APPENDICES

APPENDIX 1
Fisheries Research Division staff publications 2010/11

Scientific Papers

Andrews, A.H., Kalish, J.M., Newman, S.J., and Johnston, J.M. (2011). Bomb radiocarbon dating of three important reef-fish species using Indo-Pacific $\Delta^{14}C$ chronologies. *Journal of Marine and Freshwater* 62: 1259-1269.

Ballagh, A.C., Welch, D.J., Newman, S.J., Allsop, Q. and Stapley, J.M. (2012). Stock structure of the blue threadfin (*Eleutheronema tetradactylum*) across northern Australia derived from life-history characteristics. *Fisheries Research* 121-122: 63-72.

Bellchambers, L.M., Meeuwig, J.J., Evans, S.N., Legendre, P. (2011). Modelling habitat associations of the common spider conch *Lambis lambis* in the Cocos (Keeling) Islands. *Marine Ecology Progress Series* 432: 83-90.

Bellchambers, L.M., Meeuwig, J.J., Evans, S.N., Legendre, P. (2011). Modelling habitat associations of 14 species of holothurians from an unfished coral atoll: implications for fisheries management. *Aquatic Biology* 14: 57-66.

Berry, O., England, P., Fairclough, D., Jackson, G. and Greenwood, J. (2012). Microsatellite DNA analysis and hydrodynamic modelling reveal the extent of larval transport and gene flow between management zones in an exploited marine fish (*Glaucosoma hebraicum*). *Fisheries Oceanography* 21 (4): 243-254.

Berry, O., England, P., Marriott, R.J., Burridge, C.P. and Newman, S.J. (2012). Understanding age-specific dispersal in fishes through hydrodynamic modelling, genetic simulations and microsatellite DNA analysis. *Molecular Ecology* 21 (9): 2145-2159.

Braccini, J.M., O'Neill, M.F., Campbell, A.B., Leigh, G.M. and Courtney, A.J.(2012). Fishing power and standardized catch rates: implications of missing vessel-characteristic data from the Australian eastern king prawn (*Melicertus plebejus*) fishery. *Canadian Journal of Fisheries and Aquatic Sciences* 69: 797-809.

Braccini, M., O'Neill, M.F., Courtney, A.J., Leigh, G.M., Campbell, A.B., Montgomery, S.S., Prosser A. J. (2012). Quantifying northward movement rates of eastern king prawns along eastern Australia. *Marine Biology* (online).

Braccini, M., Van Rijn, J. and Frick, L. (2012). High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? *PLoS ONE* 7(2): e32547.

Briand, K., Molony, B. and Lehodey, P. (2011). A study on the variability of albacore (*Thunnus alalunga*) longline catch rates in the southwest Pacific Ocean. *Fisheries Oceanography* 20(6): 517-529.

Broderick, D., Ovenden, J.R., Buckworth, R.C., Newman, S.J., Lester, R.J.G. and Welch, D.J. (2011). Genetic population structure of grey mackerel *Scomberomorus semifasciatus* in northern Australia. *Journal of Fish Biology* 79: 633-661.

Campbell, H.A.; Hewitt, M.; Watts, M.; Peverell, S.; Franklin, C.E. (2012) Short- and long-term movement patterns in the freshwater whipray (*Himantura dalyensis*) determined by the signal processing of passive acoustic telemetry data. *Marine and Freshwater Research* 63 (4): 341 – 350.

Gaither, M.R., Bowen, B.W., Bordenave, T., Rocha, L.A., Newman, S.J., Gomez, J.A., van Herwerden, L. and Craig, M.T. (2011). Phylogeography of the reef fish *Cephalopholis argus* (Epinephelidae) indicates Pleistocene isolation across the indo-pacific barrier with contemporary overlap in the coral triangle. *BMC Evolutionary Biology* 11: 189.

Gaither, M.R., Jones, S.A., Kelley, C., Newman, S.J., Sorenson, L. and Bowen, B.W. (2011). High connectivity in the Deepwater Snapper *Pristipomoides filamentosus* (Lutjanidae) across the Indo-Pacific with isolation of the Hawaiian Archipelago. *PLoS ONE* 6(12): e28913.

Gibson-Kueh, S., Chee, D., Chen, J., Wang, Y.H., Tay, S., Leong, L.N., Ng, M.L., Jones, J.B., Nicholls, P.K. and Ferguson, H.W. (2011). The pathology of 'scale drop syndrome' in Asian seabass, *Lates calcarifer* Bloch, a first description. *Journal of Fish Diseases* 35: 19-27.

Gibson-Kueh, S., Thuy, N.T.N., Elliot, A., Jones, J.B., Nicholls, P.K. and Thompson, R.C.A. (2011). An intestinal Eimeria infection in juvenile Asian seabass (*Lates calcarifer*) cultured in Vietnam ? A first report. *Veterinary Parasitology* 181: 106-112.

Gibson-Kueh, S., Yang, R., Thuy, N.T.N., Jones, J.B., Nicholls, P.K. and Ryan, U. (2011). The molecular characterization of an *Eimeria* and *Cryptosporidium* detected in Asian seabass (*Lates calcarifer*) cultured in Vietnam. *Veterinary Parasitology* 181: 91-96.

Harvey, E.S., Newman, S.J., McLean, D.L., Cappo, M., Meeuwig, J.J. and Skepper, C.L. (2012). Comparison of the relative efficiences of stereo-BRUVs and traps for sampling tropical continental shelf demersal fishes. *Fisheries Research* 125-126: 108-120.

Horne, J.B., Momigliano, P., Welch, D.J., Newman, S.J. and van Herwerden, L. (2011). Limited ecological population connectivity suggests low demands on self-recruitment in a tropical inshore marine fish (*Eleutheronema tetradactylum*: Polynemidae). *Molecular Ecology* 20 (11): 2291-2306.

Horne, J.B., Momigliano, P., Welch, D.J., Newman, S.J. and van Herwerden, L. (2012). Searching for common threads in threadfins: phylogeography of Australian polynemids in space and time. *Marine Ecology Progress Series* 449: 263-276.

Hovey, R.K., Van Niel, K.P., Bellchambers, L.M., Pember, M.B. (2012). Modelling deep water habitats to develop a spatially explicit, fine scale understanding of the distribution of the Western Rock Lobster, *Panulirus cygnus*. *PLoS ONE* 7(4): e34476. doi:10.1371/journal.pone.0034476

How, J. and de Lestang, S. (2012) Acoustic tracking: issues affecting design, analysis and interpretation of data from movement studies. *Marine and Freshwater Research* 63(4):312-324.

Jackson, G., Cheng, Y. W. and Wakefield, C.B. (2012). An evaluation of the daily egg production method to estimate spawning biomass of snapper (*Pagrus auratus*) in inner Shark Bay, Western Australia, following more than a decade of surveys 1997-2007. *Fisheries Research* 117-118: 22-34.

Johnston, D.J., Harris, D., Caputi, N. and Thomson, P. (2011). Decline of a blue swimmer crab (*Portunus pelagicus*) fishery in Western Australia – history, contributing factors and future management strategy. *Fisheries Research* 109(1): 119-130.

Jones, J.B. (2011). Current trends in the study of molluscan diseases, pp. 75-92. In: Bondad-Reantaso, M.G., Jones, J.B., Corsin, F. and Aoki, T. (eds.). Diseases in Asian Aquaculture VII. Fish Health Section, Asian Fisheries Society, Selangor, Malaysia. 385 pp.

Jones, J.B. (2012). Transboundary movement of shrimp virus in crustaceans and their products. *Journal of Invertebrate Pathology* 110:196-200.

Melville-Smith, R., de Lestang, S., Johnston, D.J. and Hourston, M. (2011). Temperature affects size at maturity in western rock lobsters (*Panulirus cygnus*), but are things that simple? *Journal of the Marine Biological Association of India* 52 (2): 257-263.

Metcalf, S.J., Pember, M.B., Bellchambers, L.M. (2011). The identification of indicators of the effects of fishing using alternative models, uncertainty and aggregation error. *ICES Journal of Marine Science* doi:10.1093/icesjms/fsr050

Moore, B.R., Stapley, J., Allsop, Q., Newman, S.J., Ballagh, A., Welch, D.J. and Lester, R.J.G. (2011). Stock structure of blue threadfin *Eleutheronema tetradactylum* across northern Australia, as indicated by parasites. *Journal of Fish Biology* 78 (3): 923-936.

Moore, B.R., Simpfendorfer, C.A., Newman, S.J., Stapley, J.M., Allsop, Q., Sellin, M.J. and Welch, D.J. (2012). Spatial variation in life history reveals insight into connectivity and geographic population structure of a tropical estuarine teleost: king threadfin, *Polydactylus macrochir*. *Fisheries Research* 125-126: 214-224.

Muñoz, J., Fewtrell, J.and Fotedar, R. (2012). Seasonal variation in biomass, abundance and plant length of different life stages from *Gracilaria cliftonii* (Gracilariales, Rhodophyta). *International Journal of Algae* 14(3): 294-304.

Muñoz, J.and Fotedar, R (2011). Seasonal variations of agar extracted from different life stages of *Gracilaria cliftonii* (Gracilariales, Rhodophyta) from Western Australia. *African Journal of Marine Science* 333(1): 59-65.

Norte dos Santos, C.C., Leef, M.J, Jones, J. B., Bott, N.J., Giblot-Ducray, D. and Nowak, B.F. (2012). Distribution of Cardicola forsteri eggs in the gills of southern bluefin tuna (*Thunnus maccoyii*) (Castelnau, 1872). *Aquaculture* 344: 54-57.

Newman, S.J., Pember, M.B., Rome, B.M., Mitsopoulos, G.E.A., Skepper, C.L., Allsop, Q., Saunders, T., Ballagh, A.C., van Herwerden, L., Garrett, R.N., Gribble, N.A., Stapley, J.M., Meeuwig, J.J., Moore, B.R. and Welch, D.J. (2011). Stock structure of blue threadfin *Eleutheronema tetradactylum* across northern Australia as inferred from stable isotopes in sagittal otolith carbonate. *Fisheries Management and Ecology* 18 (3): 246-257.

Pearce, A., Feng, M., Slawinski, D., Hutchins, B. and Fearns, P. (2011). Modelling the potential transport of tropical fish larvae in the Leeuwin Current. *Continental Shelf Research* 31: 2018-2040.

Piola, R.F., McDonald, J.I. (2012). Marine biosecurity: The importance of awareness, support and cooperation in managing a successful incursion response. *Marine Pollution Bulletin* http://dx.doi.org/10.1016/j.marpolbul.2012.06.004

Potter, I.C., Chuwen, B.M., Hesp, S.A., Hall, N.G., Hoeksema, S.D., Fairclough, D.V., and Rodwell, T.M. (2011). Implications of the divergent use of a suite of estuaries by two exploited marine fish species. *Journal of Fish Biology* 79 (3): 662-691.

Sampey, A., Fromont, J. and Johnston, D.J. (2011). Demersal and epibenthic fauna in a temperate marine embayment, Cockburn Sound, Western Australia: determination of key indicator species. *Journal of the Royal Society of Western Australia* 94, 1-18.

Sinclair, W., Newman, S.J., Vianna, G.M.S., Williams, S. and Aspden, W.J. (2011). Spatial subdivision and genetic diversity in populations on the east and west coasts of Australia: the multifaceted case of *Nautilus pompilius* (Mollusca, Cephalopoda). *Reviews in Fisheries Science* 19 (1): 52-61.

Smale, D.A., Kendrick, G.A., Harvey, E.S., Langlois, T.J., Hovey, R.K., Van Niel, K.P., Waddington, K.I., Bellchambers, L.M. , Pember, M.B., Babcock, R.C., Vanderklift, M.A., Thomson, D.P., Jakuba, M.V., Pizarro, O. and Williams, S.B. (2012). Regional-scale benthic monitoring for Ecosystem-Based Fisheries Management (EBFM) using an Autonomous Underwater Vehicle (AUV). *ICES Journal of Marine Science* doi:10.1093/icesjms/fss082

Stentiford, G.D., Neil, D.M., Peeler, E.J. Shields, J.D., Small, H.J., Flegel, T.W., Vlak, J., Jones, B., Morado, F., Moss, S., Lotz, J., Bartholomay, D.C., Hauton, C. and Lightner, D.V. (2012). Disease will limit future food supply from the global crustacean fishery and aquaculture sectors. *Journal of Invertebrate Pathology* 110:141-157.

Travers, M.J., Potter, I.C., Clarke, K.R., Newman, S.J. (2012). Relationships between latitude and environmental conditions and the species richness, abundance and composition of tropical fish assemblages over soft substrata. *Marine Ecology Progress Series* 446: 221-241.

Veilleux, H., van Herwerden, L., Evans, R.D., Travers, M.J. and Newman, S.J. (2011). Strong genetic subdivision generates high genetic variability among eastern and western Australian populations of *Lutjanus carponotatus* (Richardson). *Fisheries Research* 108 (1): 74-80.

Williams, A.J., Nicol, S.J., Bentley, N., Starr, P.J., Newman, S.J., McCoy, M.A., Kinch, J., Williams, P.G., Magron, F., Pilling, G.M., Bertram, I., and Batty, M. (2012). International workshop on developing strategies for monitoring data-limited deepwater demersal line fisheries in the Pacific Ocean. *Reviews in Fish Biology and Fisheries* 22: 527-531.

Book Contributions

Fletcher, W.J., Gaughan, D.J., Metcalfe, S.J. and Shaw, J. (2012). Using a regional level, risk based framework to cost effectively implement Ecosystem Based Fisheries Management (EBFM). In: *Global Progress on Ecosystem-Based Fisheries Management*, Eds: Gordon H. Kruse, Howard I. Browman, Kevern L. Cochrane, Diana Evans, Glen S. Jamieson, Pat A. Livingston, Doug Woodby, and Chang Ik Zhang. Pp 129-146 *Alaska Sea Grant College Program* doi:10.4027/gpebfm.2012.07

Jackson, G. (2012). Silver seabream ('Snapper') – *Pagrus auratus*. In: *Reef Fish Spawning Aggregations: Biology, Research and Management.* Eds: Y. Sadovy de Mitcheson and P.L. Colin, *Fish and Fisheries Series 35*, Springer, Pp 472-478.

Kolkovski, S., Simon, Y., Hulata, G., and Ayaril, N. (2012). In: Desert Aquaculture, inland and coastal. In: *Aquaculture: Farming Aquatic Animals and Plants*. Eds: J. Lucas, and P. Southgate, *Blackwell Publishing (Second Edition)*, 627 p.

Kolkovski, S. (2011). Australian desert aquaculture, In: *Aquaculture in desert and arid lands.* Eds: Crespi, V., and Lovatellii, A. *FAO Fisheries and Aquaculture publication 20.*

Muñoz, J., Kumar, V. and Fotedar, R. (2011). Seaweed culture with special reference to Latin America. In: *Recent advances and new species in aquaculture.* Eds: Fotedar, R. and Phillips, B. *Wiley-Blackwell*. London. 416 p.

Reports

Campbell R. (2011). *Assessing and managing interactions of protected and listed marine species with commercial fisheries in Western Australia.* Report to the Fisheries Research and Development Corporation. Fisheries Research Report No. 223. Department of Fisheries, Western Australia. 48 p.

Courtney, A.J., Kienzle, M., Pascoe, S., O'Neill, M.F., Leigh, G.M., Wang, Y-G., Innes, J., Landers, M., Braccini, M., Prosser, A.J., Baxter, P. and Larkin, J. (2012). *Harvest strategy evaluations and co-management for the Moreton Bay Trawl Fishery*. Draft final report. Department of Employment, Economic Development and Innovation.

de Lestang, S., Caputi, N., How, J., Melville-Smith, R., Thomson, A. and Stephenson, P. (2011). *Stock Assessment for the West Coast Rock Lobster Fishery.* Fisheries Research Report No. 217. Department of Fisheries, Western Australia. 192p.

de Lestang, S., Hoenig, J., Frusher, S. and Hall, N.G. (2011). *Evaluating the potential use of change-in-ratio and index removal techniques for determining harvest rates and efficiency increases in the Western Rock Lobster Fishery.* Final Report FRDC Project No. 2009/019. Fisheries Research Report No. 234. Department of Fisheries, Western Australia. 40p.

Fletcher, W.J., Gaughan, D.J., Shaw, J. and Metcalf, S.J. (2012) *Ecosystem Based Fisheries Management: Case Study Report West Coast Bioregion.* Fisheries Research Report No. 212, Department of Fisheries, Western Australia 104p.

Hourston, M. (2012) *Introduced Marine Pest Monitoring Design Report: Port of Geraldton AUGET.* W.A. Department of Fisheries, Perth Western Australia.

Hourston, M. (2012) *Port of Dampier Marine Pest Monitoring Survey: Post Implementation Report.* W.A. Department of Fisheries, Perth Western Australia.

Hourston, M. (2012) *Port of Christmas Island Marine Pest Monitoring Survey: Post Implementation Report.* W.A. Department of Fisheries, Perth Western Australia.

Jones, J.B. and Fletcher, W.J. (2012) *Assessment of the risk associated with the release of abalone sourced from abalone hatcheries for enhancement or marine grow-out in the open ocean areas of WA.* Fisheries Research Report No. 227, Department of Fisheries, Western Australia 20p.

Little, L.R., Thebaud, O., Boschetti, F., McDonald, A.D., Marriott, R., Wise, B., Lenanton, R. (2011). *An evaluation of management strategies for line fishing in the Ningaloo Marine Park: final report for WAMSI Ningaloo reef project 3.2.3 biodiversity assessment, ecosystem impacts of human usage and management strategy evaluation.* CSIRO Marine and Atmospheric Research. 116p.

Molony, B., Evans, R., Jackson, G., Fairclough, D., Lenanton, R., England, P., Berry, O., Chaplin, J., Gardner, M., Gaughan, D., Little, R. and Wise, B. (2011). *Node 4.4 Captured Species Assessments. Final Report to Western Australian Marine Science Institution.* Department of Fisheries, Western Australia. 17 p. http://www.wamsi.org.au/sites/default/files/WAMSI%204.4%20Final%20Report%20Sept%202011.pdf

Munoz, J. and Bridgwood, S. (2012). *Early warning system for the monitoring of introduced marine pests. Fremantle Port 2011 - 2012 Annual Report.*

Munoz, J. and Bridgwood, S. (2012). *Early warning system for the monitoring of introduced marine pests. Dampier Port 2011 Annual Report.*

Munoz, J. and Bridgwood, S. (2012). *Early warning system for the monitoring of introduced marine pests. Port Hedland 2011 Annual Report.*

O'Neill, M. F., Leigh, G.M., Martin, J.M., Newman, S.J., Chambers, M., Dichmont, C.M. and Buckworth, R.C. (2011). *Sustaining productivity of tropical red snappers using new monitoring and reference points.* Final Report to the Fisheries Research and Development Corporation, Project 2009/037. 104p.

Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. and Gaughan, D. (2011). *The "marine heatwave" off Western Australia during the summer of 2010/11.* Fisheries Research Report No 222. Department of Fisheries, Western Australia, Perth, 36 p.

Young, J.W., Skewes, T.D., Lyne, V.D., Hook, S.E., Revill, A.T., Condie, S.A., Newman, S.J., Wakefield, C.B., Molony, B.W. (2011). *A review of the Fisheries potentially affected by the Montara oil spill off northwest Australia and potential toxicological effects.* Montara well release scientific monitoring programme study S4B. 80 p.

Conference/Workshop Papers

Kruse, G.H., Browman, H.I., Cochrane, K.L., Evans, D., Fletcher, W.J., Jamieson, G.S., Livingston, P.A., Woodby, D. and Chang Ik Zhang (2012) Panel Session: Steps for Future Progress in Ecosystem-based Fisheries Management: What's Next? pp 375-380 In: *Global Progress on Ecosystem-Based Fisheries Management*, edited by Gordon H. Kruse, Howard I. Browman, Kevern L. Cochrane, Diana Evans, Glen S. Jamieson, Pat A. Livingston, Doug Woodby, and Chang Ik Zhang,. Alaska Sea Grant College Program doi:10.4027/gpebfm.2012.019

Jackson, G., Lai, E. and Green, T. (2011). Assessing the effectiveness of quota-tags to manage recreational catches of snapper *(Pagrus auratus*) in the Freycinet Estuary, Shark Bay, Western Australia*. 6th World Recreational Fishing Conference,* Humboldt University, Berlin, Germany. p 117.

Popular Articles and Client Information

Kolkovski, S. (2012) Octopus aquaculture. *Fish Farming International (March).*

Caput, N., Wahle, R., Moore, J. 2012 (Ed.) The Lobster Newsletter. 25(1), 21p*. Department of Fisheries, Western Australia.* http://www.fish.wa.gov.au/Species/Rock-Lobster/Pages/The-Lobster-Newsletter.aspx

APPENDIX 2
Table of catches from fishers' statutory monthly returns for 2010/11

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 by-product 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 'cod' may be used for several species in the family of Serranidae.

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.

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH			
Amberjack	*Seriola dumerili*	16	16
Australian sardine (Pilchard)	*Sardinops sagax ocellatus*	2,322	2,322
Barracuda (northern pike)	*Sphyraena* spp	5	5
Barramundi (giant perch)	*Lates calcarifer*	26	40
Bass grouper	*Polyprion americanus*	1	1
Bigeye (not tuna)	Priacanthidae	19	19
Boarfish	Pentacerotidae	7	8
Bream, black	*Acanthopagrus butcheri*	53	53
Bream, monocle	*Scolopsis* spp.	14	14
Bream, Mozambique	*Wattsia mossambica*	2	2
Bream, Robinson's	*Gymnocranius grandoculis*	37	37
Bream, silver (tarwhine)	*Rhabdosargus sarba*	5	5
Bream, western yellowfin	*Acanthopagrus latus*	12	12
Catfish, sea (golden cobbler)	Ariidae	14	14
Chinaman fish (not cod)	*Symphorus nematophorus*	9	9
Cobbler	*Cnidoglanis macrocephalus*	49	69
Cod	Serranidae	59	59
Cod, bar (grey-banded, eight-bar)	*Epinephelus octofasciatus*	23	23

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Cod, breaksea	*Epinephelides armatus*	5	5
Cod, chinaman	*Epinephelus rivulatus*	1	1
Cod, Rankin	*Epinephelus multinotatus*	125	125
Cod, spotted	*Epinephelus microdon, E.areolatus, E. bilobatus*	34	34
Common Coral Trout	*Plectropomus leopardus*	1	1
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	73	75
Duskytail Grouper	*Epinephelus bleekeri*	2	2
Emperor, blue-lined (grass; black snapper)	*Lethrinus laticaudis*	3	3
Emperor, blue-spot	*Lethrinus hutchinsi*	296	296
Emperor, red	*Lutjanus sebae*	285	285
Emperor, red-spot (snapper)	*Lethrinus lentjan*	36	36
Emperor, spangled	*Lethrinus nebulosus*	71	71
Emperor, sweetlip	*Lethrinus miniatus*	67	67
Flagfish (Spanish flag)	*Lutjanus vitta, L.quinquelineatus, L.carponotatus, L.lutjanus*	107	107
Flathead	Platycephalidae	3	3
Flounder	Bothidae	2	2
Garfish, sea	*Hyporhamphus melanochir*	33	33
Groper (wrasses)	Labridae	1	1
Groper, baldchin	*Choerodon rubescens*	16	16
Groper, blue	*Achoerodus gouldii*	42	49
Halibut	*Psettodes erumei*	1	1
Hapuku	*Polyprion oxygeneios*	13	13
Herring, Australian	*Arripis georgianus*	148	148
Javelin fish	*Pomadasys* spp.	26	26
Jobfish (goldband snapper) –see Snapper, goldband			
Jobfish, rosy –see Snapper, rosy			
Jobfish (sharptooth snapper) –see Snapper, sharptooth			
Kingfish, black (cobia)	*Rachycentron canadum*	13	13
Kingfish, yellowtail	*Seriola lalandi*	1	1

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Knifejaw	*Oplegnathus woodwardi*	1	1
Leather jacket	Monacanthidae	28	52
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	11	12
Mackerel, other	Scombridae	1	1
Mackerel, scaly	*Sardinella lemuru*	339	339
Mackerel, Spanish	*Scomberomorus commerson*	203	287
Mangrove jack	*Lutjanus argentimaculatus*	15	15
Mullet, red	Mullidae	33	33
Mullet, sea	*Mugil cephalus*	233	234
Mullet, yellow-eye	*Aldrichetta forsteri*	22	22
Mulloway	*Argyrosomus hololepidotus*	14	15
Mulloway, northern (black jew)	*Protonibea diacanthus*	3	3
Parrot fish	Scaridae	5	5
Perch, darktail sea (maroon sea) -see Snapper, marron			
Perch, Moses –see Snapper, Moses			
Perch, pearl	*Glaucosoma buergeri*	23	23
Perch, red, maroon sea perch	*Lutjanus* spp *(large)*	16	16
Perch, yellowtail	*Amniataba caudavittatus*	1	1
Perches, other	Lutjanidae	5	5
Pigfish	*Bodianus* spp.	1	1
Pike, sea	*Sphyraena novaehollandiae*	1	1
Pomfret, black	*Parastromateus niger*	1	1
Redfish	*Centroberyx* spp.	9	9
Redfish, bight	*Centroberyx gerrardi*	40	41
Redfish, yelloweye	*Centroberyx australis*	12	12
Rockcod, birdwire	*Epinephelus merra*	1	1
Rockcod, blackspotted	*Epinephelus malabaricus*	25	25
Rockcod, goldspotted	*Epinephelus coioides*	30	30
Salmon, Australian	*Arripis truttaceus*	102	102
Samson fish (sea kingfish)	*Seriola hippos*	33	34
Scad, yellowtail	*Trachurus novaezelandiae*	7	7
Scorpionfishes	Scorpaenidae	1	1

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Shark, angel	*Squatina* spp.	2	4
Shark, blacktip	*Carcharhinus* spp.	1	1
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	127	199
Shark, common saw	*Pristiphorus cirratus*	6	10
Shark, eastern school	*Galeorhinus galeus*	6	9
Shark, golden (copper whaler)	*Carcharhinus brachyurus*	37	56
Shark, gummy	*Mustelus antarcticus*	246	375
Shark, hammerhead	Sphyrnidae	43	68
Shark, mako (shortfin)	*Isurus oxyrinchus*	1	2
Shark, pencil	*Hypogaleus hyugaensis*	< 500kg	1
Shark, spinner (long-nose grey)	*Carcharhinus brevipinna*	40	60
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	45	71
Shark, tiger	*Galeocerdo cuvier*	2	3
Shark, whiskery	*Furgaleus macki*	85	127
Shark, wobbegong	Orectolobidae	19	30
Shark, other		3	4
Shovelnose (fiddler rays)	Rhinobatidae *&* Rhynchobatidae	1	3
Skates and rays, other		5	13
Smelt, hardy head	Atherinidae	5	5
Snapper, bullnose (variegated emperor)	*Lethrinus ravus*	5	5
Snapper, crimson (formerly red snapper)	*Lutjanus erythropterus*	212	212
Snapper, frypan	*Argyrops spinifer*	40	40
Snapper, goldband	*Pristipomoides multidens*	674	674
Snapper, long nose	*Lethrinus olivaceus*	15	15
Snapper, maroon (formerly maroon sea perch)	*Lutjanus lemniscatus*	12	12
Snapper, Moses (formerly Moses Perch)	*Lutjanus russelli*	38	38
Snapper, nor-west	Lethrinidae	2	2
Snapper, pink	*Pagrus auratus*	456	458
Snapper, queen	*Nemadactylus valenciennesi*	51	56
Snapper, red (swallowtail) –see Snapper, crimson			
Snapper, rosy (formerly Rosy jobfish)	*Pristipomoides filamentosus*	32	32
Snapper, ruby	*Etelis* spp.	86	86

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
FISH (continued)			
Snapper, saddletail sea (formerly scarlet sea perch)	*Lutjanus malabaricus*	180	180
Snapper, sharptooth	*Pristipomoides typus*	2	2
Sole	*Ammotretis rostratus*	1	1
Sprat, blue	*Spratelloides robustus*	1	1
Sweep	*Scorpis aequipinnis*	2	2
Sweetlip	Haemulidae	48	48
Tailor	*Pomatomus saltatrix*	24	24
Threadfin	Polynemidae	10	14
Threadfin bream (butterfish)	Nemipteridae	147	147
Threadfin, giant (king salmon)	*Eleutheronema tetradactylum*	65	67
Trevalla, deepsea	*Hyperoglyphe antarctica*	3	3
Trevally, golden	*Gnathanodon speciosus*	3	3
Trevally, other (skippy)	Carangidae	121	121
Trevally, skipjack	*Pseudocaranx dentex*	10	10
Tripletail	*Lobotes surinamensis*	2	3
Trout, coral	*Plectropomus maculatus*	22	22
Trumpeters	Terapontidae	3	3
Tuna, Longtail	*Thunnus tonggol*	1	1
Tuna, other	Scombridae	1	1
Tuna, yellowfin	*Thunnus albacares*	1	1
Tuskfish, bluebone	*Choerodon* spp.	7	7
Whitebait	*Hyperlophus vittatus*	38	38
Whiting, golden-lined	*Sillago analis*	10	10
Whiting, King George	*Sillaginodes punctata*	15	15
Whiting, other	Sillaginidae	22	22
Whiting, western sand	*Sillago schomburgkii*	119	119
Other fish		140	168
TOTAL FISH		**8,588**	**9,151**
CRABS			
Crab, blue swimmer (blue manna, sand)	*Portunus pelagicus*	1,063	1,063
Crab, champagne (spiny)	*Hypothalassia acerba*	12	12
Crab, coral	*Charybdis feriata*	1	1
Crab, crystal (snow)	*Chaceon bicolor*	146	146

Common Name	*Scientific Name*	Landed weight (tonnes)	Live weight (tonnes)
CRABS (continued)			
Crab, giant (king)	*Pseudocarcinus gigas*	8	8
Crab, mud	*Scylla* spp.	< 500kg	< 500kg
TOTAL CRABS		**1,231**	**1,231**
PRAWNS			
Prawn, banana	*Penaeus merguiensis*	304	304
Prawn, brown tiger	*Penaeus esculentus*	1,122	1,122
Prawn, coral	*Metapenaeopsis* spp.	132	132
Prawn, endeavour	*Metapenaeus* spp.	160	160
Prawn, western king	*Penaeus latisulcatus*	1,503	1,503
Prawns, other	Penaeidae	< 500 kg	< 500 kg
TOTAL PRAWNS		**3,223**	**3,223**
LOBSTERS			
Bugs	Scyllaridae	14	14
Rock lobster, southern	*Jasus edwardsii*	52	52
Rock lobster, western	*Panulirus cygnus*	5,194	5,194
TOTAL LOBSTERS		**5,261**	**5,261**
MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	15	38
Abalone, greenlip	*Haliotis laevigata*	61	162
Abalone, Roe's	*Haliotis roei*	99	99
Cuttlefish	Sepiidae	50	50
Octopus	*Octopus* spp. *(mainly O. tetricus)*	219	270
Scallop, saucer	*Amusium balloti*	612	3,058
Squid	*Sepioteuthis* spp.*, Loligo* spp.	56	56
Trochus	*Trochus niloticus*	4	4
TOTAL MOLLUSCS		**1,115**	**3,737**
OTHER CLASSES			
Beche de Mer	Holothuridae	36	107
TOTAL OTHER CLASSES		**36**	**107**
GRAND TOTAL		**19,453**	**22,710**

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'.

1. *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.
2. Weight figures are round off to the nearest tonnage.

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

APPENDIX 3
Research Division - Other Activities
Activities of the Pemberton Freshwater Research Centre 2011/12

Craig Lawrence & Tony 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 150m2 breeding ponds to 1000m2 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. As part of the NRM funded hatchery infrastructure modifications a front office has been allocated for public enquiries, community education material on the department's activities and the recommencement of tours of the facility by the public. The community education material is being developed as 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 2011/12 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 2011/12 the PFRC produced 753,000 fry. These consisted of 740,000 Rainbow trout fry and 13,000 Brown trout fry, representing an increase in production of 12% and a decrease of 56% respectively, compared with 2010/11. The majority of production (66%) consisting of 490,000 Rainbow trout fry and 10,000 Brown trout fry were stocked into public waterways to support recreational fishing. A further 200,000 Rainbow trout (27%) were sold to individuals and clubs for stocking private farm dams; recreational fishing and tourism operations; and licensed aquaculture producers. The 250% increase in sales from PFRC in 2011/12 was due to increased demand from recreational fishout operators and commercial aquaculture producers for both yearlings and fry.

No sterile triploid rainbow trout were produced at PFRC in 2010/11. Consequently triploid sales to private waters for recreational fishing (0) were significantly less than in 2010/11 (36,000).

The remaining 35,000 trout produced (5%) were retained for future brood stock for PFRC, yearling stocking, and research.

In 2011/12 during the Winter-Spring months 8,700 Rainbow yearlings as well as 2,620 Rainbow and 470 Brown trout ex brood stock, were released to public waters for recreational fishing and control of stunted redfin perch populations.

The 36% reduction in yearlings stocked in 2011/12 (8,700) compared with 2010/11 (24,500) is due to compliance with the Department of Fisheries revised translocation policy. Consequently, no yearlings have been stocked since December 2011. It is anticipated that translocation approval to stock the remaining 16,000 yearlings currently being held at PFRC will be received in late June 2012. Upon which stocking will recommence and proceed 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 being investigated include 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 will enable 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 commenced 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 28oC 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 has been delayed until after the 2012 spawning season.

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 many years using temperature shock to retain the first polar body of fertilised eggs. However, temperature shocking is known to have considerable variability in triploidy rates. To address this in 2006 PFRC obtained a hydrostatic pressure chamber for manipulating chromosome numbers to produce triploids and tetraploids.

Protocols for the production of triploids and tetraploids using hydrostatic pressure were developed and trialled at PFRC in 2006. Juveniles were produced, however resource limitations prevented the percentage of triploids and tetraploids being analysed in either 2008/09 or 2009/10 or 2010/11. These samples have been frozen and will be analysed when finances permit. In 2010/11 and 2011/12 Department of Fisheries researchers have worked 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. This will enable research in this area to recommence in 2012.

Native and endangered fish conservation and biodiversity research

In response to a declining prevalence of native fish in the southwest Department of Fisheries researchers established brood stock populations of two endemic species Pygmy Perch (Edelia 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 (G. truttaceus - Critically endangered and N. balstoni - Vulnerable to extinction).

Western Minnow (Galaxias occidentalis)

In 2011/12 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 this year. The technology developed will now be 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 (Edelia vittata)

In 2011/12 Pygmy perch were spawned in tanks at PFRC following the protocols developed and refined at the Shenton Park Aquaculture and Native Fish Breeding Laboratory. This technology will now be scaled up to mass production in ponds on Thomson Flat to produce fish for restocking; and 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 the native Pygmy perch consume more mosquito larvae. Therefore, while production and stocking of Pygmy perch 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 Shenton Park Aquaculture and Native Fish Breeding Laboratory. In addition to establishing a living gene bank before these species become extinct, 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 2012/13

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 a series of experiments Department of Fisheries researchers will quantify 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

In 2005/06 a captive breeding program to conserve marron biodiversity was established at PFRC. The key focus of this program was to establish a living gene bank and breeding population of the critically endangered "hairy" Margaret River marron, before it became extinct in the wild. The South West Catchments Council (SWCC) provided funding for Department of Fisheries researchers working in collaboration with The University of Western Australia to develop a molecular genetic test (RAPID's) to identify "pure" marron from hybrids. This resulted in the establishment of the only "pure" brood stock population of the rare Margaret River marron at PFRC. These broodstock at PFRC produced over 1200 juveniles in their first breeding season. These juveniles were reared to sexual maturity at PFRC. In July 2009 these marron bred in the ponds at PFRC and 2500 progeny were tagged and restocked in the Margaret River. In 2010 during field sampling to monitor the wild population in the Margaret River a tagged marron, which had been released as juvenile in 2009, was recaptured.

In addition, a living gene bank representing marron populations from three 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 2011/12 increased requirements to provide scientific support to i) policy development (translocation, biodiversity, biosecurity) and ii) Water Corporation projects, as well as an 18-month rebuilding project at the Perth based facility, required a reallocation of resources from research activities to policy support. 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 2012.

Activities of the Fish Health Unit during 2011/12

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 1 full-time and 1 part-time fish pathologist, one research scientist, one laboratory manager, a research officer and one technical officer.

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 2011/12 were as follows:

- The fish health laboratory received a total of 180 diagnostic cases during the 2011/12 – about the same case load as last year.
- 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 two 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 remained steady at 14 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 4 cases of notifiable diseases reported in 2011/12, the diseases were all records of iridovirus in ornamental fish in quarantined imported fish.
- Investigation of disease in pearl oysters (*Pinctada maxima*) through two Fisheries Research and Development Corporation (FRDC) funded projects; FRDC 2008/30 to develop methods to detect stress in oysters and FRDC 2008/31 to investigate novel Chlamydia-like bodies in pearl oysters has concluded. The cause of the mortalities since 2006 has not yet been determined, however, a novel Chlamydia-like organism has been found to be associated with the pearl oyster mortalities. This requires further work. It is also anticipated that the stress work will develop as a new project in 2012/13 with the assistance of the pearling industry and Macquarie University.
- A new 3 year FRDC project 2011/005 to examine WA prawn samples for virus was started in early 2012.
- In collaboration with staff from the Department of Water and the Water and Rivers Commission, 23 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. As part of that activity, the Vietnamese government funded a quarantine officer to train in the Fish Health laboratories during 2012.

Activities of the Biosecurity Group during 2011/12

Marine Unit

The Marine Biosecurity Research 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 or 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 of 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 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 were previously completed in Fremantle, Port Hedland, Dampier and Christmas Island ports in late 2010/early 2011. The Marine Biosecurity Research group has also developed targeted supplementary monitoring programs, to complement the above, which occur in the off years. The supplementary monitoring has been completed for Fremantle Port (February 2012) and is planned to occur for Dampier and Port Hedland Ports in the middle of 2012 and Christmas Island the end of 2012. The Marine Biosecurity Research group has also developed monitoring program designs for the Geraldton Port Authority and HMAS Stirling (Garden Island, Defence Services Group).

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 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 2010 a single male specimen of the invasive Asian Paddle crab *Charybdis japonica* was handed in to the Mandurah District Office of the Department of Fisheries. This triggered extensive trap-based surveillance of the Mandurah waters. The original surveillance did not detect any further specimens of *C. japonica*. Repeat surveillance was conducted in late 2011, whilst a third and final survey is planned for late 2012. To date no further specimens of *C. japonica* have been detected.

Didemnum perlucidum

In 2011 the Biosecurity management group were alerted to

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

The initial detection of this species triggered further investigation by the Departments Marine Biosecurity Research group who have since found the species to be present in the Ports of Fremantle (including Henderson and Garden Island); the Swan River; Hillarys Boat Harbour and the Port of Dampier. It has also been confirmed that this species is fouling mussel lines on a commercial mussel farm in Cockburn Sound and has been recorded on the hulls of 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. Reports from the Cockburn Sound mussel farm are that this species caused approximately 80% mortality of their 2012 end-sellable harvest.

Based on detections of *D. perlucidum* by the Marine Biosecurity Research group this species has wide temperature and salinity tolerances (evident by its current known distribution). As such this species has the potential to become a significant pest in WA.

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 group has developed identification capabilities for this species based on characterisation of its DNA. Analysis of populations detected in Western Australia indicate that this species is genetically identical to specimens originating in Brazil. Initital examination of *D.perlucidum* populations sampled along our coast suggest 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 group are gathering shipping information from ports around WA from Esperance to Wyndham. This research will be looking at 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 group will quantify that risk by studying a range of recreational vessels from marinas all over the State. This will be achieved by firstly observing these vessels for the presence of known IMPs, or species displaying invasive characteristics, secondly by assessing the degree and type of fouling from different areas on a vessels hull and finally by gathering information from boat owners with respect to antifouling practices and vessel travel history.

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. Recreational vessels, are often left in-water for ease of use, their use is sporadic, vessels may travel widely but remain in areas for long periods of time and they have slow travel speeds. All these factors contribute toward providing the “right” conditions for the settlement of marine organisms, making this group of vessels a good candidate for developing innovative methods to eradicate biofouling that are user-friendly. The Marine Biosecurity Research group is running a trial in collaboration with South Australian researchers to ascertain how effective wrapping a recreational vessels hull is in eliminating/killing biofouling on the wet areas of the hull. Vessels of less than 15m are being used in this trial with the aims of determining the efficacy, ease and practical limitations of the method.

Crab condos

Baited crab traps have been used in many decapod sampling regimes around the world and are 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 group are conducting research into the efficacy of these crab condos to sample these species and evaluate their efficacy in different habitats.

Indian Ocean Territories 2011/12

The Biodiversity and Biosecurity branch have implemented a series of biosecurity related projects during 2011 – 2012.

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. To this end the Marine Biosecurity Research group are actively involved in developing and implementing targeted marine pest monitoring and research programs at Christmas Island Port in the Indian Ocean Territory. The aim is to detect the presence of introduced marine pests (IMPs) using a suite of tools. Early detection of IMPs is vital if any attempt at eradication or other management strategies are to be successful. The Marine Biosecurity Research group previously completed a large-scale marine pest monitoring program in Christmas Island port in late 2010. This biennial program adhered to the Australian Marine Pest Monitoring Guidelines and has been endorsed by the Commonwealth. The repeat survey is scheduled for late 2012. No marine pests were detected during the 2010 survey.

Marine pest research

The Marine Biosecurity Research group currently have two research projects planned for the region.

- Assessment of the likelihood of a marine pest being introduced into Christmas Island port and the Cocos Islands (Please refer the Appendix section "Activities of the Marine Biosecurity Research Unit during 2011/12" for further details on this program).
- Determination of the risk posed by unofficial vessel entries as vectors of IMP. This would involve an examination of suspected illegal entry vessel (SIEV) hulls and characterisation of fouling and its invasive potential.

Indian Ocean Territories Fishery Status Report

S.J. Newman, L. Bellchambers, C. Skepper, M. Pember, S. Evans, B. Rome and R. Green

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 of the Cocos (Keeling) Islands and Christmas Island were declared as 'excepted waters' from the Commonwealth's *Fisheries Management Act 1991*. Management responsibilities for these waters were transferred from the Australian Fisheries Management Authority (AFMA) to the Department of Transport and Regional Services. The Government of Western Australia's Department of Fisheries (the Department) has taken on management responsibilities for the marine Territorial waters of the Indian Ocean Territories, under a Service Delivery Arrangement with the Commonwealth The location of the Indian Ocean Territories and their proximity to the Western Australian coast are illustrated in Indian Ocean Territories Figure 1.

Under the Service Delivery Arrangement with the Commonwealth, the Department now manages commercial, recreational, charter and aquaculture activities at the Cocos (Keeling) Islands and Christmas Island, in addition to providing fish health diagnostic services, biosecurity services, fish habitat protection advice, fish pathology 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. There are 2 licenses in the fishery. In 2011, 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).

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 collecting biological material to assess wahoo stocks and on collecting tissue samples 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 to the north. Invertebrate fisheries research has focused on surveys to assess the abundance and biology of gong gong (*Lambis lambis*) and also to understand the abundance and distribution of bêche-de-mer (Holothurians) and clams (*Tridacna* spp.). Biodiversity research has also established a reef-monitoring program to detect changes in reef health due to natural and anthropogenic impacts.

Retained Species

Commercial landings (season 2011)

Not reportable

Wahoo (*Acanthocybium solandri*) is the main target species of the CILF. Other pelagic species are also targeted during the trolling operations and include yellowfin tuna (*Thunnus albacares*) 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 2011)

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**

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 2011 indicate that the current abundance of gong gong is lower than that 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: 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, research has been expanded to assess the status of *Tridacna* clams at the islands. In addition, an on-going reef monitoring program has been established. The implementation of these initiatives will enable the Department of Fisheries to access the health of the coral reef 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, Choat pers. comm.). 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 (Choat pers. comm.), suggesting local depletion and/or overexploitation of the stock (little is known about the stock structure of many fish species in the Indian Ocean Territories, in particular gene flow and linkages with other populations elsewhere in the Indian Ocean).

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.

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.

[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

Little is known about the biology of *C. joculator* although Allen et al. (2007)[1] 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.

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.

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 2011. 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 2011.

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 2011: 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 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 (2012)

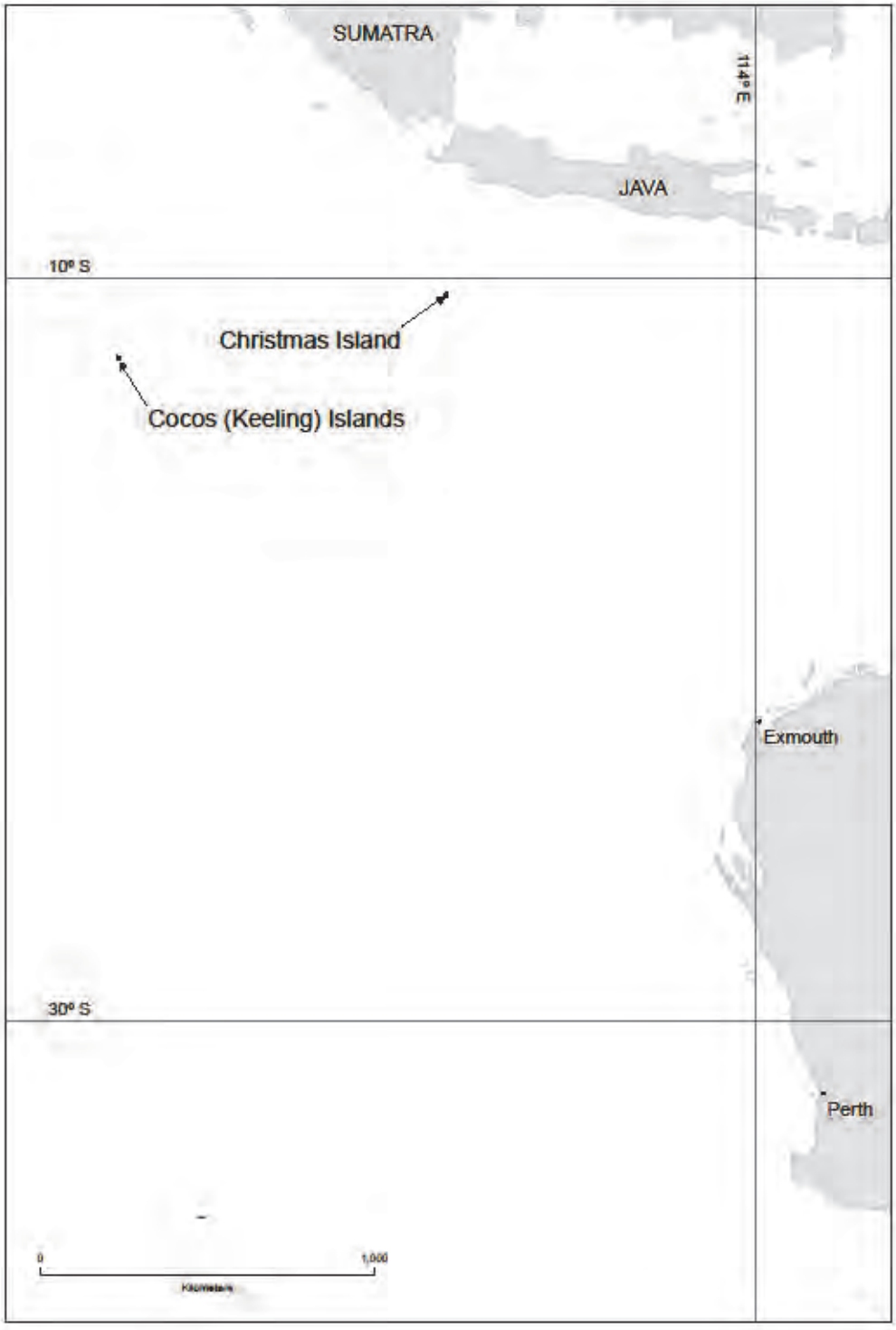
New island-specific fisheries management arrangements for the Indian Ocean Territories are currently being progressed to legislation.

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

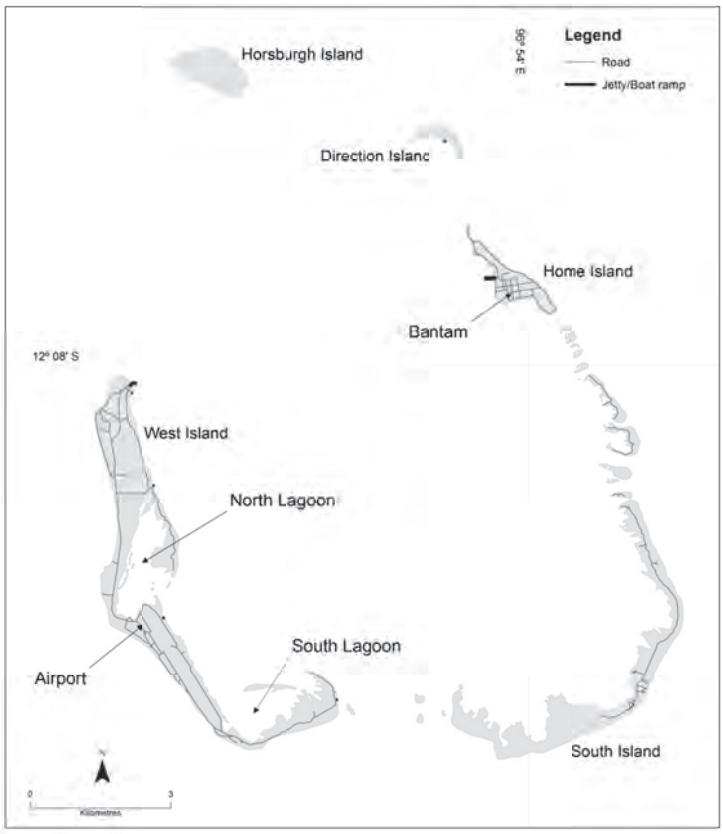
The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.

[1] 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. 284p



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.

Finfish Ageing Laboratory

Jeffrey Norriss

The Finfish Ageing Laboratory (FAL) at the WA Fisheries and Marine Laboratory continues to produce high quality otolith sections revealing the age structure of the catch of important Western Australian finfish species. Knowing the demographics of our fish stocks allows us to estimate of the rate of fishing mortality and therefore risks to their biological sustainability. Also revealed are recruitment patterns, growth rates, age at onset of sexual maturity and/or sex change, and longevity - all critical information for fisheries management.

Estimating a fish's age is a routine procedure accomplished by removing the otoliths (ear stones) and interpreting the alternating opaque and translucent zones deposited throughout the lifetime of the fish, similar to growth rings in a tree. Usually the otolith requires sectioning and mounting on a microscope slide before age can be estimated.

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.

The result: in 2011 the FAL aged over 16,000 fish (see Table 1).

Priority species processed in 2011 included those from the Inshore Demersal suite in the West Coast Bioregion: dhufish, pink snapper and baldchin grouper. From the Pilbara area of the North Coast Bioregion many red emperor, brownstripe snapper and bluespot emperor were aged to support upcoming stock assessments for what is West Australia's most valuable commercial finfish fishery. Other species aged in significant numbers during 2011 included cobbler from Wilson Inlet (South Coast Bioregion), and King George whiting (from South Coast and West Coast Bioregions) in a collaborative arrangement with Murdoch University masters student, Elena Sulin.

The FAL continues to be involved in current developments in fish ageing protocols, in association with experts from others fisheries agencies around Australia. Together we are developing national standards for establishing long-term otolith reference collections, used for testing and re-testing otolith readers and thus ensuring long term comparability of age data. This national project is being led by Department of Fisheries WA Scientist Dr Ross Marriott. Also on the agenda are protocols for repeat readings to measure precision, and possibly the incorporation of precision estimates into stock assessment confidence levels. Finally, documentation for processing and ageing indicator species are being developed.

FINFISH AGEING LABORATORY TABLE 1.

The number of fish processed and aged by the Finfish Ageing Laboratory in 2011, by Bioregion, species, ecological suite and whether it is and indicator species for that suite.

Christmas Island Bioregion	Number processed	Ecological suite	Indicator species
Red Tip Grouper *E. retouti*	39	NA	NA
Total	**39**		

North Coast Bioregion	Number processed	Ecological suite	Indicator species
Red Emperor *L. sebae*	1,000	Inshore demersal	Yes
Brownstripe Snapper *L. vitta*	1,147	Inshore demersal	Yes
Blue Spot Emperor *L. punctulatus*	1,433	Inshore demersal	Yes
Eightbar Grouper *H. octofasciatus*	22	Offshore demersal	Yes
North Coast Bioregion (continued)	Number processed	Ecological suite	Indicator species

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

Ruby Snapper *E. carbunculus*	456	Offshore demersal	Yes
Total	**4,058**		

Gascoyne Bioregion	Number processed	Ecological suite	Indicator species
Blue Lined Emperor *L. laticaudis*	8	Nearshore	No
Mulloway *A. japonicus*	7	Nearshore	No
Pink Snapper *P. auratus*	504	Inshore demersal	Yes
Goldband Jobfish *P. multidens*	278	Inshore demersal	Yes
Spangled Emperor *L. nebulosus*	725	Inshore demersal	Yes
Eightbar Grouper *H. octofasciatus*	23	Offshore demersal	Yes
Total	**1,545**		

West Coast Bioregion	Number processed	Ecological suite	Indicator species
Tailor *P. saltatrix*	467	Nearshore	Yes
Australian Herring *A. georgianus*	1,288	Nearshore	Yes
King George Whiting *S. punctada*	1,066	Nearshore	No
Dhufish *G. hebraicum*	1,930	Inshore demersal	Yes
Pink Snapper *P. auratus*	2,303	Inshore demersal	Yes
Baldchin Grouper *C. rubescens*	1,126	Inshore demersal	Yes
Breaksea Cod *E. armatus*	279	Inshore demersal	Yes
Bight Redfish *C. gerrardi*	237	Inshore demersal	Yes
Eightbar Grouper *H. octofasciatus*	45	Offshore demersal	Yes
Bass Groper *P. americanus*	28	Offshore demersal	Yes
Hapuku *P. oxygeneios*	17	Offshore demersal	Yes
Blue Eye Trevalla *H. antarctica*	137	Offshore demersal	Yes
Total	**8,923**		

South Coast Bioregion	Number processed	Ecological suite	Indicator species

Cobbler *C. macrocephalus*	1,213	Estuarine	Yes
Australian herring *A. georgianus*	302	Nearshore	Yes
King George Whiting *S. punctada*	171	Nearshore	Yes
Hapuku *P. oxygeneios*	18	Offshore demersal	Yes
Blue Eye Trevalla *H. antarctica*	137	Offshore demersal	Yes
Total	**1841**		

Southern Inland Bioregion	Number processed	Ecological suite	Indicator species
Spangled Perch	**3**	NA	NA
Total	**3**		

GRAND TOTAL	**16,409**

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 2010/11 season or the calendar year 2011 for fisheries data but up to June 2012 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 2010/11 or 2011	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	75% of quota taken in Area 5 due to adverse weather.
	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:* 17 March 2005 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: March 2013	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,	Acceptable	
Fishery: Beche-de-mer *Date of certification:* December 2004 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: December 2010	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 2011.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
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	As above
Fishery: Exmouth Gulf Prawn *Date of certification:* March 2003 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: February 2013	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	
	King prawn (spawning stock)	Total catch within acceptable range of 350–500 t	Acceptable	Below range due to conservative harvesting strategies
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 120–300 t	Acceptable	
	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	.
	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: 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 details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
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	
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 - 338	Acceptable	
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	Total catch was slightly above the upper limit due to a high level of catch in Zone A.
	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 details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
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	Below target due to very low effort.
	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.
	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: 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 in Zones 2 and 3 above performance levels due to good stock levels.
Fishery: Pilbara Trawl *Date of certification:* November 2004 *Approval type:* *:*Approved Wildlife Trade Operation Exemption *Expiry date*: June 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	

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
	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	Less than 20 captures per year recorded. Trials of new fishing gear to further minimise capture of dolphins are to be completed during 2012
	Bycatch of protected species – turtles	All skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	Number of turtles caught should be reduced by 50% of 2002 level following implementation of mitigation devices; number of turtles released alive should be greater than or equal to 72% of total captures per year
	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;
	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

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
	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 2004, extended 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	2011 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*: July 2011	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Acceptable	The catch comes from a dedicated trap fishery and prawn trawlers. A heat wave and floods over the 2010/11 summer have impacted on the crab stock available for the 2012 season.
Fishery: Shark Bay Prawn *Date of certification:* February 2003 *Approval type:* Accredited Export Exempt Fishery *Expiry date*: February 2013	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	
	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100–1,600 t, given no change in effort	Acceptable	
	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 details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
	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 2011 season, 15 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: Shark Bay Scallop *Date of certification:* February 2003 *Approval type:* Export exemption *Expiry date*: February 2013	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	Acceptable	
	Loggerhead turtles (captures)	90% of turtles captured from non-BRD nets returned alive	Acceptable	BRDs are mandatory in all net so this performance measure is no longer valid. For the 2011 season, no turtles were recorded as caught in nets.

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
Fishery: South Coast Crustacean *Date of certification:* September 2004 *Approval type:* Wildlife Trade Order *Expiry date*: September 2011	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 2010
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	Incomplete data from fisher catch and effort returns
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 now clearly evident.
	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:* August 2002 *Approval Type:* Accredited Export Exempt Fishery *Expiry date*: September 2012	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	
	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

Fishery details	Issue/species	Performance measure/Condition	Current performance in 2010/11 or 2011	Comment
	Whales and dolphins (entanglements)	No increase in rate of interactions	Acceptable	Four whale entanglements were recorded (within historical range). Indicator requires revision as whale populations are increasing hence level of interactions will also increase.
Fishery: West Coast Deep Sea Crab *Date of certification:* May 2010 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date*: May 2013	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.
Fishery: West Coast and South Coast Purse Seine *Date of certification:* February 2009 *Approval type:* Approved Wildlife Trade Operation Exemption *Expiry date:* February 2012	Bycatch and environment	Identify byproduct, bycatch (including protected species) and impacts on the marine environment. Develop strategy for mitigating interactions with flesh-footed shearwaters and dolphins; and Identify long-term trends in composition and quantity of other bycatch.		Low levels of effort in West Coast Purse Seine fishery.
	Target species	Quota and catch to remain less than 10% of spawning biomass.		

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

Staff Member	Position
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).
Simon de Lestang	PhD co-supervision, University of Western Australia, supervises Jean-Philippe Dumas - 'Examining sperm limitation as a contributing factor in recent low western rock lobster puerulus settlements.'
David Fairclough	Adjunct Senior Lecturer (Mar 2011 – Feb 2014), Centre for Fish and Fisheries Research, Murdoch University.
Danielle Johnston	Adjunct Senior Lecturer, School of Animal Biology, University of Western Australia
Brian Jones	Adjunct Professor, Murdoch University, School of Veterinary and Biomedical Sciences
	PhD co-supervision, Murdoch University, supervises Susan Keoh - “Diseases of Asian seabass or barramundi”
	MSc Co-Supervisor, University of Tasmania, supervises Graeme Knowles “Immunity and stress response in oysters”
Sagiv Kolkovski	EU COST Action LarveNet member
	MSc co-supervision, Edith Cowan University, supervises Justin King - ‘Artemia production’
Craig Lawrence	Adjunct Associate Professor, The University of Western Australia
	PhD supervision, University of Western Australia, supervises Miriam Sullivan- Aquarium fish welfare
Rod Lenanton	Adjunct Associate Professor, Faculty of Sustainability, Environmental and Life Sciences, School of Biological Sciences and Biotechnology, Murdoch University.
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
Stephen Newman	Adjunct Professor, Marine Ecology Group, School of Plant Biology, University of Western Australia.
	Adjunct Associate Professor, Faculty of Sustainability, Environmental and Life Sciences, School of Biological Sciences and Technology , Murdoch University

Staff Member	Position
Corey Wakefield	Masters co-supervision, University of Western Australia, supervises Claire Wellington – "Description and comparison of demersal fish assemblages of the continental slope of Western Australia".
	Masters co-supervision, Victoria University of Wellington, supervises Natalie Stewart – "Population structure of Polyprionidae".
	Adjunct Researcher, University of Western Australia.
	Honorary Research Fellow, Victoria University of Wellington, New Zealand.
Brent Wise	Adjunct Associate Professor, School of Mathematics and Engineering, Edith Cowan University.

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
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	Individual Transferable Quota
IUCN	International Union for the Conservation of Nature
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
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
TEP	Threatened, Endangered and Protected
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