APPENDICES

APPENDIX 1
Fisheries Research Division staff publications 2012/13

Scientific Papers

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Fairclough, D.V., Edmonds, J.S., Jackson, G., Lenanton, R.C.J., Kemp, J., Molony, B.W., Keay, I.S., Crisafulli, B. and Wakefield, C.B. (2013). A comparison of the stock structures of two exploited demersal teleosts, employing complementary methods of otolith element analysis. *Journal of Experimental Marine Biology and Ecology* 439: 181-195.

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Popular article

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APPENDIX 2
Table of catches from fishers' statutory monthly returns for 2011/12

This table contains the landed[1] and estimated live weight[2] of species recorded in the compulsory catch and fishing effort returns provided by commercial fishers each month. These data include the catch taken as byproduct as well as the targeted catch.

These catch data may differ slightly from some of the catch estimates presented for specific fisheries as the latter may include additional data from other sources, such as research log books and processors. The figures may also differ slightly from previously reported figures, as additional data may have been received by the Department of Fisheries. The table represents the latest year for which a complete set of data is available.

While scientific names have been included wherever possible, it should be noted that many fish recorded under a common name cannot be identified as belonging to a particular single species and therefore must be reported as being part of a commercial grouping of several species. For example, the common name 'Redfish' may be used for several species of the genus *Centroberyx*.

Data for species with live weight catches of less than 500 kg have been combined into the general or 'other' category within each class. Data for the Indian Ocean Territories Fishery have not been included in this table.

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
FISH				
Carcharhinidae				
	Blacktip Whaler	*Carcharhinus tilstoni / Carcharhinus limbatus / Carcharhinus spp.*	2	2
	Bronze Whaler	*Carcharhinus brachyurus*	36	56
	Dusky Whaler	*Carcharhinus obscurus*	112	177
	Sandbar Shark	*Carcharhinus plumbeus*	21	34
	Spinner Shark	*Carcharhinus brevipinna*	37	59
	Tiger Shark	*Galeocerdo cuvier*	2	4
Lamnidae				
	Shortfin Mako	*Isurus oxyrinchus*	1	2
Orectolobidae				
	Wobbegong Shark	*Orectolobidae*	21	33
Pristiophoridae				
	Common Sawshark	*Pristiphorus cirratus*	3	8
Rajidae				
	Skates	*Rajidae*	5	12
Sphyrnidae				
	Hammerhead Shark	*Sphyrnidae*	38	60

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
Squatinidae				
	Angel Shark	*Squatina spp.*	2	3
Triakidae				
	Gummy Shark	*Mustelus antarcticus*	222	354
	Pencil Shark	*Hypogaleus hyugaensis*	< 500 kg	1
	School Shark	*Galeorhinus galeus*	1	1
	Whiskery Shark	*Furgaleus macki*	68	102
	Shark, Other		4	5
	Shovelnose / Fiddler Rays	*Rhinobatidae / Rhynchobatidae*	< 500 kg	1
Ariidae				
	Catfishes	*Ariidae*	10	10
Ariidae				
	Silver Cobbler	*Neoarius midgleyi*	79	111
Atherinidae				
	Hardy Heads	*Atherinidae*	3	3
Berycidae				
	Bight Redfish	*Centroberyx gerrardi*	46	46
	Redfish	*Centroberyx spp.*	25	25
	Yelloweye Redfish	*Centroberyx australis*	9	9
Clupeidae				
	Australian Sardine (Pilchard)	*Sardinops sagax*	2410	2410
	Sandy Sprat (Whitebait)	*Hyperlophus vittatus*	83	83
Hemiramphidae				
	Southern Garfish	*Hyporhamphus melanochir*	24	24
Platycephalidae				
	Flatheads	*Platycephalidae*	6	6
Plotosidae				
	Cobbler	*Cnidoglanis macrocephalus*	46	65

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
Latidae				
	Barramundi	*Lates calcarifer*	20	31
Polyprionidae				
	Bass Groper	*Polyprion americanus*	1	1
	Hapuku	*Polyprion oxygeneios*	16	16
Serranidae				
	Breaksea Cod	*Epinephelides armatus*	6	6
Epinephelidae				
	Barcheek Coral Trout	*Plectropomus maculatus*	20	20
	Common Coral Trout	*Plectropomus leopardus*	3	3
	Birdwire Rockcod	*Epinephelus merra*	3	3
	Blackspotted Rockcod	*Epinephelus malabaricus*	27	27
	Chinaman Rockcod	*Epinephelus rivulatus*	1	1
	Coral Rockcod	*Cephalopholis miniata*	1	1
	Duskytail Grouper	*Epinephelus bleekeri*	4	4
	Eightbar Grouper	*Hyporthodus octofasciatus*	19	20
	Flowery Rockcod	*Epinephelus fuscoguttatus*	45	45
	Goldspotted Rockcod	*Epinephelus coioides*	42	42
	Rankin Cod	*Epinephelus multinotatus*	134	134
	Tomato Rockcod	*Cephalopholis sonnerati*	1	1
	Cods	*Epinephelus / Cephalopholis*	70	70
Glaucosomatidae				
	Northern Pearl Perch	*Glaucosoma buergeri*	27	27
	West Australian Dhufish	*Glaucosoma hebraicum*	85	87
Priacanthidae				
	Bigeyes	*Priacanthidae*	13	13
Terapontidae				
	Trumpeters	*Terapontidae*	3	3

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
Sillaginidae				
	King George Whiting	*Sillaginodes punctatus*	15	15
	Yellowfin Whiting	*Sillago schomburgkii*	48	48
	Whitings	*Sillaginidae*	101	101
Pomatomidae				
	Tailor	*Pomatomus saltatrix*	28	28
Rachycentridae				
	Cobia	*Rachycentron canadum*	14	14
Carangidae				
	Amberjack	*Seriola dumerili*	9	9
	Black Pomfret	*Parastromateus niger*	1	1
	Golden Trevally	*Gnathanodon speciosus*	2	2
	Queenfish	*Scomberoides commersonnianus*	< 500 kg	1
	Samson Fish	*Seriola hippos*	45	47
	Silver Trevally	*Pseudocaranx spp.*	10	10
	Trevallies	*Carangidae*	151	151
	Turrum (Goldspot Trevally)	*Carangoides fulvoguttatus*	1	1
	Yellowtail Kingfish	*Seriola lalandi*	1	1
	Yellowtail Scad	*Trachurus novaezelandiae*	12	12
Arripidae				
	Australian Herring	*Arripis georgianus*	168	168
	Western Australian Salmon	*Arripis truttaceus*	200	207
Lutjanidae				
	Brownstripe Snapper	*Lutjanus vitta*	47	47
	Chinaman Fish	*Symphorus nematophorus*	11	11
	Crimson Snapper	*Lutjanus erythropterus*	266	266
	Darktail Snapper	*Lutjanus lemniscatus*	17	17
	Five Line Snapper	*Lutjanus quinquelineatus*	3	3

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
Lutjanidae (continued)				
	Flagfish / Spanish Flag	*Lutjanus vitta / quinquelineatus / carponotatus / lutjan*	51	51
	Goldband Snapper	*Pristipomoides multidens*	727	727
	Mangrove Jack	*Lutjanus argentimaculatus*	13	13
	Moses Snapper	*Lutjanus russelli*	47	47
	Red Emperor	*Lutjanus sebae*	277	277
	Rosy Snapper	*Pristipomoides filamentosus*	5	5
	Ruby Snapper	*Etelis carbunculus*	45	46
	Saddletail Snapper	*Lutjanus malabaricus*	172	172
	Sharptooth Snapper	*Pristipomoides typus*	2	2
	Tropical Snappers	*Lutjanidae*	2	2
Nemipteridae				
	Monocle Bream	*Scolopsis spp.*	9	9
	Threadfin Breams	*Nemipteridae*	80	80
Lobotidae				
	Tripletail	*Lobotes surinamensis*	1	2
Haemulidae				
	Javelin Fish	*Pomadasys spp.*	24	24
	Painted Sweetlips	*Diagramma labiosum*	12	12
	Sand Snapper	*Haemulidae*	48	48
Lethrinidae				
	Bluespotted Emperor	*Lethrinus punctulatus*	258	258
	Drab Emperor	*Lethrinus ravus*	5	5
	Grass Emperor	*Lethrinus laticaudis*	6	6
	Longnose Emperor	*Lethrinus olivaceus*	15	15
	Mozambique Seabream	*Wattsia mossambica*	2	2
	Redspot Emperor	*Lethrinus lentjan*	28	28
	Redthroat Emperor	*Lethrinus miniatus*	62	62
	Robinson's Seabream	*Gymnocranius grandoculis*	36	36

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
Lethrinidae (continued)				
	Spangled Emperor	*Lethrinus nebulosus*	85	85
	Yellowtail Emperor	*Lethrinus atkinsoni*	1	1
Sparidae				
	Black Bream	*Acanthopagrus butcheri*	45	45
	Frypan Bream	*Argyrops spinifer*	35	35
	Snapper (Pink Snapper)	*Pagrus auratus*	478	480
	Tarwhine	*Rhabdosargus sarba*	6	6
	Western Yellowfin Bream	*Acanthopagrus latus*	9	9
Sciaenidae				
	Black Jewfish	*Protonibea diacanthus*	2	2
	Mulloway	*Argyrosomus japonicus*	14	14
Mullidae				
	Red Mullet	*Mullidae*	23	23
Clupeidae				
	Scaly Mackerel	*Sardinella lemuru*	346	346
Kyphosidae				
	Sweep	*Scorpis aequipinnis*	2	2
Pentacerotidae				
	Boarfish	*Pentacerotidae*	7	7
Oplegnathidae				
	Knifejaw	*Oplegnathus woodwardi*	1	1
Cheilodactylidae				
	Blue Morwong	*Nemadactylus valenciennesi*	41	44
Mugilidae				
	Sea Mullet	*Mugil cephalus*	193	194
	Yellow-Eye Mullet	*Aldrichetta forsteri*	22	22

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
Sphyraenidae				
	Pikes	*Sphyraenidae*	5	5
	Snook	*Sphyraena novaehollandiae*	2	2
Polynemidae				
	King Threadfin	*Polydactulus macrochir*	41	44
	Threadfin	*Polynemidae*	5	5
Labridae				
	Baldchin Groper	*Choerodon rubescens*	20	20
	Blue Groper	*Achoerodus gouldii*	37	43
	Bluespotted Tuskfish	*Choerodon cauteroma*	4	4
	Pigfish	*Bodianus spp.*	1	1
	Tuskfishes	*Choerodon spp.*	3	3
	Wrasses	*Labrid spp.*	1	1
	Parrotfishes	*Scarid spp.*	4	4
Acanthuridae / Zanclidae				
	Surgeonfishes	*Acanthuridae / Zanclidae*	2	2
Scombridae				
	Bonito	*Sarda australis*	1	1
	Grey Mackerel	*Scomberomorus semifasciatus*	10	11
	Spanish Mackerel (Narrow-barred)	*Scomberomorus commerson*	193	277
	Yellowfin Tuna	*Thunnus albacares*	1	1
	Mackerel, Other		1	1
	Tuna, Other		1	1
Centrolophidae				
	Blue-Eye Trevalla	*Hyperoglyphe antarctica*	4	4
Bothidae				
	Flounder	*Bothidae*	2	2

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
FISH (continued)				
Monacanthidae				
	Leather Jacket	*Monacanthidae*	13	19
	Fish, Other		73	74
TOTAL FISH			8668	9191
CRABS				
	Crystal Crab	*Chaceon albus*	150	150
	Champagne Crab	*Hypothalassia acerba*	10	10
	Giant Crab	*Pseudocarcinus gigas*	12	12
	Blue Swimmer Crab	*Portunus armatus*	365	365
	Crab, Other		1	1
TOTAL CRABS			538	538
PRAWNS				
	Banana Prawn	*Penaeus merguiensis*	378	378
	Black Tiger Prawn	*Penaeus monodon*	1	1
	Brown Tiger Prawn	*Penaeus esculentus*	1064	1064
	Coral Prawn	*Metapenaeopsis spp.*	174	174
	Endeavour Prawn	*Metapenaeus endeavouri*	128	128
	Western King Prawn	*Penaeus latisulcatus*	1278	1278
	Prawns, Other	*Penaeidae*	< 500 kg	< 500 kg
TOTAL PRAWNS			3023	3023
LOBSTERS				
	Southern Rock Lobster	*Jasus edwardsii*	53	53
	Western Rock Lobster	*Panulirus cygnus*	4839	4839
	Bugs/ Slipper lobster	*Scyllaridae*	6	6
TOTAL LOBSTERS			4898	4898

Family Name	Common Name	*Scientific Name*	Landed Weight (tonnes)	Live Weight (tonnes)
MOLLUSCS				
	Squid	*Sepioteuthis spp./Loligo spp.*	36	36
	Octopus	*Octopodidae*	129	166
	Cuttlefish	*Sepiidae*	34	34
	Saucer scallop	*Amusium balloti*	32	158
	Brownlip Abalone	*Haliotis conicopora*	16	39
	Greenlip Abalone	*Haliotis laevigata*	67	178
	Roe's Abalone	*Haliotis roei*	67	67
	Molluscs, Other		2	2
TOTAL MOLLUSCS			383	680
OTHER INVERTEBRATES			14	43
GRAND TOTAL			17524	18373

1. *Landed weight*: refers to the mass (or weight) of a product at the time of landing, regardless of the state in which it is landed. That is, the fish may be whole, gutted or filleted etc. This unit is of limited use for further analysis except where it is known that the product is very homogenous in nature. Where more detailed analysis of the data is required the landed weight is generally converted to a more meaningful measure, the most frequently used being termed live or whole weight or 'nominal catch'.
2. *Live weight*: refers to the landings converted to a live weight basis. This is often referred to as the 'live weight equivalent of the landings', shortened to the 'live weight'. Although live weight may be the preferred unit it is rarely obtained as a direct measure. This is because it would usually have to be made on board a fishing vessel where the practical difficulties associated with the working conditions render it impossible. Live weight has to be derived and this is usually done by applying a conversion factor to the landed weight.
3. Weight figures are round off to the nearest tonnage.
4. Common names are from the CAAB – Codes for Australian Biota database.

More information may be obtained from the 'CWP Handbook of Fishery Statistical Standards' at the website http://www.fao.org/fishery/cwp/handbook/B/en

Estimated Western Australian Aquaculture Production for 2011/12

Highlights for 2011/12

There were 488 licensed aquaculture producers

The farm gate value of aquaculture production in WA (excluding marine algae and pearl oysters) was just over $16.18 million

The most valuable industry sector was barramundi ($11.14 million), followed by marron ($1.44 million), mussels ($1.37 million) and yabbies ($0.38 million)

The industry sector with the most participants was marron with 183 productive licences.

Introduction

The statistics contained in this document represent the reported production and estimated value of the aquaculture industry in Western Australia for the financial year 2011/12. Comparisons to the previous four years have also been presented. The following summaries were produced from information held within the Aquaculture Production Returns Database at the Department of Fisheries, Research Division, Hillarys.

Quarterly records received from industry are summarised by the Department of Fisheries and reported to Parliament by the Minister for Fisheries. They are also used in the yearly Department of Fisheries *Status Reports of the Fisheries and Aquatic Resources*, the annual report provided by Australian Bureau of Agricultural and Resource Economics (ABARE) and other publications.

Producers' returns constitute the official production and value figures for the aquaculture industry and these are dependent on the accuracy of licensees' returns. The data presented are based on the Aquaculture Production Returns Database, as of the 18th July 2013.

Note that all production reported in tonnes throughout this document refers to whole weight and the farm gate value refers to the value of product at the first point of recorded sale.

The Industry in 2011/12

A total of 488 aquaculture licence holders were required to submit quarterly returns for one or more quarters in the 2011/12 financial year. Of the 488 licences, 236 i.e. 48 per cent recorded production on their returns. Marron had the largest number of producers with 183 licences recording production (Aquaculture Production Table 1).

Estimated aquaculture production increased by 19 per cent from 1402 tonnes produced in 2010/11 to 1662 tonnes in 20011/12 (excludes algae, pearl oysters, and ornamental species) (Aquaculture Production Table 2).

The estimated value of Western Australian aquaculture (excluding algae and pearl oysters) increased by 22 per cent from $13.3 million to $16.2 million in 2011/12 (Aquaculture Production Table 3). Finfish aquaculture made up 73 per cent of the total value for 2011/12.

AQUACULTURE PRODUCTION TABLE 1.

Growout production for the Western Australian aquaculture industry in 2011/12

Common name	Productive licences	Quantity	Units*	Average price ($)/ unit	Value ($)
Barramundi	6	1,127	tonnes	9.89	11,143,391
Marron	183	50	tonnes	28.62	1,443,877
Mussels	11	350	tonnes	3.91	1,367,470
Yabbies	9	19	tonnes	20.09	377,438
Silver perch	10	14	tonnes	18.02	254,883
Koi carp	7	21,366	No.	5.32	113,751
Rainbow trout	5	4	tonnes	14.52	61,012
Ornamental fish & crustaceans	11	24,908	No.	n/a	57,715
Goldfish	5	8,624	No.	2.99	25,759
Other species with <5 producers**	<5	97	tonnes	n/a	1,337,601
Algae	<5	**			**
Total (not including algae or pearls)					16,182,897

* Tonnes refer to whole weight

** Industry figures have not been included to protect the confidentiality of individual producers, as there are less than five productive licensees.

Data Comparisons over the Past Six Production Years (2006/07-2011/12)

AQUACULTURE PRODUCTION TABLE 2.

Estimated quantity of growout production of aquaculture species/categories in Western Australia over the past six financial years.

Common name	Units	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Barramundi	tonnes	43.2	365.9	455.2	433.0	862.5	1 127.0 ↑
Mussels	tonnes	621.9	481.2	433.5	506.5	364.9	349.8 ↓
Marron	tonnes	58.1	51.1	52.8	53.9	51.1	50.5 ↓
Yabbies	tonnes	87.9	60.8	44.1	46.7	19.7	18.8 ↓
Silver perch	tonnes	26.5	16.9	28.5	27.2	18.0	14.1 ↓
Rainbow trout	tonnes	11.7	13.3	11.7	7.5	11.0	4.2 ↓
Ornamental fish & crustaceans	No.	61 492	55 047	50 598	46 425	21 167	24 908 ↑
Koi carp	No.	30 124	35 620	34 270	44 787	39 944	21 366 ↓
Goldfish	No.	35 836	33 918	36 199	15 785	11 448	8 624 ↓
Other species with < 5 producers	tonnes	65.2	97.2	94.9	94.2	75.0	97.4

AQUACULTURE PRODUCTION TABLE 3.

Estimated farm gate value ($) of growout aquaculture species/categories in Western Australia over the past six financial years.

Common name/ Category	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Barramundi	467,280	3,870,071	4,793,106	4,512,123	8,391,579	11,143,391 ↑
Marron	1,387,449	1,298,672	1,434,494	1,445,252	1,418,951	1,443,877 ↑
Mussels	1,811,298	1,531,849	1,618,594	1,870,531	1,357,009	1,367,470 ↑
Yabbies	1,381,248	1,059,532	810,608	760,595	389,920	377,438 ↓
Silver perch	317,275	245,157	405,506	435,624	310,977	254,883 ↓
Koi carp	137,195	160,597	168,279	184,708	173,928	113,751 ↓
Rainbow trout	105,391	135,007	140,422	101,681	133,257	61,012 ↓
Ornamental fish & crustaceans	294,308	237,408	276,986	230,856	108,023	57,715 ↓
Goldfish	65,536	80,732	73,992	52,139	32,771	25,759 ↓
Other	883,044	1,554,289	1,715,130	1,018,211	1,024,396	1,337,601
Total (not including algae & pearls)	6,850,022	10,173,312	11,437,116	10,611,720	13,304,811	16,182,897

APPENDIX 3
Research Division - Other Activities
Activities of the Pemberton Freshwater Research Centre 2012/13

C. Lawrence and T. Church

The Department of Fisheries Pemberton Freshwater Research Centre (PFRC) is the largest freshwater hatchery and research facility in Western Australia. Located on the Lefroy Brook in Pemberton it consists of two neighbouring sites, the original PFRC hatchery and the Dr Noel Morrissy Research Ponds located on Thomson's Flat. The original PFRC hatchery site contains 10 earthen ponds, 22 concrete ponds, 36 research tanks, fish hatching and larval rearing troughs. The nearby Dr Noel Morrissy Research Ponds on Thomsons Flat feature 25 earthen ponds, ranging in size from 150m^2 breeding ponds to 1000m^2 commercial growout -scale ponds, 28 tanks and a post-harvest handling facility. This site also includes an area that is leased to Forest Fresh Marron for processing and marketing the product from over 60 local marron growers.

PFRC staff are responsible for the maintenance and production of native fish, crayfish and trout at the facility. They are also responsible for stocking trout into public waters and packing trout and marron for sale to commercial farmers. Efficient management and operation of a large production and research facility for fish and crayfish such as PFRC requires a high level of expertise. As a result PFRC staff provide a key regional extension service to aquaculture, recreational fishing and biodiversity client groups. In 2010/11 as part of the NRM funded hatchery infrastructure modifications a front office has been allocated for public enquiries, community education material and the recommencement of tours of the facility by the public. The community education material on the Department's activities in the region will be developed when resources permit. Once complete it will enable the PFRC hatchery to recommence public education tours.

PFRC provides facilities, expertise and stock to support research and industry development in the four key areas of i) conserving and recovering biodiversity, ii) recreational fishing, iii) aquaculture and iv) freshwater fisheries.

Key PFRC projects in 2012/13 are briefly discussed below:

Trout production for recreational fishing, aquaculture and research

Trout production at PFRC provides fingerlings and yearlings for recreational fishing, aquaculture and research. Two species of trout are produced at PFRC, brown trout (*Salmo trutta*) for recreational fishing and rainbow trout (*Oncorhynchus mykiss*) for both aquaculture and recreational fishing.

In 2012/13 the PFRC produced 677,000 fry. These consisted of 658,000 rainbow trout fry and 19,000 brown trout fry, representing a decrease in production of 11% and an increase of 46% respectively, compared with 2011/12. The majority of production (69%) consisting of 452,000 rainbow trout fry and 18,000 brown trout fry was stocked into public waterways to support recreational fishing. A further 168,000 rainbow trout (25%) were sold to individuals and clubs for stocking private farm dams, to support recreational fishing and tourism operations and for licensed aquaculture production. There was a 16% decrease in sales from PFRC in 2012/13 to 168,000 down from 200,000 in 2011/12.

20,000 sterile triploid rainbow trout were produced at PFRC in 2012/13 which were supplied to licenced aquaculture producers and fishing associations. The remaining 38,000 trout produced (6%) were retained for future brood stock for PFRC, yearling stocking, and research.

In the winter-spring months of 2012 and May-June 2013 29,450 rainbow yearlings as well as 2,700 rainbow and 200 brown trout ex brood stock, were released to public waters for recreational fishing and control of stunted redfin perch populations.

The 330% increase in yearlings stocked in 2012/13 (29,450) compared with 2010/11 (8,700) is due to compliance with the Department of Fisheries revised translocation policy resulting in the yearling stocking being delayed until the later half of 2012. The translocation approval to stock the remaining yearlings held at PFRC was received in late June 2012 after which stocking commenced in July and proceeded as in previous years albeit delayed.

Trout research for recreational fishing and aquaculture

In late 2006 the Department commenced a review of trout production at PFRC to consider two key factors: brown trout embryo survival and rainbow trout brood stock selection strategies. In 2007 the Department commenced research to evaluate hatchery production techniques for producing sterile triploid trout and develop improved protocols using a hydrostatic pressure chamber and tetraploids.

Brown trout embryo survival

In 2005 brown trout embryo survival was sub-optimal, however after consulting with stakeholders, prior to PFRC disposing of this valuable line, that is highly regarded by recreational fishers, Research Division staff commenced a study to confirm the extent of this problem and determine the contributing factors. This research can only be undertaken during the brief spawning period each year. Factors investigated included poor sperm motility, water quality or climate change.

Investigations by the Department into brown trout sperm motility showed that some trout were not producing motile sperm. This resulted in modifications to hatchery protocols to include assessment of sperm quality prior to egg fertilisation. In 2009/10 sperm motility assessment using basic visual evaluation of sperm quality resulted in a 500% improvement

in brown trout egg fertilisation rates. However, visual assessment of sperm motility is labour intensive. Consequently sperm motility assessment was postponed until the purchase of computing equipment and software. Computer Assisted Sperm Analysis software (CASA) was purchased by the Department in late 2010. This software enabled research staff to efficiently analyse and quantify trout sperm fitness during the 2012 spawning season.

Rainbow trout brood stock selection

The current breeding strategy for both rainbow and brown trout at PFRC focuses upon random selection of brood stock. However, trout production at PFRC has two key client groups with different objectives, recreational fishing and aquaculture. Therefore, it is likely that breeding objectives for these two groups may be different. Accordingly Research Division staff held discussions with both major client groups to establish and prioritise breeding objectives. This will ensure that in coming years, brood stock selection strategies at PFRC can be implemented to produce trout with traits that specifically meet the needs of key client groups.

The genetic line of rainbow trout at PFRC is unique. In 2008/09 staff completed a series of temperature tolerance experiments that demonstrated that the PFRC rainbow trout genetic line can withstand water temperatures of up to 28°C without any mortalities. This temperature tolerance is superior to most domesticated lines elsewhere and is significant in regards to adapting to global warming. Due to resource limitations between 2009-2012 the commencement of a trout selective breeding program to further increase temperature tolerance had to be delayed. In 2012 a Canadian based research team, with expertise in trout temperature physiology and genetics, developed a collaborative project with PFRC to undertake research into temperature tolerance of Pemberton trout.

Sterile triploid trout production

Triploids are valuable for both stocking and the environment as they cannot reproduce and continue to grow after reaching sexual maturity. The PFRC hatchery has produced triploids for over 20 years using temperature shock. However, temperature shocking is known to have considerable variability in triploidy rates.

Pressure shock provides less variability in ploidy rates than temperature shock. Over the past three years Department of Fisheries Researchers at PFRC have designed and built a system capable of delivering precise pressure shocking of embryos in a safe and reproducible manner. In the past two years researchers have developed and refined protocols for producing both triploids and tetraploids using hydrostatic pressure. In 2012 ploidy rates were validated by researchers from The University of Western Australia, with pressure shock (80%) providing better triploid rates than temperature shock (70%). Furthermore, researchers successfully produced tetraploid trout, albeit in low numbers. Department of Fisheries researchers are undertaking further work with colleagues from The University of Western Australia to develop and validate a more efficient technique of quantifying the percentage of triploids , diploids and tetraploids from embryo samples in 2013/14.

Native and endangered fish conservation and biodiversity research

In response to a declining prevalence of native fish in the Southwest, Department of Fisheries researchers have established brood stock populations of two endemic species pygmy perch (*Nannoperca vittata*) and western minnows (*Galaxias occidentalis*) at PFRC. The aim of this research is to develop large-scale pond production techniques for these species to 1) enable stocking of public and private water bodies in the Southwest, 2) develop and validate the most efficient production strategies for each species 3) transfer this technology to achieve captive breeding of two listed species (*Galaxias truttaceus* - Critically endangered and *Nannatherina balstoni* - Vulnerable to extinction).

Western minnow (*Galaxias occidentalis*)

In 2012 PFRC successfully achieved large scale spawning of the western minnow (*Galaxias occidentalis*) in hatchery ponds. Over 6,000 juveniles were produced from this pilot research project. The technology developed is now being applied to further increase mass production of western minnow for restocking and transferred to breeding the critically endangered trout minnow (*Galaxias truttaceus).*

One of the challenges of captive breeding for release programs is to ensure that genetic drift within the hatchery environment does not result in progeny that are less fit for survival in the wild. At PFRC an innovative strategy developed by Department of Fisheries researchers to address this challenge received NRM funding in 2010. This strategy is based upon the upstream spawning migration of native fish. This means that juveniles produced in the PFRC hatchery and tagged, if released into the adjacent Lefroy Brook, when they reach sexual maturity will return to the hatchery to spawn. From several thousand fish released only those genetically fit enough to survive in the wild will return to PFRC to spawn. The NRM funding enabled a fish ladder supplied with water from PFRC to be constructed between the hatchery and the Lefroy Brook. In future years, by releasing juveniles produced at PFRC at the mouth of the fish ladder, after spending two years in the wild they will now be able to swim back up the fish ladder and into the hatchery to provide the next generation of PFRC broodstock.

During the planning stage of the PFRC fish ladder, consultation between Department of Fisheries researchers and Department of Water engineers identified critical knowledge gaps in the design specification's required for native fish to successfully migrate up a fish ladder. While there are proposals by university researchers to commence testing some design specifications (i.e. swimming ability) using laboratory scale swim chambers, the lack of a full scale fish ladder for research has limited the variables that can be examined. Consequently, the PFRC Fish Ladder has been designed so that it can not only be used to validate results from laboratory experiments, but can also be modified to test the effects of variables such as board height, pool length, pool depth, barrier type, flow rate etc. in a full scale working model. The information obtained from these experiments will lead to improved and scientifically validated designs for fish ladders in WA.

Pygmy perch (*Nannoperca vittata)*

In 2012 pygmy perch were spawned in tanks at PFRC following the protocols developed and refined at the Aquaculture and Native Fish Breeding Laboratory, in Shenton Park. This technology has now been scaled up to mass production in ponds on Thomson Flat and at Shenton Park to produce fish for restocking. Techniques developed for

breeding the pygmy perch are now being transferred to the related Balston's perch (*N. balstoni*), which is listed as vulnerable to extinction.

It is thought that the decline in prevalence of native fish is related to the increased spread of introduced *Gambusia* (*Gambusia holbrooki*), but research at PFRC and a NRM funded survey by Department of Fisheries researchers in 2010 indicates that other factors may also be responsible. Although *Gambusia* were originally introduced to control mosquito populations, it appears that other native fish species consume more mosquito larvae. Therefore, while production and stocking of endemic species has direct conservation and biodiversity benefits, it is also likely to result in human health benefits through a reduction in mosquito borne diseases such as Ross River virus.

Listed native fish species

Broodstock populations of two endangered native fish species the trout minnow (*G. truttaceus*) listed as critically endangered, and Balston's pygmy perch (*N. Balstoni*) listed as vulnerable to extinction, are being established at PFRC and the Aquaculture and Native Fish Breeding Laboratory in Shenton Park. In addition to establishing a living gene bank before these species become extinct in the wild, the focus of this project is to close their lifecycles, develop large scale production techniques and restock waterbodies within their original distribution.

Native fish research priorities 2012/13

In 2012/13 Department of Fisheries will address the following native fish research priorities:

Techniques to increase production of pygmy perch & western minnows

A recent collaborative project with UWA showed that native fish are more abundant in waterbodies with complex habitat. One hypothesis, that has also improved marron breeding, is that this occurs due to the shelter provided to juveniles. This hypothesis will be examined by comparing native fish production among spawning ponds that either contain hides or without hides in 2012/13

The achievement of the first ever large scale pond production of western minnows (*G. occidentalis*) in earthern ponds at PFRC highlighted a production technology gap. The harvesting of several thousand small native fish from a pond is labour intensive, time consuming and exposes the fish to both stress and the risk of physical injury. Techniques to more efficiently remove native fish from ponds will be evaluated in 2013

Establishing key genetic lines for conservation and restocking

The Department of Fisheries NRM survey showed that genotypes of pygmy perch and western minnow among water bodies north of Collie are similar. However, those south of Collie are different from the northern populations and show increased variation among catchments. Consequently, in 2012/13 the breeding program for these two species will be split into two major populations, a northern genetic line at Shenton Park Aquaculture & Native Fish Breeding Laboratory for restocking the Swan Coastal Plain; and a southern genetic line at PFRC. This will require collection and quarantine of northern genetic lines at the Shenton Park facility in 2012/13.

Endangered fish species

Broodstock populations of two endangered native fish species the trout minnow *(G. truttaceus*) listed as critically endangered, and Balston's pygmy perch (*N. Balstoni*) will be collected and established in 2012/13. They will be managed using the same suite of husbandry techniques that Department of Fisheries scientists have developed, and shown to be effective, for the production of the related western minnows (*G. occidentalis*) and pygmy perch (*Edelia vittata*).

Mosquito predation

While it is widely accepted that native fish consume more mosquito larvae than the introduced mosquito fish (*Gambusia*) this has yet to be scientifically verified. In 2013 Department of Fisheries researchers quantified the mosquito larvae consumption of key native fish and *Gambusia*. These results will also determine which species is the most suitable for stocking artificial water bodies in which mosquito control, rather than biodiversity, is the primary objective.

Native and endangered crayfish conservation and biodiversity research

The key focus of this program is to establish a living gene bank and breeding population of the critically endangered "hairy" Margaret River marron, before it becomes extinct in the wild. Department of Fisheries researchers working in collaboration with The University of Western Australia have developed a molecular technique to distinguish pure "hairy" marron from hybrids using real time PCR. This is being used to select broodstock marron for the captive breeding program at both PFRC (traditional pond techniques) and the Aquaculture and Native Fish Breeding Laboratory, in Shenton Park (intensive hatchery techniques).

In addition, a living gene bank representing marron populations from two other river systems are bred and reared in the captive breeding program at PFRC. These broodstock represent the genetic biodiversity of the ancestral Pemberton strain upon which the WA aquaculture industry has been developed, and the rare blue marron. Their progeny are used for 1) marron farmers wishing to increase the genetic diversity of their stocks, 2) wild fisheries research involving the release and recapture of tagged juveniles in the recreational marron fishery, and 3) where appropriate, restocking both catchments and farm dams in the region.

Marron aquaculture research and development

In 2006 the FRDC project 2000/215 "Improved performance of marron using genetic and pond management strategies" was completed. Working with industry on commercial marron farms Research Division staff validated and established current best practice farming techniques. This showed that correctly constructed and professionally managed marron farms achieved production levels twice that of those which do not follow best practice.

The project also showed that poor brood stock selection, where farmers sell their largest marron and breed from the remaining slower growing animals had reduced the growth rate of marron on commercial farms. To address this, the

Research Division staff initiated a selective breeding program that resulted in a 100% improvement in growth rate. In 2007 PFRC produced around 25,000 juveniles for sale to industry. A repository population of the best performing mass and pedigree selected genetic lines was retained at PFRC for future selective breeding and sale of progeny to industry. Increased demand for these juveniles, combined with limited supply from industry, is likely to necessitate re-establishing the selective breeding program at PFRC in the near future.

Summary

In 2012/13 increased requirements to provide scientific support to i) policy development (translocation, biodiversity, biosecurity, recreational angling) and ii) Water Corporation projects, as well as the conclusion of an 18-month rebuilding project at the Shenton Park based facility, required a reallocation of resources from research activities. Despite this key core activities for recreational and aquaculture stakeholders, including trout production and monitoring of recreational marron fishery were delivered. It is anticipated that freshwater research activities will return to normal in 2013/14.

Activities of the Fish Health Unit during 2012/13

The Fish Health Unit of the Department of Fisheries was formed in 1988 following an outbreak of disease in the state trout hatchery. The unit is based at South Perth within the Animal Health Laboratories of the Department of Agriculture and Food, bringing economies of scale through sharing of equipment. The unit is permanently staffed by one full-time principal scientist, one full time and one part-time fish pathologist, one research scientist, one laboratory manager, a part-time research officer and two part-time technical officers.

The unit is accredited to ISO 17025 and provides a diagnostic service to the seafood industries in Western Australia, undertakes disease surveillance for key fisheries, investigates 'fish kills', contributes to policy advice developed by the Department, carries out research on diseases of aquatic organisms and has a minor extension role. In addition, protocols for high health hatchery status have been developed and adopted by key industries. Key activities and achievements of the unit during 2012/13 were as follows:

The fish health laboratory received a total of 165 diagnostic cases during 2012/13, which included a substantial number of *Seriola lalandi* (yellow tail kingfish) samples submitted from South Australia for pathology testing.

The provision of export health certificates for yabbies and marron has continued its downward trend since 2002, when 55 certificates were issued, to none for the last three years. This decline in export activity is due to the continuing drought and to changes in product destinations within the industry.

The provision of pearling translocation certificates declined slightly from 14 to 8 in this reporting period.

Staff spent time assisting sea-cage culture farms in WA coastal waters. This is a growing area of activity in Western Australia.

There were 8 cases of notifiable diseases reported in 2012/13.Most notifications related to records of iridovirus in ornamental fish in quarantined imported fish. The notifiable bacterium *Edwardsiella ictaluri* was isolated from *Botia locahanta* (Pakistani loach) with diagnosis being confirmed by the CSIRO Aquatic Animal Health Laboratory in Geelong. The first recorded occurrence of *Pseudomonas anguilliseptica* was also reported during health investigations into a planned eradication of *Tandanus tandanus* which is not native to Western Australia.

A new project funded by the FRDC aimed at investigating the cause of disease in pearl oysters (*Pinctada maxima)* was recently established. The project represents a collaboration with Macquarie University and the Pearling industry and aims to exploit recent advances in molecular sequencing technology to identify the genetic signature of pathogens associated with Oyster Oedema Disease (OOD). This information can be used to investigate the role of such pathogens in contributing to disease and to potentially develop diagnostic tests to support its management.

A 3 year FRDC project 2011/005 to examine WA prawn samples for virus was started in early 2012. This project aims to identify emerging pathogens of potential significance to both wild fisheries and any potential developing prawn aquaculture industry.

In collaboration with staff from the Department of Water and the Water and Rivers Commission, 7 reports of 'fish kills' throughout the State were investigated. Most 'fish kills' were due either to poor water quality or toxic algal blooms. During the 2010/11 year, the fish kill program was successfully introduced into the Indian Ocean Territories and kits were left at the islands, under agreement with the federal government. This initiative resulted in successfully obtaining samples from a fish kill, due to an algal bloom, in January 2012.

A range of national committees including: the national Subcommittee for Aquatic Animal Health; the Fisheries Research Development Corporation Subprogram on Aquatic Animal Health; the Aquatic Animal Health Project under the Australian Biosecurity Intelligence Network; and Biosecurity Australia frequently seek the expertise of the Fish Health Unit. This reflects the greater emphasis on national coordination and consultation on aquatic animal health issues.

The laboratory continued in its role as one of 7 regional resource centres for aquatic animal health within the Network of Aquaculture Centres (NACA) in the Asia-Pacific.

A member of staff attended an intensive two week training program (AQUAVET) in fish pathology in the United States of America in May-June this year. The training and travel was funded by the FRDC's People Development Program: Aquatic Animal Health Training Scheme. The training program was organized and presented by Cornell University School of Veterinary Medicine and School of Veterinary Medicine at the University of Pennsylvania but held at Roger Williams University in Rhode Island. The training covered the comparative pathobiology of a wide range of aquatic animal species and included the examination of histology slides, case interpretation and practical dissections. The course not only provided world-class education and knowledge from many aquatic animal health specialists, but facilitated the opportunity to network and meet aquatic animal colleagues from all over the world including Spain, Norway, all over the USA and New Zealand.

Members of the group also attended and presented at the FRDC Second Australasian Scientific Conference on Aquatic Animal Health in Cairns, Australia from 8th-12th July 2013. This conference represents an important opportunity to network with fish health professionals from across Australia and worldwide.

Activities of the Marine Biosecurity Research and Monitoring Group during 2012/13

Marine Unit

The Marine Biosecurity Research and Monitoring Group currently monitors high risk ports around the State and has developed research programs to increase our knowledge of the marine pest threat to our State waters.

Introduced Marine Pests

Introduced marine species are organisms that have moved, or been moved from their natural environment to another area. Many of these organisms remain inconspicuous and innocuous causing no known adverse effects. However, they can potentially threaten human health, economic values or the environment, in which case they are then referred to as marine pests. Introduced marine species are a global problem, and second only to habitat change and loss in reducing global biodiversity (Millennium Ecosystem Assessment, 2005).

The introduction of marine species into a new region can be deliberate or accidental. Deliberate introductions may result from aquaculture practices or releases from aquariums. Accidental introductions are primarily due to shipping and recreational craft moving from country to country, with the pests being transported in ballast water, on ship hulls, or within a vessel's internal seawater pipes. Introduced marine species also arrive naturally via marine debris and ocean currents.

The impacts of introduced marine pests are wide and varied. They can predate on native and farmed species, out-compete natives for space and food, alter nutrient cycles and lead to a loss of diversity in local species. In addition to environmental consequences, introduced marine pests have the potential to harm human health (e.g. cholera, paralytic shellfish poisoning), negatively affect commercial fish and seafood species, negatively affect amenity and recreational activities and reduce the fuel efficiency for all vessel types (hull fouling organisms). With increasing human population and associated travel, transport and trade, the risk of introducing new species is likely to grow (Convention on Biological Diversity, 2005).

Early detection of an introduced marine pest is vital if we are to have any chance of eradicating it before it becomes established. There has only been one introduced marine species that has been successfully eradicated to date in Australia, the black striped mussel which was found in Darwin Harbour in 1999. This program of eradication cost more than $2M, but the mussel threatened the $225M (value of production in 1998) pearling industry. If eradication is not an option then other management controls can be put in place, such as community education regarding boating habits and routines, quarantining areas and managing vessel movements between locations.

As an ocean bound nation Australia relies heavily on maritime transport, with over 95% of our imports and exports carried by sea. The large ocean going vessels that transport these goods represent one of the largest vectors of introduced species. For these reasons our ports and marinas become high risk areas for the introduction of a marine pest. The Commonwealth Government, together with the states and territory have developed a national system of policies and procedures to try and reduce the risk of marine pests arriving in Australian waters. Part of this system includes the monitoring of high risk ports, which are those ports that receive large numbers of vessels, high risk vessels (such as dredges) or are geographically close to areas with known invasive marine species.

The monitoring and research activities of the group are aimed at preventing or minimising further introductions of marine pests, and advocating control measures where they do exist.

Monitoring and Surveillance

The Marine Biosecurity Research and Monitoring Group is actively involved in developing and implementing monitoring programs for marine pests along our WA coast using a suite of tools. These programs adhere to the Australian Marine Pest Monitoring Guidelines and have been endorsed by the Commonwealth. These programs occur every two years and have been implemented in Fremantle, Port Hedland, Dampier, Geraldton and HMAS Stirling

(Garden Island, Defence Services Group) in late 2012/early 2013. The Marine Biosecurity Research and Monitoring Group has also developed targeted supplementary monitoring programs, to complement the above, which occur in the off years.

The Marine Biosecurity Research and Monitoring Group has also been approached by Garden Island, Defence Services Group to develop their marine pest incursion response plan for HMAS Stirling.

Early warning system

The Early Warning System uses settlement arrays to examine recruitment of marine organisms, thus potentially providing a mechanism for the early detection of marine pests. Settlement arrays are an established methodology currently being used by the Marine Biosecurity Research and Monitoring Group as a complementary method for marine pest monitoring in Dampier, Port Hedland and Fremantle Ports and at HMAS Stirling. These arrays are simple structures designed to act as extra surfaces for organisms to settle on, using 10cm x 10cm plates and mops as collectors. In addition to the deployment of the settlement arrays, twice a year shoreline searches are carried out and crab traps are deployed.

Surveillance in response to detection

Charybdis japonica

In 2012 three male specimens of the invasive Asian paddle crab *Charybdis japonica* were caught by members of the general public in the Swan River estuary and handed in to the Department of Fisheries Biosecurity team over a period of several months. This triggered extensive trap-based and diver surveillance of the target area in the lower reaches of the estuary. Over 8500 trapping hours and several days of diving surveillance failed to detect any more *C. japonica*. Follow up surveillance operations were conducted at 3 and 6 month intervals after the initial surveillance operation, bringing the total number of trap hours to more than 15,000. To date no further specimens of *C. japonica* have been detected by either the Department or the general public. One further survey is planned to complete this response in the second half of 2013, twelve months after the original detection.

Didemnum perlucidum

In 2011 the Department were alerted to the presence of *D. perlucidum* in our waters. This species is considered non-native to Western Australia and based on current knowledge has only been recorded once previously in Australia (on a vessel in NSW).

The initial detection of this species triggered further investigation by the Department's Marine Biosecurity Research and Monitoring Group who have since found the species to be present in many ports and marinas from Busselton to Broome. It has also been confirmed that this species is present as a component of hull fouling on several vessels traversing the coastline.

The widespread distribution and extensive growth of this species raises biosecurity concerns for the Department. *Didemnum perlucidum* is a heavy fouling species that may cover and smother other benthic assemblages. Based on information from the Northern Hemisphere, *D. perlucidum* displays typical invasive characteristics of a high growth rate, early maturity and extremely high fecundity. Further this species may spread asexually, both through lateral expansion at the edges of the colony as well as through pieces breaking off.

Previously this pest species has been confined to artificial structures such as jetty pylons and vessels. Recent surveillance in 2013 by the Marine Biosecurity Research and Monitoring group has detected this species colonising the seagrass *Halophila ovalis* in the Swan River. This is the first record of this species colonising natural surfaces. The group are currently monitoring the effect this pest may be having on the seagrass and ongoing monitoring to further investigate impacts is planned. *Didemnum perlucidum* is a very difficult species to identify and differentiate from other native species which are known to exist in Australian waters. The Marine Biosecurity Research and Monitoring Group has developed identification capabilities for this species based on characterisation of its DNA. Analysis of populations detected in Western Australia indicates that this species is genetically identical to specimens originating from Brazil. Initial examination of *D.perlucidum* populations sampled along our coast suggests very low genetic variation which is consistent with a recent appearance of this species in Western Australian waters.

Research programs

Likelihood analysis

The Marine Biosecurity Research and Monitoring Group are finalising their analysis of vessels entering WA ports. This research examines the types and number of commercial vessels that visit our ports from domestic and international last port of calls, duration of the vessels stay, duration of the voyage, the bioregions the vessel traverses on its way to WA and environmental matching between the last port of call and the WA port(s) visited. This research will provide an up-to-date analysis of the likelihood of a potential marine pest introduction to individual ports based on the above data that will inform management and policy.

Recreational vessel study

WA has a very high ownership of recreational vessels (90,000 registered vessels: Department of Transport, 2012). However, very little is known about the risk associated with recreational vessels for the introduction and translocation of marine pests along our coast line. The Marine Biosecurity Research and Monitoring Group is commencing a study of recreational vessels from marinas all over the State. This has three main components - firstly a survey of vessel owners examining vessel use and maintenance practices. Secondly an examination of vessels for the presence of known IMPs and an assessment of the degree and type of fouling from different areas on a vessels hull and finally an examination of marinas to see how fouling present on structures correlates with that found on vessels. This information will be combined to allow for predictions in vessel mediated translocation of IMPs which will inform management strategies.

Vessel wrapping

Preventative measures such as maintenance of a clean vessel hull is widely acknowledged as more effective in curtailing invasions of marine pests than are eradication or control measures. The Marine Biosecurity Research and Monitoring Group completed a trial in collaboration with South Australian researchers to ascertain the efficacy of wrapping a recreational vessels hull in eliminating/killing biofouling.

Results were very promising for these small vessels. Further successful trials were completed on the efficacy of wrapping structures such a pylons to kill fouling which are currently being written up for publication.

Crab condos

Baited crab traps have been used in many decapod sampling regimes around the world and specifically target larger predatory/scavenger crustaceans. Crabs are lured inside the traps by an attractant, typically fish-bait and stay inside until the trap is recovered. This technology is effective at capturing larger and aggressive crab species: however, juvenile, small or non-carnivorous species are generally excluded from such devices. A device nick-named the 'crab condo' was developed by New Zealand researchers to try and target these 'excluded' species. The Marine Biosecurity Research and Monitoring Group completed research into the efficacy of these crab condos to sample these species and evaluate their efficacy in different habitats. A scientific journal article on this research was recently published in the international journal Management of Biological Invasions. We are proposing to introduce this sampling methodology into the Australian National System.

Indian Ocean Territories 2012/13

The Marine Biosecurity Research and Monitoring Group are currently conducting two projects in the Indian Oceant Territories.

Marine pest surveillance

The introduction and spread of marine pests poses a serious threat to native biodiversity and can have widespread effects on both our economy and health. The Marine Biosecurity Research and Monitoring Group developed a targeted marine pest monitoring program for Christmas Island in 2010. The aim was to detect the presence of introduced marine pests (IMPs) using a suite of tools. As part of the ongoing biennial project the Marine Biosecurity Research and Monitoring Group completed a large-scale marine pest monitoring program in Christmas Island port in late 2012. No marine pests were detected during the 2012 survey.

Marine pest research

The Marine Biosecurity Research and Monitoring Group are currently assessing the likelihood of a marine pest introduction into Christmas Island from commercial and recreational vessels. The aim of this document will be outline the perceived risk, identify and rank the most likely vectors and last port of call locations that pose a risk to this region. This is due to be finalised later in 2013.

Activities of the Freshwater Biosecurity Research Program 2012

A 2010 NRM funded survey of 114, of the over 4000, listed permanent lakes and swamps of the southwest coastal plain from Geraldton to Busselton, found that fish abundance in the majority of lakes surveyed was dominated by non-native species. The survey detected two new non-native fish species and a new location for a previously detected species. This survey identified the need for a more comprehensive survey program.

Prior to 2012 there were known to be 14 finfish and 2 crustacean pest species in Western Australia, these are listed in the table below. Most of these species successfully reproduce and are therefore considered feral, whilst some appear to, so far, be unsuccessful in this regard. Golden Perch and Silver Perch are the only two species that are yet to have known self-sustaining populations, this does not necessarily imply they are unable to successfully breed in WA.

All of the species listed in Freshwater Biosecurity Table 1 can have an adverse effect on the survival of West Australian native species, this may be via direct competition for food or habitat, by predation or by habitat modification.

Management Arrangements

The Department of Fisheries maintains a Translocation approval process for species considered to be of risk to the West Australian aquatic environment. The approvals process allows the Department to reject translocation applications where the risk is too high or to apply conditions to prevent or limit the risk of release into the environment.

The greatest risk is the release of unwanted aquarium species and the deliberate release of angling species. The management of the release of fish species in this manner is difficult to prevent, however, the Department has increased community education in this area to reduce this risk. The Department has also increased its compliance activities to prevent new introductions and begun a process that would ban the entry into Western Australia of a large number of high risk ornamental fish species that are currently not kept by the ornamental fish keepers in the state.

Staff from the Research Division in addition to staff from all other Divisions across the Department have undertaken formal training in incident management so that there is readiness in case serious biosecurity incidents and emergencies that may occur in future. In tandem with the incident management training, the Department has refined its risk assessment processes and incident management protocols.

2012 Biosecurity Surveys

During 2012 the Freshwater Biosecurity Research Unit was formed to undertake comprehensive surveys, respond to pest species reports and undertake control measures of pest species where required. The survey work in 2012 was concentrated in the Perth area (Swan/Canning coastal plain), being an area identified as high risk due to; previous pest fish

detections, the large urban population and the extensive lake and drainage systems connected to the Swan/Canning Rivers.

There are approximately 1200 permanent lakes listed for the Perth area, comprised of; natural lakes and swamps, man-made or highly modified lakes, water compensating basins as part of drainage management and permanent pools in ephemeral systems. Review of recent late summer aerial photos would indicate that only approximately half of these now retain water all year. Survey work of these lakes by the dedicated Freshwater Biosecurity Research Unit commenced during 2012 with priority being given to lakes around existing known pest fish species populations. Location visits, on occasion, found some lakes to be dry, too shallow or on private property where access was unable to be obtained. Where necessary for the detection of pest fish, creeks, rivers and drains connected to these lakes were also be sampled.

Sampling methodology

The majority of sampling in the Perth area in 2012 was undertaken using fyke nets, a trap net that has a leader net attached to the bank(s) that lead to a series of hoops and funnels that the fish swim into. These nets are generally unbaited. It is accepted that not all fish species are susceptible to capture by fyke nets, however, it is the most appropriate cost effective method for the large number of locations to be sampled. Many of the locations are also often unsuitable by other methods of sampling such as seine netting, electrofishing, gill nets and opera house traps due to habitat type, by-catch and staff safety. However, sampling on occasion, included the use of electrofishing, opera house traps or gill nets where these methods were appropriate. The fyke nets used by the Department were fitted with a float ring to provide access to the surface for any wildlife that were captured.

Research Activities

Departmental staff, prior to the formation of the Freshwater Biosecurity Research Unit, undertook surveys for Spangled Perch *Leiopotherapon unicolor* (detected during 2010 NRM survey), a Gascoyne/Pilbra species, in southern Perth starting in late 2011 and this data is included here. Department of Water staff also assisted with the Spangled Perch survey.

Control measures for the Eastern States Catfish *Tandanus tandanus* (detected during 2010 NRM survey) in Marmion Reserve, Myaree, were commenced with a population assessment and survey of surrounding lakes being undertaken.

In addition, during 2012, surveys of locations outside the Perth area were undertaken for collection of fish samples from the Collie River system for mercury contamination and surveys of some trout stocking locations for the presence of native fish and the feral Redfin Perch.

During 2012 a total of 146 samplings were conducted of which 9 samplings were repeat samplings at 7 locations. A few locations were sampled indirectly due to direct connections to sampled waterbodies and have been counted as the same waterbody. Data for any repeat sampling of a location has been combined for analysis.

Survey work detected the presence of a species, the convict cichlid (*Amatitlania nigrofasciatum*), that had not previously been found in Western Australia. Two individuals of convict cichlid, *Amatitlania nigrofasciata* (Figure 2), were captured in December, 2011, in a single lake within Forest Crescent Reserve (Lat -32.071, Lon 115.952). Lengths of the specimens were 45mm and 43mm SL. Determination of sex of specimens was not possible due to the small size and deterioration after preservation. Follow up sampling did not capture any more specimens, therefore it is possible that this species has not established a self-maintaining population despite an apparent serious risk.

Impact on non-target species

The use of fyke nets for fish sampling can unintentionally capture some wildlife, the most prevalent being oblong turtles. From a total of the 137 locations, turtles were captured at 81 locations. This included the use of 252 fykes capturing 838 turtles, all of which were returned live to the water. Therefore, this method of sampling has had no indirect impact on non-fish species.

Pest Reporting and Response

Pest species are able to be reported to the Department via Fishwatch, the Freshwater Fish Distribution website and direct contact with the Department. In 2012, 17 reports were received by the Freshwater Biosecurity Research Unit. The response to these reports were prioritised according to risk and previous known distribution. From these reports 6 were responded to with sampling and 2 involved the identification of samples that were able to be provided. The remaining reports were deemed to be of low risk or reports on species already known to be present.

Management Implications

It was clear from the 2012 survey work that the pattern observed during the 2010 NRM survey was repeated - few lakes contain indigenous fish (12%) and even fewer contain purely native fish (5%). Of the lakes that contained native species, most only contained between one and three of the eleven SW native species of freshwater finfish. A far greater percentage of lakes contained no native fish, however the reasons for the lack of native fish are unclear , but they may include: reduced water levels from reduced rainfall and/or increased groundwater extraction, poor water quality, acidification, toxic chemicals, eutrophication, salinization, sedimentation or predation/competitive exclusion by pest species. Immediate action may need to be taken to protect the remnant populations before they disappear completely.

Restocking

One method to protect remnant native freshwater fish populations would be via a breeding and stocking program of lakes that do not contain native fish species. This would require considerable quantities of fish, given the high number of lakes involved in the Perth area alone (up to 560). The breeding stock for the stocking program would need to be sourced from the remnant lake stocks to ensure fish with genetic traits suitable for survival in the highly modified lakes within the metro region.

No restocking has been undertaken during 2012.

FRESHWATER BIOSECURITY TABLE 1

Known Pest Fish in WA Prior to 2012

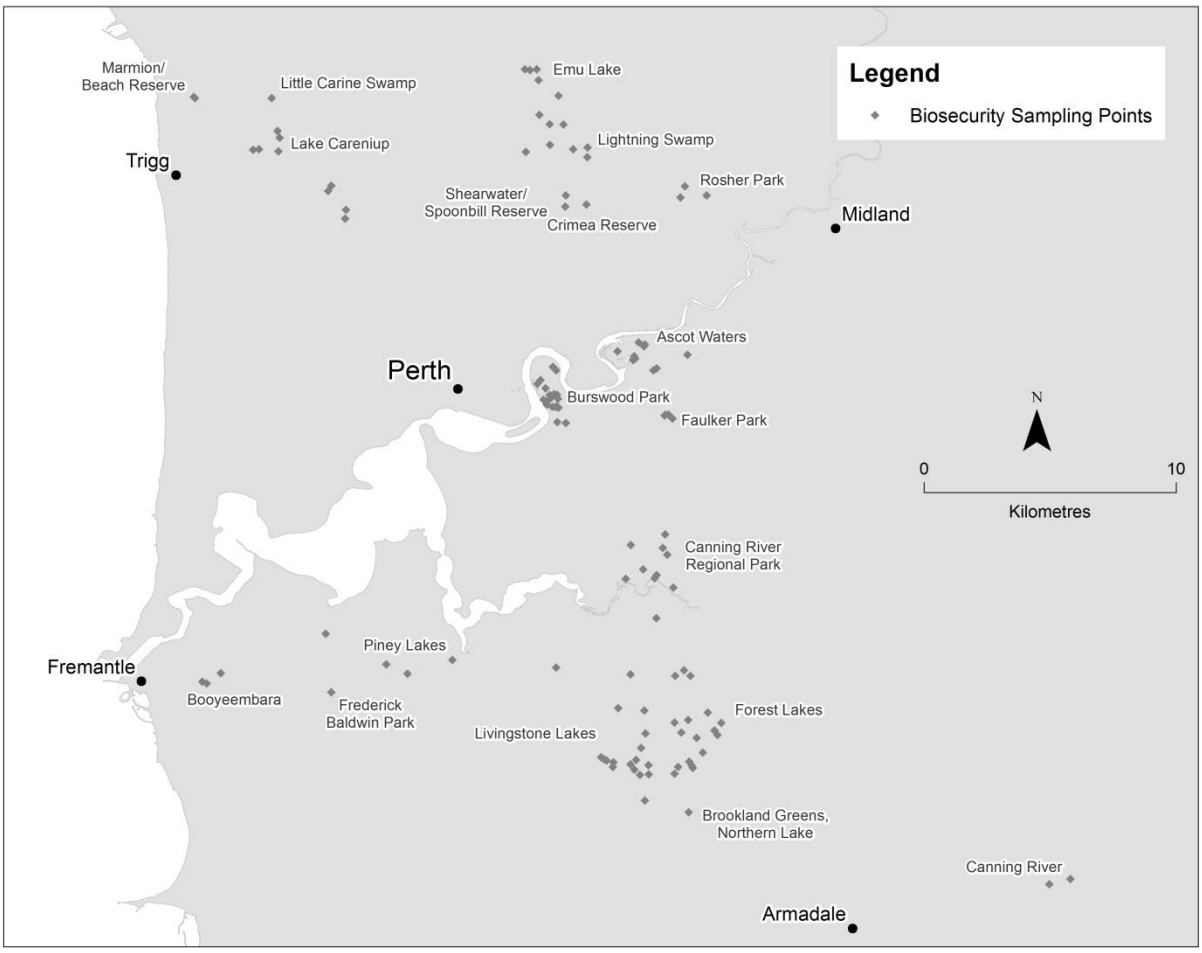
Common Name	*Scientific Name*	Origin
Finfish		
Carp (Koi)	*Cyprinus carpio*	Eurasia
ES Freshwater Catfish	*Tandanus tandanus*	Eastern Australia
Gambusia/Mosquito Fish	*Gambusia holbrooki*	Sth America
Golden Perch	*Macqaria ambigua*	Eastern Australia
Goldfish	*Carassius auratus*	Eurasia
Guppy	*Poecilia reticulata*	Sth America
Pearl Cichlid	*Geophagus brasiliensis*	Sth America
Redfin Perch	*Perca fluviatilis*	Europe
Rosy Barb	*Puntius conchonius*	SE Asia
Silver Perch	*Bidyanus bidyanus*	Eastern Australia
Spangled Perch	*Leiopotherapon unicolor*	Gascoyne
Speckled Mosquito Fish	*Phalloceros caudimaculatus*	Sth America
Swordtail	*Xiphophorus helleri*	Sth America
Tilapia	*Oreochromis mossambicus*	Africa
Crustaceans		
Redclaw Crayfish	*Cherax quadricarinatus*	Eastern Australia
Yabby	*Cherax destructor albidus*	Eastern Australia

FRESHWATER BIOSECURITY TABLE 2.

2012 Freshwater Biosecurity Sampling Results

	Total (Perth)	% (Perth)
Finfish		
Number of locations visited	153 (140)	
Number of locations by visit dry or too shallow	9 (9)	6 (6)
Number of locations sampled	137 (124)	95 (95)
Number of locations containing finfish	130 (119)	95 (96)
Number of locations containing no finfish	7 (5)	5 (4)
Number of locations containing Estuarine fish	43 (42)	31 (34)
Number of locations containing native freshwater finfish	17 (8)	12 (6)
Number of locations containing only native freshwater finfish	7 (3)	5 (2)
Number of locations containing feral freshwater fish	106 (99)	77 (80)
Number of locations containing only feral freshwater finfish	72 (71)	53 (57)
Number of new feral finfish species detected	1 (1)	<1
Number of new locations feral *Tandanus tandanus* detected in	0 (0)	-
Number of new locations feral *Leiopotherapon unicolor* detected in	8 (8)	6 (6)
Crustaceans		
Number of locations containing crustaceans	76 (66)	55 (53)
Number of locations containing no crustaceans	61 (60)	44 (48)
Number of locations containing native crustaceans	61 (51)	44 (41)
Number of locations containing only native crustaceans	38 (29)	28 (23)
Number of locations containing feral crustaceans	38 (37)	28 (30)
Number of locations containing only feral crustaceans	15 (14)	11 (24)

Note; also includes survey data (23 locations) undertaken in December 2011 for Spangled Perch (*L. unicolor*) response.



FRESHWATER BIOSECURITY FIGURE 1.

2012 Swan/Canning Coastal Plain Sampling Locations

FRESHWATER BIOSECURITY FIGURE 2.

Convict cichlids, *Amatitlania nigrofasciata* captured from a waterbody in the greater Perth region.

Finfish Ageing Laboratory

J. Norriss

The Finfish Ageing Laboratory (FAL) at the WA Fisheries and Marine Laboratory continues to produce age data for assessing stocks of key finfish species in Western Australian. Age demographics, recruitment patterns, growth rates, age at onset of sexual maturity and/or sex change, and longevity are all critical parameters for assessing fish stocks.

Estimating the age of a fish is a routine procedure accomplished by removing the otoliths (ear stones) and interpreting their alternating opaque and translucent zones deposited throughout the lifetime of the fish, similar to growth rings in a tree. Interpretation usually requires the otolith be sectioned and mounted on a microscope slide.

The priority species for the FAL are set by the Resource Assessment Framework (RAF) for Finfish Resources (Department of Fisheries WA, 2011)[1]. It identifies the most important indicator species for a range of ecological niches across four marine Bioregions, ranked in terms of their risk to sustainability. The RAF is subject to periodic review.

In 2012 the FAL processed and aged 11,548 fish (see Table 1). The priority species were red emperor, rankin cod, brownstripe snapper and bluespot emperor from the North Coast Bioregion, spangled emperor from the Gascoyne Bioregion, and West Australian dhufish, baldchin groper, Bight redfish and southern school whiting from the West Coast Bioregion.

The number of fish aged in 2012 was significantly lower than the ~16,000 fish aged in 2011. This was due to fewer fish from species that could be aged using whole rather than sectioned otoliths (e.g. 1,590 Australian herring were aged in 2011 compared with zero in 2012), and reduced staff.

The FAL continues to be involved in national developments in fish ageing protocols. It has joined the other fisheries agencies on the Australian Society for Fish Biology's committee for the National Framework for Routine Fish Ageing. A guide to methods used to age key finfish species from the West Coast and South Coast Bioregions is currently being developed, with a combined North Coast and Gascoyne Coast Bioregions guide to follow.

FINFISH AGEING LABORATORY TABLE 1.

The number of fish processed and aged by the Finfish Ageing Laboratory in 2012, by Bioregion, species, ecological suite and whether it is and indicator species for that suite.

North Coast Bioregion	Number processed	Ecological suite	Indicator species
Red Emperor *Lutjanus sebae*	1,757	Inshore demersal	Yes
Brownstripe Snapper *Lutjanus vitta*	642	Inshore demersal	Yes
Blue Spot Emperor *Lethrinus punctulatus*	683	Inshore demersal	Yes
Rankin cod *Epinephelus multinotatus*	2,204	Inshore demersal	Yes
Duskytail grouper *Epinephelus bleekeri*	56	Inshore demersal	No
Total	5,342		

1 Department of Fisheries (2011).Resource Assessment Framework (RAF) for Finfish Resources in Western Australia.Fisheries Occasional Publication No. 85, Department of Fisheries, Perth.

Gascoyne Bioregion	Number processed	Ecological suite	Indicator species
Red Emperor *Lutjanus sebae*	291	Inshore demersal	Yes
Spangled Emperor *Lethrinus nebulosus*	387	Inshore demersal	Yes
Goldband Jobfish *Pristipomoides multidens*	271	Inshore demersal	Yes
Ruby snapper *Etelis carbunculus*	3	Offshore demersal	Yes
Eightbar Grouper *Hyporthodus octofasciatus*	4	Offshore demersal	Yes
Total	956		

West Coast Bioregion	Number processed	Ecological suite	Indicator species
Southern school whiting *Sillago bassensis*	640	Nearshore	Yes
King George Whiting *Sillago punctada*	150	Inshore demersal	No
West Australian Dhufish *Glaucosoma hebraicum*	2,172	Inshore demersal	Yes
(Pink) Snapper *Pagrus auratus*	100	Inshore demersal	Yes
Baldchin Groper *Choerodon rubescens*	990	Inshore demersal	Yes
Redthroat emperor *Lethrinus miniatus*	261	Inshore demersal	Yes
Bight Redfish *Centroberyx gerrardi*	494	Inshore demersal	Yes
Eightbar Grouper *Hyporthodus octofasciatus*	43	Offshore demersal	Yes
Bass Groper *Polyprion americanus*	38	Offshore demersal	Yes
Hapuku *Polyprion oxygenios*	128	Offshore demersal	Yes
Blue Eye Trevalla *Hyperoglyphe antarctica*	48	Offshore demersal	Yes
Total	5,064		

South Coast Bioregion	Number processed	Ecological suite	Indicator species
Bass Groper *Polyprion americanus*	1	Offshore demersal	Yes
Eightbar Grouper *Hyporthodus octofasciatus*	1	Offshore demersal	Yes
Hapuku *Polyprion oxygenios*	40	Offshore demersal	Yes
Blue Eye Trevalla *Hyperoglyphe antarctica*	70	Offshore demersal	Yes
Total	112		

Statewide	Number processed	Ecological suite	Indicator species
Western wirrah *Acanthistius serratus*	1	Not assessed	No
Goldspot pigfish *Bodianus perdito*	3	Not assessed	No
Yelloweye red fish *Centroberyx australis*	8	Inshore demersal	No
Radiant rock cod *Epinephelus radiatus*	4	Not assessed	No
Flame snapper *Etelis coruscans*	1	Offshore demersal	No
Darwins roughy *Gephyroberyx darwinii*	1	Not assessed	No
Ocean perch *Helicolenus percoides*	1	Not assessed	No
Jackass Morwong *Nemadactylus macropterus*	1	Not assessed	No
Knifejaw *Oplegnathus woodwardi*	14	Inshore demersal	No
Whiteedge coronation trout *Variola albimarginata*	4	Not assessed	No
Yellowedge coronation trout *Variola louti*	9	Not assessed	No
Tomato rockcod *Cephalopholis sonnerati*	1	Not assessed	No
Red Bass *Lutjanus bohar*	6	Not assessed	No
Rosy snapper *Pristipomoides filamentosus*	16	Inshore demersal	No
Moon lighter *Tildon sexfasciatus*	1	Not assessed	No
Swallow tail *Centroberyx lineatus*	3	Inshore demersal	No
GRAND TOTAL	11,548		

Indian Ocean Territories Fishery Status Report

S.J. Newman, L. Bellchambers, C. Skepper, S. Evans and P. Carter

Main Features

Status		Current Landings	
Stock level	Some species at risk	Total	Not assessed
Fishing Level	Not Assessed	Main Commercial Fishery	Not reportable

Fishery Description

Commercial

In November 2002, the territorial seas (out to 12 nautical miles) of the Cocos (Keeling) Islands and Christmas Island were declared as 'excepted waters' from the *Fisheries Management Act 1991* (Cth). Management responsibilities were transferred from the Australian Fisheries Management Authority to the Commonwealth Government, and the Western Australian Government's Department of Fisheries has now taken on management responsibilities for the marine Territorial waters of the Indian Ocean Territories on behalf of the Commonwealth Department of Regional Australia, Local Government, Arts and Sport (Department of Regional Australia). The location of the Indian Ocean Territories and their proximity to the Western Australian coast are illustrated in Indian Ocean Territories Figure 1.

Under a Service Delivery Agreement with the Department of Regional Australia, the WA Department Fisheries manages commercial, recreational and aquaculture activities at Cocos (Keeling) Islands and Christmas Island, in addition to providing fish health diagnostic services, biosecurity, fish pathology services and licensing services. The Commonwealth Minister for Regional Australia, Regional Development and Local Government currently holds responsibility for these excepted waters under the *Fish Resources Management Act 1994 (WA) (CI/CKI)* (the 'Applied Act').

The commercial Christmas Island Line Fishery (CILF) primarily targets pelagic species, mainly wahoo (*Acanthocybium solandri*) and yellowfin tuna (*Thunnus albacares*). In addition, limited demersal fishing activities are also undertaken targeting deepwater snappers.

The Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) primarily targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Recreational

Large amounts of recreational fishing are undertaken around the Cocos (Keeling) Islands and Christmas Island targeting both finfish and invertebrate species. The Cocos (Keeling) Islands consist of a diverse range of fishable habitats that include a sheltered lagoon, fringing reefs and offshore 'blue water' environments that support a range of demersal and pelagic fish species, as well as various crustaceans (e.g. crabs) and molluscs (e.g. gong gong), which are highly sought after by fishers for both individual and community purposes. Christmas Island, on the other hand, has a limited amount of habitat available for fishing with no lagoon present, fringing reef surrounding the island and offshore 'blue water' environments that support a limited range of demersal and pelagic fish species, as well as some invertebrates.

Governing legislation/fishing authority

Commercial

Fish Resources Management Act 1994 (WA) (CI/CKI) (the 'Applied Act')

Fish Resources Management Regulations 1995(WA) (CKI/CI) and subsidiary legislation

Fishing Boat Licenses with conditions

Cocos (Keeling) Islands Marine Aquarium Fish Fishery – Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption).

Recreational

Fish Resources Management Act 1994 (WA) (CI/CKI) (the 'Applied Act')

Fish Resources Management Regulations 1995 (WA) (CKI/CI) and subsidiary legislation.

Consultation processes

Commercial

Department–industry/community consultation – Christmas Island and Cocos (Keeling) Islands.

Recreational

Community Consultation - Cocos (Keeling) Islands and Christmas Island.

Boundaries

Commercial

The territorial seas around the Cocos (Keeling) Islands and Christmas Island (Indian Ocean Territories Figure 2 and 3).

Recreational

The territorial seas around the Cocos (Keeling) Islands and Christmas Island (Indian Ocean Territories Figure 2 and 3).

Management arrangements

Commercial

The Christmas Island Line Fishery (CILF) is managed primarily through input controls in the form of limited entry to the fishery and gear restrictions. Currently there are 3 licenses in the fishery. In 2012, 2 licences operated in the fishery. The CILF also has output controls in the form of quota limits on both demersal and pelagic species to be harvested. Data for this fishery cannot be reported due to confidentiality limitations (i.e. less than 3 vessels operated in the fishery).

The commercial Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) is managed through input controls in the form of a limited entry fishery (there is only 1 licence in the fishery) and gear restrictions. The fishery also has a number of output controls in the form of limits on the species permitted to be harvested, limits on the total number of individuals of all species combined that can be harvested in a year and limits of the number of individuals within a Family that can be harvested within a year. Data for this fishery cannot be reported due to confidentiality limitations (i.e. there is only one licence in the fishery).

Recreational

Island-specific recreational fisheries management arrangements for the Indian Ocean Territories are currently being progressed to legislation.

Research summary

A risk assessment workshop was undertaken in 2011 to refine fisheries management and research priorities at the Indian Ocean Territories. Following this and previous workshops, finfish fisheries research has focused on undertaking visual census surveys of shallow reef fish assemblages, trialling baited remote underwater video systems and collecting biological material from a suite of species at the Cocos (Keeling) Islands and Christmas Island to examine their connectivity with other sites along the Western Australian coast and locations in the wider Indo-Pacific. The Marine Ecology and Monitoring section has focussed invertebrate fisheries research on the Cocos (Keeling) Islands, assessing the abundance and biology of key recreational invertebrate species of gong gong (*Lambis lambis*) and giant clams (*Tridacna* spp.) whilst also conducting surveys to understand the abundance and distribution of bêche-de-mer (Holothurians). The Marine Ecology and Monitoring section has also established a reef-monitoring program at Cocos (Keeling) Islands to detect changes in reef health due to natural and anthropogenic impacts.

Retained Species

Commercial landings (season 2012)

Not reportable

Wahoo (*Acanthocybium solandri*) is the main target species of the CILF. Other pelagic species are also targeted during the trolling operations and primarily include yellowfin tuna (*Thunnus albacares*) and other tunas (except southern bluefin tuna *(Thunnus maccoyii),* and dogtooth tuna *(Gymnosarda unicolor),* which may not be taken), and to a lesser extent mahi mahi (*Coryphaena* spp.). Some commercial fishing activities are also undertaken for demersal fish species, mainly deep slope species such as ruby snapper (*Etelis* spp.). The commercial catch for Christmas Island consists of catch data from only 2 vessels and the exact catch data is not reportable due to confidentiality provisions. The total reported catch for this fishery has been less than 10 tonnes per annum over the last 5 years.

There is no commercial line fishery at the Cocos (Keeling) Islands.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*). As there is only one license in the CKIMAFF the catch data is not reportable due to confidentiality provisions.

Recreational catch estimate (season 2012)

Not assessed

Recreational fishing vessels operate around the Cocos (Keeling) Islands and Christmas Island. The amount and magnitude of the recreational fishing catch and effort at these islands has not been assessed. Island-specific recreational bag limits, area closures, and gear restrictions are currently being progressed.

Fishing effort/access level

Commercial

Effort in the CILF has been relatively stable over the past three years. Effort in the fishery is weather dependent and is limited by access to the water through the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Effort in the CKIMAFF has been similar over the last few years providing a similar level of catch.

Recreational

Effort by recreational anglers at both the Cocos (Keeling) Islands and Christmas Island is weather dependent. At the Cocos (Keeling) Islands the prevailing weather conditions determine what part of the Island complex is subject to fishing activities. Access to the water at Christmas Island is limited to the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Stock Assessment

Assessment complete: **Yes**

Assessment method: **Risk Assessment**

Breeding stock level: **Some species at risk**

Invertebrates:

Holuthurians: In 2006 a large-scale assessment of the holothurian communities inhabiting the lagoon and outer reef at the Cocos (Keeling) Islands was undertaken to determine the status of key holothurian species and enable recommendations to be made regarding the feasibility of a commercial holothurian fishery being developed in the region. Analysis of abundance and distribution data found that the holothurian community is strongly influenced by

habitat and although some species are wide-ranging and found in relatively high densities, they tend to be of low economic value. In contrast, species of moderate to high value were recorded at densities too low to support commercial fisheries and typically had very restricted distributions. The holothurian community found at the Cocos (Keeling) Islands is near to pristine, due to a lack of historical fishing pressure. Holothurian stocks are very sensitive to fishing pressure and have been heavily overexploited in other areas of the Indian and Pacific Oceans.

Gong Gong: The common spider conch or gong gong (Lambis lambis) is a heavily recreationally-targeted gastropod inhabiting shallow waters of the lagoon. This species is vulnerable to over-fishing as it is highly accessible and presumably shares biological traits with other exploited conch species, including slow growth and late maturity. Monitoring data collected between 2007 and 2012 indicate that the current abundance of gong gong is lower than recorded historically. While heavy fishing pressure has presumably contributed to the reduction in gong gong numbers, further monitoring is required to determine the role of recruitment variability in maintaining gong gong populations at the Cocos (Keeling) Islands and changes in the lagoon system.

Giant Clams and Coral: The sustainability of giant clam (*Tridacna* spp.) and coral species were identified as potential concerns during recent risk assessments undertaken for the marine resources of the Cocos (Keeling) Islands by the Department of Fisheries. To address these concerns, a stock abundance and distribution assessment of giant clams was undertaken in 2011/12. In addition, an on-going reef monitoring program has been established to monitor natural and anthropogenic impacts on the reef communities at Cocos (Keeling) Islands.

The implementation and ongoing monitoring of these initiatives will enable the Department of Fisheries to assess the health of the invertebrate stocks and ecosystems at the Cocos (Keeling) Islands and effectively detect change, both spatially and temporally, resulting in better management of the natural resources of the Atoll.

Finfish:

Data on the abundance of finfish species is being collected and collated to determine changes over time. A number of recent surveys have been undertaken at both localities (Hobbs, pers. comm., DoF). Some species appear to have exhibited marked declines in abundance. For example, Lincoln Smith *et al*. (1995)[1] reported that the squaretail coral trout (*Plectropomus areolatus*) was abundant on shallow reefs (<10m) and was one of the species most commonly recorded on deep reefs (15-20m). Cocos Malay community members have advised that recreational fishers in the waters of the lagoon targeted these species using lines. This species is now extremely low in abundance at the Cocos (Keeling) Islands (Hobbs, Choat pers. comm.), suggesting local depletion and/or overexploitation of the stock.

The pelagic species that are targeted by the CILF (e.g. wahoo, yellowfin tuna) are likely to be part of a wider Indian Ocean stock. However, the demersal species are likely to be localised stocks that are reliant upon self-recruitment.

There is anecdotal evidence of localised depletion of some deep slope species like rosy snapper (*Pristipomoides filamentosus*) and ruby snapper (*Etelis carbunculus*) around Christmas Island. An increasing number of recreational fishers are using electric-powered lines to target deep-slope demersal finfish species at the Indian Ocean Territories, thereby increasing the effective fishing effort for these species.

It is hoped that the introduction of recreational fishing rules at the Indian Ocean Territories will help to reduce the sustainability risks identified.

Aquarium Fish:

The CKIMAFF targets *Centropyge joculator* and to a lesser extent *Centropyge flavissima*. *Centropyge joculator* is endemic to the Cocos and Christmas Islands and inhabits fringing reefs from 15 to 70 m.

Little is known about the biology of *C. joculator* although Allen *et al*. (2007)[2] describe this species as being abundant on Christmas Island.

Non-Retained Species

Bycatch species impact: Negligible

Fishing in the CILF for pelagic species such as wahoo uses specialised trolling gear to target the fish and involves limited discarding. Species occasionally caught and sometimes retained but generally discarded include billfish, barracuda, shark, mackerel tuna and trevally. A high proportion of the above species are expected to survive capture and release by the fishery. Consequently, it is considered likely that the pelagic fishery has a negligible impact on stocks of discarded species.

Fishing for demersal species in the CILF particularly those in the deep slope waters involves limited discarding as most species are retained for processing. However, catches can be lost to sharks.

The fishing techniques used to capture fish in the CKIMAFF involve using hand or scoop nets, or a small seine net of specific dimensions (the seine net cannot exceed 16 metres in length, must have a mesh of less than or equal to 28mm and a drop of not more than 3 metres) and may use SCUBA equipment. Thus, the CKIMAFF has negligible bycatch due to the highly selective nature of fishing activities.

1 Lincoln-Smith, M.P., Skilleter, G.A., Underwood, A.J., Stark, J., Smith, A.K., Hawes, P.M.H, Howitt, L., White, G.A. and Chapman, M.G. 1995. Cocos (Keeling) Islands: Quantitative baseline surveys for core marine reserves and biosphere reserve in the South Keeling lagoon (prepared for Australian Nature Conservation Agency Project 153). The Institute of Marine Ecology, University of Sydney and The Ecology Lab Pty. Ltd., Sydney, Australia.

2 Allen, G.R., Steene, R.C. and Orchard, M. 2007. Fishes of Christmas Island (Second Edition). Christmas Island Natural History Association, Christmas Island, Indian Ocean, Australia. 284 pp.

Protected species interaction: **Negligible**

The line fishing methods used in CILF are not known to catch any protected species. However, there is some potential for lines to inadvertently catch seabirds at Christmas Island.

No protected species interactions have been reported for the CKIMAFF.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The line fishing methods used in the CILF and the hand collection method used in the CKIMAFF are likely to have minimal impact on the habitat.

Social Effects

Commercial

At least 2 people were employed in the CILF around Christmas Island during 2012. This estimate is based on the number of vessels reporting catches and the average number of crew on each boat.

At least 2 people were employed in the CKIMAFF around Cocos (Keeling) Islands during 2012.

Recreational

Due to their sport fishing and eating qualities, wahoo and other pelagic species are popular target species for recreational anglers and fishing charter operators at the Indian Ocean Territories, particularly at Christmas Island. They are usually captured from small boats, although shore-based fishing is also undertaken.

A large variety of demersal and lagoon finfish and invertebrate species are caught by recreational fishers at Cocos (Keeling) Islands involving the use of a large number of small vessels. Similarly, recreational fishers at Christmas Island undertake fishing activities from a number of small vessels and also fishing from the shore and catch a large variety of demersal finfish species including a large number of deep slope species.

Economic Effects

Estimated annual value (to fishers) for 2012:

Not assessed

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. joculator* commands a high price on the international market (reported in excess of AUS $700.00 each).

Fishery Governance

Commercial

Target commercial catch range: **Not available**

Current Fishing (or Effort) Level: **Not assessed**

The potential recreational fishing effort for both pelagic and demersal fish species at both the Cocos (Keeling) Islands and at Christmas Island is high with a capacity to operate over the entire extent of the fishable area at each island group. Given the restricted amount of habitat and fishing area available it is expected that fishing pressure on some species at Cocos (Keeling) Islands or Christmas Island is above sustainable levels.

The catch of the CKIMAFF has been small since its inception in 1993. There is little incentive for the single licensee to increase catch or effort since market viability and high prices are maintained by only having small numbers of fish available for sale.

New management initiatives (2013)

New island-specific fisheries management arrangements for the Indian Ocean Territories are currently being progressed to legislation.

The effective implementation of any future fisheries management legislation at the Indian Ocean Territories, will require ongoing community education and compliance enforcement programs.

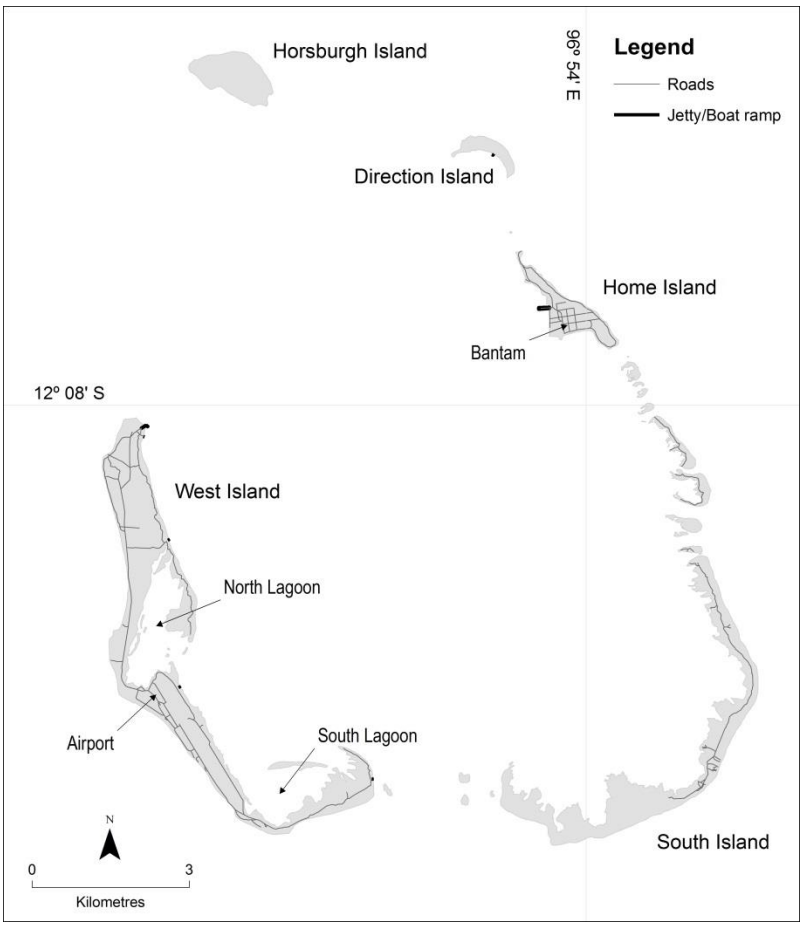
External Factors

The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.

In February 2012, the MV Tycoon was grounded in Flying Fish cove on Christmas Island spilling phosphate and fuel oils into the Cove and surrounding areas. Assessments of the impacts of the MV Tycoon grounding on fish assemblages and reef habitats are awaiting completion.

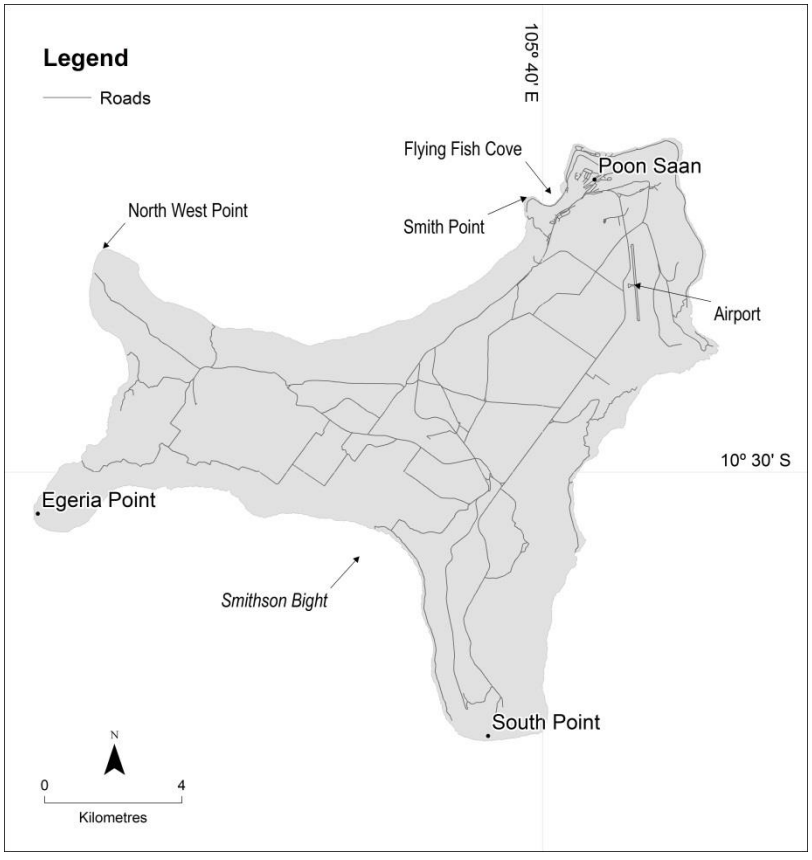
INDIAN OCEAN TERRITORIES FIGURE 1

Location of the Cocos (Keeling) Islands and Christmas Island comprising the Indian Ocean Territories within the Indian Ocean and illustrating their proximity to the Western Australian coast.



INDIAN OCEAN TERRITORIES FIGURE 2

Location of the major Islands and landmarks within the Cocos (Keeling) Islands in the Indian Ocean.



INDIAN OCEAN TERRITORIES FIGURE 3

Location of the key landmarks around Christmas Island in the Indian Ocean.

APPENDIX 4

Annual performance for commercial fisheries subject to export approval under the Commonwealth Government's Environment Protection and Biodiversity Conservation Act 1999

The following table provides a summary of the issues, performance measures and any conditions for fisheries subject to the above Act and their annual performance. The period assessed in each case is the most recent season for which complete data are available. As a result of the duration required for data collection and analysis, the years being assessed in this volume are the 2011/12 season or the calendar year 2012 for fisheries data but up to June 2013 for relevant research or management actions projects and actions.

In addition to this summary, more detailed information on the annual performance of each fishery is provided in the relevant status reports presented throughout this volume. Within the individual status reports, each performance measure assessed is shown in a highlighted box to assist the reader.

It should also be noted that where naturally occurring fluctuations in fish stocks have required management adjustments or where improvements have been made to methods of analysis, these have in some cases (asterisked) required a revision of the performance measure this year.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
Fishery: Abalone *Date of certification:* March 2008 *Approval type:* Accredited Export Exempt Fishery *Expiry date:* September 2014	Greenlip/brownlip abalone Areas 2/3 (spawning stock)	Effort range 907–1,339 diver days; minimum meat weight 140 g greenlip, 160 g brownlip	Acceptable	
	Roe's abalone Area 1 (spawning stock)	Effort range 14–43 diver days; total catch 9.9 t	Acceptable	Exploratory quota. No fishing in 2011.
	Roe's abalone Area 2 (spawning stock)	Effort range 80–106 diver days; total catch 19.8 t	Acceptable	Total catch indicator only met in the Area 2 fishery. This is due to poor economic and weather conditions.
	Roe's abalone Area 5 (spawning stock)	Effort range 100–140 diver days; total catch 20 t	Acceptable	
	Roe's abalone Area 6 (spawning stock)	Effort range 80–127 diver days; total catch 12 t	Acceptable	
	Roe's abalone Area 7 (spawning stock)	Effort range 175–215 diver days; total catch 36 t	Acceptable	Area 8 fishery closed to fishing due to environmentally induced mass mortality
	Roe's abalone Area 8 (spawning stock)	Effort range 140–200 diver days; total catch 12t	Acceptable	
Fishery: Abrolhos Islands and Mid West Trawl *Date of certification*: March 2013 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: March 2018	Scallops (spawning stock)	The residual stock index determines a predicted catch that sets the length of the next season and the fishing season ceases at a catch rate threshold level,	Inadequate	The survey catch prediction was below the target range therefore the fishery did not open in 2012 due to low stock levels

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
Fishery: Beche-de-mer *Date of certification:* December 2004 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: August 2014	Beche-de-mer species (spawning stock)	Sandfish acceptable catch range: 20-100 t. Catch rate above 25 kg/hr. Redfish acceptable catch range: 40-100 t. Catch rate above 60 kg/hr.	Acceptable	Only sandfish assessed. No fishing for Redfish occurred in 2012.
Fishery: Broome Prawn *Date of certification:* August 2004, extended April 2010 *Approval type:* Accredited Export Exempt Fishery *Expiry date:* August 2015	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any one year	Acceptable	Very low level of effort this year.
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	Low level of exploitation
Fishery: Exmouth Gulf Prawn *Date of certification:* February 2013 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: February 2018	Tiger prawn (spawning stock)	Catch rate above 25 kg/hr (6 fathom quad gear) revised from original 8–10 kg/hr (7.5 fathom twin gear)	Acceptable	Catch rate below target level but above the limit due to adverse environmental conditions and now rebuilding.
	King prawn (spawning stock)	Total catch within acceptable range of 350–500 t	Acceptable	Below range due but the catch prediction was low and landings were within the prediction range with a conservative harvesting strategy
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 120–300 t	Acceptable	Low effort as its distribution overlaps that of tiger prawns.
	Banana prawn (spawning stock)	Total catch within acceptable range of 10–60 t for years with significant rainfall and 0–2 t for years with low rainfall	Acceptable	
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–100 t	Acceptable	Low effort and value resulted In low retention rates
	Non –Retained species	The major species of bycatch are found in significant numbers outside of the trawled areas	Acceptable	
	Impact to mud/shell (habitat)	< 40% of mud/shell habitat in Exmouth Gulf trawled	Acceptable	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
Fishery: Gascoyne Demersal Scalefish Managed Fishery *Date of certification:* September 2009 *Approval type:* Export exemption *Expiry date*: September 2014	Pink snapper (spawning stock)	Catch rate not to fall below 500 kg/standard June–July boat day	Acceptable	The performance measure needs to be reviewed following significant reductions in quota and the move (in 2008) to higher resolution catch & effort reporting (daily/trip logbooks).
Fishery: Kimberley Prawn *Date of certification:* November 2004, extended April 2010 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: August 2015	Banana prawn (spawning stock)	Total catch within acceptable range of 200–450 t	Acceptable	
	Brown tiger prawn (spawning stock)	Total catch within acceptable range of 15–60 t	Acceptable	Low landings due to low effort and targeting on high catch rates of banana prawns.
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 7–80 t	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of 0–6 tonnes (10-year catch range)	Acceptable	As above
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–1 t	Acceptable	
	Squid (spawning stock)	Total catch within acceptable range of 1–50 t	Acceptable	Nil reported landings since 2004.
Fishery: Mackerel *Date of certification:* November 2009 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: November 2014	Spanish mackerel (spawning stock)	Total catch within acceptable range of 246-410 t: acceptable regional catch ranges: Kimberley 110–205 t: Pilbara 80–126 t: Gascoyne/West Coast 56–79 t	Acceptable	
Fishery: Marine Aquarium Managed Fishery *Date of certification:* October 2008 *Approval type:* Approved Wildlife Trade Operation Exemptions *Expiry date*: October 2011	Seahorses of hippocampus species	Total catch < 2000. Number taken - 1232	Acceptable	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
Fishery: Northern Demersal Scalefish *Date of certification:* June 2010 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: June 2015	Red emperor and goldband snapper (spawning stock)	Spawning biomass > 40% of virgin spawning biomass with lower limit of 30%; total annual catches should not increase > 20% above average catches of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years	Acceptable	
	Cods/groupers (spawning stock)	Total annual catch should not increase >20% above average catch of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years.	Acceptable	
Fishery: Onslow and Nickol Bay Prawn *Date of certification:* November 2004, extended April 2010 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: August 2015	Banana prawns (spawning stock)	Nickol Bay: total catch in high rainfall years within acceptable range of 40–220 t: in low rainfall years within acceptable range of 0–40 t.	Acceptable	
		Onslow: total catch within acceptable range of 2–90 t	Acceptable	No fishing undertaken In 2012.
	Brown tiger prawn (spawning stock)*	Acceptable catch ranges of Nickol Bay 2–40 t and Onslow 10–120 t	Acceptable	Below target in Nickol Bay due to low effort and targeting on high catch rates of banana prawns and fleet transfer to other trawl fisheries.
	Western king prawn (spawning stock)	Acceptable catch ranges of Nickol Bay 20–70 t and Onslow 10–55 t	Acceptable	Below target due to low effort in Nickol Bay. No fishing Iin Onslow.
	Endeavour prawn (spawning stock)	Total catch within acceptable ranges; Nickol Bay 1-10 t and Onslow 5-20 t.	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of Nickol Bay 1–15 t (10-year catch range) and Onslow 4–20 t	Acceptable	As above
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–2 t	Acceptable	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
Fishery: Pearl Oyster *Date of certification:* September 2003, extended October 2008 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: October 2013	Silver-lipped (gold-lipped) pearl oyster (spawning stock)	Fished area should be < 60% of species distribution; catch rates should not decrease by > 50% from historical averages of 29.5 oysters/hr (Zone 2) and 34.8 oysters/hr (Zone 3); > 30% of Zone 1 catch should be > 150 mm shell length	Acceptable	Catch rates have returned to normal levels after 5 years of high catch rate due to high recruitment.
Fishery: Pilbara Trawl *Date of certification:* November 2004, extended to 29 November 2013 *Approval type:* *:*Approved Wildlife Trade Operation Exemption *Expiry date*: June 2013, extended to November 2013	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass; annual trawl catch should not increase > 20% above average catch of previous 4 years; no decrease in annual trawl catch rates in > 2 consecutive years	Acceptable	
	Short-lived target species (spawning stock)	Median spawning biomass of blue-spot emperor should be > 40% of the 1993 spawning biomass in Area 1; annual catch of each short-lived target species should not increase > 20% above the average annual catch of the previous 4 years; annual catch rate of each short-lived target species should not decrease in two consecutive years	Acceptable	
	Bycatch of protected species - dolphins	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Dolphin mortalities reported in statutory logbooks have reduced to less than 25 per year since 2006
	Bycatch of protected species – turtles	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Mitigation devices implemented in nets in 2006 reduce the incidental captures of turtles by 97%
	Bycatch of protected species – syngnathids	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Number of pipefish caught and released alive should be < 500/yr; number of seahorses caught and released alive should be < 60/yr;

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
	Bycatch of protected species – sawfish	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Number of sawfish caught should be < 120/yr; number of sawfish released alive should be increased to 50% of captures by 2008
	General ecosystem – large epibenthos	The total area of the Pilbara demersal fish fishery (encompassing both trawl and trap fisheries) that is closed to trawling is 80%; the total area of the Pilbara demersal fish fishery between depths of 30 m and 120 m should remain at or below the current level of 60%	Acceptable	
Fishery: Salmon *Date of certification:* November 2009 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: November 2014	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 1,200–2,800 t	Acceptable	2012 catch below target range due to the combined effects of lack of targeting due to weak market demand, low catchability due to environmental factors (relatively high water temperatures) and low availability of fish due to recruitment variation. Stock level considered adequate.
Fishery: Shark Bay Crab Interim Managed Fishery *Date of certification:* November 2004 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: September 2016	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Inadequate:	Voluntary commercial closure since April 2012. as a result of low abundance from June 2011 due to the marine heatwave event over the 2010/11 summer.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
	Tiger prawn (spawning stock)	Level of spawning stock present based on fishery independent surveys during the spawning season to be between 25-30 kg/hr (5.5 fathom quad gear	Acceptable	The spawning stock was well below target however recruitment lin 2013 indicated no recruitment failure. The area assessed as the key spawning area is being reviewed.
	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100–1,600 t, given no change in effort	Acceptable	Slightly below the historical range but within the new range set to account for reduced effort.
	Coral and endeavour prawns (spawning stock)	Total catch within historical acceptable ranges given no change in effort: coral 80–280 t, endeavour 1–30 t	Acceptable	
Fishery: Shark Bay Prawn *Date of certification:* January 2013 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: February 2018	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	BRDs are mandatory in all nets so this performance measure is no longer valid. For the 2012 season, 6 turtles were recorded as caught in nets and all were recorded as being returned to the sea alive.
	Discarded fish (abundance)		Acceptable	Majority of bycatch species are found in relatively significant numbers outside of trawled areas
	Impact to sand/shell (habitat)	< 40% of sand/shell habitat in Shark Bay trawled	Acceptable	
	Impact to coral/sponge (habitat)	<20% of the remaining coral/sponge habitat in Shark Bay to be contained within the legally trawled area	Acceptable	
	Discarding fish (provisioning)		Acceptable	Reduction in amount of discards and ratio of discards to target catch from pre-catch reduction device levels and in water hopper system increasing survival of some bycatch species.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
Fishery: Shark Bay Scallop *Date of certification:* January 2013 *Approval type:* Export exemption *Expiry date*: January 2018	Scallop (spawning stock)	Monitoring of recruits/ residual stock to ensure the start date of the season is set so that there is adequate level of breeding stock present when spawning commences	Inadequate.	Catch prediction below target level due to poor environmental conditions and the fishery did not open.
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	No fishing effort in 2012.
Fishery: South Coast Crustacean *Date of certification:* November 2011 *Approval type:* Wildlife Trade Order *Expiry date*: November 2014	Southern rock lobster (spawning stock)	Catch to remain below 40 t for Esperance fishery	Acceptable	New management arrangements for south coast crustacean fisheries should be finalised in 2014
Fishery: Specimen Shell *Date of certification:* 25 May 2005 *Approval type:* Export exemption *Expiry date*: May 2015	Specimen shell species (spawning stock)	Preliminary acceptable catch range is from 10,000–25,000 shells; acceptable catch rate 10–40 shells per day	Not assessed	Both catch and catch rate within acceptable ranges
Fishery: Temperate Demersal Gillnet and Demersal Longline (Shark) Fisheries *Date of certification:* April 2009 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: March 2012	Dusky and sandbar sharks	Review and report outcomes of actions taken to rebuild stocks,	Underway	Recovery of dusky sharks is clearly evident and sandbar sharks is now likely.
	Australian sea lion interaction rates with demersal gillnets	(a) undertake a study to estimate risk of interactions between fishers and Australian sea lions by 30 March 2011 and (b) implement an appropriate observer program based on results of (a)	(a) Completed (b) pending (a)	A recent FRDC-funded project examined the relative spatial risks of Australian sea lion interactions and a further FRDC-funded study estimated quantitative rates of sea lion encounters with demersal gillnets
Fishery: Western Rock Lobster *Date of certification:* May 2013 *Approval Type:* Approved Wildlife Trade Operation Exemption *Expiry date*: May 2015	Western rock lobster (spawning stock)	Spawning biomass at Abrolhos Islands and coastal regions to remain above respective levels during the early 1980s with 75% certainty	Acceptable	
	Octopus (spawning stock)	Catch rate not to drop outside of historic range by > 10%	Acceptable	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2011/12 or 2012	Comment
	Sea lion (captures)	No increase in rate of capture	Acceptable	No sea lion captures were reported
	Leatherback turtle (entanglements)	No increase in rate of interactions	Acceptable	No entanglements were reported
	Whales and dolphins (entanglements)	No increase in rate of interactions	Un-acceptable	There were 13 confirmed whale entanglements in WRL gear during the 2012 humpback whale migration season. Several mitigation measures are being trialled to reduce whale entanglements.
Fishery: West Coast Deep Sea Crustacean Managed Fishery *Date of certification:* May 2013 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: May 2018	Champagne crab (spawning stock)	Unitisation of the fishery has permitted a maximum of 14t of Champagne crab (combined with Giant crab) to be taken in a season	Acceptable	
	Crystal Crab (spawning stock)	The fishery is quota based with catches limited to 140t of crystal crab per season	Acceptable	As the fishery has moved to catch quota, the performance measure needs to be updated.

APPENDIX 5
Fisheries Research Division staff adjunct positions and supervision of students

Staff Member	Position
David Abdo	Adjunct Lecturer, Faculty of Natural and Agricultural Sciences , University of Western Australia
Lynda Bellchambers	Adjunct Researcher, Faculty of Natural and Agricultural Sciences , University of Western Australia
	PhD co- supervision, University of Western Australia, supervises Luke Thomas - 'Coral recruitment on a high latitude remote reef system.'
Matias Braccini	PhD co-supervision, Universidad de Mar del Plata, Argentina, supervises Marcelo Perez – 'Patrones de desplazamiento del gatuzo (*Mustelus schmitti*) en el Ecosistema Costero Bonaerense a partir de la técnica de marcación con marcas convencionales. Implicancias para el manejo y explotación del recurso' (in Spanish).
	Honours co-supervision, University of Western Australia, supervises Matt Navarro - " Trends in abundance and management of vulnerable chondrichthyans to the effects of deep-sea fishing"
	Honours co-supervision, University of Western Australia, supervises Shelby Oliver- " Global patterns of chondrichthyan bycatch in commercial fisheries "
Dave Fairclough	Adjunct Senior Lecturer (Mar 2011 – Feb 2014), Centre for Fish and Fisheries Research, Murdoch University.
Norman Hall	Emeritus Professor, Murdoch University
	Scientific member of Northern Prawn Resource Assessment Group (NPRAG)
	Supervision, Elena Sulin - Comparisons of the size and age compositions and growth of King George whiting (Sillaginodes punctata) in different regions of south-western Australia. Research Masters by Training Degree, Murdoch University. (Thesis completed in 2012).
	Supervision, Emily Fisher - Tools for assessing data-limited fisheries and communicating stock status information. PhD, Murdoch University. (Thesis completed in 2012).
	Supervision, Calais Tink - Use of surveys and agent-based modelling to assess the management implications of the behaviours of specialised recreational boat fishers. PhD, Murdoch University
	Supervision, Alan Cottingham - Variations in the life-history characteristics of Black Bream *Acanthopagrus butcheri* in south-western Australia. PhD, Murdoch University
	Supervision, Eloïse Ashworth - Influence of environmental variables on the growth and reproductive biology of Black Bream, *Acanthopagrus butcheri*
	Supervision, Daniel Yeoh – Gillnet selectivity of Black Bream *Acanthopagrus butcheri*, Honours, Murdoch University
Alastair Harry	Adjunct Research Associate, School of Earth & Environmental Sciences, James Cook University

Staff Member	Position
Alex Hesp	Co-supervision Emily Fisher. Tools for assessing data-limited fisheries and communicating stock status information. PhD, Murdoch University. (Thesis completed in 2012).
	Co-supervision Elena Sulin. Comparisons of the size and age compositions and growth of King George whiting (*Sillaginodes punctata*) in different regions of south-western Australia. Research Masters by Training Degree, Murdoch University. (Thesis completed in 2012).
	Co-supervision Calais Tink. Use of surveys and agent-based modelling to assess the management implications of the behaviours of specialised recreational boat fishers. PhD, Murdoch University.
	Co-supervision Alan Cottingham. Variations in the life-history characteristics of Black Bream *Acanthopagrus butcheri* in south-western Australia. PhD, Murdoch University.
Craig Lawrence	Adjunct Associate Professor, The University of Western Australia
	PhD supervision Miriam Sullivan- Fishing for Answers: How can we improve welfare for aquarium fish? The University of Western Australia.
	PhD supervision Kelly Mills: Effects of oestrogens and wastewater treatment plant effluent on the Western Pygmy Perch. The University of Western Australia.
	Honours Supervision Ruyu Wang: Genetic Diversity of Western Minnow (*Galaxias occidentalis*) along the Swan and Canning river systems. The University of Western Australia.
Rod Lenanton	Adjunct Associate Professor, Faculty of Sustainability, Environmental and Life Sciences, School of Biological Sciences and Technology, Murdoch University.
Justin McDonald	Adjunct Lecturer, Faculty of Natural and Agricultural Sciences , University of Western Australia
	PhD co- supervision, University of Western Australia, supervises Tiffany Simpson - ' Factors influencing the establishment of invasive marine species'.
Brett Molony	Member of Marine and Freshwater Course Consultative Committee, Edith Cowan University.
	Member of the Technical Advisory Panel (TAP) for the Swan River Trust
	Adjunct Associate Professor, School of Biological Sciences and Technology , Murdoch University 1/11/2012 – 1/11/2015
Stephen Newman	Adjunct Associate Professor – Marine Ecology Group, School of Plant Biology, University of Western Australia
Kim Smith	Masters co-supervision, Edith Cowan University, supervises Peter Malanczak – 'Influence of hydrological factors on distribution of spawning and recruitment by Perth herring in the upper Swan Estuary'
Corey Wakefield	Adjunct Senior Lecturer, Marine Ecology Group, University of Western Australia
	Honorary Research Fellow, Victoria University of Wellington, New Zealand
	Masters co-supervision, University of Western Australia, supervises Claire Wellington – 'Description and comparison of demersal fish ecology of the continental slope of Western Australia'.

Staff Member	Position
	Masters co-supervision, University of Western Australia and Curtin University of Technology, supervises Dion Boddington – 'Comparison of the life history characteristics, habitat partitioning and stock status of three groupers off the north-western coast of Australia'.
	Masters co-supervision, Victorian University of Wellington New Zealand, supervises Natalie Stewart – 'The population structure of Polyprionidae from Australia and New Zealand'.
	Honours co-supervision, Curtin University of Technology, supervises Chella Armstrong – 'To what extent do the larger Hapuku (*Polyprion oxygeneios*) from the west coast of Western Australia reflect differences in growth or longevity to those from the south coast? Implications for management'.

GLOSSARY OF ACRONYMS

AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIMWTMF	Abrolhos Islands and Mid West Trawl Managed Fishery
BPMF	Broome Prawn Managed Fishery
BRD	Bycatch Reduction Device
BRUVS	Baited Remote Underwater Video System
CAES	Catch and Effort Statistics
CDR	Catch and disposal record
CI/CKI	Christmas Island and Cocos (Keeling) Island
CILF	Christmas Island Line Fishery
CKIMAFF	Cocos (Keeling) Islands Marine Aquarium Fish Fishery
CPUE	Catch Per Unit Effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSLPF	Cockburn Sound (Line and Pot) Managed Fishery
CW	Carapace Width
DEC	Department of Environment and Conservation (formerly Department of Conservation and Land Management)
DFAC	Developing Fisheries Assessment Committee
EBFM	Ecosystem Based Fisheries Management
ECU	Edith Cowan University
EPBC	(Commonwealth Government) Environment Protection and Biodiversity Conservation (Act 1999)
ERLF	Esperance Rock Lobster Managed Fishery
ESD	Ecologically Sustainable Development
ETP	Endangered, Threatened and Protected
FED	Fish escapement device
FHPA	Fish Habitat Protection Area
FMO	Fisheries and Marine Officer
FRDC	Fisheries Research and Development Corporation
FRMA	Fish Resources Management Act
FRR	Fisheries Research Report
GAB	Great Australian Bight
GDSF	Gascoyne Demersal Scalefish Managed Fishery
HMAS	Her Majesty's Australian Ship
IBSS	Independent Breeding Stock Survey
IFM	Integrated Fisheries Management
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IMP	Introduced Marine Pests
IMS	Introduced Marine Species
ISO	International Organisation for Standardisation
ITQ	Individually Transferable Quota
IUCN	International Union for the Conservation of Nature
IVR	Integrated Voice Response

JANSF	Joint Authority Northern Shark Fishery
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
KGBF	Kimberley Gillnet and Barramundi Managed Fishery
KPMF	Kimberley Prawn Managed Fishery
LASCF	Lake Argyle Silver Cobbler Fishery
MAF	Marine Aquarium Fish Managed Fishery
MBP	Marine Bioregional Plan
MFL	Managed Fishery Licence
MLL	Minimum Legal Length
MOP	Mother-of-Pearl
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NBPMF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NPF	Northern Prawn Fishery
NRM	Natural Resource Management
NTAC	Notional Target Total Allowable Catch
OCL	Orbital Carapace Length
OPMF	Onslow Prawn Managed Fishery
PFRC	Pemberton Freshwater Research Centre
RAP	Research Angler Program
RCL	Rostrum Carapace Length
RFBL	Recreational Fishing from Boat Licence
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee
RRAMF	Ranked Risk Assessment of Multiple Fisheries
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBCIMF	Shark Bay Crab Interim Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCRIP	Strategic Criteria for Rural Investments in Productivity
SCTF	South Coast Trawl Fishery
SEWPaC	(Commonwealth Government) Department of Sustainability, Environment, Water, Population and Communities (formerly Department of Environment, Water, Heritage and the Arts)
SFD	Standard Fishing Day
SIEV	Suspected Illegal Entry Vessel
SLED	Sea Lion Exclusion Device
SMFG	Size Management Fish Ground
SSF	Specimen Shell Managed Fishery
SWCC	South West Catchment Council
SWTMF	South West Trawl Managed Fishery
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TAE	Total Allowable Effort

TARC	Total Allowable Recreational Catch
TDGDLF	Western Australian Temperate Demersal Gillnet and Demersal Longline Fisheries
UWA	University of Western Australia
TPSA	Tiger Prawn Spawning Area
VFAS	Voluntary Fisheries Adjustment Schemes
VMS	Vessel Monitoring System
WAFIC	Western Australian Fishing Industry Council
WAFMRL	Western Australian Fisheries and Marine Research Laboratories
WAMSI	Western Australian Marine Science Institute
WANCSF	Western Australian North Coast Shark Fishery
WCB	West Coast Bioregion
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCDSF	West Coast Demersal Scalefish Fishery
WCDSIMF	West Coast Demersal Scalefish (Interim) Managed Fishery
WCEF	West Coast Estuarine Managed Fishery
WCRLF	West Coast Rock Lobster Managed Fishery
WDWTF	Western Deepwater Trawl Fishery
WTO	Wildlife Trade Operation