CSIRO Submission

Productivity Commission Inquiry into the regulation of Australian Marine Fisheries and Aquaculture Sectors

CSIRO's response to Information Requests

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Acronyms and abbreviations

AFMF:	Australian Fisheries Management Forum
CCMALR:	Commission for the Conservation of Antarctic Marine Living Resources
CCSBT:	Commission for the Conservation of Southern Bluefin Tuna
CMR:	Commonwealth Marine Reserves
CRFFF:	Coral Reef Finfish Fishery
CSF:	Coral Sea Fishery
EBFM:	Ecosystem-based Fisheries Management
EEZ:	Exclusive Economic Zone
EPBC:	Environment Protection and Biodiversity Conservation
ETBF:	Eastern Tuna and Billfish Fishery
FRAB:	Fishery Research Advisory Body
GBR:	Great Barrier Reef
GBRMP:	Great Barrier Reef Marine Park
GBRMPA:	Great Barrier Reef Marine Park Authority
HSP:	Harvest Strategy Policy
IMCRA:	Integrated Marine and Coastal Regionalisation of Australia
IMOS:	Integrated Marine Observing System
ITE:	Individual Transferable Effort
ITQ:	Individual Transferable Quota
IOTC:	Indian Ocean Tuna Commission
IUU:	Illegal, Unreported and Unregulated (fishing)
MAC:	Management Advisory Committee
MSC:	Marine Stewardship Council
MEY:	Maximum Economic Yield
MPA:	Marine Protected Area
MSE:	Management Strategy Evaluation
NPF:	Northern Prawn Fishery
OCS:	Offshore Constitutional Settlements
PZJA:	Protected Zone Joint Authority
RAC:	Research Advisory Committee
RAG:	Resource Assessment Group
RFMO:	Regional Fisheries Management Organisation

RBC:	Recommended Biological Catch
RPN:	Research Providers Network
SED:	Seal exclusion device
SESSF:	Southern and Eastern Scalefish and Shark Fishery
SPF:	Small Pelagic Fishery
TAC:	Total Allowable Catch
TACC:	Total Allowable Commercial Catch
TEPS:	Threatened, Endangered or Protected Species
TUMRA:	Traditional Use of Marine Resource Agreement
WCPFC:	Western and Central Pacific Fisheries Commission

1 Introduction

This submission has been prepared by CSIRO scientists with extensive experience and international recognition in fisheries and aquaculture research and management. In addressing the Information Requests, CSIRO primarily limits its response to matters with a technical and research focus. Other issues where CSIRO has had direct engagement in the Commonwealth fisheries management system are commented upon as appropriate.

Fisheries and aquaculture are two of several marine industries in Australia which include also offshore oil and gas, tourism, and shipping. Marine industries in total were worth more than $44 billion in 2010, having increased from $38 billion in 2008 (AIMS 2010). The growth in the marine industries sector results in increasing conflict between users, including fisheries and aquaculture. No arrangements currently exist to provide a forum for identifying integrated strategic marine management or for setting spatial management priorities across multiple sectors.

Recreational fishing is a major social and economic activity in Australia with up to four million people participating per annum and catches of many species exceeding commercial catches (Henry and Lyle 2003). This sector is managed by the States, but interacts with several Commonwealth managed fisheries.

Australian commercial fisheries are relatively small by world standards yet have disproportionately large ecological, social, and jurisdictional footprints. For example, Australian marine fisheries account for 0.2% of global marine fisheries landed tonnage but 2% of marine fisheries landed value (FRDC 2010). Demand for seafood is likely to increase with increasing populations both domestically and in our region, placing additional pressure on sustainable production of seafood. Global landings from capture fisheries are static or declining slightly while production from aquaculture continues to rise (FAO 2011).

Australian fisheries jurisdictions have increasingly adopted ecosystem-based fishery management (EBFM) as a policy goal, since the mid-2000s. EBFM takes major ecosystem components and services, both structural and functional, into account in managing fisheries. Its goal is to rebuild and sustain populations, species, biological communities and marine ecosystems at high levels of productivity and biological diversity so as not to jeopardize a wide range of goods and services from marine ecosystems while providing food, revenues and recreation for humans (US National Research Council 1998). This trend is consistent with the growing international demand for environmentally sustainable food production. Spatial management and participatory or co-management are key features of EBFM. By global standards, fisheries management in Australia is considered one of the best in the world, and second internationally in terms of sustainability (Alder *et al.*, 2010). For example, two hundred and thirty eight Australian stocks were assessed recently for their status in the light of ongoing harvest (Flood et al. 2014). Only 5% of stocks were determined to be overfished compared to 30% globally (FAO 2010b)

This submission draws on comments made in a number of previous CSIRO submissions, including to the Borthwick Review, Reviews of the Commonwealth Harvest Strategy Policy and Bycatch Policy, the Parliamentary Inquiry into the Role of Science for Fisheries and Aquaculture, and the Senate Inquiry into the Environmental, Social and Economic Impacts of Large Capacity Trawlers.

2 Australian fisheries

1. INFORMATION REQUEST

1.1 Are fish stocks allocated and managed in a way so as to ensure a viable and sustainable fishing sector both now and into the future?

Allocation

To ensure a viable and sustainable fishing sector, clarity and procedural fairness about allocation is essential.

Allocation is a complex issue, and can occur between jurisdictions, between different marine sectors (including conservation), and between different groups of fishers. Allocation between jurisdictions is largely achieved through offshore constitutional settlements (OCS), which wherever possible allocate responsibility for management of each stock fully to a single jurisdiction even if the stock crosses jurisdictional boundaries. Some 59 OCS agreements as well as associated Memoranda of Understanding have been developed between the Commonwealth and States. This is not always the case, and where stocks are managed under different jurisdictions then co-ordination between the different jurisdictions is attempted to varying degrees of success (See Information Request 15).

Allocation of the resource also occurs between different users. At the Commonwealth level, interactions between commercial fishers and other marine sectors is limited for most stocks. In Torres Strait, an explicit allocation of quota has been made between the Islander community and the non-Islander commercial fishery (Plagányi *et al.*, 2013a). Allocation of spatial areas is also made to particular users (e.g. biodiversity conservation, oil and gas, fishing exclusion zones). At the State level, greater interactions occur as a result of more competing users in the inshore waters. In some cases, specific allocations of a stock have been made to recreational fishers (e.g. Tailor in Queensland), while in other cases a notional quota allocation has been made to allow for recreational catch when determining commercial catch quotas (e.g. Snapper in Queensland). In South Australia, explicit allocations of catch are made for all fisheries between commercial, recreational and Aboriginal and Torres Strait Islander sectors.

Management

In general, Commonwealth fisheries are managed well, and in such a way as to ensure a viable and sustainable fishing sector by targeting the biomass that delivers maximum economic yield (See Information Requests 1.3 and 4). For example Australia ranks highly on most reputable international comparisons. Australian fisheries management has seen a number of improvements over the past decade, some jurisdiction-specific and others national in scope. Improvements include the adoption of formal and agreed harvest strategies to manage exploitation rates and catch levels, and widespread adoption of ecological risk assessment methods leading to better prioritization of and action on issues such as impacts of fishing on bycatch, protected species and benthic habitats. Australia is also noted for its use of participatory management systems, also an important factor in achieving viable and sustainable fisheries.

A major challenge for management is the small size and limited economic value of many Australian fish stocks. Small and low value stocks can be just as difficult and expensive to manage as larger, higher value stocks and most jurisdictions face cost pressure in managing such stocks, especially where management costs are subject to cost recovery. Another challenge arises from stocks targeted by multiple sectors, including recreational and Aboriginal and Torres Strait Islander components where the information base is generally worse (see above, and Information Requests 3.3 and 24).

Managers have a number of regulatory levers or controls that are used to achieve their objectives and ensure viable and sustainable fishing sector. These include input controls, output controls, spatial management and technical measures such as mesh sizes. There is a large body of literature on the success or otherwise of these measures. In general there is increasing acknowledgement that to meet EBFM goals some combination of some or all of these measures is required. Fulton et al. (2014) found that for fisheries in South East Australia, management that focused, for example, solely on quota management or spatial management was insufficient to address the broad range of social, economic and environmental objectives that have been identified for these fisheries. Similar work has been done for the Northern Prawn Fishery (Dichmont et al 2013).

1.2 How should the value of recreational fishing and Indigenous customary fishing be measured and so better inform access allocation decisions?

Measuring the value of recreational fisheries is extremely difficult. There is a substantial difference between measuring the contribution of recreational fishing and the marginal value of fish to recreational fishing. Most studies have focused on the former, estimating the level of expenditure and the potential flow on effects of this into regional, state and national economies (Henry and Lyle, 2003; Jones and Doonan, 2005; Jones, 2009; Taylor *et al.*, 2012). These have largely been used to demonstrate the economic impact of recreational fishing on regional economies. Other studies have valued the recreational experience itself, largely through travel cost models (Rolfe and Prayaga, 2007; Prayaga *et al.*, 2010; Rolfe and Dyack, 2011; Ezzy *et al.*, 2012; Pascoe *et al.*, 2014b). While these also do not value the marginal contribution of fish to recreational fishing, some have estimated the potential impact of changes in catch or other conditions on these values through changing recreational demand (Prayaga *et al.*, 2010; Rolfe and Dyack, 2011; Pascoe *et al.*, 2014b). A recent ABARES report proposing a framework for valuing recreational fisheries argued that a travel cost approach was more appropriate than the expenditure based approach (Georgeson et al., 2015).

The use of these measures, however, for allocation purposes may not be appropriate. First, the opportunity cost of recreational fishing is the next best recreational activity. The additional benefits of expanding recreational fishing must therefore take account also of the reduction in benefits from the other recreational activities that are foregone. This may be a reduction in recreational fishing somewhere else, or may be a change in recreational activity altogether (e.g. golf). Second, in most studies the link between stock size and recreational demand is weak. Allocating a larger share of the stock to recreational fishers may not necessarily increase the total demand for recreational fishing.

Studies attempting to estimate the marginal value of fish to recreational fishing have been limited, and have generally not been undertaken in Australia. For example, Paulrud (2006) applied contingent valuation to assess the benefits of stock improvements in Sweden. Johnston *et al.* (2006) estimated the marginal value of a range of recreational species in the US. Ideally, choice experiments should be preferred over contingent valuation for non-market valuation for a range of reasons (Boxall *et al.*, 1996). These approaches provide a better measure of the value of changing allocation between recreational and commercial fishers. However, given the large number of species managed in Australia, developing appropriate marginal values through choice experiments would be complex. Assuming that some species have similar value to recreational fishers, this could potentially be simplified by valuing species groups. However, identifying which species belongs to which groups would also require additional work. Multi-criteria approaches may be appropriate for this to identify levels of preference or indifference between different species from a recreational fisher perspective (e.g. Martin-Ortega and Berbel, 2010).

1.3 Do the current access arrangements provide for the realisation of the highest economic value from fisheries?

The Commonwealth Harvest Strategy Policy and Guidelines (DAFF, 2007) has an explicit objective of maximising the net economic returns from the resource. A target reference point has been set at the biomass that delivers Maximum Economic Yield (MEY). In 2006, a structural adjustment program in the form of a buyback removed around 50% of the harvesting capacity in all Commonwealth fisheries with the aim of achieving this balance before the MEY target was formally instigated in 2007 (DAFF, 2006). Ex-post reviews of the buyback have found that this has improved average efficiency of the fleets (Pascoe *et al.*, 2012; Pascoe *et al.*, 2013b) as well as economic performance of the fleets (Vieira *et al.*, 2010). Management in Commonwealth fisheries since 2007 has also aimed at building in mechanisms for autonomous adjustment to ensure that gains achieved through the structural adjustment program are not eroded over time.

Not all State and Territory jurisdictions have harvest strategy policies with explicit economic objectives. All jurisdictions recently signed onto a set of national harvest strategy guidelines, and some jurisdictions are developing their own policies (recently implemented in South Australia). Access arrangements are mostly based on historical levels of catch (often poorly documented for recreational and Aboriginal and Torres Strait Islander sectors) and do not necessarily reflect an attempt to realise the highest economic value from fisheries (which in any case is difficult to judge for Aboriginal and Torres Strait Islander fishing). Access arrangements across non-fishing uses of the marine environment (including conservation) are also not well aligned with obtaining the highest economic value from fisheries.

1.4 Is there a reasonable balance between the interests of different users in the current allocations of access to marine fisheries?

No CSIRO response. The balance between interests of different users is a policy issue.

1.5 Is there room to improve the process for determining the allocation of such rights? For example, how might competing interests be better reconciled?

In general, Australian fisheries jurisdictions have developed participatory processes that enable competing interests to be considered. One approach used to identify the trade-offs across a range of management and stakeholder objectives is a simulation technique called Management Strategy Evaluation (MSE; Smith et al. 1999; Sainsbury et al. 2000). The use of simulation in a participatory setting, is an effective way to show trade-offs across the objectives of different users. For example, Mapstone et al. (2004) elucidated objectives in the Queensland Coral Reef Line Fishery from stakeholders, and showed trade-offs in the conflicting objectives of stakeholders under different management strategies. The process has been repeated by the alternative management strategies for the SESSF in south eastern Australia (Fulton et al 2014), and on Ningaloo Reef (Thebaud et al. 2014). A critical characteristic of MSE methods is that they are designed to highlight trade-offs and inform decision making, not to provide a single "optimal" solution. Decisions still lie with the relevant decision making authority, but MSE can often point to "win-win" solutions, or "least-worst" outcomes, where no party is an outright loser. Such methods can therefore help better reconcile competing interests.

2. INFORMATION REQUEST

2.1 Where are there overlaps or conflicts between the rights of access for the different groups of fisheries users? How are such overlaps and conflicts best addressed? How best can the common interests of users be leveraged to improve fisheries outcomes?

As indicated above in Information Request 1.5, common interest, differences, overlaps and conflicts can best be addressed by showing trade-offs using methods such as Management Strategy Evaluation (MSE). For example, the alternative management strategies project for the Southern and Eastern Scalefish and Shark fishery (SESSF) explored potential conflicts between some fisheries in south eastern Australia , and found that the regulatory conditions in place prior to 2007 had significant potential conflict between trawl and longline fisheries in the region (Fulton et al 2007 page 246).

Commercial fishing

3. INFORMATION REQUEST

3.1 Relative to other costs (such as fuel and labour), how significant are the costs of complying with fisheries regulation?

No CSIRO response. CSIRO has little knowledge of these costs to fishers.

Do so called 'input controls' (such as limits on boat size and fishing gear) unduly restrict fishing operations, result in lost opportunities and/or discourage investment within the Australian commercial fishing industry?

Input controls such as gear restrictions impose inefficiencies on fishers (Kompas *et al.*, 2004; Greenville *et al.*, 2006; Pascoe *et al.*, 2012). However, this is what they are designed for – they aim to limit catches to sustainable levels. As technology increases (see Information Request 9), often greater controls are placed on input use to offset this productivity change. Without this offset, catches may increase above sustainable levels, resulting in deteriorating catch rates and lower revenues at both industry and fisher level. This is one reason that output controls are often preferred; in theory, at least sustainable catches are specified and allowed to be taken in the most efficient way.

An assumption is often made that input controls (which aim to limit the catch indirectly) are less desirable than output controls which aim to limit catches directly (see also Information Request 5). Input controls can lead to input substitution (i.e. substitution of unrestricted inputs for restricted inputs) resulting in a less efficient input mix as well as overcapitalisation in the industry (Townsend, 1985). However, output controls can also result in substantial inefficiencies and overcapitalisation of fisheries through a race to fish. A study in the northern prawn fishery concluded that an individual quota system may not perform as well as an input control system given the higher costs of the former and the likelihood of getting the catch quota wrong (Buckworth *et al.*, 2013).

There is little evidence that most current input controls deter investment in the fishery. In some fisheries, additional penalties on boat upgrading are required i.e. through surrender of additional boat units over and above what are required for the new vessel configuration. These controls have largely been phased out in Commonwealth fisheries, although are still in place in some State fisheries. For example, Queensland's Moreton Bay trawl fishery retains boat replacement penalties that have been credited with preventing new investment as the cost of upgrading with the penalty is greater than the expected benefits (Courtney *et al.*, 2012). Queensland also retains a maximum vessel size for the east coast prawn trawlers. While there is anecdotal evidence that larger vessels may be more profitable for the northern component of the fishery, this has not been substantiated and its impact on investment not assessed.

3.2 Are there any other aspects of fisheries regulation (such as uncertainty over the permanency of arrangements) that deter investment?

Investment in fishing takes numerous forms. Boats in most fisheries undergo regular refits, in which major capital enhancement is undertaken. Boat repairs and maintenance (which often include refit costs) and gear replacement costs are usually a large cost component, as seen in the regular ABARES survey reports, and Thebaud et al. (2012); Little et al. (2016a).

All Australian fisheries are subject to limited entry. For a new vessel to enter a fishery, an existing vessel must leave. The market for second hand vessels is also constrained by this requirement, and many vessels are sold overseas. Consideration of removing the licence restriction in Commonwealth quota managed fisheries (both input and output) has been undertaken (Pascoe and Gibson, 2009). The conclusions of that study was that as quotas were not applied to all species, the need to also hold a licence offered additional protection to existing fishers from new entrants targeting non-quota species (and potentially discarding quota species). Further, the value of the licence formed a substantial part of the total asset value of the vessel, and this value would be lost with the removal of the licence requirement (Pascoe and Gibson, 2009).

3.3 What are the major challenges and opportunities facing the commercial fishing industry over the next 20 years? What aspects of fisheries regulation need to change for the industry to best meet those challenges and opportunities?

Perhaps the greatest challenge facing the commercial sector over the next 20 years is social licence to operate. Despite the majority of Australia's fisheries being regarded as well managed, this does not always translate into strong public support. There are complex reasons why public support is lacking, including mainly negative stories in the media, absence of school-based or public education programs, and extrapolation of negative views of the global status of fisheries to Australia. Challenges and opportunities may also require new forms of management to remain sustainable – such as dynamic oceans management (Hobday et al 2014b) where real time spatial management rules are implemented using satellite and other data streams.

See also Information Request 24.

3.4 Are there instances of overcapitalisation in fisheries that is driving returns to fishers down to unsustainable levels? Where such a situation exists, what is the best remedy to return the fishery to long term viability?

Overcapitalisation has largely been removed in Commonwealth fisheries as a result of the capacity reduction program associated with the implementation of the Commonwealth harvest strategy. This has been seen as successful in both reducing capacity and improving the economic performance of the fleets (Vieira *et al.*, 2010). The average efficiency of the fisheries has also increased, with the less efficient vessels generally being those that left the industry during this process (Pascoe *et al.*, 2012; Skirtun and Green, 2015).

REGULATION OF COMMERCIAL FISHING

4. INFORMATION REQUEST

4.1 Are fish stocks managed in way that will ensure a viable and sustainable commercial fishing sector? How effective are harvest strategies, such as the Commonwealth Harvest Strategy, in guiding the management of fish stocks?

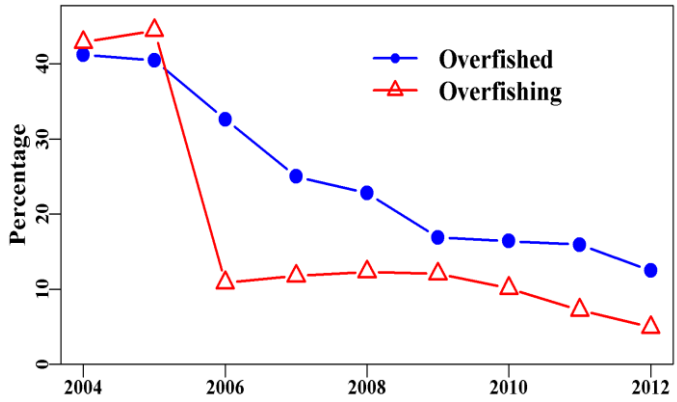
See also Information Request 1.

The status of species and fisheries is regularly reported by the Australian Government and states and territory (e.g. Patterson et al. 2015). In addition, the Australian Bureau of Agriculture and Resource Economics and Sciences, in conjunction with the Fisheries Research Development Corporation, produces annual reports on fisheries and aquaculture statistics and biannual reports on the status of key Australian fish stocks (Flood et al. 2014; Savage & Hobspawn 2015). These reports generally support a view that most Australian fisheries are well-managed.

Commonwealth fisheries are subject to the Commonwealth Harvest Strategy Policy (HSP) which aims to 1) avoid unsustainable fishing, 2) optimize yield or profits, and 3) rebuild depleted or over-fished stocks (DAFF, 2007). The Ministerial Direction to AFMA (Macdonald, 2005) identified a number of requirements but the first was that:

"…AFMA must take immediate action in all Commonwealth fisheries to: a) cease overfishing and recover overfished stocks to levels that will ensure long term sustainability and productivity."

Some aspects of the Direction have been superseded but this requirement continues. There have been attempts made to determine the effective of current management of targeted fish stocks. The success of the HSP at stopping over-fishing was demonstrated by Smith *et al*. (2014):



The percentage of AFMA-managed stocks assessed as either over-fished or subject to over-fishing out of the total number of stocks whose status was not uncertain (after Smith et al 2014).

ABARES status reports (e.g. Patterson *et al*. 2015) confirm the trends demonstrating the success of the HSP in managing and controlling fisheries continues.

As in Information Requests 1.5 and 2.1, the use of Management Strategy Evaluation (MSE) has allowed testing of harvest strategies prior to their implementation. Most Commonwealth fisheries have been simulation tested in this way, and have shown that formal harvest strategies will achieve the performance criteria of the HSP (Wayte, 2009; Haddon, 2012; Plagányi, 2013b).

Many jurisdictions have also taken a tiered approach to fisheries management by placing species into a hierarchical tier system that represents differences in management costs, data quality and ability to accurately assess stock status (Dichmont et al., 2016). In general, there is a tension between the cost of management, the risk to the resource, and the catch benefit that a fishery gains from exploitation. The general belief is that as management activity and costs increase, the risk associated with being overfished declines, which can be compensated by higher catches (Sainsbury 2005). This is known as the risk-cost-catch trade-off (Sainsbury 2005; Dowling et al. 2013; Dichmont et al. 2016; Little et al. 2016b). Current work being conducted at CSIRO is aimed at operationalising this trade-off in order to seek equivalency in the risk across tiered harvest strategies (Dichmont et al. in press).

5 INFORMATION REQUEST

5.1 Are there regulatory approaches that are better suited to achieving the objectives of fisheries regulation compared to quotas? What, if any, challenges exist in the processes for the initial allocation of quotas (for states) and subsequent determinations of allowable catch? Is quota trading functioning effectively?

There is a considerable body of literature on the benefits of quota management systems particularly those implemented as individual transferable quotas (ITQs). There are well known difficulties with these systems,

especially in multi-species fisheries and a number of approaches have been developed to deal with these, In addition, quota management still requires that catches are set appropriately.

The appropriate management system is often context specific where the same harvest strategy applied to different species can have different results in terms of risk and reward (Fulton et al, submitted, Figures 6a-c). The relative benefit of ITQs versus the effort equivalent (ITEs) depends very much on the species biology, the ability to predict the size of the population, and economic and social considerations. In the Northern Prawn Fishery, the short-lived nature and strong but often unpredictable influence of the environmental on the size of recruitment of banana prawns (Buckworth et al., 2013 Figure 3) means that setting a TAC is more likely to be incorrect than correct. This can lead to highly variable returns.

Current challenges to (initial) allocation of quota include the inability of some fisheries to catch the TAC in a range of species. This problem is seen in several fisheries including the ETBF, and SESSF, and is currently seen as a high priority research question, with potential hypotheses that include: missing markets for product, thinness of the quota trading, fleet dynamics, choke (limiting) species, and sociological effects.

In addition, it is unlikely that a single management lever or tool will meet all the objectives of ecosystem based fisheries management (Fulton et al 2014).

See also Information Requests 3 and 7.

6. INFORMATION REQUEST

6.1 Under what circumstances should regulators place restrictions on the fishing boats, trawlers, fishing equipment and technology that are used to capture wild fish stocks?

6.2 How should restrictions be determined (e.g. on scale/size of tool or operations, or with respect to different types of operations, such as 'factory fishing')?

6.3 How well do current restrictions contribute to achieving the regulatory objectives for fisheries?

There are many restrictions placed on fishing vessels in Australia and for a variety of reasons including stock sustainability, economic performance, reducing environmental impacts and even such issues as safety. These form the basis of many input controls.

Restrictions on vessels exist to reduce bycatch and discards – these include fishery closures, mitigation measures, and general bycatch reduction or exclusions devices (see Information Request 8).

There have been a large number of studies on input control managed fisheries including vessel size, fishing gear etc. The main issue relates to increasing fishing power and how this affects sustainability.

Factory fishing vessels of various sizes have been operating in Australian fisheries for many years. The size and type of a vessel does not in itself create a substantial risk to a stock. Instead it is the rules under which the vessels operate that are important. Large factory fishing vessels have been shown to be very economically efficient and have a high adaptive capacity (i.e. can flexibly respond to change).

Little et al. (2009) examined the effect of fishing power limits in the coral Reef Line fishery of the Great Barrier Reef. In this fishery, mother vessels have secondary vessels (dories) attached to them, which increases fishing power. The number of dories attached to a mother vessel has been limited in the past, and Little et al. (2009) examined the effect of changing these limits, since the issue had important relevance to National Competition Policy, and implementing less restrictive management measures. Simulation tests showed strong dependence on the TAC of the primary species, but marginal effects on fishery management objectives, and profitability, mainly owing to the thinness of any dory transfer market (Little et al. 2009; Figure 7.12-7.13; 7.18-7.19; 7.29-7.31).

7. INFORMATION REQUEST

7.1 Is there scope to reduce or get a better mix of input and output controls while achieving the same regulatory objectives?

7.2 Are there tensions between the use of different control regimes in the management of particular fisheries and/or fisheries in proximity to each other? What are the costs and benefits associated with each approach? Is any approach 'superior' in meeting the regulatory objectives with minimal regulatory burden or does a combination of these various approaches work more effectively?

The relative benefit of input and output controls depend very much on the species biology, the ability to predict the size of the population, and economic and social considerations (see Information Request 5). From an ecosystem perspective, alternative management strategies explored for the SESSF showed that a mix of regulatory methods are required to best address a broad range of objectives (across social, economic and environmental dimensions; Fulton et al 2007, 2014).

8. INFORMATION REQUEST

8.1 Are current approaches to managing by-catch and discards in commercial fishing effective?

Total bycatch has been estimated for some fisheries and jurisdictions (e.g. Tuck et al. 2013) but there has not been an assessment conducted nationally to date. Several frameworks for assessing the ecological impacts of fishing have been developed and applied to a number of Australian fisheries as a means to assess the risks to the many non-target species and to other components of the marine ecosystem (Fletcher et al 2004).

The Commonwealth Policy on Fisheries Bycatch was introduced in 2000, and in March 2012 the Minister for Agriculture, Fisheries and Forestry announced that a review of the Policy would occur with the aim of improving the management of bycatch in Commonwealth fisheries. Several reports summarising the current situation with respect to bycatch were produced as part of the review and these can be found on the DAFF website (http://www.agriculture.gov.au/fisheries/environment/bycatch/review). The main purpose of the Policy is to ensure that direct and indirect impacts on marine systems are taken into account and managed appropriately through on-board mitigation measures for protected species and mechanisms that reduce fish bycatch and impacts on the broader marine environment.

For Australia's Commonwealth fisheries, a number of measures have recently been introduced to reduce bycatch and discards – these include fishery closures to help protect Australian sea lions and Gulper sharks, seabird mitigation measures for longline and trawl fisheries of the ETBF, Sub-Antarctic Fisheries and SESSF, various seal, turtle and general bycatch reduction or exclusions devices for the NPF and SPF, and gear changes to reduce fish bycatch in the SESSF. Data suggest that these measures have, in many instances, successfully reduced bycatch and/or discards (Tuck et al., 2013). However, in other cases data are either insufficient to make reasonable judgments about bycatch or the influence of measures, or it may simply be too early to judge the effectiveness of bycatch measures. In addition, there are difficulties in estimating catches and bycatch rates for rarer species/groups when, for economic reasons, observer coverage has been set at levels optimised for commercial target species. Statistical analyses are necessary to ensure that bycatch data and results are interpreted appropriately. For example, attempting to determine the effectiveness of new bycatch reduction devices from time-series of the numbers of raw observations of bycatch can be misleading due to differences in the magnitude of annual observation effort by gear, season, area, or even species focus (Tuck, 2011).

With regard to fish bycatch, in the SESSF various measures to change gear selectivity to reduce fish bycatch by trawl have been trialled, and although potentially effective, a strong reduction in bycatch attributed to gear is not yet evident in the data for the South East Trawl sector. Bycatch management in the gillnet sector of the SESSF has focused largely on mesh size restrictions for shark gillnets to target medium sized gummy shark. The shark gillnet method is also subject to many area closures designed to reduce bycatch of pupping school shark, and interactions with TEPs (Knuckey et al., 2013). For the Antarctic fisheries, all voyages carry AFMA observers and follow strict bycatch management measures. Bycatch of fish species has generally always been low in this fishery (Welsford et al, 2013). While effort in the Coral Sea Fishery (CSF) is low, and bycatch of high risk species is also likely to be low, measures have been introduced to further reduce bycatch, including trip limits for deepwater sharks. Annual reporting of discard species in this fishery is generally low (Dowling, 2013). For the ETBF, observer and logbook data indicate no significant trend in fish discard rates over the last decade. According to observer data, small percentages of target species (tunas and billfish) are discarded, while larger percentages of shark and other bycatch species have been recorded as discarded (Campbell, 2013). The NPF catches numerous species, with total bycatch (by weight) potentially being up to 95% of the catch. As a result of voluntary license buy-backs and gear unit reductions over the period of 1998 to 2011, the estimated volume of bycatch has been reduced by around 50% (Fry and Miller, 2013).

Threatened, endangered, protected (TEP) species have been a major focus of Commonwealth fisheries over the past decade. Bycatch of seabirds and other TEPS are of very low incidence or non-existent in Australia's Antarctic fisheries, which is a major achievement given the region's proximity to breeding colonies and concentrations of seabirds (Welsford et al., 2013). Turtle bycatch in the NPF has been substantially reduced since mandating the use of Turtle Exclusion Devices in 2000 (Fry and Miller, 2013). For the ETBF, flesh-footed shearwaters were a major component of the bycatch in the early 2000s, but have not been observed caught since the mid 2000s. Similarly, observations of albatross bycatch in the ETBF have also reduced to very small

numbers since 2008 (Campbell, 2013; Tuck, 2013). Estimated rates of total seabird bycatch in the ETBF have also declined. On the other hand, observations of turtle bycatch in the ETBF have been variable with no clear trend evident (Campbell, 2013). In the CSF, while observer coverage is low, there have been no reported interactions with turtles in either the logbook or observer data. Management closures in the SESSF have resulted in large reduction in sea lion captures in the shark gill net fishery. In the trawl sector of the SESSF, every vessel is required to have a Seabird Management Plan. These plans contain a range of measures to reduce interactions (including warp deflectors which reduce heavy interactions by 75%), and industry and management are actively pursuing methods to further reduce interactions and bycatch.

There is currently no national reporting framework or requirements for bycatch and discard reporting. This has potential implications for EPBC reporting (Information Request 22).

8.2 Are these approaches sufficiently focused on preventative measures rather than dealing with by-catch once taken?

Current management tends to focus on preventative technical approaches to reduce or minimise bycatch, such as gear requirements, mitigation measures, area closures etc. (Tuck et al., 2013). For many species, mortality once taken, tends to be higher in trawl fisheries than in line fisheries.

The amount of bycatch varies across fisheries. In prawn and trawl fisheries, non-target fish bycatch can be a large proportion of the catch. In these instances, gear changes have been successfully implemented to reduce fish bycatch. Mitigation measures to reduce interactions with TEP species have also been introduced in the ETBF, SESSF, NPF and Antarctic Fisheries (Tuck et al, 2013). These include SEDs, bird scaring devices and area/temporal closures. While recognising that bycatch should be reduced to a minimal level, there is likely to always be some level of bycatch and regulations to deal with bycatch (minimising harm) once taken will continue to be necessary.

There is also anecdotal evidence that behaviour may play a large role in the level of bycatch. For example, in the eastern tuna and billfish fishery, some vessels tend to have a consistently higher catch rate of seabirds than others (unpublished and ongoing analysis), even though all are subject to the same technical restrictions. This suggests that there may be a role for incentives based measures to be considered. Several review based studies have been undertaken in Australia on the role of incentives and market based instruments to reduce bycatch, based on experiences elsewhere (Pascoe et al., 2010; Innes et al., 2015). However, implementing these under the current management framework may be difficult largely due to monitoring and enforcement issues, although the development of remote monitoring (e.g. onboard cameras) being trialled in some fisheries may reduce some of these impediments. For some species that occupy both marine and terrestrial habitats (e.g. turtles, seabirds, seals), offsets may also provide some benefits (Donlan and Wilcox, 2008; Pascoe et al., 2011; Rogers et al., 2014; Jennings et al., 2015)

A PRODUCTIVITY CONTEXT

9. INFORMATION REQUEST

9.1 What are the key influences on, or barriers to, innovation and productivity improvement in the commercial fisheries sector? Where does regulation most affect resource use and incentives to improve? What management settings should be changed or implemented to maximise productivity growth?

Fishers are generally quick to innovate and adopt new technologies, with evidence of substantial technical change in several fisheries over the last two decades resulting in an increase in overall vessel productivity (Pascoe *et al.*, 2012; Skirtun and Green, 2015).

Productivity growth through technical change, while beneficial to the individual fisher, can create problems at the fishery level. Technical change that is productivity enhancing also increases the level of effective effort applied to the fishery. This may impact on the sustainability of the stocks, and longer term economic sustainability of the fishery unless counterbalancing measures are undertaken, or that management allows for autonomous adjustment to take place. Under fisheries managed through individual transferable catch quotas (ITQs), technological change reduces the level of effort needed to be applied by the fishery to take quota. In the absence of a well-functioning quota market, this may result in decreased capacity utilisation and a potential imbalance between the level of capital and catch in the fishery. With effective quota trading, however, the more efficient vessels can purchase quota from the less efficient vessels (who exit the fishery), reducing the overall level of capital in the fishery. In theory, information about the level of technical change is not required by managers as this does not affect the quota market operations. In practice however, information about technical

change is required as stock assessments (used to set total allowable catches) rely on accurate fishing effort information (Smith et al. 2001). In Australian fisheries managed through ITQs, the end result lays somewhere in between the best and worst outcomes. While autonomous adjustment in ITQ fisheries does take place, quota markets are not perfect.

In fisheries managed through input controls, information about the level of technical change is required to set the total allowable effort (explicitly, or implicitly through adjustment of input restrictions). With individual transferable effort (ITE) quotas, a well-functioning market will facilitate autonomous adjustment, as has been seen in the Northern Prawn fishery (Kompas and Spring, 2015). As with ITQs, a poorly functioning market will result in excessive levels of fishing effort persisting in the fishery, reducing the longer term biological and economic sustainability of the fishery.

Despite the importance of the quota (catch and effort) market to the effectiveness of management, management agencies have generally not been involved with the establishment or maintenance of a quota trading market, instead leaving this to the industry to develop. With relatively small numbers of fishers in most fisheries (i.e. potential buyers and sellers, or leasers), development of an efficient trading system is challenging in Australia. Thin markets with few buyers and sellers may lead to high transaction costs as individuals have difficulty finding trading partners (Newell *et al.*, 2005). Most trades in most Australian fisheries are through personal networks rather than formal brokerage agents (van Putten and Gardner, 2010; van Putten *et al.*, 2011). Improving the efficiency of the quota trading markets may be one of the main ways in which technical change can translate to sustainable productivity growth.

In the absence of quota trading, the main other instrument that has been used in Australian fisheries (and elsewhere) to offset productivity growth is to buyback a number of licences in order to reduce the number of active vessels. A buyback program was instigated as part of the move to maximising economic returns in Commonwealth fisheries. This resulted in improved profitability in these fisheries (Vieira *et al.*, 2010), although experiences elsewhere suggest that these profits may be short term in nature, as effort can still increase through increased capacity utilisation and technical change (Curtis and Squires, 2007; Squires, 2010).

Recreational fishing

10. INFORMATION REQUEST

10.1 Are controls such as licences, bag limits and size limits effective? Is there scope to reduce the burden (time or monetary costs) of fishing rules on recreational fishers while achieving the same regulatory objectives?

Generally in Australia, recreational fishing is an open access fishery with no restrictions on the number of participants or the fishing effort they each expend. There are a small number of specific fisheries where effort is regulated, such as the tag lottery in the Western Australian Shark Bay snapper fishery. Harvest in most states is controlled by output controls such as bag, possession and size limits. There are some input controls, such as a limit on the number of fishing apparatus used at once or in possession. In general however, licencing is not specifically used to limit recreational fishing effort, but to obtain a more precise, and cost-effective, estimate of the number of participants than can be obtained through general population surveys (e.g. telephone). While removal of licencing systems may minimise the financial burden on recreational fishers, the consequence is that there will be a substantially higher financial burden on fisheries agencies to undertake expensive surveys to estimate fishing effort. The required large-scale surveys involve estimating participation from general population telephone surveys, which are becoming increasingly inefficient. This is due to incomplete sampling frames, non-response and non-contact issues associated with increasing use of mobile phones and unlisted numbers. The result is highly uncertain participation and effort estimates that are required by scientists to estimate the total catch of particular species by the recreational fishery.

With regards to bag and size limits, their efficacy can vary depending on the fishery or species. In most fisheries, the average fisher will rarely reach a bag limit and therefore many State fishery agencies have been gradually reducing bag limits to match the average catch rate of fishers. Bag limits are generally in place to ensure equity among recreational fishers, rather than being a harvest control.

Size limits are effective for protecting young age classes of fish to minimise the chance of growth overfishing. Size limits are generally well adhered to as a result of effective education campaigns over the past few decades by both recreational fishing peak bodies, but also State fishery agencies.

10.2 How well is recreational fishing recognised in current fisheries management and regulatory arrangements (including in relation to access rights)?

Recreational fishing is an important activity for many Australians and it contributes substantially to the Australian economy. In New South Wales alone, nearly 800,000 adults participated in recreational fishing in 2012, contributing to an economic output of $3.42 billion and an associated employment of 14,254 equivalent full-time jobs (ANCORS 2013). An assessment of recreational fishing at the national level to quantify participation, effort and harvest has not been undertaken since 2001 (Henry and Lyle 2003).

For some species, the amount of recreational harvest exceeds the take of the commercial catch. For example, the recreational tonnage of southern sand flathead in Tasmania in 2012–13 was six times that of the commercial fishery, while the estimated recreational harvest of King George whiting in South Australia in 2013–14 was 1.46 million fish or 367 tonnes, which was more than half (58 per cent) of the total harvest. Of the 10 key species caught by fishers in New South Wales, recreational catches exceeded commercial catches for five, with a further two only slightly lower than commercial catches.

Although recreational catches are more uncertain than commercial catches, where data are available, they are used in fishery assessments. Harvest strategies for some state and Australian fisheries include recreational catches (DAFF 2007).

Managing recreational fishing is the remit of state and territory agencies and largely takes the form of bag or boat and size limits. In some jurisdictions and for some species, management can also take the form of area, seasonal and spawning site fisheries closures or species or group specific refuges. Obligations for catch reporting and official catch recording systems are lacking for most recreational fisheries and instead large efforts are placed on developing surveys and other methods to estimate recreational catch.

10.3 How does the regulation of commercial fisheries affect recreational fishers? What are the main sources of tension between recreational fishers and other fishery users?

The regulation of commercial fisheries will generally have an impact on recreational fishers when the regulation affects (or is perceived to affect) a species targeted by both fisheries. A good example is the factory trawler issue in southern Australia. Although stock assessments were undertaken by scientists to set a quota to ensure a biologically sustainable harvest, recreational fishers strongly opposed allowing the factory trawler to fish as it was believed it would cause large localised depletions of small pelagic fish, which are the prey for recreationally important species such as southern bluefin tuna, yellowfin tuna and striped marlin.

10.4 What, if any, tensions exist between the controls on recreational fishing across jurisdictions and fisheries?

No CSIRO response. CSIRO has little experience in controls on recreational fishing.

10.5 Given the services provided by state and territory governments to support recreational fishing, do recreational fishers get good value from licence fees?

No CSIRO response. CSIRO has little experience with state and territory governments on recreational fishing services they provide.

Indigenous fishing

11. INFORMATION REQUEST

11.1 Is there sufficient awareness and understanding on the part of fisheries regulators and the broader community of Indigenous fishing rights? Do current fisheries arrangements adequately recognise Indigenous fishing rights?

Aboriginal and Torres Strait Islander peoples have the right to traditional harvesting of marine resources that has been established through a suite of legal decisions and cases, often by the High Court of Australia. The level of awareness of Aboriginal and Torres Strait Islander fishing rights appears to be low for both regulators and the public since it requires effective advocacy (e.g., clear resources used by the public) and effective methods for detecting awareness change (e.g., fishing surveys). Current initiatives for publicising the grounds of fishing rights are lacking or often poorly promoted in most regions in Australia. Across Australia, knowledge of Aboriginal and Torres Strait Islander fishing rights remains poorly quantified given there is no recent national survey of views. Use of the 2003 National Recreational and Indigenous Fishing Survey may provide outdated information for fisheries management agencies.

CSIRO is not aware of any comprehensive review of States and Commonwealth legislation for recognising Indigenous fishing rights and as such, it is difficult to track the evolving nature of recognition and the diversity of recognition arising from regional context. In New South Wales, the Fisheries Management Act 1994 was amended in 2010 to explicitly acknowledge indigenous cultural fishing and create a process to develop culturally appropriate regulations. The direction taken by New South Wales Fisheries provides other States and the Commonwealth with guidance as to how Aboriginal and Torres Strait Islander fishing rights can be recognised in legislation. The Fisheries Management Act 1991, as a piece of Commonwealth legislation, has yet to recognise Aboriginal and Torres Strait Islander traditional fishing in the objectives of the act.

11.2 Should there be any limits on the fishing methods or gear that can be used in the exercise of customary fishing rights?

Fishing methods used in traditional fishing have evolved with the advent of modern fishing gears (e.g. motorised vessels) and although this modernisation has been questioned by public opinion, it still needs to be sustainable. Fisheries management arrangements have been endorsed by Aboriginal and Torres Strait Islander communities, and include the adoption of seasonal closures, Traditional Use of Marine Resource Agreements (TUMRA), and specialised indigenous rangers with powers of compliance and monitoring human activities.

11.3 How might the scope for economic and community gain from fishing ventures by Indigenous communities best be facilitated? What are the barriers that need to be overcome?

Social and cultural aspects of fisheries can be a significant determinant of participation in and value to the community of Aboriginal and Torres Strait Islander fisheries (e.g. van Putten et al 2013a, which explores the factors influencing indigenous participation in the Torres Strait tropical rock lobster fishery). For Aboriginal and Torres Strait Islander people to benefit commercially from fishing they will usually engage in the industry as licensed commercial fishers. This means access to commercial fishing is restricted until this license is granted. The economic and community gain from fishing ventures for indigenous communities is strengthened by improving the capacity of corporations to become autonomous, active and self-sustaining.

There are opportunities and responsibilities for Traditional Owners and their respective corporations to increasingly lead economic development. Some Aboriginal and Torres Strait Islander corporations have aspirations to play a strong role in the future governance and delivery of economic initiatives in their region. This requires ongoing commitment, clear lines of communication between stakeholders, appropriate delivery of information and goodwill from all stakeholders to create and maintain economic development.

12. INFORMATION REQUEST

12.1 Is there adequate consultation and engagement with Indigenous people in relation to the management of fisheries? Do current fisheries management arrangements provide incentives for Indigenous communities to be involved in fisheries management? If not, how could this be improved?

Across Australia, there are a variety of ongoing cooperative management and planning processes that address Aboriginal and Torres Strait Islander resource use. For example, planning approaches include traditional use of marine resource agreements (TUMRA) which are a statutory arrangement for establishing partnerships between the Great Barrier Reef Marine Park Authority and Traditional owners that live adjacent to the marine park; and the Protected Zone Joint Authority (PZJA) process in Torres Strait. In 2012 the Fisheries Research and Development Corporation established an Indigenous Reference Group to assist in working towards a Fisheries Research, Development and Extension (RD&E) plan for indigenous Australians.

Coastal indigenous communities often partner with management agencies to cooperatively work towards sustainable goals. Management controls for traditional harvest as agreed to by communities include seasonal closures, Traditional Use of Marine Resource Agreements (TUMRA) as used in the Great Barrier Reef. Increasing the involvement of Aboriginal and Torres Strait Islander communities in fisheries management roles, such as committee representation and compliance officers, involves building the capacity of community members (e.g., Aboriginal and Torres Strait Islander leaders and rangers). The legal difficulties in gaining rights or titles for sea country in Australia hinders the coexistence of custom and law and can diminish the building of co-management (see Information Request 18).

Illegal fishing activities

13. INFORMATION REQUEST

13.1 What is the scale and scope of illegal fishing? What form does illegal fishing activity most often take?

Australia is a signatory to several international conventions and a member of a number of regional fishery management organisations in which Illegal, Unreported and Un-regulated (IUU) fishing is a major focus. In Australian waters non-compliance with commercial or recreational fishery regulations occurs, but is seen as small scale or opportunistic. A national study found that IUU fishing was not a significant problem, however elements of organised crime occur in some fisheries such as abalone. All jurisdictions have fishery officers or arrangements with police to enforce fisheries regulations.

13.2 Where does illegal fishing activity cause most damage to the environment and detriment to the interests of legitimate fisheries users? Where should monitoring and enforcement actions be focused?

13.3 How could the enforcement of fisheries laws be made more effective without adding to the overall regulatory burden? Should penalty regimes be strengthened?

13.4 What sort of role, if any, is there for non-government bodies, such as the Sea Shepherd, in combating illegal fishing?

13.5 How best might Australia protect its interests from illegal fishing activity in Antarctic waters? What factors should be balanced against the cost of any increase in effort to reduce illegal fishing in this remote area?

No CSIRO response. CSIRO has limited experience in enforcement, or in dealing with associated NGOs.

3 The management of fisheries

Multi-jurisdictional governance

14. INFORMATION REQUEST

14.1 Are the underlying objectives of fisheries management regulation clear and widely understood?

Objectives vary substantially between jurisdictions. The Commonwealth has an explicit objective of maximising the net economic returns to the Australian community. In commercial fisheries, this has been interpreted as achieving the maximum economic yield (MEY) (DAFF, 2007). This objective was re-iterated in the Borthwick review (Borthwick, 2012), which suggested that equal consideration also be given to the objectives of minimising bycatch and the impacts of fishing on the environment. At the State level, most legislation specifies that economic, ecological and social sustainability need to be considered. Western Australia and South Australia fisheries management however, is guided explicitly by a harvest strategy policy (Dept. Fisheries WA, 2015; PIRSA 2015) which requires operational objectives, indicators and reference points.

Several studies have been undertaken to attempt to develop more operational objectives for fisheries management, and to determine the relative importance of these objectives Pascoe *et al.*, 2013a; Pascoe *et al.*, 2014a). These have generally found that environmental (including stock sustainability and environmental impacts of fishing) and economic objectives are usually given fairly equal weighting, with social objectives generally given a lower weighting than the other two areas. A national study aimed at identifying social objectives for fisheries management found that social objectives fall into three categories, namely around fishers' welfare, community welfare and indigenous specific objectives (Triantafillos *et al.*, 2014). A further FRDC funded project (FRDC 2013-204 Meeting sustainability expectations: translating and aligning objectives, reporting and evaluation of the performance of Australian fisheries) is also currently evaluating fisheries objectives across the different jurisdictions.

14.2 What should be the main objectives of fisheries management and regulation?

No CSIRO response. The main objectives of fisheries management is a policy issue.

14.3 If social objectives should be included as objectives of fisheries laws, what priority should they be afforded relative to the other objectives of fisheries regulation?

See above comments and citations.

15. INFORMATION REQUEST

15.1 For what species, fishing methods and/or in which locations do regulatory overlaps, conflicts and/or duplication arise across Australian fisheries? What costs arise as a result? How might these overlaps, conflicts and areas of duplication best and most cost-effectively be addressed?

In the SESSF the recommended biological catches (RBCs) are determined from stock assessments and related harvest strategies, and the subsequent TAC must account for both discarding and state catches. State catches overlap with Commonwealth TACs, for example in school whiting, elephantfish, and tiger flathead. These are major components of the SESSF. Given the process of removing State catches from the RBC, the Commonwealth TACs are what remains. This results in Commonwealth TACs potentially being variable from year to year and largely out of the control of the Commonwealth managed fishery. This can lead to issues with regard to investment and surety of resource availability for Commonwealth fishers.

States have no formal representation in the Commonwealth RAG process (FAP 2015) and so their limited involvement may result in a lack of data sharing for assessment purposes, and potentially greater uncertainty in stock status. In addition, the Commonwealth industry and AFMA bare the costs of assessing the shared stocks.

In Queensland the issue is complicated in the GBRMP where conservation of biodiversity is managed by the GBRMPA, but the fisheries, notably the Coral Reef Finfish Fishery (CRFFF) and others, are managed by

Queensland state government. This has resulted in multiple management measures in the form of marine no-take areas implemented by the GBRMPA for biodiversity conservation, and a series of input and output controls implemented by the State of Queensland. Mapstone et al. 2004 (Table 9, 10) shows the interaction effects between marine reserves and effort controls in relation to conservation management objectives and fisheries management objectives. Whereas, Little et al. (2011; Figures 1 and 2) showed the trade-offs in economic return from the fishery, between marine closures and a ranges of output control in the form of TAC under ITQ, which the fishery had recently moved to.

Overlaps and conflicts between jurisdictions currently are able to be addressed through the Australian Fisheries Management Forum (AFMF): an informal network for sharing information between the state and federal government agencies involved in managing fisheries and aquaculture in Australia. AFMF is comprised of the heads of Commonwealth and state/territory fishery management agencies, with observers from relevant bodies, including the Fisheries Research and Development Corporation.

16. INFORMATION REQUEST

16.1 Are there too many authorities responsible for Australia's marine fisheries? If so, what supervisory arrangements would be most effective for Australian fisheries?

16.2 Are there other countries that provide useful lessons for governance arrangements in Australia?

No CSIRO response to 16.1-16.2. The number of authorities in marine fisheries is a government issue and beyond our ability to comment.

16.3 How can information and reporting be better shared and coordinated across jurisdictions and fisheries? For example, information on stock assessment and statistics relating to catch, by-catch and protected species? In what other ways could the jurisdictions better coordinate the regulatory effort?

Opportunities to share high level information (project results, operational issues) currently exist within and between jurisdictions exist in the form of the Research Providers Network (RPN), Australian Fisheries Management Forum (AFMF), and the AFMA RAG process.

The Australian Fisheries Management Forum (AFMF) is an informal network for sharing information between the state and federal government agencies involved in managing fisheries and aquaculture in Australia. AFMF is comprised of the heads of Commonwealth and state/territory fishery management agencies, with observers from relevant bodies, including the Fisheries Research and Development Corporation.

17. INFORMATION REQUEST

17.1 What impact do Australia's international obligations have on domestic fisheries?

Australia is a member of several Regional Fisheries Management Organizations (eg CCSBT, CCAMLR, IOTC, WCPFC). Members are required to implement and comply with obligations arising under the relevant Convention and adopted conservation and management measures, but to date, Australian has data reporting and unilateral management regimes which generally exceed the RFMO requirements.

It is recognized that CCSBT (Commission for the Conservation of Southern Bluefin Tuna) management of southern bluefin tuna has resulted in harvest that is more aggressive than would normally be consistent with the domestic harvest strategy policy (Anon. 2007) given the depleted stock status. However, the CCSBT currently has an active multilateral rebuilding strategy, devised by a simulation-tested management procedure and is currently considered an RFMO success story.

WCPFC (Western and Central Pacific Fisheries Commission) management measures have not been restrictive for Australian fleets to date (WCPFC 2016). Bycatch of ecologically related species (oceanic whitetip sharks, and silky shark, seabirds and sea-turtles) also require the implementation of various mitigation techniques and/or restrictions on fishing gears used on domestic vessels to reduce the capture and mortality of these species. There are also requirements for the use of observer programs to report relevant information on the capture of these species, and where required the mitigation techniques used. There are also specifications relating to the ban on retaining these species and where applicable their safe discarding (WCPFC 2016).

Domestically, harvest strategies have been developed for the WCPFC stocks of interest, but it remains unclear the extent to which unilateral domestic action can have a meaningful influence on the population, without

parallel action by the international fleets. Given the uncertainty in pelagic fishery population structure and connectivity, unilateral catch restrictions have only been activated through the eastern tuna and billfish fishery for swordfish and striped marlin, where the argument can be made that Australia is a major player (Campbell 2015).

17.2 What impact does illegal fishing have on domestic fisheries?

The impact of illegal international fishing on Australian domestic fisheries is largely unknown. Historical IUU catches for southern bluefin tuna undoubtedly contributed to the decline of the stock, but the problem is thought to be greatly reduced in the past decade. Given the lack of restrictive management actions in the IOTC and WCPFC, there has been less incentive for illegal fishing, and it is impossible to distinguish the impact of legal vs: illegal activities.

IUU fishing in the CCAMLR region is thought to have greatly reduced since the 1990s (CCAMLR 2016).

Management and governance models

CO-MANAGEMENT

18. INFORMATION REQUEST

18.1 Where and in what circumstances has the co-management of fisheries been particularly effective or ineffective? What are the advantages and disadvantages of the different co-management approaches of the jurisdictions and/or in individual fisheries?

There is a broad range of papers discussing Australian fisheries co-management benefits and weaknesses (e.g. for the NPF, Dichmont et al 2007; Australian federal fisheries more broadly, Smith et al 1999, Smith et al 2001) and the general conditions leading to successful co-management arrangements (e.g. Pomeroy et a 2001)

In a general sense successful co-management arrangements can lower costs, lead to more responsive management and better compliance outcomes (FRDC 2008). Through co-management arrangements it is also possible to formally accommodate Aboriginal and Torres Strait Islander traditional fishing practices (Mazur 2010). However achieving co-management in a practical way can be difficult and, because no one fishery is the same, there is no pro-forma that can be followed.

There are long lead times for successful co-management because of a need to build trust between stakeholders. Where co-management arrangements have matured, successful co-management is evident when a fishery needs to collaboratively ensure sustainability through reducing bycatch or reducing TACC (e.g. in the Northern prawn fishery and the Tasmanian rock lobster fishery respectively). Unity of purpose among stakeholders is an important characteristic for successful co-management.

In some fisheries with a small number of operators, there may be high transaction cost to the individual fishers to engage in the management process. Other approaches such as a corporate-cooperative management model may prove to achieve better outcomes in these fisheries (Coglan and Pascoe 2015).

Successful co-management may be hampered by some social demographic dimensions of fisheries, where the number of operators is small, making representation difficult. For instance, where a fishery is characterised by a group of well-established fishers, recently stablished operators often do not have as much time and experience to participate in co-management potentially leading to unequal representation of interest. Similarly skippers who do not own a vessel or quota may also have time limitation or the same imperatives for participation in co-management. A small number of operators does not need to pose a barrier however, as the case, for instance, in the Great Australian Bight Trawl Fishery (Mazur 2010).

ACCREDITATIONS

19. INFORMATION REQUEST

19.1 To what extent do private sector accreditations and certifications overlap with government regulations?

There is a wide variety of private sector accreditation and certification schemes in the fisheries and seafood sustainability space. International examples include the Marine Stewardship Council, the Monterey Bay Aquarium's Seafood Watch, Canada's SeaChoice and New Zealand's Best Fish Guide. Australian examples include the Australian Marine Conservation Society's Sustainable Seafood Guide and schemes developed by major retailers such as Coles. Each scheme has its own focus and requirements. Most focus at some level on sustainability of the resource, but they vary widely in the extent to which they consider other issues such as impacts on bycatch, habitat, and interactions with protected species. Some also deal with non-ecological issues such as labour conditions, safety at sea, food safety and trade. Given this diversity of schemes and approaches, overlap with government regulations varies widely and needs to be considered case by case.

19.2 What special value is accorded to private sector accreditations? Could private and government accreditation and certification be better differentiated and aligned?

Seafood accreditation schemes have proliferated over the past decade or more, and a number of them have established credibility in markets and in public perception. Third party schemes like the Marine Stewardship Council (MSC), which now certifies over 10% of the global fishery catch, have been around long enough (two decades) to be able to show measurable improvements in sustainability over time for the fisheries in the scheme. Some governments, for example in Western Australia, are attempting to get all their fisheries certified by MSC, recognizing the value and public acceptance of such schemes.

19.3 To what extent can third party accreditation be relied on as an alternative to regulation? Are there reasons accreditation schemes should or should not be used as alternatives to regulation?

There are obvious efficiency advantages of governments recognizing third party accreditation, potentially providing large cost savings both for the fishing industry and for government regulators, and reducing duplication and "red tape". The possibility that governments could formally recognize third party seafood accreditation schemes has been under discussion for over a decade. Clearly each scheme has to be judged on its merits, both regarding the criteria by which certification is evaluated and achieved, and with regard to specific provisions of legislation, for example Part 13 of EPBC concerning protection of marine species, and export approval under Part 13A. While a benchmarking approach would be needed across various schemes and in relation to particular legislation and regulatory requirements, the cost and efficiency benefits in the longer term would appear to make such benchmarking exercises worthwhile.

Cost-recovery in managing fisheries

20. INFORMATION REQUEST

20.1 What groups most directly benefit from the regulation of Australian fisheries? Of those groups, who obtains greater benefits?

20.2 What aspects of fisheries management costs are and should be recoverable from users? How well targeted and administered are current cost-recovery arrangements? Are there better cost recovery approaches than others in this area?

20.3 Should there be a charge on the use of fisheries to provide a return to the community from the use of marine resources?

No CSIRO response. CSIRO does not administer or manage fisheries *per se*, but participates in the process.

4 Meeting environmental objectives

21. INFORMATION REQUEST

21.1 Is the Precautionary Principle adequately defined and consistently applied within the context of Australian fisheries?

No CSIRO response. Adequacy of the Precautionary Principle definition in Australian fisheries is a policy issue, and consistency of application was not considered.

21.2 Where is there overlap between Commonwealth and state/territory environmental regulations with respect to wild catch fisheries? How well is the overlap managed and what are the consequences where it is not managed well?

There is overlap in environmental regulations with respect to the EPBC and i. wild-catch State fisheries with respect to exported species (e.g. rock lobster in state fisheries, coral trout in QLD); and ii. fisheries in world heritage areas (e.g. recreational fishing in Ningaloo Coast World Heritage Area, and the GBRMP).

In the GBRMP, conservation of biodiversity is managed by the GBRMPA, but the fisheries in it are managed by Queensland. This has resulted in multiple management measures in the form of marine no-take fishing areas implemented by the GBRMPA, and a series of input and output controls implemented by Queensland (See Information Request 15).

22. INFORMATION REQUEST

22.1 Is the process that fisheries are strategically assessed separately under the EPBC Act efficient and effective? If not, how could it be improved - for example, is there merit in and scope for AFMA and/or state/territory fisheries managers to be delegated assessment and approval functions in relation to Part 10 of the EPBC Act, with the Department of the Environment's role then becoming one of monitoring compliance with requirements?

22.2 Are assessments made under the EPBC with respect to export of produce and interactions with listed species efficient? If not, how could they be improved? What other pieces of Commonwealth regulation govern the environmental impacts of fisheries?

22.3 For fisheries located in state or territory waters, are the environmental regulations effective? If not, in what ways could they be improved?

There is currently no national reporting framework or requirements for bycatch and discard reporting (see Information Request 8).

23. INFORMATION REQUEST

23.1 How well does current scientific and research effort support the environmental and ecological objectives of fisheries management?

23.2 How effectively is scientific or research information (and developments in such information) 'translated' or incorporated into policy or regulatory settings?

Australia has a long history of science-based management for fisheries and aquaculture is highly regarded in reputable global comparisons. As mentioned above there is a broad range of papers discussing Australian fisheries co-management and this includes processes for incorporating research outputs (e.g. Smith et al 2001).

Recent examples include the HSP and Bycatch Policy Guidelines which have been reviewed and are being updated, based upon scientific studies and international best practice. These Guidelines translate Policy into practice (DAFF 2007). AFMA's Resource Assessment Groups (RAGs) and Management Advisory Committees

(MACs) provide a forum for dissemination and discussion of scientific studies that can be adopted as part of the assessment and management process (FAP 2015; figure 1).

23.3 What is the best way for regulators, fishers and other stakeholders to work together to ensure optimal outcomes from fisheries research?

CSIRO does not comment on the best way, but from our experience the current AFMA RAG process allows representation from various stakeholder groups, including industry, conservation, scientific, recreational fishing, management, and economics (FAP 2015). The Fisheries Research and Development Corporation and the National Research, Development and Extension Strategy for Fishing and Aquaculture both highlight the importance of extension to ensure uptake and adoption of research outputs.

23.4 Are arrangements for funding ongoing research in the fisheries area satisfactory?

The fairly rapid shift in fisheries management over the last decade from a focus on single target species assessments to a focus on ecosystem-based management places increasing demands on research for the provision of management advice. A focus on EBFM requires that fishing impacts on target, bycatch, habitats and ecological communities are considered. Thus the information demands for EBFM are much higher. As a result Australia has pioneered the development tiered risk assessments that start with lower cost methods and only increase research costs when a material risk with that approach is shown. Australia is seen as being at the forefront in this area of research (Gallagher et al 2012; Scandol et al 2009; Patrick et al 2009; Pikitch 2012) but the information demands are still formidable and outside the scope of traditional data-rich-based research.

The implementation of the National Research, Development and Extension Strategy for Fishing and Aquaculture, and in particular the formation of the Research Providers Network (RPN) has significantly improved collaboration across Commonwealth and State Research Agencies.

In addition, FRDC funding operations have shifted away from an annual call, to year-round opportunities. There is also less emphasis on state research advisory bodies (FRABs) which have been replaced by FRDC-run RACs, with the intention that there will be a more co-ordinated approach across jurisdictions. RAGs and RACs also have research priorities which are revised regularly and these feed into the AFMA and FRDC calls for research (FAP 2015, figure 1).

23.5 How effective are arrangements for sharing information? Is there scope to improve the planning and/or collection of data to better achieve commercial, community and policy objectives?

Opportunities to share high level information (project results, operational issues) within and between jurisdictions exist in the form of the Research Providers Network (RPN), Australian Fisheries Management Forum (AFMF), and the AFMA RAG process.

The Australian Fisheries Management Forum (AFMF) is an informal network for sharing information between the state and federal government agencies involved in managing fisheries and aquaculture in Australia. AFMF is comprised of the heads of Commonwealth and state/territory fishery management agencies, with observers from relevant bodies, including the Fisheries Research and Development Corporation.

At a lower level (fishery data including catch, and biological), only informal arrangements exist for data sharing between CSIRO and fishery agencies (AFMA, States) and where they occur are done on a case-by-case basis. As mentioned in Information Request 15, States have no formal representation in the RAG process (FAP 2015) and this could result in a lack of data sharing. Data sharing protocols pertain to for the SESSF and the NPF, between CSIRO and AFMA are currently being revised and improved.

24. INFORMATION REQUEST

24.1What effects — or likely effects — is climate change having on wild catch fisheries? If these effects are substantial, what management techniques are being, or could be, used to mitigate or adapt to negative impacts?

Climate change is already affecting Australia's marine environment. A recent review of climate change impacts on Australia's commercial marine fisheries (Holbrook and Johnson 2014) discusses the implications for management. It is likely to have both positive and negative impacts on fisheries (Hobday *et al.*, 2008; Norman-Lopez *et al.*, 2011; van Putten *et al.*, 2013b; Fleming *et al.*, 2014; Hobday *et al.*, 2014).

On-going warming of ocean waters caused by anthropogenic climate change superimposed on natural events, storminess and acidification pose risks to Australia's temperate and tropical ecosystems. Marine species are responding to these changes by adapting, moving, or declining. There have already been significant shifts in the ranges of more than 100 marine invertebrates and fish (Last et al 2011; Pecl et al 2014; Sunday et al. 2015), particularly on the east coast of Tasmania, which is one of the fastest warming ocean regions on the planet (Hobday and Pecl 2014). This pattern is likely to continue into the future (Fulton and Gorton, 2014). In addition, climate can (both directly and indirectly) modify fisheries production, either through modifying recruitment or survivorship (Fulton and Gorton 2014; Creighton et al 2016).

Management strategies in response can be implemented account for these changes, including imposition of a total allowable catch system and zoning of the harvest regions. In 2012, AFMA and the associated RAG recognised that jackass morwong recruitment was related to a change in the westerly wind index, which led to a re-assessment of the stock productivity, which reduced the long-term TAC (Wayte 2013). Given such changes may exonerate management from the consequence of a declining stock, and might be expected to increase in the future, a weight-of-evidence approach has been recognised as a way to review such proposals on a case by case basis in the future (Klaer et al. 2015).

Environmental effects are also being seen on the Great Barrier Reef, where rising summer sea temperatures and steadily increasing ocean acidity increase the risk of mass coral bleaching. Climate change is a threat multiplier, and the cumulative impacts of economic activities such port dredging and runoff of sediment, nutrients and fertiliser from agriculture, may have increased effects in the future. Flooding and cyclones have caused fishers on the GBR to leave the industry (Marshall et al 2013).

More broadly around Australia, ocean warming and changes in currents are affecting fisheries and aquaculture. Changes to the East Australian Current have brought sea urchins further south which, together with warmer waters and outbreaks of algal blooms, have resulted in depletion of kelp (urchin barrens) and affected the productivity of the rock lobster fishery in some parts of Tasmania (e.g. Frusher et al 2014; Metcalf et al. 2015). Marine heatwaves (Hobday et al 2016a) are also where many of the impacts on coastal fisheries will be seen.

Innovative research to offset declines in fisheries is ongoing, including investigation of translocation of rock lobsters from areas of slow growth to areas of more rapid growth. The implementation of marine protected areas off Tasmania has been successful in reducing the impacts of climate change (Bates et al. 2013). However, as species move into new areas, and decline in existing areas management plans and actions will require updating. Marine biodiversity governance and management regime requirements have also been identified (Lockwood et al. 2012).

Monitoring is a critical activity to document the effects and changes of from climate change. Monitoring include socio-economic indicators (Frusher et al. 2014). The Integrated Marine Observing System (IMOS), is the principal Australian body responsible for collection of physical and chemical marine observations (e.g. Lynch et al 2014). IMOS nodes collect detailed information for many regions of Australia. The Great Barrier Reef is extensively monitored through programs including the Great Barrier Reef Marine Park Authority (GBRMPA) Marine Monitoring Program, the AIMS long term monitoring program and the Joint Field Management Program (Queensland-GBRMPA) as well as IMOS. Citizen science through the Eye on the Reef program is increasing the knowledge base for over 600 reefs.

24.2 Aside from climate change, are there any developing environmental, technological or socioeconomic trends likely to impact on fisheries over the next 20 years?

Current challenges to sustainable management are likely to be compounded by long-term changes in the ocean environment which limit the value of past experience and historical patterns.

Globally, aquaculture is on an upwards trajectory, particularly in South East Asia, and this is likely to continue over the next 20 years. Aquaculture both in Australia and abroad has already affected some Australian fisheries, particularly prawn fisheries. Increased supplies on the global market have reduced prices received by Australian prawn producers by over 50 percent over the last 20 years (Savage and Hobsbawn 2015; page 4). Imports of farmed prawns into Australia have largely contributed to declines in real terms of prices on the domestic market. This affects both commercial fisheries supplying the domestic market (mostly Queensland and NSW fisheries), as well as domestic aquaculture industries that also primarily supply the domestic market. Most fish consumed in the Australian domestic market is imported, with an increasing proportion of that being farmed species from South East Asia (Savage and Hobsbawn 2015). Prices of most fish species on the Australian domestic market have also declined in real terms as a consequence. Within Australia, the

development of pacific oyster aquaculture has resulted in a decline in prices for the domestic Sydney rock oyster – also an aquaculture species (Schrobback *et al.*, 2014).

Proposed developments in Northern Australia include consideration of large scale aquaculture production (although of what is still uncertain). If such a development does go ahead, this may place increased downward pressure on domestic prices. Further, concerns exit of the impact of diverting water from the natural flows on the productivity of key commercial fisheries in the Gulf of Carpentaria.

The increase in the number of areas closed to fishing – either for recreational only use or for conservation purposes – has impinged on the area available for commercial fishing. This has occurred at both the State and Commonwealth level. Increasing strength of the conservation and recreational interest groups over the next 20 years may see more areas closed to fishing.

The developing Chinese economy will continue to result in substantial benefits to some fisheries, such as the lobster, abalone and coral trout fisheries in particular. Exports of prawns have also increased to China, reducing the reliance on the previous markets. Ongoing development of this market will provide further opportunities for these exporting fisheries.

There are a number of other trends that will likely influence fisheries in the coming decades including:

- affluence, which is strongly correlated with seafood demand and marine use (FAO 2014, page 199);
- competition from other international fisheries as Australia has high labour costs, as well as higher supply chain costs, that make our seafood relatively expensive compared to imports;
- certification and social licence, and demonstrating sustainability is paramount for many fisheries domestically and internationally;
- fuel and labour costs for Australian fisheries;
- the increasing use of marine and coastal systems by sectors such as shipping, urban development, marine tourism, and marine mining (OPSAG 2013, AIMS 2014);
- new industries such as energy generation, which have the potential to constrain the access of fisheries to fishing grounds or port facilities, and affect marine systems (Fulton and Gorton 2014).

Science has a role in addressing these challenges through advances in ocean observation systems, developing methods to assess data-poor species and fisheries, bio-economic research, 'whole of system' modelling frameworks, and social research into governance systems, including better understanding of human behaviour (Fulton et al 2011).

Forecasting of environmental conditions at seasonal time scales is possible for some fisheries in Australia (Eveson et al 2015; Hobday et al 2016b), which helps manage environmental risk. Longer term forecasts, at decadal scales, are in development (Salinger et al 2016). Combined environmental forecasts with socio-economic trends could improve overall risk management.

Marine Parks and Reserves

25. INFORMATION REQUEST

25.1 How effective and efficient are regulatory arrangements covering marine parks and reserves? How well coordinated and consistent have the jurisdictions been in designating their respective marine parks? What are the economic, environmental and social impacts of marine park areas?

Regulatory arrangements for marine parks and reserves vary depending on the maturity of the reserve and jurisdiction under which it operates. The Great Barrier Reef MPA has a very mature governance system while the Commonwealth Marine Reserve networks outside the South-East network have still to develop management plans once the government has responded to the CMR Review. States and the Northern Territory will vary in the level of governance and in particular the level of enforcement and public communication with more remote reserves harder to enforce and manage.

The Commonwealth, States and Northern Territory worked together to develop the Integrated Marine and Coastal Regionalisation (v4.0 June 2006) designed to assist national marine spatial planning including the National Representative System of Marine Protected Areas. Much new information is now available to update IMCRA – from coastal waters and the EEZ.

Coordination at the national level between the Commonwealth and States has been diminished since 2010, the last time that the National Marine Protected Areas Working Group met. This forum enabled MPA managers from the States, NT and the Commonwealth to meet and discuss progress, common issues and opportunities for moving forward in a collaborative fashion. Its loss has diminished national collaboration and efficiencies.

The scientific community maintains greater collaboration through the Australian Marine Science Association and major research partnerships including the Western Australian Marine Science Institution (WAMSI) and the Tropical and Marine Biodiversity Hubs funded under National Environmental Science Program. These research partnerships facilitate sharing of methods, results and outcomes from science designed to support marine reserve design and management.

As with climate change (Information Request 24) understanding the environmental, social and economic effects of marine reserves cannot occur without adequate monitoring. Monitoring is piecemeal although there is progress in areas like the GBR where the Reef 2050 Integrated Monitoring and Reporting Program is providing the governance and coordination to drive appropriate and cost-effective monitoring to improve future management decisions. Some of the States are also well advanced in developing monitoring frameworks. However other states and the Commonwealth are still working on this essential step. A nationally collaborative approach would provide greater efficiencies, highlight the use of current effective scientific monitoring programs and drive the development of the appropriate national facilities and shiptime needed for support.

5 Regulation of Aquaculture

26. INFORMATION REQUEST

26.1 Have any jurisdictions been able to successfully balance environmental and economic considerations and potential conflict with other resources uses? How did they achieve this success?

Each state and Territory in Australia is at a different level of maturity when it comes to this issue. Tasmania, South Australia, and recently Western Australia use aquaculture as an important contributor to regional development.

Aquaculture is a relatively new and growing use of the marine estate. This lack of history appears to contribute to a weaknesses in the procedures used to manage potential conflicts with environmental, economic or social issues possibly arising from the lack of consultation with stakeholders (Phillips et al. 2009), lack of transparency (Hishamunda et al., 2014) and failure to adaptively manage the ongoing use of the resource (Thompson 2014).

The most successful jurisdictions determine what environmental aspects are likely to be impacted by the new use of the marine estate (e.g. Fletcher et al., 2004), consult with a properly representative group of stakeholders about which of these they value, and put in place a cost effective program to monitor the status of these aspects. The monitoring results are made freely available (e.g. on the web) to anyone (Wilson et al. 2009), periodically reviewed and the monitoring, or aquaculture use, adapted if it does not meet the established targets (Kusek and Rist 2004).

The approach used by Western Australia (e.g. Sim and Masini, 2004) and some other jurisdictions to set different standards for impacts at different spatial scales (FAO 2008, Wilson et al. 2009) and move past single point compliance monitoring has also improved the balance between environmental use and protection. Where appropriate management at a larger spatial scale can reduce the cost per operator for environmental monitoring.

27. INFORMATION REQUEST

27.1 Are existing regulatory arrangements well-targeted and efficient means for managing aquaculture operations and addressing potential environmental impacts? Have regulatory arrangements inhibited the productivity and competitiveness of aquaculture in Australia?

von Berg (2009) stated “There are instances of duplication and overlap in the assessment of government regulatory control in relation to aquaculture premises. The Department of Fisheries, the Department of Environment and Conservation, the Aquaculture Council of Western Australia (ACWA) and licensees raised concerns regarding this duplication in the light of there being no perceived benefits. It was agreed that the burden on licensees and the wasteful nature of government resources needed to be addressed.” Thus there would seem to be scope to reduce regulation overlap, possibly in all jurisdictions.

Aquaculture often involves a significant change in resource use and a new industry operating in a new environment can lead to uncertainty about potential environmental outcomes. The situation was improved by the development of a risk based approach to aquaculture in Australia (Fletcher et al., 2004) and worldwide (FAO 2008). There is scope for further improvement through the development of an agreed approach to dealing with the residual uncertainty. An adaptive monitoring program is one such option (e.g. FAO 2008, Thompson 2014) where monitoring is periodically reviewed and adjusted as the uncertainty regarding potential impacts is reduced.

As is the case with land use, jurisdictions vary in their environmental regulatory requirements and in some cases have yet to be developed to the stage that potential aquaculture enterprises have certainty about the conditions that need to be met to acquire a licence to operate. The 2004 Productivity Commission report (Productivity Commission 2004) describes environmental regulatory arrangements of aquaculture across Australia. The current situation leads to a “catch 22” where potential investors do not have the required certainty to invest in new aquaculture development projects and the lack of project proposals means that the regulatory requirements are yet to be developed and implemented. Where development has been stimulated and new projects are proposed the environmental requirements can be unclear.

If jurisdictions were to create aquaculture zones by way of a spatial planning framework at a catchment scale to allow for strategic cropping and aquaculture development this would place aquaculture on an even footing with other agricultural enterprises and reduce investor risk. It would take potential industry development beyond ad-hoc.

If zoning was clear at the catchment scale, then potential investors could narrow and define geographic scope to develop specific project proposals.

27.2 What, if any, developments have there been in the aquaculture industry since 2004 that the Commission should specifically consider in this Inquiry?

The global industry has continued to grow in tonnes of food produced and in the scale of operations (Bostock et al., 2010). Growth in Australia was amongst the world's fastest at > 10% between 2001 and 2006 (FAO 2009).

Locally, since 2004 the Atlantic salmon industry has almost doubled in size. This has been achieved via more efficient use of existing leases and measured expansion into new areas. This has been undertaken at a time of increased scrutiny. Therefore, all companies involved have shown the need to demonstrate sustainability and thus gain social licence.

27.3 Are there factors outside the regulatory environment that have significantly limited the productivity and competitiveness of aquaculture production in Australia?

Disease management has been a challenge for oysters, abalone, tuna and salmon. Rising water temperatures have been a challenge for salmon aquaculture.

27.4 What are the major challenges and opportunities facing the aquaculture industry over the next 20 years?

In Northern Australia there are many opportunities for the expansion of Aquaculture (particularly in areas away from the Great Barrier Reef). For instance, preliminary broad-scale analysis has indicated that Australia's northern coastline has 1.5 million hectares that are potentially suitable for land-based (pond) coastal aquaculture (McLeod et al., 2002). This analysis takes into account a number of factors including elevation, slope, distance to water, urban buffer zones, and land tenure.

Pond based prawn aquaculture industry shows great potential to expand in northern Australia, given strong market potential (Australia currently imports around 37 000 Tonnes/annum) and one of the highest returns per land use area known. To date the industry has outstanding environmental credentials adhering to world's best practice methods with no adverse environmental impacts in over 30 years of operations. Much of tropical Australia is perfectly suited to meeting the two major requirements for aquaculture development: clean sea water and an abundance of suitable coastal land. In addition the use of seawater with only a small freshwater requirements means that aquaculture enterprises are effectively drought proof.

CSIRO is currently providing expertise to assist a number of companies and communities to determine the potential to develop new aquaculture enterprises in coastal regions of Northern Australia. These include a pre-feasibility study for one very large project of up to 10,000 hectares of saltwater ponds in the Northern Territory, and several feasibility studies with traditional owners including those in the Cape York region (Archer River catchment), the Northern Territory and Western Australia.

Aquaculture in northern Australia would provide a local market for irrigated crops as feedstock. This could provide significant impetus for northern irrigated agriculture, the growth of which has been impeded by, amongst other things, high transport costs that significantly erode profitability. A local market for cropping outputs would overcome this constraint.

Challenges include failure to adequately gauge the level of support to operate (social licence), increasing biosecurity and disease threats and a failure to adequately adapt to climate change.

28. INFORMATION REQUEST

28.1 Do the existing regulatory arrangements adequately recognise the different sectors and production methods used in aquaculture and their differing environmental impacts and interaction with other resources uses?

In Australia there are a number of different production systems in use including sea cage culture, pond culture and subtidal or intertidal rack culture of molluscs. Inevitably, each of these have different environmental impacts and these are broadly recognised by regulatory agencies. There is a disparity in how the various regional regulatory agencies rule on perceived risk and consequent regulations of each of these.

28.2 Are there technological solutions to the potential environmental problems associated with aquaculture? Where and how has the industry invested to develop solutions? To what extent, and under what funding arrangements, should governments be involved in developing innovative solutions?

Sophisticated modelling can be used to locate aquaculture into areas where their environmental impacts will be minimal, for environmental assessments or to design monitoring schemes (e.g. Wild-Allen et al., 2010, 2011) and has been used in Tasmania, South Australia and West Australia. Modelling provides the only method to adequately assess complicated environmental, economic and social issues in a holistic manner.

Selective breeding, good husbandry, better feeds (e.g. Boissy et al., 2011), improved feed conversion ratios and improved food delivery technologies, site selection can all improve the economics, and reduce the environmental impacts, of finfish aquaculture (e.g. Besson et al., 2016). In Australia these areas have been substantially invested in by aquaculture and allied industries, State and Commonwealth governments, CRCs, FRDC, CSIRO and other research providers. Governments need to invest in a continuous cycle of adaptive improvements in governance. Innovative solutions to improve environmental outcomes need to be incentivised by government (Besson et al. 2016).

Improved sensor technology, sensor networks and software systems have considerable potential for real time monitoring and rapid response by operators or regulators to environmental signals (e.g. Bostock 2009). These span spatial scales from large areas (by satellites) to individual cells (by genetics).

A reduction in the environmental impact of aquaculture has occurred through the substitution of fish meal with other sources of protein and essential fatty acids (Bell and Waagbo 2008).

29. INFORMATION REQUEST

29.1 Is a regulatory framework required for aquaculture in Commonwealth waters?

The major Australian aquaculture operations, including tuna aquaculture in Spencer Gulf, occur within State waters but nationally and internationally the industry has been moving progressively into deeper waters (FAO 2010). It is not yet clear how far offshore Australian aquaculture will move but it would seem prudent for the Commonwealth to have a regulatory framework prepared to avoid the delays that have hindered progress in other jurisdictions (e.g. Upton and Buck 2010).

6 Fish Processing, wholesale and retail

30. INFORMATION REQUEST

30.1 How effective and efficient are regulatory arrangements covering downstream seafood processing, wholesale and retailing businesses including: food safety; labelling; environmental management and other regulations?

30.2 Can fisheries regulation in these areas be improved to increase processing productivity?

No CSIRO response. Seafood processing is beyond our experience and expertise.

31. INFORMATION REQUEST

31.1 How burdensome are monitoring and enforcement requirements for downstream processors? Has monitoring of seafood held by downstream processors been an effective adjunct to the enforcement of fishing regulations? Is there scope to achieve the same (or a better) outcome in a way that imposes less burden on downstream processors?

No CSIRO response. Seafood processing is beyond our experience and expertise.

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