

ANNUAL REPORT

2000

Centre for Fish and Fisheries Research

School of Biological Sciences and Biotechnology

Division of Science and Engineering

Murdoch University

Murdoch

Western Australia 6150

ANNUAL REPORT

2000

Centre for Fish and Fisheries Research

Director

Professor Ian Potter, MA, PhD, FTSE, FLS, FAIBiol

Phone +61 8 9360 2524

Fax +61 9360 6303

Email i-potter@possum.murdoch.edu.au

Centre for Fish and Fisheries Research

Annual Report for 2000

1. Administrative details

Centre members as at 31 December 2000	4
Management board	5
Director's report.....	6
New staff appointments	7
Honours students (commenced in 2000)	8
MSc student (ongoing in 2000)	8
PhD students (ongoing in 2000)	9
PhD students (commenced in 2000)	9
PhD students (completed in 2000).....	10
External funding	11

2. Research activities

Fish and fisheries research.....	13
Fish population research	13
<i>Biology of dhufish, tarwhine, western yellowfin bream and tuskfish</i>	13
<i>Evolutionary history of coastal species</i>	13
<i>Black bream research</i>	14
<i>Elasmobranch research</i>	16
<i>Biology of the nervous shark Carcharhinus cautus and the giant shovelnose ray Rhinobatos typus</i>	16
Fish community and habitat research	16
<i>Marine fish communities and habitats</i>	16
Freshwater fish research	17
Crustacean research	18
<i>Biology of the blue swimmer crab Portunus pelagicus</i>	18
<i>Biology of the champagne crab Hypothalassia armata</i>	19
Lamprey research.....	19
<i>Bioenergetics</i>	19
<i>Phylogeny</i>	20
<i>Eyes</i>	20
Seabird research.....	21
Fish health unit	21
Refereed publications in 2000 in the areas of fish, crustacean, seabird and fisheries research	22
Conference presentations in 2000	24

1. ADMINISTRATIVE DETAILS

Centre members as at 31 December 2000

<i>Director</i>	Ian Potter, PhD (DSE)	
<i>Academic staff</i>	Stuart Bradley, PhD (DSE) Jennie Chaplin, PhD (DSE) Stan Fenwick, PhD (DVBS) Howard Gill, PhD (DSE) Russell Hobbs, MSc (DVBS) Alan Lymbery, PhD (DVBS)	Phillip Nicholls, PhD (DVBS) Margaret Platell, PhD (DSE) Shane Raidal, PhD (DVBS) Jan Thomas, PhD (DVBS) Graham Wilcox, PhD (DVBS) Ron Wooller, PhD (DSE)
<i>Adjunct appointments</i>	Belinda Cannell, PhD (DSE) Nic Dunlop, PhD (DSE) Rod Lenanton, PhD (DSE)	
<i>Research fellows</i>	David Morgan, PhD (DSE) Gavin Sarre, PhD (DSE) Glen Young, PhD (DSE)	
<i>Postgraduate students</i>	Simon de Lestang (DSE) Rob Doupé (DVBS) David Fairclough (DSE) Alex Hesp (DSE) Richard Hoddell (DSE) Gary Jackson (DSE, FWA) Alan Kendrick (DSE) Indre Kirsten (DSE) Christine Lamont (DSE) Lisa Nicholson (DSE) Karen Paton (DSE)	Matthew Pember (DSE) Chris Powell (DSE) Emilia Santos-Yap (DSE) Ertug Sezmis (DSE) Kim Smith (DSE) Richard Steckis (DSE, FWA) Fran Stephens (DVBS) Michael Travers (DSE) Fiona Valesini (DSE) William White (DSE)
<i>Histologist</i>	Gordon Thomson (DSE)	
<i>Director's secretary</i>	Colleen Hubbard (DSE)	
<i>Other staff</i>	Michelle Costello (DSE) Steeg Hoeksema (DSE) Thea Linke (DSE)	

DSE
DVBS
FWA

Division of Science and Engineering
Division of Veterinary and Biomedical Sciences
Fisheries WA

Management board

<i>Chair</i>	Professor Tony Tate
<i>Director</i>	Professor Ian Potter
<i>Secretary and Postdoctoral representative</i>	Dr Margaret Platell
<i>Centre member</i>	Associate Professor Norm Hall
<i>Centre member</i>	Dr Howard Gill
<i>Centre member</i>	Dr Jennie Chaplin
<i>Head of School</i>	Associate Professor Stuart Bradley
<i>External representative</i>	Associate Professor Rod Lenanton

Director's report

The Centre for Fish and Fisheries Research has been recognised as a centre of research excellence by Murdoch University's Board of Research and Development and commenced as an integrated centre in January 2000. During the first year of its existence, emphasis was placed on developing the links between the various groups and individuals who are involved in fish and crustacean research at Murdoch University. It is particularly pleasing to see that a Fish Health Unit is being developed in the Division of Veterinary and Biomedical Sciences and that the activities of this unit are already attracting research students.

The core work of the Centre continues to focus on obtaining data for those biological variables that are crucial for developing management plans for conserving fish and crustacean species of commercial and/or recreational value and for understanding the relationships between fish communities and different types of habitats. The work in these areas is being conducted in fresh water, estuarine and marine environments and in regions ranging from along the south coast of Western Australia northwards to as far as the Pilbara/Kimberley. The year 2000 saw the completion of studies on the biology of Western Australian dhufish (*Glaucosoma hebraicum*) and the initiation of biological studies on four species of tuskfish (Labridae) and western yellowfin bream (Sparidae). Studies of the biology of the blue swimmer crab (*Portunus pelagicus*) in different water bodies, which were carried out in collaboration with Fisheries WA, were also completed in 2000. The biological data that have been collected for species such as black bream (*Acanthopagrus butcheri*) are now being used to develop "put and take" fisheries in degraded inland waters and to facilitate the restocking of this species in estuaries in which its abundance has declined. This latter work is being carried out in collaboration with the Aquaculture Development Unit of Challenger TAFE at Fremantle and continues the fruitful association with that unit.

Members of the Centre continue to work closely with colleagues at the Bernard Bowen Fisheries Research Institute of Fisheries Western Australia. This includes not only joint projects, such as those on the fish faunas of the Pilbara/Kimberley region and on the biology of deep sea crabs, but also the joint supervision of research students located at both Murdoch University and Fisheries WA. The great help that has been provided over many years to staff and students by Dr Rod Lenanton of Fisheries WA was recognised by his appointment, during 2000, as an Adjunct Associate Professor at Murdoch University.

The Centre was successful in its submission to the FRDC for a five-year appointment of a quantitative biologist to develop innovative approaches for exploring the relationships between fisheries and the ecosystems in which they operate. We have been very fortunate in being able to appoint Dr Norm Hall to this position. Norm, who takes up his appointment in January 2001, was previously Supervising Scientist, Stock Assessment and Data Analysis, at Fisheries Western Australia. During his time at Fisheries WA, Norm was responsible for developing models for the stock assessment of many of Western Australia's major fisheries, including those of the western rock lobster, the prawn fisheries of Shark Bay and Exmouth Gulf and the pilchard fishery on the south coast of WA. Norm's mathematical and modelling expertise will add greatly to the strengths of the Centre.

During 2000, Dr Glen Young was appointed to a Murdoch University Postdoctoral Fellowship and his expertise has proved invaluable in developing an appropriate regime for sampling the fish in nearshore marine waters along the coastline of the Pilbara/Kimberley region.

Dr Bob Clarke (Plymouth Marine Laboratories, UK) visited Ian Potter and Fiona Valesini. During his stay, they developed new techniques for determining the variables that can be used quantitatively to distinguish between the different types of beaches found along the lower west coast of Western Australia. Work in the future will focus on ascertaining whether each beach type is characterised by a particular type of invertebrate and/or fish fauna.

Dr Jeremy Hatch (Department of Biology, University of Massachusetts, USA) visited Ron Wooller and Stuart Bradley to conduct research on the piscivorous roseate tern.

The year 2000 saw the introduction of an advanced undergraduate unit in Fish and Fisheries Biology, which will become a recommended elective in the Marine Science Programme at Murdoch University. This unit will be particularly useful in providing potential Honours students in the fish and fisheries area with a relevant background to their future studies.

New staff appointments

Dr Glen Young was appointed in May 2000 as a Postdoctoral Fellow in the Centre for a two-year period. Glen will be working, in collaboration with Dr Steve Newman of Fisheries WA, on the fish faunas in nearshore and offshore waters of the Pilbara/Kimberley region of Western Australia.

Dr Stan Fenwick, who is interested in certain aspects of fish health, was appointed as a Senior Lecturer in Veterinary Public Health within DVBS.

Dr Phillip Nichols, who also has interests in fish health, was appointed as a Senior Lecturer in Pathology within DVBS.

Ms Michelle Costello was appointed as a Research Assistant for one year commencing in July 2000. Michelle is responsible for studying the benthic macroinvertebrate fauna in nearshore waters in selected areas along the lower west coast of Australia, where fish habitat research is being undertaken.

Ms Thea Linke was appointed as a Research Assistant for a six month period in July 2000. Thea completed work on the diets and distribution of fish in Shark Bay.

Mr Michael Travers was appointed for a one year period commencing July 2000 as a Research Assistant on the Pilbara fish fauna project.

Ms Ayesha Whitehead was appointed as a Research Assistant for six months in 2000. Ayesha worked on both the meiofauna in nearshore waters on the lower west coast of Australia and on the black bream restocking project in the Blackwood River Estuary.

**Honours students
(commenced in 2000)**

Abbreviated thesis title

Mr Stephen Beatty	Reproductive biology of marron. Supervisor: Howard Gill (DSE) Completed (Class I)
Ms Michelle Costello	Composition of benthic macroinvertebrate communities in nearshore metropolitan waters of WA. Supervisors: Margaret Platell and Ian Potter (DSE) Part-time, completing in 2001
Ms Melanie Crockford	Genetic characterisation of the pilchard herpes virus. Supervisors: Brad Chadwick (FWA) and Graham Wilcox (DVBS) Part-time, completing in 2002
Mr David Harris	Recruitment and growth of tiger prawns in Exmouth Gulf. Supervisors: Reg Watson (FWA) and Ian Potter (DSE) Completed (Class II)
Mr Steeg Hoeksema	Biology of black bream in the upper reaches of the Swan-Canning Estuary. Supervisors: Ian Potter and Gavin Sarre (DSE) Completed (Class I)
Mr Hans Kemp	Diet of southern bluefin tuna. Supervisor: Howard Gill (DSE) Completed (Class I)
Ms Caroline Lever	Factors influencing the growth of rainbow trout in inland saline waters. Supervisors: Alan Lymbery and Rob Doupé (DVBS) Completed (Class I)
Mr Jason Mant	Biology of butterfish in Shark Bay. Supervisors: Ian Potter (DSE) and Mike Moran (FWA) Completed (Class II)
Mr Chris Powell	Nestling provisioning in shearwaters on the south coast of Western Australia. Supervisors: Ron Wooller and Stuart Bradley (DSE) Completed (Class I)
Ms Linda Schafer	Relationships between diets and habitats of fish species in nearshore marine waters. Supervisors: Margaret Platell and Ian Potter (DSE) Completed (Class I)
Ms Sandra Seidel	Composition of zooplankton communities in nearshore marine waters of Western Australia. Supervisors: Ian Potter (DSE) and Dan Gaughan (FWA) Completed (Class IIA)
Mr Mark Starcevich	Environmental management of rainbow trout aquaculture in inland Western Australia. Supervisors: Alan Lymbery and Rob Doupé (DVBS) Completed (Class I)

**MSc student
(ongoing in 2000)**

Abbreviated thesis title

Mr Andrew Chapman	Biology of spotted minnow in south-western Australia. Supervisors: David Morgan and Howard Gill (DSE)
-------------------	--

**PhD students
(ongoing in 2000)**

Abbreviated thesis title

Mr Simon de Lestang	Biology of blue swimmer crabs (<i>Portunus pelagicus</i>) in different types of water body in Western Australia. Supervisor: Ian Potter (DSE)
Ms Karen Paton	Metabolism of lampreys. Supervisors: Max Cake and Ian Potter (DSE)
Mr Alex Hesp	Biology of tarwhine and western yellowfin bream. Supervisor: Ian Potter (DSE)
Mr Richard Hoddell	Evolutionary history of selected teleosts in coastal waters. Supervisors: Jennie Chaplin and Ian Potter (DSE)
Mr Gary Jackson	Biology of pink snapper in Shark Bay. Supervisors: Ian Potter (DSE) and Mike Moran (FWA)
Mr Alan Kendrick	Biology of pipefish in south-western Australia. Supervisors: Ian Potter (DSE) and Glenn Hyndes (ECU)
Ms Lisa Nicholson	Seabirds of the Lowendal Group. Supervisors: Stuart Bradley and Ron Wooller (DSE)
Ms Emilia Santos-Yap	Genetics of black bream in Australia. Supervisor: Jennie Chaplin (DSE)
Mr Ertug Sezmis	Genetics of the blue swimmer crab in Australia. Supervisor: Jennie Chaplin (DSE)
Mr Kim Smith	Biology of the champagne crab (<i>Hypothalassia armata</i>). Supervisor: Ian Potter (DSE)
Mr Richard Steckis	Biology of tailor in Western Australia. Supervisor: Ian Potter (DSE)
Ms Fiona Valesini	Habitats of fish in south-western Australia. Supervisor: Ian Potter (DSE)
Mr William White	Biology of elasmobranchs in Shark Bay. Supervisors: Ian Potter and Howard Gill (DSE)

**PhD students
(commenced in 2000)**

Abbreviated thesis title

Mr David Fairclough	Biology of selected fish species in Shark Bay. Supervisor: Ian Potter (DSE)
Mr Rob Doupé	Selection for faster growing black bream. Supervisor: Alan Lymbery (DVBS)
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)
Mr Matthew Pember	Fish communities in nearshore waters of northern Western Australia. Supervisor: Ian Potter (DSE)
Ms Fran Stephens	Health problems of Western Australian dhufish. Supervisors: Shane Raidal and Jan Thomas (DVBS)

**PhD students
(completed in 2000)**

Abbreviated thesis title

Dr Norm Hall	Modelling of fish and crustacean populations in Western Australian waters. Supervisors: Stuart Bradley and Ian Potter (DSE)
Dr Pia Orr	Biology of four fish species in Wilson Inlet. Supervisor: Ian Potter (DSE)
Dr Glen Young	Fish fauna of the Peel-Harvey Estuary, with particular reference to the influence of the Dawesville Channel. Supervisor: Ian Potter (DSE)

External funding

Name	Project	Funding Body	Duration	Total funds (\$)
Ian Potter & Rod Lenanton (FWA)	Restocking of the Blackwood River Estuary with black bream (<i>Acanthopagrus butcheri</i>)	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
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 (FWA) & Ian Potter	Characterisation of the inshore fish assemblages of the Pilbara and Kimberly coasts	Fisheries Research and Development Corporation	Jul 2000 – Jun 2003	141,604
Howard Gill	Biology and distribution of fish in the inland waters of the Pilbara region	Natural Heritage Trust	Jan 2000 – Dec 2001	189,300
Ian Potter	The fish faunas of different habitats in nearshore, coastal waters	Recfishwest and Gordon Reid Foundation	Aug 1999 – Jun 2000	28,030
Gavin Sarre & 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 & Roy Melville-Smith (FWA)	Determining biological characteristics of the champagne crab <i>Hypothalassia armata</i> for management purposes.	Fisheries Research and Development Corporation	Jul 1999 – Jun 2002	207,632
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	Jul 1999 –	14,003

		Corporation	Jun 2002	
William White & Ian Potter	Preliminary investigation of the biology of the giant shovelnose ray <i>Rhinobatos typus</i> in the Peron Peninsula region of Shark Bay	Fishcare WA	Aug 2000 – Nov 2000	2,940
Howard Gill & Ian Potter	Relationships of the extant lampreys (Petromyzontiformes) based on a cladistic analysis	Small Research Grant (Murdoch University)	Jan 2000 – Dec 2000	20,000
Ian Potter & Roy Melville-Smith (FWA)	The collection of biological information required for management of the blue swimmer crab fishery in the central and lower west coast of Australia	Fisheries Research and Development Corporation	Jan 1998 – Dec 2000	198,867
Jennie Chaplin	Genetic (microsatellite) determination of stock structure of the blue swimmer crab in Australia	Fisheries Research and Development Corporation	Jul 1998 – Dec 2000	75,814
Howard Gill	Protection and reintroduction of native fresh water fishes	Natural Heritage Trust, Water and Rivers Commission and Fisheries W.A.	Jan 1998 – Dec 2000	204,797
Howard Gill	Captive breeding and re-introduction of rare fishes	RGC Wetlands Centre	Jun 1997 – Jul 2000	15,000

Our sincere gratitude is expressed to the various funding bodies which have supported our research activities and in particular the Fisheries Research and Development Corporation, Fisheries WA, Natural Heritage Trust, Recfishwest, Gordon Reid Foundation and the Western Australian Water and Rivers Commission.

2. RESEARCH ACTIVITIES

Fish and fisheries research

Ian Potter is responsible for supervising a number of projects on fish populations and fish communities. Some of these projects are being undertaken by postdoctoral fellows or graduate research assistants, supported by funds from the Fisheries Research and Development Corporation (FRDC), Natural Heritage Trust (NHT), Australian Centre for International Agricultural Research (ACIAR), Fisheries Western Australia, Recfishwest or Murdoch University. Most of the work on fish populations is aimed at producing biological data which can be used to develop and refine policies for conserving commercially and/or recreationally important fish species. The studies on fish communities is directed towards providing information on the types of habitats that are important for different fish species.

Fish population research

Biology of dhufish, tarwhine, western yellowfin bream and tuskfish

A study of the biology of the Western Australian dhufish (*Glaucosoma hebraicum*) was completed in 2000. The results showed that, as dhufish increase in size, they move from over flat, hard substrata to waters where large limestone reefs are present. The dhufish caught during the present study reached maximum lengths and weights of over 1100 mm and 23 kg, respectively, and a maximum age of 41 years. Sexual maturity is typically reached at *ca* 300 mm, a length that is attained at about the end of the third year of life. Although the ovaries of mature dhufish often contained between one and seven large nematode parasites of the genus *Philometra*, there were no indications that this parasite had a significant effect on those gonads.

The work on the biology of dhufish, which was funded by the FRDC, was undertaken by Alex Hesp. Alex was also responsible, together with Russell Hobbs, for the work on the nematode parasite found in dhufish. Alex is now undertaking a PhD on the biology of the tarwhine (*Rhabdosargus sarba*), an important recreational species along the west coast of Australia, and the western yellowfin bream (*Acanthopagrus latus*), a valuable commercial species in Shark Bay.

A study of four tuskfish species (including the baldchin groper) found in Shark Bay and the Abrolhos Islands, under the auspices of a grant from the FRDC, commenced in July 2000. This work, which is being conducted by David Fairclough, is progressing very satisfactorily and will undoubtedly provide useful data for the management of these commercial and recreational species.

Evolutionary history of coastal species

We are using mitochondrial DNA (MtDNA) variation, which provides a phylogenetically powerful genetic marker, to investigate the impact of recent changes in the coastal environments in south-western Australia on selected species of teleost. The

investigation has commenced with a study of the population structure and evolutionary history of two closely related species in the Family Atherinidae, namely *Leptatherina presbyteroides* and *Leptatherina wallacei*, but will ultimately include other species as well. The work is being conducted by Richard Hoddell, under the supervision of Jennie Chaplin and Ian Potter. The preliminary findings are:

1. *Leptatherina presbyteroides*, which maintains populations in estuaries and sheltered marine environments, has invaded estuaries from the marine environment on multiple occasions.
2. There is an ongoing exchange of individuals of *L. presbyteroides* between the Swan River Estuary and Cockburn Sound, but not between the Peel-Harvey Estuary and Cockburn Sound. This difference is probably related to the current topology of the coastline in this area.
3. *Leptatherina wallacei*, which occurs in estuaries, rivers and lakes, was not recently derived from the land-locking of individuals of *L. presbyteroides* in an estuary/estuaries, as has been previously proposed.
4. The populations of *L. wallacei* in the Swan River and Peel-Harvey Estuaries, or their precursors, were once connected. However, these connections have not been maintained to the present-day, probably as a consequence of the flooding of coastal environments during the Holocene marine transgression or the subsequent progressive isolation of these estuaries from the marine environment.

Black bream research

We are currently involved in three projects on black bream which have been developed in collaboration with Associate Professor Rod Lenanton (Fisheries WA), Mr Greg Jenkins (Aquaculture Development Unit, Challenger TAFE) and Mr Stan Malinowski (Springfield Waters Aquaculture).

The first of our FRDC-funded projects on black bream (*Acanthopagrus butcheri*), which commenced in June 1999, is aimed at determining the optimal suite of conditions that are required, to rear this species in the inland water bodies of south-western Australia, to a size suitable for angling. The resultant information will be able to be used by the farmers in this region to establish “put and take fisheries” on their properties. The preliminary results, which were obtained by studies under the direction of Gavin Sarre indicate that:

1. Survival rates of bream stocked into 100 m² research ponds and provided with no supplementary feed were very high, *i.e.* >92%. However, juvenile black bream need to be provided with supplementary food to achieve optimum growth.
2. The use of floating cages for rearing juvenile black bream and thus reducing the potential for avian predation does not have detrimental effects on either survival or growth.
3. The size of the water body in which the cages are placed does not significantly affect either the survival or growth of juvenile black bream.

4. Although few yabbies survived when placed in ponds with uncaged adult black bream, the provision of PVC tubes as shelter for yabbies increased markedly the ability of yabbies to survive when in polyculture with adult black bream.

It was very encouraging to discover that a cohort of small black bream, which had been introduced into our research ponds at Northam, had attained average total lengths of 153 mm and 205 mm after 12 and 16 months, respectively, which are greater than those achieved at the same ages in natural populations of black bream.

The second of our FRDC-funded projects, which is being undertaken by Simon de Lestang and Gavin Sarre and aimed at restocking the Blackwood River Estuary with black bream, commenced in July 2000. The fact that extensive sampling of this estuary on five different occasions yielded less than 100 black bream is consistent with the prior conclusion that the abundance of this species has declined markedly in this estuary. Apart from one large black bream, which was 42 cm long and 28 years old, the vast majority of fish were small and young.

Assistance will be sought from a local professional fisher in an attempt to collect 100 broodstock from the Blackwood River Estuary. If this proves unsuccessful, consideration will be given to using broodstock from the Swan River Estuary.

A third study on black bream is being undertaken by Emilia Santos-Yap, under the supervision of Jennie Chaplin. A range of genetic markers, *i.e.* allozyme, microsatellite and mtDNA markers, are being used to investigate the population structure and evolutionary history of black bream in Western Australia. The results obtained thus far demonstrate that:

1. The assemblages of black bream in different estuaries in Western Australia are each genetically distinctive and thus constitute different stocks.
2. With regard to the allozyme and microsatellite markers, there are relatively major differences between the assemblages of black bream in the Pilbara *vs* the south-western drainage divisions of Western Australia.
3. The black bream in Western Australia exhibits unusually low levels of genetic variation. This indicates that either (i) the 'population' of black bream in Western Australia underwent a significant bottleneck (reduction in size) at some time in the relatively recent past, or (ii) the 'population' of black bream in Western Australia was founded relatively recently by a small number of individuals from elsewhere. In any case, most of the black bream in Western Australia have a recent common ancestry.

Elasmobranch research

The following work on elasmobranchs is being undertaken by William White for his PhD under the supervision of Ian Potter. William is deferring his scholarship for one year so that he can undertake elasmobranch research in Indonesia on a grant to Ian Potter from the Australian Centre for International Agricultural Research (ACIAR) via Dr Steve Blaber (CSIRO, Queensland), the coordinating scientist for the project.

Gill net catches obtained at bimonthly intervals for 24 months at Herald Bight in Shark Bay demonstrate that the nervous shark *Carcharhinus cautus* is by far the most abundant shark species in the shallow, sandy areas of this region. Far smaller catches of five other species of shark were obtained. The most numerous of the rays in the same habitat was the giant shovelnose ray *Rhinobatos typus*. Four other species of ray were caught, but only in small numbers. The most abundant species of elasmobranch caught in the two seasons when gill netting was conducted over seagrass were the milk shark *Rhizoprionodon acutus*, the spinner shark *Carcharhinus brevipinna* and *C. cautus*. Small numbers of seven other species of shark were caught in seagrass.

Biology of the nervous shark Carcharhinus cautus and the giant shovelnose ray Rhinobatos typus

The females of *Carcharhinus cautus* were found to conceive in December and to give birth in the following November. This species thus has an 11 month gestation period. The trends exhibited by the annuli on the vertebral centra of this species demonstrate that these growth zones are laid down annually in spring and can thus be used to age this species. Preliminary data indicate that the maximum lengths and ages of this species are about 1300 mm and 17 years for females and about 1100 mm and 12 years for males.

The large size attained by *Rhinobatos typus* (over 3000 mm total length) has made it difficult to obtain mature individuals of this species and thus to explore its reproductive biology. The presence of small individuals in all months provides strong indications that *R. typus* breeds throughout the year.

Fish community and habitat research

Marine fish communities and habitats

Reefishwest and the FRDC are funding a study of the diverse fish habitats found in nearshore marine waters and estuaries along the lower west coast of Australia. The first aim of this study is to develop a classification scheme for the different types of beaches found in this region based on physical variables. This component of the study is being undertaken in collaboration with Dr Ian Eliot (Geography Department, University of Western Australia), who is an expert on coastal geomorphology. Progress in this area has been facilitated by the statistical input of Dr Bob Clarke (Plymouth Marine Laboratory, UK). Future work will involve ascertaining the extent to which the different types of beaches contain different suites of invertebrates and fish.

A study has been initiated to ascertain the ways in which commercial and/or recreational fish species use the nearshore waters of the Pilbara/Kimberley region as a nursery area and to determine the species composition of the by-catch of prawn trawlers

operating offshore in that region. This project, which is being funded by FRDC and commenced in July 2000, is being undertaken in collaboration with Dr Steve Newman of Fisheries Western Australia. The catches obtained in nearshore waters will be used to determine the composition of the fish fauna in those waters and how they vary with location, season and habitat type.

Freshwater fish research

Our main focus in 2000 was finalising our understanding of the distribution patterns of the endemic and introduced species of freshwater fish in south-western Australia. This NHT, Fisheries WA and Water & Rivers Commission-funded work has extended the known distributions of most of the species found in the region and discovered new species not previously recorded in this region, such as the introduced swordtail *Xiphophorus helleri*. This work also demonstrated that no introduced species are found east of the Pallinup River or in the Murchison River. As part of this work, broad-scale habitats of the inland freshwater fish species between Margaret River and Walpole have been determined, with finer-scale habitat associations being determined for the fish species in the Blackwood River.

A biological study of the endemic and restricted trout minnow *Galaxias truttaceus* has yielded valuable data for this very rare species. For example, this relatively small fish, *i.e.* less than 140 mm in total length, lives for up to seven years and spawns in April and May, *i.e.* at the onset of seasonal rains. Andrew Chapman is currently investigating the biology of the congeneric spotted minnow *Galaxias maculatus*.

We have aided in the development of a Fisheries WA brochure on introduced fishes in Western Australia, helped compile a Fisheries WA audit on threatened fishes and have produced a brochure of the freshwater fishes of south-western Australia and the inland fishes of the Murchison River.

Howard Gill and David Morgan recently received funding from the Natural Heritage Trust for a project entitled "Biology and distribution of fish in the inland waters of the North-west/Pilbara". That NHT project commenced in November 2000 and will determine the distribution of most species in the region and the biology of a number of key species, such as spangled perch. The funds from this project will also aid in the collection of barramundi from the Pilbara and thus supplement the samples collected under the Murdoch SRG projects on the biology and genetics of barramundi (David Morgan and Alan Lymbery, respectively).

Together with the Kimberley Land Council, we received NHT funding for determining the distribution of freshwater fish in the Fitzroy River over 2001 and 2002. This project involves numerous people in the region, including the traditional owners, local residents and the Kimberley Language Centre. A brochure on the fishes of the river was produced and will be updated to include traditional names and distributions. Samples of barramundi collected during this project will be used in the Murdoch SRG projects on the biology and genetics of barramundi. Carina Marshall will be working on the genetics of barramundi in Western Australia next year (2001).

Stephen Beatty completed his honours on the biology of marron *Cherax tenuimanus* in Lake Navarino and has extended his work to look at marron and yabbies in the

Geraldton region. He found that the introduced redfin perch *Perca fluviatilis* were preying heavily on the newly-hatched and juvenile marron.

Crustacean research

Biology of the blue swimmer crab Portunus pelagicus

A study of the habitats, reproductive biology and growth of the blue swimmer crab *Portunus pelagicus* in the Leschenault Estuary, Koombana Bay, Peel-Harvey Estuary, Cockburn Sound and Shark Bay was completed in December 2000. In this study, emphasis was initially placed on developing sound methods for determining the stage of maturity of crabs and obtaining reliable estimates of fecundity. Our data show that juvenile crabs live in nearshore protected waters, where the substrate is sandy, and move out into deeper waters and often into areas of sparse seagrass as they increase in size. Our results also demonstrated that, in contrast to the situation in the four southernmost water bodies, the blue swimmer crab in Shark Bay spawns throughout the year and reaches a greater size at first maturity. These differences are presumably related to the far higher water temperatures in that northern water body. Our data were also used to ascertain the relationships between the assemblages in estuaries and nearby coastal embayments. The results of this FRDC-funded project, which was undertaken by Simon de Lestang and Ian Potter, will be used by fisheries managers to help conserve this species of crab in Western Australia.

A genetic study of the blue-swimmer crab is being undertaken by PhD students Emilia Santos-Yap and Ertug Sezmis, under the supervision of Jennie Chaplin. This study, which was also funded by the FRDC, has used highly polymorphic microsatellite markers to provide a high resolution picture of the population genetic structure of this species in Australia. The main findings are:

1. In contrast to the results of a previous allozyme study, the microsatellite markers have demonstrated that there is a series of genetically-differentiated stocks of *P. pelagicus* in Australian waters. Indeed, there are at least three highly genetically-distinct groups of *P. pelagicus*. One group occurs on the east coast, another in South Australia and a third on the west coast. In addition, the west coast group exhibits considerable genetic heterogeneity and comprises distinctive northern and southern groups of stocks.
2. Individuals of *P. pelagicus* usually disperse over relatively short distances, *i.e.* less than 300 km.
3. On the east coast of Australia, between Mackay and Port Stephens, *P. pelagicus* is effectively genetically homogeneous and probably comprises either a series of overlapping assemblages or a single semi-continuous stock. Genetic connections between the more distant assemblages in this region are likely to be maintained via the cumulative effects of a series of overlapping local interchanges in multiple generations.
4. The assemblages of *P. pelagicus* in different embayments in South Australia and between Exmouth Gulf and Geographe Bay on the west coast are often genetically

distinctive and hence often constitute different stocks. Habitat availability, the relatively cold water temperatures in the more southern regions of its range and the hydrological conditions in certain embayments appear to play a role in restricting gene flow in *P. pelagicus* in these regions.

Biology of the champagne crab Hypothalassia armata

During the 1990s, a fishery was developed for the champagne crab, *Hypothalassia armata*, which is found in deep waters off the south-western Australian coast. Since there was virtually no biological data for this species, the FRDC funded a project to determine those biological variables that are required for developing management plans for this species. The results of this study, which is being conducted by Kim Smith and Ian Potter, demonstrate that, while this species is found in water depths ranging from about 80-360 m, it is most abundant in depths of about 200 m. The water temperatures in which this species is typically found range from 12 to 18°C. Data are currently being collected which will enable the size at first maturity and the fecundity of this species to be determined.

Lamprey research

Bioenergetics

The bioenergetics research on lampreys, which is being undertaken by Karen Paton, Max Cake and Ian Potter, has focused on the following aspects.

- (i) Comparing the metabolic responses to exercise of the relatively sedentary larvae (ammocoetes) and the more active young adults (downstream migrants).
- (ii) Determining which substrates are employed by non-trophic, upstream-migrating adult lampreys for regenerating muscle glycogen stores after those stores have become depleted during vigorous swimming activity.

The first of the above studies, the results of which have been accepted for publication, has demonstrated that swimming activity can be maintained for a much longer period by downstream migrants than ammocoetes. This has been shown to be due to the far greater ability of young adults to metabolise their energy reserves aerobically as a result of a greater oxygen delivery pressure to the tissues. Indeed, even during moderate swimming activity, approximately 25% of the glycogen utilised by ammocoetes is metabolised anaerobically leading to a rapid buildup of lactate.

We are currently developing the technique for measuring the rate of utilisation and extent to which radio-labelled potential precursors are used to produce muscle glycogen, after muscle glycogen has been depleted by vigorous exercise. These studies will be followed by an investigation of the levels of the various metabolic intermediates in muscle tissue at regular intervals during the protracted spawning migration of *Geotria australis*.

Phylogeny

Ian Potter and Howard Gill were invited to give an address on “The adaptive radiation of lampreys” at the Second International Sea Lamprey Symposium, which was held in the United States in August. Their address focused on describing morphological, physiological and molecular changes that have occurred during the evolution of the living lampreys. The results of the comparisons between the characteristics of the different taxa emphasised the extent to which the two southern hemisphere genera (*Geotria* and *Mordacia*) have diverged from each other and from all northern hemisphere genera. Indeed, the single species of *Geotria* was shown, in many ways, to be the most specialised of all lampreys, while the three species of *Mordacia* exhibited some of the most degenerative features.

During 2000, Ian Potter and Howard Gill continued their cladistic study of lampreys with Dr Claude Renaud (National Museum, Ottawa) and Dr Francois Chapleau (University of Ottawa). This was then extended to include the molecular expertise of Professor Rick Mayden and Dr Kevin Ho (University of Alabama). The collaboration of the above six workers led to the successful application to the National Science Foundation in the United States for a grant to undertake a comprehensive study of phylogenetic relationships among lampreys.

Eyes

The morphological and physiological characteristics of the eyes of southern hemisphere lampreys are being studied by Drs Shaun Collin and Nathan Hart (University of Queensland), Dr Julia Shand (University of Western Australia) and Ian Potter. This exciting work has provided evidence that the adults of *Geotria australis* have the capacity to discriminate colour. This represents the first time that a member of the Agnatha (jawless vertebrates) has been shown to be capable of such discrimination.

Seabird research

The members of this group, headed by Stuart Bradley and Ron Wooller, study a range of seabirds off the Western Australian coast. On Penguin Island, near Perth, Belinda Cannell recently completed a radiotracking study of foraging by little penguins at sea; Belinda is now studying the endocrinological basis of their moult. On the Abrolhos group Chris Surman continues his study of the diets of seabirds, mainly terns, and the ways in which seabird breeding success fluctuates in relation to oceanographic factors. Even further north, Lisa Nicholson has just completed the last season of her PhD studies on the seabirds of the Lowendal group, off the Northwest Shelf. On the south coast, Chris Powell has completed a study of nestling provisioning in the flesh-footed shearwater, a species impacted by long-line fisheries bycatch and by pilchard mortality events. Two PhD students just starting their studies are Christine Lamont, working with silver gulls, and Indre Kirsten, working with little and wedge-tailed shearwaters. Nic Dunlop continues his long-term studies of the range extensions and interannual variability in reproductive performance of Western Australian seabirds related to ENSO events and the Leeuwin Current. The longest study run by the group, however, is their 54 year study of Tasmanian muttonbirds (short-tailed shearwaters) in Bass Strait, in association with Dr Irynej Skira of Parks and Wildlife Tasmania and Dr Catherine Meathrel of LaTrobe University.

Fish health unit

Since its inception in 2000, the Fish Health Unit has begun slowly, but is now gaining impetus. It is intending to increase its collaboration with many research groups and departments, including those in the School of Biological Sciences and Biotechnology, Fisheries WA, Curtin University and the Aquaculture Development Unit of Challenger TAFE.

Research within the group has initially focused on the development of diagnostic tools (particularly molecular-based tools), ecotoxicology, genetic improvement of fish stocks and risk analyses of aquaculture ventures.

There are four projects currently being undertaken within the fish health unit, which rely on undergraduate and postgraduate students. Shane Raidal and Jan Thomas are supervising a project on the different health problems of West Australian dhufish, which is funded by the FRDC and the Aquaculture Development Fund. Alan Lymbery is heading two PhD investigations, the first on selection of faster-growing black bream (funding by Rural Industries Research and Development Corporation) and the second aimed at determining the genetic structure of Western Australian barramundi, which is funded by a Murdoch SRG. Graham Wilcox is collaborating with Brad Chadwick of Fisheries WA on the genetic characterisation of the pilchard herpes virus.

Refereed publications in 2000 in the areas of fish, crustacean, seabird and fisheries research

- Blaber, S.J.M., Cyrus, D.P., Albaret, J.-J., Ching, C.V., Day, J.W., Elliott, M., Fonseca, M.S., Hoss, D.E., Orensanz, J., Potter, I.C. and Silvert, W. Effects of fishing on the structure and functioning of estuarine and nearshore ecosystems. *ICES Journal of Marine Science* **57**: 590-602.
- Bradley, J.S., Cox, J.W., Nicholson, L.W., Wooller, R.D., Hamer, K.C. and Hill, J.K. Parental influence upon the provisioning schedules of nestling short-tailed shearwaters *Puffinus tenuirostris*. *Journal of Avian Biology* **31**: 522-526.
- Bradley, J.S. Wooller, R.D. and Skira, I.J. Intermittent breeding in the short-tailed shearwater *Puffinus tenuirostris*. *Journal of Animal Ecology* **69**: 639-650.
- Collin, S.P. and Potter, I.C. The ocular morphology of the southern hemisphere lamprey *Mordacia mordax* Richardson with special reference to a single class of photoreceptor and a retinal tapetum. *Brain, Behaviour and Evolution* **55**: 120-138.
- de Lestang, S., Platell, M.E. and Potter, I.C. Dietary composition of the blue swimmer crab *Portunus pelagicus* L. Does it vary with body size and shell state and between estuaries? *Journal of Experimental Marine Biology and Ecology* **246**: 241-257.
- Doupé, R.G., and Lymbery, A.J. Managing translocations of aquatic species. *Aquaculture Research* **31**: 151-156.
- Fairclough, D.V., Dimmlich, W.F. and Potter, I.C. Reproductive biology of the Australian herring *Arripis georgiana*. *Marine and Freshwater Research* **51**: 619-630.
- Fairclough, D.V., Dimmlich, W.F. and Potter, I.C. Length and age compositions and growth rates of the Australian herring *Arripis georgiana* in different regions. *Marine and Freshwater Research* **51**: 631-640.
- Garavanta, C.A.M., and Wooller, R.D. Courtship behaviour and breeding biology of bridled terns *Sterna anaethetus* on Penguin Island, Western Australia. *Emu* **100**: 169-174.
- Hamer, K.C., Hill, J.K., Bradley, J.S. and Wooller, R.D. Contrasting patterns of nestling obesity and food provisioning in three species of *Puffinus* shearwaters: the role of predictability. *Ibis* **142**: 146-150.
- Lymbery, A.J. Genetic improvement in the Australian aquaculture industry. *Aquaculture Research* **31**: 145-149.
- Lymbery, A., and Doupé, R. Genetic management of aquatic species translocations: a horses-for-courses approach. *Austasia Aquaculture* **14**:35-38.

- Lymbery, A.J., Doupé, R.G., Jenkins, G. and Thorne, T. Genetics in the aquaculture industry. *Aquaculture Research* **31**: 1-2.
- Morgan, D.L., Gill, H.S. and Potter, I.C. Age, composition, growth and reproductive biology of the salamanderfish *Lepidogalaxias salamandroides*: a re-examination. *Environmental Biology of Fishes* **57**: 191-204.
- Morgan, D.L. and Gill, H.S. Another aquarium fish (green swordtail, *Xiphophorus helleri* Heckel: Poeciliidae) established in the wild in Western Australia. *Records of the Western Australian Museum* **20**: 30.
- Morgan, D.L. and Gill, H.S. Fish associations within the different inland habitats of lower south-western Australia. *Records of the Western Australian Museum* **20**: 31-37.
- Potter, I.C. and de Lestang, S. Biology of the blue swimmer crab *Portunus pelagicus* in Leschenault Estuary and Koombana Bay, south-western Australia. *Journal of the Royal Society of W.A.* **83**: 443-458.
- Potter, I.C., Chalmer, P.N., Tiivel, D.J., Steckis, R.A., Platell, M.E. and Lenanton, R.C.J. The fish fauna and finfish fishery of the Leschenault Estuary in south-western Australia. *Journal of the Royal Society of W.A.* **83**: 481-501.
- Saffer, V.M., Bradley, J.S., Wooller, R.D. and Meathrel, C.E. Patterns of growth in nestling short-tailed shearwaters *Puffinus tenuirostris*. *Emu* **100**: 42-48.
- Saffer, V.M., Bradley, J.S., Wooller, R.D. and Meathrel, C.E. The effect of human activity on the growth rates of short-tailed shearwater *Puffinus tenuirostris* chicks. *Emu* **100**: 49-53.
- Sarre, G.A., Platell, M.E. and Potter, I.C. Do the dietary compositions of *Acanthopagrus butcheri* in four estuaries and a coastal lake vary with body size and season and within and amongst these water bodies? *Journal of Fish Biology* **56**: 103-122.
- Sarre, G.A. and Potter, I.C. Variation in age compositions and growth rates of *Acanthopagrus butcheri* (Sparidae) among estuaries: some possible contributing factors. *Fishery Bulletin, U.S.* **98**: 785-799.
- Sower, S.A., McGregor, A.J., Materne, O.L.J., Chase, C., Potter, I., and Joss, J. Evidence for lamprey GnRH-I and-III-like molecules in the brains of the southern hemisphere lampreys, *Geotria australis* and *Mordacia mordax*. *General and Comparative Endocrinology* **120**: 168-175.
- Surman, C.A. and Wooller, R.D. Nestling escape behaviour in tree, bush and ground-nesting tropical terns. *Ibis* **142**: 320-322.
- Surman, C.A. and Wooller, R.D. Seabirds off the south-western coast of Australia. *Emu* **100**: 312-317.

Wienecke, B.C., Bradley, J.S. and Wooller, R.D. Annual and seasonal variation in the growth rates of Little Penguin *Eudyptula minor* young on Penguin Island, Western Australia. *Emu* **100**: 139-147.

Yap, E.S., Spencer, P.B.S., Chaplin, J.A. and Potter, I.C. The estuarine teleost, *Acanthopagrus butcheri* (Sparidae), shows low levels of polymorphism at five microsatellite loci. *Molecular Ecology* **9**: 2225-2226.

Conference publications in 2000

Cannell, B. Effects of sprat availability upon the distribution, abundance and breeding performance of little penguins. Third International Penguin Conference, Valparaiso, Chile.

Potter, I.C. and Gill, H.S. The adaptive radiation of lampreys. Second International Sea Lamprey Symposium, Michigan, USA.

Stephens, F. *Exophiala* sp. in the Western Australian dhufish. Annual Conference of the Association of Veterinary Pathologists, Esplanade Hotel, Fremantle.