. cultrata* in fish trawls.

Catch trend in NSW Ocean Trawl



Reported landings of cuttlefish increased to about 150 – 250 t in the mid 1980s, and to a peak of 450 t in 1994/95, before declining to 200 t in 1999/2000.

Catches by other fisheries / jurisdictions

Catches of cuttlefish by other NSW fisheries are not believed to be significant. Cuttlefish are taken as an incidental catch by demersal trawl fisheries operating under other jurisdictions (mainly by fish trawl in the SEF and prawn trawl off Queensland).

Biological characteristics / level of knowledge

The level of knowledge of cuttlefish biology and population dynamics is very poor. With the possible exception of the giant cuttlefish, they are assumed to be short lived (1-2 years) species with relatively high productivity, but this has not been clearly documented. No information is available on the species or size composition of commercial catches. Biological and stock structure studies on the giant cuttlefish *S. apama* are underway in South Australia, where a commercial target fishery has been closed until more is known of the biology and dynamics of the population.

Stock status - Uncertain **(species composition of catches needs to be determined)**

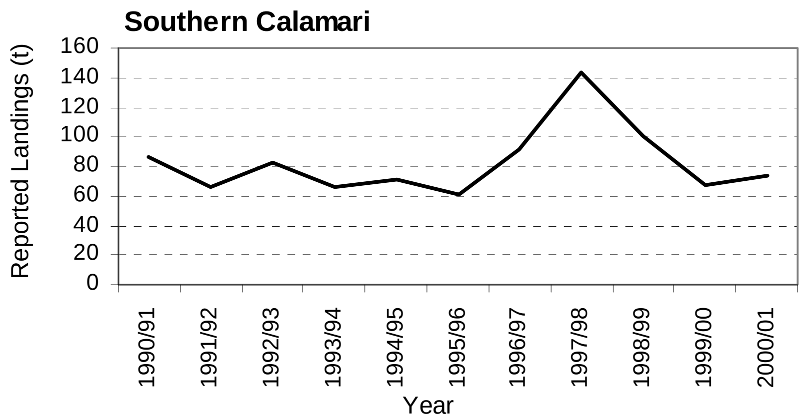
No stock assessments are available for any cuttlefish species in NSW.

Southern Calamari *Sepioteuthis australis*

Distribution

Southern calamari are found in estuarine and near-shore coastal waters around the southern coastline of Australia, and in northern New Zealand (latitude range 25º to 43ºS). The species is a significant catch in fish trawls in the Sydney to Port Stephens area of NSW.

Catch trend in NSW Ocean Trawl



Landings of southern calamari have only been recorded separately since 1990. Trawl landings have been relatively stable at around 60 to 80 t per annum, except for a period in the late 1990s when landings exceeded 100 t per annum.

Catches by other fisheries / jurisdictions

Significant quantities of southern calamari are taken by recreational anglers in NSW. Commercial and recreational fisheries for the same species are significant in all southern Australian states.

Biological characteristics / level of knowledge

Southern calamari is reported to be a relatively fast growing, short lived species, with a maximum age of about 1 year. The biology of the species has been studied off Southern Australia – sexual maturity was attained at about 7-8 months of age, and spawning occurred mainly during the summer months in relatively shallow (3 - 5 m) waters. Females attach batches of eggs (numbering up to several hundred) to the substrate. Multiple batches may be spawned in one season.

Stock status - Unknown (only fishery catch data are available)

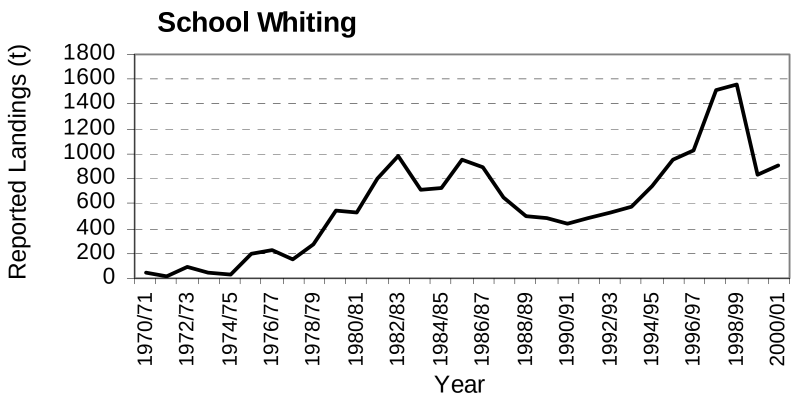
No stock assessment is available for southern calamari in NSW.

School Whiting *Sillago flindersi* (Red spot whiting) *Sillago robusta* (Stout whiting)

Distribution

Red spot whiting occur from southern Queensland to western Victoria. Early evidence suggested two stocks in this range, with the division between 'northern' and 'southern' stocks in the Sydney – Jervis Bay area. However the evidence for two stocks was weak, and current management assumes a single stock. Stout whiting is a sub-tropical species which occurs from W.A. to northern NSW. Stout whiting off southern Queensland and northern NSW are thought to belong to a single 'eastern' Australian stock.

Catch trend in NSW Ocean Trawl



School whiting were generally discarded by NSW trawlers until an export market developed in the 1970s. Landings increased to 800-1000 t in the late 1980's, declined to 500 t in the early 1990's, and peaked at 1500 t in 1998/99. The decline to 1000 t in 1999/2000 was apparently associated with the introduction of BRDs into the prawn trawl fishery, but catches have recently increased from this level.

Catches by other fisheries / jurisdictions

School whiting are not taken in significant quantities by any other commercial or recreational fisheries in NSW. 'Eastern School Whiting' (mainly red spot whiting *S. flindersi*) is a SEF quota species, targeted mainly by Danish seine boats off Lakes Entrance. Recent TACs for school whiting in the SEF have been around 1500 t, but annual landings from Commonwealth waters have been around 500 t. A targeted trawl fishery for stout whiting of southern Queensland has seen declining effort and catch since the mid 1990s. Recent landings have been around 500 t annually, from a maximum of 5 vessels participating in the fishery.

Biological characteristics / level of knowledge

There has been considerable research into the biology of both red spot and stout whiting. Growth rates and reproductive biology of both species have been determined. Information is available from research trawls conducted by FRV Kapala on the distribution and size composition by depth of both species. Some limited information is available on the size composition of NSW commercial landings.

Stock status - Fully fished

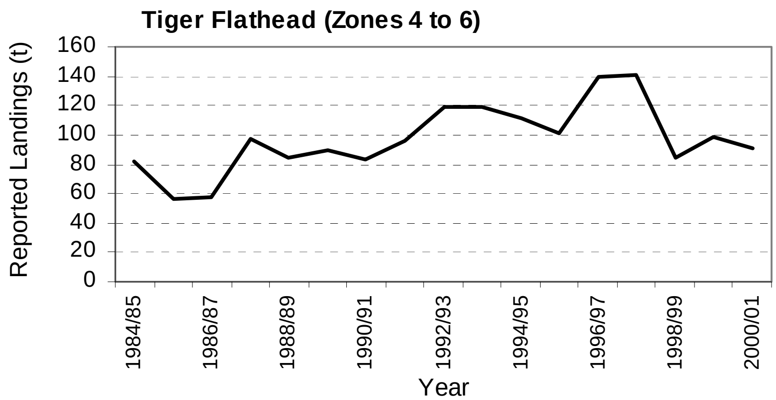
Preliminary stock assessments have been conducted for red spot whiting in the SEF and for stout whiting in Queensland. There is a need to carry out similar analyses for both species using data from the NSW fishery.

Tiger Flathead *Neoplatycephalus richardsoni*

Distribution

Tiger flathead occur from northern NSW to Tasmania, at depths of 40 to 300 m. They can easily be confused with a similar species, the ‘toothy’ or ‘gold-spot’ flathead *N. aurimaculatus*, which is common in the southern part of the range, especially in eastern Bass Strait. Trawling for fish off NSW originally concentrated on targeting tiger flathead, and the species remains significant in recent trawl landings despite being overfished in the 1950s and 1960s.

Catch trend in NSW Ocean Trawl



Landings of tiger flathead in NSW waters are difficult to separate from landings made under Commonwealth jurisdiction in the South East Trawl Fishery (SETF). The figure above shows landings reported for Ocean Zones 4 to 6 in NSW (from Smoky Cape to Sydney), which should have minimal overlap with Commonwealth waters. Landings in this area have been relatively stable at 80 to 120 t since the late 1980s.

Catches by other fisheries / jurisdictions

In NSW, tiger flathead are not taken in significant quantities by any other commercial fisheries, however about 10 – 20 t are estimated to be taken annually by recreational and charter boat fishers. Tiger flathead is included in the ‘flathead’ TAC for the SEF, which is currently set at about 3,500 t. Landings of ‘flathead’ in the SEF in 2001 were about 2,600 t – tiger flathead was the main species landed under this category.

Biological characteristics / level of knowledge

The biology and population dynamics of tiger flathead have been studied in detail since the species was first fished over 80 years ago. Growth rates and general biology have been well documented, and there is a reasonable level of monitoring information available for SEF catches. Information is also available from monitoring of the size composition of catches taken under NSW jurisdiction in the early 1990s and also for recent years.

Stock status - Fully fished

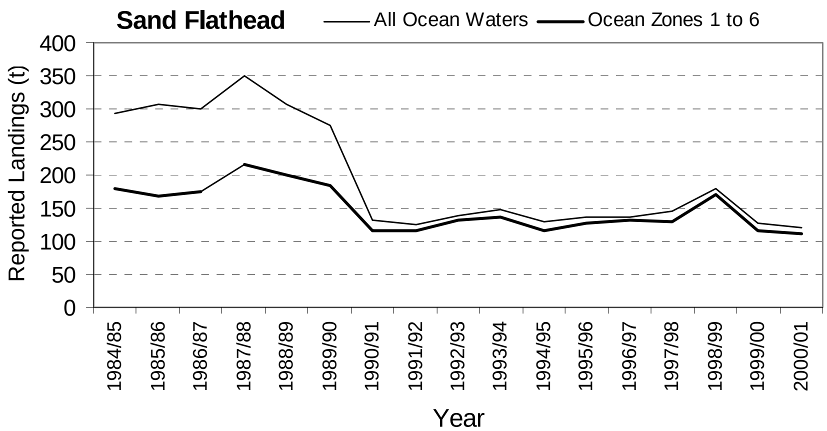
Despite the availability of much useful data, an authoritative stock assessment for tiger flathead is not currently available for the SEF. Historical assessments suggested the sustainable yield for the tiger flathead stock was around 2,500 t per annum. The current situation needs to be assessed in light of the multiple species included in the SEF catch, and the lack of an appropriate minimum legal length in Commonwealth waters.

Sand Flathead *Platycephalus caeruleopunctatus*

Distribution

Sand flathead (also called 'blue-spotted' flathead) occur at depths of 10 to 100 m in waters from southern Queensland to eastern Victoria. Two similar species may also occur less frequently in catches off NSW - the 'bar-tailed' flathead *P. indicus,* which occurs in inshore waters to 50 m depth throughout Queensland to northern NSW, and the 'northern sand flathead *P. arenarius*, which occurs in coastal waters to 60 m depth throughout most of NSW.

Catch trend in NSW Ocean Trawl



Historic landings of sand flathead in NSW waters are difficult to separate from landings from waters under Commonwealth jurisdiction. Prior to 1990/91 it appears that quantities of other flathead species may have been reported as 'sand flathead'. Landings of sand flathead by NSW ocean trawl fishers occur mainly in ocean zones 1 to 6 (north of Sydney). Reported landings for this area have been generally stable at around 120 -150 t during the past decade.

Catches by other fisheries / jurisdictions

Very significant catches of sand flathead (estimated in the early 1990s to be 200 – 230 t per annum) are made by recreational fishers in NSW ocean waters. Small landings (5 – 10 t per annum) are reported by other inshore commercial fisheries in NSW. Some sand flathead are included in catches of 'flathead' reported by SEF trawlers (accurate estimates of quantities are not readily available, but could be determined from observer data).

Biological characteristics / level of knowledge

Given its significance to commercial and recreational fisheries in NSW, surprisingly little research and monitoring has been carried out on sand flathead. Growth rates and reproductive biology have not been documented. Size composition data were collected as part of a recreational survey in the early 1990s, and there are also data from research trawls conducted by FRV Kapala. There has also been some sporadic monitoring of the size composition of commercial trawl catches at the Sydney Fish Markets, however useful data are limited.

Stock status - Fully fished

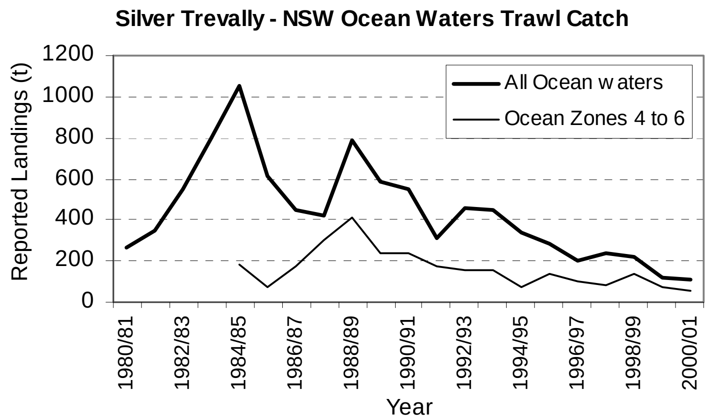
Despite its significance in both commercial and recreational catches, there is no stock assessment available for sand flathead.

Silver Trevally *Pseudocaranx dentex*

Distribution

Silver trevally occur in estuarine and coastal waters from northern NSW to eastern Victoria, and also in shallow waters around Lord Howe Island. A single genetic stock is assumed in this area. The same species also occurs in New Zealand.

Catch trend in NSW Ocean Trawl



Landings of silver trevally by NSW trawl fishers have consistently declined since the 1980s, from 800-1000 t to about 100 t in recent years. The decline in landings has been apparent in both the NSW area (Zones 4 to 6 in the graph above) and all ocean waters (which includes some landings from the SETF management area).

Catches by other fisheries / jurisdictions

Significant quantities (about 100 t per annum) of silver trevally are taken by the ocean trap and line fishery. The species is also very important in recreational catches, with about 120 t estimated to be caught by anglers in ocean waters in the early 1990s, however the most recent estimate of recreational landings of silver trevally in NSW was about 87 t. Silver trevally is a SEF quota species – in 2001 the trawl TAC was 574 t of which 139 t was landed, and the non-trawl TAC was 50 t of which just 2 t was landed.

Biological characteristics / level of knowledge

A research project on the biology of and fishery for silver trevally was completed in 2000. Trevally is a relatively long-lived species with a maximum age exceeding 20 years. They spawn throughout the summer months, with females producing 50 to 200 thousand eggs per spawning. Analysis of historic data suggested that fishing over the past two decades has had a significant impact on population structure, with a large reduction in the mean size of fish caught. Yield per recruit analyses show the current size at first capture by trawl gear is well below the optimum size. A minimum legal length of 30 cm total length (25 cm LCF) has been proposed.

Stock status - Growth overfished

The preliminary stock assessment conducted during 2000 found that silver trevally could be considered to be growth overfished – fish are being caught, on average, at a size which is well below the 'optimum' size (the size at which the biological yield is maximised).

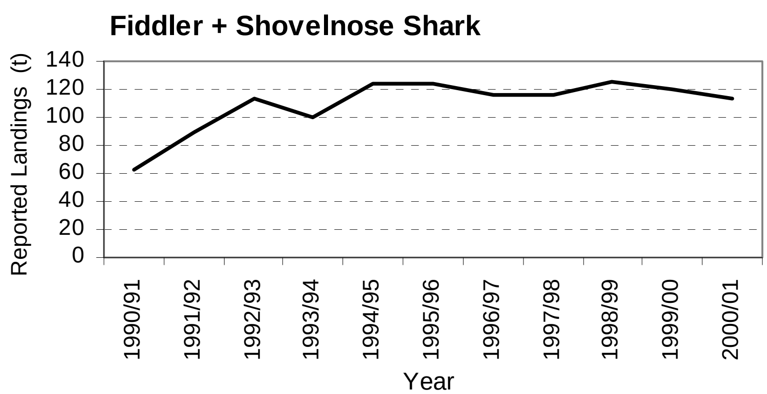
Fiddler Shark *Aptychotrema rostrata* (shovel nosed shark / ray)
Trygonorrhina 'species A' (fiddler or banjo shark / ray)

Distribution

Shovel nosed sharks *A. rostrata* (more correctly termed shovel nosed rays) occur in estuarine and continental shelf waters to depths of at least 50m, between southern Queensland and southern NSW (latitude range 27º to 36º S). The majority of the trawl catch reported as "fiddler shark" in NSW consists of shovel nosed rays, although banjo rays (*Trygonorrhina* species A), which have a similar geographic distribution, are also reported under this category.

Larger shovel nosed sharks/rays, the white-spotted guitarfish, *Rhynchobatus australiae*, and the giant shovel nosed ray *Rhinobatos typus* also occur in trawl catches from waters off northern NSW. These two species are broadly distributed throughout northern Australia and the northern Indian ocean.

Catch trend in NSW Ocean Trawl



"Fiddler shark" and "shovel nosed shark" have only been recorded as separate species categories on monthly fisher's catch returns since the early 1990s. Commercial landings have been relatively stable at around 110-120 t since the mid 1990s. All species reported as fiddler sharks are dressed before marketing (headed, gutted and generally finned) - the reported landed weights refer to the weight of dressed carcasses.

Catches by other fisheries / jurisdictions

Landings of fiddler and shovel nosed rays by other NSW commercial fisheries are low, and catches taken under other jurisdictions (e.g. by trawling off southern Queensland) are thought to be small. Significant numbers of shovel nosed rays are taken by recreational anglers.

Biological characteristics / level of knowledge

There has been very little research or biological monitoring conducted on fiddler and shovel nosed rays. Two papers on reproductive biology and feeding in Moreton Bay have recently been published. Some length frequency data are available from FRV *Kapala* trawl catches, and NSW Fisheries has some unpublished biological data from Sydney area, collected during research related to the deepwater ocean outfalls.

Stock status - Uncertain (species composition of the catch needs to be determined)

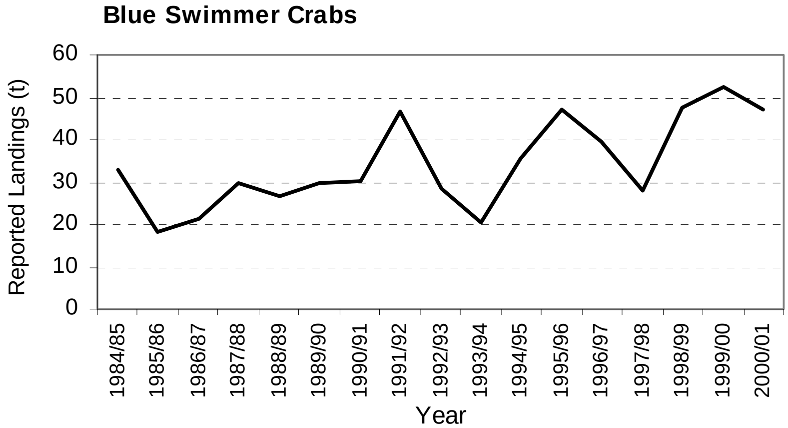
No stock assessment is available for shovel nosed or fiddler rays in NSW waters.

Blue Swimmer Crab *Portunus pelagicus*

Distribution

Blue swimmer crabs occur in estuarine and near shore coastal waters to about 50 m depth, around most of the Australian mainland. It is probable that separate stocks occur within this broad distribution, but stock structure has not been studied. It is likely that a single stock exists within the area fished by the NSW ocean trawl fishery.

Catch trend in NSW Ocean Trawl



Landings of blue swimmer crabs by NSW ocean trawlers have been relatively stable at 30 to 50 t per annum since the mid 1980s.

Catches by other fisheries / jurisdictions

In NSW, blue swimmer crabs are primarily taken in the estuary general (200 t) and recreational fisheries (155 t), while small quantities are also landed by the estuary prawn trawl fishery. Blue swimmer crabs are significant in commercial and recreational fisheries in all mainland Australian states.

Biological characteristics / level of knowledge

Blue swimmer crabs are thought to be relatively fast growing, living for a maximum of 18 months - 2 years. Females are reported to spawn several times in a season, and have a high fecundity (up to 2 million eggs).

Stock status - Fully Fished

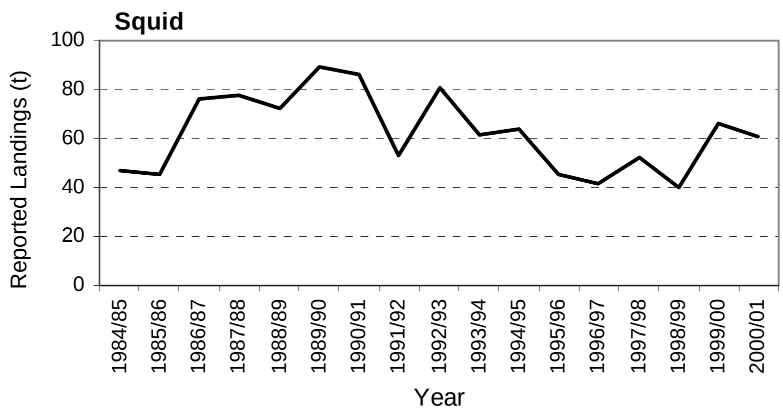
Blue swimmer crabs are exploited by a number of commercial fisheries and are taken in significant quantities by recreational fishers. Some concerns have been expressed about the appropriateness of the current minimum legal length and the size at first capture, but more information is needed to determine the status of the NSW stock.

Squid *Nototodarus gouldi* (Arrow squid)
Loligo chinensis (Mitre squid)
Photololigo spp (Pencil squids)

Distribution

Several species of squid are landed by ocean trawlers in NSW. In inshore waters, squid taken by trawling are mostly mitre squid *Loligo chinensis* and pencil squid *Photololigo* species. In offshore waters the arrow squid *Nototodarus gouldi* is the dominant species taken. The various species are not separated in landings records.

Catch trend in NSW Ocean Trawl



(Note: graph includes catches by ocean prawn trawl for all areas and ocean fish trawl for ocean zones 4-6 only, to minimise possible overlap with catches made in the Commonwealth SEF)

Squid landings by NSW ocean trawl fishers have been relatively stable at 40 to 80 t per annum since the mid 1980s.

Catches by other fisheries / jurisdictions

In NSW, squid are also landed by the Estuary Prawn Trawl fishery (50 t), and in small quantities by recreational fishers (most squid taken by recreational fishers are southern calamari). Off south-eastern Australia, significant catches of (mostly arrow) squid are also landed by the South East Trawl fishery (500 t) and a target squid-jig fishery (1000 - 1500 t).

Biological characteristics / level of knowledge

All squid species are thought to be fast growing and short lived (max. age of 2 years). The females lay clutches of eggs that are generally attached to the substrate. Both sexes apparently die soon after spawning.

Stock status - Uncertain (

Little information is available on the species composition of trawl catches of squid or the status of the stocks of the various species in the catch.

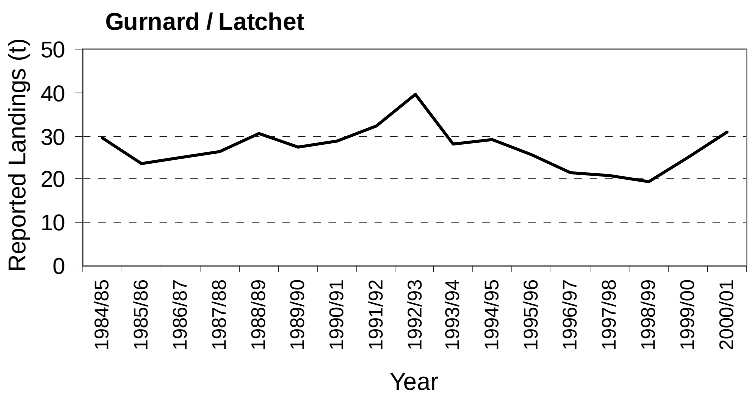
Gurnard / Latchet

***Chelidonichthys kumu* (Red Gurnard)**
***Pterygotrigla polyommata* (Latchet)**
***Pterygotrigla andertoni* (Painted Latchet)**

Distribution

Red gurnard occur in deeper estuarine and continental shelf waters to 100 m depth around Australia, and are also found throughout tropical and temperate waters of the Indo-Pacific region, including New Zealand. Latchet occur off all southern Australian states, but generally inhabit deeper waters from 50 to 400 m depth. Off NSW, painted latchet also occur in this depth range. There is confusion about the correct common names by which to report these species, and reported landings have therefore been combined.

Catch trend in NSW Ocean Trawl



(Note: graph includes catches by ocean fish trawl for ocean zones 4-6 only, to minimise possible overlap with catches made in the Commonwealth SEF)

Landings of gurnard and latchet by NSW ocean trawl fishers have been relatively stable at around 30 t per annum since the mid 1980s.

Catches by other fisheries / jurisdictions

The three species are significant in trawl catches from the SEF area, but are not taken in any significant quantity by other NSW commercial fisheries. Recreational fishers also take red gurnard and latchet, with annual landings from NSW waters estimated to be about 5 - 10 t.

Biological characteristics / level of knowledge

There has been very little study of the biology and ecology of the gurnards and latchets off south-eastern Australia. Some biological information is available from studies conducted in New Zealand in the 1970s.

Stock status - Uncertain

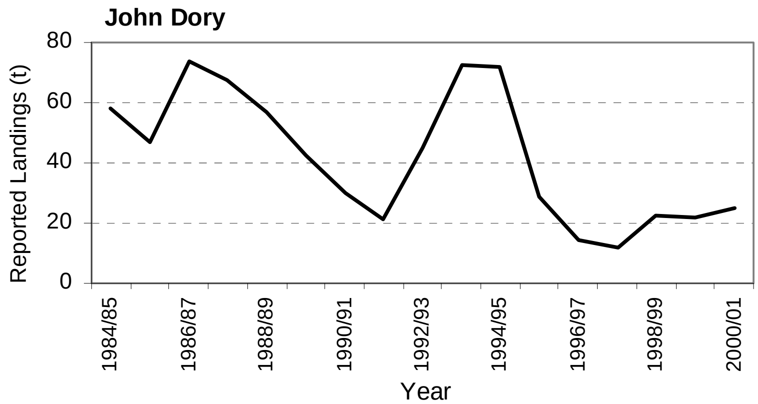
The identification by fishers of the various species is confused. It has been suggested that there has been a significant depletion since commencement of trawling in the SEF, but a detailed analysis has yet to be performed.

John Dory *Zeus faber*

Distribution

This species has a very wide distribution through temperate waters of most of the world's oceans. Stock structure within this range is unclear. John dory occur from close inshore (including deeper estuarine waters) to a depth of about 400 m.

Catch trend in NSW Ocean Trawl



(Note: graph includes catches by ocean prawn trawl for all areas and ocean fish trawl for ocean zones 4-6 only, to minimise possible overlap with catches made in the Commonwealth SEF)

Reported landings of john dory by NSW ocean trawl fishers have fluctuated between 20 and 60 t per annum since the mid 1980s, with landings in 2000/01 being at the lower end of that range.

Catches by other fisheries / jurisdictions

John dory are taken by trawl fisheries in adjacent jurisdictions, most notably in the Commonwealth-managed SEF, where they are subject to a Total Allowable Catch (currently 240 t per annum, of which about 150 t is caught). Recreational fishers also catch an estimated 1 to 2 tonnes of john dory annually.

Biological characteristics / level of knowledge

The biology and life history of john dory are poorly documented. Off NSW spawning takes place in late summer and autumn at depths of 50 to 100 m, but fecundity has not been estimated. Recent ageing studies suggest john dory have a reasonably fast growth rate, maturing at 3 to 5 years of age (25 – 30 cm in length) and reaching an age of about 12 years at a length of 50 cm. However, john dory have been observed to grow to grow to 70 cm in length and in excess of 3 kg in weight, so the maximum age is probably greater than 12 years. Long-term size composition data are available for SEF catches, but these data have not been incorporated in a detailed population model.

Stock status - Fully Fished

John dory stock status is described as ‘Uncertain” in the latest report from the Commonwealth stock assessment process, which notes a decline a catch rate of john dory since the late 1980s.

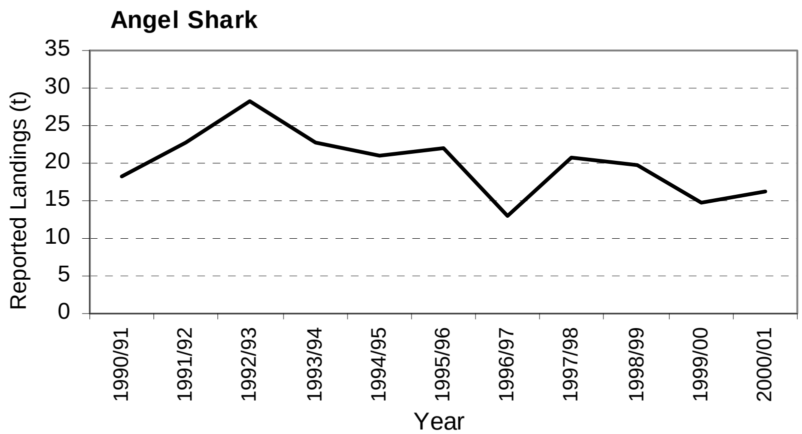
Angel Shark *Squatina australis* (Australian angel shark)

Squatina sp A (Eastern angel shark)

Distribution

S. australis occurs on shallow to mid continental shelf waters (depths to about 130 m), from Sydney around southern Australia to Western Australia. *S. species A* occurs in outer continental shelf and upper slope waters (depths from about 130 to 315 m) from northern Queensland to eastern Bass Strait. The two species are not separated in landings records, but can be separated visually, and have only a minor degree of overlap in mid-shelf water depths off southern NSW.

Catch trend in NSW Ocean Trawl



(Note: graph includes catches by ocean prawn trawl for all areas and ocean fish trawl for ocean zones 4-6 only, to minimise possible overlap with catches made in the Commonwealth SEF)

Reported landings of angel shark by NSW ocean trawl fishers have been relatively stable at 15 to 25 t per annum since the mid 1980s.

Catches by other fisheries / jurisdictions

Angel sharks are taken by trawl fishing in adjoining fisheries off Queensland and southern Australia. Significant catches are taken in the SEF, but quantities of angel sharks are not separately reported. Angel sharks are caught infrequently by recreational fishers.

Biological characteristics / level of knowledge

The biology of angel sharks is poorly known. Some data on size and sex composition of research trawl catches are available from the FRV *Kapala* surveys. No comparable data are available for commercial catches.

Stock status - Uncertain (species composition of the catch needs to be determined)

Collection of biological and fishery data for these important species is a high priority.

Flounder *Pseudorhombus arsius* (Large toothed flounder)

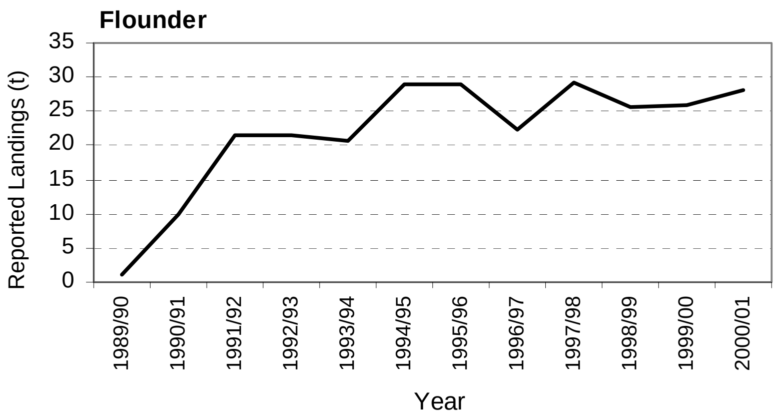
Pseudorhombus jenynsii (Small toothed flounder)

Ammotretis species (Bay flounder)

Distribution

'Flounder' are distributed in estuaries and near-shore continental shelf waters off all southern Australian states. Identification of the different species is difficult, and all are reported as 'flounder'.

Catch trend in NSW Ocean Trawl



(Note: graph includes catches by ocean prawn trawl for all areas and ocean fish trawl for ocean zones 4-6 only, to minimise possible overlap with catches made in the Commonwealth SEF)

Flounder were not recorded separately on monthly catch returns prior to 1991, and the apparent increase in landings at this time is related to this recording change. Since the early 1990s, landings of flounder by NSW ocean trawl fishers have been relatively stable at 20 to 30 t per annum.

Catches by other fisheries / jurisdictions

Flounder are taken in small quantities by trawl fisheries in adjacent jurisdictions, and the larger species are also caught by recreational fishers (the total recreational catch in NSW is estimated at about 5 t per annum).

Biological characteristics / level of knowledge

The flounders have been little studied, and for most species very little is known about their biology and life history. Some size composition data are available from research trawl catches made by FRV *Kapala*. No similar data are available for commercial catches.

Stock status - Uncertain (species composition of catch needs to be determined)

Collection of biological and fishery data for the important species is a high priority.

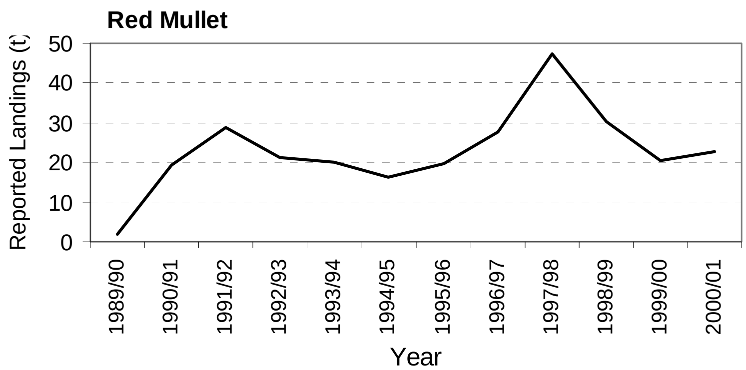
Red Mullet *Upeneichthys lineatus* (Blue-striped goatfish)

Upeneus tragula (Bar-tailed goatfish)

Distribution

Blue-striped goat fish appear to be the species most commonly marketed as 'barbounia' (fetching a high price). They occur on sand and reef areas in coastal waters from northern NSW to eastern Victoria. Bar-tailed goatfish are generally smaller and not as highly sought in the market - they are a tropical species, occurring around northern Australia from Western Australia to southern NSW. A number of other 'goat fish' species may be included in the catch marketed as 'red mullet' from the NSW ocean trawl fishery. All species are recorded as red mullet on catch returns.

Catch trend in NSW Ocean Trawl



Landings of 'red mullet' by NSW ocean trawl fishers have fluctuated between 20 and 40 t per annum since they were first recorded separately on fisher’s catch returns in the early 1990s. Red mullet are principally taken as by-product of prawn trawling.

Catches by other fisheries / jurisdictions

Various species of ‘red mullet’ are taken by trawl fisheries in adjacent jurisdictions, but the species are not reported in significant quantities by other commercial fisheries in NSW. Small quantities of blue-striped goatfish (estimated to be less than 0.5 t annually) are taken by recreational fishers in NSW.

Biological characteristics / level of knowledge

The biology and life history of these two species of goatfish is poorly known, and no monitoring data are available. Some size composition data are available from research trawl catches made by FRV *Kapala*.

Stock status - Uncertain **(species composition of catch needs to be determined)**

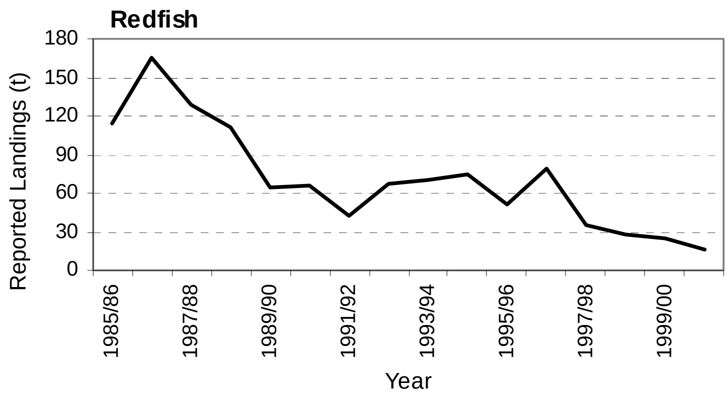
No stock assessment has been undertaken for any goatfish species in NSW.

Redfish *Centroberyx affinis*

Distribution

Redfish occur in continental shelf and upper slope waters (depths from 10 to 500 m) from northern NSW to eastern Bass Strait. Juvenile fish occur in the deeper bays and estuaries and over reefs in inshore waters. Redfish is a strongly schooling species, generally occurring in association with hard bottom types and other structures (e.g. shipwrecks).

Catch trend in NSW Ocean Trawl



(Note: graph includes catches by ocean prawn trawl for all areas and ocean fish trawl for ocean zones 4-6 only, to minimise possible overlap with catches made in the Commonwealth SEF)

Annual landings of redfish by NSW ocean trawl fishers declined from 120 - 150 t in the mid 1980s to around 50 t in the early 1990s. Landings were relatively stable at 60 - 80 t until 1996/97, but declined to around 30 t in the late 1990s.

Catches by other fisheries / jurisdictions

Redfish are mostly caught in the Commonwealth-managed SEF, where annual landings are about 800 t (with a similar quantity of small fish estimated to be discarded). Smaller quantities of redfish (20 to 30 t per annum) are taken by recreational fishers off NSW, and they are also a minor by-product of the commercial trap and line fishery.

Biological characteristics / level of knowledge

Redfish are slow growing and long-lived fish, which may reach a maximum age of about 30 years and 1 kg in weight. Most aspects of the species' biology have been studied and are reasonably well understood. A long time series of monitoring data is available for SEF catches and research trawls, and some data are available on the size composition of catches by NSW trawlers in recent years.

Stock status - Growth overfished (in the SEF)

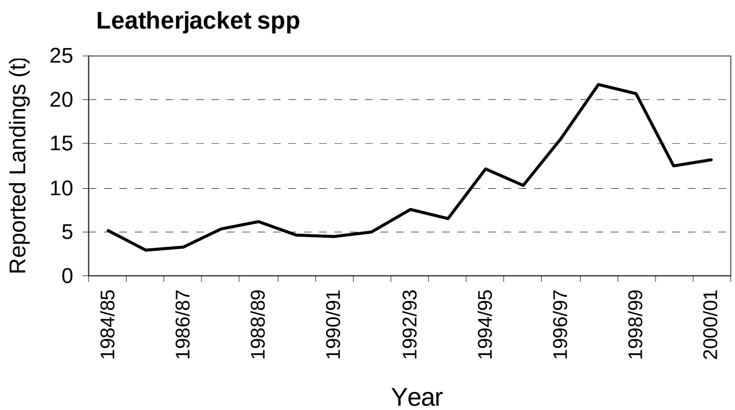
Reasonably detailed stock assessments conducted as part of the Commonwealth process indicate that the redfish stock is significantly growth overfished. Data for the NSW fishery have not been separately analysed to date, however the decline in catch in the late 1990s suggests there may be similar concerns for the NSW fishery.

Leatherjacket species *Nelusetta ayraudi* (Ocean jacket)
Parika scaber (Velvet leatherjacket)
Eubalichthys mosaicus (Mosaic leatherjacket)
Meuschenia trachylepis (Yellowfinned leatherjacket)

Distribution

A number of leatherjacket species are taken by trawlers in NSW ocean waters. Leatherjackets are mostly small, cryptic species that can be difficult to correctly identify. Most species are reasonably wide-ranging in distribution, and occur in inshore and shallower continental shelf waters. In recent years, leatherjacket landings have been dominated by ocean jackets (*N. ayraudi*) following significantly increased recruitment. Trawl catches off NSW include a number of other species in addition to those listed above.

Catch trend in NSW Ocean Trawl



(Note: graph includes catches by ocean prawn trawl for all areas and ocean fish trawl for ocean zones 4-6 only, to minimise possible overlap with catches made in the Commonwealth SEF)

Reported landings of leatherjacket species by NSW ocean trawl fishers increased to 10 to 20 t in the late 1990s. Most of this increase was due to increased landings of ocean jackets.

Catches by other fisheries / jurisdictions

Leatherjackets are commonly taken by trawl fisheries in adjacent jurisdictions, and by other commercial fisheries in NSW, most notably by the ocean trap fishery. Leatherjacket species are also commonly taken by recreational fishers, with the annual catch in NSW recently estimated to be around 108 t.

Biological characteristics / level of knowledge

Varying degrees of biological information are available for the different leatherjacket species, however in general it could be said that the biology and life history of the group are poorly documented. Very little information is available from size composition monitoring of commercial catches, however some data are available from research trawl surveys conducted by FRV *Kapala*.

Stock status - Uncertain

Accurate information on the species composition of trawl catches is needed.

"Sharks" (mixed species)

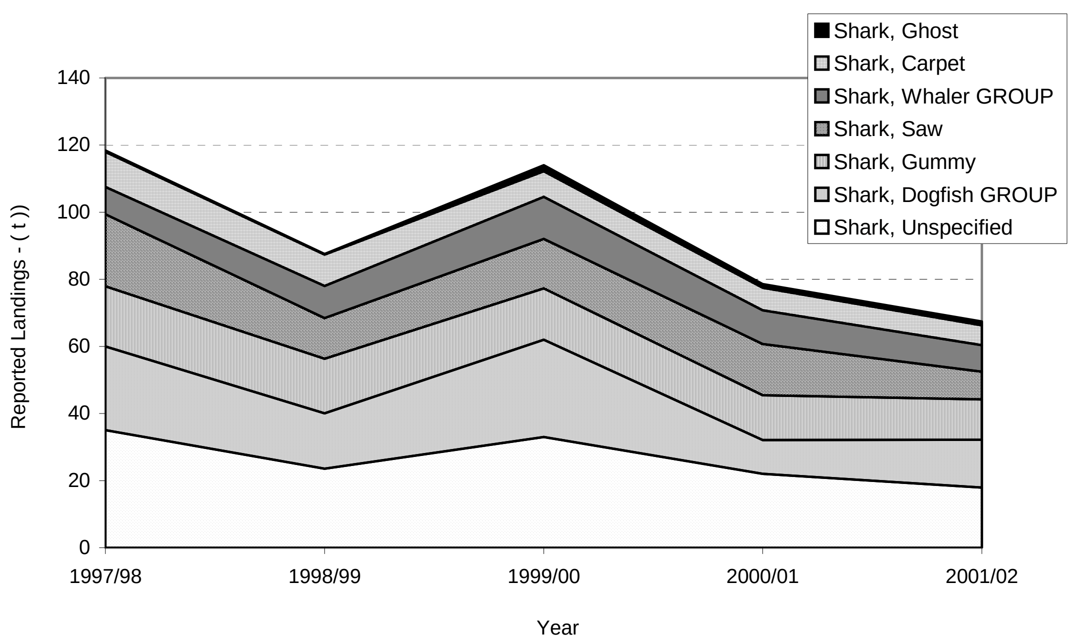
Ocean trawlers in NSW take incidental catches of a number of shark species, and the accuracy of reporting of catches of the various species varies, often due to difficulties in correctly identifying similar species. Apart from the 'angel' and 'fiddler' sharks described separately in this document, the remaining shark species taken by trawling have been included in a 'mixed shark species' group.

Between 1997/98 and 2001/02 NSW ocean trawl landings of the 'mixed' shark species averaged 93 t per annum. Of this total, 28% were reported as 'unspecified' shark species (likely to be mostly sharks in the 'whaler' group, which can be difficult to identify to species level, but this category could potentially include any shark species). The main categories separately identified in reported catches were the "dogfish group" (20%), gummy sharks (16%), saw sharks (15%), "whaler shark group" (10%), carpet sharks (9%) and ghost sharks (1%). Each of these groups is discussed in more detail below.

The "Stock Status" of all species in this group could best be described as 'uncertain' at present, due to the generally poor understanding of the species' biology and a lack of accurate reporting of catch by species in monthly fishermen's returns (this will be addressed under Objective 7.3 of the proposed FMS). Note that gummy shark (*Mustelus antarcticus*) is considered 'fully fished' under the Commonwealth's assessment program, and that significant concerns have been expressed about the vulnerability and stock status of some deepwater dogfish species (at least one of which has been nominated for listing under threatened species legislation). A brief summary of current information regarding each of these species or species groups follows.

Catch trend in NSW Ocean Trawl

The figure below shows landings for each of the shark 'groups' reported by NSW ocean trawl fishers for the years 1990/91 to 2001/02. During the early years in this catch series, reported catches include some sharks landed from waters under Commonwealth jurisdiction. With the exception of the 'dogfish' group, landings of all groups appeared to be reasonably stable throughout this period.



"Dogfish" group

Dogfish (Family: Squalidae) generally inhabit relatively deep waters on the continental slope. About 25 species of 'dogfish' occur in ocean waters off NSW, however many species occur rarely in commercial catches or are discarded because of their small size. The taxonomy of the group is still uncertain. The ten species listed below are thought to comprise the bulk of dogfish landings by the ocean trawl fishery in NSW.

- *Squalus megalops* (Piked spurdog)
- *Squalus mitsukurii* (Greeneye spurdog)
- *Squalus species* B (Eastern highfin spurdog)
- *Squalus species* F (Eastern longnose spurdog)
- Centrophorus moluccensis (Endeavour dogfish)
- Centrophorus harrissoni (Harrison's dogfish)
- Centrophorus uyato (Southern dogfish)
- Centrophorus squamosus (Deepwater spiny dogfish)
- *Deania calcea* (Brier shark)
- *Deania quadrispinosa* (Longsnouted dogfish)

Distribution

Most of the dogfish species are distributed in continental slope waters throughout the range of the NSW ocean trawl fishery, and off adjoining Australian states. The greeneye spurdog has a worldwide distribution, whereas the other three *Squalus* species are found mainly in Australian waters (note that Species B and F are uncommon in NSW waters). The *Centrophorus* and *Deania* species also have wide-spread distributions, with the exception of Harrison’s dogfish which has been recorded only from the east and west coasts of Australia.

Catches by other fisheries / jurisdictions

All species are taken by trawl and dropline fisheries in relevant jurisdictions throughout the species’ ranges. Few are taken by recreational fishers because of the depths at which they are found. Landings of dogfish have shown consistent and significant declines since fishing commenced on continental slope grounds in the 1970s, and there is concern that some dogfish species may now be overfished.

Biological characteristics / level of knowledge

The species listed have maximum sizes ranging from 60 to 115 cm, with the exception of the southern dogfish which can attain 160 cm. Most dogfish mature rather late in life, at around 70% to 80% of maximum length. All dogfish are ovoviviparous (give birth to live young), with small numbers of 'pups' (often just 1-2) and apparently long gestation periods (1-3 years). Ageing data are scarce for these species, but they are almost certainly long-lived species (> 30 years maximum age), with a lengthy juvenile life history stage (10 - 15 years) and extraordinarily low recruitment rates.

Gummy Shark *Mustelus antarcticus*

Distribution

Gummy sharks occur around southern Australia from northern NSW to Western Australia. They generally occur in inshore waters to about 100 m depth, and often form small schools. Similar (or the same?) species occur off northern Australia and New Zealand, although the taxonomic status of the group is unclear.

Catches by other fisheries / jurisdictions

Gummy sharks are the main species taken by the Commonwealth-managed southern shark fishery, with about 1,500 t being caught annually off southern Australia. Recreational fishers in NSW also catch about 2 to 3 t of gummy shark annually.

Biological characteristics / level of knowledge

Gummy sharks have been extensively studied off southern Australia. They grow to a maximum size of 180 cm and > 20 kg in weight, although most fish caught are 110 – 120 cm and around 5 kg in weight. Tagging studies have shown female gummy sharks undertake extensive migrations. Females produce an average of 14 pups after a 12-month gestation, with pupping taking place in inshore nursery areas. Growth is reasonably rapid, with maturity being reached after about 4 years for males (80 cm in length) and 5 years (85 cm) for females.

Saw shark *Pristiophorus* species A

Distribution

"Species A" is the only one of four Australian species of the genus *Pristiophorus* to occur off NSW, and it appears to be endemic to continental shelf and upper slope waters off NSW, from Coffs Harbour to Lakes Entrance in Victoria.

Catches by other fisheries / jurisdictions

The same species is taken by SEF trawlers operating off southern NSW. Saw sharks are rarely caught by recreational fishers.

Biological characteristics / level of knowledge

Very little is known about the biology of *Pristiophorus* species A, and no monitoring data are available from the commercial fishery. Some size composition and sex ratio data are available for research catches made by FRV *Kapala*.

"Whaler" group

The 'whaler' group is used here to include a diverse range of sharks from the Families Carcharhinidae; Lamnidae and Sphyrnidae. The correct identification of many of these species (especially the Carcharhinids) is very difficult. Recent data quality is better than in the past when most of these larger sharks were simply marketed as “bronze whalers” or "man-eaters", however there is still room for much improvement (e.g. significant catches of 'school shark' - *Galeorhinus galeus*, Family Triakidae - are reported by fishers in the ocean trawl fishery, but these are known to be mostly juvenile spinner sharks, or one of the other 'whaler' species).

It is thought that the majority of ‘whaler’ sharks caught in the NSW ocean trawl fishery belong to one of the following species:

- ***Carcharhinus brevipinna*** **(Spinner Shark)**
- ***Carcharhinus falciformis*** **(Silky Shark)**
- ***Carcharhinus leucas*** **(Bull Shark)**
- ***Carcharhinus limbatus*** **(Blacktip Shark)**
- ***Carcharhinus obscurus*** **(Dusky Whaler)**
- ***Carcharhinus brachyurus*** **(Bronze Whaler)**
- ***Galeocerdo cuvier*** **(Tiger Shark)**
- ***Prionace glauca*** **(Blue Shark)**
- ***Isurus oxyrinchus*** **(Shortfin Mako)**
- ***Sphyrna lewini*** **(Scalloped Hammerhead)**
- ***Sphyrna zygaena*** **(Smooth Hammerhead)**

Distribution

All these species have world-wide distributions in sub-tropical and/or temperate waters, and the NSW ocean trawl fishery occurs in a very small proportion of the species’ ranges.

Catches by other fisheries / jurisdictions

Other trawl fisheries and pelagic longline fisheries also take incidental catches of these species of shark. In NSW, significant numbers of these sharks are taken by fishers in the commercial ocean trap and line fishery. Recreational fishers also catch sharks of these species, particularly fishers in the game fishing sector.

Biological characteristics / level of knowledge

These are large, generally pelagic sharks, which attain 2.5 to 6 m in length. Varying amounts are known about the biology of the individual species, but there is little information about the sizes and biological characteristics of sharks taken in the trawl fishery.

Carpet (Wobbegong) sharks

Orectolobus maculatus (Spotted wobbegong)

Orectolobus ornatus (Banded wobbegong)

Distribution

Wobbegong sharks generally occur in inshore rocky reef areas to depths of around 100 m. They are large, bottom dwelling sharks that are susceptible to trawling when moving between reefs. Spotted wobbegongs occur around southern Australia from southern Queensland to Western Australia, while banded wobbegongs occur over the same range, but also occur off north Queensland and New Guinea.

Catches by other fisheries / jurisdictions

In NSW waters wobbegong sharks are also taken by the commercial trap and line fishery and the recreational fishery.

Biological characteristics / level of knowledge

Until recently little was known of the biology and life history of wobbegongs, but a research program is currently underway in NSW. Data are available from research catches made by FRV *Kapala*, however monitoring data from commercial fisheries are rare. Some concern has been expressed about the vulnerability of wobbegongs to exploitation, and recently there has been debate about possible declines in landings and the need for protective management measures for these species.

Ghost sharks

Callorhinchus milii (Elephant fish)

Chimaera species B and C (Short nosed Chimaeras)

Hydrolagus lemures (Blackfin ghost shark)

Hydrolagus ogilbyi (Ogilby's ghost shark)

Distribution

The ghost sharks are broadly distributed in Australian continental shelf and upper slope waters. They are uncommonly taken by the NSW ocean trawl fishery as they are more common on deeper southern trawl grounds.

Catches by other fisheries / jurisdictions

Ghost sharks are more commonly taken in the Commonwealth-managed SEF and the southern shark fishery. They are not taken in significant numbers by recreational fishers off NSW.

Biological characteristics / level of knowledge

The biology of ghost sharks is poorly known and monitoring data from commercial catches is sparse.