Australian Government
Australian Fisheries Management Authority

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Senate Standing Committee on Environment and Communications
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AFMA submission to the Senate Inquiry into the impacts of climate change on marine fisheries and biodiversity

Introduction:

The Australian Fisheries Management Authority (AFMA) is responsible for the management of domestic Commonwealth fisheries (through the AFMA Commission), Australian boats fishing on the High Seas and deterring illegal foreign fishing in the Australian fishing zone, consistent with the *Fisheries Management Act 1991* (FM Act) and the *Fisheries Administration Act 1991* (FA Act).

AFMA takes the issue of climate change impacts on the environment and Commonwealth fisheries seriously. Climate change presents both challenges and opportunities to the management of Commonwealth fisheries and is one of many issues we take into account. AFMA uses output controls in the form of total allowable catches (TACs) and individual transferable quota (ITQ) which are robust and flexible and, along with other management strategies, are able to adapt to the variability inherent in fisheries including climate change. AFMA is aware that climate change will lead to greater variability in the distribution and abundance of fish and other marine species, both spatially and temporally, and that management strategies will need to adapt accordingly.

Senate Inquiry into the impacts of climate change on marine fisheries and biodiversity

On 14 September 2016, the Senate referred to the Environment and Communications References Committee an inquiry into the impacts of climate change on marine fisheries and biodiversity, requesting initial responses by 14 November 2016 and a final report by 30 June 2017. AFMA has prepared this response to the Terms of Reference (TOR) as they apply to key aspects of its management and operations of Commonwealth fisheries, these mainly concern TOR b, d, and f.

Key Points:

- AFMA is taking the issue of climate change impacts on the marine environment and Commonwealth fisheries seriously, and we are seeking to ensure our management system can adapt to the changes predicted by the best available science.
- Our current management systems are robust and flexible as a result of adapting to the existing variability inherent in fisheries. Harvest strategies, ecological risk assessments, quota management, gear controls and spatial/temporal access rights are useful tools in the face of many predicted changes.
- Climate change is predicted to further increase variability in oceanographic and biological systems which are already difficult to predict. We will continue to use management strategy evaluation and seek expert advice to quantitatively and qualitatively assess a wide range of future scenarios.
- AFMA fully supports the work of research organisations such as the CSIRO, the FRDC and other government and tertiary institutions, as a primary source of scientific advice on climate change. We apply this advice to more effectively manage Commonwealth fisheries resources and are aware of the strong connection between land and sea.
- There are potential impediments to the success of adaptation to climate change of fisheries and its management including: behavioural flexibility (e.g. public, fishers), flexibility of governance/regulation, the seafood market and fishing business drivers, technological change and limited forecasting capability.
- Most future scenarios predict that climate change will be both good and bad for marine species and fisheries. Given the nature of these likely changes, greater national collaboration in fisheries governance, management and science will be an essential element of how well Australia benefits from its fisheries into the future.

AFMA responses to individual Terms of Reference:

(a) recent and projected changes in ocean temperatures, currents and chemistry associated with climate change;

AFMA fully supports the work of climate and oceanographic scientists and applies their knowledge and findings to managing Commonwealth fisheries resources. This section is best addressed by those scientists in research organisations such as Bureau of Meteorology (BOM), the Integrated Marine Observing System (IMOS), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Institute of Marine Science (AIMS), many of whom also collaborate with international experts and agencies.

Climate change is predicted to increase variability in marine oceanographic and biological systems in ways we do not yet fully understand. Some of these impacts will be in combination with impacts from terrestrial sources, such as nutrient and sediment transport. Some of the key challenges and opportunities arising from climate change in the marine environment are listed in Annex 1.

(b) recent and projected changes in fish stocks, marine biodiversity and marine ecosystems associated with climate change;

The likely impacts of climate change on the marine environment and to fish stocks in particular are well established through the peer reviewed work of scientists worldwide. We understand that stocks (fish, shellfish, and crustaceans) may shift locations and increase/decrease in abundance resulting from a combination of terrestrial and marine influences. Some of the key published impacts of climate change to fisheries are listed in Annex 2.

AFMA is aware that SE Australia is a hot spot for climate change and we manage many fish stocks in that region. Eastern Gemfish, Blue Warehou and Redfish, are some of those and we currently investigating to what extent climate change and other effects have been affecting catch and/or reducing recovery from fishing. AFMA applies adaptive resource management in the form of a risk/catch/cost framework that will assist with the increasing risks to fisheries brought on by climate change. New, more adaptive fishery models may need to be developed to account for increased climate variability. AFMA is currently working through the process of risk assessing its fisheries management with respect to climate change with a view towards adapting its management strategies to ensure sustainable fisheries into the future.

(c) recent and projected changes in marine pest and diseases associated with climate change;
Some climate change projections suggest that there may be a redistribution of marine pests and diseases. AFMA's management system currently addresses these incidents through enacting fisheries closures due to the economic impacts pests and diseases may have on a fishery. The Bass Strait Scallop fishery is an example of a Commonwealth fishery which has been subject to occasional outbreaks of toxic algae which resulted in the temporary closure of the fishery as a result of scallops being unsafe for human consumption.

The full scope of this TOR is better addressed by organisations, such as CSIRO and food safety agencies, which deal directly with marine pests and diseases and can expand on the science. AFMA fully supports the work of these organisations and applies their knowledge and findings to support responses to pest and disease outbreaks in Commonwealth fisheries.

(d) the impact of these changes on commercial fishing and aquaculture, including associated business activity and employment;

The scope for potential impacts of climate change on commercial fishing industry is wide, but it is still only one of many factors affecting commercial fishing. Climate change is predicted to affect terrestrial, atmospheric and marine environments and collectively these may affect fisheries in many ways including:

- abundance of stocks will vary spatially and temporally;
- effects will be species specific, including changes in range and life history;
- some species will increase in abundance while others will decrease;
- seasonal abundance of individual species may vary between extreme lows and highs;
- increased variability, on top of the existing high variability, will affect the predictive capacity for fisheries scientists to advise on fishing effort or allowable catch;
- changes in weather, especially extremes of weather for greater periods of time, may restrict access to stocks and constrain effort; and
- increased workplace safety issues and risk-taking by crews.

AFMA's existing management strategies have flexibility already built in which will assist with these issues. Harvest strategies, TACs and ITQs are in place to support sustainability of harvest of stocks with changing conditions. AFMA retains control of seasonal/annual input and output so that harvest amount can be adjusted according to stock abundance. Effort (i.e. input) controls such as statutory fishing rights and permits restrict access to a fishery. TACs and ITQs limit the amount of tonnage of fish that can be harvested from a fish stock in any fishing period. In addition, ITQs allow flexibility in effort and methods which allow limited adjustment to fishers to change fishing methods according to prevailing conditions. Other flexible arrangements which facilitate adaptation to climate change may include larger and/or multi-use fishing vessels that have greater range, can process at sea and harvest multiple species types.

AFMA is also planning to assess the ability of our management system to cope under various future scenarios. The predicted increased variability associated with a changing climate supports the need for continued flexibility in future fishery management arrangements – such as changing areas for fishery closures, setting fisheries boundaries or the development of new fisheries.

There are a variety of potential barriers which may constrain the success of adaptation to climate change of fisheries and its management including: behavioural flexibility (e.g. public, fishers), flexibility of governance/regulation, the seafood market, fishing business drivers, technological change and limited predictive capability. For example, published research suggested that adaptations will need to consider larger vessels, rather than many smaller vessels, when fishing certain stocks to limit ecological impacts. However, the use of larger vessels is contentious with some segments of the community who may find such an outcome difficult to accept. Similarly controversial would be the implementation of tighter controls on recreational fishing, as has already been proposed by the draft report of the Productivity Commission on Australian fisheries regulation, even though these may offer substantial benefits to stock sustainability.

Nationally, there may be a need to amend current Offshore Constitutional Settlement arrangements between Australian jurisdictions as species move and/or change in abundance. AFMA maintains strong partnerships with industry and stakeholders and these relationships facilitate the creation and adoption of sustainable fisheries outcomes.

(e) the impact of these changes on recreational fishing;

AFMA is responsible for day-to-day regulation of Commonwealth commercial fisheries but does takes into consideration all sources of mortality on a fish stock, including recreational harvest. Recreational catches are likely to be affected by changing climate and if stocks targeted by recreational fishers in Commonwealth waters change in abundance or distribution then management strategies may need to be adapted to account for this. The full scope of this TOR, however, is best addressed by organisations which deal directly with recreational fishing.

One major issue with recreational fishing is the absence of regular, comprehensive data collection across Australia that is readily available for use in fishery stock assessment and ecosystem risk assessment. Given recreational fishers now take more catch than commercial fishers for some key fish stocks and a major proportion of many others, a greater investment in this area would be beneficial. This equally applies to protected species interactions with recreational fishing for which there is little monitoring or data at all.

(f) the adequacy of current quota-setting and access rights provisions and processes given current and projected climate change impacts;

Climate change is predicted to increase variability in oceanographic and biological systems which are already highly variable and in most cases not well understood. Accordingly, the distribution and/or abundance of species may increase or decrease as a result of changes in climate and this will vary among species based on their optimal conditions and life histories. Current AFMA management systems, however, can respond to increases or decreases in stocks due to overfishing, climate change and natural variation. Harvest strategies, TACs and ITQs are in place to support sustainability of harvest of stocks with changing conditions. AFMA can annually adjust the amount of fish harvested according to stock abundance. AFMA is currently investigating allowing further flexibility in fishing methods which would enable fishers to change fishing methods according to ecological and economic need.

AFMA is continuing to work with the fishing industry to increase the level of flexibility currently provided. Fishery boundaries, as they currently exist, may have to change or be removed as a result of climate change or else may impact fisher ability to capture fish when fish abundance shifts geographically. Such flexible boundary management strategies are already part of certain fisheries, such as in the Eastern Tuna and Billfish Fishery, where boundaries are changed regularly within seasons, according to oceanographic conditions, in order to prevent catch of Southern Bluefin Tuna. This is based on a habitat model developed by the CSIRO. Regional management strategies are also being considered, for example, as an alternative to fixed fishery boundaries where multiple fisheries areas are combined and harvest is managed for the entire area. Such systems may allow for flexible fishing to adapt with the movements of fish stocks with climate change. Bioregional Marine Planning, including the declaration of no-take or other restricted use Marine Protected Areas (MPA), needs to be carefully considered against the backdrop of fisheries management in a changing climate.

AFMA is continually seeking to improve and adapt its management strategies and this includes adaptation to predicted climate change. AFMA is currently working through this process of updating its fisheries management strategies with respect to climate change. This will involve testing current fishery management strategies and their ability to cope with climate change under various scenarios.

(g) the adequacy of current and proposed marine biodiversity protections given current and projected climate change impacts;

Fisheries can have much broader effects on an ecosystem than just harvest of target species, potentially on the broader ecosystem and its function. AFMA manages its impact on broader marine ecosystems using an Ecological Risk Assessment (ERA) and Ecological Risk Management (ERM) process designed to assess and respond to the ecological effects of Commonwealth fishing on the marine environment and associated threatened species. This standardised management system is in place to ensure that any species, habitat or community identified as at-risk can be dealt with via management response to mitigate against that risk. All species, habitats and communities potentially impacted upon by AFMA fisheries are re-assessed on a regular (approximately 5 year) basis.

Information about many marine habitats has improved for Commonwealth waters over the past decade. AFMA has an extensive set of fishing closures (by gear type and/or time) that are greater in size than those in the proposed national MPA network. These closures also protect against unforeseen losses of habitat and biodiversity, which may impact fisheries. They combine the best elements of MPAs with the ability to be moved in response to climate effects relatively easily.

The full scope of this TOR, discussing status and efficacy of marine biodiversity protections and protected areas, is best addressed by organisations such as CSIRO, the Department of the Environment and Energy or GBRMPA, which research or regulate these areas.

(h) the adequacy of biosecurity measures and monitoring systems given current and projected climate change impacts; and

This TOR is best addressed by organisations which deal with biosecurity issues, such as the Department of Agriculture and Water Resources, Department of Health and relevant state/NT agencies.

(i) any other related matters.

Australia accesses a number of important highly migratory and high seas fish stocks, along with many other nations. Negotiations will need to be undertaken with international fisheries organisations to address climate change impacts on such fisheries. This would be led by the Department of Agriculture and Water Resources or Australian Antarctic Division, who lead the Australian delegations in such fora.

As stocks shift with climate change, there may be an increase in Illegal, Unregulated and Unreported (IUU) fishing by Australian or foreign fishers chasing stocks that have moved into new areas or areas that are under an alternative or foreign jurisdiction. Australia's Exclusive Economic Zone abuts several other nations which are facing significant challenges in managing their fisheries most often for domestic human consumption. Like Australia they will face pressures on their fisheries from climate change and it will be important that we continue to work with them to solve the regional issues that may arise.

The impact of climate change on Indigenous fishing was not mentioned in the TOR, however this is an area which, like recreational fishing, needs to be considered. AFMA, as the day to day manager of Torres Strait fisheries under the auspices of the Protected Zone Joint Authority, is working with the Torres Strait Regional Authority and the Queensland Government to assist Traditional Inhabitants to adapt to changes in their fisheries. AFMA addresses climate change directly in the Torres Strait through the use of fishery independent stock assessments. Fish remain a major source of protein and income for many indigenous communities so any changes in distribution or abundance of marine species can have significant economic and social impacts. Also, the Torres Strait is more susceptible to the impacts of sea level change as many islands are low lying.

AFMA would welcome the opportunity to appear before the Senate Committee and/or clarify any matters raised in this submission or the Authority's management of Commonwealth fisheries more generally.

Yours sincerely

Dr James Findlay
Chief Executive Officer

Attachments

1. Annex 1 – Some of the published climate changes to the marine environment

2. Annex 2 – Some of the published climate change impacts on fisheries

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Annex 1 – Some of the published climate changes to the marine environment

Climate change is expected to affect the marine environment in many different ways and this will result in both positive and negative outcomes. From the fisheries perspective, some species will increase in abundance while others will decrease in abundance.

<u>Climate change and Australian marine waters:</u>

What changes have already been seen in marine waters around Australia?

- Temperature – ocean temperatures around Australia have on average have increased by 0.68°C since 1910 (FRDC 2014)
    - Rate of temperature increase has increased from 0.08 to 0.11°C per decade (FRDC 2014)
    - Increased frequency and duration of marine heat wave events (Caputi et al. 2016)
    - Southwest and Southeast Australian waters are global warming hotspots (Reisinger et al 2014)
    - Southern Ocean is experiencing rapid change in temperature and salinity (Böning et al. 2008)

- Poleward advance of East Australia Current by 350 km in last 60 years (Reisinger et al. 2014)
- Sea level
    - Global sea level has is regionally variable but on average has risen by 0.19 m from 1901-2010 (Hoegh-Guldberg et al. 2014)
    - Rate of sea level rise has increased from 1.7 mm yr^{-1} (1901 – 2010) to 3.2 mm yr^{-1} (1993-2010) (Hoegh-Guldberg et al. 2014)
    - Rate of sea-level rise around Australia variable between 1 and 8 mm yr^{-1}
- Acidification
    - Drop in pH worldwide by 0.1 pH since 1780 (Laffoley and Baxter 2016)
    - Drop (modelled) in global Aragonite Saturation (Ω_{arag}) from 4.1 to 3.4 from1780 - 2006AD (Laffoley and Baxter 2016) (Important threshold for coral calcification Ω_{arag} 3.0)

What changes have been seen in Australian ecosystems as a result of climate change?

- Phytoplankton productivity (Thompson et al. 2009)
- Macroalgal species abundance (Johnson et al. 2011)
- Growth rates in abalone (Johnson et al. 2011), rock lobster (Pecl et al. 2009), fish (Neuheimer et al 2011) and coral (De'ath et al. 2009)
- Life cycle of Southern Rock Lobster (Pecl et al. 2009)
- Distribution of seaweeds (Johnson et al 2011), plankton (McLeod et al 2012), fish (Figueira et al. 2009) and sea urchins (Ling et al. 2009)
- Coral bleaching on the Great Barrier Reef (De'ath et al. 2012) and Ningaloo Reef (Abdo et al. 2012)
- Reduced calcification rates of corals (Laffoley and Baxter 2016)

- Macroalgae
    - Warm water macroalgae extending ranges poleward (Laffoley and Baxter 2016)
    - Coldwater macroalgae reduced ranges (esp. arctic/temperate) (Laffoley and Baxter 2016)
    - Regime shifts in macroalgae communities, herbivore outcompeting algae (Laffoley and Baxter 2016)
    - Increased bacterial assemblages linked with temperature and algae mortality (Laffoley and Baxter 2016)

What are the predicted changes to the marine waters around Australia?

- Temperature
    - Increased temperatures in Southern Ocean (Laffoley and Baxter 2016)
    - Melting ice into the Southern Ocean (Laffoley and Baxter 2016)
    - Worldwide increased thermal stratification of water layers through depth (Hoegh-Guldberg et al. 2014)
- Acidification
    - IPCC has listed as "Virtually Certain" that increased storage of CO_2 in ocean will increase acidification (Reisinger et al. 2014)
    - Decreased pH in surface waters of ~0.3-0.5 pH units by 2090 (Hoegh-Guldberg et al. 2014)
    - Decreased Aragonite Saturation Ω_{arag} on coral reef areas to <3.5 by 2050 (Laffoley and Baxter 2016)
- Sea level rise variable prediction of rise up to 0.8 m by 2100 AD (Carson et al. 2016)
- Fewer but increased intensity of storms to east coast of Australia (Dowdy et al. 2015)
- Increased "Dead Zone" areas in deeper waters (Altieri and Gedan, 2015)
- Reduced salinity of Southern Ocean waters (Laffoley and Baxter 2016)
- Stronger seasonal changes in Southern Ocean waters (Laffoley and Baxter 2016)

What are some of the predicted changes to marine ecosystems around Australia?

- Increased sediment discharge to estuaries (Gillanders et al. 2011) and reef waters (GBRMPA 2013)
- Acidification expected to affect various calcifying taxa such as corals (Fabricius et al. 2011), coralline algae (Anthony et al. 2008) and calcareous plankton (Thompson et al. 2011)
- Great Barrier Reef and other low latitude reefs will be negatively impacted by both warming and acidification through thermal stress, reduced calcification and increased frequency of bleaching (De'ath et al. 2009; Cooper et al. 2008, 2012)
- Uncertain but potentially major negative impacts to Krill abundance in Southern Ocean (Laffoley and Baxter 2016)
- Scouring of benthic habitats by sea ice/icebergs around Antarctica (Laffoley and Baxter 2016)
- Increased phytoplankton production in Southern Ocean (Laffoley and Baxter 2016)
- Macroalgae
    - Continued warm water macroalgae extending ranges poleward (Laffoley and Baxter 2016)

    - Continued contraction of cold-water (e.g. kelp) macroalgae ranges (Laffoley and Baxter 2016)
    - Increased disease outbreaks (Laffoley and Baxter 2016)
- Seagrass
    - Temperature increases exacerbate stressors to seagrasses (Laffoley and Baxter 2016)
- Mangroves
    - Temperature and sea-level impacts likely to benefit mangroves where space is available (Laffoley and Baxter 2016)
    - Relocation/expansion of mangroves with increased sea-levels will be constrained in places by development/land use (Laffoley and Baxter 2016; Lovelock et al. 2009)

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Annex 2 – Some of the published climate change impacts on fisheries

Climate change is expected to affect the marine environment in many different ways and this will result in both positive and negative outcomes to fisheries. Some species will increase in abundance while others will decrease in abundance.

Climate change and fish stocks:

How have fish stocks already been impacted by climate change?

- Range shifts of fish around the world are moving poleward on average at 10s of km per decade (Poloczanska et al. 2013)
- RedMap reporting highlights the migration/transport of lower latitude fish to high latitudes (http://www.redmap.org.au/)

How are fish stocks predicted to be impacted by climate change?

- Both positive and negative impacts on biology and life histories, depending on species and particular life history stage:
    - E.g. Australian Western Rock Lobster – higher SST results stronger settlement of larvae but also results in smaller size at maturity (Caputi et al. 2014b)
    - E.g. Prawn stocks (settlement/catch) in Western Australia increase with stronger Leeuwin Current and increased SST (Kangas et al. 2015)
- Acidification expected to affect fish physiology (Munday et al. 2009)
- Temperature effects on physiology and reproduction
    - Altered phenological responses of fish (periodic activities like spawning triggered by SST) (Laffoley and Baxter 2016)
    - Reduced body size (Laffoley and Baxter 2016)
- Pelagic and coastal fish expected to move south on both east and west coasts (Cheung et al. 2012; Hobday 2010)
- Southward migration of shallow water species expected to be limited by depth along the southern boundaries (Reisinger et al. 2014)
- Poleward establishment of tropical and subtropical fish that have previously only been vagrants (Willis et al. 2007)
- Potentially major changes to Krill and trophic food web in Southern Ocean (Laffoley and Baxter 2016)
- Shellfish fisheries likely to decrease as a result of acidification (Hoegh-Guldberg et al 2014)
- Increased spread of disease likely (Hoegh-Guldberg et al 2014)
- Predictions that some species will simply run out of habitat, e.g. Southern Rock Lobster to be replaced by Eastern Rock Lobster (van Putten et al. 2015)

Climate change and fisheries:

What impacts to fisheries have already occurred as a result of climate change? (Is this substantiated?)

- Worldwide catch data indicate increasing dominance by warm water species (Cheung et al. 2013)
- A variety of stocks are suspected of having already been affected by Climate Change, though substantiation is lacking (e.g. Western Rock Lobster, Abalone, Gemfish, Redfish, Blue/Silver Warehou)

What are the impacts to fisheries that are predicted to occur as a result of climate change?

- Changes in fish abundance and distribution will vary so that catches of species may increase or decrease depending on the location of optimal conditions for the species (Laffoley and Baxter 2016)
    - Coastal and pelagic fishes expected to further south on both east and west coasts (Hobday 2010)
- Shifts in species overlaps and implications to by-catch management in for example tuna fisheries (Hartog et al. 2011)
- Changes in species distributions resulting in changing production and profits (Norman-Lopez et al. 2011)
- Expected but uncertain changes in Tuna distribution, spawning and growth (Laffoley and Baxter 2016)
- Potentially major changes to Krill and trophic food web in Southern Ocean (Laffoley and Baxter 2016)
- Predicted overall decreases in catch potential for northern Australia, neutral for SE Australia increases for southern and south-western Australia (Cheung et al. 2016)
- Potential increases in toxic dinoflagellates (e.g. ciguatera), diatoms and cyanobacteria with increased SST (Laffoley and Baxter 2016)
- Increased SST may affect quality of pearl nacre (Hoegh-Guldberg et al 2014)

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