

# Recreational Fisheries in Australia

## Abstract

Recreational fishing is a popular sport and social activity in Australia with over 3.3 million participants catching 72 million finfish and contributing \$1.8 billion to the economy annually in 2000/01. Since this time, there has been little coordinated research on recreational fishing and relatively little research funding. In recent years however, increasing population size of coastal cities and the increasing sophistication of fishing technologies, has increased the efficacy of recreational fishers and allowed development of highly specialised sub-fisheries for several species, many of which are shared with commercial fisheries. This highlights an increasing need for greater research to produce reliable data for policy development, management and to allocate resources among recreational and commercial sectors.

## Background

Recreational fishing is an important sporting and social activity undertaken by an estimated 11.5% of the global population (Cooke and Cowx, 2004). In many countries, recreational catches have increased rapidly over the past decade, contributing to an estimated global catch of around 47 billion fish (Cooke and Cowx, 2004). In Australia, the national recreational and indigenous fishing survey (NRIFS) (Henry and Lyle, 2003) estimated that 19.5% of the population (3.36 million people) participated in recreational fishing in 2000/01. During this period, fishers undertook 23.2 million fishing events, caught 72 million finfish, and contributed \$1.8 billion to the economy.

The primary motivation for Australians to participate in recreational fishing is for relaxation and sport, rather than harvesting fish for food (Henry and Lyle, 2003). These results have led to a perception among the general community that recreational fishing is a benign leisure and social activity. However, increasing population size of coastal cities, the rapidly increasing sophistication and affordability of fishing and searching technologies, and the development of highly specialised sub-fisheries for some species (e.g. tunas and billfish), highlight the potential for growing impacts on many marine, estuarine and freshwater species by recreational fisheries. While more than 5000 species of fish are recognised within Australian waters, Griffiths and Pepperell (2006) showed that recreational fisheries interact with over 1164 of these taxa and share 245 commercial species with Commonwealth fisheries alone. Therefore, there is a national need to understand and manage recreational fisheries to ensure biological sustainability and for equitable resource sharing among sectors, and to maintain the societal and economic benefits to and from these sectors.

The management of recreational fisheries in Australia is complex. The Federal Government is ultimately responsible for the ecological sustainable development and management of Australia's fisheries resources. However, due to the large number of species caught by recreational fishers that generally have restricted coastal distributions, all responsibility for the management of recreational fishing activities has been divulged to State and Territory (herein referred to as "State") Governments. State Governments therefore have an obligation under various legislation and policies to collect and report on catch data relating to the recreational fishing sector. As such, State fishery agencies have been primarily responsible for undertaking recreational fishing research in Australia since the early 1980s, generally to address their State-specific management issues. In particular, NSW, QLD, NT and WA have had the longest history in research.

In the past decade, federal research agencies including the CSIRO, ABARES (and formally BRS) have begun to undertake recreational fisheries research due to the various issues arising from increase targeting of Commonwealth-managed species by recreational fishers such as Southern Bluefin Tuna. The CSIRO in particular have been proactive over the past decade in developing cost-effective survey tools for recreational fisheries, particularly those involving Commonwealth-managed species, and have brought the need for national approaches to recreational fishing research to the fore.

Despite the increasing importance of recreational fishing, both as a mortality source for shared commercial species (e.g. Snapper) and as additional revenue for regional economies, recreational fishing has attracted reasonably little research interest up until the last decade. This is due to the fact that large scale surveys (e.g. state-wide) are logistically difficult, labour intensive and expensive to undertake. Most Australian jurisdictions now periodically undertake State-wide recreational fishing surveys, and have since been responsible for developing cost-effective and statistically robust survey designs and analyses for large scale surveys. Such developments have earned Australian researchers an international reputation in the field of recreational fisheries research.

Several research projects have been undertaken by researchers at various Australian universities, including Murdoch University, University of New South Wales, University of Queensland, and James Cook University, but they have generally been small scale projects, due to the high costs of undertaking large scale surveys. Recreational fishing groups, such as Sunfish have also undertaken numerous 'citizen science' research projects, including one of Australia's longest running tagging programs, Suntag.

Recreational fishing research has historically attracted relatively small funds, usually from appropriation funds by State and Federal government, but also from competitive funding bodies, such as the Fisheries Research and Development Corporation (FRDC). In recent years, many States have introduced various forms of recreational fishing licences, from which a percentage of the fee is used to fund research. A recent policy of the Liberal government was to support the FRDC to conduct a national recreational fishing survey every 5 years (Anon., 2013). However, it is currently unknown as to what the level of funding will be.

## Relevance

The requirement for long-term ecological sustainability is a cornerstone of the management strategies of aquatic resource management agencies in Australia. From a fisheries perspective, it is well documented that commercial fishing activities can significantly impact the populations of their target species, which has resulted in increasingly stringent fisheries management approaches and harvest strategies in Australia.

Both Federal and State Governments have domestic and international obligations for reporting catches from all mortality sources for target species. Given the increasing recreational catches of many species traditionally caught only by commercial fisheries (e.g. tunas, billfish and sharks), there is a pressing national need for reliable estimates of the recreational catch to improve the reliability of stock assessments to aid in management of individual species and to fulfil Australia's obligations to relevant Regional Fisheries Management Organisations (RMFOs).

One emerging aspect of aquatic resource management that has developed over the past decade is the need to account for indirect or incidental impacts of anthropogenic activities such as fishing, on aquatic fauna and habitats, which have the potential to disrupt ecosystem functionality. In recent years, Australian environmental legislation has become increasingly stringent to ensure Australian fisheries operate in an ecologically sustainable manner, in particular the *Environment Protection and Biodiversity Conservation* (EPBC) Act 1999. Consequently, there is a need to collect reliable information from recreational fisheries with regards to incidental catches and impacts of their activities on specific habitats in order to assess ecosystem impacts from recreational fishing in concert with other resource users such as commercial and indigenous fisheries.

The rapid development of specialised recreational sub-fisheries in Australia that target cross-jurisdictional species such as Striped Marlin off eastern Australia, has led to increasing demands by recreational fishers for a greater proportion of resources shared with commercial fisheries. In several cases this has led to conflict with the commercial sector since the relative value of particular species caught by the primarily catch and release recreational fishery cannot be easily quantified (see Bromhead et al., 2004). Although direct valuation can readily determine the contributions to the economy by commercial fisheries, it becomes less clear for the recreational sector, who also make significant financial investments into the activity. Non-tangible social, psychological and health benefits of the recreational fishing experience are also high and need to be included in estimating 'value' of species to the sector in resource allocation negotiations.

Given the high social and economic importance of recreational fishing in Australia, research that addresses social and economic factors will be of high importance to the recreational fishing industry and the economic supply chain, as well as the public more generally. In recent press release by FRDC's Recfishing Research committee, it was claimed that "There are preliminary indications that fishing can help improve self esteem, enhance social relationships, aid breast cancer recovery, improve mental health, and help reduce delinquency in young adults." Such the potential health and social benefits of increased participation in recreational fishing may have economic benefits by reducing costs of some health services to society.

## Science needs

Despite the much publicised importance of recreational fishing to society in many countries worldwide, including Australia, there is little reliable scientific evidence to conclusively support such claims. Although many millions of dollars and hours of labour have been invested in attempting to quantify and understand components of recreational fisheries, the vast volumes of data that have been collected are often used to provide estimates for which the direction of bias and level of precision are often admitted to be completely unknown (Kearney, 1999). This is a direct result of attempting to extract precise quantitative scientific data from non-scientific members of the general public whose motivations to fish are not for data collection, but for recreation.

Fisheries scientists in many parts of the world therefore face a common problem of trying to obtain representative data from recreational fisheries. Depending on management objectives and information needs, these may relate to behaviour, motivations for fishing, social and demographic profiles, economic activity, and catch and effort, which can be scaled to the total recreational fishing population for inclusion in stock assessment and to inform management (e.g. Zeller et al., 2008).

While a diversity of sampling methods are available to collect recreational catch and effort data, they differ significantly in the type, quality, and quantity of information they can gather, as well as their cost-effectiveness. Despite attempts by researchers to employ survey methodologies appropriate for a given situation, surveys are often expensive and limited by small sample sizes and inadequate designs. Sampling and non-sampling errors, which may not always be recognised, frequently result in high uncertainty in estimates.

The fundamental problem underlying recreational fisheries research is that sampling frames rarely exist for recreational fishers and where licensing is in place, fishers are typically not required to report their catch and/or effort. Furthermore, licensing systems often include numerous categories of exemptions, such as for children (<18 years), indigenous persons, senior citizens, and persons on welfare. As a result, researchers typically lack a complete sampling frame from which to survey and estimate total catch and effort, or to recruit a representative sample of individuals for cost-effective survey methods, such as angler diaries that can collect information over monthly or seasonal scales.

To further increase the complexity, recreational fisheries worldwide are experiencing a radical transformation due to rapidly increasing sophistication, availability and affordability of fishing and searching technologies, which has created numerous highly specialised sub-fisheries for species traditionally only targeted by commercial fisheries (e.g. blue eye trevalla, swordfish). These specialised and spatially diffuse fisheries most likely account for the majority of the total recreational catch of these species (e.g. SBT off Tasmania and Victoria). However, in the absence of a complete sampling frame (e.g. a licence list of fishers) and the rarity of these fishers within the general fishing community, it is too costly to employ probability-based sampling such as general population telephone surveys, which are often used to intercept recreational fishers within the overall community (e.g. Essig and Holliday, 1991; Henry and Lyle, 2003).

Irrespective of expense, such surveys rarely yield a random sample from a population due to non-coverage of households and persons without landline telephones and non-contact issues, and an increasing refusal rate due to telemarketing saturation (N.R.C., 2006). Therefore, accessing a representative sample from these minority groups is a significant challenge in the absence of a complete list frame of fishers, but is a problem that needs to be addressed in light of the growing pressure on many fish stocks that are shared by both commercial and recreational fisheries.

# Perspective

## Within 5 years

### *Improved survey designs*

There is a large number of knowledge gaps that Australian researchers will need to focus upon in order to meet the science needs relating to recreational fishing in Australia. Although there have been significant developments in the design and implementation of large-scale recreational fishing surveys in the last decade using telephone diary surveys further work is required to keep pace with an evolving society. For example, the increasing use of mobile telephones, the exclusive use of landlines for internet connections (Grande and Taylor, 2010; Barr et al., 2012), and an increase in refusals due to telemarketing saturation (Curtin et al., 2005; Groves, 2006), non-contact bias and survey refusals are likely to become increasingly significant problems for these survey designs in future. Not accounting for these biases will result in unreliable data that may have a significant bearing on how recreational fisheries and their target species are managed. As a result, the development of cost-effective survey tools and models to account for society's rapidly evolving technologies and lifestyles will be a key focus area of research in the next 5 years.

### *Social effects of recreational fishing*

Several surveys have suggested that social attributes are the most important motivations for Australians to fish recreationally (Henry and Lyle, 2003; Ormsby, 2004; Sutton and Tobin, 2009). Recently, there has been an increasing focus on assessing the social benefits of recreational fishing on the health and wellbeing of fishers in an attempt to quantify the economic benefits to society (see McManus et al., 2011). For example, recreational fishers may be healthier and therefore less reliant upon health and support services. Therefore, there is a need to be able to understand the social dynamics of fishers in order to be able to understand and manage the activities of this sector, and to be able to predict how they might respond to specific pressures on their activities (e.g. marine protected areas) (Hunt et al., 2013). As a result, an increasing number of recreational fishing stakeholder groups define social aspects of recreational fisheries as being a key priority for research. Specifically, stakeholders are interested in obtaining social data that is representative of the fishery to:

- Understand who is the 'average' recreational fisher and how they behave,
- Identify behaviours and resultant economic flow on to regional areas,
- Enhance communication between researchers/managers and fishers,
- Identify and understand benefits (e.g. health, lifestyle and additional food sources),
- Understand changing use and access to recreational fishing areas,
- Link intended and resultant effects of policy decisions (e.g. marine parks),
- Improve tailoring of management plans and policy.

Unfortunately, few previous surveys have focused on specific social aspects of recreational fisheries, since the majority of large scale surveys are designed (and funded) to collect the highest priority information that is required to manage these fisheries, primarily catch, effort and participation. Although general descriptive demographic data such as age and gender composition of fishers is often and easily collected in surveys, the greatest hindrance in furthering social research in recreational fisheries is the difficulty in quantifying social values or having access to social indices that can be used to answer the common questions posed by recreational fisher and resource managers, such as the health or wellbeing benefits of fishing. The development of robust quantitative social indices would be a key research area, which would likely extend beyond recreational fisheries into other recreational, commercial and indigenous activities.

### *Quantifying the economic value of recreational fisheries*

Economic valuation of recreational fisheries is perhaps the highest research priority for recreational fishing stakeholders in developed countries, especially Australia, Germany and the US. The need for this information is directly related to stakeholders wanting to place a dollar value on a recreational fishery to enable a direct comparison with competing commercial fisheries. This can provide a justification for fishery managers to change resource sharing arrangements for species shared between recreational and commercial sectors.

Although there are several economic valuation metrics available ranging from *Market Information* that measures actual economic value using market prices, to *Hedonic Pricing* that uses implicit prices for attributes that are not directly observed (e.g. rise in value of property used for fishing), using a single metric to place a value on recreational fishing is difficult for several reasons. For example, an individual's investment in the recreational fishery is often not completely related to fishing, such as a boat purchased to serve multiple purposes. Recreational fishers cannot sell their catch and many fish for sport and release their catch, as so the 'value' of these fish is not equivalent to market prices for the same species caught in commercial fisheries. Furthermore, the motivations for participation and the level of investment are often driven by social factors that are difficult to quantify in dollar terms. The development of quantitative indicators to assess the economic value of recreational fisheries is a key research focus area.

### *Multi-frame sampling*

One approach may be to develop ways to make better use of existing partial list frames for recreational fishers to conduct dual- or multi-frame sampling. Dual-frame or multi-frame sampling is the utilisation of two or more separate, but overlapping, sample frames to access individuals from a population where a single complete list frame does not exist. For recreational fisheries, these incomplete list frames may be recreational fishing licence holders, boat registries, fishing club membership lists, and general population telephone lists.

### *National register of recreational fishers*

Perhaps the greatest hindrance for researchers in undertaking cost effective surveys of recreational fisheries is the absence of complete list frames of participants. These lists can facilitate the use of low cost off-site survey methods (mail and telephone) to cost-effectively collect data that is representative of the recreational fishing community. The development of a national registry of recreational fishers has been raised in a number of workshops and national forums (see Griffiths et al., 2010a) as a potential solution for providing a sampling frame from which national and jurisdictional recreational fishing statistics could be derived. A similar register for recreational fishing in marine waters is in the process of being implemented in the US (N.R.C., 2006). Licence frames, albeit not a complete list of participants, have been used to good effect in NSW and Victoria to reduce labour and telephone survey costs to recruit fishers to diary programs for estimating catch rates. The logistics of developing and maintaining such a registry in Australia will be complex and would involve additional compliance at the State level, but it would allow more timely and accurate estimates of key national and jurisdictional statistics such as participation rates.

### *National data portal on recreational fisheries*

An objective of a recent national recreational fishing project run by the CSIRO (Griffiths et al., 2014) was to develop the framework for a public data portal for recreational fisheries data. This was in response to a need by recreational fishing stakeholder groups and fishery managers to have public access to up-to-date data that can be quickly and easily queried to answer key questions relating to recreational fishing in Australia, such as participation and catch estimates for popular species. Although a seemingly simple proposition, there are several political impediments to establishing such a data portal, due to each State being responsible for their datasets. A portal requires careful coordination and an ongoing commitment between a data custodian of the portal and the State agencies in order for the portal to be updated in a

timely manner with the most recent information that can be used by recreational fishing stakeholder groups. One major issue that is outstanding is which organisation would take responsibility for a national portal and who would be responsible for its ongoing maintenance.

## **Within 10-20 years**

### *Modelling and assessment*

Given the high uncertainty in many aspects of the recreational fishery (e.g. social metrics), fishery and ecosystem models may be a key science need to develop management controls for recreational fisheries, which should not only take into account the biology of target species (including spatial variability in biological parameters), but also the potential social and economic impacts. This could entail sophisticated Management Strategy Evaluation (MSE) modelling that has been applied successfully in many commercial fisheries such as the NPF (Dichmont et al., 2008), the SESSF (Punt et al., 2001) and in the Ningaloo Marine Park (Little et al., 2011). Such models could be used to explore the optimal management strategies (e.g. large minimum length, but small bag limits) that would maximise values important to recreational fishers, but also other user groups.

One major area of concern for recreational fishing stakeholder groups is the scientific basis of Marine Protected Areas (MPAs). MSE and spatial modelling could also be used in this instance where multiple use management scenarios can be explored that maximise the benefits to all user groups in terms of maintaining biodiversity, ensuring the sustainability of target species and maximising the social and economic benefits to the community.

### *Ecosystem effects of recreational fishing*

The management paradigm of many fisheries worldwide has shifted from a single species (i.e. target species) focus to considering fishery impacts on entire ecosystems. This has arisen in response to growing evidence showing fishing activities can adversely affect components of the fishery's supporting ecosystem (e.g. bycatch and habitat alteration), alter community structure and change the overall functionality of the ecosystem. Given that recreational catch of high trophic level species such as tunas, billfish and sharks appears to be increasing, it will be important to consider the ecological effects of this increase. Ecosystem models are one of the few ways to quantify the direction and magnitude of change in species that are directly and indirectly linked with recreational fishery target species. Although several models have been constructed for a range of ecosystems around Australia using Atlantis or Ecopath in the southeast (Fulton et al., 2007), the east coast (Griffiths et al., 2010b), west coast (Lozano-Montes et al., 2011), and the Gulf of Carpentaria (Okey, 2006; Okey et al., 2007; Griffiths et al., 2010d), few of these models included reliable recreational fishery information. As a result, researchers and managers have little information as to the potential ecological impacts of recreational fisheries in Australia.

### *Fishing power*

Once reliable survey methods are developed for recreational fisheries in Australia over the next decade, it would be expected that there will be an increase in the number and frequency of surveys being undertaken at the State and national level to provide data for stock assessment of key recreational species, particularly those shared with commercial fisheries, such as SBT. If a time series of recreational catch-per-unit-effort (CPUE) is the preferred data type for stock assessment models, as it is for many commercially-important species, the time series will need to be standardised due to the increasing efficiency, or fishing power, of recreational fishers over time. This is already apparent for Commonwealth-managed species such as blue eye trevalla, where fishers are increasingly using powerful and accurate echo sounders, radar, and GPS to locate fish and suitable fishing habitats, and improved fishing tackle such as fine diameter braided lines and electric reels to hook and land fish. Such advances in fishing efficiency need to be incorporated into fishing effort estimates so that CPUE indices can better reflect the relative abundance of the target species.

### *Remote monitoring technologies*

In recent years there have been significant advances in remote camera technologies and automated image processing that may be used to cost-effectively monitor recreational fishing effort or fleet movement dynamics in spatially discrete fisheries or MPAs. One such technology is the high resolution Gigapan camera system that can be deployed for extended periods to capture both seasonality and small scale temporal and spatial trends in recreational fishing effort. The system allows for precise geo-referencing of fishing vessels across multiple kilometre scales and identification of boat registrations and other identifying features by sampling at the rate of 1 picture every 15 minutes.

## **Realisation**

Since the NRIFS in 2000/2001 there have been few attempts to convene a national forum on recreational fishing to facilitate a better understanding of the common information needs of fishers, managers, policy makers and scientists. However, the increasing need for reliable national recreational fishing data has initiated small national projects to develop novel and cost-effective options for monitoring recreational fishing at the national level (Griffiths et al., 2010a), improve knowledge on recreationally-important species such as longtail tuna (Griffiths et al., 2010c), and to explore approaches for coordinating national recreational fishing data collection (Griffiths et al., 2014). A number of key messages have arisen out of these and other projects that may allow a coordinated approach to recreational fishing research to move forward to realise some of the science needs in this area.

### **Research funding**

At present, the single greatest impediment in undertaking high quality recreational fisheries research is funding. Since the National Recreational and Indigenous Fishing Survey in 2000/01, there has been no other recreational fishing survey conducted that aimed to provide national estimates. There may be various political and logistical reasons why a national survey has not been repeated. However, the primary reason appears that some jurisdictions considered that they did not gain fine-scale information from the survey that was designed to gather broad-scale estimates. As a result, the data gathered were considered to be of limited use for some decision-making processes at the jurisdictional level, though relevant at the national scale. As a result, there has been no impetus to invest State funding towards another national survey.

Since the last Federal election, the Federal Government has made a commitment to support the repeat of a national recreational fishing survey every 5 years. However, there appears to be no clear guidelines as to when this will begin, what level of funding will be available, or which organisation(s) will be responsible for the survey, analyses and delivery of the results. There needs to be close collaboration between science providers and policy makers in order for the survey to produce reliable outcomes that can be used with confidence by fishery managers.

### **Coordination of research activities**

Since the 2000/01 national survey there has been a number of State surveys undertaken at irregular time intervals to address specific management issues. Interestingly, the majority of these State surveys have used a similar telephone-diary survey approach as used in the 2000/01 national survey. Until now, there has been little need for recreational fishing statistics at a national level, since recreational fishing is managed by States governments. However, the increased targeting of Commonwealth-managed species by recreational fishers has meant that recreational data can no longer be ignored or assumed to be insignificant. Therefore with improved coordination of existing State surveys, it is possible for a national picture of recreational fishing to be assembled cost-effectively in future. Complex political issues can



become apparent between jurisdictions in the area of recreational fisheries, which may hinder the ability of science goals to be realised. However, with clear goals and expectations defined from the outset of collaborations, progress can be made in the recreational fisheries science area.

### **Stakeholder engagement**

Recreational fishing in each State is regulated by numerous input and output controls. However, fishers are not required by law to provide a record of catch or effort, which is the case for most commercial fisheries. Consequently, successful recreational fishing research largely relies upon the goodwill and cooperation of recreational fishers to provide key information, such as catch and effort. In order for this relationship between scientists and fishers to work effectively, there needs to be a level of trust established between the two parties.

At present there are apparent concerns among recreational fishing groups that relate to the reliability and credibility of recreational fishing catch and effort estimates collected by Government agencies. This is believed to be due to the use of inconsistent and or/inadequate survey methodologies that hinder the collection of reliable representative quantitative data that can be compared across various spatial and temporal scales. However, this issue has been further exacerbated by an apparent lack of transparency and accountability of researchers and managers and inadequate stakeholder engagement. Further survey design research as well as improved education regarding the components of the surveys may help alleviate the concerns from fishers.

Recfish Australia has also expressed concerns over the lack of reliable and up-to-date information that is available for use in rapidly emerging management issues, such as the prohibition of catching the recently EPBC listed Mako and Porbeagle Sharks, and the concerns by CCSBT over the extent of recreational catches of SBT (see Green et al., 2012). As a result, Recfish have requested increased availability of reliable data in a central repository that can be easily accessed and interrogated for catch, effort and economic information at various spatial and temporal scales. Although the conceptual framework of such a repository was addressed in a recent FRDC project (Griffiths et al., 2014), this may be a key area where researchers can ensure recreational fishers are kept informed of the latest research developments and data.

During the course of the most recent national recreational fishing forums (Griffiths et al., 2010a; Griffiths et al., 2014), recreational fishing stakeholder groups have made a number of recommendations with respect to how researchers and Government could improve the research and management of recreational fisheries in Australia. Overall, the request has been for researchers and Government to collect and provide robust information on who is fishing, what species they are targeting, where they are fishing, why they fish in these locations, how they fish (what tactics and tackle), the level of catch and release, and the economic and social benefits derived from each species. Specifically, these recommendations include:

- Develop a regional or jurisdictional-based data collection approach with a nationally consistent standardised approach that provides statistically robust outcomes.
- Provide standardised, timely and scientifically sound estimates for fisheries managers and stock assessment scientists and make data publicly available with user-friendly tools
- Address the reliability and credibility of recreational fishing catch and effort estimates to allow an informed decision making process.
- Develop fisher-driven programs to minimise the perception of transparency and accountability issues by use of innovative technologies (e.g. iPhone apps).
- Develop a spatial analysis capability to identify recreational catch and effort differences associated with species/locations across the various jurisdictions.
- Get buy-in, cooperation and engagement from a range of stakeholders who are prepared to trust the data collected and are confident in the integrity of the information collected.

Recreational fishers have also called for greater transparency in the processes by which recreational fisheries are regulated, particularly in regards to input controls. For example, Recfish Australia wish to see a greater demonstration of high quality science that underpins the spatial variation in biological parameters for recreationally-important species that can better justify management strategies used in the various jurisdictions, such as bag, possession and size limits. They have also expressed concern over the reliability of science supporting exclusion of fishing from Marine Protected Areas (MPAs) as they believe there are insufficient baseline data in most cases, which hinders the ability of stakeholders to fully understand the efficacy of management actions.

## **List of contributing authors and affiliations**

Shane Griffiths, Ocean and Atmosphere Flagship, CSIRO

Daniel Gledhill, Ocean and Atmosphere Flagship, CSIRO

Darren Dennis, Ocean and Atmosphere Flagship, CSIRO

Tim Lynch, Ocean and Atmosphere Flagship, CSIRO

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