ANNUAL REPORT

2002

Centre for Fish and Fisheries Research

School of Biological Sciences and Biotechnology
Division of Science and Engineering
Murdoch University
Murdoch
Western Australia 6150

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Centre for Fish and Fisheries Research

Annual Report for 2002

1. Administrative details

2. Research activities

1. ADMINISTRATIVE DETAILS

Centre members as at 31 December 2002

Director	Ian Potter, PhD (DSE)	
Assistant Director	Norm Hall, PhD (DSE)	
Academic staff	Lynnath Beckley, PhD (DSE)	Alan Lymbery, PhD (DVBS)
	Stuart Bradley, PhD (DSE)	Phillip Nichols, PhD (DVBS)
	Max Cake, PhD (DSE)	Shane Raidal, PhD (DVBS)
	Jennie Chaplin, PhD (DSE)	Malcolm Tull, PhD (DBITL)
	Stan Fenwick, PhD (DVBS)	Graham Wilcox, PhD (DVBS)
	Howard Gill, PhD (DSE)	Ron Wooller, PhD (DSE)
	Russell Hobbs, MSc (DVBS)	
Adjunct appointments	Belinda Cannell, PhD (DSE)	Rod Lenanton, PhD (DSE)
	Nic Dunlop, PhD (DSE)	Jeremy Prince, PhD (DSE)
Research fellows	Simon de Lestang, PhD (DSE)	Margaret Platell, PhD (DSE)
	David Morgan, PhD (DSE)	Glen Young, PhD (DSE)
Postgraduate students	Steve Beatty (DSE)	Karen Paton (DSE)
	Sara Belmont (DSE)	Matthew Pember (DSE)
	Rob Doupé (DVBS)	Kellie Pendoley (DSE)
	David Fairclough (DSE)	Chris Powell (DSE)
	Alex Hesp (DSE)	Emilia Santos-Yap (DSE)
	Richard Hoddell (DSE)	Ertug Sezmis (DSE)
	Steeg Hoeksema (DSE)	Kim Smith (DSE)
	Gary Jackson (DSE, DFWA)	Richard Steckis (DSE, DFWA)
	Ashlee Jones (DSE)	Robin Thomson (DSE)
	Indre Kirsten (DSE)	Michael Travers (DSE)
	Christine Lamont (DSE)	Fiona Valesini (DSE)
	Carina Marshall (DSE)	William White (DSE)
	Gavin Partridge (DSE)	Brent Wise (DSE)
Histologist	Gordon Thomson (DSE)	
Director's secretary	Colleen Hubbard (DSE)	
Other staff	Michelle Costello (DSE)	Dan French (DSE)
	Peter Coulson (DSE)	Mat Hourston (DSE)
	Bryn Farmer (DSE)	

DBITL	Division of Business, Information Technology and Law
DSE	Division of Science and Engineering
DVBS	Division of Veterinary and Biomedical Sciences
DFWA	Department of Fisheries WA

Management board

Chair	Professor Yianni Attikiouzel
Director	Professor Ian Potter
Assistant Director	Associate Professor Norm Hall
Secretary and Postdoctoral representative	Dr Margaret Platell
Centre member	Dr Howard Gill
Centre member	Dr Jennie Chaplin
Centre member	Dr Lynnath Beckley
Centre member	Dr Stan Fenwick
Head of School	Associate Professor Stuart Bradley
External representative	Associate Professor Rod Lenanton

Director's report

I am pleased to report that the application for the continuation of the Centre for Fish and Fisheries Research at Murdoch University for a further four years has been approved. The members of the Centre are delighted at this recognition of the continuing success of their research activities.

Staff activities

During August, I attended an excellent international conference on estuarine fishes, which was held at the University of Hull (United Kingdom). I presented a joint paper with Glen Young on the impact of the Dawesville Channel on the fish fauna of the Peel-Harvey Estuary. After the conference, I visited Drs Bob Clarke, Richard Warwick and Peter Claridge at the Plymouth Marine Laboratories to discuss our ongoing joint research activities on the relationships between faunal composition and habitat type and Professor Helmut Bartels at Munich University, where we completed a review on the role of the gills in the osmoregulation of lampreys.

In February 2002, Norm Hall was invited to Seattle by the Centre of Independent Experts at the Rosenstiel School of Marine and Atmospheric Science at the University of Miami to participate in and provide an independent report on the review by the STAR (Stock Assessment Review) panel of the Pacific whiting assessment. Later in the year, that same group invited Norm to chair and report on the review by the Stock Assessment Review Committee (SARC 35) on the summer flounder and scup assessments at Woods Hole, Massachusetts. The Fisheries Research and Development Corporation, one of the main funding agencies for our Centre, invited Norm to review the final report from the Fish Futures Project (FRDC 1999/160). The Australian Fisheries Management Authority requested that Norm review the data and assess the status of the silver trevally and mirror dory fisheries in the south-eastern trawl fishery.

Norm Hall, together with Margaret Platell, is responsible for coordinating the highly successful unit N205 (Fish and Fisheries Biology) which, although not a core unit, attracted over 30 students in 2002. This unit includes lectures and workshops given by Centre members such as Margaret Platell, Jennie Chaplin, Howard Gill, Ron Wooller and Glen Young, and staff at external agencies such as the Western Australian Department of Fisheries and Conservation and Land Management. Jennie Chaplin's important contribution to the different marine biology units in the School of Biological

Sciences and Biotechnology led to her being appointed Program Chair of Marine Sciences during 2002.

Dr Jeremy Prince, a former student of mine, who is now a highly-regarded fisheries consultant in Australia and overseas, was appointed as an Adjunct Lecturer in the School of Biological Sciences and Biotechnology. The members of the Centre will obviously benefit from his expertise, as do the undergraduate students in N205 (Fish and Fisheries Biology) in which he provides an excellent and provocative lecture on the problems facing the managers of abalone stocks.

I was delighted when Dr Lynnath Beckley accepted a senior lectureship (Marine Sciences) in the School of Environmental Sciences. Lynnath, who arrived in February 2002, has settled in very quickly and has established a much-needed seminar series in Marine Sciences. The talks in these regular seminars have been given by both internal and external scientists and have been extremely well attended by staff. I am particularly pleased that undergraduate students have also been attending this series as it exposes them to a wide range of research activities in local marine waters. Lynnath has already built up a strong network of research contacts with staff at other universities, state agencies and local authorities.

In addition to Lynnath's seminars, we have instituted a series of seminars for Honours and PhD students. These informal seminars are aimed at providing students with the opportunity of obtaining constructive comments from their peers and staff as to the best ways of developing their studies. The wide range of topics that have been covered include the biology of snapper and two species of whiting in Shark Bay and of mulloway and silver trevally in local waters and the characteristics of the fish faunas in the upper Blackwood River Estuary. All members of the Centre are strongly encouraged to attend these seminars so that everyone is aware of the work that is being undertaken in our research group.

Our work in elasmobranchs in Indonesia, which is a joint ACIAR initiative between particularly William White and Malcolm Tull of Murdoch and Steve Blaber at CSIRO (Queensland), is allowing us to vastly expand our expertise in the Indo-Pacific region. This work has also involved both Peter Last and John Stevens of CSIRO (Hobart). The work of the Seabird Research Group is highly regarded and has yielded some very relevant results on the interactions between seabirds and their fish prey.

The Fish Health Unit was delighted that the School of Veterinary and Biomedical Sciences has invested in the development of a facility for their research unit, which comprises offices, laboratories and large aquaria facilities. This facility,

which, in the future, will be supported by a substantial grant from the Aquaculture Development Fund, will be invaluable for attracting funds for research projects and also Honours and PhD students. Just as importantly, it provides a facility in which fish husbandry, anaesthesia, surgery and pathology can be taught in an effective manner to undergraduate veterinary students.

Overseas visitors

It was with great pleasure that the Centre hosted a workshop on the use of multivariate statistics for analysing data on biotic communities and particularly those in marine waters. The workshop was given by Dr Bob Clarke (Plymouth Marine Laboratory), who is the world authority in this area and has worked with us closely over recent years. The 25 people who enrolled in the workshop included Murdoch staff and postgraduate students, staff from the Department of Fisheries and the Water and Rivers Commission and interstate agencies and also from the University of the South Pacific (Fiji).

We were also very fortunate in having Dr Richard Warwick (Plymouth Marine Laboratories) spend a couple of weeks in our Fremantle laboratory. Richard has worked closely with Bob Clarke in developing a variety of approaches for analysing marine communities and, in particular, the ways in which those communities are subject to environmental perturbations. Since Richard is one of the foremost experts on meiofaunal communities in estuaries and coastal marine waters, he was able to provide invaluable advice as to how we might best study the meiofauna along our coast. The quality of the work of Mat Hourston, who commences his PhD in 2003, will benefit greatly from Richard's annual visits to Murdoch and his joint supervision of the studies for his thesis.

Drs Greg Skilleter (Queensland University) and Jeremy Hindell (MAFRI, Victoria) visited us to discuss our mutual interests in the categorisation of fish habitats in nearshore marine waters and the relationships between fish faunas and habitat types. We aim to maintain the strong links we have developed with these researchers in the future.

Honours students (Enrolled in 2002)	Abbreviated thesis title and other details
Mr Mark Allen	Biology of the Murchison River hardyhead Supervisor: Howard Gill (DSE) Full-time, completed (Class I)
Mr Thomas Bennett	Controlling nutrient outflow from rainbow trout aquaculture in inland Western Australia Supervisor: Alan Lymbery (DVBS) Full-time, completed (Class I)
Ms Carly Bruce	The fish fauna of the Blackwood River Estuary Supervisors: Ian Potter and Simon de Lestang (DSE) Full-time, completed (Class I)
Mr Ben Chuwen	Status of the fish faunas of selected south coast estuaries Supervisor: Ian Potter (DSE) Part-time, completing in 2003
Ms Natasha Coen	Distribution and abundance of epibenthic invertebrate communities in nearshore waters of WA Supervisors: Margaret Platell and Ian Potter (DSE) Part-time, completed (Class I)
Mr Peter Coulson	Biology of *Sillago schomburgkii* and *Sillago analis* in Shark Bay, Western Australia Supervisors: Ian Potter and Norm Hall (DSE) Part-time, completing in 2003
Ms Melanie Crockford	Genetic characterisation of the pilchard *Herpes* virus Supervisors: Brad Chadwick (DFWA) and Graham Wilcox (DVBS) Part-time, completed (Class IIA)
Mr Bryn Farmer	Age and growth, reproduction and diet of the mulloway, *Argyrosomus japonicus* Supervisors: Ian Potter and Norm Hall Part-time, completing in 2003
Mr Dan French	Age, growth, reproduction and diet of the silver trevally, *Pseudocaranx dentex* Supervisors: Ian Potter and Norm Hall Part-time, completing in 2003
Mr Mat Hourston	Diets of selected nearshore marine fish species in south-western Australia Supervisors: Margaret Platell and Ian Potter (DSE) Part-time, completed (Class IIA)
Mr Justin King	Fish faunas of mangroves in Shark Bay

	Supervisor: Ian Potter (DSE) Part-time, completing in 2003
Mr Mark Maddern	Distribution, biology and ecological impacts of three introduced freshwater fish species Supervisor: Howard Gill (DSE) Part-time, completing in 2003
Ms Pippa Milton	Evolutionary relationships of lampreys Supervisor: Howard Gill (DSE) Full-time, completing in 2003
Mr Mark Pagano	Genetics and stock structure of barramundi Supervisor: Alan Lymbery (DVBS) Full-time, completed (Class I)
Mr Drew Rowland	Fish faunas of Lake Kununurra and the biology of the catfish *Arius graeffii* Supervisor: Howard Gill (DSE) Full-time, completing in 2003

MSc students (Enrolled in 2002)	**Abbreviated thesis title and other details**
Mr Andrew Chapman	Biology of the spotted minnow in south-western Australia Supervisors: David Morgan and Howard Gill (DSE)
Ms Heather McCletchie	Molecular diagnostic tests to detect epizootic ulcerative syndrome and crayfish plague Supervisor: Stan Fenwick (DVBS)

PhD students (Enrolled in 2002)	**Abbreviated thesis title and other details**
Mr Steve Beatty	Biology of freshwater crustaceans in south-western Australia Supervisor: Howard Gill (DSE)
Ms Sara Belmont	Uncertainty associated with alternative ecosystem representations Supervisors: Norm Hall (DSE) and Graeme Hocking (MPS)
Mr Rob Doupé	Selection for faster growing black bream Supervisor: Alan Lymbery (DVBS)
Mr David Fairclough	Biology and ecology of four species of labrid in Shark Bay Supervisor: Ian Potter (DSE)

Mr Alex Hesp	Biological studies of two species of sparid in Australian waters Supervisor: Ian Potter (DSE)
Mr Richard Hoddell	Evolutionary history of selected teleosts in coastal waters Supervisors: Jennie Chaplin and Ian Potter (DSE)
Mr Steeg Hoeksema	Characteristics of the fish faunas in different estuaries of south-western Australia Supervisor: Ian Potter (DSE)
Mr Gary Jackson	Fisheries biology and management of Shark Bay inner gulf pink snapper stocks Supervisors: Ian Potter (DSE) and Rod Lenanton (DFWA)
Ms Ashlee Jones	Biological parameters of selected shark and ray species in marine waters of south-western Australia Supervisor: Ian Potter (DSE)
Ms Indre Kirsten	Nestling provisioning in two shearwater species on the west coast of Western Australia. Supervisor: Ron Wooller (DSE)
Ms Christine Lamont	Egg production, maternal body condition and offspring sex ratio of the silver gull Supervisor: Stuart Bradley (DSE)
Ms Carina Marshall	Genetic structure of barramundi (*Lates calcarifer*) in Western Australia Supervisors: Howard Gill (DSE) and Alan Lymbery (DVBS)
Mr Gavin Partridge	A study of microdiet utilisation in the larvae of certain marine fish species Supervisors: Max Cake and Sagiv Kolkovski (TAFE)
Ms Karen Paton	Enzymatic mechanism(s) involved in the partitioning of fatty acids into either catabolic or anabolic processes Supervisors: Max Cake and Ian Potter (DSE)
Mr Matthew Pember	Fish communities in nearshore waters of north-western Australia Supervisor: Ian Potter (DSE)
Ms Kellie Pendoley	Sea turtles and environmental management of industrial activities in north-western Australia Supervisor: Stuart Bradley (DSE)
Mr Chris Powell	Nestling provisioning by the fleshfooted shearwater *Puffinus carneipes* Supervisors: Ron Wooller and Stuart Bradley (DSE)

Ms Emilia Santos-Yap	Population genetic structure of black bream and blue swimmer crab in Western Australia Supervisors: Jennie Chaplin and Ian Potter (DSE)
Mr Ertug Sezmis	Population genetic structure and evolutionary history of the blue swimmer crab in Australia Supervisors: Jennie Chaplin and Ian Potter (DSE)
Mr Kimberly Smith	Biology of two deepwater crabs, *Chaceon bicolor* and *Hypothalassia acerba*, endemic to Australia Supervisor: Ian Potter and Norm Hall (DSE)
Mr Richard Steckis	Biology of tailor (*Pomatomus saltatrix*) in Western Australia Supervisors: Ian Potter (DSE) and Rod Lenanton (DFWA)
Ms Robin Thomson	Management strategy evaluation of blue-eye trevalla (*Hyperoglyphe antarctica*) Supervisor: Norm Hall and Ian Potter (DSE)
Mr Michael Travers	Fish communities in offshore waters of the Kimberley Supervisor: Ian Potter (DSE)
Ms Fiona Valesini	Interrelationships between fish and invertebrate faunas and the physical characteristics of nearshore habitats in marine waters of south-western Australia Supervisor: Ian Potter (DSE)
Mr William White	Age compositions, growth, reproductive biology and resource partitioning amongst chondrichthyan fishes Supervisors: Ian Potter and Norm Hall (DSE)
Mr Brent Wise	Ageing and growth of various fish species in south-western Australia Supervisors: Ian Potter and Norm Hall (DSE)

PhD students (completed in 2002)	Abbreviated thesis title and other details
Dr Simon de Lestang	Biology of the blue swimmer crab in Western Australia Supervisor: Ian Potter (DSE)
Dr Alan Kendrick	Biology of syngnathids in south-western Australia Supervisors: Ian Potter (DSE) and Glenn Hyndes (ECU)
Dr Lisa Nicholson	Comparative breeding ecology of three tern species on the Lowendal Islands, north-western Australia (submitted). Supervisors: Stuart Bradley and Ron Wooller (DSE)
Dr Fran Stephens	Health problems of the West Australian dhufish Supervisors: Jan Thomas and Shane Raidal (DVBS)

New staff appointments

Mr Peter Coulson	Assisting Norm Hall with his modelling activities
Mr Bryn Farmer	Assisting Norm Hall with his modelling activities
Mr Dan French	Determining dietary contents of tuskfish
Mr Mat Hourston	Nematode identification for the fish habitat project

External funding

Name	Project	Funding Body	Duration	Total funds ($)
Ian Potter	Biological parameters for managing the fisheries for blue and king threadfin salmons, estuary rockcod, malabar grouper and mangrove jack in north-western Australia	Fisheries Research and Development Corporation	Jul 2002 - Sept 2005	336,077
Ian Potter	Determination of biological parameters for managing the fisheries for mulloway and silver trevally in Western Australia	Fisheries Research and Development Corporation	Jul 2002 - Sept 2005	199,217
Ian Potter	Impact of environmental changes on the biota of Western Australian south-coast estuaries	Fisheries Research and Development Corporation	Jul 2002 – Sept 2005	115,374
Margaret Platell and Norm Hall	Synthesis and gap assessment of fish dietary data required for modelling ecosystems in south-western Australia	Fisheries Research and Development Corporation	Jul 2002 – Sept 2004	121,209
Norm Hall	Development and testing of a dynamic model for data from recreational fisheries	Fisheries Research and Development Corporation	Jul 2002 – Sept 2004	112,207
Shaun Collin and Ian Potter	The evolution of colour vision in vertebrates	Australian Research Council (Discovery)	Jul 2002 – Jun 2004	345,000
Jennie Chaplin, Howard Gill and Ian Potter	The phylogeny of lampreys: An assessment based on the gene order and nucleotide sequence of the mitochondrial genome	Special Research Grant (Murdoch University)	Jan 2002- Jul 2002	14,000

Name	Project	Funding Body	Duration	Total funds ($)
Alan Lymbery	Microsatellite markers for pedigree determination in culture fish species	Special Research Grant (Murdoch University)	Jan 2002 – Dec 2002	7,900
Ian Potter	Biological and fisheries data for managing deep sea crabs in Western Australia	Fisheries Research and Development Corporation	Jul 2001 – Jun 2005	347,677
Norm Hall	Development of research methodology and quantitative skills for integrated fisheries management in WA	Fisheries Research and Development Corporation	Jul 2001 – Dec 2005	579,814
Alan Lymbery	Environmental management systems for trout production systems in inland saline water	Rural Industries Research and Development Corporation	Jul 2001 – Jun 2004	163,122
Alan Lymbery	Selection for faster growing black bream	Rural Industries Research and Development Corporation	Jul 2001 – Jun 2003	101,175
Ian Potter and Steve Blaber (CSIRO)	Artisanal shark and ray fisheries in East Indonesia: their socio-economic and fishery characteristics and relationship to Australia	Australian Centre for International Agricultural Research	Jan 2001 – Jun 2003	134,466
Ian Potter and Rod Lenanton (DFWA)	Restocking of the Blackwood River Estuary with black bream	Fisheries Research and Development Corporation	Jul 2000 – Jun 2004	161,734
Ian Potter	The importance to commercial and recreational fish species of the various habitats found in the nearshore marine waters and estuaries of south-western Australia	Fisheries Research and Development Corporation	Jul 2000 – Jun 2003	277,688

Name	Project	Funding Body	Duration	Total funds ($)

				($)
Ian Potter	Determination of the biological parameters required for managing the fisheries of four tuskfish species and western yellowfin bream	Fisheries Research and Development Corporation	Jul 2000 – Jun 2003	186,868
Steve Newman (DFWA) and Ian Potter	Characterisation of the inshore fish assemblages of the Pilbara and Kimberly coasts	Fisheries Research and Development Corporation	Jul 2000 – Jun 2003	537,932
Gavin Sarre and Ian Potter	Factors required for the successful aquaculture of black bream in inland water bodies	Fisheries Research and Development Corporation	Jul 1999 – Jun 2002	244,679
Ian Potter and Roy Melville-Smith (DFWA)	Determining biological characteristics of the champagne crab *Hypothalassia acerba* for management purposes.	Fisheries Research and Development Corporation	Jul 1999 – Jun 2002	216,738
Ron Wooller	Feeding ecology of seabirds nesting at the Abrolhos Islands, Western Australia	Fisheries Research and Development Corporation	Jul 1999 – Jun 2002	153,944
Alan Lymbery	Dhufish health	Fisheries Research and Development Corporation	Jul 1999 – Jun 2002	14,003

Our sincere gratitude is expressed to the various funding bodies which have supported our research activities and particularly to the Fisheries Research and Development Corporation, Department of Fisheries WA, Natural Heritage Trust, Recfishwest, Rural Industries Research and Development Corporation and the Western Australian Water and Rivers Commission.

2. RESEARCH ACTIVITIES

Modelling and ecosystem studies

Norm Hall has continued to develop a model for assessing the status of recreational fisheries, which is capable of handling the sparse data that are usually available for such fisheries. The progress of the modelling studies at Murdoch is being enhanced by the involvement of Robin Thomson, who previously worked for CSIRO and is now enrolled for a PhD with Norm. Robin is undertaking a management strategy evaluation for the blue-eyed trevalla for the south-eastern trawl fishery.

Ecosystem modelling is continuing to be developed by Norm and his PhD student Sara Belmont. Their work is aimed specifically at modelling the interactions of key commercial finfish species in the marine waters of the south-west bioregion. Sara was fortunate in obtaining one of the CSIRO SFRME (Strategic Fund for Research in the Marine Environment) Scholarships.

Norm's contribution to developing the quantitative skills of the Honours and PhD students cannot be overestimated. In particular, he has worked with Alex Hesp to develop a more rigorous approach to estimating both the natural and total mortality of finfish species. The improvement in the quality of the mortality estimates that can now be obtained for key fish species will increase the rigour of Norm's ecosystem models. Norm and Alex have also developed a method for modifying the von Bertalanffy growth curve to accommodate those cases where the overall growth curve does not describe adequately the growth of a species when that species undergoes a length-dependent movement offshore.

Work with Simon de Lestang assisted in developing techniques for describing the progression of modes in monthly length-frequency distributions of blue swimmer crabs and in obtaining estimates of total fecundity based on the batch fecundity and the number of batches produced by crabs of different sizes.

The collation and synthesis of dietary data for fish from south-western Australia, which is being undertaken by Margaret Platell as part of a FRDC project, is identifying the areas where there is a deficiency in the dietary data for the most abundant species. The data that have been collated by Margaret, which are being used to determine trophic interrelationships in the marine and estuarine ecosystems of south-western Australia, are also being employed by Norm Hall for enhancing the quality of his ecosystem modelling.

Habitat research and resource partitioning

This project has developed a quantitative approach for identifying the different types of habitats in nearshore marine waters along the lower west coast of Australia and for determining the relationships between those habitat types and the compositions of their fish and invertebrate assemblages. This project is producing a predictive mechanism, whereby environmental and fisheries managers can identify quantitatively the habitat type to which any nearshore site belongs and the fauna that it is likely to contain.

Fish, benthic macroinvertebrates, epibenthic invertebrates, zooplankton and meiofauna were collected at regular intervals from a range of habitat types in the above nearshore waters between 2000 and 2002. Preliminary analyses indicate that the composition of each of the above faunal assemblages differ significantly among the various habitat types, with the greatest differences occurring between the most highly sheltered habitat type (which also contains seagrass) and the other habitat types, which vary in their level of exposure to wave activity and the extent to which they contain seagrass or reefs. Concomitant studies on the dietary compositions of the most abundant fish species in the various habitat types indicate that the success of these species is due, in part, to their opportunistic feeding behaviour. These investigations were undertaken by Fiona Valesini as part of her PhD, and by Natasha Coen, Michelle Costello, Mat Hourston, Linda Schafer and Sandra Seidel for their Honours studies. Following the completion of his Honours, Mat Hourston, in conjunction with Dr Richard Warwick of the Plymouth Marine Laboratory, subsequently analysed, in greater detail, the composition of the nematode assemblages in the samples of meiofauna collected in 2000 and 2001.

Fish population biology and community studies

The work on the biology of four species of tuskfish in Shark Bay, including that of the recreationally and commercially very important baldchin groper *Choerodon rubescens*, has reached an advanced stage. This work, which is funded by the FRDC, has benefited from the carefully designed and implemented sampling and analytical regime developed by David Fairclough. Each of the above species has been shown to be a protogynous hermaphrodite, *i.e.* changes sex from female to male as it increases in age and size. However, in the case of the blackspot tuskfish *Choerodon schoenleinii*,

David's work has shown that only a very small number of females change to males and, as a consequence, the males are assumed to have harems, as is the situation with some other species of labrids. The growth rates and age at maturity of the baldchin groper in Shark Bay have been shown to differ from those of this species in the Abrolhos Islands. As with all of our population studies, the focus of the research on the four tuskfish species is directed towards obtaining the types of biological data that are required by fisheries managers for developing plans for conserving these resources.

The studies on tuskfish in Shark Bay are being accompanied by an investigation of the biology of the western yellowfin bream *Acanthopagrus latus*, which is also being funded by the FRDC. This work, which was conducted by Alex Hesp, has demonstrated that, in contrast to the four species of tuskfish, this species is a protandrous hermaphrodite, *i.e.* changes from male to female as it increases in size and age. The results also show that this sparid changes habitat from mangroves to areas over reefs as it increases in size. *Acanthopagrus latus*, which spawns during a short period between late winter and early spring, forms large spawning aggregations, and is thus subject to targeting by commercial haul net fishers in Shark Bay. Although mortality estimates indicate that the population of *A. latus* in Shark Bay is not currently under threat, this is almost certainly due to the legislated reduction in the number of commercial fishers targeting this species that was introduced as a result of reports that the numbers of this species were declining.

As part of his PhD, Alex has also been studying the biology of the tarwhine *Rhabdosargus sarba* in Shark Bay and in the Swan River Estuary and nearby coastal waters much further south. His results show that this species is a rudimentary hermaphrodite, *i.e.* it possesses gonads with both testicular and ovarian material, but does not change sex with increasing body size and age. This sparid undergoes pronounced changes in habitat as it increases in size and age, and grows more rapidly in the Swan River Estuary than nearby marine waters where food is presumably less plentiful. *Rhabdosargus sarba* does not spawn in the Swan River Estuary until salinities have risen to elevated levels in the spring and, as a consequence, its spawning period occurs later in estuaries than in marine waters. Spawning takes place in the lower estuary on those occasions when ebb tides commence at about dawn and this results in the eggs and larvae being swept out to sea.

Peter Coulson is another of our current Honours students undertaking work in Shark Bay. Peter is determining the age and size compositions, growth rates and reproductive biology of yellowfin whiting (*Sillago schomburgkii*) and comparing these

with data recorded previously for this species in more southern waters near Perth. Peter is also studying the biology of another *Sillago* species, *S. analis*, in Shark Bay. The biological work on the above two fish species in Shark Bay is being complemented by the Honours project of Justin King, who is based at the Department of Fisheries WA. Justin is studying the fish faunas of the mangrove areas in this remote environment.

Matt Pember and Glen Young have been sampling the nearshore waters of the Pilbara/Kimberley coast with the aim of determining the roles played by these waters in the life cycles of the most important commercial and recreational fish species found in that region. This FRDC-funded study has found that these nearshore waters are crucial nursery areas for the mangrove jack *Lutjanus argentimaculatus*, the estuary cod *Ephinephelus coioides* and the Malabar grouper *Ephinephelus malabaricus* and that the threadfin salmons *Eleutheronema tetradactylum* and *Polydactylus macrochir* spend the whole of their life cycle in those waters. The last two species grow at a very fast rate, with *P. macrochir* achieving lengths of 60 cm before they are two years old.

Samples of fish have also been collected further offshore in water depths of ca 10 and 25 m and from different habitat types using fish traps over reefs and otter trawls over sandy substrates. This FRDC-funded study, which is being carried out in collaboration with Steve Newman of the Department of Fisheries WA, is focusing on determining the composition of the fish faunas in those waters and collecting biological information on some of the more abundant species. Preliminary analyses have shown that the compositions of the fish faunas change progressively and markedly with latitude and differ significantly between water depths and between areas with hard substrate (rock and/or reef) and soft substrates. In the context of habitat type, lethrinids and lutjanids were more abundant over rocky substrates than leiognathids or carangids, whereas the reverse was true for soft substrates.

We have begun collecting samples of silver trevally (*Pseudocaranx dentex*) and mulloway (*Argyrosomus japonicus*) from metropolitan and more northern waters. Dan French and Bryn Farmer, who commenced Honours in the middle of the year, are involved in the studies of the biology of these two important finfish species. Many of our samples are being supplied by recreational and commercial fishers, and we look forward with gratitude to their continuing support for the duration of this project.

South coast estuaries

During 2001, Steeg Hoeksema observed a massive fish kill in the basin of Culham Inlet and the lower reaches of its main tributary river. These deaths were believed to have been caused by a combination of extremely high salinities and greatly reduced nocturnal oxygen levels and/or the production of the toxins that were associated with the development of massive algal blooms. The black bream *Acanthopagrus butcheri* suffered particularly heavy mortalities. Since this estuary has previously housed the largest commercial fishery for *A. butcheri* in Western Australia, we applied to FRDC for funding to study the compositions of the fish faunas in this and other similar estuaries on the south coast of WA and the biology of black bream in those water bodies. The studies were aimed at increasing our understanding of the deleterious outcomes of anthropogenic activities in the catchments of these estuaries on the fish faunas of these systems. Our ongoing work has also focused on elucidating the influence on the fish faunas of the breaching of the bar at the mouths of these normally-closed estuaries and the role played as refugia by upstream pools.

Steeg Hoeksema's studies in these estuaries are forming part of his PhD. His studies are being enhanced by the involvement of Ben Chuwen, who is carrying out complementary work for his Honours.

Black bream

Simon de Lestang, together with Greg Jenkins and his colleagues at the Aquaculture Development Unit at South Challenger TAFE, completed a restocking programme for the black bream *Acanthopagrus butcheri* in the Blackwood River Estuary, in which the abundance of this species has declined markedly over recent years. Thus, approximately 250 000 juvenile black bream, which were reared at TAFE using Blackwood River Estuary broodstock, have been released into this estuary, the otoliths of all of which had been marked with the non-toxic Alizarin complexone. Subsequent recaptures of over 50 of these marked fish in healthy condition and the fact that their Alizarin mark was still clearly visible, strongly indicate that this species is a good candidate for restocking estuaries in which its numbers have been depleted and that we have a means by which we are able easily to identify, for at least several months, any cultured fish that had been released. The fact that over 80% of the fish of the 2001 year class that were subsequently caught in the Blackwood River Estuary possessed marked otoliths is consistent with the view that the wild population has been depleted. Simon's trips to the Blackwood River Estuary provided a means for Carly

Bruce to study the fish faunas of the upper Blackwood River Estuary for the thesis component of her Honours. Despite the extensive nature of her sampling programme, Carly caught very few black bream of any age class in this estuary, thereby providing further evidence that the abundance of this species had fallen to relatively low levels.

Ian Potter and Gavin Sarre's project on determining the factors that would ensure the successful aquaculture of black bream in inland water bodies, which was conducted in collaboration with Greg Jenkins at Challenger TAFE, was completed during 2002.

Crustaceans

All of the work that has been conducted on the biology of the blue swimmer crab *Portunus pelagicus* in Western Australian waters, which was largely supported by grants from the FRDC, has now been written up for publication as a series of papers in international journals. The quality of the results produced for *P. pelagicus* owes much to the industry and originality of Simon de Lestang. The studies of this commercially and recreationally important species focused on elucidating the roles played in the life cycle of this species by estuaries and marine embayments and the ways in which its biology in temperate and subtropical waters differs. The results emphasise the importance of estuaries as nursery areas for this species and that, while spawning was seasonal in temperate waters, it occurs throughout the year in the subtropical marine embayment of Shark Bay.

Modifications to existing models have enabled the rate of growth of *P. pelagicus* in different environments to be determined in a more rigorous manner than was previously possible and this facilitated the production of realistic estimates of the number of batches of eggs produced during the life cycle. A particularly important outcome of the biological studies was the development of a gonadal staging scheme that could be used to ascertain when male crabs became mature and which would thus enable the size at maturity to be determined more accurately than, as previously, using an indirect method based on differences in the pattern of growth of juvenile and adult crabs. Simon completed his PhD thesis in December 2002 entitled "Biology of the blue swimmer crab, *Portunus pelagicus* (Linnaeus), in Western Australia".

Work on deep sea crabs has been continuing under the auspices of grants from the FRDC and in collaboration with the Department of Fisheries WA. The biology of the champagne (spiny) crab *Hypothalassia acerba* is being studied off the lower west

and south coasts, while that of the crystal (snow) crab *Chaceon bicolor* has been studied throughout its full range along the west coast. The results, which owe much to the persistence and commitment of Kim Smith, demonstrate that the distribution of these two species is closely related to water depth, with the champagne crab occurring predominantly in depths of 200 to 300 m off the west coast and of 140 to 250 m off the south coast, whereas the crystal crab is found mainly in water depths of approximately 800 m. Currently, methods are being developed that will enable the attainment of maturity of both species of crabs to be determined more accurately and thus facilitate better estimates of their size at first maturity.

Elasmobranchs

William White has been continuing his studies of the compositions of the elasmobranch catches that are taken to fish markets in Indonesia and using the shark and ray material he obtains from those markets to determine values for some of the basic biological parameters for the main species. The data have shown that at least 77 species of shark and 61 species of ray are marketed in Indonesia and that approximately a quarter of these species are undescribed. William's results also demonstrate that some species are heavily fished before they have reached first maturity. The work carried out in Indonesia will constitute part of William's PhD thesis. The other component of the thesis, which comprises a study of the biology of the nervous shark *Carcharhinus cautus* in Shark Bay and the resource partitioning of elasmobranchs in part of that large embayment, has been completed. William anticipates completing his thesis in early September, 2003.

Associate Professor Malcolm Tull has been working in tandem with William in determining socioeconomic aspects of the artisanal component of the elasmobranch fisheries in Indonesia. His study has been focusing specifically on elucidating the extent to which local communities depend on the fishery for sharks and rays, which yields not only flesh for human consumption but also material for a variety of other purposes.

Ashlee Jones, a graduate of the University of Calgary, has commenced a PhD and is working on the biology of selected shark and ray species on the lower west coast of Australia, and in particular of the Port Jackson shark *Heterodontus portusjacksoni*. Her project will also extend to examining the elasmobranch community as a whole and thus extend our earlier studies of resource partitioning amongst elasmobranchs on this coast.

Genetics

Richard Hoddell and Ertug Sezmis have continued their PhD research on the population structure and evolutionary history of *Leptatherina wallacei* (Swan River hardyhead) and *Portunus pelagicus* (blue swimmer crab), respectively. Both projects are approaching completion and their theses are on schedule for submission in late 2003. The above two coastal species have each been shown to exhibit large amounts of population subdivision, particularly over regional scales, indicating that there are significant restrictions to their ability to disperse beyond their natal environments.

Freshwater fish and crustaceans

Howard Gill's freshwater fish group has been concentrating their efforts on sampling the inland waters of the Pilbara/Kimberley region with a view to developing baseline data on the distributions and habitat associations of the main freshwater and migratory species that are found in this isolated region of Western Australia. The results provide strong evidence that, on the basis of the distribution patterns of these species, the Pilbara can be divided into two distinct biotic provinces. The biology of species such as the barramundi *Lates calcarifer*, the Murchison River hardyhead *Craterocephalus cuneiceps*, the salmon-tailed catfish *Arius graeffii* and various introduced species are being investigated. The results demonstrate that the Pilbara and Kimberley stocks of the protandrous barramundi are clearly genetically distinct and that the size and age at which this species changes sex and attains maturity in the Fitzroy River in the Kimberley differ from those recorded elsewhere in Australia. Dave Morgan and Howard Gill have repeatedly expressed their gratitude for the invaluable help and local knowledge provided by the Kimberley Land Council, Kimberley Resource and Language Centre and local Aboriginal communities.

While sampling for barramundi in the Fitzroy River and its environs, Dave Morgan and Dean Thorburn made an exciting discovery of a healthy population of a formally undescribed freshwater shark (*Glyphis* species C). Their sampling also unearthed one of the largest populations of a sawfish species yet found anywhere in the world (*Pristis microdon*) and two undescribed species of glassfish (Ambassidae).

Howard's group has shown that the introduction of the redfin perch (*Perca fluviatilis*) in a large dam in Pemberton has led to the decimation of the local freshwater

fish species and had a highly detrimental effect on the recruitment success of marron. Steve Beatty is continuing to work closely with Brett Molony of the Department of Fisheries WA in projects aimed at elucidating the age composition, growth, reproductive biology and trophic interrelationships of freshwater decapods in south-western Australia.

Larval fish

Lynnath Beckley, through the Strategic Research Fund for the Marine Environment (SRFME), is a member of a major new collaborative programme aimed at exploring the biota in deeper waters off the south-western Australian coast. Led by CSIRO, a team of investigators is examining the physical and chemical oceanography, phytoplankton, zooplankton and ichthyoplankton in these waters, with Lynnath being responsible for analysing the data collected on larval fish assemblages. Lynnath has now participated in several of the multi-institutional research cruises conducted along a transect to the north of Perth and which extends to about 50 km offshore.

Lynnath has continued her work with scientists and students at the Oceanographic Research Institute in Durban, South Africa, and this has yielded manuscripts on the results of field trials which were established to assess the usefulness of light traps for examining recruitment, evaluating the status of estuarine line fisheries and determining the age and growth of the sparid *Rhabdosargus sarba*. Field sampling for the shore and boat angling components of the project which is assessing the fisheries in the port of Richards Bay is continuing.

Gavin Partridge enrolled in a PhD early in the year, and is working on determining the microdiet utilisation of the larvae of certain marine fish species.

Rottnest Island

Despite its proximity to Perth, very little is known about the ways in which the marine resources at Rottnest Island are used by the public. Lynnath Beckley has thus designed a questionnaire aimed at elucidating the demographics, attitudes and socio-economics of shore-based anglers. This thorough study involves monthly trips to survey the anglers on Rottnest Island. In 2003, this study will be complemented with an assessment of boating activity and a creel survey aimed at estimating the total catch and effort of the anglers. Lynnath is interacting with Neil Sumner, who works on recreational fisheries at the Department of Fisheries WA, to ensure the outcomes for this project are optimised.

Lampreys

Howard Gill and Ian Potter, in collaboration with Rick Mayden (University of St Louis), Francois Chapleau (University of Ottowa), Kevin Roe (University of Mississippi) and Claude Reynaud (Canadian Museum of Nature), have used cladistic analyses of morphological data to construct a phylogeny of the living lampreys. They are extending their studies to include molecular data which they will subsequently incorporate with the morphological information to produce a phylogeny based on total evidence. This work is being complemented by the studies of Pippa Milton, who has commenced her Honours studies. Pippa is using both sequence and gene order mitochondrial DNA data in a further attempt to clarify more precisely the relationships between the two southern hemisphere and single northern hemisphere families.

Associate Professor Shaun Collin (University of Queensland) visited Murdoch in July 2002 to continue his collaboration with Ian Potter on work aimed at elucidating aspects of the evolution of colour vision in vertebrates. This work forms part of a collaborative ARC Discovery Grant. During Shaun's visit, a paper was completed on the morphology and spectral absorption characteristics of retinal photoreceptors in the southern hemisphere lamprey *Geotria australis*. The results emphasised that the visual system in this lamprey is unique and provides arguably the first example of a vertebrate that has the characteristics required for colour vision. Shaun and Ian also spent time preparing a manuscript on the characteristics of the single class of photoreceptor found in the eye of *Mordacia mordax*, another species of southern

hemisphere lamprey. The results of this study demonstrate that the eye of *M. mordax* is ideally adapted for the photophobic life style of this species.

The carbohydrate and lipid metabolism of the lamprey *Geotria australi*s during their upstream migrations, during which it does not feed, is being investigated by Karen Paton during her PhD studies. Following vigorous exercise, muscle glycogen levels become markedly depleted but recover within one hour of the cessation of exercise. The potential source of this glycogen repletion is being examined, using radioactively-labelled lactate, alanine and glycerol. These experiments are aimed at determining whether lactate is the source of this repletion, as is typically the case in vertebrates, or whether it is derived from glycerol. Karen has also been determining the relative contributions of the various lipoproteins to serum lipid levels, with a view to understanding more fully the ways in which ovarian development is facilitated during the extended non-feeding stage of lampreys. Karen hopes to submit her thesis by the end of 2003.

Seabirds

The seabird research group continues working on aspects of the biology of seabirds along the full stretch of the West Australian coastline. Chris Surman and Ron Wooller's work has elucidated the ways in which five abundant and co-occurring species of tern on the Abrolhos Islands are able to breed simultaneously. The diets of these species were thus shown to differ not only in the species composition of their prey, but also in the prey size and particular location of feeding. Lisa Nicholson submitted her PhD thesis on the seabirds of the Lowendal Islands, in north-western Australia, which also focused on resource partitioning amongst those seabirds. Two other PhD students, Indre Kirsten and Chris Powell, are continuing their work on nestling provisioning in different species of shearwater, while Christine Lamont is well into her studies on maternal condition and egg production of the silver gull.

Fish health unit

Three Honours students, Thomas Bennett (rainbow trout aquaculture), Melanie Crockford (genetic characterisation of the pilchard *Herpes* virus) and Mark Pagano (genetic structure of barramundi), completed their projects this year, with Melanie hoping to continue her studies as a postgraduate in 2003. Rob Doupé is

continuing his investigations into the factors governing the selection for faster growing black bream, and anticipates submitting his thesis in 2003.

Fran Stephens submitted her PhD thesis on “Health problems of the West Australian dhufish”, which was based on the epidemiology and pathophysiology of the health problems, such as exophthalmos, that are characteristic of dhufish kept in captivity. Her work demonstrated convincingly that dhufish is not a very suitable candidate for aquaculture activities. She also discovered a new species of monogenean parasite, which she described as *Haliotrema abaddon*.

Refereed publications in 2002 and onwards

Allen, M., Morgan, D.L. and Gill, H.S. in press. Distribution, zoogeography and biology of *Craterocephalus cuneiceps* Whitley, an atherinid endemic to the Indian Ocean (Pilbara) Drainage Division of Western Australia. *Marine and Freshwater Research*

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Doupé, R.G. and Lymbery, A.J. in press. Toward the genetic improvement of feed conversion efficiency in fish. *Journal of the World Aquaculture Society*

Doupé, R.G., Lymbery, A.J., Sarre, G.A., Jenkins, G.I., Partridge, G.J. and George, R.J. 2003. The national research and development plan for commercial inland saline aquaculture: a view from afar. *Natural Resource Management* **6**: 31-34.

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Brochures and posters in 2002 and onwards

Food of fishes: importance for ecosystem modelling (Poster)

Freshwater fishes of the Fitzroy River (including the Gooniyandi and Bunuba names) (Poster)

Inland fishes of the Murchison River (Poster)

Introduced freshwater species in Western Australia (Brochure)

Marine/estuarine fishes in the freshwaters of the Fitzroy River (including the Gooniyandi and Bunuba names) (Poster)

Native freshwater fishes of south-western Australia (Brochure)