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Community involvement in recreational fisheries data collection: Opportunities and challenges

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Summary

Recreational fisheries information, especially catch and fishing effort data are required to support sustainable management of marine ecosystems. Information about the changing condition and use of recreational fisheries is incomplete, with many gaps in coverage through space and time. Comprehensive statistics are difficult to obtain due to seasonality of recreational fishing effort and variety of species caught. The high cost of traditional survey methods provides an incentive to explore alternative data collection strategies.

Community monitoring provides an alternative and potentially cost-effective way of extending recreational fisheries data collection while raising community awareness about the health of fisheries and marine ecosystems.

This study focuses on opportunities and challenges involved in community monitoring, in particular the:

- potential benefits for fisheries management
- issues and best practices that have been used to address them
- social and institutional characteristics relevant to establishing and maintaining community monitoring networks.

A number of recreational fisheries community monitoring programs operate in Australia. Six programs were profiled to provide insights into application of community monitoring, and to assess their contribution to fisheries management, the recreational fishing community and the broader community.

Information for the community monitoring program profiles was gathered from published material and interviews with key stakeholders and community monitoring program participants, particularly volunteers. This process revealed the critical factors affecting the feasibility and success of community monitoring generally.

Key messages from the review of recreational fisheries community monitoring in Australia are:

- Community monitoring can provide some types of biological data with reliability and over a long term for use in fisheries research and stock assessments but are usually a component of an overall data collection strategy.
- Estimates of total recreational catch and fishing effort have not yet been provided through community monitoring at a scale suitable for fisheries management.
- Community monitoring programs can be a means of encouraging the fishing community to participate in research and sustainable management of fisheries.
- Community monitoring programs face numerous challenges, such as obtaining long-term funding, recruiting and maintaining volunteers and ensuring the quality and credibility of data.

- Appropriate quality assurance procedures and sufficient training are critical for ensuring the quality of data collected.
- Partnerships with research and government institutions and existing fishing club networks were important to the programs reviewed.

Use of community monitoring in Commonwealth fisheries has been limited to date, mainly confined to gamefish (tuna and billfish) tagging and tournament monitoring.

Community monitoring programs have not yet provided a viable alternative to traditional survey approaches for estimating total catch and fishing effort at the geographic scale needed by fishery managers.

Consideration should be given to engaging peak recreational fishing bodies with options for partnerships with government to investigate community monitoring of tuna and billfish.

1 Introduction

Recreational fisheries information, especially catch and fishing effort data, is necessary to support sustainable management of fish resources. Information about changing condition and use of recreational fisheries is incomplete, characterised by many gaps in coverage through space and time. Comprehensive statistics are difficult to obtain due to the seasonality of recreational fishing effort and the wide variety of species targeted and caught. The cost of traditional recreational fishing survey methods (such as creel surveys) provides incentive to explore alternative data collection strategies.

Community data collection activities provide an alternative for extending recreational fisheries data collection, while potentially raising community awareness about the health of fisheries and marine ecosystems. In many other natural resource management sectors, governments rely on extensive community monitoring activities to provide information (Measham & Barnett 2007). Interest is growing in the potential for community monitoring to be part of a framework for involvement in management of local fisheries and marine environments. Acceptance of the evidence underpinning fisheries management decisions could potentially be improved through community participation in monitoring. However, there is a range of challenges associated with community monitoring.

Community involvement in monitoring of recreational fisheries occurs in a number of different ways. For the purposes of this study, 'community monitoring' is defined as any program in which members of the community are involved in initiating, designing, planning, collecting, analysing or interpreting data for natural resource management. The 'community' is made up of many people and groups, such as recreational fishers, local anglers, gamefishers and local residents; a community may be defined by a geographical area or a particular interest or concern. Because the terminology for describing community monitoring varies, 'community monitoring' is used generally to describe 'community-based research', 'community-based monitoring' and 'volunteer monitoring'. Characteristics of recreational fisheries community monitoring programs in Australia are not, however, widely understood. Such characteristics include how they are run, the community's involvement, the institutional design of the programs and the utility and reliability of data collected.

This project explores the potential for community monitoring to contribute to recreational fisheries management in Commonwealth waters. A number of recreational fisheries community monitoring programs are operating in Australia, at various stages of development, but in most cases little information is available on their contribution to fisheries management or acceptance by recreational fishers.

The approach taken in this study was to review selected recreational fisheries community monitoring programs and identify characteristics that contributed to their success.

Understanding these characteristics will enable future community monitoring programs to be designed appropriately. Insights from the study will help recreational fishers, researchers and managers decide if community involvement in recreational catch and effort data collection in Commonwealth fisheries is appropriate and effective.

The aims of this project were to:

- Review use of community-based data collection in natural resource monitoring and identify important factors affecting success.
- Determine suitable data items and recommend potential approaches for community-based monitoring of recreational catch and effort in Commonwealth fisheries.

2 Methods

The research was conducted in three phases:

- **Phase 1:** Desktop review and synthesis of literature on community involvement in natural resource and environmental monitoring.
- **Phase 2:** Profile characteristics of existing recreational fisheries community monitoring initiatives.
- **Phase 3:** Synthesis and reporting of findings and recommendations.

Phase 1: Desktop review of community involvement in monitoring

A review of community monitoring in natural resources and environment sectors more broadly (for example, water management, weather tracking, ornithology, coral reef and other environmental monitoring) was undertaken. The review focused on the opportunities and challenges posed by community monitoring, including the:

- potential benefits for governments and communities
- 'best practices' used to address issues identified
- social and institutional characteristics relevant to establishing and maintaining community monitoring networks.

The review informed the choice of profiling characteristics relevant to understanding recreational fisheries community monitoring programs in Australia (appendix A).

Phase 2: Profile characteristics of community monitoring initiatives for recreational fisheries

Six community monitoring programs were profiled to identify the key features influencing their success. The key questions guiding the study were:

- How do volunteers, industry groups, researchers and agencies participate in recreational fisheries monitoring initiatives?
- What social, economic, biological or environmental data are collected, how are these stored and used?
- What are the characteristics of existing recreational fisheries monitoring programs?
- What are the institutional and social constraints or drivers to establishing and maintaining community programs for recreational fisheries monitoring?

The success of any monitoring program needs to be measured against its objectives. With this in mind, each profile identified key characteristics relevant to answering these questions. Characteristics of monitoring programs identified were:

- background, objectives and drivers
- conceptual model and design
- stakeholder and community involvement
- institutional form/governance
- strategies for engaging volunteers
- data collection strategies
- data management and custodianship
- funding arrangements
- quality assurance components
- outcomes and impact.

Profiling these characteristics enabled a better understanding of how existing community monitoring programs in fisheries function and their contribution to improved resource management. Recommendations for designing community monitoring programs were then identified based on findings from each case.

Selection of community monitoring programs

The study aimed to represent a range of recreational fisheries community monitoring programs. All programs were at post-implementation stage but ranged in time of operation from those initiated one year ago to those that have been operating for more than 10 years. This enabled an understanding of how the period of operation affects outcomes, including credible data production.

Different jurisdictions were represented to obtain insight into different institutional contexts. Some programs were regionally-focused while others were state or national in scope. Programs with different 'lead' organisations (such as, government, non-government) were also chosen to determine if this had any bearing on success of the program. The six case studies chosen and key characteristics are presented in table 1.

Data collection protocols

The study included key informant interviews to verify and supplement publicly available information on the community monitoring programs. Key informant groups included:

- program managers
- participating volunteers, anglers and community members
- potential data users, such as fisheries agency staff, researchers and scientists (table 2).

1 Summary of characteristics of community monitoring programs profiled

name of program	lead organisation	type of organisation	program description	key volunteer groups	geographic scope	time period (yrs)
CapReef	Infofish Services	Community organisation	Community participation, catch and effort monitoring	Recreational fishers/ local residents	Queensland Capricorn Coast	2004 – current
Great Australian Shark Count	AUF	Community organisation	Community awareness/shark count	Spearfishers, scuba divers, snorkellers	National	2008 – current
Western Australia Research Angler Program	Department of Fisheries (WA)	Government	Catch and effort monitoring	Recreational fishers	Western Australia	2004 – current
Volunteer Recreational Fisheries Monitoring Programs	DEEDI	Government	Catch and effort monitoring; fish frame collection	Recreational fishers	Queensland	2007 – current
Suntag	Infofish Services/ ANSA	Community organisation	Fish tag and release	Recreational fishers	Queensland	1986 – current
Game Fish Tagging Program	I&I NSW	Government	Fish tag and release	Gamefishers	New South Wales	1973 – current

Notes: ANSA = Australian National Sportfishing Association Ltd; AUF = Australian Underwater Federation; DEEDI = Department of Employment, Economic Development and Innovation (Queensland); I&I NSW = Industry and Investment New South Wales.

2 Key informant groups of monitoring programs approached for interviews

key informants	stakeholder roles	value for our study
Program managers	Developing and/or managing the monitoring program	Perspectives on key issues and challenges for the monitoring project, what works, and what did not work.
Recreational fishers/anglers/ community members	Involved as volunteers in the monitoring program; or as community champions	Perspectives of volunteers: what they do, why they became involved. Community champions: how did they become involved, what did they do and why.
Data users (e.g. state agencies, researchers or scientists)	Users of the data generated/ funding bodies	Perspectives on the value of data generated; any issues or data needs for natural resource management.

Comments from those directly involved in monitoring helped researchers gain in-depth understanding of the issues.

Key informants were identified from public documents available on each monitoring program and were people directly involved in the programs. Seventeen key informants were interviewed between 30 April and 11 June 2009.

Potential key informants were asked if they would be happy to participate in an interview. A fact sheet about the study (appendix B) was sent before the interview and a time was arranged for an interview (by phone or face-to-face).

Key informants were asked about their experiences of community monitoring—how and why they are involved, what they do in relation to the program, what data are collected and how these are used, data quality assurance and what they see as the key benefits and challenges for community monitoring. Interview questions were slightly different for each key informant group (see appendix C for the different questionnaires and protocols used in interviews).

Interviews with the key informants were recorded using a digital voice recorder and handwritten notes. Summaries of key informant interviews were written up and used as the basis for data analysis. Summaries of interviews were sent to those interviewees who requested them (seven out of 17 people) for factual checks.

Ethics and consent

Use of a project fact sheet helped communicate the aims of the study to key informants and explain how the information they provided would be used. The fact sheet was sent to each key informant before the interview for informed consent. Consent was also obtained, at the start of each interview, for the interview to be digitally recorded.

Phase 3: Synthesis and reporting of findings and recommendations

Key informant interviews were used to verify and extend the desktop review of each community monitoring program. A content analysis approach—a method used in social sciences for studying the content of communications (Krippendorff 2004), in this case using transcripts of recorded interviews—was used to identify which comments pertained to the characteristics of interest (see chapter 3). Selected comments were incorporated into the profiles to illustrate themes or issues, or to describe differing perspectives.

Comparison of the six profiles revealed common factors for the success and feasibility of community monitoring programs. These factors are discussed in detail in chapter 5.

3 Characteristics of existing recreational fisheries community monitoring programs

This chapter describes 10 key social and institutional characteristics relevant to understanding the opportunities and challenges involved in existing community monitoring programs.

Key questions to explore when interviewing key informants or reviewing background documents were identified under each characteristic. These characteristics offer a general guide for assessing community monitoring.

Background, objectives and drivers

It is important to establish the background to the program and its local context, including why it was set up and what it was meant to achieve. Local context includes the history of interaction between recreational fishers and government agencies in the area, or between recreational fishers and the commercial fishing sector.

Some aspects considered were: the stated objectives of the monitoring program; what led to initiation of the program; was the program initiated by government, industry or the community; and did the program aim to fill data gaps? The objectives involved collection and use of monitoring data for resource management or science, but could also extend to social outcomes such as developing awareness of recreational fishing 'rules'.

Conceptual model and design

For community monitoring recreational fishing data to be useful, appropriate data items or variables must be identified and measured. What model or hypothesis was used to guide data collection? What were the key concepts used, what questions are being asked, and what are the key relationships or processes between these concepts? In some cases the design might evolve based on changing objectives. The design of the program needs to be appropriate to achieve these objectives. The geographical extent of data collection and monitoring must also be considered.

Stakeholder and community consultation

Stakeholder and community consultation processes are likely to influence the way the monitoring initiative is received and the amount of long-term support. Relevant issues include: what consultation process was used with key stakeholders in relation to setting up the program; the formal and informal processes used to work with stakeholders and local communities to implement the program; and whether these processes encouraged partnerships with stakeholders, such as natural resource managers, researchers or the community?

Institutional form/governance

This characteristic considers what would be needed to facilitate involvement and coordinate a range of participants toward achieving monitoring tasks (for example, agreed roles and responsibilities, guiding protocols for volunteers, and legal/governance arrangements).

Strategies for engaging volunteers

This characteristic considers how volunteers are recruited, what issues or challenges were associated with recruiting and retaining them and, if possible, why people volunteer.

Another issue of interest is how program managers sought to maintain motivation to participate (for example, regular public meetings, newsletters, recognition or rewards) and how volunteers responded.

Data collection strategies

This characteristic describes the method of data collection, whether community monitoring activities are directed by a sampling strategy or opportunistic in nature. How the community submits data, including use of paper forms or technology such as email and online forms was considered. Data entry processes undertaken by program administrators are also included.

Data management and custodianship

How people are able to acquire and use data is an important issue for community monitoring. Underpinning this is an adequate data management system. What provisions were made for storage and retrieval of data? Who looks after the data and data requests? Who has access to the raw data? What arrangements were made to protect the privacy and confidentiality of personal information of those contributing their data?

Funding arrangements

Resourcing and capacity issues may shape opportunities for community monitoring and affect the quality and continuity of data collection. Issues for investigation included funding sources (grants, industry levies and donations), criteria for grant funding, and the potential effect of funding on the focus and direction of the monitoring initiative.

Quality assurance components

It is important to have systems in place to ensure data collected are of sufficient quality or 'fit for purpose' (Boudreau & Yan 2004; Delaney et al. 2008; Newman et al. 2003). This is critical to the acceptance of community-collected data by government agencies, industry groups and

scientists. The two main types of quality assurance dimensions are: validity (ensuring the data are fit for purpose) and reliability (ensuring the data represents reality by minimising error and bias). While this study does not directly assess the validity and reliability of the data, it does consider what arrangements were in place to ensure the data are valid and the estimates accurate.

Data quality also depends on volunteer capacity, skills and ability to carry out monitoring tasks. The sorts of questions that arise include: How well are volunteers able to accurately identify fish species, size, gender or other item of concern? Is sufficient information and training provided to ensure the data collected are reliable and of a high quality? Are there activities that are well suited or less well suited to volunteer monitoring?

Outcomes and impacts

The study focuses on the outcomes and impacts as understood by stakeholders, participants or users of the monitoring information. Different groups may have different views on success or impact depending on what their needs are and how they see the purpose of the initiative. For example, anglers may be interested in using the information to lobby government or to improve their fishing experience. However, scientists may be interested in using the data to estimate abundance of fish stocks or catch rates. Outcomes and impacts need to be measured against whether these different objectives are being met.

The types of issues the study considers are: What measures of performance or success did the participants use to judge the outcomes of the program? Did participants articulate any social or environmental benefits? How was community data used in natural resource management decision-making or incorporated into policy or research?

4 Community monitoring program profiles

CapReef, Infofish Services

Background, objectives and drivers

CapReef (Capricorn Reef Monitoring Program) is a community monitoring program initiated by residents of the central Queensland coastal region in 2004–05 to 'collect information on the effects of management changes on fish and fishers' (Recfish Australia 2007). The program was set up in response to regulatory changes, mainly introduction of new marine protected areas.

The 2004 Great Barrier Reef Marine Park (GBRMP) and State Coastal Marine Park rezoning brought regulatory changes that affected when, where and how recreational fishers could fish. For example, 'green zones' were introduced in 33 per cent of the GBRMP, in which no fishing could take place, and gear limitations were imposed in other zones (Granek et al. 2008; Sawynok et al. 2009). Possession limits and size limits were also reviewed by the Queensland Government in 2003.

Following the rezoning consultation, CapReef was set up to achieve two overarching objectives:

- improve community knowledge of the Great Barrier Reef (in the Capricorn region)
- improve community involvement in management of the Great Barrier Reef (Sawynok 2007).

CapReef was established to provide recreational fishers with information about the impact of the management changes on fish stocks as 'many questions [were being asked] about the validity of the justification for the zoning'. One claim was that the closures would create a 'spill-over effect' such that fish populations would increase in the adjacent areas as the protected fish would grow and spawn. However, many fishers doubted the evidence supporting closures (Jago et al. 2005).

A related agenda was to provide a voice for recreational fishers to be 'heard and represented'. Key informants noted the 'community angst' about the closures and that some people 'didn't trust the process and wanted to do a parallel set of consultations to raise community awareness and to put across our side of the story'.

The goals of the CapReef program have evolved over time. Whereas initially, the goal was simply 'to collect information on catches and catch rates to see whether this changed over time and if it was related to the management changes', the program has become 'more responsive to community questions about fish resources in Central Queensland'. There is a range of other issues on the research agenda, such as environmental influences (river floods) on fish stocks and the impacts of climate change on fisheries.

Conceptual model and design

CapReef encompasses several monitoring activities, each linked to the drivers and goals of the program. Given the current areas of interest, data are collected and analysed on a range of indicators (Platten et al. 2008):

- recreational fishing catch and effort
- relative abundance and size structure of key fish species
- changes in fisher participation or fishing patterns resulting from the new management plans
- movement of key fish species from extended marine national park and conservation zones.

Vessel-based fishers in the CapReef monitoring area are identified as having the main interactions with the resource and therefore, the monitoring design focuses on their activities (Platten et al. 2007).

Fishery independent research methods are used to study fish populations inside and outside the 'green zones', including Baited Remote Underwater Video and tag-recapture methods. Several tagging projects also track stocked fish in estuaries, rivers and impoundments (Sawynok & Pearce 2006).

Stakeholder and community consultation

The Great Barrier Reef Marine Park Authority (GBRMPA) 2004 consultation for rezoning the GBRMP was one of the largest public consultations on an environmental planning issue in Australia. The idea of CapReef emerged from discussions among local groups during the rezoning consultation. Groups involved included Capricorn Sunfish (a recreational angling group) and the GBRMPA Local Marine Advisory Committee.

Ongoing consultation with stakeholders is facilitated through the CapReef steering committee.

Institutional form/governance

CapReef is coordinated through Infofish Services, a small family business established in 1995; see www.info-fish.net. A core group of about 20 people provide the main support for the CapReef program, including a part-time manager, the steering committee, a small number of casual staff and several volunteers who contribute to regular tasks (for example, boat ramp surveys, data entry and analysis). In addition, at least 200 other people regularly provide their fishing information to CapReef.

CapReef's manager, Bill Sawynok, is an active member of the community and coordinates data collection and management. He is widely seen as a 'champion' of the program—a leader and advocate—who everybody knows. CapReef's manager facilitated development of good relationships with the recreational fishing community as well as agencies and research networks.

The only formal structure in the program is a steering committee whose members include recreational fishers from the Australian National Sportfishing Association (ANSA) and local clubs, researchers (James Cook University) and agencies—GBRMPA and the Queensland Department of Employment, Economic Development and Innovation (DEEDI).

Strategies for engaging volunteers

The volunteer members of the core group are highly engaged people, due to personal interest in the CapReef program. CapReef also depends on the willingness of the wider public to voluntarily provide their recreational fishing information.

To engage the recreational fishing community and foster a sense of community ownership for CapReef, regular information updates are provided about fishing and the resource. In addition, rewards (such as free t-shirts, drink holders and hats) are given to people who submit catch and effort information or fish frames for biological analysis.

It was reported that promotional activity is not needed to motivate people to become involved as most are 'self-recruited'. There is some 'turnover' of volunteers but organisers endeavour to find a balance between what volunteers want to do and what they are prepared to do, avoiding potential issues of volunteer 'burnout'.

Comments by key informants suggested that local ownership was needed to sustain CapReef in the long-term.

Data collection strategies

A range of data collection strategies and activities is employed, with the main data collection methods including:

- regular surveys of local fishers
- boat ramp surveys and trailer counts
- fishing trips reported by email or toll free phone
- fish tagging to monitor growth and movement
- specific research projects (such as, fish frame collection)
- underwater video surveys
- weather monitoring (Fitzroy Basin Association Inc. 2009; Sawynok 2007).

Most data are collected by volunteers or casual staff, or reported voluntarily by recreational fishers. The boat ramp surveys are conducted by local volunteers at popular boat ramp sites. This is supplemented by boat ramp traffic counts using Queensland Department of Main Roads automatic traffic counters.

The limited number of highly used boat ramps on the CapReef section of the Capricorn Coast helps volunteers sample fishing (Platten et al. 2008). However, emphasis on major public boat ramps means data collection strategies may not adequately cover beach and private access.

Fishing trip data are collected through distribution of catch cards and their collection upon return or logging through the internet or email (Infofish Services 2003). The catch cards record information including how long people fished, where they went, how many were in the group, and numbers of fish retained or released. Local fishing clubs have been important contributors of trip data.

CapReef also used Baited Remote Underwater Video in 2007–08 to observe fish abundance and feeding habits. This method relies on non-hooking/non-capture methods of observation and therefore makes it possible to compare fish abundance and behaviour in areas closed to fishing with areas open to fishing access (Platten & Sawynok 2008b).

In some cases, CapReef has been commissioned to undertake specific data collection or research. For example, in 2008 the Queensland Department of Employment, Economic Development and Innovation (DEEDI) contracted CapReef to collect barramundi and mackerel fish frames caught by recreational anglers in the south-east coast region to provide data for the Long-Term Monitoring Program (Department of Primary Industries and Fisheries 2008a).

Data management and custodianship

Infofish Services manages CapReef data using a web-based SQL database system; 'Infofish 2006' developed as part of the Suntag recreational tagging program. The database can only be accessed by authorised users and different levels of access are possible (that is, personal records to full access) (Sawynok 2008).

Datasets are available on request and while there is a user agreement, it is only used occasionally as the organisers know and trust most users. Datasets are published in a way that does not uniquely identify individuals and GPS information is given to researchers only upon request.

CapReef organisers make information accessible to the wider public through use of straightforward, colloquial style reports (available at www.info-fish.net). The reports are 'targeted to local people in the community' and avoid some of the complexities of formal science reporting that people often find difficult to understand (Platten & Sawynok 2007, 2008a, 2008b; Platten et al. 2007, 2008).

Funding arrangements

CapReef was intended to be set up for about a 10-year period to match the life of the current GBRMP zoning plan. Despite this intended timeframe, continued funding of the project is a significant challenge.

During the four years in which CapReef has operated, short-term funding has been obtained from the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) and GBRMPA (Platten et al. 2008). In addition, CapReef has received funds from the local natural resource management group, Fitzroy Basin Association, and in-kind support from regional universities and DEEDI.

Several key informants suggested that lack of a proven track record is a reason continued funding has been difficult to obtain. As the datasets cover a longer timeframe they are likely to be more useful to researchers and resource managers.

Quality assurance components

CapReef data benefit from the formal quality assurance processes in place for the Suntag program—the data are stored on the same database and similar error checking protocols are used (see the Suntag profile). To maintain data quality, information collected at boat ramps, during fish tagging projects and by video surveys was gathered by experienced members of the CapReef core volunteer group. However, it is unclear to what extent volunteer training is actively undertaken as part of the CapReef program.

The quality of fishing trip report data is likely to be variable in terms of species identification, especially data provided by telephone. However, comparison of fish lengths collected at boat ramps with those reported directly by fishers showed close correlation.

Outcomes and impact

CapReef has been recognised for its success at different levels, including as an awareness raising and educational program, as a means of engaging the recreational fishing community in management issues and as a strategy for generating biological information on fisheries within the Capricorn Reef area.

Community building

CapReef has provided a channel for recreational fishers' constructive participation in fisheries planning in the Capricorn Reef area. A shared knowledge base has developed and there are strong partnerships with recreational fishers beyond what a formal scientific monitoring program might have achieved.

Partnerships and research

Strong partnerships have been important to the success of CapReef. For example, the diversity of people on the steering committee enables research, government and local community perspectives to inform progress of the program. Collaborative research with universities and government has been a key partnership. These mechanisms have helped develop more trust between government, resource users and researchers following the Great Barrier Reef rezoning.

Fisheries management

It is difficult to establish the extent to which CapReef has influenced fisheries management decisions. However, key informants have described how CapReef data informed management decisions on several occasions, such as implementation of new fish size limits and zoning plans. Early in the program's history CapReef volunteers submitted a single public submission to GBRMPA that captured preferred GBRMP zoning changes for the recreational fishing community, particularly for inshore areas. The proposed changes were ultimately reflected in the final zoning plan GBRMPA released (Recfish Australia 2007).

The activities associated with CapReef have encouraged greater compliance with regulations. CapReef organisers have found the most successful approach is that of 'selling the message about bag limits as one of social equality' rather than bag limits as a management tool. The willingness of local fishers to comply may be partly due to having a process of scientific enquiry based within the community that encourages people to question and learn about the fishery.

The limited geographic area covered by CapReef has meant its impact on management at the fish stock or fishery level has been limited. Some resource managers claim it would be useful for CapReef to be extended throughout the whole Queensland coast (rather than limited to the Capricorn area).

Great Australian Shark Count, Australian Underwater Federation

Background, objectives and drivers

The Australian Underwater Federation (AUF) initiated the Great Australian Shark Count (GASC) in 2007–08 to monitor threatened shark species and provide education for underwater fishing activities in Australia (AUF 2008a). The project was begun in the context of widespread concerns about increasing numbers of sharks caught in Australian waters (Smith et al. 2008).

In particular, the GASC was initiated to provide evidence about the population status of the grey nurse shark. Legal action brought by the Nature Conservation Council against the Australian Government in 2007 aimed to mandate marine sanctuaries and fishing gear changes at a number of sites to protect grey nurse sharks (AAT 2007). GASC organisers sought to be 'proactive rather than reactive and negative' to this situation by starting community monitoring.

Objectives of the GASC were to 'tap into our knowledge and observations and have them recorded in a more organised manner' and provide an 'opportunity to educate the public about sharks'.

Conceptual model and design

The monitoring program design involved reporting of shark numbers by spearfishers and divers who regularly interact with sharks around Australia's coasts. Shark counts were made by divers involved in organised shark counting events, as well as during personal recreational diving or spearfishing activity. The types of data targeted include the distribution and relative abundance of 10 shark species, out of about 160 possible shark species, in Australian waters. These 10 species were chosen because they are relatively easy to identify and have conservation significance.

The program was modelled on the Great Annual Fish Count, a non-profit environmental education program held each July since 1992 in many locations around the United States, Canada and the Caribbean (Pattengill-Semmens & Semmens 2003).

Stakeholder and community consultation

The GASC used existing recreational sportfisher and diver networks and mass media promotional activity to engage the wider community.

Organisers developed a mailing list to communicate program news and maintain contact with stakeholders, participants and interested groups. Media releases and information about weekend counting activities were sent through this mailing list.

A strength of the program noted by key informants was its ability to 'bring disparate groups together—including recreational fishers'. This was important in establishing a shared knowledge base likely to be recognised by all groups.

Institutional form/governance

The GASC was organised and hosted through the AUF, which the Australian Sports Commission recognises as a national sporting organisation. It was an initiative of those involved in the recreational spearfishing committee within the AUF (AUF 2008b); a small steering committee of AUF members manages the program.

Strategies for engaging volunteers

Most participants who undertook shark monitoring for the GASC were scuba divers, skin divers, underwater spearfishers and other recreational water users. Many were existing members of the 1000 strong AUF membership, and some were from external scuba diving clubs. The main strategy used to recruit these volunteers was promotional advertising encouraging them to incorporate shark counts and reporting into their ordinary diving activities. In addition, four dedicated shark counting weekends were widely promoted in the media and through existing research networks (Taylor 2008).

Incentives given to participants included monthly random prize-draws, such as wetsuits, sunglasses and branded t-shirts. A challenge that arose for some volunteers was the amount of time needed to enter significant amounts of data onto the database.

Data collection strategies

The main methods used were dedicated and opportunistic counts (Smith et al. 2008).

Groups of spearfishers conducted dedicated shark counting weekends in 2008 in four locations, including the Coral Sea off the coast of Queensland between Cooktown and Cairns. Sharks were counted if they swam within 30 meters of the spearfishers.

Spearfishers and divers undertook opportunistic counts. During their daily ongoing activities they recorded information on shark sightings (Smith et al. 2008). Opportunistic shark counters provided data by logging onto the GASC website using a login and username.

Data recorded included location of sighting, shark species, length, sex, date, period, water temperature, visibility, depth observed and details of the observer. Data collected from dedicated shark counts were limited to counts by species and size range observed (Smith et al. 2008). Volunteers directly entered data onto the GASC website using a login and username.

Potential shortcomings of the data collection methods that can affect the quality of shark abundance data include the ability to accurately determine shark densities and account for seasonal variation; the incidence of individual sharks being counted by multiple divers; and the reliance on opportunistic sampling.

Data management and custodianship

The data are stored on the AUF computer network in both web-based and spreadsheet formats. Originally the data were accessible through the AUF website and updated monthly but were removed to prevent others publishing the information before the AUF.

The AUF National Communications Officer undertakes the role of the GASC data manager on a voluntary basis and maintains an archive of the GASC data. The data are available upon request and have been used by several researchers.

Funding arrangements

The GASC has been supported by a range of government, scientific, community and industry groups including DAFF, the Fisheries Research and Development Corporation (FRDC), Reef Check and The Ecology Lab (Smith et al. 2008). A proportion of the project funding came from the Australian Government Recreational Fishing Community Grants Program which approved a grant of \$73 000. Much of the cost is carried by volunteers who use their own gear, organise and pay for their own travel and use their unpaid time to monitor sharks.

The Recreational Fishing Community Grants Program ceased on 30 June 2010. Continued funding for the project is uncertain.

Quality assurance components

The program steering committee undertakes data quality control activities. For example, the committee verifies data logged on the website for possible errors and duplication. Committee members also randomly select 20 per cent of participants who logged data and phone them for data verification (Smith et al. 2008)

Another issue is how accurately volunteers can identify the shark species and sex. To aid identification, an artist was commissioned to produce colour illustrations for the 10 species of interest and the images were published on the GASC website www.auf-spearfishing.com.au/public/protected_species/protected_species.php.

Outcomes and impact

The support recreational spearfishers and divers have given the GASC reflects significant enthusiasm in the community for participation in monitoring sharks. Anecdotal evidence suggests participants have developed a sense of stewardship for the environment as a result of the program.

Social outcomes include a positive awareness of sharks and an appreciation for the importance of sustainable shark populations in the future.

Program organisers acknowledge the limitations of the GASC for assessing shark abundance, but see potential for the data on species distribution and spatial patterns in species composition and relative abundance to be used in future shark assessments (Smith et al. 2008).

Consequently, a challenge has been to manage stakeholder and audience expectations about the utility of the data produced. An important lesson is that the utility of community data produced by the project needs to be made clear to stakeholders and the public.

Research Angler Program, Department of Fisheries, Western Australia

Background, objectives and drivers

The Research Angler Program is conducted by the Department of Fisheries, Western Australia (WA) and consists of a series of projects aimed at collecting data on recreational fisheries in freshwater, estuarine and open ocean environments. All volunteers who carry out recreational fisheries research in Western Australia are considered part of the Research Angler Program (Department of Fisheries WA 2009b). These recreational data collection projects vary in scope and location and are one element of a wide range of research activities the department carries out to facilitate sustainable use of Western Australian fisheries.

Part of the impetus for initiating the Research Angler Program was the need to collect monitoring data over a large area of the Western Australian coastline, including its inland waterway systems (Department of Fisheries WA 2009a). The objectives of the Research Angler Program are to:

- collect comprehensive data on regional and seasonal catch and catch composition (species, sizes, including discards), and fishing effort by all recreational methods
- provide opportunity for recreational fishers to contribute to research and monitoring projects.

Conceptual model and design

The Department of Fisheries WA runs a number of projects under the Research Angler Program that help monitor various nearshore and estuarine fisheries. The program relies on the voluntary contribution of recreational fishers in two ways:

- Voluntary reporting of catch, effort and fish lengths through a daily angler's logbook and through catch cards for fishing tournaments.
- Participation in research projects aimed at biological data collection.

This profile focuses on the angler's logbook (or diary) program. The angler's logbook program was launched in April 2004 as a means of collecting volunteer data to better understand fishing catch and effort, and the ecological status of specific fisheries. Initially, most logbook participants were located in the West Coast and South Coast regions (Smith, Hammond & Brown 2007) but specific research and management developments later targeted anglers in the Rottne Island and Gascoyne regions (Department of Fisheries WA 2007).

Stakeholder and community consultation

Cooperation between government and users is demonstrated by the high level of voluntary contribution of data by recreational fishers (Fletcher & Santoro 2009). In addition to collecting data for monitoring of recreational fishing stocks, 'Fisheries Volunteers' also provide recreational fishing education support. This extensive community education activity builds trust between resource users and the Department of Fisheries WA and encourages collection of research data (Smith, Brown & Hammond 2007). Fisheries and Marine Officers throughout the state support research program activities by maintaining compliance and enforcing fishing rules.

Institutional form/governance

The Department of Fisheries WA initiated and managed the Research Angler Program. It began as a diary/logbook program and expanded to incorporate other research activities. This simplified the interface with the department for volunteers as the Research Angler Program became the one-stop-shop for anyone wanting to be a volunteer.

One coordinator and a part-time officer administer the program, including data entry, sending out logbook kits, responding to public enquiries and preparing quarterly newsletters. Several other staff provide assistance.

Strategies for engaging volunteers

Volunteer recruitment is closely tied to how much the program is promoted. Methods used to recruit participants include media statements, and brochures and posters distributed by fisheries officers.

Recruitment has been directed toward areas of need. In a separate recruitment drive, for example, scientists approached 2200 people living along Mandurah's canals to help monitor and manage the sustainability of crab and fish stocks in the estuary (Department of Fisheries WA 2008).

Logbooks are only completed by individual recreational anglers but clubs, charter operators, community groups and students also contribute data to other projects within the Research Angler Program (Department of Fisheries WA 2009a). Angler recruitment to the program has increased from 307 logbook participants in October 2005 (Department of Fisheries WA 2005) to more than 500 current registered fishers.

Maintaining volunteer involvement over the long-term is critical to the success of the program. This issue is addressed in several ways. Members of the Research Angler Program become part of a network and receive regular newsletters that include recent research results, information about fish species, news of forthcoming research projects and special events. Members are encouraged to participate through offers of rewards and prizes such as t-shirts and gift vouchers (Department of Fisheries WA 2009a). Members also receive individual summaries of their annual fishing activity.

A low turnover of volunteers saves money; it costs a great deal to reach and recruit volunteers. The program coordinator never gives out logbooks on first contact; only 'keen, genuine' anglers are wanted. This also helps maintain consistency and reliability of data.

Data collection strategies

Different methods are used depending on the information needed:

- angler logbooks
- tournament catch cards
- collection of biological samples (fish frames)
- specific surveys (for example, the tailor recruitment survey using catch and release)
- fish tagging
- fish and shark observer studies (Department of Fisheries WA 2009a).

Angler's logbooks are applicable to all recreational fishing methods used in the state and are considered the cornerstone of the program. Logbooks are supplied by the Department of Fisheries WA and participating anglers are asked to report detailed daily records of catch and fishing effort (for example, location, fishing start/end time, gear/tackle used, species caught, number and length) (Smith, Hammond & Brown 2007). Tournament catch cards only report catch in terms of species, number and size and allow multiple anglers' data on a single form.

Data management and custodianship

Data are stored as hardcopy and on a Microsoft Access database on the Department of Fisheries WA network.

Logbook data accumulates on this system to a point where it is sufficient to be useful and is opportunistically used when required. Electronic data are also available to external researchers and stakeholders on request. Confidentiality restrictions apply to data supplied for both internal and external users.

Funding arrangements

Funding for the Research Angler Program comes from the Department of Fisheries WA research budget. The research budget was not originally supplemented to allow for implementation of the Research Angler Program, so funding was limiting in the early years of the program. Access to funding from the Swan Catchment Council (Smith & Hammond 2008) and the Natural Resource Management Rangelands Coordinating Group using a Natural Heritage Trust grant in 2007 has supported further development of the Research Angler Program and the angler logbook in particular. The Government of Western Australia has made a commitment to long-term funding.

Quality assurance components

Data are checked for obvious errors upon entry into the database. Inconsistencies in logbook data are checked with the reporting angler by email or telephone, where possible.

Quality of some volunteer data is also strengthened through training programs (relating to some specific research projects in the Research Angler Program).

Outcomes and impact

Key informants advised that volunteer data gathered in the Research Angler Program have been used to inform fisheries research and used to assess fish stock status, especially where phone/diary or creel surveys have not been conducted for some time; for example, Rottnest Island (Smith & Hammond 2008).

The angler logbook, catch cards and fish frame donation and other volunteer monitoring provide low-cost methods of maintaining long-term monitoring between periods of intensive fisher surveys and field sampling. The angler's logbook program also presents an opportunity for keen recreational fishers to contribute to research. The regular Research Angler Program newsletters keep anglers informed of developments in fisheries research and management, and how their data are used.

Suntag, Infish Services, Queensland

Background, objectives and drivers

Suntag began as a recreational fishery tagging program in 1987–88 in Queensland and involved members of the Australian National Sportfishing Association (ANSA). Initially it aimed to track certain fish species, but has evolved into an established program that provides data for scientific research. Suntag has its origins in the 1970s, when a group of Queensland ANSA fishers approached the Queensland Department of Primary Industries and Fisheries, now the Department of Employment, Economic Development and Innovation (DEEDI) to start a fish tagging program. The Department of Primary Industries and Fisheries initiated the Recreational Sport Fish Tagging Program, but in 1987 the program was handed over to ANSA Queensland to run. In the mid 1990s, the name of the program was changed to Suntag to align with other

ANSA state tagging programs under Austag (the ANSA Research Program). Suntag has become one of the largest recreational fish tagging programs in the world with over 570 000 fish tagged and over 40 000 recaptures.

Conceptual model and design

Suntag relies on catch-and-release fishing activities of anglers who are members of ANSA, either as individuals or members of affiliated clubs. However, the organised model implemented through ANSA is increasingly being used to collect other data that is not dependent on general catch-and-release fishing, but is gathered during focused short-term projects. The name Suntag is now used to identify the ANSA Queensland Research Program. Suntag data are used for a range of biological research purposes, including the study of fish migration and growth rates, released fish survival rates, monitoring of stocked fish, and catch and effort estimates (Sawynok 2008). The main component of the data collection is the long-term database of catch-and-release records for many species of sportfish in Queensland waters. Suntag is also unique in that DEEDI uses its database to store tagging data generated by the department's own researchers.

Stakeholder and community consultation

The Suntag Coordinator regularly consults key stakeholders, such as DEEDI, the ANSA Queensland Executive, Recfish Australia, FRDC and ANSA Club Tagging Officers (ANSA Ltd 2009). Consultation with the wider recreational fishing community occurs through fishing clubs and events. An indication of the ongoing interaction of the recreational fishing community is given by participation rates in the tagging program. As at 2010, 8480 taggers had participated since 1987 and 15 250 fishers had reported recapture of a tagged fish (Sawynok 2010).

Institutional form/governance

Suntag is the fisheries research program of ANSA Queensland and is a joint program with DEEDI, which provides an annual grant for administration and management (Sawynok 2009).

Infotish Services has managed Suntag on behalf of ANSA Queensland for five years, and some of the people managing the program are also involved in the CapReef program. Infotish Services provides two part-time staff—a manager who coordinates tag distribution, data collection, distribution of recapture information and news bulletins, and a data entry assistant. Volunteer tagging officers in fishing clubs distribute tags to members and manage tag-release data.

All ANSA state and territory tagging programs in Australia are managed and operated independently but all are linked to Austag. Austag is a national program that provides the framework and standards for collecting recreational tagging data for research (Sawynok 2009).

Strategies for engaging volunteers

Most volunteers are members of fishing clubs or associations—recruitment occurs by word of mouth through such clubs and associations.

As with other fish tagging programs, a key participation motivator seems to be curiosity to find out the fate of the fish. Other motivators mentioned are opportunities for networking and sharing the fishing experience with other fishers, such as by phoning the previous tagger.

Potential volunteers are screened to ensure a high level of commitment to regular reporting and appropriate use of tagging equipment and protocols. This involves volunteers paying a registration fee and undergoing a trial period where a small number of tags are issued to check quality of data provided and establish level of commitment to the program.

Regular feedback is provided to volunteer taggers to maintain motivation. This includes information about recaptured fish, sent to the individual tagger, and distribution of news and information about interesting tag stories through Suntag news bulletins.

Data collection strategies

Participating anglers are required to ensure fish species tagged are within the scope of approved Suntag projects and are required to follow approved instructions for handling fish, measuring fish lengths and applying tags (ANSA Ltd 2009). The Suntag Manual specifies time frames for reporting of fishing trip and tag data, which can be submitted through the Suntag website or by email to the Suntag coordinator. The number of tags used in the program is closely controlled so the number of 'unmatched recaptures' is low (2 per cent). This helps improve tag data reliability and data users' confidence.

Specific data collection strategies are undertaken as part of commissioned scientific research studies or for fishing club stocking programs.

Data management and custodianship

Infish Services is the custodian and manager of the Suntag tagging database. The same database used for CapReef data is also used to store Suntag data. Access to the database is limited to authorised users.

The Suntag Manual sets out the standards for data management for the program, including validation and loading of trip and tagging records. Data must be forwarded to Club Tagging Coordinators or the Suntag Coordinator within 14 days of a fishing trip for electronic records and within 30 days for paper records (ANSA Ltd 2009).

Funding arrangements

The Suntag program is funded mainly by DEEDI (Sawynok 2009). The funding provided to Suntag is derived from the Private Pleasure Vessels Levy (Olyott 2009).

The Department of Primary Industries and Fisheries reviewed the operation of the Suntag program in October 2000 and, based on the outcomes, agreed to continue its funding. The arrangement suggests that outsourcing some aspects of the tagging program to a community-based organisation is a valued and cost-effective arrangement for DEEDI in the long term.

Quality assurance components

Quality assurance protocols for collecting, storing and distributing volunteer tagger data are articulated in the Suntag Manual (ANSA Ltd 2009). In addition, taggers are referred to the ANSA Code of Practice on Releasing Fish for accepted practice when tagging. It is incumbent upon taggers to know and follow accepted procedures in order to release fish in the healthiest state possible. However, it is less clear whether training and education of fishers about the protocols is routinely undertaken.

Some problems with data quality were reported for specific research projects. Where experimental design required strict protocols, some volunteers were more likely to overlook critical instructions. This situation reinforced the need for effective training and close liaison between researchers and volunteers.

Outcomes and impact

There appears to be consensus that Suntag is a beneficial program, for its contribution to fisheries research, as well as its potential benefits in the recreational fishing community.

Community benefits of the program include the wide range of recreational fisheries information accessible to the average fisher and the improved understanding of the science. Responsible fishing practices is just one area where the program makes a contribution; for example, appropriate catch and release methods, tagging techniques, ethical handling of fish, and bag and size limits. This influence is strengthened through the program's strong links into fishing club activities.

Research benefits

Long-term Suntag datasets (for example, longer than 20 years) are valuable to researchers and potentially to resource managers, as they can be used to detect changes in catch and effort over time. Researchers and fisheries scientists have used data subsets for a range of collaborative projects (Sawynok 2008). This research has improved understanding of recreational fishing effects on the resource and handling practices that might aid sustainability of the fishery.

Fisheries management

It is more difficult to establish a direct connection between Suntag monitoring data and natural resource management or policy changes.

Volunteer Recreational Fisheries Monitoring Programs, Queensland DEEDI

Background, objectives and drivers

DEEDI coordinates two community monitoring programs involving recreational fishers: the Recreational Fishing Diary Program (RFISH) and the Keen Angler Program.

DEEDI has conducted four statewide recreational fishing surveys since 1996 using a telephone screening survey and diary completion by participating anglers (the RFISH program). In 2007, the survey design was changed to continue a fishing diary without the telephone screening survey as a means of recruiting volunteers (Department of Employment, Economic Development and Innovation 2009).

Current objectives of the RFISH program are to collect statewide representative data on catch, fishing effort and expenditure; and to engage stakeholders (recreational fishers). The key driver for the diary is the ongoing need for data on recreational catch and fishing effort for stock assessment and fisheries management.

The Keen Angler Program targets species where biological sampling of the recreational catch is difficult or expensive and was instigated by DEEDI fisheries assessment teams in 2000. The Keen Angler Program complements biological data collection under the Long-Term Monitoring Program (LTMP) that provides data for stock assessments of key commercial and recreational fish species in Queensland. DEEDI found it difficult to get sufficient samples of some species, such as spotted and Spanish mackerels, and sought assistance from anglers to collect fish frames and submit critical data describing associated fishing trips. In recent years other species, such as bream, whiting and flathead, have been added to the Keen Angler Program target list (Department of Primary Industries and Fisheries 2008b).

Conceptual model and design

The programs rely on the support of anglers who volunteer in response to targeted publicity and requests for contribution. For the current fishing diary program, this contrasts with use of general population sampling to recruit diarists from the fishing population (as used in the previous RFISH surveys).

Both programs rely on a pool of volunteers to provide data or biological samples that are representative of the angler population and the target species catch.

Stakeholder and community consultation

The fishing diary was developed from the RFISH diary survey used between 1996 and 2005 but focuses on keen anglers who are most likely to participate in data collection.

Consultation for the Keen Angler Program occurs through the LTMP steering committee and public consultation is covered by the LTMP communications strategy (Department of Primary Industries and Fisheries 2008b).

Institutional form/governance

Both programs are run by DEEDI but from different sections of the organisation. The Recreational Fishing Unit has a staff of four—a data manager and three scientists. The LTMP team includes a number of biologists and technicians.

Both are publicised under the banner of volunteer monitoring programs and the DEEDI website provides links for anglers to contact each section and volunteer.

Strategies for engaging volunteers

Volunteers for the fishing diary program were recruited through publicity material distributed in a number of ways. Most were contacted through pamphlets mailed with recreational vessel registration renewal letters. Incentives for participation include regular prize draws, and newsletters provide feedback to anglers. If diary forms are not received for three months, a reminder is posted to the volunteer to encourage submission of their diary records (Department of Employment, Economic Development and Innovation 2009).

Keen Angler Program volunteers are recruited from anglers encountered in boat ramp surveys and other field work, as well as through fishing clubs. Volunteers are rewarded with small prizes, such as floating key rings.

Data collection strategies

A 'diary kit' including paper diary sheets, fish identification guide and instructions are posted to volunteers who contact DEEDI (Department of Employment, Economic Development and Innovation 2009). The diary program uses paper forms or electronic forms for reporting on fishing trips, depending on the angler's preference, and an online version of the trip report can now be accessed through the DEEDI website.

Diarists complete an initial questionnaire that collects information on their age and gender, and their usual fishing habits, such as frequency and main area of activity, seasons fished, boat usage, and main target species. They are encouraged to report details of all subsequent fishing trips on separate trip forms, including trips where no fish were caught.

The Keen Angler Program relies on receiving fish frames from anglers along with a completed label that identifies the angler by a code and records important attributes of the fishing trip on which the fish were caught. DEEDI gives anglers free fish frame kits and picks up fish frames from their homes.

Regular newsletters, providing summary statistics from the database, feedback on quality of data received and general information on fishing regulations and other DEEDI fisheries research projects, are sent to participants.

Data management and custodianship

Data from both programs are entered and stored in a central database at DEEDI using SQLServer software. One person in each program is responsible for maintaining the data and managing access.

Detailed data from the diary program are not currently available to users outside DEEDI, although summary statistics are reported to the public through the *Monitoring our Fisheries* newsletter, and analysis of diary data for 2008 has been published (Department of Employment, Economic Development and Innovation 2009).

Funding arrangements

The DEEDI appropriation is sourced partly from levies on recreational vessel registrations, and funds both programs.

Quality assurance components

Diary forms are checked for anomalies such as unexpected species and the data entry software also identifies data outliers. Anglers are contacted if more details are needed to verify data.

In the Keen Angler Program, labelling of samples throughout the data collection process is essential. The sample labels are checked for consistency with the specimens when they are processed. Volunteers are encouraged to include their contact details on the labels so anomalies can be verified.

Outcomes and impact

Both programs increase the involvement of keen anglers in fisheries assessment and management but the overall numbers are low compared to the angler population (for example, 1000 diary participants compared with an estimated 790 000 Queensland anglers over the age of five from the National Recreational and Indigenous Fishing Survey 2000–01). The fishing diary program allows for ongoing monitoring of recreational catch rates and fisher behaviour at a reduced cost compared to past RFISH surveys, but its contribution to fisheries management has not been as significant as the population-wide sampling that previous surveys provided.

The Keen Angler Program has also had an impact by collecting data from remote regions and increasing the number of samples that can be obtained and processed by available LTMP staff.

Game Fish Tagging Program, Industry and Investment NSW

Background, objectives and drivers

The Game Fish Tagging Program (GFTP) was initiated in December 1973 as a cooperative project between the Game Fishing Association of Australia (GFAA) and NSW Fisheries (the NSW fisheries management agency at that time). At the time, interest in contributing to scientific knowledge of gamefish was increasing and GFAA members proposed an Australian-based gamefish tagging program. The number of fish tagged increased steadily until 1990–91 when numbers peaked at about 18 000 fish. Numbers have fluctuated since then, but have usually exceeded 10 000 fish per annum (NSW DPI 2005). The program has achieved recognition as the largest saltwater tagging program in the world. Since program inception, 300 000 tag cards have been returned and 6000 recaptures recorded. Industry and Investment NSW (I&I NSW) now manages the GFTP.

Program objectives are to:

- collect data on the biology of gamefish, particularly movement and growth and factors influencing abundance of billfish, tuna, shark and other large pelagic species
- promote responsible fishing practices
- involve fishers in managing gamefish resources.

The main driver early in the program was to involve fishers in the scientific study of tuna and billfish. In the 1990s the culture of catch-and-release fishing, particularly in club competitions and tournaments, became a major driver for participation.

Conceptual model and design

The GFTP is based around gamefishers—the main participants, in terms of tagging activity—and also relies on reporting of tagged fish recaptures by gamefishers and other recreational and commercial fishers. The gamefishers are mostly affiliated with clubs, and tags are generally distributed through club contacts. I&I NSW has the primary role in managing acquisition of tags, maintaining the database of tag releases and recaptures, reporting of individual tag-recapture records to gamefishers and publishing results of the program.

Tags from I&I NSW are distributed to club contacts who then provide them to participating gamefishers. Similarly, for charter operators a single contact coordinates distribution among the fleet.

Stakeholder and community consultation

The program was initiated by gamefishers and with the agreement of the New South Wales Government commenced as a collaborative program. There is regular communication between the project team at I&I NSW and gamefishing associations about results and

operational issues. The recreational fishing community is informed of unique fish recaptures through newsletters, articles in angling magazines and summaries of program results published on the I&I NSW website.

Institutional form/governance

The program is run on a collaborative basis with I&I NSW undertaking the management and reporting functions. A part-time manager oversees the program, including promotion through articles in print media and websites. A full-time project officer maintains the tag stock and distribution, data entry and data management. Contacts in the GFAA and state gamefishing associations and charter contact manage distribution of tags among volunteers and monitor tag usage and reporting within their group.

Strategies for engaging volunteers

Volunteers are recruited through gamefishing associations but there is some promotion of the program to the general angling population through articles in fishing media and on websites. When a tagged fish is recaptured, both the person who first tagged the fish and the person recapturing it are sent details of the fish's movement and growth (NSW DPI 2005).

Data collection strategies

All data collected relate to the tagging event for an individual fish. Data collection depends on gamefishers reporting tagged fish details on a report card that is submitted to the GFTP manager through club tagging officers or directly by post. Reporting has also been possible in recent years through an online form on the I&I NSW website. Gamefishing associations and clubs encourage tagging through allocation of competition points to gamefishers for each fish tagged. Anglers who capture tagged fish provide similar details along with the number on any additional tag applied (NSW DPI 2005).

Data entry is undertaken by the I&I NSW project officer using a data entry interface that is integrated within the tagging database. Some records are loaded directly from online forms saved to the I&I NSW website.

Data management and custodianship

Data are stored in a Microsoft Access database, located on the I&I NSW file server and maintained by the project manager.

The GFTP database can be accessed by a limited number of I&I NSW staff. Requests for data are handled by the project team and although raw tag and recapture data may be provided, no details of people supplying the data are provided. A data licence agreement must be signed by people requesting tagging and recapture records.

Funding arrangements

The management component of the program is currently funded from the New South Wales Recreational Fishing Trusts and in the past was funded from government appropriation. A considerable amount of time is volunteered by the club/charter contacts who then coordinate tag distribution and report card submission.

Quality assurance components

The tag and recapture reports are checked by the project team to identify any erroneous values. In some cases the data are checked with the individual fisher or club contact for verification.

The project team does not provide structured training, but basic tagging instructions are provided on the NSW I&I website and club contacts provide assistance to volunteers.

Outcomes and impact

The program has maintained communication between government and gamefishers, particularly in New South Wales. The program has promoted the catch-and-release philosophy and increased the rate of uptake of catch-and-release among gamefishers.

Data collected by the program has been used in many research projects, theses and journal papers. The database is the only source of information on activities of gamefishers over a wide geographic range in Australian waters and has been used in decision-making within fisheries management and fisheries policy.

ABARES has used GFTP data for descriptive statistics of gamefishing activities (for example, national reports to the international Commission for the Conservation of Southern Bluefin Tuna). GFTP data have also been used for more detailed analysis, such as exploring interactions between commercial and recreational fisheries for striped marlin (Knight et al. 2006), and reviewing striped marlin biology and fisheries (Bromhead et al. 2004).

5 Discussion

Drivers and objectives

One of the main drivers for establishing recreational fisheries community monitoring programs was to provide long-term scientific data where data were not available from existing sources. For some programs, another important driver was the contested nature of scientific evidence. The CapReef and Shark Count programs are examples of responses to situations where knowledge about the status of fisheries was contested. In both cases, a gap existed between what recreational fishers 'knew' about the resource and the information available to fisheries managers. In these two cases the community organisations sought alternative means to involve the wider recreational fishing community in knowledge generation and resource management.

The stated objectives of programs ranged from an emphasis on biological data collection through to community education and advocacy. Often several objectives were apparent. Programs that most explicitly aimed to achieve community awareness or advocacy were those managed by non-government groups (for example, CapReef and Shark Count).

Roles and motivation of participants

Participants' roles in the programs related to program design and extent of community involvement, that is, whether it was government-run or community-run (table 3). The community-based programs (CapReef, Shark Count and Suntag) offered a diverse range of roles for the community—from asking research questions and designing data collection to interpreting and communicating results. The involvement of members in monitoring design and interpreting data was aided by partnerships with scientists.

Different groups had different motivations for being involved in community monitoring. Scientists wanted accurate data to answer specific questions. Fishers were motivated by the prospect of contributing to research, finding out what happens to their (tagged) fish, social interaction or having a say in resource marine planning processes that affect them. The volunteer monitors emphasised attachment, connection and care.

Community-based programs often rely on individuals or 'community champions' who bear a significant responsibility in administering, promoting and establishing the monitoring program.

Importance of partnerships

Most programs had strong partnerships between recreational fishing groups and government and/or researchers. These partnerships were an important feature of both government and community-based programs. The presence of strong partnerships suggests the government can assume alternative roles apart from centralised management (Hildebrand 1997). This is an important consideration since management of fisheries resources and marine environments must be effected through changing behaviour of individuals. Engaging communities in management can be an effective way to influence individual fishers.

3 Roles of volunteers in community monitoring programs

Program	coordinator	role of community volunteers					
		define problem	design study	collect data	interpret data	communicate results	take action
CapReef	Infofish Services	✓	✓	✓	✓	✓	✓
Great Australian Shark Count	AUF	✓	✓	✓	✓	✓	
Research Angler Program	Department of Fisheries WA			✓			
Suntag	Infofish Services	✓	✓	✓	✓	✓	✓
Diary/logbook program and Keen Angler Program	DEEDI			✓			
Game Fish Tagging Program	I&I NSW			✓			

Notes: AUF = Australian Underwater Federation; DEEDI = Department of Employment, Economic Development and Innovation (Queensland); I&I NSW = Industry and Investment New South Wales; WA = Western Australia

Quality assurance and credibility of community monitoring

All program organisers regarded validation and accuracy of data as an important issue. Quality control and quality assurance procedures were generally used to ensure validity and accuracy. Processes commonly included data entry checks (visual and range checks), confirming data by contacting volunteers, documenting protocols for data collection and data entry. However, formal protocols for maintaining data quality, including manuals and training guides, were only developed for Suntag.

Training of volunteers did not appear to be actively practised. Program organisers did what they could to promote skills, within the constraints of limited funding. In most cases volunteers' existing skills were relied upon.

In some programs, partnerships with scientific institutions may have improved quality assurance. However, it appeared that a balance was still needed between the skills and aptitudes of volunteers and the need for robust scientific data. This is because fishers tend to be involved for different reasons to scientists and may have less appreciation for the need to maintain formal protocols.

It may be harder to gain scientific acceptance of data if community monitors are involved in data collection; depending on the use or purpose of the data. Scepticism from some in the wider research community and fisheries managers was apparent in relation to the quality of volunteer data. The main concerns of data users were with potential bias and consistency of data collection methods.

The length of time the programs had existed had some bearing on the degree of credibility and recognition. Time is required to develop the 'soft infrastructure' needed to deliver outcomes, including bringing stakeholders on board, getting volunteers involved, and developing management structures. The programs profiled were at different stages of development (table 4), some in their infancy (Great Australian Shark Count and CapReef) and others existing for 20 years (Suntag and Game Fish Tagging Program). The longer-lived programs have a considerable track record and were more widely recognised by industry and government.

Recruiting and retaining volunteers

An advantage for recreational fisheries community monitoring programs is the strong personal enthusiasm that comes from a shared passion for and enjoyment of fishing. Many programs recognised this and aligned monitoring tasks with volunteers' interests. Despite this, the need to recruit and retain volunteers was common to all programs. Key strategies used to keep volunteers engaged were social activities (tournaments and events), rewards and incentives, and regular feedback.

Recruitment seemed to be easier in programs that had strong links into fishing clubs and communities (CapReef, Suntag and Game Fish Tagging Program). Government program organisers expended significant effort to engage the angling community and maintain volunteer involvement. Government programs tended to operate in the 'community workers' model, with its focus on using volunteers' capacity for data collection (table 4).

All programs had to balance recruitment with running costs. This can be seen in the need for some programs to 'filter people out' to reduce the expense of retaining volunteers who are not 'committed to the cause'. This conserved resources by avoiding the costs of a high turnover of volunteers and maintained data reliability.

The profiles in chapter 4 illustrate the varied experience and knowledge of volunteers and the importance of matching skills with monitoring tasks. Organisers of community monitoring programs need to manage this issue, not only to maximise data quality and program credibility but also to maintain volunteers' effectiveness and enthusiasm.

Community monitoring programs used information systems, particularly websites, to facilitate volunteer interaction and communicate with constituencies. These systems functioned as a networking tool—with news, blogs and events posted.

Data access

Public access to data and information was an important goal in the community-based programs. Public domain information access and knowledge sharing were seen as integral to the programs. However, in some cases data ownership was not fully clarified and may be complicated if datasets in the public domain required protection of volunteers' personal data. Ownership of data and privacy of information may be an issue for government departments running community monitoring programs. None of the case study databases were available online; they required a written request to the program manager.

Funding

Continuity of funding was critical to the long-term success of all programs examined. Funding was sourced directly from the recreational fishing sector in only three cases: CapReef and Suntag in Queensland, and the Game Fish Tagging Program (GFTP) in New South Wales. CapReef and Suntag received grants raised from the Private Pleasure Vessels Levy and the GFTP received money from the New South Wales Recreational Fishing Trusts, which is directly funded from recreational fishing licence fees. Significant in-kind contributions were also made to these programs, from partnerships with research institutions and industry.

Considerable time and effort was devoted to seeking funding for community monitoring programs. The burden of securing funding was taken on in some cases by 'community champions' who provided continuity for programs between grants.

The states that receive direct funding from levies or licence fees (Queensland, New South Wales) appear to have more community monitoring activity, possibly because there is more certainty in funding.

Contribution of community monitoring programs

Informants identified a wide range of contributions of the six community monitoring programs. Contributions spanned social, environmental and economic outcomes. Key contributions were:

- scientific (including peer reviewed) publications
- 'grey' literature/community science publications
- public access to datasets
- evidence to underpin management decisions
- increased trust between recreational fisher groups and agencies

- community awareness, ownership and local responses to problems
- credible and accepted knowledge base
- constructive advocacy of fisher point of view
- adoption of responsible fishing practices and stewardship of fish stocks.

It was sometimes difficult to identify program contributions. Some articulated outcomes well, but generally it was less clear how they contributed to management or policy outcomes. Perspectives on the relative importance of contributions varied among different groups; for example, 'public good' benefits to the community were more commonly identified by those involved in community-based data collection programs.

All programs produced datasets that participants considered valuable to research or fisheries assessments. While measuring the value of these inputs can be difficult, it is important to note that the two tagging programs continue to receive funding from government fisher licence fees and levies; it is clear they are valued for their data collection, not just their engagement of fishers.

The two programs with a focus on volunteer angler diaries (Western Australia and Queensland) were less clear in terms of value—both states still rely on use of traditional sampling frames, such as phone–diary surveys of the population and on-site interviews, for collection of catch-and-effort data. The volunteer diaries have value in informing researchers and managers of trends and patterns in fisher activity, particularly where no alternative data were available. Their links with biological data collection such as size sampling and fish frame collection may also be important. The use of volunteer diaries requires further examination to resolve questions about representativeness and how to incorporate the data into catch estimates.

The Great Australian Shark Count (GASC) and CapReef (both community-based programs) had similar objectives but in practice were quite different in terms of implementation and outcomes. The GASC used a single data collection strategy (that is, diver counts of sharks) over a broad geographic region while CapReef focused on a specific region of central Queensland and used a variety of data collection methods. The GASC has had limited impact in terms of shark management, although it may have been effective in raising awareness of shark conservation. CapReef has produced a significant store of data on angler activity in the Capricorn region and analysis of the data has been made accessible to all users through an effective communications strategy. Most CapReef data have been collected since the Great Barrier Reef zoning plan was implemented and its value may become more important in future marine park management consultation. The main factor affecting CapReef's impact is its limited geographic scope.

Community monitoring can provide benefits to the community and natural resource management, such as engaging fishers and encouraging stewardship of fisheries resources and marine environments, which need to be considered when making decisions about investing in community monitoring programs.

Considerations for Commonwealth fisheries

To date, use of community monitoring in Commonwealth-managed fisheries has been limited. The Game Fish Tagging Program and the NSW Gamefish Tournament Monitoring Program (Park 2007) are the only two programs with significant involvement, in those cases targeting tuna and billfish. However, all programs chosen as case studies in this report have collected information on some fish species where the Commonwealth has a role in resource management.

The main issues for Commonwealth fisheries managers, scientists and policy staff are determination of fishery status and management of the fishery so use of those fish resources and associated ecosystems are sustainable. In some circumstances, the fishery will need management of both commercial and recreational use and usually the most valuable information is the total harvest of fish and the value of that harvest to each sector.

The geographic scale of Commonwealth fisheries presents a problem for collection of recreational fisheries data. For example, the Eastern Tuna and Billfish Fishery, extending from Cape York to the Victorian – South Australian border, is a commercial fishery, but the same species (large tuna and billfish species) that commercial fishers target in this area are also important to gamefishers. Traditional survey techniques would require sampling of the whole population of recreational fishers who target gamefish in eastern Australia. This approach is expensive and would be difficult to implement because there is no current sampling frame other than through telephone interviews or mail surveys (off-site methods). Available data indicate that a small proportion of the angling population target gamefish species due to the relative high investment needed to fish offshore waters. This means many people must be contacted to identify sufficient numbers of gamefishers for a valid sample. Similarly, boat-ramp surveys (on-site methods) need considerable human resources to capture a sufficient sample.

Some of the programs discussed in this report collect data from a wide geographic range (Suntag and the Game Fish Tagging Program), but their objectives are limited compared to those that focus on smaller geographic areas such as the CapReef program. For data capture at the scale the Commonwealth needs, the cost appears prohibitive, but would still be worthy of investigation for a particular region to confirm the feasibility and cost. For example, the southern New South Wales coast gamefishery could be examined using a mix of community monitoring and traditional on-site methods, incorporating volunteer diaries and sampling of boat ramps and harbours to construct a sampling frame based on an area–time model of fishing effort (Pollock et al. 1994). In the absence of an alternative sectoral sampling frame, such as gamefisher licensing or registration, this approach may be the most economical means of monitoring fishing effort and total catch.

Future of community monitoring in fisheries

Development of stronger cooperation and partnerships between government and recreational fishers is a theme that will receive more attention and debate in the future, particularly with respect to ongoing resource sharing issues. The recreational sector is likely to support community–government partnerships for fisheries management and even community-based monitoring for data collection and management.

Since the first National Recreational Fishing Policy in 1994, recreational fishers have advocated a more active role in data collection, data custodianship, research and analysis.

These views promote community monitoring as a desirable data collection method that can contribute to the store of knowledge about recreational fishing. The recreational fishing sector's willingness to participate in monitoring provides an opportunity to gather information that supports fishery management, provided the objectives and design of programs have broad support and carefully match the strengths of community monitoring with management needs.

4 Summary of key findings from the assessment

program	aims	key volunteer groups	geographical boundary	period	drivers	main data users	data collection strategies	key factors influencing outcomes
CapReef	Improve community knowledge, involve community in management	Anglers/local residents	Queensland central coast	2004–ongoing	GBRMIPA re-zoning (lack of data)	CapReef, researchers	Boat ramp surveys and counts, trip reports, tagging	Funding, local community support and trust, partnerships, fisher keenness
Great Australian Shark Count	Community awareness of sharks, monitor shark stocks	Spearfishers, divers, snorkellers	National	2008–ongoing	Grey nurse shark evidence (lack of data)	AUF, research	Dedicated/opportunistic shark counts	Funding, staff resources, fisher/diver keenness
Research Angler Program	Study catch composition, fishing effort monitoring, involve anglers in research	Anglers	Western Australia	2004–ongoing	Lack of recreational catch and effort data in estuaries (data gaps)	Researchers and resource managers	Angler logbooks	Departmental support, ongoing funding, fisher keenness
Suntag	Monitoring fish movement and growth, contribute to research	Anglers	Queensland	1986–ongoing	Push from anglers for tagging and provide biological data	Suntag, researchers, scientists	Fish tagging, tag cards, tournaments	ANSA and local club networks, research partnerships, government support, fisher keenness
Recreational Fishing Diary Program/Keen Angler Program	Catch and effort monitoring, biological sampling	Anglers	Queensland	2007–ongoing	Provide participation, catch, effort and biological data	DEEDI	Angler logbooks, collection of frames	Departmental support, fisher commitment
Game Fish Tagging Program	Monitoring fish movement and growth, promote responsible fishing, involve anglers in management	Gamefishers	National and Indo-west Pacific	1973–ongoing	Provide data on gamefish distribution, movement, abundance and exploitation	I&I NSW and external researchers	Fish tagging, tag cards, tournaments	Connection to GFAA networks, increasing popularity of tagging

Notes: ANSA = Australian National Sportfishing Association Ltd; AUF = Australian Underwater Federation; DEEDI = Department of Employment, Economic Development and Innovation (Queensland); GBRMPA = Great Barrier Reef Marine Park Authority; GFAA = Game Fishing Association of Australia; I&I NSW = Industry and Investment New South Wales.

6 Conclusions

This study provided insight into the opportunities and challenges of community monitoring practices in recreational fisheries in Australia and the contributions of the community in the recreational fisheries sector.

Key messages

Opportunities

- Community monitoring can provide some types of biological data (such as tag-release) with reliability and over the long term for use in fisheries research and stock assessments.
- Community monitoring can contribute to stock assessments as part of an overall data collection strategy (for example, size monitoring, biological sampling, catch rate trends from fisher diaries).
- Community monitoring programs offer more than an opportunity to collect scientific data—they can be a means of encouraging the fishing community to participate in research and sustainable management of fisheries.

Challenges

- Community monitoring programs face numerous challenges, such as obtaining long-term funding, recruiting and maintaining volunteers and ensuring the quality, credibility and acceptance of data for broader fisheries and conservation management use.
- Estimates of total recreational catch and fishing effort have not yet been provided through community monitoring at a scale suitable for fisheries management.
- Understanding the motivations of volunteers is critical for designing successful community monitoring programs, including engagement strategies and rewards and incentives systems.
- The skills, interests and abilities of volunteer monitors need to be matched with monitoring tasks to reduce potential for burnout or loss of commitment.
- Encouragement needs to be provided in different ways to maintain volunteer involvement over the long term, including opportunities for face-to-face interaction.
- Appropriate quality control and quality assurance procedures need to be practised to improve confidence in the data. Regular training is likely to be critical for ensuring the quality of data collected.
- Importance of partnerships with research and government institutions and existing fishing club networks.

Relevance for Commonwealth fisheries management

Community monitoring programs have not yet provided a proven alternative to traditional survey approaches where a reliable estimate of total catch and fishing effort is needed for a large geographic region. Regions of this scale are common to the fishery management areas applying to Commonwealth fisheries. However, a number of the programs have produced catch rate data that have informed fishery assessments in terms of catch rate, proportions of target species, spatial/temporal distribution of fish abundance, and fishing effort. While the outcomes have not revealed a definite model that should be used for monitoring recreational use of Commonwealth fish stocks, the following actions are worthwhile considering:

- Engagement of recreational peak bodies in discussion about options for partnerships between government and the recreational community in collecting fishery data.
- Investigation of recreational fishing effort monitoring methods that can be used to produce estimates of total fishing effort and a catch sampling frame in terms of time and area.
- Trial of a volunteer diary for gamefishers in eastern Australia, with direct emphasis on recruiting fishers active in a particular region where past data collection has been undertaken.
- Investigation of internet technology for efficient collection and processing of volunteer diary information.
- Development of a communication strategy for any pilot project, including all phases of consultation and monitoring design, engagement and recruitment of volunteers, and feedback to participants.

Areas for further investigation

Several issues emerged from this analysis which were not able to be fully explored, but may merit further investigation. These include:

- Recreational fishers who participate in volunteer programs may be heavily self-selected. It may be useful to further investigate ways of handling bias in community monitoring data that is caused by contributions of highly motivated volunteers.
- More research into training in community monitoring programs would help in understanding what support the programs may need.
- Volunteer-collected data may be as accurate as that collected by paid monitoring staff, if the same experience, training and support mechanisms are in place. A parallel study using paid monitoring staff and volunteers to collect data would be a useful way of testing this hypothesis in the recreational fisheries context. This could increase the confidence of program funders and data users.
- The economics of volunteer programs merits further investigation, compared with professional data collection, to better understand the costs and benefits of community monitoring programs as part of a broader evaluation of fisheries data collection methods.

A Community involvement in monitoring natural resources—background

Availability of adequate data about the environment is often limited but is critically important for understanding changes in natural resources and for management to respond. Interest is increasing in the potential for community monitoring to contribute to collecting information, community education and improving management of environment and natural resources.

A number of programs in Australia rely on volunteers' time and effort to monitor the environment or natural resources, including water quality monitoring, coral reef health checks and recreational fisheries monitoring. Some of the best known programs in Australia include Waterwatch (Waterwatch Australia 2008) and Reef Watch (Turner et al. 2006). These programs not only offer opportunities for gathering useful data which can underpin natural resource management, but they also represent an opportunity for communities to become involved in scientific enquiry in order to understand what is happening in their natural environments. Analysis of the lessons from such experiences could tell us much about the potential of community monitoring to contribute to natural resource and environmental management.

Few studies have considered community involvement in recreational fisheries monitoring in Australia. This select review focuses on what can be learned about the opportunities and challenges of community involvement in natural resource monitoring more broadly, including the ways this practice potentially contributes to a range of social and environmental outcomes. It considers the various ways communities can be involved in natural resource monitoring, ranging from participation in data collection through to management actions.

What is community-based monitoring?

Community-based monitoring is a particular approach to monitoring that emphasises community leadership in collecting data and producing shared knowledge about what is happening in the local natural environment. A range of definitions of community-based monitoring of natural resources exist. One popular definition is given by the Canadian Community Monitoring Network (CCMN):

Community-based monitoring is a process where concerned citizens, government agencies, industry, academia, community groups and local institutions collaborate to monitor, track, and respond to issues of common community concern (Fleener et al. 2004).

This perspective views community monitoring as a social process—built around cooperation, collaboration and trust—whereby a range of different participants work together to develop a shared knowledge about the natural environment. Partnerships are sometimes developed with governments, scientists, researchers and/or industry groups, often for the purposes of environmental rehabilitation, restoration, prevention or management (Carr 2004; Hildebrand 1997).

Successful partnerships between community volunteers, scientists and governments have developed to monitor fish biology and population dynamics. For example, in the United States, the US National Marine Fisheries Service uses volunteers to track fish populations and have done so since 1954 (Lee 1994). In Australia, the South Australian Reef Watch program engages recreational scuba divers in reef fish and habitat monitoring on a volunteer basis (Turner et al. 2006).

Some of the best known examples of community monitoring come from the fields of astronomy, meteorology and ornithology (Goffredo et al. 2004). For instance, more than 11 500 volunteers take daily observations for the National Weather Service in the United States (compared with only 300 non-volunteer stations) providing valuable data to underpin weather forecasts (Lee 1994). Extensive volunteer bird monitoring activities in north America, Australia and Europe are well documented examples of successful volunteer monitoring efforts that have contributed to bird population and abundance studies (Greenwood 2003; Lee 1994).

Observers have identified different kinds of community monitoring, only some of which are community-based. Carr (2004) makes a distinction between science that is done by the community (community science, community-based research, community-based monitoring) and other forms of science. According to Carr, the key elements of community science are:

- usually a cooperative effort practiced by groups of volunteers
- sometimes in partnership with agencies, museums or universities
- usually issue or concern-driven rather than policy or funding-driven
- involve interaction between established scientific knowledge systems and emerging locally-based scientific efforts.

With these distinctions in mind, the authors drew on a working definition of community monitoring for the purposes of this study: community monitoring includes any programs in which members of the community are involved in initiating, designing, planning, collecting, analysing and/or interpreting data for the purposes of natural resource management.

Why the current interest in community monitoring?

One of the most frequently cited reasons for interest in community monitoring is the potential to extend monitoring beyond what scientists can undertake within time and funding constraints (Goffredo et al. 2004). In a biodiversity study of seahorse distribution in Italy, 2536 volunteers were recruited for a three-year data collection program. The equivalent cost if scientists had carried out the monitoring was estimated at US\$1.4 million and would have taken 20 years (Goffredo et al. 2004). Savan et al. (2003) argue that significant time and public funds can be saved if volunteer effort is used. The potential advantages of community involvement in monitoring are summarised in table 5.

Who is the community?

'Community' is a term that covers heterogeneous groups of people who may share an interest or concern, practice or locality. In the context of environmental monitoring, it usually means local grassroots communities, such as community activists and community-based organisations (Savan et al. 2003). A range of different kinds of individuals and community groups have traditionally been involved in scientific data collection activities, including nature enthusiasts (such as, bird watchers), game fishers and anglers, hunters, local residents, youth groups or clubs, and school children (for example, Lee 1994; Stokes et al. 1990).

5 Potential benefits of community monitoring

goals	potential of community monitoring to contribute to goals
Social and environmental goals	Provides a potential means of collecting baseline data on the environment that can not only be of use to scientists and decision makers, but also act as an important educational tool for raising community awareness.
Expand physical effort	Volunteers significantly expand the resources available for a monitoring program while considerably reducing associated costs and filling gaps where government cuts to monitoring programs have taken place. Monitoring large geographical areas requires a large workforce and would be difficult to achieve without volunteers.
Detect local changes earlier	Community monitoring can provide decision makers with timely information on local environmental changes (which gives the best chances of cost-effective management of a problem).
Partnerships	Provides a means of developing partnerships between groups that would otherwise not have worked together (such as, researchers and residents, local environmental bodies, industry or educational institutions).
Empower the community	Provides the community with a sense of stewardship for the environment and opportunities to participate in managing their local environment.

Sources: Drawn from Delaney et al. 2008; Jacoby et al. 1997; Turner et al. 2006; Whitelaw et al. 2003.

Usually community monitors perform data collection tasks on a volunteer basis, meaning they are not paid for undertaking those tasks, although in some cases volunteers may receive limited payments or other incentives (such as, clothing, fishing accessories). In Australia, the Australian Bureau of Statistics (ABS) reports that a significant number of volunteer hours (21 per cent) are spent in supporting sport and recreational organisations across the nation (ABS 2000). This suggests that considerable potential exists for volunteer involvement in recreational fisheries monitoring.

Different models for community involvement in natural resource or environmental monitoring

Community volunteers play a range of different roles in monitoring the natural environment. The form of community involvement depends on the aims of the program, as well as the characteristics and the extent of the natural system being monitored, the species, or ecological changes. Participation also depends on the local community culture, volunteer interests, skills and abilities (Frost Nerbonne & Vondracek 2003; Newman et al. 2003). Community tasks might change depending on whether the monitoring programs are initiated and run by members of the local community or by governments.

A typology of forms of involvement, as proposed by Stadel and Nelson (1995), is presented in table 6. They characterise community-based monitoring as an activity governed, run or hosted by community groups. This is similar to Carr's (2004) community science model where there is a high degree of ownership over the process of enquiry, data gathering, results, and actions to address any problems found. The other types reflect less community participation, the simplest model being an activity where the community is only informed of program results and outcomes.

6 Ways the community can be involved in environmental monitoring

type of community activity	characteristics of involvement
Community-based	Citizens govern program
Partnerships	Community is part of network
Planning	Involvement in defining purpose and approach
Data management	Data are managed by the community
Data collection	Citizens collect data for government
Information	Citizens are informed about monitoring

Source: Stadel & Nelson 1995

Programs have been known to shift between different models. This has meant moving from government-initiated to community-run—or the reverse. An example of this transition given by Wilderman et al. (2007) is the Alliance for Aquatic Resource Monitoring (ALLARM) program that began in 2002–03 as a government-initiated community monitoring program in Pennsylvania but later became a wholly community-based endeavour.

The functions that members of the community perform can also be used to understand the operational model being used for community monitoring. Wilderman and Ely (2008) and Wilderman et al. (2004) propose a typology of community monitoring that identifies the functions communities undertake compared with functions professionals undertake (table 7). The term professional is used here to identify paid qualified researchers working on a project or program, rather than community volunteers.

Highly participatory (bottom-up) approaches are programs where the local community is central to the process and may define the issue or problem to be researched. In addition, the community designs the study as well as the data collection and interpretation and communication of results. This is described as ‘science by the people’.

7 Wilderman's typology of operational models of community research: Top-down to bottom-up approaches

function: who does the tasks?	community workers model	consulting model	participatory model
Who defines the problem?	Professionals/scientists	Community	Community
Who designs the study?	Professionals/scientists	Professionals/scientists	Community
Who collects the data?	Community	Professionals/scientists	Community
Who interprets the data?	Professionals/scientists	Professionals/scientists	Community
Who communicates the results?	Professionals/scientists	Professionals/scientists	Community
Who takes the action?	Professionals/scientists	Professionals/scientists	Community

Sources: Wilderman et al. 2004; Wilderman & Ely 2008

The model that evolves or is intended will depend on the purpose of the monitoring and the management objectives. Carr (2004) notes the tension between ‘pull’ for local data, detailed knowledge and recognition of local concerns and perspectives and the ‘push’ for meaningful comparisons at regional, state, national and international levels that might be of interest to natural resource managers, decision makers and/or governments.

Although useful, the typologies offered here for understanding community involvement in monitoring are somewhat simplistic and tend to assume a clear distinction between decision makers and the community. In reality, it is more likely that those involved will play multiple and changing roles in the monitoring effort. Recognising the potential for transformation is part of the strength of community monitoring programs. Indeed, several studies point out how community monitoring can blur the boundaries—with citizens becoming experts or experts taking a citizen’s perspective—and developing a capacity to understand the relevance of their science for the communities with whom they work (Carr 2004; Irwin 1995).

What are the issues and challenges for community monitoring?

A number of challenges have arisen for community monitoring, primarily:

- ensuring data quality
- managing large datasets
- making volunteer-collected data credible.

Recruiting and retaining volunteers

People are motivated to become involved in community monitoring for a variety of reasons. Measham and Barnett (2007) grouped motivations for environmental monitoring into the following broad categories:

- helping a cause, assisting others or giving something back to the community
- social contact—meeting new people and making friends
- personal development—learning new skills, gaining experience and self-esteem
- pursuing a personal interest, such as understanding an issue, discovering new ideas
- care for the environment or a particular place.

Measham and Barnett (2007) identify the importance of designing tasks that are manageable for volunteers, but also the need to understand volunteers' motivations in order to work out strategies to sustain volunteer commitment over the long-term.

Penner (2004) distinguishes between the motivations initially needed to become involved in volunteering ('pro-social behaviour') and the motivations needed to keep a person involved over time. Issues identified that affect the long-term commitment to volunteering include the characteristics of the organisation in which volunteering takes place, the exchanges between individual volunteers and the organisation, and changes in these relationships over time.

Some studies have attempted to identify the characteristics of environmental volunteers. Delaney et al. (2008) mention the endurance of volunteers as an issue for difficult or tedious data collection tasks. Newman found that the physical fitness of volunteers was a significant predictor of the reliability of volunteer-collected data (Newman et al. 2003). However, the propensity to volunteer is most correlated to education and levels of income (Penner 2004): increased education or income increases the likelihood of a person volunteering. The relationship between demographic characteristics and volunteering is usually indirect and may be mediated for an individual by other factors, such as the amount of free time they have.

Regular feedback about the findings from monitoring is often mentioned as a key means of maintaining interest in volunteering (Stem et al. 2005; Vos et al. 2000). Sometimes reward systems are used to keep volunteers interested, such as recognition for contributions, reward point systems (for example, in fishing tournaments), or gifts of program-branded items (for example, Department of Fisheries WA 2009b).

Some studies suggest it may be easier to maintain involvement of a small core or central network of volunteers if they have a passion and interest in the program findings. It can also include local people who live nearby or use the resource being monitored. However, the converse is also apparent with potential for volunteer burnout associated with higher levels of involvement in Landcare program activities (Byron et al. 2001).

Perhaps the most challenging issue is the ability to engage people in volunteer monitoring efforts and sustain that motivation over time. While the motivations of volunteer monitors have been a significant area of research interest, there are still gaps in understanding what motivates volunteers.

Understanding the motivations, needs and characteristics of volunteers can aid in design of monitoring programs and training that makes best use of volunteers (for example, tailoring recruitment messages, ensuring effective placement of volunteers, and fulfilling needs to sustain volunteer engagement over the long term; Esmond & Dunlop 2004). While this study does not attempt to specify why volunteers participate in monitoring, it considers the extent to which motivations may arise as an issue in recreational fisheries monitoring programs.

Ensuring data quality

The data generated from community monitoring have often been criticised for lack of reliability and consistency (Greenwood 1994), particularly among scientific groups. Lee (1994) and Delaney et al. (2008) agree that a common challenge has been addressing scientists' lack of confidence in the quality of data.

Data quality can be maintained in community monitoring in several ways, the most important being provision of adequate equipment and training.

How reliable are data collected by volunteers? Several studies have audited or parallel tested volunteer data by using scientists to check the accuracy of volunteer-collected data (Boudreau & Yan 2004; Frost Nerbonne & Vondracek 2003; Newman et al. 2003; Streamwatch 2008). Newman et al. (2003) compared the validity of mammal data collected by 155 volunteers with that collected by scientists and found that trained volunteers could generate reliable data. The field tasks involved trapping and handling small mammals, surveying and counting badgers, estimating deer populations from droppings, and transect surveys for mammal field signs. Another study of the accuracy of macroinvertebrate identification by volunteers reported in Fore et al. (2001) found that volunteers can collect reliable data and make stream assessments that are comparable to those made by professionals.

Similarly, in Australia the Streamwatch program reports annually on the accuracy and reliability of community water quality data. In 2006, the program found that on average 87 per cent of volunteer data was within the acceptable range (Streamwatch 2008). These studies indicate that while volunteer collected data can be reliable compared with that collected by experienced scientists in the field, this depends on whether there is sufficient training and knowledge of quality assurance/quality control procedures.

The accuracy of volunteer observations will also partly depend on balancing the types of observations needed with the skills and commitment of volunteers (Stokes et al. 1990). The tasks may be time-consuming, require patience, and involve complex monitoring or simple observations. To help find this balance between tasks and skill levels, techniques for taking in-field observations are sometimes simplified. For example, the Reef Watch program uses dive training techniques that are adapted for volunteers from scientific and professionally accredited courses (SODS 2009). However, these simplifications can mean that credibility of data may be harder to establish.

Managing large datasets

As with any scientific monitoring activity, technical and data management issues can challenge community monitoring programs. This may be the case in the context of collaborative programs where a number of groups are involved and where data sharing is important.

Use of standard databases and visual checks are essential for ensuring volunteer data are credible and of value to potential data users (EPA 1997). Many community monitoring programs are now using sophisticated web-based systems for volunteer data entry and information retrieval. These systems reduce the time taken for data entry and also increase accessibility of the data for analysis and reporting. Delaney et al. (2008) highlight the need to have ready access to data and discuss the potential for using technologies, such as the internet, geographical information systems and online mapping tools (for example, Google Earth), for data entry and sharing. These systems can enable public accessibility, standardise data, and facilitate basic quality checks and rapid responses to data user requests.

Making volunteer-collected data credible

Most studies emphasise the need for adequately resourced, tailored and hands-on training of volunteers to obtain high quality data. However, addressing issues of data validity and reliability also requires external recognition and awareness that data are credible. The perception of rigour in community monitoring can be established by documenting and promoting quality assurance procedures and data management plans, developing partnerships with other organisations to address data completeness issues, and obtaining a better understanding of end users' needs (Truong 2007).

Turner et al. (2006) suggest that having scientific and management agency representatives on the steering committees of volunteer monitoring programs can facilitate feedback from governments, and vice versa.

Best practice strategies to underpin community-based data collection

Some best practice strategies necessary to underpin and strengthen community monitoring efforts include:

- secure adequate funding and commitment before initiating community monitoring
- provide regular feedback to volunteers on how their work is contributing to planning and management
- understand participant motivations and skill levels and match these to the monitoring protocols selected
- use simple and scientifically tested methodologies
- incorporate training on monitoring protocols, field supervision and verification of monitoring data into the design

- document and promote quality assurance procedures and data management plans
- establish a volunteer recognition program
- focus on outcomes that serve society and deliver policy relevant information.

These strategies (drawn from Truong 2007; Whitelaw et al. 2003) are relevant to all monitoring programs, not just those involving community volunteers. But perhaps they are more pertinent for community programs because of the issues about data credibility and acceptance.

B Study fact sheet

Study fact sheet sent to key informants participating in this study



Community involvement in recreational fisheries monitoring activities

Introduction

Recreational fisheries information, especially catch and fishing effort data, is needed to support effective natural resource management. Community involvement in data collection activities provides a cost-effective way of extending traditional data collection while raising community awareness and participation in fisheries and local environmental management.

The Fisheries and Marine Sciences Program of the Bureau of Rural Sciences is conducting an assessment of community involvement in recreational fisheries monitoring activities. The study is looking at the potential for community participation in monitoring fish stocks managed by the Australian Government. The study is funded by the Sustainable Resource Management Division of the Department of Agriculture, Fisheries and Forestry.

The key questions are:

- * How do volunteers, industry groups, researchers and agencies participate in recreational fisheries monitoring initiatives?
- * What social, economic, biological or environmental data are collected, how are these stored and used?
- * What are the characteristics of existing recreational fisheries monitoring projects?
- * What are the constraints or enablers to establishing and maintaining projects for recreational fisheries monitoring?

Methods

There are two main research methods used in this project:

- * a literature review and analysis of community involvement in monitoring recreational fisheries
- * interviews with managers of fisheries monitoring projects who have engaged the community, volunteers who undertake data collection and data users.

The combination of these methods will provide an assessment of the constraints and enablers to involving community volunteers and the utility of volunteer data.

Expected outcomes

This research will contribute to:

- * recreational fishing management for sustainable fisheries into the future
- * improved understanding of barriers and impediments to the participation of volunteers in recreational fisheries monitoring and how they might be overcome or lessened
- * an assessment of community involvement in monitoring to provide recreational fisheries data for resource managers.

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appendix **C** Questionnaires

Researchers used three questionnaires to guide interviews with key informants; that is, program managers, data users and recreational fishers/members of the community, directly involved in the six programs reviewed.

Community involvement in recreational fisheries monitoring

(Program managers)

Interview questions and directions for researchers

Interviewee:

Interviewer:

Date/time: Length of interview:

Type of recording: Recorder switched on? y/n

Make the interviewee aware that the session is being recorded and ask for their consent verbally (record them giving the consent)

Remind the interviewee that:

- the information they provide will only be used for research purposes*
- they won't be named in any publications arising from the research*
- they can speak 'off the record' at any time*
- can end the interview at any time during the session*
- Check on their time allocation so that the questions can be prioritised if they need to leave*

During the interview today, we'll be asking you about the [Name of community monitoring program]. The interview should take about 40 minutes, but you're welcome to talk about this for longer if you like.

.....

BACKGROUND

— Just to begin with could you tell me a little about the background of the community monitoring program? How did it get started? *[Briefly]* And what led to you getting involved in it?

— Can you describe the main goals of the program?

PERSONAL INVOLVEMENT AND VALUES

— What is your role in the community monitoring program? *[Personal or professional role; what they actually do]*

— What is it that matters to you most about the whole initiative? *[Valued aspects]*

IMPLEMENTATION AND PARTICIPANTS

— Who are the key people in the community monitoring program and what do they do?

— What role(s) do community monitors have?

Probes: Do they define the purpose of the project, plan & organise, collect data, manage data, analyse or report the results, etc?

— How are they recruited? How do you find them?

— What data are collected?

— What if any quality assurance or validation is used to check the accuracy of data collected by volunteers?

— Were there any issues or challenges that came up in maintaining volunteer involvement?

DATA PROTOCOLS

— Where are the data stored? Which organisation hosts the data?

— How are the data managed?

— How are the data used and by whom?

ISSUES AND CHALLENGES

— Were there any major issues or challenges for you in making the program happen?

Probes: What are the best aspects? What are the worst aspects?

— Did your priorities or goals change at any time? If so, what was it that led to the change?

— What would you advise anyone trying to develop a similar approach for initiating recreational fisheries monitoring that involves the community?

Probes: What would you have liked to change about the program?

INFLUENCE ON POLICY OR DECISION-MAKING

— What do you think are the benefits of such a program?

— What changes have you seen as a result of the program?

Probes: Can you think of any examples of how it influenced policy/decision-making, research or the community?

— Where do you see the program going in the future?

FURTHER INFORMATION/CONTACTS

— Are there any other people who we could talk to about the program?

— Do you have any other information you think would be useful for our study?

— Would you mind if I emailed or called you if we had any other queries? Y/N

Would like a summary of the interview – Y/N

Community involvement in recreational fisheries monitoring

(Agencies/data users)

Interview questions and directions for researchers

Interviewee:

Interviewer:

Date/time: Length of interview:

Type of recording: Recorder switched on? y/n

Make the interviewee aware that the session is being recorded and ask for their consent verbally (record them giving the consent)

Remind the interviewee that:

- *the information they provide will only be used for research purposes*
- *they won't be named in any publications arising from the research*
- *they can speak 'off the record' at any time*
- *can end the interview at any time during the session*

Check on their time allocation so that the questions can be prioritised if they need to leave

During the interview today, we'll be asking you about the *[Name of community monitoring program]*. The interview should take about 40 minutes, but you're welcome to talk about this for longer if you like.

BACKGROUND

Just to begin with could you tell me a little about the background of the community monitoring program? How did it get started? And what led to you getting involved in it?

Can you describe the main goals of the program?

PERSONAL INVOLVEMENT AND VALUES

What is your role in relation to the community monitoring program? *[Personal or professional role; what they actually do]*

How would you describe your relationship with the community data providers?

DATA COLLECTION AND PROTOCOLS

What community data are you using from the program, if any?

How are you using it? (if current data users)

How have you accessed the data? Has this been satisfactory for you?

Probes: for example, ease of use, who requested the data, etc.

Are you aware of any quality assurance or validation used to check the accuracy of data collected by volunteers?

If yes, does this (/If no, would this) increase the value of the data for your purposes?

INFLUENCE ON POLICY AND ISSUES

What do you think are the main benefits of the community monitoring program?

What are your views on community generated monitoring data—do you have any issues or concerns?

Probes: for example, Does it help fill in gaps in data/allow better coverage, continuity over a longer period, incorporate local knowledge, etc.?

How useful is the community data for understanding fish stocks/managing fisheries?

Can you think of any examples of how it has influenced policy/decision-making, research or the community?

What changes have you seen as a result of the program?

Where do you see the program going in the future?

What would you advise anyone trying to develop a similar approach for recreational fisheries monitoring that involves the community?

FURTHER INFORMATION/CONTACTS

Are there any other people who we could talk to about the program?

Do you have any other information you think would be useful for our study?

Would you mind if I emailed or called you if we had any other queries? Y/N

Would like a summary of the interview – Y/N

Community involvement in recreational fisheries monitoring

(Community/anglers/volunteers)

Interview questions and directions for researchers

Interviewee:

Interviewer:

Date/time: Length of interview:

Type of recording: Recorder switched on? y/n

Make the interviewee aware that the session is being recorded and ask for their consent verbally (record them giving the consent)

Remind the interviewee that:

- *the information they provide will only be used for research purposes*
- *they won't be named in any publications arising from the research*
- *they can speak 'off the record' at any time*
- *can end the interview at any time during the session*

Check on their time allocation so that the questions can be prioritised if they need to leave

During the interview today, we'll be asking you about the *[Name of community monitoring program]*. The interview should take about 40 minutes, but you're welcome to talk about this for longer if you like.

BACKGROUND

Just to begin with could you tell me a little about the background of the community monitoring program? How did it get started? *[Briefly]* And what led to you getting involved in it?

Can you describe the main goals of the program?

PERSONAL INVOLVEMENT AND VALUES

What is your role in the community monitoring program? *[Personal or professional role; what they actually do]*

What is it that matters to you most about the whole initiative? *[Valued aspects]*

IMPLEMENTATION AND PARTICIPANTS

Who are the key people in the community monitoring program and what do they do?

How are they recruited? How do you find them?

What data are collected?

What is it that keeps you committed to working on the program?

Were there any issues or challenges that came up for you in maintaining your involvement?

What do you think are the benefits of such a program?

What training, skills development or quality assurance activities have you participated in if any?

Are there any issues that you can see for keeping the program going?

INFLUENCE ON POLICY OR DECISION-MAKING

What changes have you seen as a result of the community monitoring program?

Probes: Can you think of any examples of how it influenced policy/decision-making, research or the community?

Where do you see the program going in the future?

FURTHER INFORMATION/CONTACTS

Are there any other people who we could talk to about the program?

Do you have any other information you think would be useful for our study?

Would you mind if I emailed or called you if we had any other queries? Y/N

Would like a summary of the interview – Y/N

Glossary

AAT	Administrative Appeals Tribunal
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
ALLARM	Alliance for Aquatic Resource Monitoring
ANSA	Australian National Sportfishing Association Ltd
AUF	Australian Underwater Federation
CCMN	Canadian Community Monitoring Network
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
DEEDI	Department of Employment, Economic Development and Innovation (Queensland)
FRDC	Fisheries Research and Development Corporation
GASC	Great Australian Shark Count
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GFAA	Game Fishing Association of Australia
GFTP	Game Fish Tagging Program
I&I NSW	Industry and Investment New South Wales
LTMP	Long-Term Monitoring Program
RFISH	Recreational Fishing Diary Program

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