4

Every stage in the domestication of plant and animal life requires inventions, which begin as technical devices, and from which flow scientific principles. The basic devices of the nimble-fingered mind lie about, unregarded, in any village anywhere in the world. Their cornucopia of small and subtle artifices is as ingenious, and in a deep sense as important in the ascent of man, as any apparatus of nuclear physics: the needle, the awl, the pot, the brazier, the spade, the nail and the screw, the bellows, the string, the knot, the loom, the harness, the hook, the button, the shoe – one could name a hundred and not stop for breath. The richness comes from the interplay of inventions; a culture is a multiplier of ideas, in which each device quickens and enlarges the power of the rest. Settled agriculture creates a technology from which all physics, all science takes off.[1]

Aquaculture

4.1 Aquaculture – whilst dating back at least four millennia in Egypt[2] – is the most recent human domestications of wild living things: agriculture, believed to have begun with wheat in the Middle East, is probably eleven or twelve thousand years old.[3] Despite aquaculture's ancient beginnings, most domestications of freshwater and marine animals and plants have taken place in the last century (see figure below).

4.2 Australian aquaculture has mostly developed in the last half-century. Australian aquaculture income is based on a fairly narrow range of

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1 Jacob Bronowski, *The Ascent of Man*, BBC, London, 1973, pp.73-4.

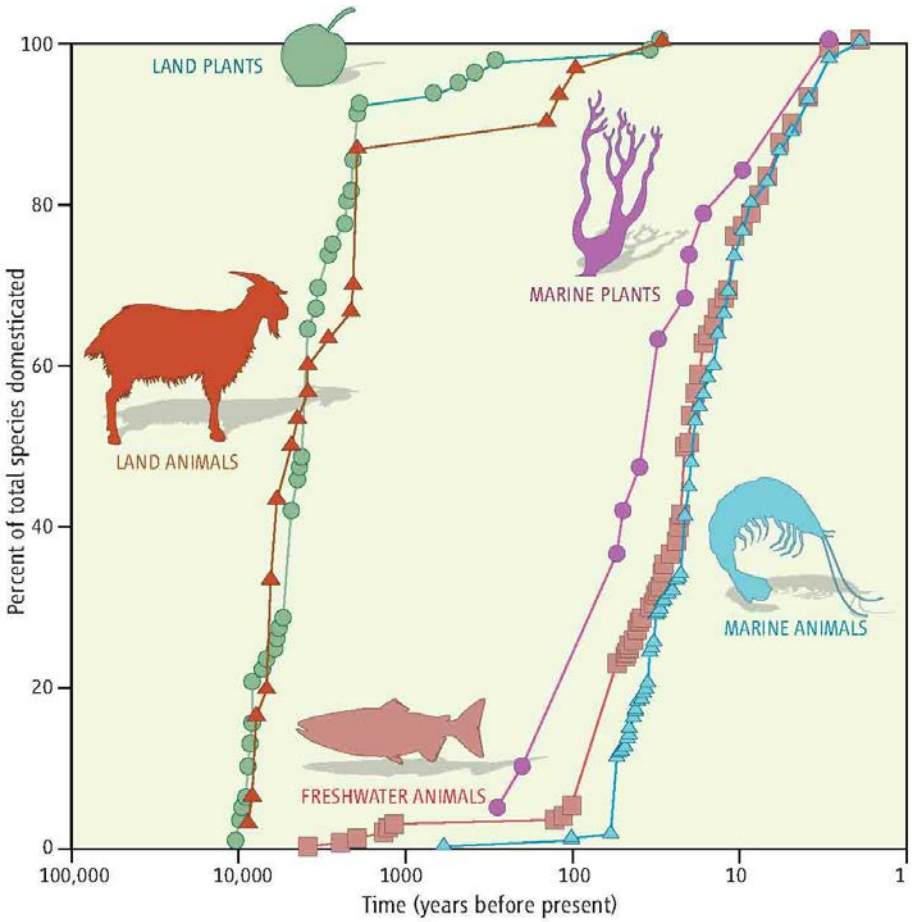
2 Carlos Duarte, 'Beyond Malthusian pessimism: Aquaculture as a milestone in human history', *The Conversation*, https://theconversation.edu.au/beyond-malthusian-pessimism-aquaculture-as-a-milestone-in-human-history-6895, 7/5/12.

3 Carlos M. Duarte, Nùria Marbá & Marianne Holmer, 'Rapid Domestication of Marine Species', *Science*, 316: 382-3.

species. Based on annual figures from 2009-10, the five most valuable aquaculture species were salmonids ($370 million), pearl oysters ($104 million), bluefin tuna ($102 million), edible oysters ($99 million) and prawns ($77 million).[4] Together, these five species comprised over eighty-five per cent of the value of Australia's aquaculture production in 2009-10.

4.3 Aquaculture in each species is often focussed in a particular region: over $360 million of the salmonid value is produced in Tasmania; all farmed tuna is from South Australia; over $75 million of prawn aquaculture is located in Queensland; and over $85 million of pearl oysters are grown in Western Australia.[5]

Figure 1 Domestication of plants and animals: land versus water



Source *Science, 316: 382-3.*

4 ABARES, 'Australian Fisheries Statistics 2010', August 2011, p.72.

5 ABARES, 'Australian Fisheries Statistics 2010', August 2011, p.72.

4.4 The Committee notes that in 2004, the Productivity Commission released a research paper on environmental regulation and aquaculture.[6] Key points included:

- aquaculture production is 'subject to an unnecessarily complex array of legislation and agencies' and there are 'complex approval processes' that can take 'significant time'; and
- there could be 'greater use of innovative policy instruments' such as 'tradeable permits... to manage pollution discharges.'[7]

4.5 In the Committee's view, many of the Productivity Commission's 2004 observations remain relevant in 2012.

4.6 With the above comment in mind, this chapter will discuss the current state of aquaculture in Australia, as well as its long-term potential. It will consider:

- the roles and responsibilities of governments in Australia;
- the potential growth of aquaculture;
- the role of science for aquaculture;
- national policy; and
- committee comment and recommendations.

4.7 Governance issues, including those cross-cutting aquaculture and fisheries management, are dealt with in more detail in Chapter 6.

Potential growth of Aquaculture

4.8 Many submissions to the inquiry suggest that Australia's aquaculture industry has a significant potential to grow:

> There is the opportunity to develop and apply knowledge and technology to enable the Australian aquaculture industry to achieve its full potential for sustainable growth.[8]

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6 Productivity Commission, 'Assessing Environmental Regulatory Arrangements for Aquaculture', February 2004.

7 Productivity Commission, 'Assessing Environmental Regulatory Arrangements for Aquaculture', February 2004, p.xx.

8 CSIRO, Submission 23, p.2.

> Tropical aquaculture, including on-shore, near-shore and offshore industries, has significant untapped potential to contribute towards meeting the future food production needs of Australia. Australia's northern coastline has 1.2 million hectares that are potentially suitable for aquaculture.[9]
>
> Unfortunately, it appears that Australia is not meeting the potential for sustainable aquaculture that is suggested by our enormous coastline, variety of water temperatures, and vast marine biodiversity.[10]

4.9 However, the Committee has been unable to ascertain an estimate of growth – whether expressed in the potential value of products, volume of production or employment, for example. Much evidence about the potential growth of aquaculture was speculative: 'The prawn industry in Australia is currently worth about $75 million. There is no reason we cannot have a $500 million prawn industry.'[11] Some evidence emphasised that there is no obvious limit to the growth potential:

> The general view is that there is no obvious limit to growth in terms of areas where development is possible. We are aware of various groups exploring the possibilities of investing and expanding. There is no immediate physical limit to that.[12]

4.10 Quite apart from the potential size of aquaculture, two major themes regarding the expansion of aquaculture have emerged throughout the inquiry, and will be discussed below:

- Making strategic choices; and
- Balancing economic and environmental considerations.

Strategic choices

4.11 The Committee sought evidence about the best way for governments to support growth in aquaculture in Australia. Evidence frequently supported Australia making strategic decisions about where to direct future efforts in aquaculture.

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9 Northern Territory Department of Resources, Submission 9, p.6.

10 Southern Cross University, Submission 13, p.1.

11 Dr Patrick Hone, *Committee Hansard*, 20 June 2012, p.4.

12 Mr Gordon Neil, *Committee Hansard*, 12 September 2012, p.3.

4.12 Evidence from the FRDC underlined the importance of making careful decisions and investments, so that Australian aquaculture can compete against foreign competitors:

> Australian producers must achieve the operating scale, global technologies and human capacity to be internationally competitive, and these ventures must be based on new differentiated products. It is unlikely Australia will be able to compete on price alone.[13]

4.13 The following considerations are central to making strategic decisions that will enable Australian aquaculture to expand and continue to be internationally competitive:

- Australia's competitive and seasonal advantages;
- foreign competitors;
- regional zoning; and
- availability of capital and development of markets, particularly in Asia, to respond to rising demand.

Australia's competitive and seasonal advantages

4.14 There are numerous competitive advantages identified by witnesses throughout the inquiry; specifically, climate variety, product quality and safety, the quality of science and proximity to markets.

4.15 The FRDC highlighted Australia's great diversity of geography and climates, and the potential variety of species that could be farmed:

> Australia would not be well served going down a one-species model, maybe because of geographic issues. We have a tropical climate; we have a very cold climate; we have a mid-temperate climate; and we also have an east and west which are very different. So the strategy would include more species for Australia's type of country.[14]

4.16 Associate Professor Rob Day said Australia's reputation as a producer of high-quality and safe food provides an advantage:

> We have good regulation to try to ensure biosecurity of our aquaculture is maintained, and that gives us a good edge in the

13 FRDC, Submission 19, p.32.

14 Dr Patrick Hone, FRDC, *Committee Hansard*, 20 June 2012, p.4.

> market because we can ensure that we always produce high quality.[15]

4.17 The quality of seafood products is a direct result of high quality science:

> Australia has a very good history and world standing in the quality of the science that we throw at developing technology... The salmon industry is a good example of a very efficient industry, up at world class, competing against the big boys like those in Norway and Chile. The work that I came to Australia to do at the beginning was in domestication of the black tiger prawn, and that has been commented on in previous inquiries here. We are at world class for that species of prawn, and that was using the expertise and skills of Australian researchers.[16]

4.18 Evidence also pointed to Australia's strength in producing high-value, luxury foods for foreign markets, driven by investment in research:

> The important thing is that we have nearly $1.2 billion worth of production research, which is aimed at producing food which essentially will be a discretionary luxury purchase in Asia and in China these days.[17]

4.19 Australia also has a competitive advantage by its proximity to Asian markets, and the capacity of producers to transport fresh seafood into those markets. As noted by Dr Patrick Hone (FRDC), this could enable Australia to be a 'food bowl' for many regional economies, particularly given Australia's reputation for safe, high-quality food:

> They do not have the processes around food safety and quality and all of the things that we can deliver which would give us that marginal cost above the competitive product—and we are next door. There is only one hour, two hours difference in time zones, and we are only an eight-hour flight or a relatively short shipping trip away. So there is lots of opportunity there in terms of Asia as a destination for food, let alone seafood.
>
> [...]
>
> For example, the Australian Atlantic salmon industry can put fresh salmon into Singapore, Hong Kong and China. It is very hard for our competitors in Europe or in North America to do that

15 Associate Professor Robert Day, *Committee Hansard*, 29 June 2012, p.8.

16 Dr Mike Hall, *Committee Hansard*, 31 July 2012, p.2.

17 Dr Len Stephens, *Committee Hansard*, 22 August 2012, p.2.

> because they have just that much further to travel. So we do have some advantages.[18]

Foreign competitors

4.20 Witnesses underlined the importance of potential aquaculture species being assessed for their economic viability, considering the relevant cost of production in other countries:

> With aquaculture, it depends a lot on the species you are talking about and our ability to grow it economically. You would not try to grow everything that occurs in the wild in an aquaculture sense. You need to pick the winner that is best for your particular piece of real estate and for the cost structures around that and also be mindful of the competition that is out there from South-East Asia and other countries that sometimes can outcompete us on price because of their lower wages and so on. Aquaculture is very much a species-by-species proposition.[19]

4.21 Some competitors also have weaker environmental protection, and hence can produce aquaculture products that are cheaper but more damaging to the environment.[20]

4.22 Additionally, some countries have focussed on a single species, in order to develop an industry that enjoys economies of scale and returns big enough to invest in research and development. A particularly striking example is the Norwegian salmon industry:

> Norway is essentially the inventor of salmon aquaculture and they now farm close to a million tonnes a year. I am not exactly sure how much it is worth, but it may be something like €10 billion a year...
>
> The Norwegian government has invested in major research facilities. They have entire salmon farms that are simply for research...There are actually four of these facilities in Norway. Some of them are completely state run. Some of them are a consortium whereby the industry runs the facility as a for-profit farm and the researchers conduct research in a dedicated way around that facility.[21]

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18 Dr Patrick Hone, *Committee Hansard*, 12 September 2012, p.19.

19 Professor Steven Kennelly, *Committee Hansard*, 15 August 2012, p.5.

20 Associate Professor Robert Day, *Committee Hansard*, 29 June 2012, p.8.

21 Dr Timothy Dempster, *Committee Hansard*, 29 June 2012, p.8.

4.23 Australia has competitors with considerable investments in research, and it is important that Australia assess the abilities of other countries to seize opportunities. As noted by Dr Patrick Hone:

> Chile has some of the best partnerships in the world in terms of research. They have a fantastic partnership with Norway. They have a fantastic partnership with the Canadians and the Scots. They really do partner well in research. They also have a very good mechanism by which other companies can co-invest. There are a lot of Norwegian companies in Chile, for example. So there is a lot of transfer of technology. They are great adopters of technology. Their own science facilities are very good. They are some very good, well-trained Chilean scientists.[22]

4.24 At the same time, existing foreign competition is not necessarily a bar to new developments in Australia. The most telling case is Salmon: despite the considerable Norwegian salmon aquaculture industry, as well as a mature industry in Chile, the Australian salmon industry is continuing to grow with expansions currently proposed.[23]

Regional zoning

4.25 Australia has an enormous range of climatic and environmental conditions within its borders and many local endemic species. As pointed out by witnesses to the inquiry, choices must be made about the best locations for aquaculture development:

> A very senior aquaculture scientist once said to me, 'You can grow tomatoes in the Antarctic, but if you want to make lots of money out of it you grow tomatoes where it is easiest to grow them.' That was in reference to trying to grow a tropical species like mud crabs down in the southern part of Australia. It is more economic to grow them in the northern part of Australia where the water is warmer and mud crabs are used to growing.[24]

4.26 In 2011, the Western Australian Government announced funding to create two 'aquaculture development zones' within the state.[25] According to the Fisheries Minister, 'the objective of the investment-ready zones was to

22 Dr Patrick Hone, *Committee Hansard*, 12 September 2012, p.19.

23 Dr Patrick Hone, *Committee Hansard*, 20 June 2012, p.4.

24 Professor Steven Kennelly, *Committee Hansard*, 15 August 2012, p.4.

25 For further information, see the following website: <http://www.fish.wa.gov.au/Fishing-and-Aquaculture/Aquaculture/Aquaculture%20Zones/Pages/default.aspx>.

provide pre-approved areas for defined commercial aquaculture activities to be undertaken'. The funding would allow:

> comprehensive information to be gathered to undertake strategic environmental assessments required for environmental approvals for the identified zones...[and would] also enable additional research for planning approvals, continuing environmental management and monitoring of the zones, which would provide investors greater certainty on locations than the current project-by-project model.[26]

4.27 As described by Mr Timothy Nicholas, Western Australian Department of Fisheries:

> The idea of those zones is to get the government to do a lot of the baseline studies and the initial scientific work that needs to be done to get over the line in terms of environmental approvals and, hopefully, to remove some of the burden from the companies that would ordinarily have to deal with that.[27]

4.28 The Australian Government, in an agreement with the Queensland Government, has also agreed to a regional aquaculture zone, for the Great Sandy Marine Park (around Fraser Island). Under the 'Conservation Agreement', a certain class of actions – non-intensive aquaculture operations approved by the state government – may be conducted in the marine areas of the Park, without needing separate *EPBC Act* approval.[28]

4.29 These two examples demonstrate how aquaculture can be encouraged at a regional level, but this approach needs careful planning, consultation and implementation. This regional planning approach will be discussed further below.

Balancing economic and environmental considerations

4.30 As will be discussed below, the regulation of aquaculture in each jurisdiction must find a balance between economic and environmental considerations.

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26 Hon Norman Moore, Minister for Fisheries (Western Australia), *Zoning provides future security for aquaculture*, Media Release, 16/12/11.

27 Mr Timothy Nicholas, *Committee Hansard*, 9 July 2012, p.52.

28 Commonwealth of Australia and State of Queensland, *Conservation Agreement / Agreement in relation to aquaculture operations in the Great Sandy Marine Park* , 7/9/11, Paragraph 6 – Declaration.

4.31 Evidence to the inquiry stressed the need for governments to carefully consider both economic and environmental impacts of aquaculture when making decisions about new ventures. Science will be central to both developing new ventures, and understanding their environmental impacts:

> ...research has an important role in supporting this development through developing planning instruments for industry and government that permit rigorous, quantitative evaluation of the potential for aquaculture production systems to provide economic and social benefits whilst conserving ecosystem health and biodiversity.[29]

Environmental impacts of aquaculture

4.32 CSIRO emphasised the role of Australian science in improving the environmental impact of aquaculture:

> All Australian aquaculture industries operate within strict environmental regulations applied at national and state government levels. The industry, CSIRO, and other research providers have made globally significant advances over the past two decades in environmentally sustainable management of near-shore sea-cages ... and on-shore coastal ponds.[30]

4.33 Aquaculture can be conducted either in marine waters or inland (usually in ponds). In both cases the types of environmental impacts are similar, although the impact on the local environment depends on a number of variables.

4.34 Evidence from Murdoch University outlined the major environmental management issues for the future of aquaculture:

> 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.[31]

4.35 As noted by the same submission:

> The science behind many of these issues is well understood and the primary requirement is now the development of appropriate

29 CSIRO, Submission 23, p.12.

30 CSIRO, Submission 23, p.10.

31 Murdoch University, Submission 8, p.4.

> regulatory or economic incentives for implementing environmental management systems.[32]

4.36 The World Wildlife Fund pointed out that aquaculture is not without risks and that understanding its sustainability depends on scientific knowledge:

> While WWF believes there is an important role for aquaculture in satisfying global demand for seafood products, we wish to emphasize that science-based and sustainable management is as important for aquaculture enterprises as it is for wild capture fisheries. The nature or the weighting of the risks involved in aquaculture may vary from that of wild capture fisheries but the need to understand and to mitigate those risks remains. Aquaculture does not represent a riskless solution to overfishing of wild fish stocks...[33]

4.37 Dr Patrick Hone (FRDC) summed up the dynamic relationship between economic and environmental considerations very neatly:

> Dr Hone: It is very hard to get a prawn farm up with zero impact.
>
> CHAIR: Can't the science solve the issues? How do you make it sustainable?
>
> Dr Hone: We can create a prawn farm with zero impact—it is just too expensive to run.[34]

4.38 In the absence of technologies that can make 'zero impact' aquaculture a competitive proposition, aquaculture operations will continue to be assessed on the balance they strike between economics and environmental impact.

4.39 Technological solutions to the problem of aquaculture pollution continue to be developed across Australia. One example is the use of algae to clean water from aquaculture operations. At James Cook University, the Committee toured facilities where researchers are growing algae in water from aquaculture ponds, which produces a marketable product and cleans the water simultaneously. As discussed by Professor Michael Kingsford:

> We are way ahead of the game now compared to 20 years ago...We now have things like different types of algae that we can use to sequester the nutrients, which are a major source of pollution. There is now the opportunity to harvest the algae as novel

32 Murdoch University, Submission 8, p.4.

33 World Wildlife Fund, Submission 11, p.8.

34 Dr Patrick Hone, *Committee Hansard*, 20 June 2012, p.4.

> products for Australia. And there is now the opportunity to grow that type of algae in mixed polyculture, which addresses carbon sequestration. I would suggest to you there are a whole range of innovative new industries that are available through aquaculture as well as its addressing the increased demand for protein for Australia. Rather than buying Nile perch from South-East Asia, where there is very little environmental consideration for how they are raised—or, for that matter, the prawn industry over there—we could actually focus very carefully on developing that area in Australia.
>
> [...]
>
> The aquaculture problem has been a pollution one. Certainly [the Great Barrier Reef Marine Park Authority] has been very concerned about any suggestion of aquaculture around here, for the reason of its putting nutrients on the reef. The truth of the matter is that, if you look at local initiatives now—in collaboration with JCU, I have to say—they can actually get it down to zero. The water quality going out is sometimes better than that going in, to be honest, by the time they have actually treated it.[35]

Regulatory arrangements to find the balance

4.40 The National Aquaculture Council (NAC) expressed its view that: 'the science demonstrates that the risks to the environment from aquaculture are well managed.'[36] Nonetheless, the NAC outlined six areas of potential work to improve environmental regulation:

1. standardize environmental impact statement reporting;
2. establish national aquaculture environmental monitoring and management standards;
3. develop cost effective and real time environmental monitoring and reporting systems;
4. understand the structure of the ecosystems.
5. develop ecological carrying capacity models that will enable the carrying capacity to be undertaken on a regional, multi-user, coastal scale; and

35 Professor Michael Kingsford, *Committee Hansard*, 31 July 2012, p.22.

36 National Aquaculture Council, Submission 35, p.5.

6. develop validation tools for the carrying capacity models.[37]

4.41 The NAC added that 'time, cost and complexity is the enemy of investment'. It further submitted that 'decision-making and regulatory conditions' are heterogeneous, particularly in respect of:

- certainty in the decision making process;
- application of risk assessments; and
- application of risk management tools, namely the application of licence conditions.[38]

4.42 The NAC suggested added that this was symptomatic of 'the absence of contemporary understanding of the environmental risks that aquaculture poses, by environmental regulatory authorities.'[39] Further:

> The environmental risks of aquaculture are well understood, however, there should be investment in extending this information into the environmental regulatory authorities e.g. State Environmental Protection Authorities (EPA's). Furthermore, this science needs to be used to establish national aquaculture environmental monitoring, reporting and management standards to ensure equivalence between states.[40]

4.43 The regulation of environmental protection at a state and territory level is a matter for those governments, but there is scope for coordination and standardisation, particularly through cooperation between governments. In addition, regional aquaculture planning under the *EPCB Act* – such as the approach taken in the Great Sandy Marine Park – is a promising way to ensure that environmental protection and aquaculture development are both promoted in a balanced way. This will be discussed further, below, in the section regarding national policy.

Roles and responsibilities of governments

4.44 The vast majority of aquaculture production (by value) occurs within four States – Tasmania, South Australia, Queensland and Western Australia. Under Australia's constitutional arrangements, the regulation of aquaculture is a matter for the States and Territories and would be a

37 National Aquaculture Council, Submission 35, p.5.
38 National Aquaculture Council, Submission 35, p.6.
39 National Aquaculture Council, Submission 35, p.6.
40 National Aquaculture Council, Submission 35, p.6.

matter for the Australian Government if conducted in Commonwealth waters in the future.

The Australian Government

4.45 As noted by DAFF's most recent Annual Report (2010-11), there is 'no current provision [for aquaculture in Commonwealth waters] in the Fisheries Management Act 1991.'[41] However, the Department's website states that 'the Australian Government is working with state and territory governments to develop a regulatory framework for aquaculture in Commonwealth waters.'[42]

4.46 As aquaculture is 'primarily managed by the states and the Northern Territory'[43], the Australian Government's role in aquaculture is limited to 'issues that require a national focus.'[44] Areas of activity include:

- research;
- quarantine;
- fish health;
- food safety;
- market access and trade;
- business development; and
- farm management assistance.[45]

4.47 Under environmental law, the Australian Government also has a role relating to aquaculture, by virtue of the *Environment Protection and Biodiversity Conservation Act 1999*. If an aquaculture venture were to trigger the approvals process under that Act, it would be referred to the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) for assessment and, if necessary, decision by the Environment Minister.

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41 Department of Agriculture, Fisheries and Forestry, 'Annual Report 2010-11', p.81.

42 Department of Agriculture, Fisheries and Forestry, http://www.daff.gov.au/fisheries/aquaculture/the_aquaculture_industry_in_australia, viewed 12/9/12.

43 Department of Agriculture, Fisheries and Forestry, Submission 24, p.2.

44 Department of Agriculture, Fisheries and Forestry, Submission 24, p.7.

45 Department of Agriculture, Fisheries and Forestry, http://www.daff.gov.au/fisheries/aquaculture/supporting, viewed 12/9/12.

4.48 SEWPaC told the Committee that the Australian Government has had some involvement in assessing aquaculture ventures. According to Mr Dean Knudson (SEWPac):

> since 2002 we have had eight referrals of projects under the Act, which have continued on to approval stage. Of those, seven have been approved. One is at the first stage of the assessment process, so it is awaiting a referral decision, which will then determine the level of assessment and whether it needs to continue with assessment under the Act. So zero projects have been denied under the Act.[46]

4.49 The outstanding project noted by Mr Knudson relates to a proposed 'marine farming expansion', at Macquarie Harbour Tasmania. The proposal would expand the area for salmon farming from the current 564 hectares to 926 hectares.[47] The proposal was received by the Department on 30 May 2012. On 3 October 2012, the Environment Minister approved the proposal, subject to certain conditions. A media release from the Tasmanian Salmonid Growers Association indicated that the expansion will go ahead.[48]

4.50 Understanding the conditions and workings of the *EPBC Act* and the interplay with State environment legislation can be a challenge. SEWPaC may wish to consider how applicants could be assisted, such as with more information about the approval process and whether proposal scrutiny could be streamlined.

The States & Territories

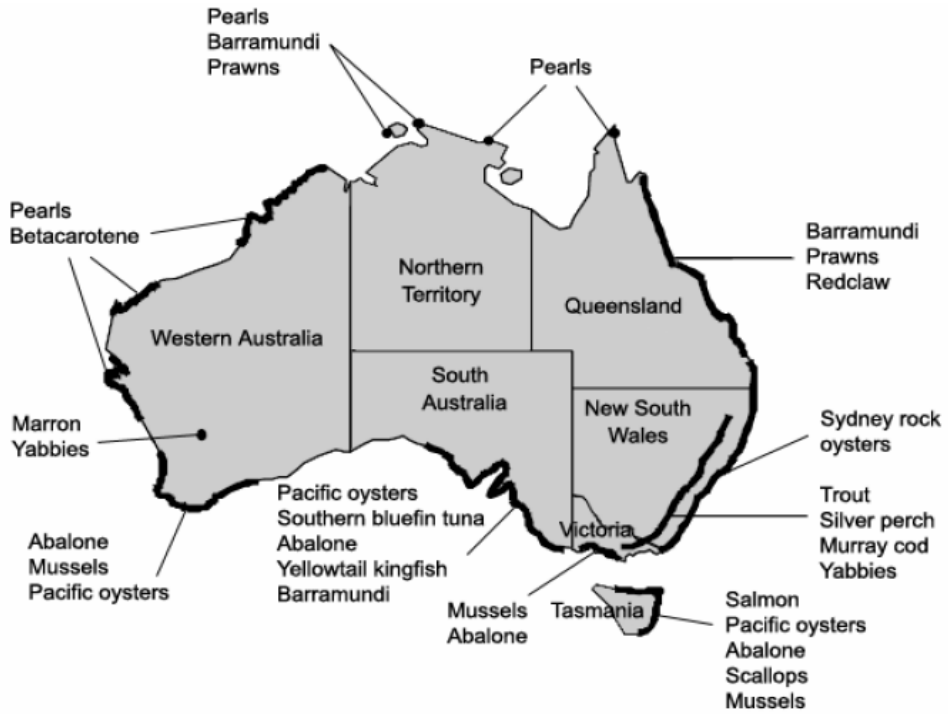
4.51 The four largest aquaculture products are almost exclusively grown within single jurisdictions. Of the fifth largest product – edible oysters – almost half of national production is grown in New South Wales, with most of the balance grown in South Australia and Tasmania. Species tend to be concentrated into distinguishable regions, illustrated by the map below.

46 Mr Dean Knudson, *Committee Hansard*, 19 September 2012, p.7.

47 Referral of proposed action, *Marine Farming Expansion - Macquarie Harbour Tasmania*, reference number 2012/6406, www.environment.gov.au, p.4.

48 Tasmanian Salmonid Growers Association, *Federal Government Approval for West Coast Expansion*, media release, 8 October 2012.

Figure 2 Aquaculture in Australia



Source Productivity Commission, 'Assessing Environmental Regulatory Arrangements for Aquaculture', February 2004, p.2.

4.52 Regulation differs in each state, depending on local conditions and species most commonly being produced. In South Australia, for example, aquaculture operations are organised by zones:

> 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 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.[49]

4.53 The process for developing aquaculture zones in South Australia 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

49 Primary Industries and Regions South Australia, Submission 22, p.11.

> technical investigation undertaken by [the South Australian Research and Development Institute] to determine the suitability of a zone for aquaculture activities.
>
> When assessing individual aquaculture applications, [Primary Industries and Regions South Australia] Fisheries and Aquaculture uses a strict set of guidelines to assess potential environmental impacts associated with the proposed activities.[50]

4.54 Tasmania has a similar 'zonal' approach to aquaculture:

> Under [the *Marine Farming Planning Act 1995*]...marine farming development plans are prepared, designating areas in State waters where marine farming may occur.
>
> All marine farming operations must be licensed under the *Living Marine Resources Management Act*. Licences include environmental conditions to ensure that marine farming operations are sustainable and do not have an unacceptable impact on the marine environment.
>
> [...]
>
> In addition, the Department of Health and Human Services manages the Tasmanian Shellfish Quality Assurance Program under the *Public Health Act 1997* and the *Food Act 1998*. This includes monitoring water quality in shellfish growing areas and the public health status of shellfish on marine farms, to ensure the safety of farmed shellfish for human consumption.[51]

4.55 However, in Tasmania, freshwater (on-shore) aquaculture is regulated separately from marine aquaculture. Regulation of the former is undertaken by the Inland Fisheries Service:

> Any fish farming proposal that is put forward goes through a rigorous assessment procedure involving consultation and approvals from various Government authorities. There is a coordinated process for reviewing applications that ensures each application meets high and consistent standards in relation to land and water usage, environmental impacts, disease control etc.
>
> In particular the IFS assesses the effects on recreational trout fisheries, including access to these fisheries, the effects on

50 Primary Industries and Regions South Australia, Submission 22, p.11.

51 Tasmanian Department of Primary Industries, Parks, Water and Environment, http://www.dpiw.tas.gov.au/inter.nsf/WebPages/ALIR-4YS2XW?open, viewed 12/9/12.

> migratory fish and freshwater fauna, and the possibility of fish escaping.
>
> The Service opposes any loss of existing trout fisheries and does not permit privatisation of public waters for this purpose. Similarly, grow-out of farmed fish in public access inland waters has not been permitted. The Service believes that a properly controlled fish farm does not pose a risk to Tasmania's fisheries.[52]

4.56 New South Wales, with a smaller share of aquaculture than other states, has in place:

> [A] whole of government approach to the development of the oyster and land based [aquaculture industry] in NSW to promote sustainable industry development. NSW Oyster and Land Based Sustainable Aquaculture Strategies detail a streamlined approval process and advice on best aquaculture practice for species and site selection, design and operation. Research undertaken on aquaculture production assists with industry development and supports the development of policy and management practices for future developments in NSW.[53]

The role of science for aquaculture

4.57 Evidence throughout the inquiry repeatedly stressed the central importance of science for all aquaculture operations.

4.58 The Australian Prawn Farmers Association (APFA) submitted:

> Everything prawn farmers do has been underpinned by millions of dollars worth of research and has covered topics in relation to key environmental issues, domestication, genetics, disease resistance, water quality, sustainable feed, spatial analysis, seasonal forecasting, energy auditing, value adding and better feed conversion ratios.[54]

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52 Tasmanian Inland Fisheries Service, http://www.ifs.tas.gov.au/fishery-management/commercial-fisheries/fish-farms, viewed 12/9/12.

53 New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/fisheries/aquaculture/about-aquaculture, viewed 12/9/12.

54 Australian Prawn Farmers Association, Submission 45, p.1.

4.59 As noted by the Australian Shellfish Quality Assurance Advisory Committee, some aquaculture products are 'high risk' and their safety for consumers relies heavily on good science:

> Bivalve shellfish are a high risk food group as they are filter feeders and therefore can concentrate contaminant particulates from their environment. Contaminants that potentially impact on human health include pathogenic bacteria and viruses, toxic algae, heavy metals and pesticides...Science plays a pivotal role in maintaining the currency of the Australian Shellfish Quality Assurance Program when facing the wide range of issues found in the diverse growing areas around the country.[55]

4.60 The CSIRO has engaged in partnerships with industry to produce research that has a direct benefit for aquaculture productivity of species that are already commercially grown:

> CSIRO and its industry partners have responded to this challenge by established long-term (decadal) R&D programs to optimise the cumulative benefits of domestication and selective breeding of Atlantic salmon, Pacific oysters, prawns and abalone. Other species, including barramundi, amenable to domestication are likely to be the next candidates for selective breeding. Recent achievements of these partnerships include: 60 per cent increase in the harvest yields of black tiger prawns; 15 per cent genetic response to selection for growth and disease resistance in farmed Atlantic salmon; 10 per cent genetic gains in growth rates of abalone; and 8.5 per cent improvement in the economic performance of Pacific oysters.[56]

4.61 The Australian Institute of Marine Science documented numerous areas of aquaculture research needing further attention:

> Key areas requiring science input include microbial management; the identification of nutritional requirements for the target species; development of specific feeds that are independent of wild harvested fishmeal and fish oils; and seawater processing engineering to ensure the highest quality seawater.
>
> [...]
>
> As the use of antibiotics in food production systems is being increasingly banned, the use of 'good' bacteria as probiotics to

55 Australian Shellfish Quality Assurance Advisory Committee, Submission 2, p.1.

56 CSIRO, Submission 23, p.16.

> control the establishment and spread of 'bad', or pathogenic bacteria is becoming increasingly important. The development of technologies that minimize production loss due to pathogens is an important area for research.
>
> [...]
>
> As in agriculture, there is an ongoing requirement for research to allow the development of microbial and parasite management regimes that either minimise their impact or neutralise them.[57]

4.62 As well as maintaining and improving the viability of existing aquaculture operations, research and development is vital for assisting the expansion of aquaculture. As noted above, there are a number of opportunities for new aquaculture production, but strategic choices must be made to direct effort in the most promising direction. Research is central to illuminating the costs and benefits of new aquaculture possibilities:

> 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.[58]

4.63 The role of science in particular elements of aquaculture will be discussed below, as follows:

- transition of species from wild to farmed;
- future development of aquaculture; and
- exporting science.

Transition from wild to farmed

4.64 As already discussed, there is considerable work involved in the domestication of wild fish stocks for aquaculture production. During the course of the inquiry, the Committee toured a number of research projects where this work is being done.

4.65 At the Western Australian Department of Fisheries in Perth, the Committee was able to see close hand the research being done to develop ranching techniques for octopus as well as attempting to 'close the life cycle' of *Octopus tertricus*, which would enable the production 'of octopus

57 AIMS, Submission 20, p.5.

58 AMSA, Submission 14, p.5.

juveniles in sufficient numbers and to a sufficient size to make it a commercially successful aquaculture operation.'[59]

4.66 At the Australian Institute of Marine Science in Townsville, the Committee was impressed with the ongoing work on Rock Lobster:

> current research at AIMS is closing the life cycle of the Tropical Rock Lobster — a species of high interest to the Asian market — through expertise in seawater processing engineering, nutrition and disease mitigation for high health.[60]

4.67 The CSIRO identified two examples where the domestication of species was a priority, and would likely assist the industry greatly if achieved. Firstly:

> There has been a progressive decline in the value of the southern bluefin tuna (SBT) 'farming' industry over the past decade, in contrast to the growth of Atlantic salmon. The industry relies on the fattening of wild caught fish in sea cages. There are no domesticated SBT broodstock and the industry has yet to succeed in rearing any stocks to sexual maturation in captivity.[61]

And secondly:

> Farmed production of Australian native barramundi is mainly from pond-based systems in Queensland and the Northern Territory, with one sea cage operation in North Western Australia. Some domesticated stocks have been produced but selective breeding of this species is still in early stages of development. Growth of the industry to its current farm gate value of $27 million has been from progeny of wild broodstock.[62]

4.68 As recently reported in the *Australian*, closing the southern bluefin tuna life cycle is 'the blue sky for aquaculture'. Following the efforts of the Clean Seas company, the paper described how it:

> has 24 very large tuna in a 3.5 million litre tank which it uses as brood stock. Water temperature and light is manipulated to trick the fish into spawning. It is the first and only company to get captive southern bluefin tuna to spawn; the only problem is that for a species that migrates annually from the tropical waters of Indonesia to the Southern Ocean, the waters off Port Lincoln are

59 'Octopus aquaculture comes to the fore', *Intrafish*, March 2012, pp.20-21.

60 AIMS, Submission 20, p.2.

61 CSIRO, Submission 23, p.15.

62 CSIRO, Submission 23, p.15.

> proving too cold for the juveniles to survive. For the third year running, the tuna fingerlings bred in captivity have failed to make it to summer.[63]

4.69 The Australian Institute of Marine Science outlined the importance of conducting rigorous and comprehensive research into species before domestication can be attempted:

> Scientific evaluation of wild species is essential to identify the select few species that meet the prerequisites for domestication. These species must have reasonable fast growth rate; the ability reproduce in captivity; the ability to be held in reasonably high densities; manageable nutritional requirements and future market prospects. Few species are suitable for domestication. As a comparison, only 0.08 per cent of land plant species and 0.0002 per cent of land animal species have been domesticated and it is expected that there will be similar limits on the suitability of species for aquaculture. In both cases timelines for domestication are in many years to decade.[64]

4.70 So-called 'closing the life cycle' can involve research with many generations of animals:

> 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[65].

4.71 The Committee sought an overview of the process used by the FRDC to decide whether to support research on species that hold potential for aquaculture production. Dr Patrick Hone (FRDC) said:

> The FRDC has a long record of emerging species for aquaculture. We effectively have three types of aquaculture. We have what we call 'total market failure', where no-one owns it—we call them orphans—and there is no actual industry. Rock lobster was a classic. When it started there was no industry, no members, no nothing. We created a complete structure around the country to

63 The Australian, *Catch 22*, the Weekend Australian Magazine, 15/9/12, p.18.

64 AIMS, Submission 20, p.4.

65 AMSA, Submission 14, p.5.

> create rock lobster aquaculture. We are now stepping back a bit because the commercial investors are coming in...
>
> When it moves from orphaned it then goes to what we call 'in the shed'; in other words, it is that pioneer phase. People are tinkering. It is not quite commercial; it is not quite an orphan. There are identified people in it. We have had various industries go through that phase. Abalone was a classic. Abalone started with nothing. It then went through that shed phase where you have to do different types of research. Usually what we do is research when it is in the shed, which is in the public space. It is the health research, the nutrition research. We get away from the IP bit at that stage. That is where they think they have a competitive advantage. If they have it, go out and flog it. Good stuff.
>
> Finally, you have the commercial industries: the salmons, the tunas, the pearls et cetera. That is another completely different thing.
>
> [...]
>
> To get into that orphan group—the ones to identify—we have a set of criteria. We only will farm species endemic to Australia. In other words, they have to occur in Australia. It is not going to be introduced. You have to demonstrate a market. You have to demonstrate a business plan—in other words, that your estimates of the cost of production will be less than the sale price that you think you will get for it. You think that might be trivial, but you would be surprised how few people do the business plan. So there are a range of things. Plus you have to show evidence that the state government has a plan in which it will allow the approval of the planning process.[66]

4.72 Lastly, to produce carnivorous fish through aquaculture, these fish need to be fed other fish or a cost-effective substitute.

4.73 Professor Michael Harte (World Wildlife Fund) said that if three kilograms of wild fish are used as feed to produce one kilogram of farmed fish, 'you have to question that equation'.

4.74 Alternative sources of feed need to be developed to reduce the 'fish-in, fish out' ratio. A low ratio not only has environmental advantages, but also reduces costs and potentially makes more fish species viable within

66 Dr Patrick Hone, *Committee Hansard*, 12 September 2012, p.13.

an aquaculture business model. Agricultural by-product, for example, could re-processed into fish feed.

Future development of aquaculture

4.75 Evidence to the Committee highlighted an emerging aquaculture opportunity that would combine the production of food with the production of other valuable products, so-called 'Aquaculture 2.0':

> links the mass production of food with the production of high-value molecules for sophisticated and emerging biotechnological applications...
>
> In terms of the research impetus to develop this aquaculture 2.0 we need to revitalise marine biotechnology as a research strategy and link that to the development of aquaculture.[67]

4.76 Professor Carlos Duarte (UWA) argued that Australia should redevelop a capacity in marine biotechnology, which he said had been neglected in recent years:

> Australia used to be a big player in the field of marine biotechnology, but it made a strategic decision for some Commonwealth agencies that were playing the leadership role, like AIMS and, to a lesser extent, the CSIRO, to abandon this research line. Unfortunately, they did so just at the time that the major revolution of molecular biology and modern biotechnology was about to emerge. These opportunities would have been with us if we had maintained that research effort in marine biotechnology. Now we need to start from scratch but, again, it is imperative that we couple those research efforts in marine biotechnology with those in food production from the ocean.[68]

4.77 Professor Euan Harvey (UWA) noted the opportunities to collocate marine aquaculture with energy production, both through renewable energy technology and by using infrastructure established to extract offshore oil and gas.[69]

4.78 Witnesses expressed support for the possibility of this kind of integration, but averred that, to their knowledge, it remains mostly unexplored:

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67 Professor Carlos Duarte, *Committee Hansard*, 12 September 2012, p.8.

68 Professor Carlos Duarte, *Committee Hansard*, 12 September 2012, pp.8-9.

69 Professor Euan Harvey, *Committee Hansard*, 9 July 2012, p.26.

> In terms of energy, I am not sure where we sit, but the potential for tidal energy up there must be enormous.[70]
>
> Yes, there probably is a lot of opportunity. Marine based aquaculture in those areas is a very big specialised investment, so it is not something to be done on the side but there may be opportunities to bring those things together.[71]

4.79 In addition, research is being conducted to explore the viability of powering onshore aquaculture operations with renewable energy, particularly in the context of a changing climate:

> [Australian Prawn Farmers Association] recently received a Farm Ready grant to better prepare farmers for the impacts of climate change. This confirmed that increasingly isolating Australia's sustainable prawn farms from the ocean makes them highly dependent on energy for aeration, and the project examined options for powering farms using renewable energy in line with future developments in the carbon economy. Following the project a study of seasonal weather forecasting was also begun to help farmer's manage production in the face of changing weather.[72]

4.80 Opportunities for aquaculture engineering and technology are many and varied. Aquaculture methods could be used to produce seaweed and algae, amongst others. The CSIRO submitted:

> There is a global need to develop cost effective alternatives to wild-harvest fishmeal and fish oil. CSIRO recently has achieved significant advances toward this goal. These include the bioconversion of low value agricultural plant waste to a high value bioactive feed that doubles the rate of farmed prawns...[73]

4.81 These options should be explored to improve productivity and capitalise on the growth of Asian markets, a trend highlighted in the Australian Government's Asian Century White Paper.[74]

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70 Professor Neil Loneragan, Murdoch University, *Committee Hansard*, 9 July 2012, p.44.

71 Associate Professor Alan Lymbery, Murdoch University, *Committee Hansard*, 9 July 2012, p.44.

72 APFA, Submission 45, p.5.

73 CSIRO, Submission 23, p.10

74 Australian Government, 'Australia in the Asian Century: White Paper', October 2012, pp.44-45 and p.124.

National policy

4.82 In 2003, the Primary Industries Ministerial Council considered and endorsed the *National Aquaculture Policy Statement,* which provides that:

> All Australian Governments commit to working in partnership with the aquaculture industry to achieve maximum sustainable growth, whilst also meeting national and international expectations for environmental, social and economic performance.[75]

4.83 The statement recognises and acknowledges numerous benefits from aquaculture, as well as identifying the importance of research and development to the expansion of aquaculture in Australia. The statement commits the governments, together, to four main areas of work:

- The facilitation of effective, efficient, timely and transparent planning and approval processes [for domestication, growth, regulation, statutory approvals and the use of Commonwealth waters];
- Supporting and recognising continual improvement of ecologically sustainable aquaculture practices and to develop environmental performance standards for aquaculture;
- Provide and encourage investment for growth [especially in the areas of capital, branding and research and development]; and
- Ensuring participation of the Australian industry and broader community in aquaculture planning and management.[76]

4.84 However, much evidence throughout the inquiry focussed on the absence of a comprehensive, detailed and widely agreed national policy to encourage the growth of aquaculture.

4.85 Some evidence drew parallels between the absence of a more comprehensive national policy and the relatively small size of aquaculture today. The National Aquaculture Council submitted:

> The uneven rate of expansion of the aquaculture industry is symptomatic of the absence of a whole of government approach to enable aquaculture development. This can easily be remedied by promulgating a National Policy Statement on the importance and its commitment to aquaculture's ongoing development, especially

75 Primary Industries Ministerial Council, *National Aquaculture Policy Statement*, 2003, p.1.

76 Primary Industries Ministerial Council, *National Aquaculture Policy Statement*, 2003, pp.4-5.

given its importance to address Australia's trade imbalance of this critical protein source.[77]

Policy areas

4.86 The FRDC has identified a number of areas of priority for the industry, that need reflection in or coordination by national policy:

- engage with local communities to increase awareness of aquaculture practices and demonstrate the sustainability, positive economic contribution and excellent products created by aquaculture, and in so doing secure endorsement to gain access to waters and natural resources;
- align legislation across jurisdictions to motivate and promote efficient, sustainable investments by industry based on competitive advantages of regions and ecosystems;
- continue to invest in innovation and closely monitor and adopt/adapt technologies available in advanced aquaculture operations worldwide;
- jointly plan development strategies for each species and identify the key research areas that drive the strategic competitive advantages of that species.[78]

4.87 The CSIRO has argued that the expansion of aquaculture could be integrated into more broad planning regimes:

> All Australian aquaculture industries operate within strict environmental regulations applied at national and state government levels...CSIRO suggests there is a need to integrate climate change and resource use research into spatial planning frameworks that include environmental and social values, species selection, production systems, market demand, and other uses of environments surrounding areas of aquaculture potential. Such integrated R&D will be important to enable industry and policy makers to realise the full potential for sustainable growth of Australian aquaculture.[79]

4.88 The CSIRO has also noted the potential for indigenous economic development through aquaculture:

> A preliminary spatial analysis of Australia's northern coastline identified 1.2 million hectares that are potentially suitable for pond based marine aquaculture ... Indigenous Australians own a large

77 NAC, Submission 35, p.3.

78 FRDC, Submission 19, p.32.

79 CSIRO, Submission 23, p.16.

> percentage of the areas. Aquaculture could play a pivotal role in the future livelihoods in these coastal communities and research has an important role in supporting this development through developing planning instruments for industry and government that permit rigorous, quantitative evaluation of the potential for aquaculture production systems to provide economic and social benefits whilst conserving ecosystem health and biodiversity.[80]

Committee Comment

4.89 A number of areas for national discussion and agreement have been identified throughout the inquiry. These areas for agreement fall under the general categories of national ambition, governance, regional planning and community agreement. A national policy framework would need to address all of these issues:

- National ambition:
  - a national aquaculture production goal;
  - a national process to identify strategic species;
  - a national strategy to promote the economic, social and environmental benefits of aquaculture, as well as promoting the quality of Australian aquaculture products;
  - a national plan to drive indigenous economic development through aquaculture;
  - a national plan to drive market-identification and marketing strategies for new species
- Governance:
  - identifying barriers to aquaculture expansion;
  - identifying ways to remove barriers to expansion, including through regulatory harmonisation and streamlining;
  - promoting a standardised and streamlined environmental assessment process across all jurisdictions;
- Regional planning:
  - a national process to identify regional aquaculture hotspots;

80 CSIRO, Submission 23, p.18.

- a national process to develop pre-approval templates for aquaculture in these hotspots
- regional infrastructure plans to facilitate aquaculture expansion;

- Community agreement:
  - a process for achieving regional community agreement on aquaculture development, balancing economic, social and environmental considerations.[81]

- Technology:
  - Supporting skills training in aquaculture engineering and infrastructure construction.

4.90 In general, the framework should consider factors influencing the competitiveness of Australian aquaculture. Australia may wish to lead on environmental standards; however, the challenge is to regulate the industry without making it wholly uncompetitive, which would increase reliance on imports and perpetuate low production standards offshore. State and Federal conservation agreements under the *EPBC Act* are one mechanism that could streamline and minimise regulation.

4.91 The Committee believes that aquaculture presents an enormous opportunity for Australia. It holds the potential for considerable economic growth in regional and rural areas, as well as for indigenous economic development. In addition, it represents a path for Australia to contribute even more to the global food supply, improving food security in Australia and overseas.

4.92 Aquaculture has been focussed on a fairly narrow range of species, in very particular geographic regions. This has certainly contributed to the success of Australian aquaculture to date: the Tasmanian Salmon industry is a good example of the benefits of focus.

4.93 Whilst there is a clear potential for significant growth in aquaculture, the Committee was unable to ascertain an estimate of growth. It is evident that more detailed work on this question is needed. Such an estimate – and a related production goal – would be an important part of a national policy on aquaculture, discussed further below.

4.94 The environmental regulation of aquaculture differs around Australia, and is minimal at the federal level. There exists scope for governments to

81 CSIRO, Submission 23, p.8.

coordinate and standardise their environmental assessment processes, and this should be the focus of intergovernmental discussion and cooperation.

4.95 There is a particular role for the Australian Government to play in developing regional aquaculture plans, as conservation agreements under the *EPBC Act*, as discussed above. The Committee believes that this is a particularly fruitful area for further work and cooperation between the Australian Government and state and territory governments.

Recommendation 11

4.96 **The Committee recommends that the Australian Government work with state and territory governments to develop further conservation agreements to streamline assessments under the *EPBC Act*, to facilitate the growth of aquaculture.**

4.97 Science has an important part to play in all areas of aquaculture, including improving the productivity and environmental performance of existing aquaculture species, the domestication of wild species, and the future integration of numerous activities in so-called 'Aquaculture 2.0'. The Committee commends researchers around Australia who are working in these fields, contributing to existing and future aquaculture operations in Australia and around the world.

4.98 The Committee is concerned about the lack of prominence for aquaculture science in Australia. Whilst the FRDC has a central role in coordinating and funding aquaculture research, its name does not reflect this. Whilst altering the name of the FRDC to include 'aquaculture' would be a formal reflection of its full mandate, this would entail considerable administrative costs. The Committee does not believe that such costs would be justified however, and looks forward to continuing efforts by FRDC to clearly state its involvement in aquaculture research.

4.99 Australia can make a contribution to food security overseas, through the export of Australian research, development and technology. The Committee believes that this should be an important priority of Australia's work to improve food security through its aid program. The Committee looks forward to seeing AusAID and the Australian Centre for International Agricultural Research continuing to export Australian aquaculture science to improve food security, particularly in the region.

4.100 The Committee believes that the current national policy statement on aquaculture is a valuable agreement on the need for a national approach to aquaculture. However, it falls well short of providing the kind of detailed policy necessary to promote the expansion of aquaculture. The Committee notes that, in the Government's Discussion Paper for a National Food Plan, aquaculture is not discussed in much detail. This may be symptomatic of the small size of the industry, but also due to the lack of a comprehensive national policy focus for aquaculture. Submissions on the discussion paper are available online, and some deal with aquaculture.[82]

4.101 If aquaculture is to achieve its growth potential, Australia must have a comprehensive national policy, with the agreement of all state and territory governments, as well as the Australian Government. As noted above, there are a number of priority areas for national policy, and the Committee believes that a national policy should be developed that identifies the roles and responsibilities of all governments to make such a national policy work.

Recommendation 12

4.102 **The Committee recommends the Australian Government, through the Council of Australian Governments, lead the development and agreement of a detailed and comprehensive national aquaculture policy, including the roles and responsibilities of all governments, to address (amongst others) the issues contained in paragraph 4.89, at least in the areas of:**

- **National ambition;**
- **Governance;**
- **Regional planning;**
- **Community agreement;**
- **Technology; and**
- **International competitiveness**

82 See, for example, Western Australian Aquaculture Council submission, available at <http://www.daff.gov.au/nationalfoodplan/process-to-develop/issues-paper/submissions-received>