Inquiry into the Role of Science for Fisheries and Aquaculture
Submission by Centre for Fish, Fisheries and Aquatic Ecosystem Research, Murdoch University
(Neil Loneragan and Alan Lymbery, 3rd May 2012)

Background

The Centre for Fish, Fisheries and Aquatic Ecosystem Research was established by Murdoch University in 2000 (then the Centre for Fish and Fisheries Research) in recognition of the history of excellence in research and research training in this area. Since then, this focus has been maintained and broadened to include many aspects of aquatic ecosystem research. Currently, 15 academics, 6 post-doctoral fellows, 30 PhD students and 10 Honours students are Centre members. Research by Centre members contributes mainly to the fields of Fisheries Science, Ecology, and Zoology. In the 2010 Excellence in Research for Australia assessment, Murdoch University was the only University in Western Australia, and only one of five Universities in Australia, to be assessed in Fisheries Science and our research was rated as above the International average in this field (Zoology was also rated at above the International average, while Ecology was at the International average). We are pleased to have this opportunity to contribute to the Federal inquiry into the role of science for Fisheries and aquaculture.

Currently, the fisheries and aquaculture industries in Australia face a number of challenges, some of which are common to other jurisdictions around the world. The commercial fisheries sector faces declining returns due to several factors, such as the high value of the Australian dollar and increasing requirements to demonstrate sustainability, taking into account the harvested species, the ecosystem effects of fishing and the socio-economics of fishing. This reduces the funds available from the commercial industry to contribute to research and this places a priority on the science being targeted and cost-effective. Engaging agencies other than government departments, such as Universities and TAFEs/Institutes, can provide independent and cost-effective alternatives to help achieve these goals. Recreational fishing pressure is increasing with increasing population size and managers are challenged with providing people with a recreational fishing experience, without depleting the stocks.

The aquaculture industry is widely seen as offering the potential to fill the gap between increasing worldwide demand for fish products and declining supply from wild capture fisheries, but there are serious constraints to the growth of aquaculture in Australia that need to be addressed. Among these constraints are the challenge of obtaining access to coastal waters to have the right to produce fish, vulnerability of cultured fishes to infectious disease outbreaks, poor productivity because of limited genetic improvement of stock and the need for improved environmental management.

The allocation of resources among commercial, recreational, indigenous and conservation sectors is an issue, particularly the declaration of Marine Protected Areas for conservation management. Areas zoned as sanctuaries or no-take zones within MPAs affect the ability of fishers to access traditional fishing grounds.

In this submission, we briefly address the following subset of the terms of reference:

a) The relationship between scientific knowledge of fish species, ecosystems, biodiversity and fish stock sustainability;
b) Fishery management and biosecurity

c) Research, development and applied science of aquaculture
d) Governance arrangements relating to fisheries and aquaculture, including the implications for sustainability and industry development;
g) Any other related matter (education and training in fisheries and aquaculture).

a) The relationship between scientific knowledge of fish species, ecosystems, biodiversity and fish stock sustainability

The accuracy and uncertainty in assessing the sustainability of fisheries and their associated ecosystems depends on the knowledge of fundamental biological and ecosystem parameters e.g. age and growth, reproductive biology, estimation of mortality (both natural and fisheries mortality). This information provides the basis for stock assessment and sustainability of fishing on the target stocks. Dietary studies and chemical tracer studies provide the basis for understanding food webs, trophic flows and the core information for ecosystem models. Studies aimed at elucidating the environmental and habitat factors that affect the spatial and temporal patterns of key fish species are also critical, as are those that lead to tools for predicting fish distribution at various stages of their life cycle. Fisheries managers continue to need rigorous biological and ecological studies to provide the fundamental basis for assessing stocks and ecosystems with greater accuracy and less uncertainty. We also need the continued development of stock assessment and ecosystem models, and the development of new approaches in this field to reduce the costs and time of model development.

Increasing evidence is accumulating that fish stocks consist of many micro-stocks that function independently in a fisheries sense. The ability to be able to discern appropriate scales for management requires knowledge of the connectivity of the stocks – this can be achieved through research using genetic, micro-chemistry and other chemical tracers. It also requires that data are collected and analysed at finer spatial and temporal scales. These data also provide commercial and recreational fisheries with the information to make a greater, evidence-based contribution to the designation of MPAs for conservation management, particularly the location and size of their sanctuary zones. Information on the movement patterns and home ranges of species of commercial and recreational significance is also important for determining the size and location of sanctuary zones.

The interaction of fisheries with other species, including byproduct, bycatch, and Protected, Endangered and Threatened species (PETs) is an area of growing importance. Public perceptions on bycatch are changing and the Australian community is becoming less tolerant to large bycatch in fisheries and the capture of significant numbers of PETs, particularly marine mammals, turtles and sawfish. Science is required to understand the extent of these interactions and develop ways of reducing the severity of the interactions, either through closures that target main areas or times of interaction (spatial and seasonal closures) or reduce the numbers retained in the nets (understanding the behaviour of PETs and response to fishing operations and developing modified net designs). This requires an understanding of the extent of the interactions, the biology and behaviour of some of the PETs and skills in fishing operations and net design.

b) Fishery management and biosecurity

- *The calculation and monitoring of stock size, sustainable yield and bycatch, as well as related data collection*

The significance of fundamental biological and ecological research for providing the information to assess fisheries accurately and with less uncertainty has been outlined in

section a). The quantitative methodologies needed have also been discussed in this section and the need to collect data on finer spatial scales. The need for training in quantitative methodologies, including training in managing large data sets for fisheries and aquaculture are discussed in section g) on education and training.

- *The effects of climate change, especially relating to species dispersion, stock levels and impacts on fishing communities*

The improved fundamental biological and ecological data on fish and their associated ecosystems, higher resolution data on fisheries and the modelling tools outlined in a) above, provide essential information for evaluating climate change scenarios. In addition to these data, an understanding of the social and economic systems of fishing communities and their resilience to changing climate provides the basis for developing adaptation strategies for fisheries and assessing the potential impacts on fishing communities.

- *Pest and disease management and mitigation and minimising risks to the natural environment and human health*

Our ability to minimise and appropriately manage disease risks in natural fish populations is constrained by a relatively poor understanding (compared with terrestrial wildlife) of the diversity, life cycles and transmission capabilities of infectious agents. This means that we have a very limited capacity to develop proactive preventative measures and we rely almost invariably on reactive responses after the outbreak has occurred. An increased scientific investment is required to improve our knowledge of the transmission of infectious diseases (aetiology) in commercially and recreationally important fish diseases. This is particularly important in diseases that can be transmitted from fishes to people (i.e. zoonotic diseases, such as anisakiasis). The key requirements here are for basic ecological data on the life cycles of disease agents (i.e. viruses, bacteria and parasites), which will allow quantitative modelling of infection risk and the efficacy of control programs.

c) Research, development and applied science of aquaculture, including:

- *Transitioning from wild fisheries to aquaculture in individual species*

The technical requirements of closing the life cycle have been achieved for a large number of aquaculture species. However, large, mobile species, such as southern bluefin tuna, still present important challenges, and such species cannot be considered as 'cultured' until they are be bred in captivity. A major limitation, however, to the productivity of almost all cultured fish species is the lack of coordinated genetic improvement programs. In this respect the aquaculture industry stands in stark contrast to terrestrial livestock industries, in which most of the improved productivity, gained during the last 60 years, has been due to selective breeding. There is an urgent need to adapt and apply modern techniques of assisted reproduction, genetic parameter estimation and artificial selection to cultured fish species, particularly for traits such as growth rate, feed conversion efficiency and disease resistance.

- *Improving sustainability and lifecycle management practices and outcomes*

Globally, veterinarians with skills in aquatic animal health, to meet the disease challenges of capture fisheries and aquaculture, are in short supply. Very few veterinary courses in Australia, or overseas, provide even basic training in fish diseases. Exacerbating the shortage of fish health professionals is the very limited availability of advanced training courses in fish health within Australia. Although some courses are

run by organisations such as the University of Tasmania, Murdoch University and CSIRO, these are typically limited in scope, often *ad hoc* and usually pitched at a relatively basic, entry-level audience.

Although aquaculture is often seen as having a positive environmental impact, by reducing fishing pressure on wild fish stocks, important environmental management issues need to be addressed to develop a sustainable aquaculture industry in Australia. These include: the need to reduce the collection of wild fishes for breeding stock, reducing the reliance on fishmeal in aquaculture feeds, minimising the release of cultured stock into the wild and mitigating the impacts of aquaculture wastes, particularly nutrients, on receiving environments. The science behind many of these issues is well understood and the primary requirement is now the development of appropriate regulatory or economic incentives for implementing environmental management systems. One important area in which more scientific knowledge is required, however, is in developing alternative protein sources to reduce the amount of fishmeal required in feeding cultured carnivorous fish species.

- *Pest and disease management and mitigation*

Infectious disease is a major problem in the aquaculture industry, because of the artificial environments in which fishes are kept, leading to outbreaks of disease on a scale rarely seen in natural populations. Effective management and mitigation of disease outbreaks in the aquaculture industry face similar challenges to that in wild fishery stocks, i.e. poor understanding of the diversity, life cycles and transmission capabilities of infectious agents. An increased scientific investment in fish health is required to address these challenges (see section g below).

d) Governance arrangements relating to fisheries and aquaculture, including the implications for sustainability and industry development;

The increasing requirements for assessing sustainability in fisheries and aquaculture to take into account all elements of the system – target species, ecosystem, other species affected by the system and socio-economics of the industry – has consequences for the type of science required and the way it is carried out in the future. These requirements mean that new, cost-effective approaches to science and management need to be found. In fisheries, this includes the move to co-management and greater engagement and accountability of the industry in assessing and monitoring its operations. Hence, the role of government may gradually shift to one of auditor and manager of compliance with legislation.

g) Any other related matter

- *Education and training*

To meet many of the challenges facing the fisheries and aquaculture industries of Australia identified above, much greater expertise is needed in quantitative methodologies and data management. This is not currently readily available in the postgraduate training of fisheries scientists at universities in Australia. One possible exception is the postgraduate training in Quantitative Marine Science, offered to postgraduates at the University of Tasmania. However, this does not provide the breadth of training needed for the quantitative assessment of natural resources, such as fisheries. Recently, a study commissioned by the FRDC to develop quantitative training for fisheries identified some of the major issues in the area. The Summary from

this draft report is provided below (Attachment 1) and the full draft report can be provided on request.

Yours sincerely

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Attachment 1: DRAFT Report on

Quantitative Fisheries Science Education in Australia: Current Challenges and Future Directions, Prepared for the Fisheries Research and Development Corporation of Australia as part of FRDC 208/304

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Summary of report (Full report can be provided on request)

This is a brief opinion piece on the need for reform in how Fisheries Science postgraduate education and training is delivered in Australian universities.

Fisheries science has evolved into a distinct scientific field that requires interdisciplinary training in various aspects of biology and environmental science, quantitative methods and human dimensions. Fisheries science is primarily studied either at the postgraduate level or through continuing education in the work place. The Australian model of almost exclusive focus on research after the B Sc degree is causing serious problems with how to provide the training effectively. Some overseas universities and some other disciplines in Australian universities provide this training by providing formal postgraduate courses. I contrast the research model of higher education with the mixed research and teaching model to illustrate the difficulties we face in providing this training without formal postgraduate courses being available.

Much of the specialised fisheries science training needed in areas like quantitative fisheries methods or human dimensions is currently either provided in workshops or short courses or not provided at all. Special issues with short courses and how to make them most effective are briefly presented. Short courses will always have an important place especially to provide continuing education and also to provide postgraduate students advanced technical knowledge (for example in an advanced technical stock assessment workshop).

My conclusion is that using short courses as the basis of Australian postgraduate education in fisheries science and training is unsatisfactory and that the whole model of Australian postgraduate education in fisheries science needs to change. I suggest the need to set up multiple university consortiums to provide the postgraduate courses needed. In formulating solutions one can build on the approaches used overseas and in other disciplines in Australia. However, the solutions will need to be adapted and modified to suit the special challenges of Australian Fisheries education.