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Inquiry into the Role of Science for Fisheries and Aquaculture

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The Chair
The Hon. Dick Adams MP
House of Representatives Standing Committee on
Agriculture, Resources, Fisheries and Forestry
Parliament House
CANBERRA ACT 2600

Inquiry into the Role of Science for Fisheries and Aquaculture

Dear Hon. Dick Adams

Please find attached the submission from the Primary Industries and Regions South Australia (PIRSA) for the Commonwealth House of Representatives Agriculture, Resources, Fisheries and Forestry Committee's inquiry into the role of science for fisheries and aquaculture.

Should you require any further information please do not hesitate to contact me.

Yours sincerely

Ian Nightingale
CHIEF EXECUTIVE

Submission to:

House of Representatives Standing Committee on

Agriculture, Resources, Fisheries and Forestry

Regarding their inquiry into

The Role of Science for Fisheries and Aquaculture

Executive summary

The Primary Industries and Regions South Australia (PIRSA) welcomes the opportunity to make a submission to the Commonwealth House of Representatives Standing Committee on Agriculture, Resources, Fisheries and Forestry inquiry into the role of science for fisheries and aquaculture.

The key messages in this submission are:

1. Australia and South Australia have a long history of successful fishery management because it is underpinned by comprehensive science, monitoring and data collection programs that are linked to fishery management plans. These plans document management decision frameworks and harvest strategies that, themselves, have a foundation in science and evidence-based decision making.
2. There are core science and data needs related to stock assessment and harvest strategies that should be met to ensure appropriate catch levels are set. High certainty in stock assessment (and hence catch settings) requires high quality, diverse data and the application of contemporary scientific methods.
3. Science is integral to developing innovative solutions in fisheries and aquaculture, which in turn leads to increased productivity and the development of risk-based approaches to management.
4. Science plays a key role in ensuring a comprehensive understanding of the ecological impacts of fisheries and the development and testing of strategies to ensure the risks to the natural environment are minimised.
5. Pest and disease prevention relies on a science-based framework that manages risk. Biosecurity science has delivered enhanced risk assessments, diagnostic tools, disease management and mitigation, biosecurity principals and provided the foundation for policy development and structured systems for pest surveillance and management.
6. Science has enabled human health issues in seafood to be identified, including the development of risk assessments and risk reduction strategies to enable government and industry to implement appropriate risk management guidelines and protect our valuable seafood industries.
7. Science-based, innovative approaches have enabled South Australia to develop successful aquaculture operations. The two key elements underpinned by science are (1) policy, legislation and regulation; and (2) the diversity in species cultured and environments used.

8. Significant opportunities for science in relation to fisheries and aquaculture, include: (1) consolidating research activities, and in particular stock assessments to a reduced number of agencies with scientific capacity and capability (i.e. critical mass), which would provide economic efficiencies in an ever challenging funding environment; (2) developing closer linkages between wild fisheries and aquaculture through stock enhancement and adding value through grow-out to increase production volume and value; and (3) expanding both production from existing cultured species and the number of species cultured.
9. Ongoing dedicated funding through the Fisheries Research and Development Corporation and relevant Co-operative Research Centres, including co-investment from industry and research partners is critical to continue delivering key scientific outcomes required for the sustainable management and utilisation of fisheries resources and improved productivity in aquaculture operations. Partnerships between industry, management and research providers are fundamental in delivering these outcomes.

Background

This submission to the Commonwealth House of Representatives Standing Committee on Agriculture, Resources, Fisheries and Forestry has been prepared by the Primary Industries and Regions South Australia (PIRSA). The submission incorporates views from the PIRSA research and policy divisions related to fisheries and aquaculture. These include the South Australian Research and Development Institute (SARDI) and the Fisheries and Aquaculture Division.

SARDI is the South Australian Government's principal research institute that undertakes research to support the sustainable utilisation of aquatic resources and environments across southern Australia in a series of major science programs including Fisheries, Aquaculture, Inland Waters and Catchment Ecology, Oceanography, Marine Environment and Ecology and Seafood. Research from these science programs leads to direct outcomes for the seafood industries of South Australia.

PIRSA Fisheries and Aquaculture is the government agency responsible for ensuring that the aquatic resources and aquaculture industries of South Australia are managed in accordance with the principles of ecologically sustainable development.

South Australia's marine, estuarine and freshwater aquatic resources are community owned resources. The role of the Government, as custodian of these resources on behalf of the broader community and future generations, is to ensure that they are protected and used in a manner that is consistent with ecologically sustainable development.

The fishing and aquaculture industries are of significant importance to the South Australian economy. In 2009/10, total production across the commercial fishing and aquaculture sectors was about 67,000 tonnes (t), valued at $395M (ABARES 2011). Of this, wild fisheries catch accounted for about 47,000 t ($200M) and aquaculture 20,000 t ($195M) and, collectively, they provided employment for nearly 3,000 people. For aquaculture, this represents significant growth from the late 1980s, when it was almost non-existent. In 2009/10, the most valuable commercial fisheries were those targeting Southern RockLobster, Western King Prawns, Abalone and Australian Sardine (ABARES 2011). For aquaculture, the most significant species were Southern Bluefin Tuna, which involves ranching wild caught fish to increase quality and value, Pacific Oysters and Yellowtail Kingfish (ABARES 2011). Recreational fishers also undertake significant fishing activity and harvest substantial numbers of fish (Jones 2009). Since most wild fisheries and aquaculture activities occur away from Adelaide, these activities provide significant social, economic and employment benefits to regional South Australia.

This submission addresses the following 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
e) Current initiatives and responses to the above matters by state, territory and Australian governments.

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

Human demand for seafood has resulted in increasing pressure to exploit aquatic resources. Fisheries provide crucial employment and income for millions of people around the world. According to the Food and Agricultural Organisation of the United Nations, total global wild catch production is relatively stable at about 90 million tonnes; albeit that the demand for seafood continues to grow.

Fishery management in Australia and South Australia is underpinned by comprehensive science, monitoring and data collection programs that are linked to fishery management plans documenting management decision frameworks and harvest strategies that, themselves, have a foundation in science. Furthermore, the most robust frameworks are built on a partnership between management, industry and the science provider.

The scientific basis for management relies on the analysis and interpretation of (ideally) long-term data sets. These data sets and their analysis and interpretation comprise the fundamental basis for decision making. In South Australia, and elsewhere, this has been facilitated by the recovery of funds from industry that are dedicated to meeting core science and data needs related to stock assessment and harvest strategies. High certainty in stock assessment (and hence catch settings) requires high quality, diverse data and the application of contemporary methods. Both need financial resources but, collectively, they provide a sound and robust framework for provision of scientific advice.

Over time, there has been a shift from understanding the biology of harvested species to comprehensive fishery stock assessment for single species. These assessments typically synthesise data provided by commercial fishers (i.e. catch, fishing effort, catch rate) and that collected by researchers (i.e. survey estimates of abundance); the multiple data sets are often integrated by sophisticated numerical models that provide outputs in a risk-analysis framework. Much of the development and improvement of these scientific approaches has been funded by the Fisheries Research and Development Corporation (FRDC) through competitive research grants, as well as through co-investment by industry and research and management agencies, such as SARDI and PIRSA.

In recent years, fisheries assessments have been transitioning towards providing science-based advice to support ecologically sustainable development (ESD) and ecosystem-based fishery management (EBFM) objectives which are relevant to management of aquatic resources and systems in the 21st century. In most cases, these have a strong focus towards threatened, endangered and protected species (TEPS). This includes evaluation of bycatch, trophic interactions and the evaluation of cumulative and/or interactive extractions where competition for resources is high (e.g. in the Spencer Gulf there are fisheries for Abalone, Prawns, Blue Swimmer Crabs, Sardines, Snapper, Garfish, Whiting and Southern RockLobster, among others, as well as significant aquaculture industries for Southern Bluefin Tuna and Yellowtail Kingfish). Using a similar, science-based approach, environmental water requirements, habitat rehabilitation, land use and catchment management underpin the sustainability of ecosystems for inland fisheries.

Given these complexities, there is a need for a scientific, multi-disciplinary approach to integrate fisheries, biological, ecological, environmental and economic data to provide

information and advice to underpin multiple-use (e.g. fishing, aquaculture, mining, tourism and shipping), resource allocation and management of these complex marine and freshwater systems. Comprehensive oceanographic and environmental data collection programs, such as the Southern Australian Integrated Marine Observing System, will be critical for underpinning future broader ecosystem models that assess the impacts of multiple-use in marine systems.

Science programs have also been developing frameworks around uncertainty so informed decisions can be made even where data are limited or imperfect. This incorporates a risk-based approach and enables the costs of research, monitoring and assessment to be explicitly linked to the sustainability risk posed by catch. Thus, lower catches, with consequent lower risk, require less research, monitoring and assessment. However, more comprehensive scientific information is required to support less-conservative harvest decisions.

Science also supports other areas related to fisheries. These include animal health, harvest methods, product development, product diversification, product quality and market access. These approaches substantially increase the value of the wild catch production and are currently being supported by funding through the Australian Seafood Co-operative Research Centre.

Fishery management and biosecurity

Scientific information plays a key role in ensuring the aquatic resources of South Australia are managed in an ecologically sustainable and economically efficient manner.

The *Fisheries Management Act 2007* requires the development of fishery management plans that:

- Describe the biological, environmental and social characteristics of the fishery
- Identify and assess ecological impacts
- Identify the objectives, goals and strategies
- Specify the share of the fishery to be allocated to each fishing sector
- Detail the harvest strategy for the key target species
- Detail research and stock assessment requirements
- Detail compliance and monitoring requirements
- Detail the regulatory arrangements.

A harvest strategy is a critical component of broader fishery management strategies and forms an explicit part of a fishery management plan. Harvest strategies focus on how decisions are made in setting exploitation levels for key species. Harvest strategies are developed by fishery managers, working closely with fisheries scientists and industry members, and take into account the best available scientific information, including the biological characteristics of the species, stock status, ecological impacts and environmental influences.

The key elements of harvest strategies (defined objectives, performance indicators, stock assessments, target and limit reference points, and decision rules) vary considerably in their application across Australian jurisdictions. The Australian Fisheries Management Forum (AFMF) agreed that a coordinated, nationally consistent approach to developing harvest strategies for Australian fisheries was required and developed a research project to address this issue, which was funded by the Fisheries Research

and Development Corporation (FRDC). PIRSA Fisheries and Aquaculture is currently leading this research project titled 'Development of a National Harvest Strategy Framework' (FRDC Project 2010/061) to establish a framework for the development of harvest strategies across Australian fisheries management jurisdictions.

Fisheries management plans also outline strategic research priorities and document the collection, analysis and interpretation of scientific data and how this information is used to inform management decisions.

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

Scientific assessments, including the analysis of catch and effort data provided by commercial fishers and direct survey measures of the distribution, abundance and biomass of target species, are the basis for determining stock size, estimating sustainable yields and minimising bycatch.

Data typically provided by commercial fishers include catch (kg landed), fishing effort (hours/days fished), fishing location, date fishing occurred, and information on the length/age structure of the catch. Most of these data are obtained from mandatory commercial logbooks that are completed for each fishing trip. The ongoing collection and analysis of these data are critical, particularly for those fisheries where these may be the sole data source for decision-making.

Scientific (or fishery-independent) surveys undertaken by South Australian researchers use a variety of methods to obtain data for estimating abundance and biomass of key commercial species. These include direct observation by divers (e.g. Abalone), trawl surveys (e.g. Prawns), netting (e.g. Garfish), fish egg and larval surveys (e.g. Sardines) and the use of pots (e.g. Southern RockLobster and Blue Swimmer Crab). Surveys of fishing effort and catch by recreational fishers are also undertaken. Typically, there are two key advantages of these data over those provided by commercial fishers: (1) they provide data from both the legal-sized and sub-legal-sized components of the target species; and (2) they are representative of the stock and the fishery.

In combination, the data collected by researchers and that provided by commercial fishers are integrated through a range of diverse analyses and models to estimate stock size and determine sustainable yields. Three South Australian examples are: (1) data from egg, larval and adult fish sampling across the spawning grounds are integrated by the daily egg production model to estimate the spawning biomass of sardines, which is combined with a series of harvest decision rules to set quota in this fishery, which is the largest in Australia by weight; (2) pre-fishing trawl surveys are used to determine the distribution and abundance of Western King Prawns so that fishers are able to maximise profitability and efficiency by targeting fishing into suitable fishing grounds during the subsequent fishing period; and (3) biennial surveys on mud cockles provide estimates of sustainable yields within a risk analysis framework.

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

It is likely that climate change will influence Australia's aquatic environment and fisheries. Potential impacts are likely to be both positive (e.g. increased pelagic fish production) and negative (e.g. reduced abalone production from Spencer Gulf).

The current science focus through the multi-agency funded South East Australia Program (SEAP) is towards preparing fisheries for climate change through awareness of potential changes and examination of management approaches to take advantage of the positive, and mitigate the negative, impacts of climate change. This follows from a broad risk assessment of fisheries and aquaculture and subsequent species-specific risk assessments.

Impacts of climate change will occur over an extended period of time. This will require science-based, long-term monitoring and assessment of changing environmental conditions, species distributions, productivity changes and temperature-driven changes to the biology of individual species (e.g. minimum legal sizes reflect the interaction between rates of growth and size at sexual maturity, both of which may be strongly influenced by temperature).

Pests and disease management and mitigation

Pathogens and non-indigenous pest species are a substantial threat to fisheries production and the aquatic environment.

Managing aquatic diseases and invasive species is challenging and expensive because containment is difficult. Once established, these agents are usually impossible to eradicate. Australian species and environments are often susceptible to pests and diseases, compounding the difficulties of management.

Pest and disease prevention relies on a science-based framework that manages risk. Diagnosing and managing diseases requires complex veterinary science and epidemiology (e.g. outbreak of abalone viral ganglioneuritis in Victoria). Managing pests requires environmental and ecological science (e.g. carp control in the River Murray using Cyprinid herpes virus, separation cages and pheromones).

In addition to enhanced risk assessment, aquatic biosecurity science has delivered diagnostic tools, disease management and mitigation, biosecurity principals and provided the foundation for policy development (e.g. AQUAPLAN and AQUAVETPLAN). Science has also structured systems for pest surveillance and management (i.e. The National System for the Prevention and Management of Marine Pest Incursions).

Strategic scientific research, including (1) more applied risk assessment; (2) socio-economic and cost-benefit evaluation of emergency responses; (3) more sensitive surveillance systems that are less resource intensive; (4) management of existing pests and diseases, including identification, epidemiology and development of diagnostic tools; and (5) effects of climate change on aquatic pests and diseases would enhance biosecurity. These will underpin delivery of the Beale review recommendations for shared biosecurity plans for monitoring, surveillance and cost agreements.

Minimising risks to the natural environment and human health

Scientific information plays a key role in ensuring a comprehensive understanding of the ecological impacts of fisheries and the development and testing of strategies to ensure the risks to the natural environment are minimised. This enables the ESD and EBFM objectives consistent with contemporary fisheries management to be realised.

The *Fisheries Management Act 2007* requires that ecological impacts be identified and assessed, as the first step in developing a fishery management plan. The Act specifically requires that the following impacts are identified:

- Current known impacts of the fishery on the ecosystem
- Potential impacts of the fishery on the ecosystem
- Ecological factors that could have an impact on the performance of the fishery.

These impacts/risks must be assessed to determine the most serious ones, whilst strategies for addressing them must be developed. The ecological impacts associated with individual fisheries are identified, assessed and prioritised through the process of conducting an ecologically sustainable development (ESD) risk assessment. The National ESD Reporting Framework for Australian Fisheries (Fletcher et al. 2002) is the risk assessment process used in South Australia.

Such risk assessments ensure that fisheries consider all real, potential and perceived impacts on the environment. There is, however, a need to expand these science-based risk assessments to include cumulative/interactive extractions across broader spatial areas and regions.

Identification of potential risks to the natural environment has been followed by rigorous scientific programs to establish the extent of, and test strategies to mitigate, possible impacts. These science-based approaches provide a high level of confidence to all stakeholders that these fisheries are ecologically sustainable.

The following are five South Australian examples where science has provided significant outcomes to minimise the impacts of fishing. First, the need for an ecological allocation of sardines for key predators (including fur seals, sea lions, sea birds and dolphins) was formally evaluated. Second, methods to reduce the entrapment and mortality of dolphins in purse-seine nets were developed and subsequently examined for effectiveness. Third, approaches to diminish interactions between Australian sea lions and rock-lobster pots were evaluated. Fourth, structured, systematic surveys on prawn trawl bycatch in Spencer Gulf have enabled the fishery to identify areas and species susceptible to trawling. Fifth, there has recently been the development of an alternative net design that minimises bycatch, maximises escapement of juvenile prawns and improves the quality of prawns captured.

In some circumstances seafood can be impacted by a range of contaminants that are detrimental to human health if present at significant levels. These contaminants include pathogenic bacteria, food-borne viruses, toxic algae, heavy metals and other chemical residues. To enable government and industry to implement appropriate risk management guidelines it is necessary to scientifically evaluate factors such as: the prevalence of contaminants in the environment and seafood; potential exposure of humans to contaminants through seafood consumption; contaminant uptake and elimination in seafood; and risk reduction strategies that can be implemented through the supply chain.

A core function of SARDI is the provision of human health risk assessments which comprehensively evaluate these factors and are undertaken within the Codex risk assessment guidelines. Recent examples of core science undertaken by SARDI include: studies on the national prevalence of food-borne viruses (e.g. hepatitis A and norovirus), pathogenic bacteria (e.g. *Vibrio parahaemolyticus* and *Vibrio vulnificus*), and marine biotoxins in seafood and the environment; the official EU residue and contaminant monitoring program for aquaculture products (under a delegation from

DAFF); and risk assessments focused on marine biotoxins in bivalve shellfish and abalone, vibrios in bivalves and prawns, heavy metals in crustaceans, and parasites in finfish.

SARDI provides these scientific outputs to various Australian and New Zealand government agencies including FSANZ, NSWFA, Tasmanian DoH, PIRSA/SASQAP, and the NZ Food Safety Authority. The science provided has resulted in the implementation of new policies that reduce the public health impact of contaminants in seafood, and the reduction/removal of technical barriers to trade for seafood.

The South Australian Shellfish Quality Assurance Program (SASQAP) is a joint initiative between PIRSA and the fishing and aquaculture industries of South Australia. The main role of SASQAP is to provide public health protection for consumers of South Australian shellfish and thus allow the development of a sustainable shellfish industry across the state. SASQAP is managed from Port Lincoln South Australia, where it operates a NATA Accredited laboratory performing all microbiological testing.

Cooperation among Australian Governments on the above

There is significant co-operation among Australian Governments in relation to fisheries science and management. For example, there are several national forums (e.g. Primary Industries Standing Committee; Australian Fisheries Management Forum; Australian Biosecurity Intelligence Network; National Cooperative Research Infrastructure Scheme; Australian Shellfish Quality Assurance Advisory Committee; SafeFish; Subcommittee on Aquatic Animal Health; Murray-Darling Basin Native Fish Strategy Fish Advisory Panel) where common issues are discussed.

The South East Australia Program, which is working to help prepare fisheries for climate change, is a good example of Commonwealth and State Governments working collaboratively to address a regional issue. The States involved in this program are New South Wales, Victoria, South Australia and Tasmania.

Cross-border analyses, assessments and management are likely to be increasingly required in future years. This is because (1) in some cases it would more appropriately reflect stock structure and species movement patterns; and (2) costs to the fishing industry could be reduced through efficiencies obtained by consolidating stock assessments and research to a reduced number of agencies with critical mass and appropriate skills.

The alliance between SARDI Aquatic Sciences and the Victoria's Department of Primary Industries provides a good example of stock assessment consolidation. Currently, South Australia is undertaking rock lobster assessments for the Victorian rock lobster fishery, with additional fisheries likely to be assessed under similar contractual arrangements in the future.

The human health risk assessments generated by SARDI are undertaken in conjunction with public health regulators and are used to underpin effective risk management policy, both domestically and internationally. This national cooperation ensures that research outputs are used by national regulators to add significant technical substance when addressing technical issues (market entry barriers) as part of negotiations for retaining access to existing markets (including the domestic market) and/or establishing entry to new markets. This strength enables collaboration with trade jurisdictions (Codex, DAFF and FSANZ) ensuring emerging technical barriers to trade

are predicted in advance of market access negotiations and are proactively mitigated to prevent costly port-of-entry shipment rejections.

Recently, SARDI through resources provided by the Australian Seafood Cooperative Research Centre, established a national forum called SafeFish. SafeFish is a partnership of Commonwealth and State Government technical experts, including representatives of DAFF and FSANZ. SafeFish aims to ensure the safety of Australian seafood, address technical barriers to trade, and act as a clearing-house for research projects that address technical trade and food safety priorities identified by the Seafood Access Forum. This has seen greater engagement and collaboration between industry, seafood regulators and trade officials.

Research, development and applied science of aquaculture, including:

Transitioning from wild fisheries to aquaculture in individual species

Demand for high quality seafood both domestically and internationally continues to grow. As the production from wild catch fisheries plateaus, aquaculture has been and will continue to meet the gap in demand. In the CSIRO report titled 'Modelling Australia's Fisheries to 2050', aquaculture production is estimated to double in tonnage by 2020, and then double again by 2050 due to consumer demand.

The aquaculture industry in South Australia is very diverse and includes Southern Bluefin Tuna, finfish, Oysters, Mussels, Yabbies, Marron, Barramundi and Abalone. The success of the aquaculture industry has been dependent on scientific investigations relating to the development of farming systems and artificial fish diets, as well as understanding the basic biology of the species. Scientific research is ongoing to investigate the suitability of new aquaculture species and technologies to further develop the aquaculture industry in South Australia.

South Australia's aquaculture industry continues to farm both on land and at sea through innovative technologies, and effective government management regimes and support. PIRSA Fisheries and Aquaculture's activities are underpinned by ongoing research to ensure that ecological sustainable development is achieved.

Approximately 6,000 hectares of water are currently allocated for aquaculture production and 11 aquaculture zone policies have been developed to secure access to the resource. An aquaculture zone is an area in the sea designated for aquaculture activities. An aquaculture zone policy stipulates the amount of area available for leasing, the types of aquaculture than can be undertaken and the biomass that can be farmed in the area. A carrying capacity model developed by SARDI is used to calculate the maximum quantity (or biomass) of fish that can be farmed.

The process for developing aquaculture zones begins with a combination of desktop analysis and the collection of field data information from wide regions considered suitable for aquaculture development. Following consultation with the aquaculture industry, smaller areas are identified for possible aquaculture zone development. It is these areas that are targeted for a more detailed technical investigation undertaken by SARDI to determine the suitability of a zone for aquaculture activities.

When assessing individual aquaculture applications, PIRSA Fisheries and Aquaculture uses a strict set of guidelines to assess potential environmental impacts associated with the proposed activities. PIRSA Fisheries and Aquaculture's ESD risk assessment process is based on the National ESD Framework (Fletcher et al. 2004), which is

underpinned by the Australian and New Zealand Standard/International Standards Organisation AS/NZS ISO13000:2010 for risk management. The integrity of the assessment process rests on understanding the nature of the environment in which aquaculture is practised, and the manner in which aquaculture interacts with or changes the environment that surrounds it. This ultimately contributes to the ecologically sustainable development of all sectors of the aquaculture industry in South Australia. These assessments are justified by relevant peer reviewed scientific literature.

Science has provided pivotal support to the aquaculture sector and the alignment of fisheries and aquaculture operations provides an opportunity to maximise scientific benefits. Driven by economic need due to an increasingly restricted wild quota fishery, the Southern Bluefin Tuna aquaculture (ranching) industry is probably Australia's best example of the benefits of this linkage. The Southern Bluefin Tuna ranching industry sector approximately doubles the weight of fish available for sale from a quota restricted wild fishery, and enhances the market price of the fish by enabling growers to produce a higher-quality product and better target times of higher market price ("smart marketing").

Improving sustainability and lifecycle management practices and outcomes

Science-based approaches have enabled South Australia to develop successful aquaculture operations. These approaches are required because a high level of knowledge on the biology of the cultured species is necessary. Scientific information is fundamental to investment decisions, business development and risk management. Subsequently, technical developments for site selection, culture system designs, hatchery seed production, grow-out, and harvest all depend on scientific information.

Scientific information has enabled aquaculture to develop rapidly in South Australia. Two examples are the Pacific Oyster industry, which developed rapidly after a scientific feasibility study and culture systems were completed in 1986, and the Southern Bluefin Tuna ranching industry. Currently, a diverse array of species is cultured in South Australia. These include Southern Bluefin Tuna, Yellowtail Kingfish, Pacific and Native Oysters, Abalone, Mussels, microalgae, Mulloway, Salmonids, freshwater crustaceans and finfish, and a number of aquarium species and live feeds for them. This capitalises on the State's natural competitive advantages, in particular its "clean green waters", two major gulfs, numerous shallow large bays, warm temperate environment, and inland geothermal and saline ground waters. Investment in scientific research has enabled this level of diversity in both species cultured and environments used.

Other examples where science has played a significant role in aquaculture in South Australia include (1) the propagation and at-sea-culture of Snapper, Mulloway, and Yellowtail Kingfish; (2) tank culture of Mulloway using Riverland salt interception scheme groundwater; and (3) onshore tank and at-sea-cage culture of Cockles, Mussels and Native Oysters. Nutrition research has been instrumental in developing commercial manufactured feeds for Abalone, Yellowtail Kingfish and Southern Bluefin Tuna. In each case, scientists continue to work with aquaculturists and commercial aquafeed producers to further refine the products available.

There is an opportunity to expand both production from existing cultured species and the number of species cultured (e.g. Cockles, Octopus, microalgae for biofuels and macroalgae). However, this requires scientific investment into (1) biology and culture

and (2) evaluation of multiple resource users in an ESD framework. The Fisheries Research and Development Corporation and the Australian Seafood Co-operative Research Centre, along with co-investment from SARDI, are providing support for some of these initiatives that, if successful, will provide for further expansion of the production and value of this sector.

Another opportunity is to develop closer linkages between wild fisheries and aquaculture particularly through linking to markets. Thus, "smart marketing", rather than "transitioning" could combine aquaculture with wild fisheries to increase the value of production. The third opportunity is to develop mixed-species aquaculture.

In South Australia, aquaculture policy, legislation and regulation are based on science to ensure ESD and underpin (1) equitable sharing of coastal waters among stakeholders; (2) associated, regional aquaculture coastal zone plans; and (3) environmental monitoring programs, including hydro-biogeochemical models to determine carrying capacity of farmed species.

Science will be increasingly important in providing advice to Government and aquaculture businesses for making complex resource allocation decisions (e.g. Spencer Gulf, where there is increasing competition between aquaculture, fisheries, tourism, mining, shipping, etc), and to provide support for adapting or amending policies and/or activities with respect to climate change. This will maintain the competitive advantage of Australian aquaculture.

Pest and disease management and mitigation

Aquaculture can cause aquatic pests and diseases to spread or proliferate because of high stock densities, stresses that can be induced by a culture environment, and the translocation of stock/infrastructure. Pathogen containment in aquatic environments is problematic because most aquaculture systems are "contiguous" with the surrounding environment (including sea-cages and shore-based, flow-through systems).

There is an opportunity for scientific research to provide frameworks for managing risk and diseases by enhancing surveillance systems, epidemiology and diagnostic tools. These will underpin sector-specific biosecurity plans.

The aquatic resources of South Australia are community owned and as such management of biosecurity issues relating to fisheries and aquaculture activities are paramount to maintaining a healthy environment. PIRSA Fisheries and Aquaculture is committed to minimising the risk of disease through participation in state and national forums (e.g. Network for Aquatic Animal Health in South Australia) where aquatic animal health issues and future research priorities are discussed.

Fundamental to ecological sustainable development practices, PIRSA Fisheries and Aquaculture are developing policies and emergency response procedures in relation to mitigation and management of pests and disease based on peer reviewed scientific literature and discussions with researchers and veterinarians at state and national levels.

Governance arrangements relating to fisheries and aquaculture

PIRSA Fisheries and Aquaculture administers the *Aquaculture Act 2001*, the *Fisheries Management Act 2007* and associated regulations.

The *Aquaculture Act 2001* establishes a framework to promote sustainable aquaculture industry growth through aquaculture planning, zoning, leasing and licensing. The South Australian Aquaculture Act is the only one of its type nationally and has been cited by industry participants as a competitive advantage in terms of business and investment certainty and supporting sustainability.

The objects of the *Aquaculture Act 2001* are to promote ecologically sustainable development of marine and inland aquaculture; to maximise benefits to the community from the State's aquaculture resources; and otherwise to ensure the efficient and effective regulation of the aquaculture industry.

The *Aquaculture Act 2001* establishes the Aquaculture Advisory Committee (AAC). The functions of the AAC are to advise the Minister on any matter relating to aquaculture that should, in the opinion of the AAC, be brought to the Minister's attention; and to advise the Minister on the administration of the *Aquaculture Act 2001*. Members of the AAC are appointed by the Governor and include scientific expertise.

The *Fisheries Management Act 2007* provides for the conservation and management of aquatic resources of the State, the management of fisheries and aquatic reserves and the control of exotic aquatic organisms and disease. Ecologically sustainable development is established as the overall object of the *Fisheries Management Act 2007* and a number of biological, social and economic factors are identified that must be balanced when trying to achieve this. However in pursuing sustainable development, the principle of protecting resources from over-exploitation is deemed to take precedence over all other principles outlined in Section 7(1).

The *Fisheries Management Act 2007* establishes the Fisheries Council of South Australia. The Council has responsibility for the preparation of management plans under the Act and for advising the Minister on a range of fisheries management matters. In particular, the Council has been formed to provide advice on strategic issues such as allocation and promoting the co-management of fisheries.

The South Australian Government has a policy of full cost recovery for the management of commercial fisheries, which has been in effect since 1995. Under this policy, licence holders pay through licence fees for the cost of managing their respective fisheries and are involved in developing the policy, compliance, research and other programs for the fishery.

South Australia's aquaculture and fisheries legislation invokes the precautionary principle. Where there are considered to be threats of serious or irreversible damage to fisheries resources, or the environment upon which they depend, a lack of full scientific certainty or insufficient information will not prevent the Government from making decisions. Where resource management decisions must be made in an environment of uncertainty, the Government, in partnership with the fishing industry, will take a precautionary approach to the management of South Australia's aquatic resources.

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

As part of its commitment to supporting industry growth and developing an adaptive resource management framework, PIRSA Fisheries and Aquaculture plays a key role in a number of strategic research initiatives. One of the division's major research programs is the Innovative Solutions for Aquaculture Planning and Management suite

of projects (IS). The IS Program is a joint initiative between PIRSA Fisheries and Aquaculture and the Fisheries Research and Development Corporation (FRDC) that fosters the continued development of South Australia's aquaculture industry in an ecologically sustainable manner.

PIRSA Fisheries and Aquaculture developed a communication and extension plan to ensure that the outputs from all IS projects are communicated and extended to end-users and beneficiaries both in South Australia and nationally. To date, this has assisted in the integration of research outcomes into decision making processes such as those associated with aquaculture zoning, disease control, and managing interactions with protected wildlife species.

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