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Inquiry into the Role of Science for Fisheries and Aquaculture

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RECEIVED
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by:

The Chairman,
House of Representatives Standing Committee on
Agriculture, Resources, Fisheries & Forestry
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Dear Sir,

Inquiry into the Role of Science for Fisheries and Aquaculture

The Australian Marine Sciences Association, the largest association of professional marine scientists in the country, hereby wishes to lodge our submission with respect to the government Inquiry into the role of science for fisheries and aquaculture. We have consulted widely amongst our members for this submission and drawn on their considerable expertise with respect to the many specific aspects that your committee requested information about. We thank you for the opportunity to contribute to this important inquiry.

Yours sincerely,

Professor Lynnath Beckley
President of AMSA

Inquiry into the Role of Science for the future of Fisheries and Aquaculture

Submission by Australian Marine Sciences Association (3rd May 2012)

The Australian Marine Sciences Association (AMSA) is the nation's peak body of marine scientists with over 1,000 professional and student members spread around the country. Many of our members are engaged in the science supporting sustainable fisheries and aquaculture and we are pleased to be able to contribute to the federal inquiry into the role of science for the future of these industries.

In a recent major international assessment of the management effectiveness of the world's marine fisheries, Australia was highly rated (Mora *et al.* 2009). In particular, scientific robustness, policy-making transparency and probability of sustainability of fisheries were rated in the best category (Figure 1).

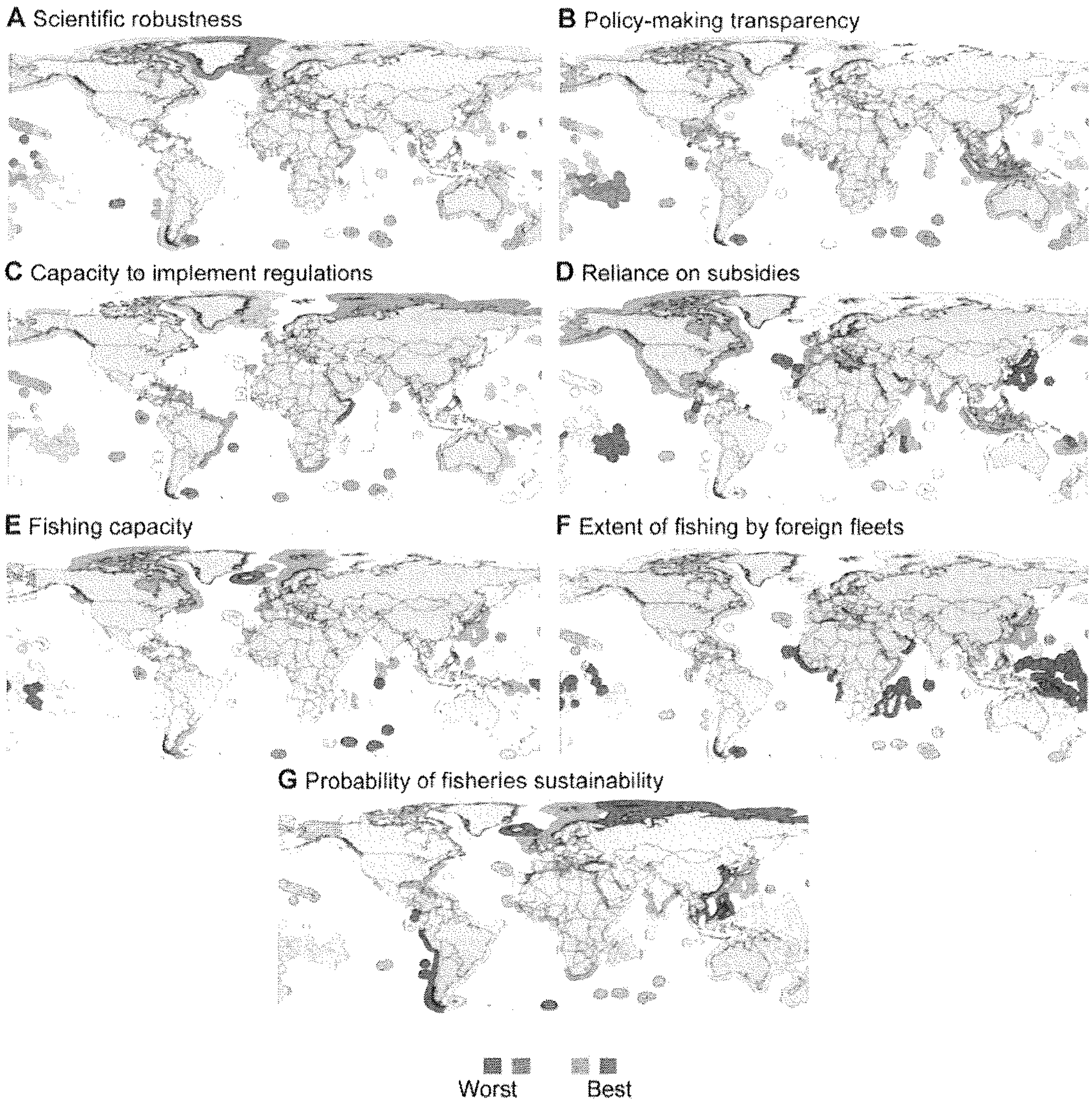

Figure 1. Management effectiveness and sustainability of the world's fisheries (Source: Mora *et al.* 2009).

With this as background we refer to the specific questions posed by the inquiry.

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

Fisheries in Australian waters target a wide diversity of fishes and invertebrates, particularly molluscs and crustaceans. Scientists have documented over 4,500 species of fishes in Australian waters (Hoese *et al.* 2006) and, each year, new species continue to be discovered and described in the scientific literature. Although the majority of fishes in the tropical north of Australia are of Indo-Pacific origin, many of our fish species are endemic (occur only in Australian waters) and the southern temperate areas have particularly high endemism (Fox & Beckley 2005, Gomon *et al.* 2008, Last & Stevens 2009). Unlike the fisheries in many other parts of the world, which tend to focus on huge catches of a few species, the oligotrophic boundary currents on both the east and west coasts of Australia do not support large single-species fisheries. Nevertheless, a huge variety of different species is caught in commercial, recreational and traditional fisheries in Australia (Yearsley *et al.* 2006). So, in the first instance, scientific knowledge of taxonomy and biogeography is essential for identifying the species upon which our fisheries and associated by-catch are based. The high endemism implies that, unless Australian scientists investigate these species, it is highly unlikely that the information necessary for sustainable fisheries management will be available from international sources.

In fisheries, stock discrimination is an important scientific activity contributing to management arrangements. For example, in the south-east fishery, stock differentiation has revealed clear distinction in gemfish stocks (Ward & Elliot 2001) and, more recently, the genetic structures of the blue-eyed trevalla and warehou species have been examined (Robinson *et al.* 2008). For the Western Australian black bream fishery, it has been shown that each estuary supports a genetically distinct stock (Chaplin *et al.* 1998) which needs to be managed accordingly. In contrast, in some tropical reef species in the north of Australia (Blaber *et al.* 2005) and also in wide-ranging, pelagic migratory species such as tuna (Hobday & Campbell 2009), the stocks may be shared between several countries and elucidation of this is paramount with respect to international co-operative arrangements.

The biology of species targeted by fisheries around Australia has long been investigated by fisheries scientists because basic information such as age and growth, reproduction, migration and mortality rates are fundamental to determining levels of sustainable use. For example, long-lived, slow-growing reef fishes that only mature after many decades [e.g. Western Australian dhufish attains > 40 years (Hesp *et al.* 2002)] cannot sustain the intensity of harvesting that short-lived, fast-growing, pelagic species can. Nevertheless, much research remains to be done, particularly in the northern parts of Australia where there has been less attention to the biology and ecology of many species now being targeted. Further, most of our fisheries rely on species that have a planktonic larval stage; understanding the scale of dispersal (Leis *et al.* 2011), connectivity of populations (Jones *et al.* 2011), nursery areas, and the relationship between settlement of juveniles and subsequent recruitment to the fisheries is of paramount importance. For example, the recent decline in puerulus settlement of the extremely valuable western rock lobster and subsequent management response is currently under considerable scientific scrutiny (Brown 2009, WA Dept of Fisheries 2012).

Fishes are important components of marine ecosystems, be they tropical coral reefs, temperate kelp beds, oceanic pelagic systems or any of the many other ecosystems around the coast of Australia. Fishes are vital links in marine food webs, operating at a variety of trophic levels from those feeding on phytoplankton or seaweeds through to apex predators at the top of the food chain. With the increasing importance of ecosystem-based fisheries management in Australia, ascertaining trophic linkages, modelling ecosystems and the effects of fisheries, and using end-to-end modelling to assist in strategic decision-making are assuming greater importance (Fulton 2010).

b) Fishery management and biosecurity

The scientific basis on which management recommendations are made is critical to the success of fisheries management (Walters & Martell 2004). One of the current major challenges facing fisheries management is how to deal with the ecosystem effects of fishing and, unless these interactions are understood, the risks associated with multi-species management will continue to grow. In addition to ecosystem modelling, fishery scientists are also developing risk-based approaches to this problem, using an ISO 17000 series risk management framework. This allows relative weightings of the risks posed by the various components and pressures on an ecosystem as well as informing sensitivity analysis to identify the major risks and drivers of change. It is anticipated that, in future, the role of science will be even more important in this regard especially considering cumulative anthropogenic disturbances in coastal ecosystems which importantly includes impacts related to climate change (see below).

In Australia, participation rates in recreational fishing are high compared to global norms with about 20% of the population participating in fishing at least once each year (Henry & Lyle 2003). This open access sector of Australian fisheries is relatively poorly studied with few time series available. This is despite the actual tonnage caught for some fish species exceeding that of the commercial sector (McPhee *et al.* 2002, Wise *et al.* 2007). In future, more scientific research will be necessary with respect to quantification of the recreational fishery in terms of spatial and temporal distribution, ecological impact and socio-economic benefits.

Co-incident with changes in fisheries management, over the last decade there has been extensive development of the Australian network of Marine Protected Areas for biodiversity conservation. In future, greater co-operation, integration and collaboration between fisheries and conservation managers is advisable as, increasingly, scientific research is demonstrating the associated concomitant fisheries benefits from protected areas (Russ & Alcala 2011). Nevertheless, the establishment of 'no-take' areas may result in displacement of fishing effort to other areas, and scientific investigations with respect to structural adjustment packages to buy out such fishing effort and alleviate financial hardship are encouraged.

In view of the concerted effort put into bioregional planning for the waters of the Exclusive Economic Zone of Australia over the past decade, there is obvious scope to extend this approach beyond biodiversity conservation to all sectors of marine management. Fisheries management is especially conducive to this as it relies on fish stocks which, by and large, have specific bio-geographical distribution patterns. The Australian Fisheries Management Authority has already made some progress in this respect. There remains, however, considerable scope for Australia to confirm its place as one of the world's leaders in marine management by further consolidating and integrating its bioregional planning to include fisheries and aquaculture, not only in Commonwealth waters but in state jurisdictions as well.

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

  Stock assessments require information on the fishery (e.g. total catch, catch rates, temporal and spatial extent) and the biology of the target species (including growth rate, age structure of the catch, age at first spawning, spawning time and location, fecundity, recruitment, migration patterns as well as estimates of natural and fishing mortality). Obtaining such information (which may be fishery-dependent or fishery-independent) relies on fisheries biologists and mathematical modellers, regular sampling by fisheries observers, compilation and analyses of catch data by scientists and computation of various scenarios with respect to yield. The wide application of ecosystem-based and precautionary approaches to the management of both commercial and recreational fisheries in Australia is expected to continue into the future.

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

  Recent scientific studies on the effects of climate change on fisheries indicate that extreme weather events, changes in ocean temperatures, currents and acidity will, and already are, changing the distribution and resilience of fish stocks (Munday *et al.* 2009, Gillanders *et al.* 2011, Meynecke & Lee 2011). It is also important to acknowledge that impacts of climate change are likely to be cumulative, although initially they may be non-lethal [e.g., reduced reproduction, changes in timing of reproduction and reduced rates of calcification in some species (Przeslawski *et al.* 2008)]. Severe impacts from climate change on fishing communities are expected and, in some places, are already in occurring due to increased abundance of invasive species and rising temperatures (Ling *et al.* 2009). In Australia, fisheries in some regions may benefit from climate change but other regions are likely to experience significant reduction of catches (particularly in southern temperate waters). There is an urgent need for scientific documentation of changes experienced so that management of fisheries can incorporate climate change impacts on fish stocks. An example of an ongoing scientific initiative to document range extensions of fishes is *'Redmap'* which includes fishers registering unusual sightings of marine species along the coast of Tasmania (www.redmap.org.au).

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

Minimising of risk to the environment and human health is vital in the fishing and aquaculture industries. For example, shellfish (such as mussels and oysters) are a high risk food group as they are filter feeders and therefore concentrate particulates from their aquatic environment. Contaminants that potentially impact on human health include pathogenic bacteria and viruses, toxic algae, heavy metals and pesticides. Shellfish quality assurance programs around Australia monitor and manage shellfish growing areas based on scientifically developed risk assessment and risk management procedures. Science plays a pivotal role in maintaining the currency of the Australian Shellfish Quality Assurance Program and covers issues on the scale of catchments (e.g., caused by human activities upstream), regions (e.g., changes to the distribution of toxic algae), or nationwide (e.g., technical trade issues caused by international developments that may be relevant to Australia). Scientific research often leads to outcomes that have considerable benefits and facilitates the updating of risk management practices which underpin positive human health and commercial outcomes.

- **Cooperation among Australian governments on the above**

There are numerous co-operative arrangements for management of fisheries between the State/Territory and federal governments and, in some cases, between states which share stocks of harvested species. It is essential that such co-operation persists into the future to ensure sustainable use of our nation's marine resources. AMSA endorses the priority issue of the COAG Standing Council on Primary Industries with respect to undertaking co-ordinated action across jurisdictions to strengthen long-term food security (particularly as fishes show no respect for political boundaries!).

c) Research, development and applied science of aquaculture

Aquaculture is dependent on scientific research. Knowledge about the life history and biology of candidate species enables informed decision-making regarding the most appropriate species to culture for return on investment and also to ensure the best growth rates and food conversion rates. Scientific research has supported the aquaculture industry throughout Australia since its inception, with numerous examples such as tuna aquaculture in Port Lincoln, Atlantic salmon in Tasmania, oysters in New South Wales, tropical rock lobster in Queensland, and the Kimberley pearl oysters.

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

To achieve independence from endangered wild stocks, closing the life cycle under culture conditions is essential for future sustainable aquaculture industries. In many instances the transition from wild fisheries to aquaculture is facilitated by selective breeding programs that give animals a growth and survival advantage over their wild counterparts. For example, the Sydney rock oyster industry, historically dependent on wild-caught spat, is increasingly transitioning to use of hatchery-produced spat due to the development of disease-resistant and fast growing lines (O'Connor & Dove 2009). Both the practices of selection and husbandry can lead to aquaculture stocks with reduced genetic variation relative to wild populations. Consequently, where selectively bred animals reproduce with, or settle into wild populations, changes in the genetic structure of wild populations may occur. There is a continued need for genetic studies assessing any change in the genetic structure of wild populations of animals in areas of significant aquaculture. Low levels of genetic diversity may reduce the capacity of wild populations to adapt to environmental change, lead to higher rates of inbreeding, and a reduction in population fitness. This is particularly important given the changes observed and projected from the impacts of climate change.

Spiny lobsters constitute Australia's most economically valuable wild-caught fishery but total production gains are likely to be relatively small unless supplemented through aquaculture. However, culture of hatchery-reared lobsters has proved difficult because of the protracted planktonic larval phase (exceeding a year in some species). The tropical rock lobster was identified as a suitable candidate for culture due to its relatively short larval phase and rapid post-juvenile growth rate (Jones *et al.* 2001, Jones 2009). In recent times, there have been significant advances, resulting in the production of hatchery-reared juveniles of this species. Full closure of the life-cycle has now been completed in captivity, representing a significant step towards the domestication of the species and a transition from wild fisheries to aquaculture. Commercial- scale hatchery production of this species in the future will represent a significant advancement for Australian aquaculture; progress that would not have been achievable without the contribution of science.

- **Improving sustainability and lifecycle management practices and outcomes**

The whole-of-ecosystem assessment of environmental issues for salmon aquaculture in Tasmania is an excellent example of the role of science in the development of aquaculture management and outcomes (Volkman *et al.* 2009). This comprehensive study which covered oceanography, hydrodynamic modelling, nutrient cycling, plankton ecology and biogeochemical modelling generated considerable knowledge on the key processes in the ecosystem, identified possible environmental effects, and led to the development of monitoring and modelling tools that could be linked to risk assessment. In this example, if monitoring indicates that the ecosystem no longer meets a particular trigger level then a series of management actions takes place. Similar scientific studies are necessary to improve sustainability and lifecycle practices and outcomes in some existing and future aquaculture developments around Australia (including those that may occur inland).

The pearl oyster aquaculture industry in the remote Kimberley region of Western Australia has been operating for decades. A recent project on the development of the scientific requirements of an Environmental Management System for the pearling industry has resulted in the pearling industry obtaining better information about sustainable development, management practices and ensured that there is minimal risk to the natural environment from pearl farming (Jelbart *et al.* 2011). Such studies highlight the role of science in the future of a sustainable aquaculture industry in Australia.

Globally, there is an increasing awareness of polyculture or integrated multi-trophic aquaculture where the wastes from farmed animals are used to grow other organisms. Scientific studies on Australian applications could provide innovative and economically feasible options and render aquaculture more environmentally sustainable as evidenced by recent studies with concurrent abalone and seaweed farming in South Africa (Troell *et al.* 2006)

- **Pest and disease management and mitigation**

Veterinary science, bacteriology, virology and pathology are vital sciences for aquaculture as the concentration of animals in captivity may create an environment conducive to disease. Increasingly, emerging diseases are threatening the commercial viability of some aquaculture industries. For example, QX-disease has forced closure of the Sydney rock oyster industry in six NSW estuaries over the past decade and the Pacific oyster herpes virus, recently detected in the Georges Estuary and Sydney Harbour, now also threatens the Pacific oyster industry. In many instances, these disease-causing parasites and viruses are much more widely distributed than may be suggested by the expression of the disease. Scientific investigation has led to an understanding of environmental triggers that lead to disease expression such as a decline in estuarine water quality (Butt *et al.* 2006). It has also assisted in ascertaining transmission pathways, which often involve intermediate hosts, and wild species that serve as reservoirs of the disease-causing parasites (Green *et al.* 2011). Selective breeding programs, underpinned by solid science, have developed disease-resistant family lines of aquaculture stocks for use in disease-afflicted estuaries (Dove & O'Connor 2009).

With much of the nation's aquaculture industry based upon non-native species, science has also played a critical role in ensuring that these do not become pest species. At the production phase, improvements in technologies for producing sterile triploids have enabled aquaculture industries to expand into areas where they were previously considered a bio-security risk. Ecological studies addressing interactions between non-native aquaculture and native species have been vital in ascertaining and managing invasion risk (Krassoi *et al.* 2008). Well-designed ecological assessments are also required to monitor any impact or proliferation of aquaculture species in natural ecosystems following their introduction for aquaculture (Bishop *et al.* 2010). With the anticipated increase in the development of aquaculture in the future, similar studies will be essential.

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

AMSA endorses the priority issues of the COAG Standing Council on Primary Industries with respect to undertaking co-ordinated action across jurisdictions to reform the national biosecurity system, to promote the ongoing productivity and sustainability of primary industry, and to strengthen long-term food security.

There are strong links between science and governance of fisheries and aquaculture, particularly in view of the support by states of ecologically sustainable development. This is a process that requires a thorough scientific understanding of natural resources, ecosystem processes and the changes that may occur as a result of fishing or aquaculture activities.

e) Current initiatives and responses to the above matters by state, territory and Australian governments

Fishery science is challenging, expensive and needs to be undertaken over long periods in order to develop the knowledge-base which takes into account environmental variability and ecosystem complexity. However, unless such science is undertaken, the needs of management (including informed decision-making) will not be met. This could result in imposition of overly conservative and risk-averse management decisions or, on the other hand, poorly informed management decisions could increase the risk of stock collapse.

The outcomes statement of the 2002 World Summit on Sustainable Development contained a commitment to phasing out destructive fishing practices in the marine environment by the year 2012. Australia endorsed this statement. AMSA reminds the state and federal governments of Australia of this commitment to phase-out destructive fishing practices.

f) Any other related matters

Research into fisheries and aquaculture in Australia is funded through several sources. While the total research funding has not been estimated, it is likely to be substantial once personnel, ships, equipment/infrastructure and administration are all taken into account. In many cases co-investment is also required from industry, either as in-kind support (access to catch records, accommodating fisheries observers, participation in co-management committees etc) or direct cash/levies.

Historically, the commercial fishing industry and aquaculture producers have been seen as the primary stakeholders involved in setting research and development priorities, along with scientists and management agencies. More recently, however, the recreational sector has been identified as an important stakeholder and, increasingly, this is likely to be an important area to consider when setting priorities. Stakeholders such as indigenous fishers and community groups have also had relatively little direct input into, or opportunities for, setting the national research agenda.

In terms of funding by the Australian Research Council, very few grants are awarded each year in the Fisheries Sciences field of research code (0704). However, considerable other research into marine and freshwater ecosystems is funded (under different codes) and contributes significantly to our understanding of the aquatic organisms and ecosystems that underpin sustainable fisheries management and development. Similarly, a significant research contribution is made through the CSIRO, Australian Institute of Marine Science, the universities and state government research branches.

Australia contributes significantly to global fisheries and aquaculture science, both through the wider significance of research done here, and through collaborative research with international scientists. Australia also demonstrates excellence in the institutions involved in the training of fisheries and aquaculture scientists and many international students come from around the world to study here. In the national Excellence in Research Assessment in 2010, all five of the institutions who submitted for assessment under the Fisheries Sciences field of research code (0704) were ranked 'above world standard'. This bodes well for the role of science in the future of fisheries and aquaculture in Australia.

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