Establishment of a self-sustaining facility for fisheries modelling and multivariate analysis, and for effective management of extremely large databases

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Murdoch University

FRDC Project No. 2008/304

June 2013

Australian Government

Fisheries Research and Development Corporation

MURDOCH UNIVERSITY
PERTH, WESTERN AUSTRALIA

Centre for Fish, Fisheries and Aquatic Ecosystems Research

ISBN: 978-1-92-1877-04-9

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OBJECTIVES:

1. The appointment of a suitable highly-qualified fisheries scientist to lead the training facility and develop courses.
2. The development and delivery of courses and training in fisheries and ecosystem modelling, multivariate analysis and management of very large databases.
3. Implementation of a business strategy to achieve self-sufficiency as an ongoing evolving training facility from short course training within Australia and on-line within three years.

1. NON TECHNICAL SUMMARY:

OUTCOMES ACHIEVED TO DATE

Professor Ken Pollock was appointed to the position of Professor of Quantitative Methodologies for natural resources and, with advice from the project's Steering Committee, developed a package of training workshops for professionals and postgraduate students. These workshops were delivered by a number of people known internationally for their expertise in estimating mortality (Dr John Hoenig), mark-recapture analyses (Professor Ken Pollock), population modelling (Professor Terry Quinn III) and qualitative modelling (Dr Jeffrey Dambacher). The workshops have helped strengthen collaborations in Western Australia with Dr Hoenig and Professor Pollock in particular. In addition to developing and delivering quantitative training to professions and postgraduate students, Professor Pollock collaborated with researchers at the Department of Fisheries WA on sampling designs and analysis for recreational fisheries and at Murdoch University researchers and postgraduate students on sampling design and population estimation for marine wildlife. After two years, Professor Pollock returned to the United States and the project was terminated. The project was not successful in establishing a self-sustaining facility for training in quantitative methodologies due to four main reasons: 1) professionals and postgraduate students in the natural resources do not have the funding to pay the real costs of courses; 2) the market is small and training is readily saturated within a year; 3) logistics issues on arranging workshops are very time consuming; and 4) the diversity of tasks for the

appointee made it difficult to sustain a comprehensive workshop schedule.

The project identified that training in this area is a deficit in the training of Australian postgraduate students and a new approach needs to be adopted in the University system to meet this need, possibly modelled on Universities forming consortia to deliver the required diversity and depth of training. This model has been adopted in medical statistics in the eastern states.

Although Professor Pollock returned to the United States, he will maintain his collaborations in Western Australia, particularly with Murdoch University and DoF, through his appointment as a Sir Walter Murdoch Distinguished Adjunct Professor. This appointment provides funding for his travel and expenses to Australia for one month a year from 2012 until 2014.

The health and vitality of the fisheries science profession is crucial to the future Australian economy and more generally to Australian society. Sound fisheries management in the face of many increasing challenges depends on sound fisheries science. Fisheries science is an interdisciplinary field in applied science with modern mathematical and statistical techniques a crucial component. Providing quantitative fisheries science training is a great challenge to Australian Universities and there is a need for training facilities to provide workshops and short courses.

In addition to the three objectives in the FRDC proposal (Objectives above), because of funding considerations ($150,000 from FRDC; $150,000 from the Department of Fisheries WA [DoF]; and $182,000, Murdoch University), two additional objectives were added to the project:

4. That the person appointed would provide high-level statistical and quantitative methods advice to the DoF.
5. That the person appointed would function as a research professor at Murdoch University, focusing on Quantitative Methods.

Following the commitment by FRDC to fund the project, a Steering Committee was established to guide project development (Dr Malcolm Haddon – CSIRO, Professor Norm Hall – Murdoch University, DoF, Professor Peter Rogers – Murdoch University, and Dr Tony Smith – CSIRO), the selection of the key appointment and the development of training. The project was established in October 2009 when Professor Ken Pollock, a professor at North Carolina State University in Statistics, Biomathematics and Biology, specialising in quantitative methods for fisheries, wildlife and conservation biology, was appointed to the position.

Sixteen major and eight minor workshops were run during the project, an average delivery of about one workshop per month. The courses were universally successful and well received. All workshops involved a mix of lectures and computer exercises and had a very strong “hands on flavour”. All participants received copies of lecture material pdfs and data sets on USB drives at the beginning of the workshops. The content, delivery and relevance of short course were evaluated through seeking feedback from course participants following each workshop.

The organisation of these workshops required significant logistical support and during the two years, this proved challenging due to organisational changes at Murdoch University. In addition to logistical challenges, generating continuing interest in the workshops after the first 12 months proved challenging. The total income generated from the activities led by Professor Pollock has been about $75,000, with $36,000

coming from the net income from the workshops, and $39,000 coming from consultancy income.

Our business analysis showed that a facility to provide workshop and short course training in quantitative methods for fisheries (and conservation biology) will not be viable without subsidies from agencies or universities. Further, such training facilities require a broader focus, which includes time for the academics involved to: carry out research to develop new quantitative methods; train students in advanced quantitative methods; and to provide training for all fisheries scientists in introductory quantitative methods. We believe that fisheries science and management in Australia would benefit greatly if teams of quantitative methods specialists could be set up around Australia to address these related research and training issues.

We also considered broader training issues. In Australia, training in fisheries science is provided primarily at the postgraduate level or through continuing education while in the work place. However, as the Australian model of higher education in fisheries is almost totally research focused, knowledge has to be obtained by students, either by reading on their own, or through short courses or workshops. We suggest that this model is unsatisfactory and that the fisheries and natural resource assessment professions should be moving towards providing this training through postgraduate coursework (as opposed to research) perhaps run by a consortium of universities.

Quantitative fisheries science consists of many distinct mathematical and statistical disciplines and the appropriate computational tools to carry out these techniques. All fisheries scientists need to be trained in the fundamental aspects of these methods and some fisheries scientists also require advanced specialized training in these methods. University and agency fisheries research groups in Australia are very small and lack specialists in these quantitative areas. We believe that for the long term, fisheries agencies and universities need to work together to provide more quantitative fisheries specialists in Australia. This is necessary to provide the training for fisheries students and professionals but also to provide the research necessary so that fisheries research in Australia continues to be of high international standard in the future.

Professor Pollock's research and consulting activities at the Department of Fisheries Western Australia have focussed on four main areas: a) recreational fisheries survey design and analysis; b) fisheries tagging studies involving tag-recapture and tag return models; c) routine statistical consulting and d) co-ordination and delivery of staff training workshops. His activities at Murdoch focused on the following main areas: a) recreational and commercial fishing sampling and modeling; b) estimation of population demographic parameters for marine mammals using photo-identification techniques and aerial surveys; c) estimation of population demographic parameters for wildlife species of a variety of taxa; and d) general statistical consulting for fisheries and wildlife staff and postgraduate students. More detail on these activities has been included in the body of the report.

Pollock has published twenty scientific papers and book chapters during this project. Six more manuscripts were submitted while employed through this project.

KEYWORDS: Quantitative methodologies, workshops, postgraduate training, training for professions.

2. Acknowledgements

We thank the FRDC, Department of Fisheries Western Australia (DoF) and Murdoch University for funding this project. In particular, we acknowledge the DoF for their generous support in holding workshops in the second year of the project and the support of the DoF CEOs, Mr Peter Millington and Mr Stuart Smith, for their project. The Reference Group for the Project of: Dr Daniel Gaughan (DoF), Dr Malcolm Haddon (CSIRO), Emeritus Professor Norman Hall, Emeritus Professor Peter Rogers and Dr Tony Smith (CSIRO), made valuable contributions in advising on strategies and workshops for development. We thank all the people who presented workshops and made such an impact on the participants – they were Dr Jeffrey Dambacher (CSIRO), Dr Alex Hesp (Murdoch University, now DoF), Dr John Hoenig (Virginian Institute of Marine Science), Professor Terry Quinn II (University of Alaska), Dr Lyndon Brooks (University of Southern Cross), and Dr Fiona Valesini (Murdoch University). In the first year of the project, Ms Carla De Gois and Ms Marjorie Pashley at Murdoch University made the logistics of running workshops very easy and smooth. Their contributions were missed greatly in the project's second year.

3. Background

The ongoing development of quantitative skills in fisheries science, stock assessment and, more generally, in the natural resource management field is important for the management of sustainable fisheries and marine ecosystems in Western Australia and Australia. In this project, Murdoch University appointed a "world-class" mathematician specializing in population dynamics and broader ecosystem assessments, as a successor to Professor Norm Hall, who became an Emeritus Professor in 2010. The focus of this appointment was on the eventual establishment of a self-sustaining facility for training in fisheries and ecosystem modelling, stock assessment, multivariate analysis and data management that will continue to provide human capital development at a postgraduate level to meet national and international training needs in the field.

This project was developed with the financial support of Murdoch University, the Western Australian Department of Fisheries (DoF), and the support of the Western Australian Department of Environment and Conservation and the Western Australian FRAB.

Once the project was funded, a Steering Committee was formed to assist in developing the selection criteria for the position and canvassing potential candidates, and providing advice on running a survey to identify training needs and the development of the training workshops in this project.

4. Need

Coastal development, marine park reservation and population growth, coupled with use of remote sensing technologies, require a range of complex analyses, covering stock assessments and evaluation of ecosystem-wide impacts on fish communities and fisheries. Independent advice relating to compensation and Marine Park planning and reservation, with the needs of triple bottom line reporting is also required. The increasing use of detailed spatial data relating to fish, fisheries and the environment also increases the demand for fisheries scientists with strong quantitative abilities.

Currently, the PhD program in Quantitative Marine Science offered by the University of Tasmania and CSIRO Marine and Atmospheric Research is the only program established specifically to produce marine scientists with the necessary quantitative skills. However, the demand in Australia cannot be met by this program alone, particularly on the west coast of the continent.

Short courses need to be delivered, on an ongoing basis, to upgrade the skills of existing fisheries scientists, empowering them to deliver answers to the range of policy questions now posed. Postgraduate and in-service training need to be adaptive, but capable in the short term of delivery on-line throughout Australia, targeted to the specific needs of fisheries scientists, marine ecologists and the fishing industry. With the emergence of new technologies, ongoing course development, the application and use of very large databases using super computers, and implementation of new modelling tools, are essential requirements for training.

This project was designed to provide the seed funding to attract an appropriate person to lead the development and establishment of such a training facility.

5. Objectives

1. The appointment of a suitable highly-qualified fisheries scientist to lead the training facility and develop courses.
2. The development and delivery of courses and training in fisheries and ecosystem modelling, multivariate analysis and management of very large databases.

3. Implementation of a business strategy to achieve self-sufficiency as an ongoing evolving training facility from short course training within Australia and on-line within three years.

In addition to the funding from the FRDC ($150,000), the Department of Fisheries ($150,000) Western Australia and Murdoch University ($182,000) made significant contributions to make this project possible. The following two objectives were added to the project to make the project possible:

4. That the person appointed would provide high level statistical and quantitative methods advice to the Department of Fisheries, WA.
5. That the person appointed would function as a research Professor at Murdoch University, focusing on Quantitative Methods.

6. Methods

APPOINTMENT PROFESSOR OF QUANTITATIVE METHODOLOGIES

After a formal search, the project was established in October 2009 with Professor Ken Pollock, a statistician from North Carolina State University, appointed to the position for two years. Professor Pollock took a two-year leave of absence from North Carolina State University to accept the position, with the possibility of extension to a third year under the funding available.

Professor Pollock has been a Professor at North Carolina State University in Statistics, Biomathematics and Biology specializing in quantitative methods for fisheries, wildlife and conservation biology. He was trained as a statistician and was elected as a fellow of the American Statistical Association in 1996. The original intent was to hire a fisheries mathematician interested in stock assessment similar to Professor Hall. The fact that Pollock was a statistician and an international expert in sampling methods for fish and wildlife populations caused some subtle but significant changes in how the project subsequently developed.

This report focuses on the FRDC component of the position (Section 7) but also includes information on the other components required by DoF and Murdoch University in Sections 7.1 and 7.2 below. In addition to developing and delivering a program of workshops for the FRDC, Professor Pollock was committed to providing one day per week to research projects for the DoF, in recognition of their funding support for his position. He also functioned as a senior research faculty member at Murdoch University to look for opportunities to engage in research and research consultancies. In addition, he provided some guests lectures in undergraduate units, participated in developing an

introductory program for Honours students and provided advanced statistical advice to faculty and postgraduate students in fisheries and conservation biology. As there are no other statisticians in Perth with his knowledge in sampling animal populations, this became a significant part of his position due to the number of fisheries and wildlife biologists in the region.

In summary, Professor Pollock had three main activities in this project. These were to:

- Develop workshops for the training facility;
- Function as statistical consultant/researcher at WA Fisheries; and
- Function as senior research faculty member in Quantitative Methods at Murdoch University;

Professor Pollock decided to return to his position at North Carolina State University in the United States at the end of November 2011. The Reference Group believed that it would not be possible to attract and appoint someone to this position for the remaining 12 months of the project and, that the best use of project funds and resources, was to terminate the project when Professor Pollock left.

This report begins with a description of what was achieved on the training component (Section 7 below), followed by the components for DoF and Murdoch University (Sections 7.1 and 7.2 below). This is followed by an analysis of the experience and the lessons learned (Section 7.3). We conclude with a discussion of future directions and a summary of specific recommendations.

DEVELOPMENT OF WORKSHOP PROGRAM

A needs analysis for training was carried out in 2008. Researchers, managers and industry representatives were surveyed electronically on the types of courses, course delivery and duration of courses that would best meet the needs of the fisheries and natural resource sector (see report "Defining Training Needs for the Fisheries Sector", submitted to FRDC in April 2009, included as Appendix 1 of this report). This survey identified that the courses should be short in duration (< 5 days) and that the greatest priorities for scientists and managers were: Linking GIS to data sets and spatial data analyses; training on statistical packages; and qualitative modelling of ecosystems. The courses developed in this project were designed around the results of the needs analysis.

7. Results and Discussion

In 2010, 10 workshops were co-ordinated by Professor Pollock and run by staff of Murdoch Link, which was the commercial arm of Murdoch University. All workshops made a profit after all costs including labour costs of presentation were factored in. Midway through 2010, Murdoch University abolished Murdoch Link to take effect by January 2011. From this time, all workshops had to be organised and run by the presenters or be contracted out to commercial conference organisers, which would have greatly increased the cost and complexity of running the workshops.

Because of these changes within the University, we revised the arrangements for running workshops in 2011. In 2011, two workshops were held at Murdoch University, two workshops were organised by WA Fisheries and run at their research facility at Hillarys in Perth, and two workshops were delivered outside Western Australia (Newcastle NSW and Brisbane Qld). These latter two workshops were organised by Dr Lyndon Brooks and staff of Southern Cross University.

All workshops involved a mix of lectures and computer exercises but there was a very strong "hands on flavour" to all the workshops. All participants received copies of lecture material pdfs and data sets on USB drives at the beginning of the workshops. The content, delivery and relevance of short course were evaluated through seeking feedback from course participants following each workshop. Reports of the workshops and their evaluation by participants were provided in project milestone reports to FRDC. The courses were universally successful and well received.

During the two years the project was in operation, sixteen major and eight minor workshops were run (see below for details). This is an average rate of around one workshop per month. The total income generated from the activities led by Professor Pollock has been about $75,000 with $36,000 coming from net income from the workshops and $39,000 coming from consultancy income.

MAJOR SHORT COURSES PRESENTED IN 2010

a) 2010 short courses presented at Murdoch University

March 11-12, 2010. An introduction to programming in R: statistical and graphical analysis with examples from the ecological sciences. Dr John Hoenig, Virginian Institute of Marine Science (2 days).

April 6-7, 2010. Tag-recapture and tag-return introductory workshop using MARK and other software. Professor Ken Pollock, Murdoch University (2 days).

June 14-16, 2010. Qualitative modeling workshop. Dr Jeff Dambacher, CSIRO (3 days).

July 21-23, 2010. Multivariate analysis workshop. Dr Fiona Valesini, Murdoch University (3 days).

July 26-28, 2010. Excel Programming for Biosciences. Dr Alex Hesp, Murdoch University (3 days).

December 1-5, 2010. Tag-recapture intermediate workshop using MARK and other software. Professor Ken Pollock, Murdoch University and Lyndon Brooks, Southern Cross University. In association with the Statistical Society of Australia meeting in Perth. (4 1/2 days).

b) 2010 workshops presented in other cities in Australia were:

July 11, 2010. Melbourne in Association with the Australian Society of Fish Biology Conference. Tag-recapture and tag-return introductory workshop using MARK and other software. Professor Ken Pollock, Murdoch University (1 day).

August 4-5, 2010. NSW Fisheries Research Centre. Cronulla. Tagging and telemetry introductory workshop. Professor Ken Pollock, Murdoch University (2 days).

August 17-18, 2010. NT Fisheries. Darwin. Tag-recapture and tag-return introductory workshop using MARK and other software. Professor Ken Pollock, Murdoch University (2 days).

December 8, 2010. The design and analysis of ecological field studies. Ecological Society of Australia Meeting, ANU Canberra. Professor Ken Pollock, Murdoch University (1 day).

MAJOR SHORT COURSES PRESENTED 2011.

The six major short courses delivered in 2011 were:

January 2011. Intensive week long, WAMSI-funded workshop at Murdoch University for Honours students. Kenneth H Pollock, Mike Calver, Ian Wright and Alex Hesp Murdoch University -

March 2-4,2011. R Programming Workshop for Fisheries Biologists. Dr John M. Hoenig VIMS. WA Fisheries. (3 days).

March 21-25, 2011. Intermediate Capture-Recapture Workshop. Professor Kenneth H Pollock and Dr Lyndon Brooks. Newcastle University (4 ½ days).

June 6 – 10, 2011. Kenneth H Pollock and Lyndon Brooks "Intermediate Capture-Recapture Workshop" University of Queensland June 6-10, 2011. (5 days).

July 11-13, 2011. Estimation of detection probability in count surveys. Professor Kenneth Pollock, Theodore Simons, Russell Alpizar and Phillipe Bouchet. (2 ½ days).

August 2-4 2011. Introductory stock assessment workshop. Professor Terry Quinn, University of Alaska, USA. Department of Fisheries WA. (3 days).

Almost all of the workshops were in great demand and were repeated in multiple places or multiple years where practically possible. Due to the termination of the project a year early, we were not able to present the course on spatial statistics or develop the online distance course for delivery in 2012.

OTHER WORKSHOPS AND SEMINARS

2010

In 2010, Professor Pollock also presented seven free half-day workshops for postgraduate students and professionals, primarily in Perth (see Appendix X). He also delivered five seminars, three in Perth and two in Victoria (Appendix X). In 2011, he presented one comprehensive workshop for undergraduates:

October 3-4, 2011. Murdoch University. Capture-Recapture and Tag-Return Models, two lectures and 3 hour computer lab for undergraduates in the undergraduate unit Bio 205 Sustainable Management of Fish and Wildlife., and eight lectures and seminars (Appendix X)

These workshops were delivered primarily in Perth.

February 12, 2010. Murdoch University. Design of Ecological Field Studies: Overview.

March 26, 2010. Murdoch University. Design of Ecological Field Studies: Experimental Design.

April 16, 2010. Murdoch University. Design of Ecological Field Studies: Quasi Experimental Design.

May 14, 2010. Murdoch University. Design of Ecological Field Studies: Sampling Design.

May 26, 2010. Tasmanian Aquaculture and Fisheries Institute, Hobart. Tag-recapture and tag-return introductory workshop using MARK and other software.

July 8, 2010. WA Fisheries. Closed Tag-recapture models using program MARK.

July 29, 2010. WA Fisheries. Open Tag-recapture models using program MARK.

Professor Pollock also presented five seminars in 2010:

February 22-26, 2010. WA Fisheries. The design of recreational angler surveys. Four lectures as part of a 5 day workshop on this topic in at WA Fisheries in Perth.

April 13, 2010. Murdoch University. Mathematics and Statistics. The estimation of animal abundance from counts for rare and elusive species: accounting for detection probability.

July 16, 2010. Victoria Fisheries, Queenscliff. Use of Indices in Fisheries Management.

July 16, 2010. Victoria Fisheries, Queenscliff. Tag-Return and Telemetry Models in Fisheries and Wildlife Research.

November 17, 2010. Curtin University. Mathematics and Statistics. The estimation of animal abundance from counts for rare and elusive species: accounting for detection probability.

2011

Pollock presented one comprehensive workshop for undergraduates:

October 3-4, 2011. Murdoch University. Capture-Recapture and Tag-Return Models. Two lectures and one 3-hour computer lab for undergraduates in Bio 205 Sustainable Management of Fish and Wildlife.

Professor Pollock also presented 8 lectures and seminars in 2011:

February 22, 2011. Australian National University. Fenner School of the Environment. The estimation of animal abundance from counts for rare and elusive species: accounting for detection probability.

February 23, 2011. Murdoch University. Wildlife Science Group. The estimation of animal abundance from counts for rare and elusive species: accounting for detection probability.

May 10, 2011. University of Canberra. Institute of Applied Ecology. The estimation of animal abundance from counts for rare and elusive species: accounting for detection probability.

June 15, 2011. Southern Cross University. Coffs Harbour. Tag-Return and Telemetry Models in Fisheries Research.

June 16, 2011. Southern Cross University. Lismore. The estimation of animal abundance from counts for rare and elusive species: accounting for detection probability.

July 6, 2011. Australian Marine Science Association Conference in Fremantle. The Design of Environmental Impact Surveys for Marine Mammals.

September 13, 2011. Statistical Society of Australia, Perth. Capture-Recapture Models with Focus on the Robust Design.

September 21, 2011. Murdoch University. Capture-Recapture Models. Lecture in Bio 317 Wildlife Biology.

In addition to these very significant activities, Professor Pollock has made significant contributions to research at the WA Department of Fisheries (see 7.2 below) and Murdoch University (7.3 below). The significance of these contributions is demonstrated by his extensive collaborations and list of publications (Appendix 2). During his time in Australia, Pollock had 20 papers and book chapters published or in press. In addition, he submitted six more manuscripts for publication.

DEPARTMENT OF FISHERIES WA COMPONENT

Professor Pollock's research and consulting activities at the Department of Fisheries Western Australia have focused on several main areas: a) recreational fisheries survey design and analysis; b) fisheries tagging studies involving tag-recapture and tag return models; c) routine statistical consulting and d) co-ordination and delivery of staff training workshops.

A major component of Pollock's research and advice at WA Fisheries has been on recreational angler surveys. From October 2009 to November 2011, he has been part of a team of people led by Drs Brent Wise and Daniel Gaughan, designing a new integrated survey of boat based recreational angling for all of Western Australia, which began in January 2011. The survey has several major components: a year long longitudinal telephone diary survey of boat based angling; an on-site access point validation survey in the Perth Region; and a state wide biological sampling survey. Pollock provided high level statistical advice on many aspects of the design and planned analysis methods.

The integrated survey is actually several linked surveys with the most important being a year long longitudinal telephone diary survey of boat based angling based on the new boat license frame. A large sample of boat anglers are contacted roughly once a month and asked to provide catch and effort information about all their fishing trips. Another important component is a bus route access point survey of six major boat ramps in the Perth metro area to validate the harvest estimates obtained in the telephone survey. Use of camera data will be an innovative feature of the access point survey. The third major component is a state wide biological sampling survey to obtain information on size information for key species. We also plan on incorporating information on compliance with the new boat fishing license into our integrated estimation procedure. This project will continue after Pollock's departure and he continued his involvement with it in 2012.

Pollock has also been an important member of a team working on recreational shore based fishing in the Perth region of Western Australia. We used an Aerial-Roving survey where aerial counts and roving shore interviews on beaches and jetties were augmented with some camera information. Smallwood et al. (2011a) provides details on this project in a final report and we are about to submit a paper to the North American Journal of Fisheries Management because of some very innovative features in the design. He also reviewed the bus route access point recreational survey analyses carried out by Brent Wise and Norm Hall. He advised Gary Jackson on a Shark Bay pink snapper harvest tag study involving a telephone recall survey. Jackson plans to write a paper on the effectiveness of harvest tags as a management method in the coming year and Pollock will be a co-author on this work.

Pollock has worked on several tag-recapture and tag-return projects while at WA Fisheries. He worked with shellfish biologists on several capture-recapture studies. He also advised lobster and finfish biologists on the design and analysis of tag-return studies. A tag-return study on Australian herring with Dr Kim Smith and colleagues is now being planned for the West Coast Region beginning in late 2011 and going for 3-5 years. He has had, and will continue to have, substantial involvement in the study design for this project. A tag-recapture and tag-return study on Cobbler (*Cnidoglanis macrocephalus*) in Wilson Inlet is planned with Dr Kim Smith, a study with many unusual features in design and analysis.

While at WA Fisheries, Pollock was involved in various staff training workshops that are mentioned elsewhere in this report. In early 2010, he co-led a week-long

workshop on recreational angler surveys where we began planning for the integrated survey. This involved substantial lecturing on recreational angling sampling designs based on and extending material in my textbook on the subject. Later in 2010, he presented two half-day workshops on tagging models and the use of Program Mark. In 2011, he co-ordinated and provided some financial support through his research consultancies for two key training workshops of great importance to WA Fisheries. The first 3-day workshop was by Dr John Hoenig, of the Virginia Institute of Marine Science USA, on the use of Program R in Fisheries data analysis. The second 3-day workshop was by Dr Terry Quinn, University of Alaska Juneau, who is an international stock assessment expert. It was an introduction to population dynamics and basic stock assessment methods.

MURDOCH UNIVERSITY COMPONENT

Professor Pollock's research and consulting activities at Murdoch have focused on several main areas: a) recreational and commercial fishing sampling and modeling; b) estimation of population demographic parameters for marine mammals using photo-identification techniques and aerial surveys; c) estimation of population demographic parameters for wildlife species of a variety of taxa; and d) general statistical consulting for fisheries and wildlife staff and postgraduate students.

Pollock has continued his research on recreational angler survey methods with most of this described in his work for WA Fisheries above. In addition he has worked on Response Driven Sampling with Dr Shane Griffiths of CSIRO in Brisbane and this has related in one publication so far. He is also a co-supervisor of one of Griffith's PhD students at the University of Queensland.

Pollock has continued his research on the use of removal models for estimating fisheries stock size from catch and effort data. He has collaborated with Dr Jim Prescott of AFMA on a sea cucumber fishery in the MOU Box between Australia and Indonesia. A temporary assistant, Ms Camille Vogel, was employed to work on the data analysis for this project. Funding of $10,000 was provided by Dr Prescott. A manuscript is being developed to submit to Marine and Freshwater Research.

Pollock worked with Dr Steve Beatty, Murdoch University, on a capture-recapture study of freshwater marron, which has just been published in Marine and Freshwater Research.

A major component of Pollock's time at Murdoch has been devoted to research on marine mammal photo-id methods with researchers in the Cetacean Research Unit at

Murdoch University (led by Dr Lars Bejder and many co-workers and students). These methods involve the use of sophisticated capture-recapture models where his expertise is valuable. Several future papers are likely on this general topic and he is currently co-supervising several masters and PhD students with Lars Bejder and Neil Loneragan. A similar approach was used in a capture-recapture study of Irawaddy dolphins in Cambodia with Dr Isabel Beasley and Professor Helene Marsh of James Cook University. A paper on this work has been accepted for publication in Marine Mammal Science. Other related work on humpback whales with Dr Lyndon Brooks of Southern Cross University is ongoing.

Another research area with the same research group has been on aerial survey designs used in environmental impact assessments of marine mammals. Partly due to Pollock's presence at Murdoch University, Dr Amanda Hodgson came with a three-year post-doctoral fellowship funded by the Australian Marine Mammal Centre. She is working on the use of unmanned aerial vehicles for marine mammal surveys and there are substantial statistical issues related to detection probability involved. On a related aerial survey project, Pollock has continued his collaboration with Professor Helene Marsh of James Cook University on estimating the availability of dugongs. We published a methods paper together in 2006, which needs further refinement. Another aerial survey project, with Dr Joshua Smith, on humpback whales, on the Great Barrier Reef has just been funded by the Australian Marine Mammal Centre.

Other capture-recapture studies have also been a significant focus. He worked with Dr Belinda Cannell on little penguin capture-recapture studies on Penguin Island WA. We have one paper coming out in the journal of Wildlife Research soon and others are planned. Terrestrial marsupial mammal capture-recapture studies have also been common and involved Dr Adrian Wayne from the Department of Environment and Conservation WA and several PhD students at Murdoch and UWA.

Pollock has been involved in several projects involving domestic and feral cats and their effects on native wildlife species with Dr Mike Calver who is an Associate Professor of Animal Biology at Murdoch.

While at Murdoch, Pollock has functioned as a statistical consultant primarily to postgraduate students in fisheries and conservation biology. To make this more effective, in 2010 he provided a series of half-day workshops on study design for ecologists. Later, he followed up with some free workshops on capture-recapture methods at WA Fisheries to which Murdoch students were invited. In January 2011, Dr

Mike Calver and he co-ordinated and ran a one week quantitative workshop for new honours students in Biology.

Professor Pollock was asked to obtain support for his research through research consultancies and four major consultancies resulted during the last two years. In 2010, one was to provide a review of the Tasmanian recreational rock lobster fishery and a second to provide advice on the design of a statewide recreational telephone diary survey for NSW Fisheries. In 2011, he completed a third consultancy for the NT Government to provide advice on the design of a photo-id, capture-recapture study in Darwin Harbour for three species of dolphins (bottlenose, snubfin, and humpback dolphins). Finally, in 2010 Pollock obtained a consultancy from the Department of Environmental Conservation in Western Australia to provide ongoing advice on the design and analysis of various capture-recapture and occupancy studies on endangered mammals and insects.

Pollock has attended many planning meetings and offered expert advice and consultation on the need for substantial strengthening of quantitative methods in fisheries, wildlife and conservation biology at Murdoch University and in Australia more generally. Like many other Australian Universities, Murdoch has a very small number of academics, specialising in mathematics and statistics. No staff members at Murdoch have a history of interest in quantitative methods in fisheries and conservation biology.

ANALYSIS OF TRAINING AND RESEARCH NEEDS IN QUANTITATIVE FISHERIES SCIENCE

Here we present a critical analysis of training and research needs in quantitative fisheries science. We begin by presenting the mathematical and statistical components of quantitative fisheries science. We then focus on training courses and workshops with respect to organisation, delivery and finances. We conclude by considering broader issues like the shortage of quantitative specialists in Australia; the need for linkages to conservation biology, which is facing many of the same challenges; and the need to link more closely to the disciplines of mathematics and statistics. Material in this section and Section 9 (Further Development) forms the basis for an opinion piece that has been submitted to Australian Zoologist for consideration as a publication (Fisheries, Wildlife, and Conservation Biology Education in Australia: Current Challenges and Future Directions, by Pollock, Loneragan and Calver). The submitted manuscript is included as Appendix 3 in this report (See Section 12.3).

THE INTERDISCIPLINARY NATURE OF FISHERIES SCIENCE

We begin our analysis of this topic noting that the health and vitality of the fisheries science profession, and science for managing natural resources more generally, is crucial to the future Australian economy and more generally to Australian society. Sound fisheries management in the face of many increasing challenges depends on sound fisheries science. Fisheries Science has developed as a separate field of applied science over the past 50 years. It is complex and interdisciplinary in nature with many components including human dimensions and quantitative methods (Box 1).

Box 1. Components of Fisheries Science showing the interdisciplinary nature of the field.

1. Basic Biology
2. Fisheries Biology
3. Environmental Science
4. Human Dimensions
    a. Economics
    b. Sociology
5. Quantitative Fisheries Science
    a. Mathematical Modelling
    b. Statistical Modelling
    c. Computational Skills

Currently, training in fisheries science in Australia is primarily provided at the postgraduate level or through continuing education while in the work place. As the Australian model of higher education in fisheries is almost totally research focused, this means that this knowledge has to be obtained by students, either through their reading, or through short courses or workshops. In Appendix 3, we present an opinion piece, suggesting that this model is unsatisfactory and that the fisheries profession should be

moving towards providing this training through postgraduate courses, perhaps run by a consortium of universities. Other fields in Australia have already moved to providing a significant amount of postgraduate training through coursework. Training through postgraduate coursework is also the norm in the US and Canada.

Our main focus in this document is training through workshops and short-courses, as it is not the usual practice to deliver formal postgraduate courses in Australia. Therefore, we focus on how to make workshops most effective in providing this training. We begin by briefly discussing the key elements of core and advanced training in quantitative methods. We then consider the design of effective workshops and then conclude with a discussion of business and infrastructure issues.

QUANTITATIVE FISHERIES SCIENCE COMPONENTS

In Box 2 we present what we view as the key elements in training fisheries biologists in quantitative methods. It is important to recognise that there are core mathematical concepts, core statistical concepts and also the need for strong computational and GIS skills.

In addition to the core training described in Box 2, individual fisheries scientists will require more advanced and specialised workshops to train them for a particular skill they have for a research project. For example, a fisheries scientist may be assigned the task of running stock assessments for an agency but not be trained in all the advanced techniques they need. Another scientist may require a workshop on spatial statistics and yet another may need a course in tag-return model statistical software.

RESEARCH AND TRAINING IN ADVANCED QUANTITATIVE METHODS

Another area for consideration is that quantitative methods in fisheries (i.e., mathematical and statistical modelling), like other areas of fisheries science, require new research. Initiatives to provide quantitative training for biologists need to consider this as it has several important implications which are not always recognised. First, staff that are providing the training also need to be involved in carrying out research so that they will not be able to spend all of their time providing training. Second there is a serious shortage of statisticians and mathematicians working in fisheries in Australia and around the world. How are we going to train the next generation of fisheries statisticians and mathematicians? Is Australia going to train them here or attempt to bring them in from overseas?

The key point here is that providing training for fisheries scientists in quantitative methods in Australia cannot be considered in isolation. It needs to include the hiring and training of more fisheries statisticians and mathematicians who can train the fisheries scientists but who can also carry out research on new designs, analysis and models. Universities and Fisheries Agencies around Australia will need to work together if solutions to these connected problems are to be found.

Box 2. Crucial Components of Quantitative Fisheries Science for all Ph D Students and professionals in Fisheries Science.

Mathematical Modelling

- Basic Mathematics
- (Calculus, Matrix Algebra, Simple Diff Equations)
- Population Dynamics Models (Intro)
- Stock Assessment Methods (Intro)

Statistical Modelling

- Basic Statistical Methods (Analysis of Variance and experimental design, Multiple Regression, Nonparametric Methods)
- Basic Sampling Methods
- Sampling Animal Populations
- Generalised Linear Models (Intro)
- Spatial Statistics (Intro)
- Multivariate Methods (Intro)

Computational Methods

- Excel and Basic Stat Packages
- GIS packages like Arcview
- R programming

Note- The requirements for Ph D students specialising in quantitative methods would be much more than these topics. Mathematical statistics 2 semesters and possibly an introductory Bayesian statistics class.

TRAINING WORKSHOPS: DELIVERY ISSUES

Topics and Specialist Presenters

Basic and advanced workshops, ranging from the use of excel to multivariate statistics to a course in fisheries stock assessment methods, were offered during the two years of this project. Discussions with workshop participants, like the results of the earlier needs analysis, confirmed that courses at all levels of expertise were needed.

The focus of several workshops on more advanced courses was partly the result of Professor Pollock's interest in fisheries and wildlife research and partly because we wanted to focus on his international connections to get some specialists to visit Australia in a cost effective way. We were fortunate to have Drs John Hoenig, Terry Quinn, and Theodore Simons visit from the United States, and Dr Russell Alpizar-Jara visit from Portugal. One point we will return to later is that there is a shortage of quantitative specialists in fisheries mathematical and statistical modelling in Australia and especially in Western Australia.

Workshop Audience

The audience of our various workshops included postgraduate students, made up of honours students and higher degree students (masters and doctorate), as well fisheries professionals, some of whom were part-time students. Almost all of our major workshops were for mixed audiences of higher degree students and professionals, with one exception: the one-week workshop in 2011, designed exclusively for honours students in Biology at Murdoch University

Postgraduate students and continuing education of professionals are two distinct markets for short courses In Australia. We believe that we need to consider carefully whether they should be taught together in the same workshops or whether workshops should sometimes be designed separately for the two segments. The goals and pressures on the two groups are quite different.

For postgraduate students, an argument could be made for having a two week short-course with multiple presenters, on key quantitative methods in fisheries, aimed exclusively at new honours or new higher degree students. The course could cover many methods and projects and assessment could be built into the course to make it more effective for learning. Theoretically, one could also bring the group back together for short follow-up meetings every week or fortnight for the rest of the year so that desired learning outcomes could be reinforced. Further assessment is of great importance to

universities and it is very difficult to build effective assessment into short workshops where time is limited.

For professionals, the focus needs to be on short 3-5 day workshops on core topic components, as this group typically is only able to take limited time away from core duties. Specialised advanced topics, which would have a narrower appeal, could also be taught in short workshops to mixed audiences of postgraduate students and professionals.

Mode of Delivery: In Person vs. Distance Education

We focused on in-person workshops with one or several presenters. This was the primary focus of the original proposal. We were unable to deliver a distance workshop in 2011, although one was originally planned. However, we have spent some time considering whether the delivery mode for workshops may be in person or by distance education using the internet.

Distance education is very widely used by universities now because it is cheaper and because it is so convenient for part time working students who may not live in the same city as the university campus offering the course. However, we believe that it is not as suitable as in-person for many of the technical subjects needed to be mastered in quantitative fisheries science.

We believe that a combination of distance education and in person workshops could be valuable and cost effective. For example postgraduate students from multiple universities could come to one location for a two week intensive workshop at the start of their program and then have web based modules that built on the intensive workshop over the next several months.

Length of workshops

The major workshops we offered ranged in duration from 1 to 4 ½ days. The two one-day workshops were to fit in with participants coming to a conference and having the workshop as a bonus opportunity. Most of our single presenter workshops were 2 or 3 days long. The capture-recapture workshops were offered with one presenter over 1-3 days and also offered with two presenters over 4 ½ days for scientists who wanted a lot of technical detail on the models and the software. We believe that the optimal length for workshops when considering the cost and time trade-offs versus the learning trade-offs is from 3-5 days.

Multiple Presenters

Most of our workshops were offered with a single presenter but we believe there are learning advantages of using multiple presenters. The major disadvantage of using multiple presenters is the increased cost. However, for the 4-½ day capture-recapture workshops, we found that it was essential to have the two presenters as the workshop involved intensive interactions with the participants.

Content and Structure

All of our workshops, except for the one day workshop in Canberra on Ecological Study design, used a mix of lectures and computer demonstrations and exercises using key software products. Logistically, it was much easier to present workshops where the participants bring their own laptops already loaded with the appropriate software. We did use Murdoch computer laboratories for some workshops but it is not ideal due to severe timetable restrictions. Proprietary software can cause significant cost and logistical issues for workshop presenters but sometimes has to be used because it is so superior to its competitors. For example, the Primer Software used in the multivariate statistics course has become a world standard for analysing multivariate ecological data.

TRAINING WORKSHOPS: BUSINESS ISSUES

INFRASTRUCTURE AND LOGISTICAL SUPPORT

A crucial feature of providing high quality training workshops and short course over the long term is having good infrastructure and logistical support in place. This involves both technical and operations co-ordination. Professor Pollock was to provide overall leadership of the workshop initiative and function as the technical co-ordinator running all the workshops. He also presented all or part of 10 of the 16 major workshops run over the two years. In addition, he presented seven half-day free workshops for postgraduate students in 2010 and one undergraduate workshop for Murdoch students in 2011.

Operations co-ordination became a major issue on this project. In 2010, Murdoch Link, the commercial arm of Murdoch University, ran six of the major workshops using the facilities of Murdoch University. Murdoch Link had all the skills and infrastructure in place to run these workshops and did an excellent job. They had appropriate websites, advertising networks, staff skilled in producing brochures, and accounting staff to collect all the fees and process them. They also co-ordinated room rentals, and making refreshments available. Participants were expected to make their own travel and

accommodation arrangements but Murdoch Link provided information on the options available to participants.

In June 2010, Murdoch University decided to abolish Murdoch Link and put all the infrastructural demands for running workshops back onto organisers or their home departments. Fortunately, the University agreed to allow Murdoch Link staff to keep running our workshops until the end of 2010. However, in 2011, we had to develop a new organisational structure to run workshops.

After some reflection, a radically different approach was adopted for running the workshops in 2011. The DoF, through Dr Daniel Gaughan, agreed to support and run two key workshops at Hillarys Research Laboratories: these were the Hoenig R workshop in February and the Quinn stock assessment workshop in August. The DoF provided the facilities without cost and the costs of the workshops were split equally between Murdoch University and DoF. Approximately half of the 20 participants at each workshop were from each organisation. There was a focus on getting key young staff and postgraduate students to each workshop. Financial support from Murdoch University came from Pollock's research consultancy income and from the Centre for Fish, Fisheries and Aquatic Ecosystems Research. The workshop presenters, Drs Hoenig and Quinn, were paid travel expenses and a fee for presenting their workshops. Participants were not charged for attending the workshops.

We ran two other workshops in Perth in 2011. These workshops were both at Murdoch University. The first one was a special, one week workshop for Honours students in January. No fees were charged and Murdoch Staff presented it: Professor Ken Pollock, Associate Professor Mike Calver, and Dr Alex Hesp and Dr Ian Wright, formerly a DoF statistician. The other major workshop, on detection probability in July, was co-ordinated by Professor Pollock and a postgraduate student, Ms. Krista Nicholson. This approach worked reasonably well but would not be viable as a long-term option. Participants were charged a fee for attending the 2½-day workshop and some subsidy of travel expenses for two international presenters was made from Professor Pollock's research consultancy income.

Four workshops offered by Pollock in 2010 were run remotely with operational organisation offered by the host institution. In 2011, two more workshops offered by Pollock used a similar procedure. Murdoch University charged the host institution a fee for running these workshops. It was much easier to run the workshops remotely because there are no organisational issues for the technical co-ordinator/ presenter to

deal with. Dr Malcolm Haddon from CSIRO Marine and Atmospheric Research in Hobart (pers. comm.) noted that he had the same experience when he ran fisheries modelling workshops through the FRDC supported program at the University of Sydney in earlier years, i.e., that it was much easier to run workshops remotely, with the host organisation taking responsibility for the logistics of the workshops, including payments by participants.

One key lesson learnt from our experience is that is crucial to have stable, long-term, operational infrastructure and logistical support in place. In retrospect, it is also clear that the initial budget for the project should have included the costs for some operational support, rather than just for Professor Pollock's salary. Another issue that arose is that the technical co-ordinator of the workshops needs to be an experienced senior academic but they cannot do this work full time as they need to also complete research.

FUNDING OF WORKSHOPS

In 2010, we ran six workshops at Murdoch on a participant fee paying basis. We ran 4 additional workshops where Pollock charged a fee for presenting the workshop to the host institution. As we noted earlier, in 2011 two workshops were run at DoF without fees being charged, one workshop was presented on a participant fee paying basis and Pollock charged a fee for two other remote workshops. Finally one other workshop for Murdoch honours students had no participant fees charged.

The key challenge that affected how the project changed in 2011 was the closing of Murdoch Link. However, the other challenge was financial. Pollock was expected to work roughly one third of his time on co-ordinating and presenting workshops but in 2010 he spent way more than this to co-ordinate 10 major workshops. Even under the best of circumstances, this would not have been sustainable in 2011. Further, it was not possible to run enough workshops, or charge the rates for the workshops, necessary to generate enough profit to make the training facility self-sustaining financially.

When planning the first year's workshops, we considered carefully what fees to charge in our workshops. Developing a policy on workshop fees was difficult because each workshop situation was different and we had very little information on which to base a decision. We researched what workshops were charging around Australia and found that while charges varied a fee of $300- $400/ day was normal with some fees higher especially for very short workshops of one or two days. We used this level of $400/day in our first three workshops because we had very well known presenters with

international reputations and we budgeted that this would allow a good return after labour costs, if we had around 20 participants. We found that we got many participants wanting to attend the two early two-day duration workshops, which cost $800. However, for the third workshop by Dr Dambacher, which was over three days, and cost $1200, we did not reach our target of 20 participants. This workshop basically broke even when all labour costs including those of Pollock as well as Dambacher were considered. For the next two workshops by Drs Hesp and Valesini we dropped our fees to $900 for 3 days or $300/day but still could not attract 20 participants.

For the December workshop by Professor Pollock and Dr Brooks, we needed the workshop to be 4½ days and have two presenters, we decided to drop the price to $1,000 with a significant 30% discount for PhD D students. Professor Pollock decided that the $400/day charge, which would translate to a charge of $1,800, was just not possible if we wanted the workshop to succeed. We got 20 participants but we had to pay two presenters and just broke even after we paid labour costs.

In 2011, we charged fees for only one workshop and the fee was set at $400 for 2 ½ days because we wanted to attract postgraduate students. Presenters came at very low rates and the workshop costs were subsidised with $2,000 from Professor Pollock's research consultancy income. We reached 35 participants and Pollock also got publicity in the conservation biology community and research benefits from the visit.

During the two years the project was in operation, the total income generated from the activities led by Professor Pollock was about $75,000, with $36,000 coming from workshops and $39,000 coming from consultancies.

To summarise, an obvious and crucial feature of workshops is who is to pay for them. We found that there was significant cultural resistance in the fisheries profession to paying higher fees to attend workshops. Agency professionals and post-graduate students expected the workshops to be offered either for free, or at very low fees. As we mentioned earlier, Dr Lyndon Brooks and Professor Pollock found that the 4½-day capture-recapture workshop, which cost $1,000 for professionals and $700 for full time PhD students, only recovered our labour costs and all other expenses, when we had around 20 participants. To make significant income from such a workshop, which could contribute to making a self sustainable training facility, we would have needed to charge about $1,800, or approximately $400/day.

While all our 16 workshops were well received, we detected a surprising lack of awareness of how expensive workshops are to run from some participants, and a

perception that the costs and profits were excessive. In reality, many of the courses were breaking even. For example, it would not have been possible to attract 60 people come to the three capture-recapture workshops, if the fees had been set at $2000/person. None of the workshops would have attracted enough participants if we had asked that level of fee. Another example of the resistance to paying full costs of workshops is from the workshop on Qualitative Modeling by Dr Jeffery Dambacher. This was an excellent workshop by the international leader in the field, and well received by participants. Ideally, it should have been offered again over 4 days, at a fee of around $1,600 per participant, but this was not practical when we had attracted only 16 participants at a fee of $1200 for 3 days.

Another factor we found challenging was that workshop preparation time was very significant. For example, the travel and preparation time for a one-week workshop was estimated at least an extra one week. Another hidden cost was the large amounts of time taken to coordinate workshops run by other presenters, even though the logistic details of the workshops were run very ably by Murdoch Link in 2010.

In one final remark on finances, let us consider postgraduate students and fisheries professionals as separate groups. We argue that Universities should pay for all their postgraduate students to attend a 2 week workshop on core topics at the beginning of their program. We believe that this model of long introductory workshops, with assessment, is crucial to improving postgraduate education and that Universities have a duty to provide it, even though many are not at the moment. We also believe, based on our experience, that participants should pay some of the cost for shorter introductory or advanced workshops, aimed at combined audiences of postgraduate students and continuing professionals. However, key agencies and Universities are likely to need to provide significant subsidises for these workshops, if they want them to occur and be successful. This is especially true when national or international expert presenters in specialised disciplines have to be used and travel costs are therefore high.

SCARCITY OF QUANTITATIVE FISHERIES SPECIALISTS IN AUSTRALIA

An underlying issue that is related to the training of fisheries scientists in quantitative methods is there is a severe shortage of quantitative specialists, both stock assessment modellers and statisticians, in Australia. This leads to increased travel costs for presenting workshops because presenters often need to be brought in either from other parts of Australia or often from overseas. It also means that many postgraduate students cannot get the guidance they need when writing their theses. Further, many

fisheries agencies in Australia find it difficult to attract enough well trained quantitative staff to carry out their research effectively. We believe that any solutions to providing better quantitative fisheries training will have to consider this as one core issue.

LINKAGE BETWEEN FISHERIES AND CONSERVATION BIOLOGY

Another significant factor to be taken into account in considering solutions on how to provide good cost effective training in quantitative methods is that many of the techniques used in fisheries are also used in conservation biology for terrestrial and marine wildlife. This means that students from both disciplines can be taught many techniques together at significant cost savings. However, there needs to be much closer co-operation between professionals in both the universities and the government agencies. At the moment, there seems to be little awareness of the synergies between these two areas due to the separation into separate agencies and disciplines, with wildlife staff often not knowing fisheries staff and vice versa.

LINKAGES TO MATHEMATICS AND STATISTICS PROGRAMS

We have found that mathematics and statistics programs in Australian universities are often very small. In fact with some universities forced to specialise, groups appear to have contracted in recent years. Without some radical change in university policy nationally, this appears likely to increase further in the next few years. Further the existing programs often have few people interested in fisheries and conservation biology applications of mathematical or statistical modelling. Links need to be strengthened between fisheries scientists and mathematicians and statisticians as there are difficulties in finding enough quantitative students in fisheries. Where will the new quantitative fisheries scientists come from in the future? Will they all come from biology?

8. Benefits and adoption

This project has been successful in identifying and delivering a program of workshops of for training fisheries scientists and students around Australia. It has introduced international experts to Australian professionals and students in the areas of population estimation, qualitative modelling, and mark-recapture techniques. However, the program was not successful in establishing a self-sustaining facility. It has identified barriers to establishing such a system and recommended changes in the training for Australian postgraduate students to overcome the lack of available training in quantitative methods for fisheries and conservation scientists.

9. Further development

Fisheries Science is a distinct interdisciplinary field in applied science. In addition to Biology and Environmental Science, it includes Human Dimensions and Quantitative methods. The complexity and breadth of the field creates special challenges in providing this training. Fisheries Science has very close links to other fields like Conservation Biology and Marine Science, which need to be strengthened in the future (see Section12.3: Appendix 3 "Fisheries, Wildlife, and Conservation Biology Education in Australia: Current Challenges and Future Directions", by Pollock, Loneragan and Calver).

Education in Fisheries Science in Australia is primarily at the postgraduate level or through the continuing education of professionals. Due to the current research model used for educating PhD students, much of the training has to be through short courses of workshops. This is different from other fields in Australia (such as education or psychology) or fisheries science education in North America where longer formal postgraduate courses form a central part of postgraduate education. We believe that this reliance on short courses is unsatisfactory because it doesn't allow for optimal teaching methods and assessment to be used. In the medium to long term, Australia will need to move towards a system where formal postgraduate courses are offered. As Australian university fisheries science groups are small, this will only be feasible if universities can form consortiums to share the costs involved. Distance education will also have to be used as a part of a practical solution.

A key theme in finding solutions to challenges in fisheries science education in Australia is the need for co-operation between many entities. There is the need for universities to form consortiums to provide postgraduate training through courses or workshops. There is the need for the co-operation between federal and state fisheries agencies and the universities to find appropriate funding models. Further, there is the need for co-operation between conservation biology and fisheries agencies and university groups. Many of the training needs are common across these closely aligned disciplines and economies can be achieved by tapping in to a larger market and co-ordinating training across these related disciplines.

Quantitative Fisheries Science consists of many distinct mathematical and statistical techniques plus the appropriate computational tools to carry out these techniques. All fisheries scientists need to be trained in the fundamental aspects of these methods and some fisheries scientists also require advanced specialized training in

these methods. There are several challenges in providing workshops to provide training in these methods. One challenge is that university and agency research groups in Australia are very small and are very short of specialists in these quantitative areas. We believe that in the long-term, fisheries agencies and universities need to work together to provide more quantitative fisheries specialists in Australia. This is necessary to provide the training for fisheries students and professionals but also to provide the research necessary so fisheries research in Australia continues to be of high international standard in the future.

Another challenge is that fisheries science students and professionals requiring the training are spread around Australia and are often in very small groups. This means that travel and accommodation costs are an important factor in the finances of providing fisheries science training. We believe that distance education using the internet should be part of the solution for providing training but that for quantitative methods training there will always be a need for a substantial component of the training to be face to face despite the higher costs involved.

Workshops have two distinct markets: postgraduate students; and employed fisheries professionals, who need more training to be effective in their jobs. One component of the training should be to provide special two-week, introductory, short courses for postgraduates at the beginning of their programs. These short courses would require multiple presenters and involve students from multiple locations. This would enable good assessment methods to used and guarantee that optimal learning occurs. Distance education to enhance the learning over the next few months, would also be very valuable. Shorter introductory courses over a few days, like the ones we have provided, are another component directed at a mixed audience of postgraduate students and professionals. A third component is advance specialized short workshops for both groups. These will need very specialized instructors who may have to be brought in from overseas due to the current shortage of quantitative specialists in Australia.

A training facility to provide workshop training in quantitative methods for fisheries and conservation biology will not be viable without subsidization by agencies or universities. Further, such training facilities require a broader focus which includes time for the academics involved to: carry out research to develop new quantitative methods; train students in advanced quantitative methods; and to provide training for all fisheries scientists in introductory quantitative methods. We believe that it would be very valuable for fisheries science and management in Australia if teams of quantitative

methods specialists could be set up around Australia to address the training needs in these related research areas.

10. Planned outcomes

The planned major outcome from this project was to establish a self-sustaining university-based training facility in Western Australia. The business case towards establishing such a training facility for fisheries scientists and marine ecologists was built around two specialized short courses being delivered in years one and two, with further course development occurring in year three, with parallel on-line courses being offered in years two and three. The business plan involved training about 40 scientists in year one, building to around 100 by year three and onwards, supplemented by extension to international training opportunities.

Initially, the vision was to develop these courses to meet the ongoing training needs of practicing Australian fisheries scientists and marine ecologists. This would then move towards building human capital and facilities for management agencies throughout Australia and for addressing key policy outcomes.

The project was not successful in establishing a self-sustaining facility for training in quantitative methodologies due to four main reasons: 1) professionals and postgraduate students in the natural resources do not have the funding to pay the real costs of courses; 2) the market is small and training is readily saturated within a year; 3) logistics issues on arranging workshops are very time consuming; and 4) the diversity of tasks for the appointee made it difficult to sustain an intense workshop program. The project identified that training in this area is a deficit in the training of postgraduate students in Australia and a new approach needs to be adopted in the University system to meet this need, possibly modelled on Universities forming consortia to deliver the required diversity and depth of training. This model has been adopted in medical statistics in the eastern states.

11. Conclusions

Professor Ken Pollock was appointed to the position of Professor of Quantitative Methodologies for natural resources and, with advice from the project's Steering Committee, developed a package of training workshops for professionals and postgraduate students. These workshops were delivered by a number of people known internationally for their expertise in estimating mortality (Dr John Hoenig), mark-recapture analyses (Professor Ken Pollock, Dr Lyndon Brooks), population modelling

(Professor Terry Quinn III) and qualitative modelling (Dr Jeffrey Dambacher). The workshops have helped strengthen collaborations in Western Australia with Dr Hoenig and Professor Pollock in particular. In addition to developing and delivering quantitative training to professionals and postgraduate students, Professor Pollock collaborated with researchers at the Department of Fisheries WA on sampling designs and analysis for recreational fisheries and at Murdoch University researchers and postgraduate students on sampling design and population estimation for marine wildlife.

After two years, Professor Pollock decided to return to the United States and following discussions with the Project Reference Group and FRDC, we decided to terminate the project. The project was not successful in establishing a self-sustaining facility for training in quantitative methodologies due to the four main reasons outlined in the Outcomes above i.e., 1) professionals and postgraduate students in the natural resources do not have the funding to pay the real costs of courses; 2) the market is small and training is readily saturated within a year; 3) logistics issues on arranging workshops are very time consuming; and 4) the diversity of tasks for the appointee made it difficult to sustain an intense workshop program. The project identified that training in this area is a deficit in the training of postgraduate students in Australia and a new approach needs to be adopted in the University system to meet this need, possibly modelled on Universities forming consortia to deliver the required diversity and depth of training. This model has been adopted in medical statistics in the eastern states.

Although Professor Pollock returned to the United States, he will maintain his collaborations in Western Australia, particularly with Murdoch University and DoF, through his appointment as a Sir Walter Murdoch Distinguished Adjunct Professor. This appointment provides funding for his travel and expenses to Australia for one month a year over three years.

12. Appendices

APPENDIX 1: RESULTS OF NEEDS ANALYSIS: Defining Training Needs for the Fisheries Sector

Defining Training Needs for the Fisheries Sector

November 2008

Authors: **Peter Rogers and Neil Loneragan**

Appendix 1

Table of Contents

1.0 Executive Summary

An e-mail survey targeted at fisheries scientists and managers across Australia provided insights into the in-service short term training needs of 238 respondents across 25 topics. The survey suggests the priority course topics for development by the Centre are:

- Linking of GIS to data sets and spatial data analyses
- Training on statistical packages e.g. 'SPSS' and 'R'
- Qualitative modelling of ecosystems

The choices by managers for staff training, to a substantial extent agreed with the priority choices for all respondents across the basic and advanced fields. We also investigated the preferred mode of delivery and duration of courses. Most respondents preferred that the basics courses were of 2 to 3 days in duration and that the advanced courses were no more than 5 days in duration. The outcomes from the survey, particularly for shorter modules of delivery *in-situ*, has implications for the Centre for Fish and Fisheries Research in both training and business performance for the delivery of short courses. The responses are also presented for scientists, managers and by State (see Appendices).

2.0 Background

The Centre for Fish and Fisheries Research, as a component of FRDC project 2008/304 "Establishment of a self-sustaining facility for fisheries modelling and multivariate analysis and for effective management of extremely large data bases," sought to undertake a needs analysis of potential training topics for practicing fisheries and marine scientists. The needs analysis was undertaken by e-mail survey to scientists and industry across Australia. The intent of the survey was to provide information on the priority needs for training, preferred modes for training, and the extent of time marine and fisheries science practitioners were prepared to dedicate to participating in fee paying short courses. The information collected will provide input to the design and delivery of short term training packages on relevant demand driven fisheries topics throughout Australia.

This report summarises the approach taken, specifies the questions asked, summarises the results from the email-survey and makes conclusions based on those results and discussions with research and training leaders in the fisheries field.

The outcomes of this work ultimately will be used to assist with planning and implementation of project FRDC 2008/304.

3.0 Survey Approach

A small questionnaire was developed by the Centre for Fish and Fisheries Research focusing on training needs, delivery modes, i.e. covering various time periods (2-10 days) and timing, whether web-based, *in-situ* or in-combination. We also collected information on the respondent metrics covering age, organisation type and State. The full questionnaire is provided in *Appendix 1*.

A total of 25 training topics were assessed and prioritised by respondents according to their individual needs or alternately, the perceived view of

supervisors for their staff. There was also the scope to raise other topics of interest in case the list missed topics of relevance.

As the Centre did not have access to a national mailing list of Fisheries scientists, the survey was designed using Survey Monkey, a web-based product creating, distributing and analysing results within a registered account with Murdoch University. As experience from other surveys has found that response rates can be low, the approach taken towards the survey was multi-faceted, leading in many instances to scientists being approached on up to three occasions to participate in the survey.

Fisheries scientists throughout Australia were contacted by email and asked to volunteer a small period of their time, to complete the survey to identify their in-service training needs. A prize of a carton of Margaret River wine was provided to a respondent who completed the survey, to encourage participation. The prize winner, Dr Adrian Linnane, was randomly selected from the data base from the population of participants in the survey, who revealed an interest in the prize.

Three email approaches were used concurrently to encourage participation. These included

(i) a direct approach to research directors and their chief executive officers, for them to encourage their staff to participate in the survey.

(ii) an invitation, extended by e-mail from the Centre Director, encouraging individuals to complete the survey using a broadcast mail out from an address list held by the Fisheries Research and Development Corporation (FRDC). In this case, due to privacy requirements, the emails were issued by FRDC without exposure of address details to Centre staff.

(iii) a similar e-mail distribution was sent to members of the Australian Marine Science Association to participate in the survey by the Centre Director.

The total population of scientists approached within Australia by the email survey was estimated to be between 5,000 – 6,000 individuals. The Centre had no opportunity to vet the email lists or determine the extent of bounce back (failed email mail outs) or level of multiple emails.

A total response of 238 completed questionnaires was received by the Survey-Monkey survey from principally Fisheries scientists (59.3%) and management (26.2%). This sample size was considered sufficient for the conclusions to be valid, as it was anticipated those having an interest in further training were more likely to complete the survey. This bias was expected to improve the value of the results.

The summary of results for all participants can be found in section 4.0.

Appendix 3 provides a separate result summary for scientists and managers whereas *Appendix 4* provides the data presented by state. *Appendix 5* shows individual comments made by participants on the survey, providing additional insights.

When examining the data, readers are encouraged to look at the absolute number of responses rather than the percentage values due to the way survey monkey calculates percentages across different cell values.

4.0 Summary of Survey Results

Defining training needs for the fisheries sector

1. Basic Courses			
	Yourself	Direct staff requirements	Response Count
Experimental Design	**65.2% (43)**	48.5% (32)	66
Univariate Statistical Analysis	56.3% (27)	**60.4% (29)**	48
Multivariate Analysis	**74.7% (62)**	48.2% (40)	83
Basic Excel data management and analysis	49.0% (25)	**66.7% (34)**	51
Advanced Excel programming	**81.0% (64)**	41.8% (33)	79
Length Composition Analysis	**77.1% (27)**	45.7% (16)	35
Aging techniques and analysis	**66.7% (22)**	63.6% (21)	33
Fish Dietary Studies and understanding food webs and ecosystem function	**70.7% (29)**	53.7% (22)	41
Linking of GIS to data sets and spatial data	**79.8% (87)**	42.2% (46)	109
Reproductive biology and analysis	**58.3% (21)**	50.0% (18)	36
Training in statistical packages (eg.) 'SPSS' & 'R'	**76.0% (73)**	44.8% (43)	96
A basic course in risk assessment	**73.2% (52)**	42.3% (30)	71
		answered question	**212**
		skipped question	**26**

2. Advanced Courses			
	Yourself	Direct staff requirements	Response Count
Gap assessment	**82.1% (23)**	25.0% (7)	28
Development of integrated models of populations	**86.2% (50)**	25.9% (15)	58
Population Viability Assessment	**79.1% (34)**	34.9% (15)	43
Quantitative modelling	**76.4% (55)**	34.7% (25)	72
Catch and effort analysis	**80.0% (56)**	40.0% (28)	70
Specialized modelling and statistical tools	**85.9% (61)**	26.8% (19)	71
Bayesian belief networks	**83.3% (45)**	31.5% (17)	54
Qualitative modelling of ecosystems	**83.5% (66)**	31.6% (25)	79
		answered question	**189**
		skipped question	**49**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	**73.4% (69)**	50.0% (47)	94
Importance of Age,Growth & Reproduction in Fisheries Science	**73.7% (42)**	52.6% (30)	57
Modeling as a tool in fisheries management	**84.0% (84)**	35.0% (35)	100
Basics of economics in fisheries	**82.4% (70)**	41.2% (35)	85
Basics in Fisheries Management	**71.0% (76)**	44.9% (48)	107
		answered question	**171**
		skipped question	**67**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	47
Reason for specific need	**100.0%**	47
Level of course	70.2%	33
Topic 2	34.0%	16
Reason for specific need	31.9%	15
Level of course	23.4%	11
Topic 3	14.9%	7
Reason for specific need	12.8%	6
Level of course	14.9%	7
	answered question	**47**
	skipped question	**191**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	30.0% (65)	**42.4% (92)**	27.6% (60)	217

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**66.0% (142)**	27.0% (58)	7.0% (15)	215

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**63.3% (136)**	3.3% (7)	33.5% (72)	215
			answered question	**218**
			skipped question	**20**

6. Please select your preferences for delivery of advanced topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Web based plus written tutorial & assignment**	**c) Designated 'in-situ' course delivery**	**d) Combined (b) & (c) modes of delivery**	**Response Count**
Advanced Topics	2.0% (4)	11.9% (24)	22.3% (45)	**63.9% (129)**	202
Time Commitment to Topics					
	3 Days	**5 Days**	**10 Days**		**Response Count**
Advanced Topics	37.4% (76)	**44.3% (90)**	18.2% (37)		203
Timing of Delivery					
	Week days only	**Weekends only**	**Mixture week/weekend days**		**Response Count**
Advanced Topics	**60.2% (121)**	2.5% (5)	37.3% (75)		201
				answered question	**203**
				skipped question	**35**

7. Please select your preferences for delivery of general topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Designated 'in-situ' course delivery**	**c) Combined (a) and (b) modes of delivery**		**Response Count**
General Topics	36.6% (71)	13.9% (27)	**49.5% (96)**		194
Time Commitment to Topics					
	1/2 Day	**1 Day**	**2 Days**		**Response Count**
General Topics	14.4% (28)	**46.9% (91)**	38.7% (75)		194
Timing of Delivery					
	Evenings only	**Day only**	**Weekends only**	**Week days only**	**Response Count**
General Topics	11.2% (21)	35.1% (66)	10.1% (19)	**43.6% (82)**	188
For Web Delivery Only					
	At specified times	**Dial up delivery (on demand)**	**Topic (Menu driven)**		**Response Count**
General Topics	13.6% (21)	**44.8% (69)**	41.6% (64)		154
				answered question	**194**
				skipped question	**44**

8. Age

	Response Percent	Response Count
Less than 30	19.5%	43
30-40	**33.0%**	73
40-50	29.9%	66
50+	17.6%	39
answered question		**221**
skipped question		**17**

9. Organisation

	Response Percent	Response Count
State Fisheries agency	**53.8%**	119
Commonwealth Research Agency	8.1%	18
University	18.6%	41
Other	19.5%	43
answered question		**221**
skipped question		**17**

10. Category

	Response Percent	Response Count
Research	**59.3%**	131
Management	26.2%	58
Fisherman	0.5%	1
Other Industry	5.0%	11
Other	9.0%	20
answered question		**221**
skipped question		**17**

11. State

	Response Percent	Response Count
Qld	**22.1%**	48
NSW	12.0%	26
Vic	20.3%	44
SA	11.1%	24
TAS	10.6%	23
NT	3.7%	8
WA	20.3%	44
answered question		**217**

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

	Response Count
	29
answered question	**29**
skipped question	**209**

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

	Response Percent	Response Count
Name:	**100.0%**	155
Email Address:	**100.0%**	155
answered question		**155**
skipped question		**83**

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

	Response Percent	Response Count
Name:	**100.0%**	167
Company:	85.0%	142
Address:	98.2%	164
Address 2:	25.7%	43
City/Town:	98.2%	164
State:	99.4%	166
ZIP/Postal Code:	98.8%	165
Country:	92.8%	155
answered question		**167**
skipped question		**71**

5.0 Discussion of Results

Respondents tended to prioritise three choices in each of the Basic Course, Advanced Course and General Course categories rather than choosing across the three categories. Others selected more than three choices where they had an interest in more than three topics, although this was not a major issue. On average, each respondent made five choices across all three categories. Thus, the absolute numbers need to be carefully interpreted between the grouping of basic course, advanced course and general course topics. However, despite this aberration, the key choices for training in priority order were considered representative and were as follows:

Basic Courses (Summary Results 1)

1) Linking of GIS to data sets and spatial data
2) Training in statistical packages (e.g.) SPSS & 'R'
3) Advanced Excel data management and analysis
4) Multivariate analysis

Advanced Courses (Summary Results 2)

1. Qualitative modelling of ecosystems
2. Specialised modelling and statistical tools
3. Catch and effort analysis
4. Qualitative modelling

General Courses (Summary Results 3)

1. Modelling as a tool in fisheries management
2. Basics in fisheries management
3. Basics of economics in fisheries
4. Basics in understanding stock assessment and resource sharing

Noting how respondents approached the questions based on the needs analyses; the survey suggests the priority course topics for development by the Centre are:

- Linking of GIS to data sets and spatial data analysis
- Training in statistical packages e.g. 'SPSS' & 'R'
- Qualitative modelling of ecosystems

In drawing this conclusion, it was pleasing to note the Centre for Fish and Fisheries at Murdoch University has developed training packages for both Excel (Excel programming for the Biosciences) and multivariate analyses (PRIMER – Multivariate techniques and community ecology) which were identified as priority areas. The survey indicated that it is also worth developing training packages on broader topics of basics in fisheries management, as shorter course options. The choices of managers for staff training, to a substantial extent, agreed with the priority choices for all respondents' across the basic and advanced fields.

The preferred delivery mode for basic topics was web based plus written assignment, over a short period of two days (Results 5). Whereas respondents preferred a combined delivery of web based plus written tutorial and assignment, accompanied by *in-situ* delivery for advanced topics for a longer period of five days (Results 6). General educational topics were more generally sought over a one or two day period, to be web based with desirably '*in-situ*' delivery (Results 7).

The majority of respondents were not interested in weekend delivery with a strong preference for normal work day course delivery. This desire for flexibility in the delivery of short courses '*in-situ*', supported prior views expressed by longer term trainers in the fisheries science field.

6.0 The Implications of Survey Outcomes for the Training Project FRDC

From a business view point, the majority of the market for in-service training for busy people, namely practicing fisheries scientists, managers and industry respondents, with existing workloads, could be quite restrictive as attendees possibly will not be able to attend lengthy training sessions. Five day modules or shorter periods of training appear to be the preferred pathway, with courses delivered *in-situ*.

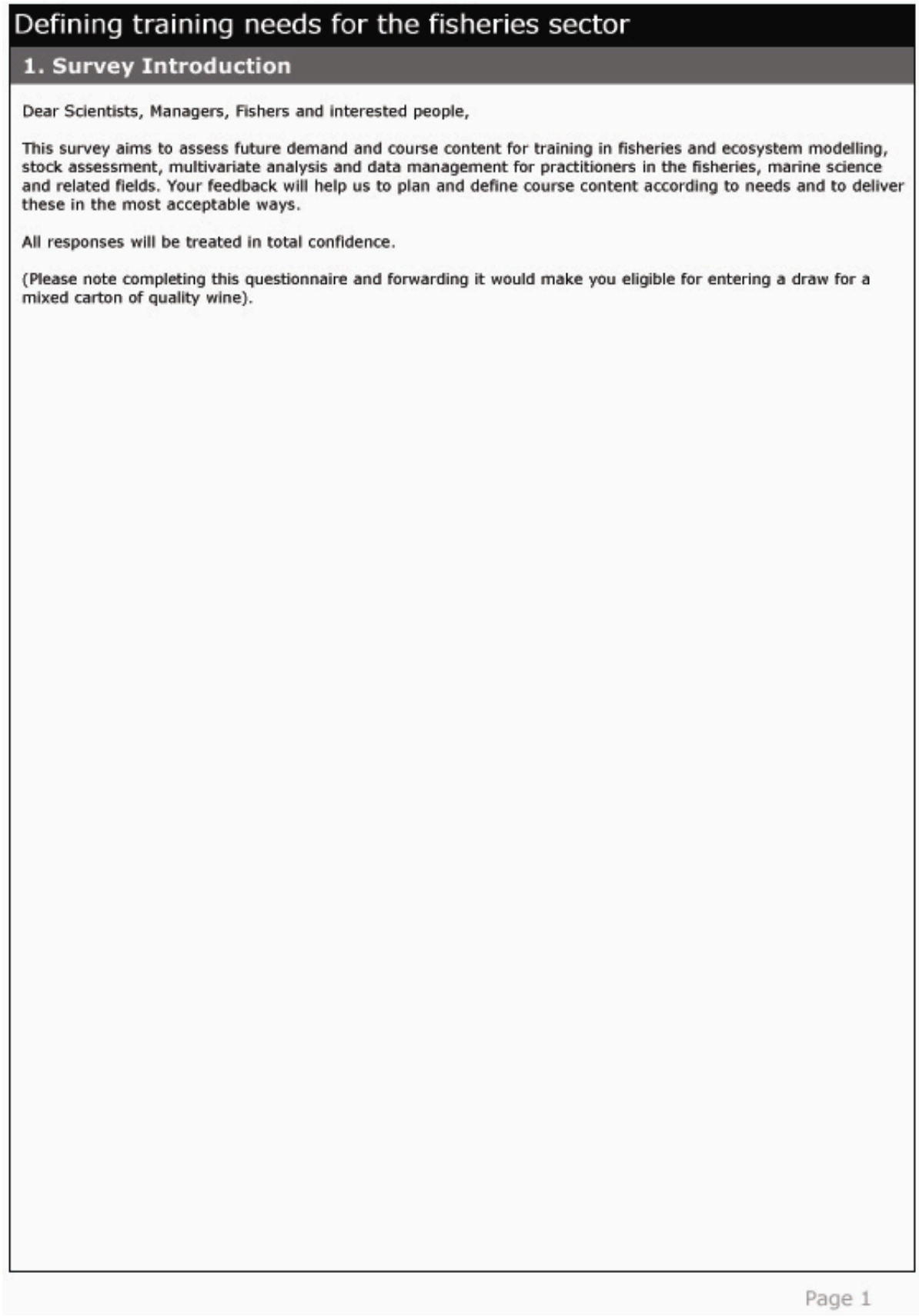
In considering Murdoch University's location on the western side of the Australian continent, relative to a large market on the east coast, success in this program for an eventual self-funded training facility for fisheries depends on a number of strategies. Training needs to meet the following criteria:

- Advanced 'training' needs to be delivered in modules of not more than five days.
- Ideally training should be delivered on a capital city basis in a host organisation that is prepared to allow others external to the host organisation, to be in attendance.
- To be multiple faceted in its delivery covering web based, *in-situ* training along with externally managed tutorials as relevant.
- To the extent practical, the project leader will need to embrace existing 'high end' specialised training capacity (eg: UTAS, CSIRO, NSW DPIF) within Australia to facilitate broader delivery and success of the project and the longer term training goal.
- Experience from the Centre's short course training programs for fisheries and those of existing 'high end' fisheries marine trainers was that *in-situ* training not only facilitated better understanding of the topics, the participants also learnt many aspects of computational skills and personal experience knowledge from face to face engagement with the trainer. For this reason, web based delivery on its own is likely to be less effective.
- Training needs to be delivered *in-situ* especially given the cost of travel and accommodation, reducing the fee charged for training delivery, particularly for major customers.
- To reduce training costs *in-situ* on a capital city only basis, several topics to be offered covering a range of hosts and needs, requires a very flexible business approach for delivery. This has implications for administration, the use of external support tutors and delivery arrangements and formal accreditation. This shift in direction needs to be accommodated within the FRDC project approval. The present arrangements and business case has been built on a series of 10 day training modules which will now need to be modified for more effective delivery.
- The business approach adopted by the Centre for Fish and Fisheries Research in the promotion of courses, their approval and delivery, setting of fees and collection of revenue under a more

'flexible' mode of short course training will be fundamental to the success of the longer term outcome of the FRDC project 2008/304. A flexible approach to administration of short courses will be as equally important to success of the program as the delivery and development of courses.

- Formal accreditation of course work under a University training program will significantly reduce flexibility and timeliness of delivery. Desirably, the emphasis should be on meeting short term training needs of respondents without accreditation as formal units in the broader University training program.

Appendix 1 - Questionnaire Survey



Defining training needs for the fisheries sector

1. Survey Introduction

Dear Scientists, Managers, Fishers and interested people,

This survey aims to assess future demand and course content for training in fisheries and ecosystem modelling, stock assessment, multivariate analysis and data management for practitioners in the fisheries, marine science and related fields. Your feedback will help us to plan and define course content according to needs and to deliver these in the most acceptable ways.

All responses will be treated in total confidence.

(Please note completing this questionnaire and forwarding it would make you eligible for entering a draw for a mixed carton of quality wine).

Page 1

Defining training needs for the fisheries sector

2. Training needs

The questions on this page are designed to identify priority training needs for yourself and any staff directly responsible to you. Please identify your top choices of training from the list by checking a maximum of three boxes in total from this page across the basic, advanced and general categories.

In the event you have staff who are directly responsible to you, under "direct staff requirements", select from the list the training priorities for those staff by checking a maximum of three boxes from this page across the basic, general and advanced categories.

If you would like to identify some additional topics of short course training of interest to you or your organisation please do so in the text boxes provided at the bottom of this page.

Basic Courses

	Yourself	Direct staff requirements
Experimental Design	☐	☐
Univariate Statistical Analysis	☐	☐
Multivariate Analysis	☐	☐
Basic Excel data management and analysis	☐	☐
Advanced Excel programming	☐	☐
Length Composition Analysis	☐	☐
Aging techniques and analysis	☐	☐
Fish Dietary Studies and understanding food webs and ecosystem function	☐	☐
Linking of GIS to data sets and spatial data	☐	☐
Reproductive biology and analysis	☐	☐
Training in statistical packages (eg.) 'SPSS' & 'R'	☐	☐
A basic course in risk assessment	☐	☐

Advanced Courses

	Yourself	Direct staff requirements
Gap assessment	☐	☐
Development of integrated models of populations	☐	☐
Population Viability Assessment	☐	☐
Quantitative modelling	☐	☐
Catch and effort analysis	☐	☐
Specialized modelling and statistical tools	☐	☐
Bayesian belief networks	☐	☐
Qualitative modelling of ecosystems	☐	☐

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Defining training needs for the fisheries sector

General Courses

	Yourself	Direct staff requirements
Basics in understanding Stock Assessment & Resource sharing	☐	☐
Importance of Age,Growth & Reproduction in Fisheries Science	☐	☐
Modeling as a tool in fisheries management	☐	☐
Basics of economics in fisheries	☐	☐
Basics in Fisheries Management	☐	☐

Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

Topic 1	
Reason for specific need	
Level of course	
Topic 2	
Reason for specific need	
Level of course	
Topic 3	
Reason for specific need	
Level of course	

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Defining training needs for the fisheries sector

3. Delivery Modes

Each of these topics can be delivered in a number of ways, by course presentation at Murdoch University, through web based delivery, a combination of web delivery and course work, supported by tutorial at Murdoch University or interstate. It is likely that the basic and general topics could be delivered solely as a web based product or through direct course attendances.

The advanced topics would require a least some time as direct lectures and tutorials and are therefore likely to be more expensive than the basic topics with delivery being dependent on at least a minimum number attending due to costs.

To assist planning please indicate your preference for delivery mode and time commitment to attend.

Please indicate your preferences for delivery of basic topics from the drop down menus

	Preferred Delivery Mode	Time Commitment to Topics	Timing of Delivery
Basic Topics			

Please select your preferences for delivery of advanced topics from the drop down menus

	Preferred Delivery Mode	Time Commitment to Topics	Timing of Delivery
Advanced Topics			

Please select your preferences for delivery of general topics from the drop down menus

	Preferred Delivery Mode	Time Commitment to Topics	Timing of Delivery	For Web Delivery Only
General Topics				

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Defining training needs for the fisheries sector

4. Metrics

Please provide us with the following information about you:

Age

- ◯ Less than 30
- ◯ 30-40
- ◯ 40-50
- ◯ 50+

Organisation

- ◯ State Fisheries agency
- ◯ Commonwealth Research Agency
- ◯ University
- ◯ Other

Category

- ◯ Research
- ◯ Management
- ◯ Fisherman
- ◯ Other Industry
- ◯ Other

State

- ◯ Qld
- ◯ NSW
- ◯ Vic
- ◯ SA
- ◯ TAS
- ◯ NT
- ◯ WA

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Defining training needs for the fisheries sector

5. Further Information

Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

Name:

Email Address:

If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

Name:

Company:

Address:

Address 2:

City/Town:

State:

ZIP/Postal Code:

Country:

To check for the winner of the wine, the result will be posted on the Centre for Fish and Fisheries Research website (http://www.cffr.murdoch.edu.au/)on the 30th September 2008

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Appendix 2 – Summary of Scientists' Responses

Defining training needs for the fisheries sector

1. Basic Courses	Yourself	Direct staff requirements	Response Count
Experimental Design	56.5% (26)	**60.9% (28)**	46
Univariate Statistical Analysis	51.4% (19)	**64.9% (24)**	37
Multivariate Analysis	**74.6% (47)**	49.2% (31)	63
Basic Excel data management and analysis	45.5% (10)	**77.3% (17)**	22
Advanced Excel programming	**77.3% (34)**	45.5% (20)	44
Length Composition Analysis	**82.6% (19)**	52.2% (12)	23
Aging techniques and analysis	**72.7% (16)**	68.2% (15)	22
Fish Dietary Studies and understanding food webs and ecosystem function	**79.2% (19)**	54.2% (13)	24
Linking of GIS to data sets and spatial data	**77.8% (49)**	47.6% (30)	63
Reproductive biology and analysis	55.0% (11)	**60.0% (12)**	20
Training in statistical packages (eg.) 'SPSS' & 'R'	**75.4% (52)**	52.2% (36)	69
A basic course in risk assessment	**70.4% (19)**	33.3% (9)	27
		answered question	**125**
		skipped question	**6**

2. Advanced Courses	Yourself	Direct staff requirements	Response Count
Gap assessment	**62.5% (5)**	50.0% (4)	8
Development of integrated models of populations	**92.1% (35)**	26.3% (10)	38
Population Viability Assessment	**84.0% (21)**	40.0% (10)	25
Quantitative modelling	**72.9% (35)**	43.8% (21)	48
Catch and effort analysis	**87.9% (29)**	42.4% (14)	33
Specialized modelling and statistical tools	**87.7% (50)**	28.1% (16)	57
Bayesian belief networks	**85.4% (35)**	34.1% (14)	41
Qualitative modelling of ecosystems	**88.2% (45)**	31.4% (16)	51
		answered question	**110**
		skipped question	**21**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	**71.4% (30)**	52.4% (22)	42
Importance of Age,Growth & Reproduction in Fisheries Science	**74.1% (20)**	59.3% (16)	27
Modeling as a tool in fisheries management	**86.7% (39)**	40.0% (18)	45
Basics of economics in fisheries	**87.5% (28)**	40.6% (13)	32
Basics in Fisheries Management	**67.4% (29)**	48.8% (21)	43
		answered question	**79**
		skipped question	**52**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	27
Reason for specific need	**100.0%**	27
Level of course	77.8%	21
Topic 2	37.0%	10
Reason for specific need	33.3%	9
Level of course	29.6%	8
Topic 3	18.5%	5
Reason for specific need	18.5%	5
Level of course	18.5%	5
	answered question	**27**
	skipped question	**104**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	24.4% (31)	**42.5% (54)**	33.1% (42)	127

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**63.8% (81)**	28.3% (36)	7.9% (10)	127

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**64.6% (82)**	3.9% (5)	31.5% (40)	127
			answered question	**127**
			skipped question	**4**

6. Please select your preferences for delivery of advanced topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Web based plus written tutorial & assignment**	**c) Designated 'in-situ' course delivery**	**d) Combined (b) & (c) modes of delivery**	**Response Count**
Advanced Topics	2.5% (3)	14.9% (18)	16.5% (20)	**66.1% (80)**	121
Time Commitment to Topics					
	3 Days	**5 Days**	**10 Days**		**Response Count**
Advanced Topics	38.5% (47)	**41.8% (51)**	19.7% (24)		122
Timing of Delivery					
	Week days only	**Weekends only**	**Mixture week/weekend days**		**Response Count**
Advanced Topics	**55.4% (67)**	3.3% (4)	41.3% (50)		121
				answered question	**122**
				skipped question	**9**

7. Please select your preferences for delivery of general topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Designated 'in-situ' course delivery**	**c) Combined (a) and (b) modes of delivery**		**Response Count**
General Topics	38.2% (42)	14.5% (16)	**47.3% (52)**		110
Time Commitment to Topics					
	1/2 Day	**1 Day**	**2 Days**		**Response Count**
General Topics	13.6% (15)	**48.2% (53)**	38.2% (42)		110
Timing of Delivery					
	Evenings only	**Day only**	**Weekends only**	**Week days only**	**Response Count**
General Topics	14.0% (15)	**40.2% (43)**	11.2% (12)	34.6% (37)	107
For Web Delivery Only					
	At specified times	**Dial up delivery (on demand)**	**Topic (Menu driven)**		**Response Count**
General Topics	11.4% (10)	**47.7% (42)**	40.9% (36)		88
				answered question	**110**
				skipped question	**21**

8. Age

	Response Percent	Response Count
Less than 30	15.3%	20
30-40	**35.1%**	46
40-50	32.1%	42
50+	17.6%	23
answered question		**131**
skipped question		**0**

9. Organisation

	Response Percent	Response Count
State Fisheries agency	**48.9%**	64
Commonwealth Research Agency	13.0%	17
University	30.5%	40
Other	7.6%	10
answered question		**131**
skipped question		**0**

10. Category

	Response Percent	Response Count
Research	**100.0%**	131
Management	0.0%	0
Fisherman	0.0%	0
Other Industry	0.0%	0
Other	0.0%	0
answered question		**131**
skipped question		**0**

11. State

	Response Percent	Response Count
Qld	**23.3%**	30
NSW	13.2%	17
Vic	16.3%	21
SA	11.6%	15
TAS	8.5%	11
NT	4.7%	6
WA	22.5%	29
answered question		**129**

	skipped question	**2**

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

		Response Count
		13
	answered question	**13**
	skipped question	**118**

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

		Response Percent	Response Count
Name:		**100.0%**	90
Email Address:		**100.0%**	90
	answered question		**90**
	skipped question		**41**

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

		Response Percent	Response Count
Name:		**100.0%**	98
Company:		83.7%	82
Address:		99.0%	97
Address 2:		23.5%	23
City/Town:		98.0%	96
State:		99.0%	97
ZIP/Postal Code:		98.0%	96
Country:		90.8%	89
	answered question		**98**
	skipped question		**33**

Appendix 3 – Summary of Managers' responses

Defining training needs for the fisheries sector

1. Basic Courses			
	Yourself	Direct staff requirements	Response Count
Experimental Design	**71.4% (5)**	42.9% (3)	7
Univariate Statistical Analysis	**66.7% (2)**	**66.7% (2)**	3
Multivariate Analysis	**57.1% (4)**	**57.1% (4)**	7
Basic Excel data management and analysis	**61.1% (11)**	50.0% (9)	18
Advanced Excel programming	**89.5% (17)**	31.6% (6)	19
Length Composition Analysis	**50.0% (3)**	**50.0% (3)**	6
Aging techniques and analysis	**75.0% (3)**	25.0% (1)	4
Fish Dietary Studies and understanding food webs and ecosystem function	**75.0% (6)**	50.0% (4)	8
Linking of GIS to data sets and spatial data	**84.0% (21)**	44.0% (11)	25
Reproductive biology and analysis	**66.7% (4)**	33.3% (2)	6
Training in statistical packages (eg.) 'SPSS' & 'R'	**77.8% (7)**	33.3% (3)	9
A basic course in risk assessment	**68.0% (17)**	56.0% (14)	25
		answered question	**46**
		skipped question	**12**

2. Advanced Courses			
	Yourself	Direct staff requirements	Response Count
Gap assessment	**90.0% (9)**	20.0% (2)	10
Development of integrated models of populations	**66.7% (4)**	33.3% (2)	6
Population Viability Assessment	**50.0% (3)**	**50.0% (3)**	6
Quantitative modelling	**87.5% (7)**	12.5% (1)	8
Catch and effort analysis	**65.2% (15)**	47.8% (11)	23
Specialized modelling and statistical tools	**75.0% (3)**	25.0% (1)	4
Bayesian belief networks	**83.3% (5)**	16.7% (1)	6
Qualitative modelling of ecosystems	**69.2% (9)**	46.2% (6)	13
		answered question	**43**
		skipped question	**15**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	**65.5% (19)**	62.1% (18)	29
Importance of Age,Growth & Reproduction in Fisheries Science	**66.7% (10)**	46.7% (7)	15
Modeling as a tool in fisheries management	**82.4% (28)**	29.4% (10)	34
Basics of economics in fisheries	**76.5% (26)**	47.1% (16)	34
Basics in Fisheries Management	**64.9% (24)**	51.4% (19)	37
		answered question	**53**
		skipped question	**5**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	15
Reason for specific need	**100.0%**	15
Level of course	73.3%	11
Topic 2	20.0%	3
Reason for specific need	20.0%	3
Level of course	20.0%	3
Topic 3	6.7%	1
Reason for specific need	6.7%	1
Level of course	6.7%	1
	answered question	**15**
	skipped question	**43**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	38.6% (22)	**40.4% (23)**	21.1% (12)	57

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**67.9% (38)**	25.0% (14)	7.1% (4)	56

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**63.2% (36)**	1.8% (1)	35.1% (20)	57
			answered question	**58**
			skipped question	**0**

6. Please select your preferences for delivery of advanced topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Web based plus written tutorial & assignment**	**c) Designated 'in-situ' course delivery**	**d) Combined (b) & (c) modes of delivery**	**Response Count**
Advanced Topics	1.9% (1)	5.7% (3)	30.2% (16)	**62.3% (33)**	53
Time Commitment to Topics					
	3 Days	**5 Days**		**10 Days**	**Response Count**
Advanced Topics	**43.4% (23)**	**43.4% (23)**		13.2% (7)	53
Timing of Delivery					
	Week days only	**Weekends only**		**Mixture week/weekend days**	**Response Count**
Advanced Topics	**75.5% (40)**	1.9% (1)		22.6% (12)	53
				answered question	**53**
				skipped question	**5**

7. Please select your preferences for delivery of general topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Designated 'in-situ' course delivery**		**c) Combined (a) and (b) modes of delivery**	**Response Count**
General Topics	35.8% (19)	13.2% (7)		**50.9% (27)**	53
Time Commitment to Topics					
	1/2 Day	**1 Day**		**2 Days**	**Response Count**
General Topics	15.1% (8)	35.8% (19)		**49.1% (26)**	53
Timing of Delivery					
	Evenings only	**Day only**	**Weekends only**	**Week days only**	**Response Count**
General Topics	7.8% (4)	25.5% (13)	7.8% (4)	**58.8% (30)**	51
For Web Delivery Only					
	At specified times	**Dial up delivery (on demand)**		**Topic (Menu driven)**	**Response Count**
General Topics	15.0% (6)	32.5% (13)		**52.5% (21)**	40
				answered question	**53**
				skipped question	**5**

8. Age

	Response Percent	Response Count
Less than 30	19.0%	11
30-40	32.8%	19
40-50	**34.5%**	20
50+	13.8%	8
answered question		**58**
skipped question		**0**

9. Organisation

	Response Percent	Response Count
State Fisheries agency	**79.3%**	46
Commonwealth Research Agency	1.7%	1
University	0.0%	0
Other	19.0%	11
answered question		**58**
skipped question		**0**

10. Category

	Response Percent	Response Count
Research	0.0%	0
Management	**100.0%**	58
Fisherman	0.0%	0
Other Industry	0.0%	0
Other	0.0%	0
answered question		**58**
skipped question		**0**

11. State

	Response Percent	Response Count
Qld	25.0%	14
NSW	7.1%	4
Vic	**30.4%**	17
SA	8.9%	5
TAS	10.7%	6
NT	1.8%	1
WA	16.1%	9
answered question		**56**

	skipped question	2

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

		Response Count
		12
	answered question	12
	skipped question	46

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

		Response Percent	Response Count
Name:		**100.0%**	40
Email Address:		**100.0%**	40
	answered question		**40**
	skipped question		**18**

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

		Response Percent	Response Count
Name:		**100.0%**	45
Company:		91.1%	41
Address:		95.6%	43
Address 2:		37.8%	17
City/Town:		97.8%	44
State:		**100.0%**	45
ZIP/Postal Code:		**100.0%**	45
Country:		97.8%	44
	answered question		**45**
	skipped question		**13**

Appendix 4 – Summary of Responses by States

4.1 NEW SOUTH WALES

Defining training needs for the fisheries sector

1. Basic Courses

	Yourself	Direct staff requirements	Response Count
Experimental Design	50.0% (4)	**62.5% (5)**	8
Univariate Statistical Analysis	**66.7% (6)**	44.4% (4)	9
Multivariate Analysis	**81.8% (9)**	45.5% (5)	11
Basic Excel data management and analysis	50.0% (2)	**75.0% (3)**	4
Advanced Excel programming	**75.0% (3)**	50.0% (2)	4
Length Composition Analysis	**80.0% (4)**	40.0% (2)	5
Aging techniques and analysis	**50.0% (2)**	**50.0% (2)**	4
Fish Dietary Studies and understanding food webs and ecosystem function	**71.4% (5)**	42.9% (3)	7
Linking of GIS to data sets and spatial data	**84.6% (11)**	46.2% (6)	13
Reproductive biology and analysis	**50.0% (3)**	**50.0% (3)**	6
Training in statistical packages (eg.) 'SPSS' & 'R'	**80.0% (8)**	50.0% (5)	10
A basic course in risk assessment	**57.1% (4)**	**57.1% (4)**	7
		answered question	**22**
		skipped question	**4**

2. Advanced Courses

	Yourself	Direct staff requirements	Response Count
Gap assessment	**80.0% (4)**	20.0% (1)	5
Development of integrated models of populations	**100.0% (8)**	12.5% (1)	8
Population Viability Assessment	**80.0% (8)**	20.0% (2)	10
Quantitative modelling	**85.7% (6)**	14.3% (1)	7
Catch and effort analysis	**100.0% (6)**	0.0% (0)	6
Specialized modelling and statistical tools	**100.0% (8)**	25.0% (2)	8
Bayesian belief networks	**85.7% (6)**	28.6% (2)	7
Qualitative modelling of ecosystems	**77.8% (7)**	33.3% (3)	9
		answered question	**23**
		skipped question	**3**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	**84.6% (11)**	38.5% (5)	13
Importance of Age,Growth & Reproduction in Fisheries Science	40.0% (2)	**60.0% (3)**	5
Modeling as a tool in fisheries management	**71.4% (5)**	28.6% (2)	7
Basics of economics in fisheries	**91.7% (11)**	33.3% (4)	12
Basics in Fisheries Management	**57.1% (8)**	42.9% (6)	14
		answered question	**21**
		skipped question	**5**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	7
Reason for specific need	**100.0%**	7
Level of course	57.1%	4
Topic 2	28.6%	2
Reason for specific need	28.6%	2
Level of course	28.6%	2
Topic 3	14.3%	1
Reason for specific need	14.3%	1
Level of course	14.3%	1
	answered question	**7**
	skipped question	**19**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	40.0% (10)	**48.0% (12)**	12.0% (3)	25

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**76.0% (19)**	12.0% (3)	12.0% (3)	25

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**45.8% (11)**	8.3% (2)	**45.8% (11)**	24
			answered question	**25**
			skipped question	**1**

6. Please select your preferences for delivery of advanced topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	d) Combined (b) & (c) modes of delivery	Response Count
Advanced Topics	4.0% (1)	16.0% (4)	32.0% (8)	**48.0% (12)**	25

Time Commitment to Topics

	3 Days	5 Days	10 Days	Response Count
Advanced Topics	32.0% (8)	**60.0% (15)**	8.0% (2)	25

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Advanced Topics	45.8% (11)	0.0% (0)	**54.2% (13)**	24
			answered question	**25**
			skipped question	**1**

7. Please select your preferences for delivery of general topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Designated 'in-situ' course delivery	c) Combined (a) and (b) modes of delivery	Response Count
General Topics	41.7% (10)	0.0% (0)	**58.3% (14)**	24

Time Commitment to Topics

	1/2 Day	1 Day	2 Days	Response Count
General Topics	12.5% (3)	**66.7% (16)**	20.8% (5)	24

Timing of Delivery

	Evenings only	Day only	Weekends only	Week days only	Response Count
General Topics	21.7% (5)	26.1% (6)	17.4% (4)	**34.8% (8)**	23

For Web Delivery Only

	At specified times	Dial up delivery (on demand)	Topic (Menu driven)	Response Count
General Topics	18.2% (4)	**59.1% (13)**	22.7% (5)	22
			answered question	**24**
			skipped question	**2**

8. Age

	Response Percent	Response Count
Less than 30	30.8%	8
30-40	19.2%	5
40-50	**34.6%**	9
50+	15.4%	4
answered question		**26**
skipped question		**0**

9. Organisation

	Response Percent	Response Count
State Fisheries agency	30.8%	8
Commonwealth Research Agency	0.0%	0
University	**42.3%**	11
Other	26.9%	7
answered question		**26**
skipped question		**0**

10. Category

	Response Percent	Response Count
Research	**65.4%**	17
Management	15.4%	4
Fisherman	3.8%	1
Other Industry	7.7%	2
Other	7.7%	2
answered question		**26**
skipped question		**0**

11. State

	Response Percent	Response Count
Qld	0.0%	0
NSW	**100.0%**	26
Vic	0.0%	0
SA	0.0%	0
TAS	0.0%	0
NT	0.0%	0
WA	0.0%	0
answered question		**26**

skipped question	0

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

	Response Count
	3
answered question	3
skipped question	23

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

	Response Percent	Response Count
Name:	100.0%	14
Email Address:	100.0%	14
answered question		14
skipped question		12

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

	Response Percent	Response Count
Name:	100.0%	16
Company:	81.3%	13
Address:	100.0%	16
Address 2:	25.0%	4
City/Town:	93.8%	15
State:	100.0%	16
ZIP/Postal Code:	100.0%	16
Country:	100.0%	16
answered question		16
skipped question		10

4.2 NORTHERN TERRITORY

Defining training needs for the fisheries sector

1. Basic Courses			
	Yourself	Direct staff requirements	Response Count
Experimental Design	**100.0% (1)**	0.0% (0)	1
Univariate Statistical Analysis	**100.0% (1)**	0.0% (0)	1
Multivariate Analysis	**100.0% (1)**	0.0% (0)	1
Basic Excel data management and analysis	**100.0% (1)**	0.0% (0)	1
Advanced Excel programming	**66.7% (2)**	**66.7% (2)**	3
Length Composition Analysis	**100.0% (2)**	50.0% (1)	2
Aging techniques and analysis	**100.0% (1)**	**100.0% (1)**	1
Fish Dietary Studies and understanding food webs and ecosystem function	**100.0% (3)**	33.3% (1)	3
Linking of GIS to data sets and spatial data	**80.0% (4)**	40.0% (2)	5
Reproductive biology and analysis	**100.0% (1)**	0.0% (0)	1
Training in statistical packages (eg.) 'SPSS' & 'R'	**100.0% (3)**	33.3% (1)	3
A basic course in risk assessment	**100.0% (1)**	**100.0% (1)**	1
		answered question	**8**
		skipped question	**0**

2. Advanced Courses			
	Yourself	Direct staff requirements	Response Count
Gap assessment	**100.0% (1)**	**100.0% (1)**	1
Development of integrated models of populations	**100.0% (5)**	20.0% (1)	5
Population Viability Assessment	**100.0% (1)**	**100.0% (1)**	1
Quantitative modelling	**75.0% (3)**	50.0% (2)	4
Catch and effort analysis	**100.0% (1)**	**100.0% (1)**	1
Specialized modelling and statistical tools	**100.0% (1)**	**100.0% (1)**	1
Bayesian belief networks	**80.0% (4)**	40.0% (2)	5
Qualitative modelling of ecosystems	**100.0% (2)**	50.0% (1)	2
		answered question	**6**
		skipped question	**2**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	**100.0% (4)**	75.0% (3)	4
Importance of Age,Growth & Reproduction in Fisheries Science	**100.0% (3)**	66.7% (2)	3
Modeling as a tool in fisheries management	**100.0% (5)**	40.0% (2)	5
Basics of economics in fisheries	**100.0% (3)**	66.7% (2)	3
Basics in Fisheries Management	**100.0% (4)**	50.0% (2)	4
		answered question	**5**
		skipped question	**3**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	2
Reason for specific need	**100.0%**	2
Level of course	50.0%	1
Topic 2	**100.0%**	2
Reason for specific need	**100.0%**	2
Level of course	50.0%	1
Topic 3	50.0%	1
Reason for specific need	50.0%	1
Level of course	50.0%	1
	answered question	**2**
	skipped question	**6**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	25.0% (2)	**37.5% (3)**	**37.5% (3)**	8

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**50.0% (4)**	37.5% (3)	12.5% (1)	8

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**62.5% (5)**	0.0% (0)	37.5% (3)	8
			answered question	**8**
			skipped question	**0**

6. Please select your preferences for delivery of advanced topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Web based plus written tutorial & assignment**	**c) Designated 'in-situ' course delivery**	**d) Combined (b) & (c) modes of delivery**	**Response Count**
Advanced Topics	0.0% (0)	**42.9% (3)**	14.3% (1)	**42.9% (3)**	7
Time Commitment to Topics					
	3 Days	**5 Days**	**10 Days**		**Response Count**
Advanced Topics	28.6% (2)	**57.1% (4)**	14.3% (1)		7
Timing of Delivery					
	Week days only	**Weekends only**	**Mixture week/weekend days**		**Response Count**
Advanced Topics	**71.4% (5)**	0.0% (0)	28.6% (2)		7
			answered question		**7**
			skipped question		**1**

7. Please select your preferences for delivery of general topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Designated 'in-situ' course delivery**	**c) Combined (a) and (b) modes of delivery**		**Response Count**
General Topics	**50.0% (4)**	0.0% (0)	**50.0% (4)**		8
Time Commitment to Topics					
	1/2 Day	**1 Day**	**2 Days**		**Response Count**
General Topics	25.0% (2)	25.0% (2)	**50.0% (4)**		8
Timing of Delivery					
	Evenings only	**Day only**	**Weekends only**	**Week days only**	**Response Count**
General Topics	25.0% (2)	25.0% (2)	12.5% (1)	**37.5% (3)**	8
For Web Delivery Only					
	At specified times	**Dial up delivery (on demand)**	**Topic (Menu driven)**		**Response Count**
General Topics	0.0% (0)	**60.0% (3)**	40.0% (2)		5
				answered question	**8**
				skipped question	**0**

8. Age

	Response Percent	Response Count
Less than 30	12.5%	1
30-40	**50.0%**	4
40-50	12.5%	1
50+	25.0%	2
answered question		8
skipped question		0

9. Organisation

	Response Percent	Response Count
State Fisheries agency	**62.5%**	5
Commonwealth Research Agency	0.0%	0
University	12.5%	1
Other	25.0%	2
answered question		8
skipped question		0

10. Category

	Response Percent	Response Count
Research	**75.0%**	6
Management	12.5%	1
Fisherman	0.0%	0
Other Industry	12.5%	1
Other	0.0%	0
answered question		8
skipped question		0

11. State

	Response Percent	Response Count
Qld	0.0%	0
NSW	0.0%	0
Vic	0.0%	0
SA	0.0%	0
TAS	0.0%	0
NT	**100.0%**	8
WA	0.0%	0
answered question		8

	skipped question	0

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

		Response Count
		1
	answered question	1
	skipped question	7

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

		Response Percent	Response Count
Name:		100.0%	5
Email Address:		100.0%	5
	answered question		5
	skipped question		3

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

		Response Percent	Response Count
Name:		100.0%	5
Company:		80.0%	4
Address:		100.0%	5
Address 2:		20.0%	1
City/Town:		100.0%	5
State:		100.0%	5
ZIP/Postal Code:		100.0%	5
Country:		100.0%	5
	answered question		5
	skipped question		3

4.3 QUEENSLAND

Defining training needs for the fisheries sector

1. Basic Courses			
	Yourself	Direct staff requirements	Response Count
Experimental Design	**83.3% (10)**	33.3% (4)	12
Univariate Statistical Analysis	57.1% (4)	**71.4% (5)**	7
Multivariate Analysis	**70.6% (12)**	41.2% (7)	17
Basic Excel data management and analysis	41.7% (5)	**66.7% (8)**	12
Advanced Excel programming	**82.4% (14)**	35.3% (6)	17
Length Composition Analysis	**81.8% (9)**	36.4% (4)	11
Aging techniques and analysis	**85.7% (6)**	57.1% (4)	7
Fish Dietary Studies and understanding food webs and ecosystem function	60.0% (3)	**80.0% (4)**	5
Linking of GIS to data sets and spatial data	**73.7% (14)**	36.8% (7)	19
Reproductive biology and analysis	**71.4% (5)**	57.1% (4)	7
Training in statistical packages (eg.) 'SPSS' & 'R'	**89.5% (17)**	36.8% (7)	19
A basic course in risk assessment	**83.3% (10)**	33.3% (4)	12
		answered question	**43**
		skipped question	**5**

2. Advanced Courses			
	Yourself	Direct staff requirements	Response Count
Gap assessment	**100.0% (2)**	0.0% (0)	2
Development of integrated models of populations	**92.3% (12)**	23.1% (3)	13
Population Viability Assessment	**88.9% (8)**	44.4% (4)	9
Quantitative modelling	**86.7% (13)**	26.7% (4)	15
Catch and effort analysis	**72.2% (13)**	44.4% (8)	18
Specialized modelling and statistical tools	**95.2% (20)**	14.3% (3)	21
Bayesian belief networks	**92.3% (12)**	23.1% (3)	13
Qualitative modelling of ecosystems	**84.2% (16)**	31.6% (6)	19
		answered question	**41**
		skipped question	**7**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	**77.3% (17)**	45.5% (10)	22
Importance of Age,Growth & Reproduction in Fisheries Science	**81.8% (9)**	54.5% (6)	11
Modeling as a tool in fisheries management	**96.0% (24)**	24.0% (6)	25
Basics of economics in fisheries	**90.9% (20)**	31.8% (7)	22
Basics in Fisheries Management	**73.9% (17)**	34.8% (8)	23
		answered question	**41**
		skipped question	**7**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	14
Reason for specific need	**100.0%**	14
Level of course	78.6%	11
Topic 2	21.4%	3
Reason for specific need	21.4%	3
Level of course	14.3%	2
Topic 3	7.1%	1
Reason for specific need	7.1%	1
Level of course	7.1%	1
answered question		**14**
skipped question		**34**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	34.0% (16)	**42.6% (20)**	23.4% (11)	47

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**60.9% (28)**	34.8% (16)	4.3% (2)	46

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**60.9% (28)**	4.3% (2)	34.8% (16)	46
			answered question	**47**
			skipped question	**1**

6. Please select your preferences for delivery of advanced topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	d) Combined (b) & (c) modes of delivery	Response Count
Advanced Topics	0.0% (0)	8.7% (4)	15.2% (7)	**76.1% (35)**	46

Time Commitment to Topics

	3 Days	5 Days	10 Days	Response Count
Advanced Topics	30.4% (14)	**43.5% (20)**	26.1% (12)	46

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Advanced Topics	**63.0% (29)**	4.3% (2)	32.6% (15)	46
			answered question	**46**
			skipped question	**2**

7. Please select your preferences for delivery of general topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Designated 'in-situ' course delivery	c) Combined (a) and (b) modes of delivery	Response Count
General Topics	**42.2% (19)**	20.0% (9)	37.8% (17)	45

Time Commitment to Topics

	1/2 Day	1 Day	2 Days	Response Count
General Topics	20.0% (9)	**44.4% (20)**	35.6% (16)	45

Timing of Delivery

	Evenings only	Day only	Weekends only	Week days only	Response Count
General Topics	11.1% (5)	**40.0% (18)**	13.3% (6)	35.6% (16)	45

For Web Delivery Only

	At specified times	Dial up delivery (on demand)	Topic (Menu driven)	Response Count
General Topics	14.7% (5)	41.2% (14)	**44.1% (15)**	34
			answered question	**45**
			skipped question	**3**

8. Age

	Response Percent	Response Count
Less than 30	20.8%	10
30-40	**35.4%**	17
40-50	31.3%	15
50+	12.5%	6
answered question		**48**
skipped question		**0**

9. Organisation

	Response Percent	Response Count
State Fisheries agency	**60.4%**	29
Commonwealth Research Agency	10.4%	5
University	14.6%	7
Other	14.6%	7
answered question		**48**
skipped question		**0**

10. Category

	Response Percent	Response Count
Research	**62.5%**	30
Management	29.2%	14
Fisherman	0.0%	0
Other Industry	2.1%	1
Other	6.3%	3
answered question		**48**
skipped question		**0**

11. State

	Response Percent	Response Count
Qld	**100.0%**	48
NSW	0.0%	0
Vic	0.0%	0
SA	0.0%	0
TAS	0.0%	0
NT	0.0%	0
WA	0.0%	0
answered question		**48**

	skipped question	**0**

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

		Response Count
		9
	answered question	**9**
	skipped question	**39**

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

		Response Percent	Response Count
Name:		**100.0%**	33
Email Address:		**100.0%**	33
	answered question		**33**
	skipped question		**15**

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

		Response Percent	Response Count
Name:		**100.0%**	40
Company:		92.5%	37
Address:		**100.0%**	40
Address 2:		50.0%	20
City/Town:		97.5%	39
State:		**100.0%**	40
ZIP/Postal Code:		**100.0%**	40
Country:		92.5%	37
	answered question		**40**
	skipped question		**8**

4.4 SOUTH AUSTRALIA

Defining training needs for the fisheries sector

1. Basic Courses

	Yourself	Direct staff requirements	Response Count
Experimental Design	**66.7% (4)**	**66.7% (4)**	6
Univariate Statistical Analysis	50.0% (2)	**75.0% (3)**	4
Multivariate Analysis	**87.5% (7)**	37.5% (3)	8
Basic Excel data management and analysis	57.1% (4)	**85.7% (6)**	7
Advanced Excel programming	**84.6% (11)**	53.8% (7)	13
Length Composition Analysis	**100.0% (3)**	33.3% (1)	3
Aging techniques and analysis	**100.0% (4)**	75.0% (3)	4
Fish Dietary Studies and understanding food webs and ecosystem function	**100.0% (2)**	50.0% (1)	2
Linking of GIS to data sets and spatial data	**72.7% (8)**	54.5% (6)	11
Reproductive biology and analysis	50.0% (2)	**75.0% (3)**	4
Training in statistical packages (eg.) 'SPSS' & 'R'	**62.5% (5)**	**62.5% (5)**	8
A basic course in risk assessment	**88.9% (8)**	33.3% (3)	9
		answered question	**21**
		skipped question	**3**

2. Advanced Courses

	Yourself	Direct staff requirements	Response Count
Gap assessment	**100.0% (1)**	0.0% (0)	1
Development of integrated models of populations	**100.0% (3)**	0.0% (0)	3
Population Viability Assessment	**50.0% (1)**	**50.0% (1)**	2
Quantitative modelling	**85.7% (6)**	42.9% (3)	7
Catch and effort analysis	**83.3% (5)**	33.3% (2)	6
Specialized modelling and statistical tools	**75.0% (3)**	25.0% (1)	4
Bayesian belief networks	**83.3% (5)**	50.0% (3)	6
Qualitative modelling of ecosystems	**100.0% (7)**	14.3% (1)	7
		answered question	**15**
		skipped question	**9**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	55.6% (5)	**77.8% (7)**	9
Importance of Age,Growth & Reproduction in Fisheries Science	**66.7% (6)**	**66.7% (6)**	9
Modeling as a tool in fisheries management	**77.8% (7)**	55.6% (5)	9
Basics of economics in fisheries	62.5% (5)	**75.0% (6)**	8
Basics in Fisheries Management	**63.6% (7)**	**63.6% (7)**	11
		answered question	**16**
		skipped question	**8**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	7
Reason for specific need	**100.0%**	7
Level of course	85.7%	6
Topic 2	57.1%	4
Reason for specific need	42.9%	3
Level of course	28.6%	2
Topic 3	28.6%	2
Reason for specific need	28.6%	2
Level of course	28.6%	2
	answered question	**7**
	skipped question	**17**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	**34.8% (8)**	30.4% (7)	**34.8% (8)**	23

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**65.2% (15)**	30.4% (7)	4.3% (1)	23

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**78.3% (18)**	4.3% (1)	17.4% (4)	23
			answered question	**23**
			skipped question	**1**

6. Please select your preferences for delivery of advanced topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Web based plus written tutorial & assignment**	**c) Designated 'in-situ' course delivery**	**d) Combined (b) & (c) modes of delivery**	**Response Count**
Advanced Topics	10.0% (2)	15.0% (3)	20.0% (4)	**55.0% (11)**	20
Time Commitment to Topics					
	3 Days	**5 Days**	**10 Days**		**Response Count**
Advanced Topics	35.0% (7)	**50.0% (10)**	15.0% (3)		20
Timing of Delivery					
	Week days only	**Weekends only**	**Mixture week/weekend days**		**Response Count**
Advanced Topics	**80.0% (16)**	5.0% (1)	15.0% (3)		20
				answered question	**20**
				skipped question	**4**

7. Please select your preferences for delivery of general topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Designated 'in-situ' course delivery**	**c) Combined (a) and (b) modes of delivery**		**Response Count**
General Topics	33.3% (7)	19.0% (4)	**47.6% (10)**		21
Time Commitment to Topics					
	1/2 Day	**1 Day**	**2 Days**		**Response Count**
General Topics	14.3% (3)	**42.9% (9)**	**42.9% (9)**		21
Timing of Delivery					
	Evenings only	**Day only**	**Weekends only**	**Week days only**	**Response Count**
General Topics	4.8% (1)	**47.6% (10)**	14.3% (3)	33.3% (7)	21
For Web Delivery Only					
	At specified times	**Dial up delivery (on demand)**	**Topic (Menu driven)**		**Response Count**
General Topics	**35.7% (5)**	28.6% (4)	**35.7% (5)**		14
				answered question	**21**
				skipped question	**3**

8. Age

	Response Percent	Response Count
Less than 30	12.5%	3
30-40	**37.5%**	9
40-50	25.0%	6
50+	25.0%	6
answered question		**24**
skipped question		**0**

9. Organisation

	Response Percent	Response Count
State Fisheries agency	**45.8%**	11
Commonwealth Research Agency	0.0%	0
University	16.7%	4
Other	37.5%	9
answered question		**24**
skipped question		**0**

10. Category

	Response Percent	Response Count
Research	**62.5%**	15
Management	20.8%	5
Fisherman	0.0%	0
Other Industry	4.2%	1
Other	12.5%	3
answered question		**24**
skipped question		**0**

11. State

	Response Percent	Response Count
Qld	0.0%	0
NSW	0.0%	0
Vic	0.0%	0
SA	**100.0%**	24
TAS	0.0%	0
NT	0.0%	0
WA	0.0%	0
answered question		**24**

	skipped question	0

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

		Response Count
		4
	answered question	4
	skipped question	20

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

		Response Percent	Response Count
Name:		**100.0%**	15
Email Address:		**100.0%**	15
	answered question		**15**
	skipped question		**9**

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

		Response Percent	Response Count
Name:		**100.0%**	20
Company:		90.0%	18
Address:		95.0%	19
Address 2:		25.0%	5
City/Town:		95.0%	19
State:		95.0%	19
ZIP/Postal Code:		95.0%	19
Country:		95.0%	19
	answered question		**20**
	skipped question		**4**

4.5 TASMANIA

Defining training needs for the fisheries sector

1. Basic Courses

	Yourself	Direct staff requirements	Response Count
Experimental Design	60.0% (3)	**80.0% (4)**	5
Univariate Statistical Analysis	**66.7% (2)**	**66.7% (2)**	3
Multivariate Analysis	42.9% (3)	**71.4% (5)**	7
Basic Excel data management and analysis	**60.0% (3)**	**60.0% (3)**	5
Advanced Excel programming	**100.0% (4)**	25.0% (1)	4
Length Composition Analysis	**100.0% (1)**	0.0% (0)	1
Aging techniques and analysis	**100.0% (1)**	0.0% (0)	1
Fish Dietary Studies and understanding food webs and ecosystem function	**100.0% (2)**	50.0% (1)	2
Linking of GIS to data sets and spatial data	**90.0% (9)**	60.0% (6)	10
Reproductive biology and analysis	**50.0% (1)**	**50.0% (1)**	2
Training in statistical packages (eg.) 'SPSS' & 'R'	46.2% (6)	**69.2% (9)**	13
A basic course in risk assessment	**75.0% (6)**	50.0% (4)	8
		answered question	**23**
		skipped question	**0**

2. Advanced Courses

	Yourself	Direct staff requirements	Response Count
Gap assessment	**66.7% (2)**	33.3% (1)	3
Development of integrated models of populations	**66.7% (2)**	**66.7% (2)**	3
Population Viability Assessment	**50.0% (1)**	**50.0% (1)**	2
Quantitative modelling	**75.0% (6)**	37.5% (3)	8
Catch and effort analysis	**85.7% (6)**	42.9% (3)	7
Specialized modelling and statistical tools	**62.5% (5)**	50.0% (4)	8
Bayesian belief networks	**75.0% (3)**	50.0% (2)	4
Qualitative modelling of ecosystems	**66.7% (4)**	50.0% (3)	6
		answered question	**20**
		skipped question	**3**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	**100.0% (5)**	0.0% (0)	5
Importance of Age,Growth & Reproduction in Fisheries Science	**66.7% (2)**	**66.7% (2)**	3
Modeling as a tool in fisheries management	**72.7% (8)**	54.5% (6)	11
Basics of economics in fisheries	**57.1% (4)**	42.9% (3)	7
Basics in Fisheries Management	**71.4% (5)**	42.9% (3)	7
		answered question	**16**
		skipped question	**7**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	3
Reason for specific need	**100.0%**	3
Level of course	33.3%	1
Topic 2	0.0%	0
Reason for specific need	0.0%	0
Level of course	0.0%	0
Topic 3	0.0%	0
Reason for specific need	0.0%	0
Level of course	0.0%	0
	answered question	**3**
	skipped question	**20**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	17.4% (4)	**52.2% (12)**	30.4% (7)	23

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**60.9% (14)**	34.8% (8)	4.3% (1)	23

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**65.2% (15)**	4.3% (1)	30.4% (7)	23
			answered question	**23**
			skipped question	**0**

6. Please select your preferences for delivery of advanced topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Web based plus written tutorial & assignment**	**c) Designated 'in-situ' course delivery**	**d) Combined (b) & (c) modes of delivery**	**Response Count**
Advanced Topics	0.0% (0)	8.7% (2)	21.7% (5)	**69.6% (16)**	23
Time Commitment to Topics					
	3 Days	**5 Days**	**10 Days**		**Response Count**
Advanced Topics	34.8% (8)	**43.5% (10)**	21.7% (5)		23
Timing of Delivery					
	Week days only	**Weekends only**	**Mixture week/weekend days**		**Response Count**
Advanced Topics	**47.8% (11)**	4.3% (1)	**47.8% (11)**		23
				answered question	**23**
				skipped question	**0**

7. Please select your preferences for delivery of general topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Designated 'in-situ' course delivery**	**c) Combined (a) and (b) modes of delivery**		**Response Count**
General Topics	40.0% (8)	0.0% (0)	**60.0% (12)**		20
Time Commitment to Topics					
	1/2 Day	**1 Day**	**2 Days**		**Response Count**
General Topics	5.0% (1)	**60.0% (12)**	35.0% (7)		20
Timing of Delivery					
	Evenings only	**Day only**	**Weekends only**	**Week days only**	**Response Count**
General Topics	5.6% (1)	22.2% (4)	11.1% (2)	**61.1% (11)**	18
For Web Delivery Only					
	At specified times	**Dial up delivery (on demand)**	**Topic (Menu driven)**		**Response Count**
General Topics	5.3% (1)	**63.2% (12)**	31.6% (6)		19
				answered question	**20**
				skipped question	**3**

8. Age

	Response Percent	Response Count
Less than 30	13.0%	3
30-40	21.7%	5
40-50	**47.8%**	11
50+	17.4%	4
answered question		**23**
skipped question		**0**

9. Organisation

	Response Percent	Response Count
State Fisheries agency	**34.8%**	8
Commonwealth Research Agency	**34.8%**	8
University	13.0%	3
Other	17.4%	4
answered question		**23**
skipped question		**0**

10. Category

	Response Percent	Response Count
Research	**47.8%**	11
Management	26.1%	6
Fisherman	0.0%	0
Other Industry	8.7%	2
Other	17.4%	4
answered question		**23**
skipped question		**0**

11. State

	Response Percent	Response Count
Qld	0.0%	0
NSW	0.0%	0
Vic	0.0%	0
SA	0.0%	0
TAS	**100.0%**	23
NT	0.0%	0
WA	0.0%	0
answered question		**23**

	skipped question	0

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

		Response Count
		2
	answered question	2
	skipped question	21

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

		Response Percent	Response Count
Name:		**100.0%**	19
Email Address:		**100.0%**	19
	answered question		**19**
	skipped question		**4**

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

		Response Percent	Response Count
Name:		**100.0%**	18
Company:		94.4%	17
Address:		**100.0%**	18
Address 2:		11.1%	2
City/Town:		**100.0%**	18
State:		**100.0%**	18
ZIP/Postal Code:		**100.0%**	18
Country:		94.4%	17
	answered question		**18**
	skipped question		**5**

4.6 VICTORIA

Defining training needs for the fisheries sector

1. Basic Courses	Yourself	Direct staff requirements	Response Count
Experimental Design	**54.5% (6)**	45.5% (5)	11
Univariate Statistical Analysis	28.6% (2)	**85.7% (6)**	7
Multivariate Analysis	**70.0% (7)**	**70.0% (7)**	10
Basic Excel data management and analysis	50.0% (4)	**62.5% (5)**	8
Advanced Excel programming	**93.8% (15)**	25.0% (4)	16
Length Composition Analysis	**75.0% (6)**	50.0% (4)	8
Aging techniques and analysis	40.0% (2)	**60.0% (3)**	5
Fish Dietary Studies and understanding food webs and ecosystem function	**75.0% (6)**	50.0% (4)	8
Linking of GIS to data sets and spatial data	**95.0% (19)**	30.0% (6)	20
Reproductive biology and analysis	**57.1% (4)**	42.9% (3)	7
Training in statistical packages (eg.) 'SPSS' & 'R'	**93.3% (14)**	26.7% (4)	15
A basic course in risk assessment	**73.3% (11)**	26.7% (4)	15
		answered question	**35**
		skipped question	**9**

2. Advanced Courses	Yourself	Direct staff requirements	Response Count
Gap assessment	**83.3% (5)**	16.7% (1)	6
Development of integrated models of populations	**88.9% (8)**	22.2% (2)	9
Population Viability Assessment	**100.0% (5)**	20.0% (1)	5
Quantitative modelling	**69.2% (9)**	30.8% (4)	13
Catch and effort analysis	**90.9% (10)**	36.4% (4)	11
Specialized modelling and statistical tools	**92.3% (12)**	15.4% (2)	13
Bayesian belief networks	**88.9% (8)**	22.2% (2)	9
Qualitative modelling of ecosystems	**100.0% (15)**	20.0% (3)	15
		answered question	**34**
		skipped question	**10**

3. General Courses

	Yourself	Direct staff requirements	Response Count
Basics in understanding Stock Assessment & Resource sharing	**66.7% (12)**	44.4% (8)	18
Importance of Age,Growth & Reproduction in Fisheries Science	**80.0% (8)**	30.0% (3)	10
Modeling as a tool in fisheries management	**90.0% (18)**	25.0% (5)	20
Basics of economics in fisheries	**85.7% (12)**	21.4% (3)	14
Basics in Fisheries Management	**80.0% (20)**	32.0% (8)	25
		answered question	**33**
		skipped question	**11**

4. Please identify other topics of short course training of interest to your organisation or you in fisheries, marine science, modelling or stock assessment.

	Response Percent	Response Count
Topic 1	**100.0%**	7
Reason for specific need	**100.0%**	7
Level of course	85.7%	6
Topic 2	14.3%	1
Reason for specific need	14.3%	1
Level of course	14.3%	1
Topic 3	0.0%	0
Reason for specific need	0.0%	0
Level of course	0.0%	0
	answered question	**7**
	skipped question	**37**

5. Please indicate your preferences for delivery of basic topics from the drop down menus

Preferred Delivery Mode

	a) Only Web based	b) Web based plus written tutorial & assignment	c) Designated 'in-situ' course delivery	Response Count
Basic Topics	27.9% (12)	**44.2% (19)**	27.9% (12)	43

Time Commitment to Topics

	2 Days	5 Days	10 Days	Response Count
Basic Topics	**67.4% (29)**	23.3% (10)	9.3% (4)	43

Timing of Delivery

	Week days only	Weekends only	Mixture week/weekend days	Response Count
Basic Topics	**62.8% (27)**	0.0% (0)	37.2% (16)	43
			answered question	**43**
			skipped question	**1**

6. Please select your preferences for delivery of advanced topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Web based plus written tutorial & assignment**	**c) Designated 'in-situ' course delivery**	**d) Combined (b) & (c) modes of delivery**	**Response Count**
Advanced Topics	2.5% (1)	10.0% (4)	30.0% (12)	**57.5% (23)**	40
Time Commitment to Topics					
	3 Days	**5 Days**	**10 Days**		**Response Count**
Advanced Topics	**50.0% (20)**	37.5% (15)	12.5% (5)		40
Timing of Delivery					
	Week days only	**Weekends only**	**Mixture week/weekend days**		**Response Count**
Advanced Topics	**51.3% (20)**	0.0% (0)	48.7% (19)		39
				answered question	**40**
				skipped question	**4**

7. Please select your preferences for delivery of general topics from the drop down menus					
Preferred Delivery Mode					
	a) Only Web based	**b) Designated 'in-situ' course delivery**	**c) Combined (a) and (b) modes of delivery**		**Response Count**
General Topics	34.3% (12)	20.0% (7)	**45.7% (16)**		35
Time Commitment to Topics					
	1/2 Day	**1 Day**	**2 Days**		**Response Count**
General Topics	11.4% (4)	42.9% (15)	**45.7% (16)**		35
Timing of Delivery					
	Evenings only	**Day only**	**Weekends only**	**Week days only**	**Response Count**
General Topics	14.7% (5)	32.4% (11)	2.9% (1)	**50.0% (17)**	34
For Web Delivery Only					
	At specified times	**Dial up delivery (on demand)**	**Topic (Menu driven)**		**Response Count**
General Topics	11.1% (3)	37.0% (10)	**51.9% (14)**		27
				answered question	**35**
				skipped question	**9**

8. Age

	Response Percent	Response Count
Less than 30	13.6%	6
30-40	**43.2%**	19
40-50	22.7%	10
50+	20.5%	9
answered question		**44**
skipped question		**0**

9. Organisation

	Response Percent	Response Count
State Fisheries agency	**79.6%**	35
Commonwealth Research Agency	2.3%	1
University	4.5%	2
Other	13.6%	6
answered question		**44**
skipped question		**0**

10. Category

	Response Percent	Response Count
Research	**47.7%**	21
Management	38.6%	17
Fisherman	0.0%	0
Other Industry	2.3%	1
Other	11.4%	5
answered question		**44**
skipped question		**0**

11. State

	Response Percent	Response Count
Qld	0.0%	0
NSW	0.0%	0
Vic	**100.0%**	44
SA	0.0%	0
TAS	0.0%	0
NT	0.0%	0
WA	0.0%	0
answered question		**44**

skipped question	0

12. Please provide any comments or feedback you wish to make concerning the survey, development of course content or on course delivery below.

	Response Count
	5
answered question	5
skipped question	39

13. I you are interested in receiving email information on short courses as they are advertised by the Centre for Fish and Fisheries Research, please enter your name and email address below

	Response Percent	Response Count
Name:	100.0%	34
Email Address:	100.0%	34
answered question		34
skipped question		10

14. If you would like to be entered into the draw for a mixed carton of premium Adinfern Estate Margaret River Wine please enter your delivery adress here

	Response Percent	Response Count
Name:	100.0%	35
Company:	85.7%	30
Address:	94.3%	33
Address 2:	20.0%	7
City/Town:	100.0%	35
State:	100.0%	35
ZIP/Postal Code:	100.0%	35
Country:	91.4%	32
answered question		35
skipped question		9

Appendix 5 – Individual Respondent's Comments on the Survey

	Comment Text	Response Date
Find	**1.** Fisheries management and scienec are sunset pursuits. Market and industry development are the emerging priorities. Extension and communictions in fisheries has also been sadly lacking.	Wed, 10/15/08 3:06 PM
Find	**2.** I suggest that you/FRDC consider delivering short courses for professional development in conjunction with ASFB conferences each year. These could be costed / sponsored as a distinct package and hosted by a different University in each State. The course would involve a 1-2 day introduction followed by a web based training module. Through a partnership with ASFB, there would be an opportunity for an annual follow up with some participants so participants could build up skills each year and resolve difficulties encountered from web based delivery through a face to face meeting. FRDC could sponsor a specific number of participants from each state. A longer period of engagement with participants would allow workshopping with real data from each state, problem solving and ongoing collaboration.	Tue, 10/7/08 3:45 PM
Find	**3.** Only comment on the survey was the limited focus. Understandably the survey was aimed at a particular direction for the project ie development of courses for researchers, fishers, managers etc. However while this is important, the greater risk to fisheries is the loss of fisheries knowledge as the current generation of scientists, managers and fishers retire and replaced with fresh students who are unlikely to have either a fisheries based education nor the older generation to teach them on the job. The very reason that the project	Tue, 10/7/08 12:15 PM

was successful in getting funding (ie the need for improved quantitative fisheries skills) should at the very least indicate that universities/tafes are currently not producing students with these abilities. It could be argued that if institutions had been successful at producing well rounded "fisheries trained" students the project application may not have been as successful. So in summary there is an urgent need to take students interested in fish and the marine environment and provide them with solid backgrounds in quantitative science, social science or economics. All the skills necessary for ESD, EBFM and EBM. And this should be the focus of the current project!

Find **4.** This survey is very science driven. Most of the detailed topics are too advanced or of limited interest to industry peak bodies or even members. Some topics would be of value to those that sit on Management Advisory Committees but other skills are far more relevant to the industry. These include development of management skills, business skills, marketing and fund raising skills. Also a course on communication would be extremely value. Courses on how to grow capacity and develop leadership skills are vital for both the commercial and recreational sector. Engaging with government can be a real challenge so negotiation skills would be useful. For scientists and managers, there is a need to better understand social and economic impacts of fisheries management decisions. This has been neglected in favour of the biology and this survey continues to reflect that bias. I speak with authority on this topic as a senior fisheries scientist for 6 years with Qld DPI&F and now CEO of an industry peak body. Tue, 10/7/08 8:14 AM

Find **5.** This survey conflates the degree to which these needs Thu, 10/2/08 1:11 PM

exist and the extent to which the reviewer beleives they can be met by Murdoch University. This restricts the generalisability of assessment of demand/training needs. In some cases there is a need, but Murdoch would not be an instituion that I would assess is best placed to assist -for example relating to policy/economics/management interaction as well as financial/mgt design.

Find	**6.**	Would this be available (*in-situ* training) in each state of Queensland or would short courses also involve travel/accom expenses to undertake training at Murdoch uni?	Tue, 9/30/08 10:40 AM
Find	**7.**	Thanks for the chance for input. Good luck.	Tue, 9/30/08 9:30 AM
Find	**8.**	This type of training is needed as it has not been run for some time. We need an east coast class location though.	Tue, 9/30/08 8:40 AM
Find	**9.**	Data collection by commercial abalone divers using data loggers has opened up a broader information base for making stock assessment decisions.This is gathered on a finer spatial scale than had previously been possible using scuba divers counting estimating etc. Training should focus on improving the divers understanding of this method of data collection,how best to use equipment etc and how best to analyse this collected data. This is happening across Aus abalone fisheries and could be utilised by other dive fisheries ie sea urchins Result should be a more comprehensive spatial spread of fishery information which is cost effective.	Mon, 9/29/08 3:31 PM
Find	**10.**	Having an *in-situ* component to the courses is important so that participants have an opportunity to discuss topics, particularly with other students from differents states or fields. An important part of all	Mon, 9/29/08 2:48 PM

courses should be to explain how the topic ultimately relates to fisheries management decision-making.

Find	**11.**	As a research organisation we only employ staff with a minimum of hons, but more often PhD'S. I therefore expect them to have learnt these skills while at university. I do not think it should be our role to train staff in basic science, that is the role of universities, they should ensure that their graduates obtain these skills before entering the job market.	Mon, 9/29/08 2:36 PM
Find	**12.**	In respect of some of the options for course delivery, a combination of web and ins-itu would work well for basic course too but was not offered as an option.	Mon, 9/29/08 1:09 PM
Find	**13.**	1. I think that ongoing development of skills for Fishery Scientists and Fishery Managers is a great idea. 2. I also think that a large part of knowing how to target research that is appropriate to a particular fishery is not provided by a general science degree and comes with experience. A course for recent graduates that gives an overview of fishery methods but emphasises how best to support Fisheries Management would be valuable. 3. Fisheries 101 for fishers would be invaluable. Fishery Management meetings are not a good forum for trying to guage how much of the science has been understood by fisher representatives. Also, if major management measures are likely to result from the science, fishers may be reluctant to ask relevant questions about the science.	Mon, 9/29/08 12:28 PM
Find	**14.**	In providing these answers, I give no guarantee that if they were offered I would take them up.	Mon, 9/29/08 12:18 PM
Find	**15.**	I think the course content needs to be applied, through real life examples to create better understanding and future use by participants.	Fri, 9/26/08 1:26 PM
Find	**16.**	WE are very remote, so any course must be either	Fri, 9/26/08 9:30 AM

delivered via the internet or have a lecturer/assessor come to us.

Find	**17.**	Are course instructors able to travel to conduct courses? This would be very helpful.	Wed, 9/24/08 10:06 AM
Find	**18.**	could these courses be accessible not only to those attending university but for those people in research institutions such as Museums, AMSA members, and to those who may have a general interest.	Wed, 9/24/08 7:06 AM
Find	**19.**	Dedicated fisheries management courses are a good idea, however, it is important when dealing with a complex resource such as fisheries that a multi-discilplinary approach is used involving social and economic aspects and also guides on how to engage stakeholders and the general community in your research and management. Fisheries research by its very nature cannot be done in isolation from the people involved.	Wed, 9/24/08 6:59 AM
Find	**20.**	There is considerable interest in techniques for stock assessment using recreational fishers instead of the more usual commercial catch and effort data. You might consider a course which plots the development of this new field and updates participants on the latest advances and applications.	Tue, 9/23/08 11:45 AM
Find	**21.**	I think that it is really important that more people involved with fisheries management have a better grasp of the legislative system and especially the Act that governs their particular state. I know that in my office, only ex-fisheries officers have an understanding of the workings of the Act.	Tue, 9/16/08 2:13 PM
Find	**22.**	Consider marketing of stock assessment and modelling internationally - clients already in need of these skills throughout the Indian Ocean	Mon, 9/15/08 11:44 PM

Find	**23.**	A focus on data extration and manipulation with larger database models would be useful for many of my coworkers - as many are already engaging other learning sources or self-teaching to build up a skillset in DB querying/SQL. Perhaps engaging your school of ICT to present some SQL training options may be useful in getting people away from relying on packages more suited to analysis of smaller datasets such as MS Excel and Access. The qualitative and quantitative options presented look interesting, though.	Mon, 9/15/08 5:30 PM
Find	**24.**	These courses are very focussed on the fisheris research for what coudl be called 'commercial' finshereis. There is a need to broaden understanding of the interactions between the olsdcommercial fisheries and aquaculture since it is the way of the future. It would also help in breaking down barriers between the various schools of thought that continue within management agencies.	Fri, 9/12/08 11:26 AM
Find	**25.**	The courses seem to be more strongly focussed on the mathematics of managing stocks (stock assessment & ecosystem modelling) than on areas such as managing fisheries as part of ecosystems, and developing the high level skills in economics and social science that are needed to effectively manage fisheries. While managers endeavour to manage stocks, they do this using tools that influence human behaviour. Fisheries are complex systems that need to be managed using a suite of tools that go way beyond traditional single species stock assessment models. A question: Will these courses be offered to university students as well as salaried people?	Fri, 9/12/08 10:04 AM
Find	**26.**	In NSW at least, most of the key commercially and recreationally fished species are reliant on estuarine	Fri, 9/12/08 8:18 AM

habitats for at least part of their life cycle. Yet habitat requirements are usually ignored by fisheries managers who still concentrate on stock assessments and allocation of catch/effort. In this era of EBFM, much, much more needs to be done (incl. at the training level) to understand habitat requirements and interdepencies of estuarine and oceanic systems.

Find **27.** Most of the topics (except in the general category) relate to fisheries biologists so as a fishery manager are not directly relevant to my position except perhaps a section covering interpretation of results for managment. I defiantely support training on stock assessment and modelling etc as important tools but for my position the key is taking the results that are presented by the scientists and integrating them into development of management arrangments. Fri, 9/12/08 7:59 AM

Find **28.** i think this is a really great idea and i hope that as a employee of the Qld government i would have the opportunity to complete some short courses via the web aslo as an external student. Fri, 9/12/08 7:38 AM

Find **29.** It has been very difficult to source training in a range of fisheries based courses and it would be great to see some become available. In our area, we work with industry, research, management and compliance and it is difficult to find courses to fill knowledge gaps when such a range of information is needed to work across all these areas. Thu, 9/11/08 2:46 PM

APPENDIX 2: POLLOCK: RESEARCH PUBLICATIONS FOR 2010-2011.

During the time he has spent at Murdoch Pollock has had 20 papers and book chapters published or in press. In addition 6 more have been submitted.

Book Chapters

Jones, C. M. and K. H. Pollock. (2011). Angler Survey Methods. Chapter in Fisheries Techniques Manual. American Fisheries Society. In Press.

Pine III, W. E., Hightower, J. and Pollock, K. H. (2011). Capture-Recapture Methods. Chapter in Fisheries Techniques Manual. American Fisheries Society. In Press.

Hightower, J. E., and K. H. Pollock. (2011). Tagging methods for estimating population size and mortality rates of inland striped bass populations. Pages xx-xx in J. S. Bulak, C. C. Coutant, and J. A. Rice editors. Biology and management of inland striped bass and striped bass hybrids. American Fisheries Society, Symposium XX, Bethesda, Maryland. In Press.

Pollock, K. H., Karanth, U., and Nichols, J. D. (2011). Estimation of Demographic Parameters. In Carnivore Ecology and Conservation: A Handbook of Techniques. Roger Powell and Luigi Boitani Editors. Oxford University Press. In Press.

Papers

Published

Jun Yoshizaki, Cavell Brownie, Kenneth H. Pollock, William A. Link (2011). Modeling errors that results from use of genetic tags in capture-recapture studies. Environmental and Ecological Statistics 18:27-55.

Smallwood, C.B., Pollock, K.H., Wise, B.S., Hall, N.G. and Gaughan, D.J. (2011). Quantifying recreational fishing catch and effort: a pilot study of shore-based fishers in the Perth Metropolitan area. Fisheries Research Report No. 216. Final NRM Report - Project No. 09040. Department of Fisheries, Western Australia. 60pp.

Griffiths, S.P., Pollock, K.H. , Lyle, J. M., Pepperell, J.G., Tonks, M.L., and W. Sawynok (2010). Following the chain to elusive anglers. Fish and Fisheries, 11: 220-228.

Pledger, S**.**, Pollock, K.H. ,and Norris, J.L. (2010). Open capture-recapture models with heterogeneity: II. Jolly-Seber model. *Biometrics*, **66,** 883-890.

Wen, Z., K. H. Pollock, J. D. Nichols,and P. Waser (2010). Augmenting Superpopulation, Capture–Recapture Models with Population Assignment Data. Biometrics Online.

Cooch, E. V., Conn, P. B., Ellner, S. P., Dobson, A. P. and K. H. Pollock (2010). Disease dynamics in wild populations: modeling and estimation a review. Journal of Ornithology. Online.

Tarr, N. M., T. R. Simons and K. H. Pollock (2010). An experimental assessment of vehicle disturbance effects on migratory shorebirds. Journal of Wildlife Management 74: 1776-1783.

Riddle, J.D., R.S. K.H. Pollock, and T.R. Simons. (2010). An unreconciled double observer method for estimating detection probability and abundance. Auk 127:841-849.

Riddle, J.D., S.J. Stanislav, K.H.Pollock, C.E. Moorman, and F.S. Perkins. (2010). Separating components of the detection process with combined methods: an example with northern bobwhite. Journal of Wildlife Management 74:1319-1325.

Riddle, J.D., R.S. Mordecai, K.H. Pollock, and T.R. Simons. (2010). Effects of prior detections on estimates of detection probability, abundance, and occupancy. Auk 127:194-99.

Link, W.A., Yoshizaki, J., Pollock, K.H., and Bailey, L. L. (2010). Uncovering a latent multinomial: analysis of mark-recapture data with misidentification. *Biometrics* 66: 178-185.

Stanislav, S., Pollock, K.H., Simons, T. R. and M.W. Alldredge. (2010). Separation of Availability and Perception Processes for Aural Detection in Avian Point Counts: a Combined Multiple Observer and Time-Of-Detection Approach. Avian Ecology and Conservation. 5 Online.

In Press

Beasley, I.L., K. Pollock, T.A. Jefferson, P. Arnold, L. Morse, S. Yim, S. Lor Kim and H. Marsh. (2011). Likely extirpation of another Asian river dolphin: the Critically Endangered population of the Irrawaddy Dolphin in the Cambodian Mekong River is small and declining. Marine Mammal Science. In Press.

Cannell, B., Pollock, K. H., Bradley, S. ,Wooller, R., Sherwin, W., and J. Sinclair (2011). Augmenting Mark-Recapture with point counts to estimate the abundance of Little Penguins on Penguin Island, Western Australia. Journal of Wildlife Research. In Press.

Beatty, S., de Graaf, M., Molony, B., Nguyen, V. and K. Pollock (2011). Plasticity in population biology of *Cherax cainii* (Decapoda: Parastacidae) inhabiting lentic and lotic environments in south-western Australia: implications for the sustainable management of the recreational fishery. Fisheries Research. In Press.

Turner, M. M., Rockhill, A. P., Deperno, C. S., Jenks, Klaver, J.A., Jarding, R.W., Grovenburg, T. W., and K. H. Pollock (2011). Evaluating the effect of predators on white-tailed deer: movement and diet of coyotes. Journal of Wildlife Management 75 In Press.

Submitted

Smallwood, C.B., Pollock, K.H., Wise, B.S., Hall, N.G. and Gaughan, D.J. (2011). A new complementary survey approach for estimating shore-based recreational fishing catch and effort. North American Journal of Fisheries Management. Submitted.

Friedl, S. E., Buckel, J. A., Hightower, J. E., Scharf, F. S. and Kenneth H. Pollock, K. H. (2011). Telemetry-based Mortality Estimates of Juvenile Spot in two North Carolina Estuarine Creeks. Transactions of the American Fisheries Society. Submitted.

Calver, M. C., Adams, G., Clark, W. and K. H. Pollock. (2011). Assessing the safety of collars used to attach predation deterrent devices to pet cats. Biological Conservation. Submitted.

Prescott, J., Vogel, C., Pollock, K., Hyson, S., Octaviani, D., and A. Sisco Panggabean (2011). Estimating sea cucumber abundance using depletion methods: old methods shed new light on abundance. Marine and Freshwater Research. Submitted.

Smith, H. C., Pollock, K. H., Waples, K., Bradley, S. and L. Bejder (2011). Use of the Robust Design model to estimate abundance and demographic parameters for a coastal bottlenose dolphin (*Tursiops aduncus*) population. Marine Mammal Science. Submitted.

Webster, R. A., Pollock, K. H., and T. R. Simons. (2011). Spatial models for understanding the distribution of bird species. Methods in Ecology and Evolution. Submitted.

APPENDIX 3: OPINION PIECE ON TRAINING FOR RESEARCH STUDENTS.

Revised manuscript submitted to Australian Zoologist in May 2013.

Fisheries, Wildlife, and Conservation Biology Education in Australia: Current Challenges and Future Directions

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Abstract

Fisheries Science, Wildlife Management and Conservation Biology are crucial to the Australian economy and society. We question whether Australian doctoral education is adequate for these fields. It assumes that students commence with well-developed relevant skills, or acquire them autodidactically or from their supervisors. We believe that this model is no longer adequate, and argue for compulsory coursework within doctoral programs.

Currently, most specialised education in quantitative methods, advanced genetic techniques (including population genetics) or human dimensions is provided in short courses or workshops, if at all. Short courses provide advanced technical knowledge (e.g., an advanced stock assessment workshop for fisheries scientists or population viability analysis workshops for conservation biologists), but they are voluntary. Multiple university and multiple discipline consortia could provide the compulsory postgraduate coursework needed for structured development of quantitative skills in Australian PhDs. Online education should be part of the solution, but it is not a panacea because some material should be taught in person for effective learning. Solutions can build on modified approaches used overseas and in other disciplines in Australia.

Key words: Fisheries, Wildlife Management, Conservation Biology, graduate education, professional doctorate.

Introduction

Globally, there is a substantial, growing literature is on change and innovation in the structure of higher degrees by research, especially in skills acquisition (Murtonen *et al*. 2008; Raman 2008; Lee and Aitchison 2009), the relative importance of coursework and research projects (Neumann 2009; Chiteng Kot and Henda 2012), integrating industry perspectives or professional experience (Costley and Stephenson 2009; Scott *et al*. 2009), interdisciplinarity (Lyall and Meagher 2012; Franklin *et al*. 2012), and supervisorial expertise and practice (Brew and Peseta 2009). Fisheries science, wildlife management, conservation biology and other sciences relevant to applied natural resource management integrate all these topics. These fields of science share several attributes: they are distinct fields heavily dependent on quantitative techniques (mathematics, statistics, spatial analyses, computational skills and molecular/genetics techniques, especially those related to the genetic connectivity of populations) that can be acquired in different ways; they relate directly to the workplace; they require an interdisciplinary education across biology, environmental science and sociology; and they place heavy demands on the pedagogical and disciplinary skills of the supervisors. Currently, these attributes are acquired primarily either through postgraduate study or through continuing education in the work place.

Australian postgraduate education is ill-suited to developing interdisciplinary and quantitative skills. It is based on traditions in the United Kingdom, which assume that candidates enter the research higher degree well-grounded in relevant skills (Evans 2007). This is questionable given the pace at which many techniques are developing – PERMANOVA, for example, is barely a decade old (Anderson 2001), Bayesian analyses are undergoing a resurgence in numerous forms (Woodward 2012) and new genetic analyses are developing speedily (e.g., Lee *et al*. 2012). Thus, research students learn autodidactically or from their supervisors in the 'research apprenticeship' model (Monk *et al*. 2012). Students

do not learn in a group with specialist instructors, forfeiting the benefits of interacting with experts in diverse areas and reinforcing understanding through peer learning (Dresner 2008; Evans and Stevenson 2010). Furthermore, this model of postgraduate education encourages the 'vanishing act' (Fincher 2012), whereby students work at home, in isolation, and often become unsure of their progress, as Ross *et al.* (2011) reported in relation to writing skills. Other problems, including the social isolation felt by some international students (Erichsen and Bolliger 2011) and a low academic self-concept (Curtin *et al*. 2013), are exacerbated by withdrawal from the campus environment and can also contribute to poor progress.

While some supervisors counter this with informal mentoring, this is often *ad hoc* (Fincher 2012) and depends very much on the supervisory skills and commitment of the supervisors (Brew and Peseta 2009). It also assumes the supervisor's competence in all core areas, which may require that the supervisor gain competence in new skills (Mohan and Radhakrishnan 2011) . Thus, successful supervison depends heavily on the skills of the individual supervisor. Furthermore, recent research has identified the value of 'collective academic supervision', with multiple supervisors working with students to create the best environment for students to learn core academic competencies (Nordentoft *et al.* 2013). This can also balance the 'tough love' approach of some supervisors, who deliberately create a critical environment for their students who need to rise to the expectations or leave (Aitchison *et al*. 2012).

Many overseas universities and some disciplines in Australian universities have responded to these evolving requirements for providing fundamental skills to research students with postgraduate courses within higher degrees by research to cover critical learning skills, provide peer-learning interactions amongst students and expose students to a wide range of subject experts (e.g., Maxwell and Shanahan 1997; Sarros *et al.* 2005; Stephenson *et al*. 2006; Rolfe and Davies 2009; Chiteng Kot and Henda 2012). These are known variously as research-coursework doctoral programs (Trigwell *et al*. 1997), professional doctorates (Chiteng Kot and Henda 2012), professional research doctorates (Nerad 2007), or work-based doctorates if they involve significant practitioner liaison (Costley and Lester 2012). Usher (2002) sees these developments as responding to changes in employer expectations of graduates: 'If knowledge is the currency of the new economy, universities are inevitably involved in its production. Their activities are knowledge intensive. They are also critically involved in the formation of those who take their place in this economy as knowledge workers. This means that universities have to ensure that these workers take their place with the right amount and kind of human capital -- with in other words the right skill set. Government and society, rightly or wrongly, now demand no less.'

Here, we contrast two models for doctoral education: the research model that requires no coursework and the mixed research and teaching model (embracing both coursework within the traditional degree and a distinct research-coursework doctoral program (using Trigwell *et al*.'s 1997 terminology)). This illustrates the challenges in providing effective postgraduate education in fisheries science, wildlife management and conservation biology without formal postgraduate courses. We focus on training in quantitative methods given our knowledge and interests, although other disciplines are relevant. Part of this knowledge was developed through building quantitative training in a project funded by the Fisheries Research and Development Corporation of Australia, the Department of Fisheries Western Australia and Murdoch University (Pollock and Loneragan 2012). We argue that including relevant coursework will improve Australian graduate

education in these disciplines, as part of the traditional research PhD or as a research-coursework doctoral program.

Why is this important?

The health and vitality of the related professions of fisheries science, wildlife management and conservation biology are crucial to the Australian economy and to Australian society (e.g., Beattie 1995; Bunn *et al.* 2007; Kirkpatrick 2011; Prowse and Brook 2011; Wardell-Johnson *et al*. 2011). Natural resources management, which faces increasing challenges (Box 1), depends on sound science.

Natural resource scientists working in agencies and universities need to be well educated in every area in Box 2, not just in their discipline. In general, successful graduate research programs across the sciences internationally have a diverse disciplinary base (Kroll 2007; Newing 2010; Vinhateiro *et al*. 2012) or a strong industry focus (Bissonnette *et al*. 2000; Ladesic *et al*. 2012).

The interdisciplinary nature of fisheries science, wildlife management and conservation biology: implications for education in Australia

The interdisciplinary nature of these sciences creates special problems in education. Undergraduate students receive introductory overviews on all the topics in Box 2, but degree requirements and time pressures preclude in-depth treatment. For example, Dickman and Crowther (2009) include brief descriptions of hypothesis testing, Bayesian analysis, information-theoretic approaches, animal ethics and publishing science in their chapter on scientific method in an introductory textbook. This raises awareness, but does not equip students with the ability to apply these skills. Some skills are reinforced in advanced units, but many students could enter postgraduate study with only limited awareness and poor skills in important areas.

To check the minimum preparation of students in quantitative skills after their undergraduate degrees, we documented the required quantitative units in seven randomly chosen Australian undergraduate degrees in wildlife ecology/ecology, conservation biology, or marine science. We considered marine science because we know of no majors in fisheries science and marine science is a major source of fisheries postgraduate students. While quantitative skills may be integrated in other units within these courses and students can enrich the minimum requirement with electives, we found the level of preparation highly variable. Many students take an introductory statistics unit only, or an introductory statistics unit plus an experimental design unit (for full tabulated results, email the corresponding author).

Therefore, almost all the education in quantitative methods occurs at the postgraduate level, followed by continuing education in the work place. Students enter postgraduate programs from varied backgrounds with uneven expertise in component 5 of Box 2 (quantitative science) and, although we have no data, we suspect that this is also true of component 4 (human dimensions). This contributes to 'statistical confusion' amongst graduate students, who may fail to integrate study design, analysis and writing (Boyles *et al*. 2008).

We now consider how the postgraduate education in these fields should be structured. We contrast the Australian model with that of the US, where a European

influence has been stronger compared to the influence of the United Kingdom on the Australian model (Evans 2007).

Contrasting models of university education: Australia and the United States.

The Australian system has adopted the one-year Honours course, often mainly by research, at the end of the BSc as a 'fast track' preparation for a graduate research degree, in contrast to the two-year Masters degree common elsewhere (Evans 2007; Dobson 2012). By contrast, the US model uses coursework more extensively. In Box 3, we show the major components of each system in a simplified form.

The differences are striking. Most Australian students require no formal coursework after the undergraduate degree, whereas in the United States, formal coursework continues from BSc to PhD. Australia gives students narrowly focused training, with more emphasis on research thesis training and less on coursework. We believe that the traditional, research-only model causes special challenges for interdisciplinary fields, particularly for quantitative methods. Of course, the US model is not without critics, with their concerns centred on:

"• Doctoral students are educated and trained too narrowly.
- They lack key professional skills, such as collaborating effectively and working in teams, and have no organizational and managerial skills.
- They are ill prepared to teach.
- They are taking too long to complete their doctoral studies and in some fields, many do not complete their degrees at all.
- Doctoral students are ill informed about employment outside academia." (Nerad 2004).

We note that the same criticisms could be made of the Australian system. We acknowledge these criticisms, but argue that carefully chosen coursework overcomes them – something that the Australian system could adopt from the U.S.

The U.S. system also aligns strongly with the structure of higher education agreed in the Bologna Process, designed to create a European higher education area with better aligned education structures and standards to facilitate co-operation and the movement of students. It operates on a three step system of bachelor degree, masters degree, doctorate (European Commission 2013). While the Australian government views the Australian higher education system as also having three steps (bachelor, honours, doctorate), it also recognises the potential problems of (i) recognition of Australian qualifications if the European professional standard becomes a bachelors degree followed by a masters, and (ii) potential problems for Australian honours graduates seeking direct entry to European PhDs (Department of Education, Science and Training 2006). More coursework, and a re-examination of the role of the honours degree (see critiques in Zeegers and Barron 2009; Manathunga *et al*. 2012) may be needed to maintain opportunities for Australian students internationally and to attract international students to Australia. The honours degree is also under critical examination in the United Kingdom (Yorke *et al*. 2008).

The University of Tasmania has already moved to a mixed model of postgraduate education in a closely related field, with their PhD in quantitative marine science (including a fisheries component), where formal coursework comprises about one third of the requirements. Business, psychology and education academic programs in Australia have already recognised the importance of relevant coursework in higher degrees through developing explicit Doctor of Business Administration, Doctor of Psychology, Doctor of

Education and Doctor of Clinical Psychology degrees: Chiteng Kot and Henda (2012) estimate that about 20 of these are on offer in Australia now. These all require advanced coursework, usually focused on research methodology, which is completed before students undertake a major research project. For two Doctor of Psychology degrees, the coursework meets the Australian Psychological Accreditation Council's accreditation requirements. Although the education and business degrees may not seek professional accreditation, they do focus on practical skills and applied problems, which Chiteng Kot and Henda (2012) acknowledge are strong reasons for adopting such degrees. According to Trigwell *et al*. (1997), the coursework component of these degrees varies from 17% to 67%.

A key to the professional doctorate approach is placing professional practice centrally (Maxwell and Shanahan 1997). While there has been some confusion about the relative emphases of professional doctorates compared to the research PhD (Sarros et al. 2005), they nevertheless ground students thoroughly in research methodology via coursework. We believe that the education of Australian postgraduates in the natural resource fields should emulate this approach, but it will take time and resources to achieve this.

Shortcourses and workshops

The main advantages of short courses are lower cost, flexibility and the ease of repeat delivery at different times in different places. They integrate well with the current Australian postgraduate education system. However, it is difficult to demonstrate improved learning in the absence of formal assessment and the time for learning is short, which probably leads to lower retention of learning in short courses compared with semester long teaching.

Postgraduate students and continuing education of professionals are two distinct markets for short courses. We need to consider carefully whether all groups should be taught together, or whether workshops should be designed separately for different sectors/groups/target participants. For example, an argument could be made for a two-week short course on key quantitative methods in fisheries aimed primarily at new postgraduate students. It could cover many methods and include projects and assessment. For professionals, however, it makes more sense to focus on short (e.g., three-day) workshops on core topic components because of the participants' time limitations. Shorter workshops also minimise costs such as accommodation for students travelling to participate, as well as easing the logistical constraints on the availability of venues. Very advanced topics, with a narrower appeal, could be taught to mixed audiences of postgraduate students and professionals.

A crucial feature of workshops is who is to pay for them. We argue that universities should pay for their postgraduates to attend a two-week workshop on core topics. We believe that this model of long workshops with assessment is so crucial to improve postgraduate education that universities have a duty to provide it until they put semester long units in place. We believe that participants should pay some of the cost for advanced workshops aimed at both postgraduate students and continuing professionals, but key agencies and universities should subsidise them. This is especially true when international presenters in specialised disciplines are used and travel costs are high.

Workshops may be delivered in person, distance/online, or a combination. While distance education is cheaper, we suggest that it is not as effective as in person delivery for

technical subjects, where students benefit from immediate feedback and peer learning. A combination of distance education and in person workshops may be valuable. For example, postgraduate students from multiple universities could assemble for a two-week intensive workshop at the start of their program and then complete online modules later. A better understanding of the potential for such online elements may come from an evaluation of pioneering work (Edge and Sanchez 2011).

Quantitative science

In an ideal world all PhD students in fisheries, wildlife, population ecology and conservation biology would include these topics in their PhD: two semesters of basic statistical methods, one semester of sampling animal populations, one semester of population dynamics/ stock assessment and perhaps one or more additional statistics classes in multivariate analysis, spatial statistics or nonparametric statistics (Box 4). They would also need a GIS class and basic calculus. This as a bench mark for Australian programs to reach a high international standard. Students who aspire to working more on quantitative methods at the interface of mathematics, statistics and biology would need training in differential equations, matrix algebra and mathematical statistics.

Linkages to other related disciplines

Many of the quantitative methods described above are relevant to many disciplines. For example, a mathematical population dynamics class, or a sampling animal populations class, could be taught to postgraduate students in fisheries science, wildlife biology and conservation biology. We also believe many specialised biological courses (such as advanced genetics techniques) or human dimensions courses could be taught this way. Communication between these related professions needs to be improved so that postgraduate education can be developed along these lines.

Some suggestions for a new Australian model for teaching postgraduate fisheries science and conservation biology

In our opinion there are ways to build a superior Australian system of postgraduate education. It should use information from overseas and from other disciplines adapted to Australian realities. Some general bases for a solution might be: first, to recognise that Australian universities are severely underfunded (OECD 2011), especially in providing quality postgraduate education; and second, reform postgraduate education to achieve economies of scale recognising the “tyranny of distance” and the small size of the Australian population – features distinguishing Australia from the United States and European postgraduate systems.

We believe that the current Australian model of BSc + Hons + PhD(Research Thesis) (Box 3) is not working well and that three alternative models should be considered carefully:

1. BSc + 2 yr Masters (Coursework and Research Thesis) + PhD (Research Thesis)
2. BSc + Hons + 1 yr Masters (Coursework) + PhD (Research Thesis)
3. BSc + Hons (Coursework? and Research Thesis?) + PhD (Coursework and Research Thesis)

We believe that completing the requirements of a masters degree, as in model 1 or 2 above, is necessary to reach a minimum professional level as a wildlife or fisheries biologist. Therefore, degree paths that include strong masters degrees should probably become the norm. Students could stop at that point and have a very satisfactory education and career or

continue for the PhD to focus on research. If students reached this masters level, they would also reach the level needed for accreditation if that became a requirement for membership in professional societies. However, we have not considered or discussed accreditation for the natural resources disciplines here. Model 1 has the strong advantage of close alignment with the Bologna Accord, while Model 3 is the one favoured by other fields such as education.

Including formal coursework, as in models 2 and 3, offers more time to learn and therefore provides stronger reinforcement and longer retention of learning, more effective assessment and greater opportunities for different learning approaches such as peer learning. While coursework is costly, less flexible and more difficult to integrate into the current style of Australian postgraduate research degrees relative to short courses, we believe that the advantages of coursework outweigh these problems.

One valuable reform would be to construct postgraduate consortia that span multiple universities and are based on deep, mutually-beneficial co-operation. These postgraduate consortia could teach postgraduate semester long courses, such as those offered in major universities in the United States. The courses would most likely have to be offered using a mixture of in person and distance education to be effective. Distance education can be part, but not all, of the solution. Thus, some members of a consortia might be relevant to different geographic regions of Australia (e.g., Western Australia, south-eastern Australia, Queensland). This should allow students to study subjects aligned closely with their research themes, which Raman (2008) claims is vital in ensuring student engagement.

One advantage would be that universities could share the costs of specialists in quantitative methods. Although we have not done any formal assessment, it is our experience that specialists in sampling animal populations, fisheries stock assessment models, ecosystem models, or spatial models are rare in Australian universities. We also believe that specialists are needed in other areas such as applied molecular genetics.

Some existing Australian inter-university collaborative models for postgraduate students in other disciplines show how this might be achieved for quantitative methodologies in natural resources. For example, medical statistics, now commonly named biostatistics, has a severe shortage of professionals. Medical statisticians created the Biostatistics Collaboration of Australia (http://www.bca.edu.au/), involving statistics groups at seven Australian Universities (University of Queensland, University of Newcastle, University of Sydney, Macquarie University, University of Melbourne, Monash University and the University of Adelaide). They offer diplomas and masters degrees in biostatistics with part time and distance education options. No single university could provide all the resources alone. Some aspects of this model may be suitable for fisheries and wildlife science. One weakness of the biostatistics model is the almost exclusive use of distance education, reducing opportunities for prompt feedback and peer learning.

Another feature of the solution will be to enhance existing linkages and build new ones between universities in Australia, Europe and North America where there are substantial numbers of fisheries and wildlife scientists. This would require enhanced funding for visits in both directions and help engage more international specialists in Australian fisheries, wildlife and conservation biology postgraduate education and research.

In their assessment of research-coursework doctoral programs in Australian universities, Trigwell *et al*. (1997) singled out the Education Doctorate degree from Deakin University as 'exemplary'. The coursework included 'Professional Journal Writing, Critical Reflective Writing, Critical Review of Literature 1 and 2, Research Methodology 1 and 2, and Proposal Writing 1 and 2. ' They also note that high-quality doctoral programs requiring coursework, 1) outline clearly the relative contributions of the coursework and the research components, 2) demonstrate how the coursework will improve candidates' understanding of practical research issues, 3) involve relevant professionals or professional bodies as well as university faculty, 4) offer all coursework and research components at a very high level, and 5) include sufficient flexibility to accommodate full-time and part-time students. Although the content of research methodology coursework would obviously vary between education and natural resources management, the description provided by Trigwell *et al*. (1997) provides a compelling outline of our vision for postgraduate education in natural resources management in Australia.

Acknowledgements

We thank Drs Alex Hesp and Lars Bejder of Murdoch University, Dr Sandra Diamond from the University of Western Sydney and Texas Tech University, and two anonymous reviewers for helpful comments on an earlier version of the manuscript. Ideas for this paper were stimulated during KP's appointment as a Professor of Quantitative Methodologies at Murdoch University with funding from Murdoch University, the Fisheries Research and Development Corporation of Australia (FRDC 2008/304) and the Western Australian Department of Fisheries.

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Box 1. Some natural resource management challenges in Australia.

- Habitat degradation and loss
- Effects of climate change
- Development due to populations growth, mining, oil, and natural gas exploitation
- Marine and National Parks establishment and maintenance
- Endangered species (freshwater fish, marsupials and monotremes)
- Exotic species introductions
- Over exploitation of fish stocks by commercial and recreational fishers

Box 2. Components of Fisheries and Wildlife Science showing the interdisciplinary nature of the fields.

1. Basic Biology
2. Fisheries or Wildlife Biology
3. Environmental Science
4. Human Dimensions
5. Quantitative Science
    a. Mathematical Modelling
    b. Statistical Modelling
    c. Computational Skills

Box 3. Standard academic pathways for natural resource scientists in Australian Universities compared to those in the United States. These are contrasting models for postgraduate education.

Australia	United States
B Sc 3 years by coursework	**B S** 4 years by coursework
B Sc Hons 1 year by research thesis	**M S** 2-3 years coursework, research thesis mix
Ph D 3-5 years by research thesis only	**Ph D** 3-4 years coursework thesis mix
Total time ~7-9 years Coursework time ~3 yrs Research time ~4-6 yrs	Total time ~9-11 years Coursework time ~6yrs Research time ~3-4 yrs

Note- there are masters degrees given in Australia but the B Sc. Hons and then directly to Ph. D is still the standard pathway. There may be some coursework in some Australian Ph. D. programs but what we have presented are roughly the norms for Australia and the United States.

Box 4. Important components of Quantitative Science for all Ph. D. students and professionals in Natural Resource Sciences.

Mathematical Modelling

Basic Mathematics

(Calculus, Matrix Algebra, Simple Differential Equations)

Population Dynamics Models (Intro)

Stock Assessment Methods (Intro) for fisheries students

Statistical Modelling

Basic Statistical Methods (Analysis of Variance and experimental design, Multiple Regression, Nonparametric Methods)

Basic Sampling Methods

Sampling Animal Populations

Generalised Linear Models (Intro)

Spatial Statistics (Intro)

Multivariate Methods (Intro)

Computational Methods

Excel and Basic Stat Packages

GIS packages like Arcview

R programming

Note- The requirements for Ph.D. students specialising in quantitative methods would be much more than these topics. This would include two semesters of Mathematical statistics and possibly an introductory class in Bayesian statistics.

13. Intellectual property

The intellectual property developed during this project is for general publication.

14. Staff

Professor Ken Pollock	MU: Appointed to the position of Professor of Quantitative Methodologies, Developer, Coordinator and presenter of workshops.
Professor Neil Loneragan	MU: Advisor to Professor Pollock, Chair Reference Group for the Training Facility
Professor Peter Rogers	MU: Developer of initial concept and proposal, leader of Needs analysis and survey, member of the Reference Group
Professor Norm Hall	MU: Contribution to Development of initial concept and proposal, member of the Reference Group

Australian Government

Fisheries Research and Development Corporation