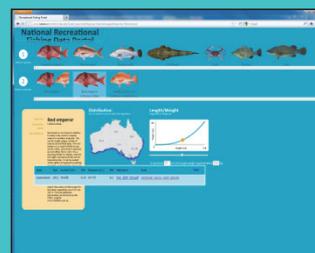
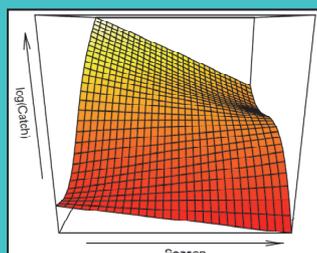


A coordinated national data collection for recreational fishing in Australia

FRDC Project 2011/036

Shane Griffiths, Phil Sahlqvist, Jeremy Lyle, William Venables, Kenneth Pollock, William Sawynok and Chris Moeseneder

28 February 2014





FRDC

FISHERIES RESEARCH &
DEVELOPMENT CORPORATION

FINAL REPORT

A coordinated national data collection for recreational fishing in Australia

**Shane Griffiths, Phil Sahlqvist, Jeremy Lyle, William Venables,
Kenneth Pollock, William Sawynok and Chris Moeseneder**

28 February 2014

FRDC Project No. 2011/036

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Researcher Contact Details

Name: Dr Shane Griffiths
Address: GPO Box 2583
Brisbane QLD 4001
Phone: 07 3833 5927
Fax: 07 3833 5501
Email: shane.griffiths@csiro.au

FRDC Contact Details

Address: 25 Geils Court
Deakin ACT 2600
Phone: 02 6285 0400
Fax: 02 6285 0499
Email: frdc@frdc.com.au
Web: www.frdc.com.au

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Non-technical Summary

2011/036 A coordinated national data collection for recreational fishing in Australia

PRINCIPAL INVESTIGATOR: Dr Shane P. Griffiths
ADDRESS: CSIRO Marine and Atmospheric Research
GPO Box 2583
Brisbane QLD 4001
Telephone: (07) 3833 5927 Fax: (07) 3833 5501

OBJECTIVES:

1. Provide an understanding of the current state of knowledge, and identify information gaps, across the recreational fishing sector at a national scale;
2. Explore approaches to filling key information gaps and begin development of system(s) and protocols that will allow data to be stored, aggregated and analysed to answer questions related to recreational fishing in a timely and responsive way;
3. Assess the feasibility of aggregating available recreational fishing datasets to provide reliable regional and national information on catch, effort, participation, and social and economic aspects in the recreational fishing sector.

OUTCOMES ACHIEVED TO DATE

- An improved understanding of the available datasets, and data deficiencies, relating to recreational fishing in Australia through the successful collaboration of researchers, fishery managers and recreational fishing groups.
- Identification and prioritisation of recreationally-important species at the national level.
- A quantitative assessment using statistical modeling demonstrated the available datasets are too fragmentary in space and time to produce reliable national estimates. A dedicated national survey or better coordination of jurisdictional surveys is required.
- Revised jurisdictional estimates of the participation, total catch and effort, and catch of key recreationally-important species provided an up-to-date picture of recreational fisheries nationally.
- Completion of a framework and web-based prototype of a national recreational fishing data portal to improve access of updated information for recreational fisheries stakeholders, which may be used in management of specific fish stocks, marine bioregional planning, resource allocation for shared stocks, identification of regionally important areas and economies, and business and infrastructure planning through identification of growth trends.

Recreational fishing is a popular sport and pastime in Australia. The first National Recreational Fishing Survey (NRFS) was undertaken in 2000/01 and showed that 19.5% of Australians, or 3.36 million people, participated in recreational fishing, undertook 23.2 million fishing trips and caught 72 million finfish. The constituent state and territory-wide surveys interlinked with a common survey methodology to comprise the national survey, which provided regional, jurisdictional and national breakdowns of social, sport and economic components of recreational fishing. Such information has been invaluable in guiding management of particular species and decision-making processes.

Since the 2000/01 NRFS, there has been no other recreational fishing survey conducted that aimed to provide national estimates. There may be various political and logistical reasons why a national survey has not been repeated. However, the primary reason appears that some jurisdictions considered that they did not gain fine-scale information from the survey that was designed to gather broad-scale estimates. As a result, the data gathered were considered to be of limited use for some decision-making processes at the jurisdictional level, though relevant at the national scale.

Since the national survey there have been a number of state and territory-based surveys to address specific management issues. However, there has been little, if any, coordination of surveys between jurisdictions. The result has been a discontinuous dataset in space and time. Considering the high cost of undertaking a coordinated national survey and the general reluctance of some jurisdictions to invest in national-level data, a priority of the National Recreational Fishing Industry Development Strategy (RFIDS) was to assess the feasibility of aggregating available datasets to provide an update to the national picture of recreational fishing, and to determine how best to make these data available to the public.

The project comprised five primary components, which required close collaboration with recreational fishing groups, jurisdictional researchers and managers. The components were: i) a national audit of datasets relating to recreational fishing in Australia, ii) determining priority species for which catch and effort estimates were of importance nationally, iii) collation of data for priority species at regional, stock and jurisdictional scales, iv) quantitative assessment of the feasibility of aggregating the available datasets through statistical modelling to produce reliable estimates at the national level, and v) development of a framework to enable the best available national estimates to be available to the public in a timely and readily accessible manner.

Fulfilling project objectives was achieved in part through two project workshops and ongoing collaboration with recreational fishing stakeholders. The national data audit identified 91 projects undertaken since 1990, of which 76 had complete descriptive metadata, while 50 project descriptions identified the key species and scale of associated catch estimates (jurisdiction annual totals or partial estimates) for specific periods or regions. A total of 33 projects indicated the collection of social data, while 18 projects indicated collection of some economic data. Although data for high priority species such as Rock Lobster and Abalone have been collected every 2-3 years, and sometimes more frequently, in some jurisdictions since 2000/01 there have only been 10 jurisdictional-wide surveys across seven jurisdictions in the same period. As a result, recreational fishing data in Australia is highly fragmented and jurisdictional data cannot simply be summed to produce national estimates.

A total of 41 species and 17 species groups was selected for the development of 'best available' national estimates. These taxa were selected by recreational fishing peak bodies, fishery scientists and managers in a national recreational fishing data workshop. A customised data request template for each jurisdiction later gathered statewide and regional data for the identified priority species where available. Jurisdictional managers also identified stock boundaries for key species in order to explore the potential for stock-level estimates to be made. Although some community monitoring programs collected data on some priority species, none produced estimates of total catch and/or effort for a defined region, and therefore could not be integrated into the database.

Statistical modelling was used to determine the feasibility of aggregating the available datasets to produce national estimates. Given the significant spatial and temporal heterogeneity of datasets there was concern among statisticians and stakeholders as to whether the datasets could be aggregated in a

statistically defensible way. Because there was a significant temporal mismatch of surveys between jurisdictions, an approach was taken to use more readily available continuous time series data that could be a proxy of effort, such as fishing licence holder numbers, to predict the catch for years where survey data were unavailable.

Three recreational fishing datasets with the longest time series (i.e. WA Rock Lobster, and Tasmanian Rock Lobster and Abalone) were used as case studies with the assumption that if statistical modelling could not produce reliable estimates of catch and effort, then modelling would not be useful for general finfish catch data for which significantly fewer data are available. Annual fishing licence numbers were used as a proxy for fishing effort in each case to predict catch for the entire time series, and then particular survey years were omitted from the time series to more closely reflect the temporally fragmented general finfish surveys.

Generalised Additive Models (GAMs) were able to make reasonable estimates of catch from licence numbers using the entire time series for the WA data, but was far less successful for the shorter Tasmanian data series. When modelled on the reduced datasets, the predictive ability of the models were significantly degraded, indicating that more than five annual surveys over a 13-year period would be required before estimates could be made in years where survey data are unavailable. Because annual licence numbers or other effort measures are not available for all jurisdictions, and maximum of three state-wide surveys have been undertaken for finfish in any jurisdiction since 2001, it was concluded that the available datasets for recreationally important finfish species could not be feasibly aggregated in a statistically defensible way to produce reliable national estimates for any given year.

In order to improve recreational fisheries data at the national level it is recommended that either another national survey be undertaken, or improved coordination occur among jurisdictions to undertake surveys close together, using comparable sampling approaches, and accounting for interstate (and international) fishers. However, if cross-jurisdictional data are required for species taken in specialised fisheries (e.g. Southern Bluefin Tuna), coordinated and targeted surveys will be required.

Despite the available jurisdictional datasets not allowing aggregation to produce reliable national statistics, the project was valuable in bringing together the latest information collected since the national survey. Access to these unpublished data has been considered problematic by a number of recreational fishery stakeholders. Therefore, an aim of the project was to develop a framework for a national recreational fishing data portal that would make recreational survey data available in one, readily accessible place. A framework and prototype for a national recreational fishing data portal was completed, which contained the best available catch estimates for key species, effort and participation by region, species stock and jurisdiction. National estimates were not provided following the recommendations of recreational fisheries stakeholders who considered summing catch or effort across surveys, that were undertaken up to 10 years apart, would be misleading and be of little use to fishers, researchers, managers or policy makers.

The data portal was also designed to be a repository for not only the latest catch, effort and participation data, but also other key information for recreational fisheries stakeholders such as key biological information on recreationally important species, direct access to grey literature, and recreational fishing regulations by jurisdiction. Further development is required beyond the current project to optimise the functionality of the portal for recreational fishery stakeholders, and to address fundamental operational issues relating to custodianship and on-going maintenance of any such database. There are a number of options to house the national recreational fishing data within other established national oceanic and environmental data portals. The portal could also exist as a standalone resource that can be maintained at low cost by a suitable custodian. It is recommended that the portal be housed and managed by a government organisation with demonstrated longevity and ongoing interaction with the recreational fishery at a national level.

Keywords

Resource allocation, recreational fishing, survey design, data aggregation, hard-to-reach population.

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Background

Recreational fishing is a popular sport and social activity in Australia. In 2000/01, the National Recreational Fishing Survey (NRFS) (Henry and Lyle, 2003) determined that 19.5% of the Australian population, or 3.36 million people, participated in recreational fishing and contributed \$1.8 billion to the economy. Although the study estimated that fishers undertook 23.2 million fishing trips and caught 72 million finfish, the primary motivation to fish was not for extractive purposes, but for relaxation and sport.

Despite the common perception by the general community that recreational fishing is a benign leisure activity, an increasing number of studies suggest that catch from recreational fishers can approach, and even exceed, the commercial catch for some species (Ferrell and Sumpton, 1998; Murray-Jones and Steffe, 2000; Leigh and O'Neill, 2003; Lyle et al., 2005; Reid and Montgomery, 2005; Zischke et al., 2012).

Increasing population size of coastal cities and the rapidly increasing sophistication and affordability of fishing and searching technologies (e.g. radar and sonar), and the development of specialised sub-fisheries for species traditionally only targeted by commercial fisheries (e.g. swordfish) highlight the potential for growing impacts on such species that are now commonly caught by recreational fishers. In a review of Australian recreational fisheries, Griffiths and Pepperell (2006) found that recreational fishers interact with over 1164 fish taxa and share at least 245 species that are of commercial importance in 20 of 21 Commonwealth fisheries. For some species, such as Striped Marlin off eastern Australia, increasing demands by recreational fishers for a greater proportion of the resource share has led to conflict with commercial fisheries (see Bromhead et al., 2004). Consequently, there is an increasing need to understand and manage recreational catches to ensure biological sustainability of fish stocks, but also to inform any discussions of resource allocation among recreational and commercial fisheries.

Unfortunately, there is a fundamental mismatch between the management jurisdictions for recreational fisheries and the target species of these fisheries. This has created a range of complex issues concerning collecting recreational fishing data. For example, some recreationally important species, such as Snapper (*Pagrus auratus*), are managed separately by state governments, despite some jurisdictions sharing a stock. Other species, however, such as tunas and billfish, are managed by the Commonwealth, but have management arrangements in place with state and territory jurisdictions for recreational fishing. In effect, all recreational fishing in Australia is managed by state and territory governments, which are obliged under various legislation and policies to report on recreational catches within their own jurisdiction. State and territory fisheries agencies have conducted various types of recreational fishing surveys over the past few decades, but they have generally been designed to address jurisdiction-specific issues.

Due to differences in sampling methodologies and spatial and temporal scales of surveys, reliable estimates of catch, effort, participation and social and economic aspects have been lacking at the national level since the NRFS, where much of the data (e.g. participation rates) is now out-dated and of limited use for decision-making. Consequently, there is a need for up-to-date national recreational fishing statistics.

Need

In many states, territories and regions around Australia there is a lack of current and reliable recreational fisheries data (e.g. participation rates, catch) that can be used in decision-making processes at the state, territory or national levels. The stock boundaries of some recreationally-important species can span several jurisdictions and be shared with commercial and indigenous fisheries. For example, the recent increase in the number of specialised recreational fishers targeting Commonwealth-managed species, such as Striped Marlin off eastern Australia (see Bromhead et al., 2004), has resulted in conflict between the recreational and commercial fishing sectors over resource allocation. Such incidences have also raised concern among fishery managers, who have obligations to report on all mortality sources for species shared across multiple Australian jurisdictions and Regional Fisheries Management Organisations. Resolution of such complex management issues requires reliable broad-scale data on recreational catch and effort in order for stock and resource allocation assessments to be undertaken.

Unfortunately, the results of the NRFS undertaken in 2000/01 are now considered outdated in many respects, and are of limited use for rarely-caught species (e.g. tunas and billfish), specialised fisheries (e.g. deep water drop line), and some regions due to issues of scale. Since the NRFS, various recreational fishing surveys have been undertaken by state and territory fishery agencies, but generally to address only their own specific management issues. However, there has been some commonality in that these surveys have generally been undertaken using telephone-diary approaches based on the 'Fishcount' methodology used in the NRFS (Lyle et al., 2002). Additionally, community-based recreational fishing data collection has been undertaken at regional levels by community and recreational fishing groups (e.g. Sawynok et al., 2009). However, to date these programs have not contributed to reporting at a national level.

Recreational fishing stakeholders have also highlighted a need for up-to-date recreational fisheries data to be easily accessible in a national data repository. Such a resource would allow stakeholders to answer common queries regarding participation, effort and catch of recreationally-important species. Therefore, there was a requirement for the current project to assess the feasibility of aggregating data from the various surveys undertaken around Australia to provide reliable up-to-date information at regional and national levels and to explore the options for developing a framework for a public national recreational fishing data portal.

Objectives

- 1) Provide an understanding of the current state of knowledge, and identify information gaps, across the recreational fishing sector at a national scale;
- 2) Explore approaches to filling key information gaps and begin development of system(s) and protocols that will allow data to be stored, aggregated and analysed to answer questions related to recreational fishing in a timely and responsive way;
- 3) Assess the feasibility of aggregating available recreational fishing datasets to provide reliable regional and national information on catch, effort, participation, and social and economic aspects in the recreational fishing sector.

Method

National recreational fisheries data audit

A national audit of available recreational fishing datasets was undertaken in close collaboration with State, Territory, and Federal fishery agencies. The objective of the audit was to gather broad metadata on each dataset collected after 1990 to explore how the datasets could be used together to produce national estimates of participation, catch, effort, as well as key social and economic measures.

The audit was initiated in February 2012 and involved representatives from each Australian jurisdiction completing a data matrix proforma. The data matrix comprised a number of tables relating to various data categories considered important for reporting at a national scale (see spreadsheet tabs in Figure 1).

The metadata were then compiled in a relational database developed in Microsoft Access. The specific components of each table in the data matrix are presented hereafter and a summary of the metadata is provided in Appendix 2.

Instructions for completion of data matrix

The first component of the data matrix provided explicit instructions regarding the population of each matrix component linking to each project identified in a literature search and a review previously conducted by Griffiths et al. (2010a) (Figure 1).

In particular, instructions were given regarding reporting of complete or partial estimates of catch and/or effort were available by species, method and region.

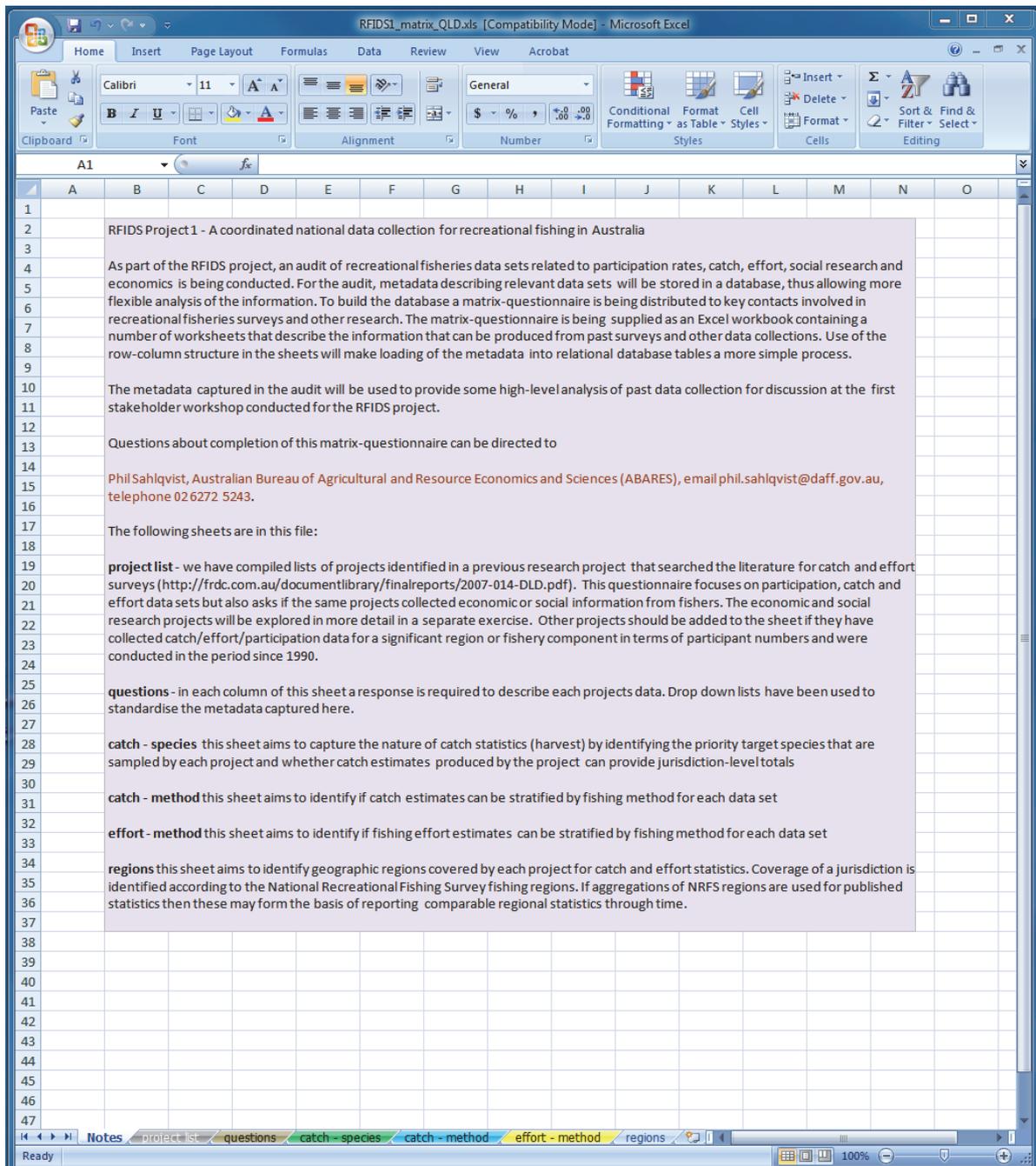


Figure 1: Screen shot of the instructions page to ensure consistent data types were being collected across all surveys.

Project list

The project list table of the data matrix sought general information about each unique recreational fishing survey, including the jurisdiction, project title, data custodian, and a description of how and what types of data were collected in each survey (Figure 2).

Although projects and metadata were pre-filled in the matrix, participants were encouraged to include additional projects that were absent from the list.

	A	B	C	D	E
1	project_id	jurisdiction	short_title	data custodian	description
2	Q001	QLD	Capricorn reef monitoring program (CAPREEF)	Infofish Services Pty Ltd	Access point surveys and counts of boat trailers at boat ramps with traffic cameras are used to estimate catch and effort.
3	Q002	QLD	RFISH – Recreational fishing telephone/diary survey program 1996-2005.	DEEDI	Telephone survey to establish participation rate and an offsite diary with telephone followup interview to estimate catch rates.
4	Q003	QLD	RFISH – Recreational fishing volunteer diary program 2007	DEEDI	Initial telephone survey to establish participation rate and an offsite diary method for volunteer dairies is different to the 1996-2005 method.
5	Q004	QLD	Commercial Fishing Tour Logbooks	DEEDI	Logbooks used to monitor catch of individual species using total catch or such as number of days fished, number of boats accessing the fishery or
6	Q005	QLD	Coastal streams recreational fishery survey 1997-98	DEEDI	
7	Q006	QLD	Moreton Bay blue swimmer recreational fishing survey 2000?	DEEDI	Access point survey used to gain a better understanding of size structure and catch in Moreton Bay.
8	Q007	QLD	Queensland Recreational Fishing Boat Ramp Survey Program 2007-2008	DEEDI	Bus route creel surveys used to estimate regional catch and effort from
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Figure 2: Screen shot of the project list table of the data matrix, which gathered general information on individual recreational fishing surveys.

Questions

The questions table of the data matrix sought specific information about each unique recreational fishing survey including the jurisdiction, and detailed descriptions of how data were collected, what types of data were collected (e.g. social, economic, catch in numbers or weights) and the spatial and temporal coverage of the survey as described by the NRFS reporting regions (Figure 3). To assist in our high-level description of metadata, we needed to ensure the way in which metadata were described was consistent across jurisdictions. Therefore, where possible, we employed drop-down menus where the researcher could select the most appropriate entry.

1	A	B	C	D	E	F	G	H	I	J	K
	project_id	short_title	jurisdiction	start year	start month	end year	end month	spatial extent	survey method	catch estimates	effort estimates
2	Q001	Capricorn reef monitoring program (CAPREEF)	NATIONAL								
3	Q002	RFISH – Recreational fishing telephone/diary survey program 1996-2005.	NSW								
4	Q003	RFISH – Recreational fishing volunteer diary program 2007	VIC								
5	Q004	Commercial Fishing Tour Logbooks	SA								
6	Q005	Coastal streams recreational fishery survey 1997-98	WA								
7	Q006	Moreton Bay blue swimmer recreational fishing survey 2000?	NT								
8	Q007	Queensland Recreational Fishing Boat Ramp Survey Program 2007-2008	QLD								
9			TAS								

CLICK AND DRAG THIS TEXT BOX TO ALLOW DATA ENTRY IN CELLS

project id Select the project id as per the project list sheet or add a new project to the project list sheet and insert the new project id here (hint: copy an existing row with formatted cells to the end before changing the project id and short title).

jurisdiction Select from dropdown the jurisdiction where the survey was conducted. Select MULTIPLE if more than one state/territory was surveyed but not all jurisdictions.

start year start month end year end month enter the starting year of the survey and end year and select the month in each case from the dropdown list. If there are multiple survey periods insert a new row for each and repeat the project id

spatial extent national/statewide/region/locality. If the extent is for a region or localities within a state/territory, where possible please complete the regions sheet to indicate overlap with NRFS regions.

survey method select approach used

catch estimates select whether the project collects retained catch only, retained/released/dicarded catch, released catch only, no catch data.

effort estimates Does the project provide fishing effort estimates Yes/No

NRFS_regions Does the project use NRFS regions for recording location of catch and effort? (See regions sheet map if you are not sure)

fishing region strata If the project collected catch and effort by fishing region strata other than NRFS regions, please select type. If possible, definition of the project region strata should be sent with the completed questionnaire.

species strata Are catch estimates stratified by species? If YES, add details to catch - species worksheet (green tab).

fishing method strata Are catch and fishing effort estimates stratified by fishing method? If YES, then add details to catch - method worksheet (blue tab) and effort - method worksheet (yellow tab).

participation Does the project provide fishing participation estimates in terms of numbers of fishers or proportion of population (not fisher-days which is a measure of fishing effort)? Yes/No

demographics What statistics are available by demographic strata eg age/sex/education etc?

residence region strata If the project collects residence region strata, please select type.

sampling frame select type of sampling frame if known.

social data does the project collect social data eg attitudinal information, social networks, industry engagement? Yes/No

economic data does the project collect economic information eg expenditure, capital value of boats/gear? Yes/No

Figure 3: Screen shot of the questions table of the data matrix, which gathered specific information about each survey including the jurisdiction, collection methods, data types and, spatial and temporal coverage.

Catch – species

The catch-species table of the data matrix gathered information about availability of catch estimates from each unique recreational fishing survey for the jurisdiction in question. A simple drop-down entry system was used to describe simply whether full or partial (i.e. incomplete fishery coverage) catch estimates were available from a specific survey for all species, or the 20 most important species for the particular jurisdiction as reported in the 2000/01 NRFS (Figure 4). A request was made to include additional species considered to be of high importance to the jurisdiction in question (e.g. conservation or management concern).

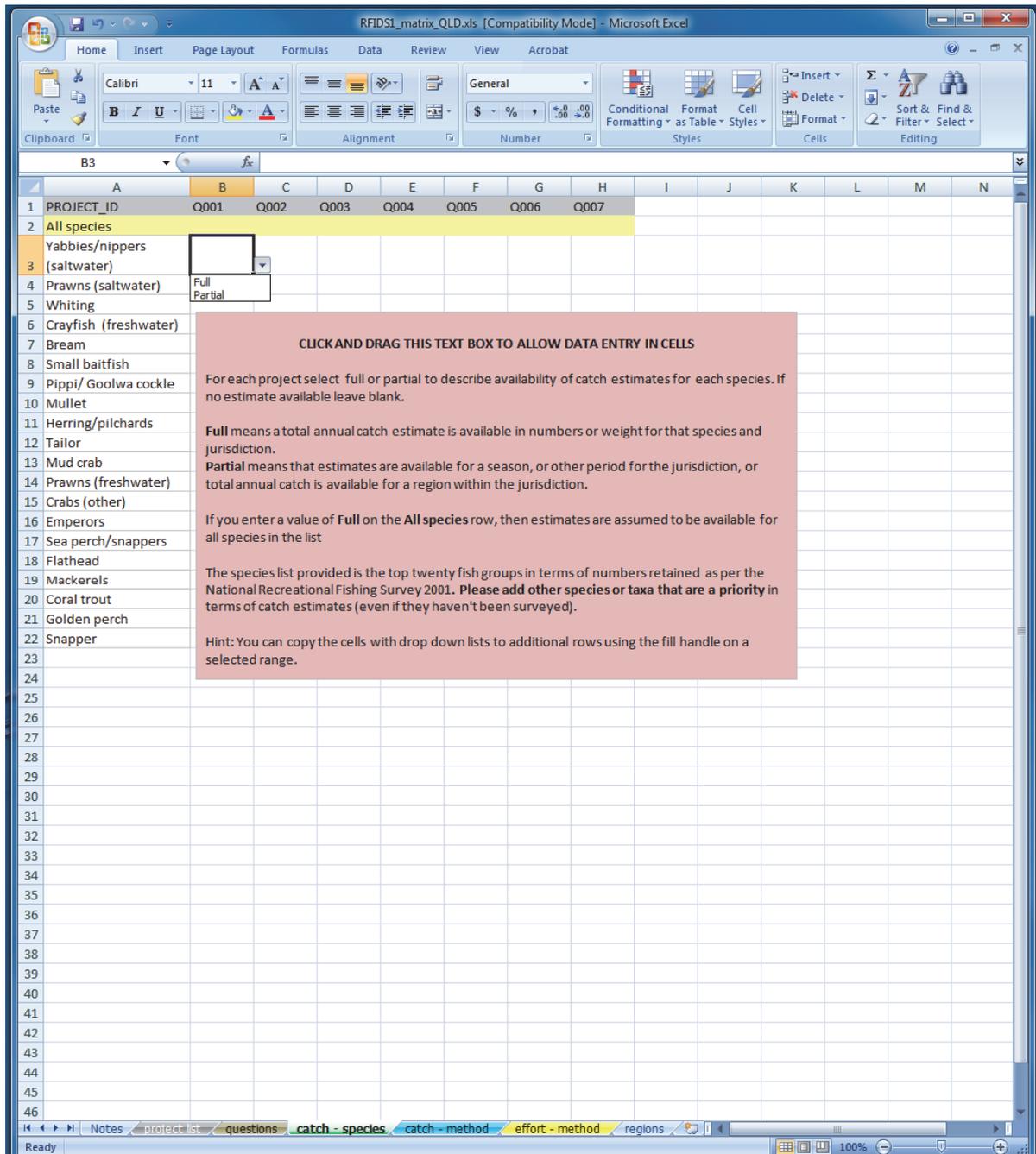


Figure 4: Screen shot of the species catch table of the data matrix, which determined whether full or partial catch estimates were available for priority species in individual surveys within a particular jurisdiction.

Catch – method

The catch-method table of the data matrix gathered information about the availability of catch estimates from specific (or all) methods within each unique recreational fishing survey for the jurisdiction in question. Again, a simple drop-down entry system was used to simply describe whether full or partial catch estimates were available from a specific survey for specific (or all) methods (Figure 5). An instructions box was provided to assist users in selecting the most appropriate descriptor relating to a project.

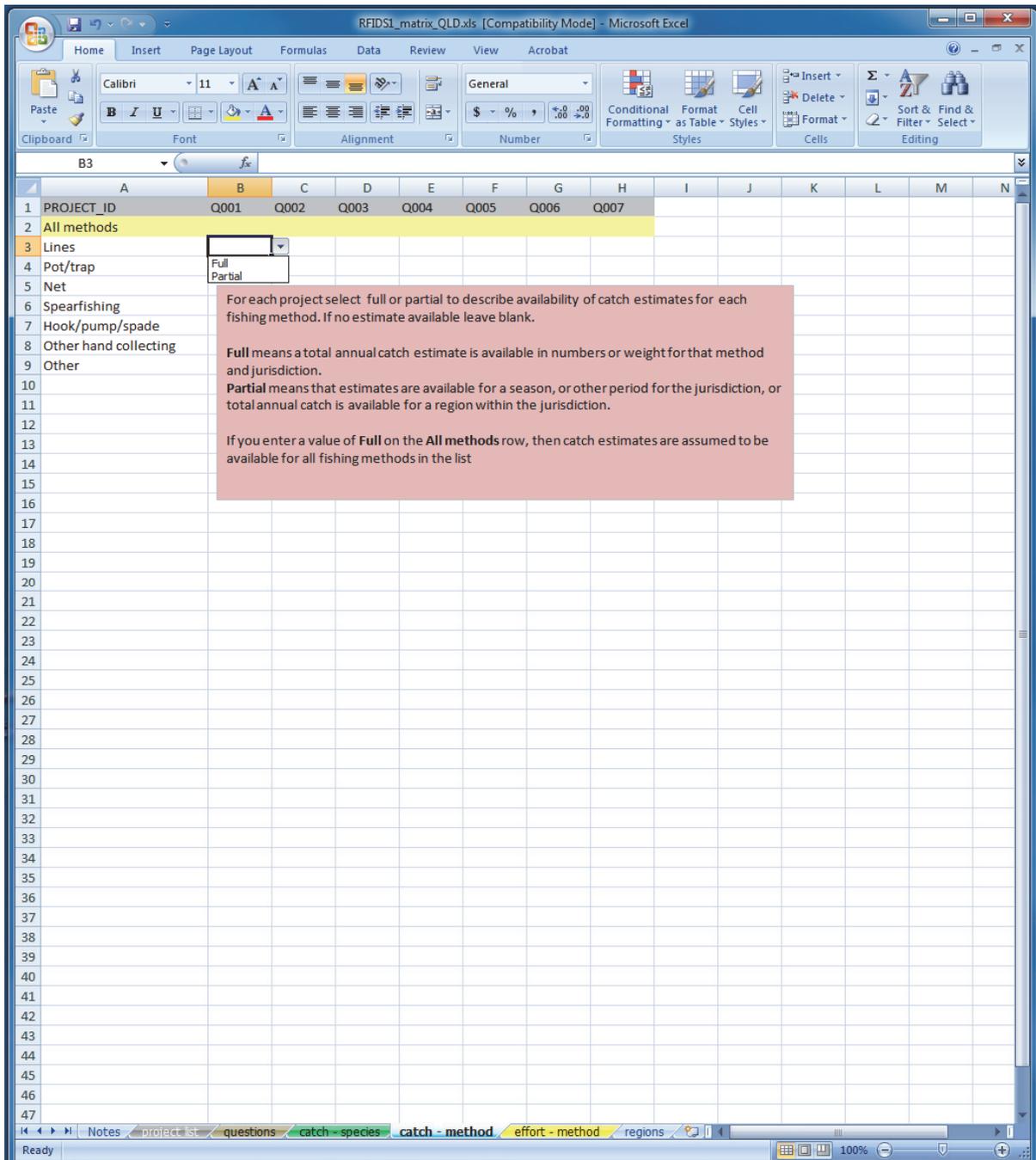


Figure 5: Screen shot of the catch by method table of the data matrix, which determined whether full or partial catch estimates were available for each fishing method identified in individual surveys within a particular jurisdiction.

Effort - method

The effort-method table of the data matrix gathered information about availability of effort estimates from specific (or all) methods within each unique recreational fishing survey for the jurisdiction in question. A simple drop-down entry system was used to simply describe whether full or partial effort estimates were available from a specific survey for specific (or all) methods (Figure 6). An instructions box was available on screen to assist users in selecting the most appropriate descriptor relating to a project.

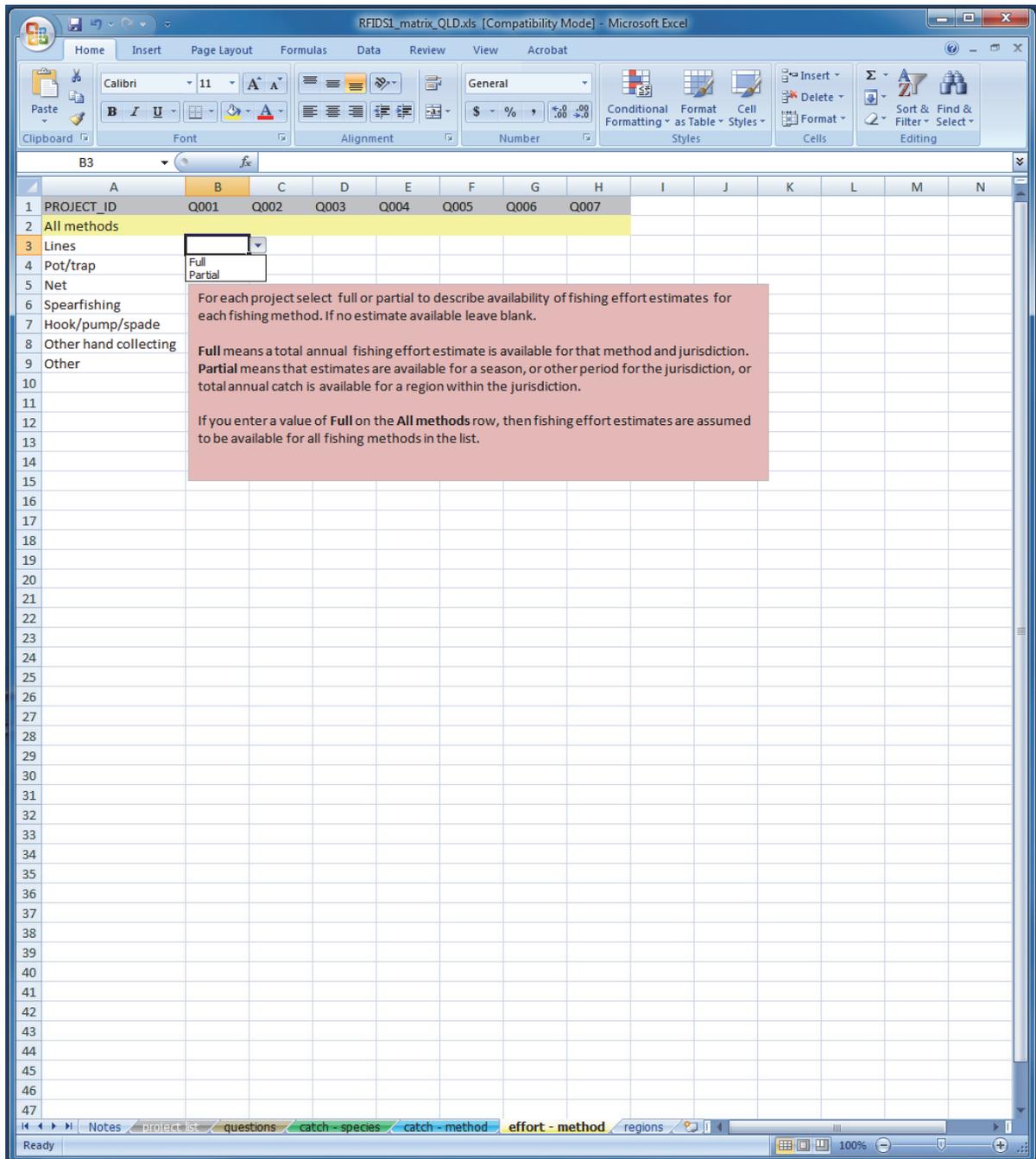


Figure 6: Screen shot of the effort by method table of the data matrix, which determined whether full or partial effort estimates were available for each fishing method identified in individual surveys within a particular jurisdiction.

Regions

The regions table of the data matrix sought specific information about the spatial coverage of each unique recreational fishing survey. For consistency across jurisdictions data custodians were requested to nominate the specific regions where each survey collected catch or effort data, as described by the NRFS reporting regions. A map of the National Survey reporting regions was included in the spreadsheet to identify the most appropriate region for each survey (Figure 7).

The screenshot shows an Excel spreadsheet titled 'RFIDS1_matrix_QLD.xls'. The table has columns for 'NRFS Regionno', 'Regionname', and seven 'Q' columns (Q001-Q007). The 'Regionname' column lists 20 regions in Queensland, Australia. A red text box contains the following instructions:

Please select YES from the dropdown list in cells for NRFS regions covered fully or partially by each project. The map of NRFS fishing regions below may help in determining regions although not all locations are shown, especially small impoundments and estuaries.

For some jurisdictions, the large number of fishing regions used in the National Recreational Fishing Survey are not suitable for published estimates of catch or fishing effort but aggregations of these regions are likely to be suitable.

If you have agreed on analysis regions that can be used for published statistics, please provide a separate list of NRFS regions and associated analysis regions.

The map below shows the outline of Australia with numerous small yellow and blue regions labeled with codes, representing the NRFS reporting regions. Two inset maps provide a closer view of the Queensland coastline and the southern part of the country.

Figure 7: Screen shot of the region table of the data matrix, which determined whether individual surveys within a particular jurisdiction collected data in accordance with the NRFS reporting regions.

Workshop 1 – National recreational fisheries data

The National Recreational Fishing Data Workshop was undertaken as a key component of the project to bring together custodians of recreational fishing datasets as well as industry stakeholders and resource managers to discuss the most appropriate means by which to aggregate available datasets to answer key questions commonly posed by recreational fishers, researchers and managers. The workshop participants and their affiliations are listed in Appendix 3.

The specific goals of the workshop were to:

1. Facilitate exchange of the latest recreational fishing research information between state/territory, Commonwealth fisheries research and management agencies and recreational fishery stakeholders;
2. Complete a spatial and temporal matrix of all available recreational datasets to better understand coverage and gaps;
3. Identify key recreationally-important species from each state, territory and Commonwealth jurisdiction to provide data to meet the needs of fishers and managers;
4. Discuss the feasibility of aggregating available datasets to produce regional, state, species stock, and national level estimates of recreational fishing participation, effort and catch of key recreationally-important species;
5. Discuss the framework design of a public data portal that can cost-effectively provide ‘best available’ estimates (with error) of recreational fishing participation, effort and recreational catch of identified key recreationally-important species.

Session 1: Overview of recreational fisheries research and management in Australia

The first session of the workshop comprised a series of presentations by the project team, representatives of key stakeholder groups, and recognised experts on recreational fishing survey design, and social and economic aspects of recreational fisheries. Together, these talks provided the necessary background information in order to fully understand the political, logistical and statistical issues associated with the project. This ranges from the need for national data on recreational fishing, the origins of the project through the National Recreational Fishing Industry Development Strategy (RFIDS), and an approach to make the current project successful by building on the lessons learned from the 2000/01 NRFS. The presentations also explained the emerging research area of community monitoring, or ‘citizen science’, and provided overviews of understanding the importance of social and economic elements of recreational fisheries and how these elements could be measured. The agenda of talks is provided in Appendix 4.

Session 2: National review of recreational fishing datasets

The second session of the workshop comprised a series of presentations by each state, territory and federal representative, each of whom briefly provided a synopsis of the recreational fishing datasets held by their respective agency, which were reported as metadata in the National data audit. Presenters were asked to provide details on the spatial and temporal coverage of surveys, the types of data collected (e.g. catch, effort, social, economic), and whether estimates for particular species or fisheries/methods were complete or partial. Structuring the workshop in this way was intended to provide all workshop participants with sufficient background knowledge to be able to objectively assess the feasibility of utilising various datasets to produce national estimates for particular species or fisheries. The agenda of talks in the second session is provided in Appendix 4.

Session 3: Development of an analysis approach

The third session of the national recreational fishing data workshop comprised a series of presentations by the project team, structured to encourage input from workshop participants and work towards obtaining a consensus on key elements of the project that would help move toward providing an approach for statistical analyses.

The session began with a summary of results from the National Recreational Fishing Data Audit (as presented in Results section “National recreational fisheries data audit”), which aimed to identify major spatial and temporal gaps in the datasets and assist the workshop group to determine the most appropriate period to characterise national level estimates. For example, if the main overlap in datasets occurred between 2005-2007 then the group may indicate that national estimates should represent an average of this period. The session progressed with identification of key recreationally-important species and a process for identifying regions for catch reporting for these species and representation in the data portal.

Identification of key recreationally-important species

The data matrix used for the national data audit listed the 30 most important species (or species groups, e.g. ‘Tropical Snapper’) by catch numbers for each jurisdiction based on the NRFS. This was done in order to help focus on the highest priority species as well as recognising that reliable national catch estimates would not be feasible for many of the less commonly caught species. This is due to their relative rarity in catches and therefore, the statistical uncertainty surrounding catch estimates would be too large to be meaningful when expanded to the national level. Nonetheless, workshop participants were requested to include additional species on the list that they saw as a high priority species. This resulted in an overall national list of 48 species/species groups.

The workshop group was asked to condense the list to a manageable size for reporting purposes within the current project of around 20 species that had national importance to recreational fishing stakeholder groups and resource managers. In particular, the focus of the group was to identify priority species that straddle multiple jurisdictional boundaries rather than species that may be important to individual jurisdictions, such as Dhufish in Western Australia.

Each jurisdictional representative was asked to score the level of importance (Medium - 2, High - 3) for each of the 48 species. Recreational fishing stakeholder representatives were also consulted during the scoring of each species for each of the jurisdictions. The group was able to condense the list to 30 priority species/species groups in the first attempt. Further consultation with resource managers and recreational fishing stakeholders was also considered necessary to confirm or amend priorities. This issue was foreseen by the project team, and was the primary impetus for inviting representatives of the Australian Fisheries Management Forum, the Gamefishing Association of Australia, and the

Australian Fishing Trade Association. Unfortunately, representatives of these groups were not able to attend the workshop.

There was agreement among workshop participants that the project team should approach resource managers out of session to seek further justifications as to why nominated priority species should be included on the final list of nationally important species. The types of justifications were agreed by the group to represent one or more of the following categories:

- Sustainability (i.e. stock status)
- Conservation status (e.g. listed, endangered)
- Resource allocation (e.g. inter-sector conflict)
- Performance measures (e.g. CPUE trend)
- Legislative requirements (e.g. EPBC Act, RFMO reporting)
- Iconic value (e.g. prestige of gamefish capture)
- Increasing effort (including increasing participation and general interest in the species)
- Economic benefit (e.g. high cost gamefish fisheries, species supporting specific economies)
- Social benefit (e.g. relaxation value of trout fishing)

Identification of key reporting regions

Once the priority species were determined, discussion was directed towards the most appropriate level of reporting for the final report, but most importantly for the data portal after a framework is developed in the current project. This was in response to the need for stakeholders and managers to be able to aggregate or disaggregate data at various regional, jurisdictional or national levels. A summary of these workshop group discussions are summarised in the Results section.

Identification of national priority species and data harvesting from identified datasets

Collation of data for priority species

A key outcome of Workshop 1 was the identification of priority species for each of the State and Territory jurisdictions and from the perspective of the recreational fishing industry. The workshop group recommended that jurisdictional fisheries managers also be consulted as to their view on priority species, since they are often the end-users of recreational fisheries data for addressing management issues, such as resource allocation conflict between commercial and recreational fisheries (e.g. Striped Marlin in the Eastern Tuna and Billfish Fishery). The group also believed they may be able to identify management stock boundaries for priority species. The group agreed the types of justifications that a priority species from a manager's perspective would need to have a significant issue relating to one or more of the categories defined in Session 3 of Workshop 1.

Once the species/species groups were identified by jurisdictional researchers, fishery managers and recreational peak bodies, the top 20 were chosen as priority species for estimating 'best available' estimates at the national level.

A customised data request template was developed for each jurisdiction and sent out to each representative for completion in early February 2012. This template requested jurisdictional-wide and regional data for each species identified as being a priority for the jurisdiction. In particular, jurisdictional managers were asked to identify stock boundaries for key species in order for the project team to explore the potential for stock-level estimates to be provided in a data portal. The key components of the data template are presented in the following section.

The response by jurisdictional representatives was generally very good, but unfortunately, incomplete or incorrect datasets were submitted in some cases, which resulted in the project team deriving the most recent data from published reports to ensure only the best quality data were collated for the project.

The data received from jurisdictional representatives were cleaned and reformatted to allow storage in a Microsoft Access database. The catch and effort records were loaded into database tables so that the information could be analysed and tabulated.

Effort

Effort data were collected at two broad spatial scales, jurisdictional and regional. The jurisdictional level effort table of the data template gathered effort estimates for all species combined from each unique recreational fishing survey for the jurisdiction in question since the 2000/01 national survey. Effort in fisher days was requested, but in some cases, this was not available, so data custodians noted their effort measure to allow for later conversion. A simple drop-down entry system was used to describe simply whether full or partial (i.e. incomplete fishery coverage) effort estimates were made from a specific survey (Figure 8).

Jurisdictional effort

1	Waters surveyed	Project ID	Fishing effort unit	Effort total	Partial estimate code	Partial estimate code	Partial estimate code
2	NSW	A001	Fisher Days	5585059	A Interstate visitors not surveyed		
3	NSW	A001	Fishing Events	6208830	B Interstate visitors not surveyed		
4	NSW	A001	Fisher Hours	22712041	C boat fishers only surveyed		
5					D shore fishers only surveyed		
6					E survey period < 1 year		
7					F incomplete sampling of state/territory		
8					G incomplete sampling of region		
9					H incomplete sampling of fishing methods		

Regional effort

1	Waters surveyed	Project ID	Region code	Fishing effort unit
2	North West	A001	1	378,239 Fisher Days
3	North West	A002	1	369,207 Fisher Events
4	North West	A003	1	1,740,905 Fisher Hours
5	Darling River	A004	2	89,777 Fisher Days
6	Darling River	A005	2	87,023 Fisher Events
7	Darling River	A006	2	529,895 Fisher Hours
8	South West	A007	3	649,497 Fisher Days
9	South West	A008	3	633,969 Fisher Events
10	South West	A009	3	3,359,565 Fisher Hours
11	Murray River	A010	4	497,770 Fisher Days
12	Murray River	A011	4	465,097 Fisher Events
13	Murray River	A012	4	3,172,208 Fisher Hours
14	North Coast	A013	5	943,477 Fisher Days
15	North Coast	A014	5	926,945 Fisher Events
16	North Coast	A015	5	3,495,447 Fisher Hours
17	Solitary Islands	A016	6	230,141 Fisher Days
18	Solitary Islands	A017	6	227,642 Fisher Events
19	Solitary Islands	A018	6	658,867 Fisher Hours
20	Mid North Coast	A019	7	989,562 Fisher Days
21	Mid North Coast	A020	7	986,412 Fisher Events
22	Mid North Coast	A021	7	3,124,500 Fisher Hours
23	Hunter	A022	8	1,339,763 Fisher Days

Figure 8: Screen shots of the effort tables in the data template, which collected information on jurisdictional effort (top panel) and regional effort (bottom panel).

Catch – species group

The species group table of the data template gathered jurisdictional-level catch estimates for broad priority species groups (e.g. ‘tropical Snappers’) from each unique recreational fishing survey for the jurisdiction in question since the 2000/01 NRFS (Figure 9). A simple drop-down entry system was used to describe simply whether full or partial (i.e. incomplete fishery coverage) catch estimates were available from a specific survey for each priority species group. Where possible, estimates were collected for both retained and non-retained catch, and a measure of uncertainty in the estimate (usually reported as Relative Standard Error).

1	Species group	Scientific name	CAAB	Waters surveyed	Number of priority species	Project ID	Retained catch number	Retained catch RSE	Non-retained catch number	Non-retained catch RSE	Partial estimate code	Partial estimate code	Partial estimate code
2	ABALONE	HALIOTIDAE	24 038000	NSW	1	A001	35233	0.45	36045	na	na	na	na
3	AUSTRALIAN SALMON	Arripis spp	36 344900	NSW	1	A001	110988	0.13	88108	na	na	na	na
4	FLATHEAD	PLATYCEPHALIDAE	37 296000	NSW	3	A001	2217059	0.11	2051421	na	na	na	na
5	JEWFISH	A. hololepidotus & P. diacanthus	37 354903	NSW	1	A001	136852	0.16	43678	na	na	na	na
6	MUD CRAB	Scylla spp	28 911902	NSW	1	A001	51274	0.24	45518	na	na	na	na
7	ROCKLOBSTER	PALINURIDAE	28 820000	NSW	1	A001	10569	0.34	5158	na	na	na	na
8	SHARKS AND RAYS	ELASMOBRANCHII	37 990027	NSW	>6	A001	30093	0.22	257785	na	na	na	na
9	SQUID AND CUTTLEFISH	DECAPODIFORMES	23 615000	NSW	>2	A001	154627	0.35	7328	na	na	na	na
10	TUNA	SCOMBRIDAE (Thunnini/Sardini)	37 441912	NSW	6	A001	140747	0.29	18034	na	na	na	na
11	WHITING	SILLAGINIDAE	37 330000	NSW	2	A001	1791276	0.25	1134429	na	na	na	na
12	Blue Swimmer Crab	Portunus armatus	28 911005	NSW	NA	A001	412883	0.28	137611	na	na	na	na
13	Golden Perch	Macquaria ambigua	37 311075	NSW	NA	A001	542107	0.09	394887	na	na	na	na
14	Murray Cod	Maccullochella peelii	37 311076	NSW	NA	A001	93973	0.07	346439	na	na	na	na
15	Snapper	Pagrus auratus	37 353001	NSW	NA	A001	334191	0.13	1176413	na	na	na	na
16	Tailor	Pomatomus saltatrix	37 334002	NSW	NA	A001	1010943	0.17	771847	na	na	na	na

Figure 9: Screen shot of the catch by species group table in the data template.

Catch – individual species

Species-specific catch estimates were requested for individual priority species at both the jurisdictional and regional levels for each unique recreational fishing survey question since the 2000/01 NRFS. Where possible, estimates were collected for both retained and non-retained catch, and a measure of uncertainty in the estimate (usually reported as Relative Standard Error) (Figure 10).

1	Species	Species group	Scientific name	CAAB	Waters surveyed	Region code	Project ID	Retained catch number	Retained catch RSE	Non-retained catch number	Non-retained catch RSE
2	Abalone	HALIOTIDAE	24 038000	North West	1	A001	-	-	-	-	-
3	Abalone	HALIOTIDAE	24 038000	Drafting River	2	A001	-	-	-	-	-
4	Abalone	HALIOTIDAE	24 038000	South West	3	A001	-	-	-	-	-
5	Abalone	HALIOTIDAE	24 038000	Murray River	4	A001	-	-	-	-	-
6	Abalone	HALIOTIDAE	24 038000	North Coast	5	A001	-	-	-	-	-
7	Abalone	HALIOTIDAE	24 038000	Solitary Islands	6	A001	-	-	-	-	-
8	Abalone	HALIOTIDAE	24 038000	Mid North Coast	7	A001	1807	-	-	0	-
9	Abalone	HALIOTIDAE	24 038000	Hunter	8	A001	2349	-	-	0	-
10	Abalone	HALIOTIDAE	24 038000	Sydney	9	A001	-	-	-	-	-
11	Abalone	HALIOTIDAE	24 038000	Mid South Coast	10	A001	24419	-	-	28478	-
12	Abalone	HALIOTIDAE	24 038000	South Coast	11	A001	6858	-	-	7567	-
13	Abalone	HALIOTIDAE	24 038000	Lord Howe Island	12	A001	-	-	-	-	-
14	Australian salmon	Arripis spp	36 344900	North West	1	A001	-	-	-	-	-
15	Australian salmon	Arripis spp	36 344900	Drafting River	2	A001	-	-	-	-	-
16	Australian salmon	Arripis spp	36 344900	South West	3	A001	-	-	-	-	-
17	Australian salmon	Arripis spp	36 344900	Murray River	4	A001	-	-	-	-	-
18	Australian salmon	Arripis spp	36 344900	North Coast	5	A001	-	-	-	-	628
19	Australian salmon	Arripis spp	36 344900	Solitary Islands	6	A001	-	-	-	-	-
20	Australian salmon	Arripis spp	36 344900	Mid North Coast	7	A001	16054	-	-	10892	-
21	Australian salmon	Arripis spp	36 344900	Hunter	8	A001	17923	-	-	47606	-
22	Australian salmon	Arripis spp	36 344900	Sydney	9	A001	757	-	-	3235	-
23	Australian salmon	Arripis spp	36 344900	Mid South Coast	10	A001	28943	-	-	9344	-
24	Australian salmon	Arripis spp	36 344900	South Coast	11	A001	45098	-	-	15803	-

Figure 10: Screen shot of the catch by individual species table in the data template.

Workshop 2 – Assessment of requested recreational fishing datasets for statistical analyses

The National Recreational Fishing Data Workshop was developed as a key component of the project to bring together custodians of recreational fishing datasets as well as industry stakeholders and resource managers to discuss the most appropriate means by which to aggregate available datasets to answer key questions commonly posed by recreational fishers, researchers and managers. The workshop invitees and participants and their affiliations are listed in Appendix 3, while the agenda is provided in Appendix 4.

The specific goals of the workshop were to:

1. To facilitate exchange of the latest recreational fishing research information between fisheries research and management agencies and recreational fishery stakeholders;
2. Provide information from a national recreational fishing data audit and key outcomes from Workshop 1 and confirm key recreationally-important species at a national level;
3. Determine the feasibility of aggregating available datasets to produce regional, state, species stock, and national level estimates of recreational fishing participation, effort and catch of key recreationally-important species;
4. Provide ‘best available’ national estimates of catch for key recreationally-important species, effort and participation;
5. Define a framework of a public data portal that can cost-effectively provide ‘best available’ estimates (with error) of recreational fishing participation, effort and recreational catch of identified key recreationally-important species.

The first session of the workshop primarily involved the project team delivering presentations that provided background to the project and an overview of the project’s progress in order for workshop participants to be able to determine what was required for the project to meet its objectives. In particular, a reasonable time was spent revisiting the results of the national data audit, where the high spatial and temporal heterogeneity among datasets was highlighted as a major challenge for the project team to meet its subsequent objectives, in particular, bringing the datasets together to produce statistically sound estimates of catch and effort.

Statistical analyses of the available datasets

Following the national data audit, prioritisation of recreationally-important species in Workshop 1, and collation of catch and effort data of priority species using a standardised reporting template, we sought to use statistical modelling to explore the feasibility of reliably producing up-to-date catch and effort estimates at the national and species stock level, for priority species, using the survey data that are currently available from State and Territory fishery agencies.

Objectives of the statistical analyses

The specific goals of statistical analyses were to:

1. Determine the feasibility of aggregating fragmented datasets collected across different spatial and temporal scales in order to provide national or stock-level estimates of catch and effort for priority recreationally-important species
2. Use case studies to demonstrate the feasibility of using annual license holder numbers as a proxy of fishing effort, which may allow jurisdictional-level catch and effort to be estimated for years where no recreational fishing survey data are available
3. Make recommendations as to the most appropriate means to use existing data, collect further ancillary data, or collect jurisdictional-level data for the purposes of providing reliable national-level estimates.

Initial assessment of the datasets

The datasets received in the standardised data templates from each jurisdiction were aggregated into a single database. An overall observation of the data in space and time by project statisticians Bill Venables and Ken Pollock in the project technical workshop on 20 March 2013 at the Ecosciences Precinct, Brisbane suggested that aggregation of data to produce national estimates would be problematic. This was because it would need to be assumed that populations of fishers, and target species, did not change between the significant periods between surveys, and that the slightly different sampling methodologies adopted in each survey did not appreciably contribute to differential sampling biases.

Despite the project team feeling strongly that such assumptions would almost certainly have been violated, the team decided to use case studies using the highest quality and longest time series data to explore under various sub-sampling scenarios, the possibility of 'back-filling' data for years in particular jurisdictions where data are absent and to illustrate the statistical difficulties inherent for this kind of situation. The project team believed that the number of licence holders is an annual data source that may serve as a proxy of fishing effort, and if so, the catch of particular species may be estimated for years where no surveys have been undertaken.

Therefore, the key question we addressed in statistical modelling was:

“If a recreational fishery for which we have a time series were surveyed less frequently than annually, to what extent is it possible to fill in the gaps from the data provided?”

Assuming the data available is sufficiently accurate, it is then possible to compare the results of back-filling with the estimates obtained directly from the surveys that were, in fact, done. If this type of statistical modelling proves successful, then it may be feasible to produce catch and effort estimates for each jurisdiction for any given year, regardless of whether a survey had been undertaken or not, thus allowing national estimates to be produced.

However, if the modelling proved unsuccessful, even for the highest quality datasets available, it would clearly demonstrate that modelling would be unable to be used to interpolate catch and effort for finfish species where survey data are considerably more fragmented. In such a case, a dedicated national recreational fishing survey would be required.

We undertook three case studies whereby statistical models were built and assessed for making predictions of annual catch and effort in Australian recreational fisheries that have the longest and most frequent time series of survey data: the Western Australian recreational Rock Lobster fishery, and the Tasmanian recreational Rock Lobster and Abalone fisheries.

Western Australian Recreational Rock Lobster Fishery

The Western Australian Rock Lobster recreational fishery is perhaps the best-surveyed recreational fishery in Australia, where an estimate of the annual catch and effort, coupled with reliability estimates, has been produced for a continual period of 25 years since 1986. Due to issues relating to confidentiality of data in the latter period of the data series, only the first 13 years of data were available for analysis, which is published in Table 2 of the publicly available technical report by Melville-Smith and Anderton (2000). It was decided that this 13-year dataset was appropriate to be used in exploratory modelling.

The modelling approach taken was to explore various forms of Generalised Additive Models (GAMs) to be fitted to the full dataset and then to a reduced dataset of five survey years. This was to explore the feasibility of making predictions of catch or effort for years where no survey data may be available by using annual licence numbers as a proxy for effort.

Tasmanian Recreational Rock Lobster and Abalone fisheries

The Western Australian recreational Rock Lobster data analysed in the first case study is the longest continuous recreational fishing time series in Australia. Although it provides a sound basis to explore statistical modelling approaches to estimate catch or effort for years where surveys were not undertaken, the dataset is not representative of the typical recreational fishing datasets currently available in Australia. Therefore, we undertook further statistical analyses using two additional case studies, the Tasmanian recreational Rock Lobster and Abalone fisheries. These datasets were considered to be more typical of surveys undertaken for finfish species, although the frequency of surveys is higher, being bi-annual since 2000/01.

The modelling approach taken was the same as for the Western Australian Rock Lobster in that a model would be fitted to the full dataset and then to a reduced dataset to explore the feasibility of making predictions of catch or effort for years where no survey data were available by using licence numbers as a proxy for effort.

Results and Discussion

National recreational fisheries data audit

The national data audit identified 91 projects that had associated data relating to recreational fishing in Australia. Of these datasets, 76 had complete descriptive metadata, while 50 project descriptions identified the key species and scale of associated catch estimates (jurisdiction annual totals or partial estimates) for specific periods or regions. A total of 33 projects indicated the collection of social data, while 18 projects indicated collection of economic data. A complete description of metadata of each survey is provided in Appendix 2.

We acknowledge that some catch data – some spanning decades – are held by amateur fishing clubs and associations and have been used in specific scientific studies (e.g. Pollock and Williams, 1983; Stevens, 1984; Pepperell, 1992; Gartside et al., 1999). However, club data generally represents a restricted (and undefined) geographic range, fishing techniques (e.g. land vs. boat-based; general fishing vs. specialised game fishing) and quantification of catch and effort vary between clubs, and fishing club members are generally more avid and experienced fishers (Gartside et al., 1999). Therefore, we felt these data would not be able to provide large-scale representative catch and effort data that could be reliably expanded to jurisdictional or national levels, and thus, we not included in the data audit.

Spatial-temporal coverage of jurisdictional surveys

Preliminary analysis of the metadata revealed that only South Australia, Tasmania, Northern Territory and Queensland had completed state-wide recreational fishing surveys of all species using a phone-diary survey design since the 2000/01 NRFS.

Figure 11 shows a highly fragmented time series of datasets with only South Australia and Tasmania undertaking jurisdictional surveys in the same period (2007/2008) since the NRFS. Other states have also completed jurisdictional surveys since the NRFS, but these were undertaken using an incomplete general fishing licence frame (Victoria in 2006), or a specific fishing licence frame, namely the Recreational Fishing from a Boat Licence (Western Australia in 2011).

In contrast to the general jurisdictional recreational fishing surveys, species-specific jurisdictional recreational fishing surveys for a small number of individual species of high importance to the recreational fishery were undertaken more frequently, usually every 2-3 years. These surveys include Rock Lobster in Western Australia, Tasmania and South Australia, and for Abalone in Western Australia and Tasmania. Each of these surveys utilised a diary methodology, while a mail survey has also been conducted for Western Australia Rock Lobster every year since 1986 (Melville-Smith and Anderton, 2000).

It was recognised that a number of jurisdictions are currently undertaking or planning jurisdictional surveys for the near future using the phone-diary survey methodology, including NSW, Victoria, Queensland, Tasmania, Western Australia and South Australia (Figure 11). Western Australia also plans to repeat the statewide boat fishing survey on a regular basis. Unfortunately, the analyses of these jurisdictional surveys were not completed in time to be included in the current project.

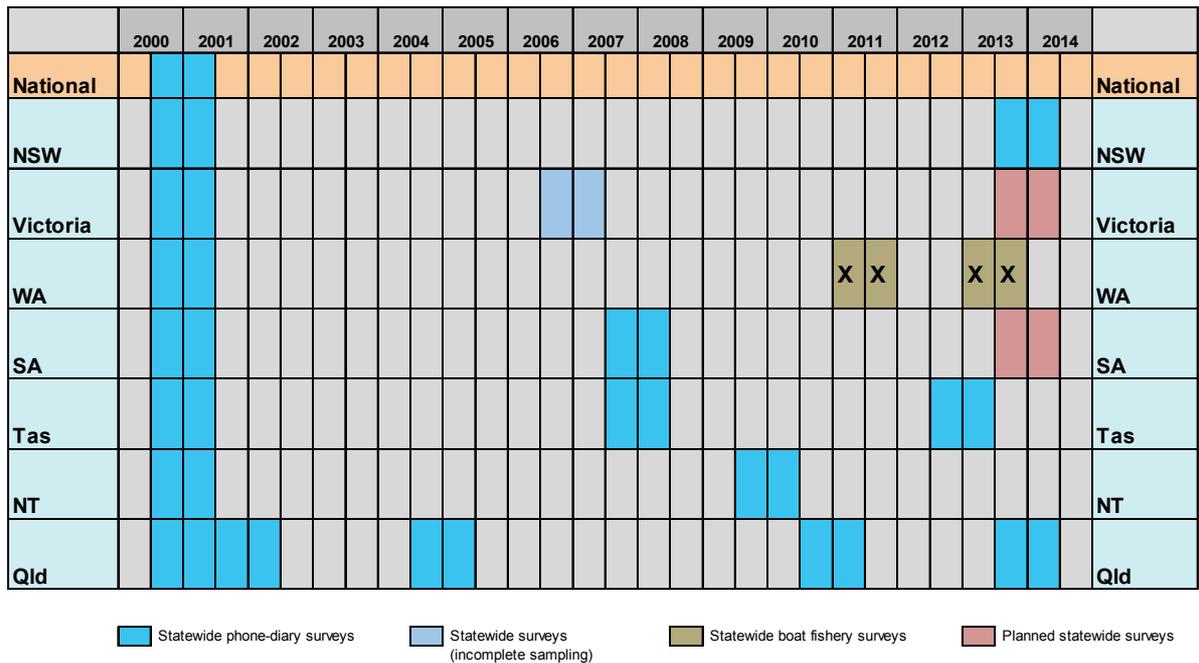


Figure 11: Timeline of jurisdictional-wide recreational fishing surveys of all species undertaken by jurisdictional fishery agencies since the last National Recreational Fishing Survey conducted in 2000/01. Surveys are denoted by their use of a phone-diary survey methodology or surveys using a sampling frame of boat-based fishers only. Surveys with an “X” indicated data are currently unavailable.

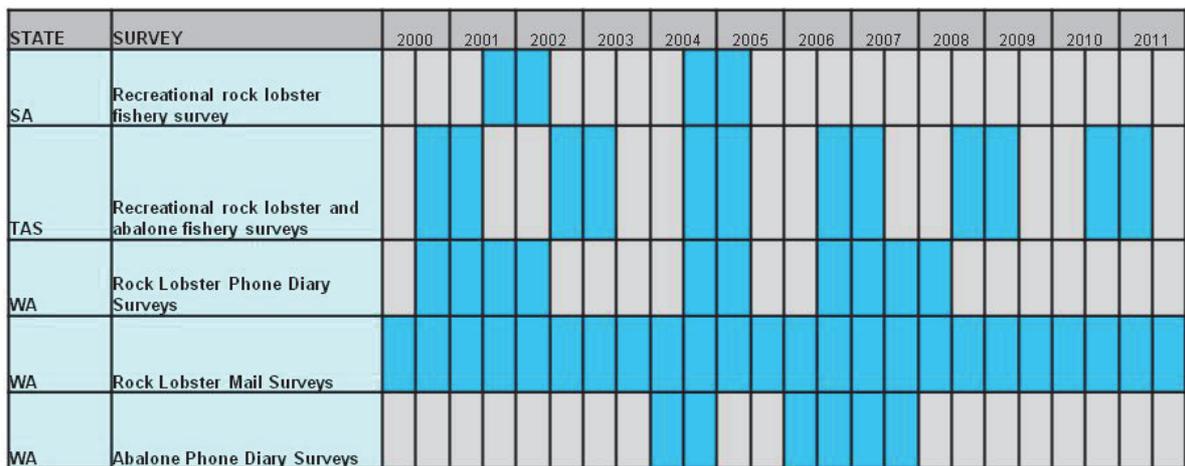


Figure 12: Timeline of jurisdictional-wide recreational fishing surveys of all species undertaken by jurisdictional fishery agencies since the last National Recreational Fishing Survey conducted in 2000/01.

Spatial-temporal coverage of regional surveys

A total of five regional surveys – that is, those surveys undertaken outside of jurisdictional surveys – were reported through the audit for the period 2000-2005, with the vast majority of the survey areas being located in NSW (Figure 13).

For the period since 2005, 12 regional surveys were reported in the audit, primarily in the same regions, but with additional surveys in Victoria (Figure 13). A number of regional surveys are known to have been conducted in Western Australia, Northern Territory and South Australia since 2000. Unfortunately, the majority of these surveys have not been published or made publically available.

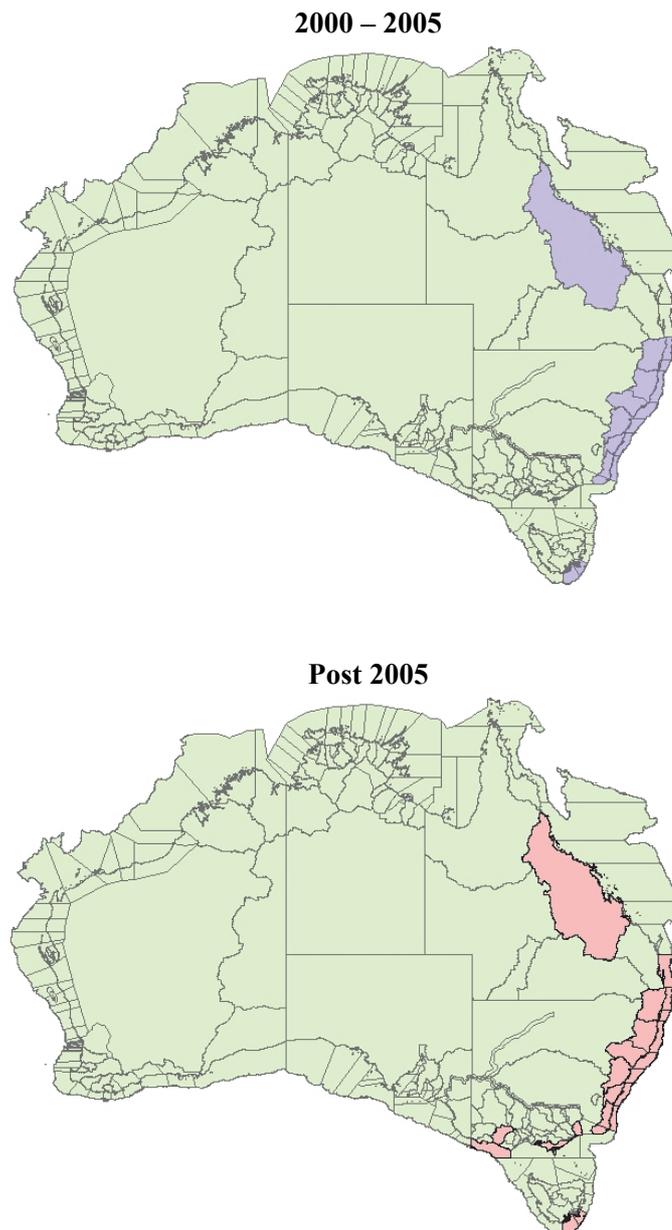


Figure 13: Maps for two periods, 2000-2005 and post 2005, with shaded areas showing the spatial distribution of regional recreational fishing surveys identified in the national data audit. Reporting zones shown are those used in the 2000/01 National Recreational Fishing Survey.

Workshop 1 – National recreational fisheries data

Session 1: Key outcomes from the overview

A number of key points arose from the first session of Workshop 1 talks that helped participants understand the need for the project and updated national estimates for recreational fisheries, and the data needs of recreational fishing stakeholders and resource managers, which are briefly detailed under the following discussion categories:

Overview of recreational fisheries research and management in Australia

- The current project was explained to be part of 10 key recreational fishing projects identified by the recreational fishing industry as priority areas for investment under the National Recreational Fishing Industry Development Strategy (RFIDS). This was a \$2 million investment in recreational fishing initiated by the Australian Government in 2008 to help forge collaborations between fishers, industry and governments.
- The objectives of the current project are primarily aligned with bringing together available datasets held by various agencies in order to identify gaps and to produce ‘best possible’ national estimates that can be used by recreational fishery stakeholders, resource managers and the general public.
- It was explained that there would be a large focus in the project to produce data that are easily accessible and interpretable by a general non-scientific audience through a public-facing data portal. This comes in response to recreational fishing stakeholder groups being unable to access the most up-to-date data in a timely fashion. It was reiterated in the workshop that the construction of the portal and its population with data is beyond the scope of the current project. The project will suggest a framework for the portal and provide a case study of how it may function when populated.
- Commentary was made as to the proposed use of the data and the questions from fishers and managers that it could realistically answer. This generated discussion around expectations of management and that the data were unlikely to answer all questions about all species and fisheries. It was agreed that the project, and ultimately the portal, should be limited to answer only the key questions posed by fishers and managers for key fisheries and recreationally-important species nationally. Recognising that the focus of many recreational fishing surveys has been on addressing questions relating to participation, catch and effort, the present study will primarily concentrate on these issues.

National data needs of recreational fishers

- The workshop group was given a clear description from Recfish Australia’s perspective of the key recreationally-important species for each jurisdiction for both saltwater and freshwater. These species are shown in Table 1 for offshore, estuarine and freshwater recreational fisheries for each jurisdiction.

Table 1: Priority species for further research as identified by Recfish Australia for offshore, estuarine and freshwater recreational fisheries in each State and Territory jurisdiction. Species considered to be of highest priority in each jurisdiction are underlined.

Jurisdiction	Species		
	Offshore	Estuary	Freshwater
Vic	<u>Flathead</u> , <u>Snapper</u> , <u>Tuna</u> , Sharks, Whiting, <u>Calamari</u>	<u>Bream</u> , <u>Flathead</u> , Tailor, Luderick, Salmon, Mulloway, Estuary Perch	<u>Trout</u> , <u>Cod</u> , <u>Yellowbelly</u> , Bass, Yabbies
NSW	Flathead, Snapper, <u>Tuna</u> , <u>Marlin</u> , Kingfish, Morwong,	<u>Bream</u> , <u>Flathead</u> , Tailor, Luderick, Salmon, <u>Mulloway</u>	<u>Trout</u> , <u>Cod</u> , <u>Yellowbelly</u> , Bass, Yabbies
Tas	Flathead, <u>Tuna</u> , Mako <u>Sharks</u> , <u>Calamari</u> , Squid, Australian Salmon, Flounder, Trumpeter, Trevally, Rock Lobster, Abalone	<u>Bream</u>	<u>Trout</u>
NT	Tuna, Trevally, Sharks, Mulloway	<u>Barramundi</u>	
WA	<u>Snapper</u> , <u>Samson</u> , Marlin, Sailfish	<u>Barramundi</u>	<u>Trout</u>
SA	<u>Snapper</u> , <u>Tuna</u> , <u>Mulloway</u>	<u>Bream</u> , <u>Flathead</u> , Tailor	
Qld	Coral Trout, <u>Black Marlin</u> , <u>Red Emperor</u> , Spanish Mackerel	<u>Bream</u> , <u>Flathead</u> , Tailor, Mangrove Jack, Whiting, <u>Barramundi</u>	Barramundi (impoundments)
ACT	<u>Marlin</u> , Tuna, Kingfish		Natives, <u>Trout</u>

- The issues faced by recreational fishers represented by Recfish Australia were described with respect to working with government. They expressed concerns over:
 - Reliability and credibility of recreational fishing catch and effort estimates.
 - inconsistent survey methodologies and various biases preventing robust quantitative comparisons of data among jurisdictions.
 - The transparency and accountability of researchers and managers and inadequate stakeholder engagement.
 - The lack of a central repository for available data that can be easily accessed and interrogated for catch, effort and economic information at various spatial and temporal resolutions.
 - The need to understand the spatial variation in biological parameters for particular species to guide management in the various jurisdictions (e.g. bag/possession/size limits).
 - Insufficient baseline data in each jurisdiction, which hinders the ability to understand the efficacy of management actions (e.g. marine parks).
 - The need for a coordinated approach to the collection of recreational fishing data, both current and historical.
 - Why there was such a disparity between the quantity and quality of commercial and recreational fishing data.

- A number of recommendations were made to the workshop group with respect to how researchers and government could improve the research and management of recreational fisheries in Australia. These recommendations included:
 - Develop a regional or jurisdictional-based data collection approach with a nationally consistent standardised approach that provides statistically robust outcomes.
 - Provide standardised, timely and scientifically sound estimates for fisheries managers and stock assessment scientists.
 - Address the reliability and credibility of recreational fishing catch and effort estimates to allow an informed decision making process.
 - Develop fisher-driven programs to minimise the perception of transparency and accountability issues by use of innovative technologies (e.g. iPhone apps).
 - Develop a program that aids in the identification of species that are economically or socially important to stakeholders, including indigenous fishers.
 - Develop a spatial analysis capability to identify recreational catch and effort differences associated with species/locations across the various jurisdictions.
 - Make the data publicly available in a standardised format with user-friendly tools for data queries.
 - Get buy-in, cooperation and engagement from a broad range of stakeholders who are prepared to trust the data collected and are confident in the integrity of the information collected.
 - Identify top 10 species for northern and southern Australia – a pilot study approach.
- Overall, the request from recreational fishers was for researcher and government to: collect and provide robust information on who is fishing, what species they are fishing for, where they are fishing, why they fish in these locations, how they fish (what tactics and tackle), the level of catch and release, and the economic benefit derived from each species.

Lessons learned from the 2000/01 National Recreational Fishing Survey

- A brief recap of the 2000/01 national survey was provided detailing the main objectives of the study, which were similar to the present project objectives. In particular, these were to determine the participation rate, quantify catch, effort and expenditure nationally, by State and where appropriate, regionally.
- The key lessons learned from the national survey were described to highlight some of the significant issues that need to be addressed in the current project. In particular, the key lessons were:
 - The statistical complexity of the analyses. It was noted that the “RecSurvey” analytical module had been developed to facilitate data analysis and has been applied to subsequent surveys and reanalysis of the national survey in some jurisdictions.
 - Avoid overselling the product and manage expectation. For example, large-scale surveys provide big picture data, it is an unrealistic expectation for such surveys to provide reliable information about rare or specialist activities – such as fishing in a

small estuary or game fishing for billfish – specifically designed surveys are required in such instances.

- There is a need to sell the product to resource managers and stakeholders. There has been a perception from some that the sole output of the national survey was the national report, when in fact the survey provided a dataset that provided information at a range of spatial scales (regional and state-wide) and sub-fisheries (by method and water body type). States are now starting to recognise the significance of the national survey dataset and in many instances, it represents the only baseline information available at statewide and regional scales for the recreational fishery.
- Understanding the different agendas and expectations of stakeholders. While there was consensus regarding the need for information about the recreational fishery, there were differing agendas that need to be understood. For example, the recreational sector was more interested in participation, social benefits and economic value, primarily to support lobbying for recognition of the sector. In contrast, there was a lack of clarity and consistency amongst resource managers as to the utility of the survey for policy development, resource sharing, and addressing sustainability issues. This situation was exacerbated by the fact that few jurisdictions undertook further analyses of the survey database at the scale that states and territories manage their fisheries.

Social data in recreational fisheries

- A general overview was provided as to the importance of social data in recreational fishing surveys, as well as a brief audit of surveys that included social aspects, the data collection methods used, and the data custodians. The key reasons why social data were considered important were:
 - Understanding who the ‘average’ recreational fisher is and how they behave.
 - Enhancing communication between researchers/managers and fishers.
 - Identifying and understanding benefits (e.g. health, lifestyle and additional food sources).
 - Identifying behaviours and resultant economic flow on to regional areas.
 - Understanding changing use and access to recreational fishing areas.
 - Linking intended and resultant effects of policy decisions (e.g. marine parks).
 - Improves tailoring of management plans and policy.
- A summary of the key findings across recreational fishing studies that collected social data were:
 - Difficult to get consistency in data collection methods and therefore, comparison of data and findings over time.
 - Longitudinal studies are most useful, but difficult to secure and retain funding for.
 - Differences in behaviour and attitude occur between recreational fishers by age/ gender/residence, body of water fished, and species targeted.

- Data are often underutilised due to a lack of ability to ‘mine’ the data.
- A brief discussion was undertaken to identify the types of social data, or social indices that could be used to answer the common questions posed by recreational fisher and resource managers relating to social aspects of recreational fishing. General descriptive demographic data such as age and gender composition of fishers was often collected in surveys but was often not reported or integrated in analyses.
- Few other social metrics were specifically mentioned as being useful for recreational fisheries. Some participants suggested that the specific questions need to be determined first, identifying the specific audience, and then consulting with the key stakeholders before looking to the datasets to see what can be used to answer the question. A hierarchy of questioning was suggested, beginning with resource managers who may be interested in the broadest sustainability issues, tapering down to smaller stakeholder groups that may have more specific interests, such as gaining access to a specific resource. The workshop group was referred to the “Proposed social objectives and indicators for monitoring performance of Australian fisheries management” project (FRDC 2010/040) for further information.

Economic data in recreational fisheries

- A useful approach for measuring the economic value of recreational fisheries was described as seeking a “GVP Equivalent” that is:
 - Endorsed by fishers, end users, and stakeholders (i.e. has ‘credibility’)
 - Repeatable
 - Economically sound and accurate
 - Portable across all recreational fisheries and jurisdictions
 - Cost-effective
 - A reflection of economic contribution, not economic impact (i.e. what happens to the economy if this activity ceases)
- A summary of the current approaches used to measure economic value of recreational fisheries in other countries was presented, focusing on research undertaken in Canada, USA, New Zealand, Ireland, the UK, and France. The summary revealed that a range of survey methodologies have been employed to collect economic information including mail-out surveys to licence holders, on-site surveys at boat ramps, and telephone surveys. Similarly, a range of economic valuation measures were used, but the Travel Cost approach was the most common measure employed.
- An overview of the economic valuation options was presented, consisting of nine metrics ranging from “Market Information” that measures actual economic value using market prices, to “Hedonic Pricing” that uses implicit prices for attributes that are not directly observed (e.g. rise in value of property used for fishing). It was noted that the “Travel Cost” methods was the preferred approach for valuation of recreational fisheries, since actual trip cost data are used as well as direct and indirect costs, as well as expenses and investments in relation to recreational fishing. Market information was determined to be unachievable for recreational fisheries generally and even use of ‘proxy’ goods was not possible.

Session 2: National review of recreational fishing datasets

The second session of the workshop comprised a series of presentations by each state, territory and federal representative, and a synopsis of each presentation is detailed below.

Tasmania

- State-wide general fishing surveys:
 - General fishing surveys using a phone-diary survey method and based on general population sampling - conducted in 2000/01, 2007/08 and planned 2012/13.
 - Rock Lobster and Abalone fisheries surveyed using a phone-diary survey method and based on sampling from a licence frame - conducted biennially since 2000.
 - Gillnet fishing activity using a phone-diary survey method and based on a sampling from a licence frame - conducted in 1996-98 and 2010.
 - Trout fishing surveys using mail surveys of licence holders - conducted annually.
- Regional catch and effort surveys:
 - Gamefish fishery (southeastern Tasmania) using on-site surveys in 2003, 2008 and phone-diary and on-site surveys in 2012 (the phone-diary survey involved sampling from the Tasmanian boat registry database).
 - Scallop fishery (southeastern Tasmania) by using dive surveys and phone surveys of licence holders – conducted between 2005-2008.
- Surveys involving the collection of social and economic data - social data included demographics, motivation to fish, centrality to lifestyle, consumptive orientation and attitudes. Economic data have included expenditure and examined non-market (contingent) valuation, specifically contingent valuation and expenditure.
 - General recreational fishing surveys conducted in 2000/01 and 2007/08.
 - Rock Lobster fishery survey in 2007/08.
 - Socio-economic survey of the gamefish fishery in 2007.

Queensland

- A general overview of the statewide, regional and specific surveys undertaken in Queensland was described. The state-wide surveys were:
 - SWRFS 2010
 - RFISH Fishing Diary: 1997, 1999, 2002, 2005
 - RFISH Telephone Survey: 1996, 1998, 2001 & 2004
 - NRIFS 2000
 - Logbooks for charter vessels operating >3m depth

- The Queensland Department of Agriculture, Fisheries and Forestry also hold data for various regional surveys including:
 - SEQ boat ramp survey, 2008
 - Blue Swimmer Crab survey in Moreton Bay, 2000
 - Recreational fishing survey in the Burnett, Maroochy and Pumicestone passage water bodies, 1997-98
 - Normanton and Burketown fishing competition survey, 1998
 - Small Mackerel survey, 1994-95
- It was explained that several other datasets were available that describe recreational fishing in Queensland, but were owned by other institutions. These include:
 - CSIRO: Impact of Moreton Bay marine park on human activity, 2008-2010
 - JCU: Baseline socio-economic data for Qld east coast inshore and rocky reef stakeholders, 2008
 - Southern Gulf Environmental information program – pilot study 2002
 - Recent NERP projects including the social long-term monitoring program focusing on the Great Barrier Reef Marine Park
- Special reference was made of the CAPREEF Community monitoring program in central Queensland, which commenced 2005/06 and is ongoing. This program comprises multiple projects utilising regional access point surveys, diaries and BRUVS to collect data on trends in recreational fishing in the region such as:
 - change in catch and effort, size and abundance of key species
 - changes to participation and patterns
 - fish movement in relation to marine park zoning
 - social and economic values
- The Queensland Game Fishing Association was identified by the group to hold detailed trip-specific data of its members through its logbook program. The group was informed that DEEDI was not responsible for managing this dataset. A representative of QGFA was invited to the workshop, but no response was received. It was noted that this dataset might be of importance if the top priority species of the project includes pelagic fish species such as billfish and tunas.

Victoria

- An overview was provided of the datasets held by Victoria's Department of Primary Industries, which include:
 - State-wide surveys
 - On-site Recreational Fisheries Surveys

- Victorian Angler Fishing Diary Program
- Victorian Freshwater Creel Surveys
- RFL Database
- 12 or more historical datasets
- The state-wide and regional surveys of the general recreational fishery was described to be undertaken using an off-site phone-diary methodology for:
 - NRFS in 2000/01
 - Recreational fishing in coastal Victoria in 2006/07
 - A new survey currently in development
- The offsite phone-diary surveys aimed to provide annual estimates of total recreational harvest. The Victorian component of the 2000/01 NRFS aimed to document fishing (for all methods) in all Victorian waters using household-based sampling of over 2,000 anglers for a 12 month period. The Recreational fishing in coastal Victoria 2006/07 survey documented line fishing in coastal Victorian waters for 650 anglers from the recreational fishing licence frame over 12 months.
- Descriptions were given of surveys aiming to provide a time series of estimated catch rates, size and age structure for key species in key fisheries for providing input into species-specific stock assessments. These surveys included:
 - On-site surveys of three major fisheries (Port Phillip Bay, Western Port, Gippsland Lakes - ongoing) and several minor fisheries (periodic).
 - The ongoing Angler Diary Program, which uses ‘research anglers’ who fish with prescribed gear as a means to standardise effort and selectivity, and ‘general anglers’, who document everyday fishing activities.
- It was also described that some social information was collected in some surveys. An example was given from the Mallacoota Inlet access point survey where ‘non-catch’ values of shore-based and boat-based fishers was high (e.g. fish to relax).

Western Australia

- The recreational fishery in Western Australia was described to cover 20,000+ km of coastline, span four marine bioregions and five habitat regions, and comprise 200+ species.
- It was revealed that a total of 16 recreational fishing surveys (primarily boat-based) were undertaken since 1996, most of which were regional in nature and focused on the southwest of the state. The most recent was a survey of boat-based fishers in 2011-12, which utilised the boat-based recreational fishing licence frame.
- Examples of the recent boat-based statewide survey and the statewide Rock Lobster survey were given to illustrate the vast diversity in the recreational fishery and the specific approaches used to survey each fishery.

- Details of auxiliary validation and calibration surveys were presented to demonstrate how biases (e.g. non-response) were taken into account to produce robust estimates of the recreational western Rock Lobster catch.

Northern Territory

- Surveys undertaken in the Northern Territory were described mainly as being jurisdictional-wide comprising:
 - Fishcount 95 undertaken in 1995
 - The NT component of the 2000/01 National survey
 - The Territory-wide recreational Fishing Survey completed in 2010
 - Fishing tour operator (FTO) logbook data spanning 1994 to present
- It was described that the jurisdictional-wide surveys were undertaken using the Fishcount 95 phone-diary-interview methodology, which also provided the methodological basis of the 2000/01 NRFS.
- The objectives of the surveys were to document:
 - Resident and visitor trends Territory-wide
 - Fishing effort, catch and release by method and area (catchments)
 - Expenditure and investment of fishers
 - Participation rates for fishers and their profiles
 - Awareness and opinions of fishers
- Fishing Tour Operator (FTO) logbook data were described to be an important dataset for characterising the recreational fishery in the Northern Territory. It was explained that the FTO log sheets are designed to provide:
 - Numbers of line hours fished in each reporting grid (or by GPS) using specific fishing methods (e.g. barramundi, game, reef and bottom, crabbing and other minor methods)
 - Numbers of each species caught and released using each method in each grid
 - Numbers of clients from each state and country and days fished
 - Trip duration
- It was also noted that the guided fishing industry's annual contribution to the NT economy is currently being analysed using logbook data.
- Detailed summary tables were presented of trends in catch and effort and total catches/releases for FTOs. An interesting trend was the decrease in client fishing days over the past two years, explained as a result of the global economic downturn.

South Australia

- The recreational fishery in South Australia is comprised of three primary components: the licensed charter boat fishery, permit fisheries (namely Rock Lobster), and unlicensed fisheries.
- The charter boat fishery has 105 licenses (~80 active) and reporting has been ongoing since 2005 with respect to effort, catch and principle residence of clients. Annual catch (in numbers) is estimated by species and fishing block. Additionally, release rates are estimated for King George Whiting and Snapper.
- The Recreational Rock Lobster pot permit fishery has been ongoing since ~1990 and was surveyed in 1998/99, 2001/02, and 2004/05 using a phone-diary approach using randomly sampled permit holders to produce estimates of annual total harvest and effort.
- Statewide surveys of the unlicensed general recreational fishery were undertaken in 2000/01, 2007/08 using the phone-diary method of 1200-1700 screened fishing households, as well as limited on-site sampling. These surveys both produced estimates of participation, catch, and effort for around 70 species.
- It was explained that the social data were collected at the end of each statewide survey of the unlicensed fishery including fishing motivations, and awareness of recreational fishing regulations. It was also noted that a recent project 'Development of Social Performance Indicators for the Recreational Fishery' was undertaken in January – February 2012 in three SA Case Study Areas (Ceduna, Port Lincoln, Wallaroo).

New South Wales

- Detailed descriptions were provided on the 12 specific surveys included in the metadata matrix, which were taken from the ~40 studies conducted in New South Wales since 1980. The surveys were described to have widely varying temporal and spatial scales and most were commissioned as reactions to specific events, such as surveys in the Richmond and Macleay Rivers in 2001 in response to fish kills.
- Several regional surveys were described including:
 - Recreational Fishing Haven study using on-site surveys of Lake Macquarie and Tuross River in 2000/01, 2003/04 and 2011.
 - Gamefish Tournament Monitoring Project using logbook and dockside surveys from 1993 to present.
 - Offshore boat-based recreational fishing survey using on-site sampling and boat movement logbooks at Coastguard towers during 1993 and 1994.
 - Tournament angling catch and effort surveys (saltwater and freshwater) using logbooks and on-site surveys from 1988 – present.
 - Gamefish Tagging program undertaken with the cooperation of fishers from 1973 to present. The program has tagged ~400,000 fish and accounted for ~7,000 recaptures.
 - Charter fishing logbook program involving ~150 licensed boats from all major ports and estuaries in NSW (and some freshwater guides) running from 2000 to present. It is a condition of the licence but there are data quality and compliance issues.

- Greater Sydney Region recreational fishing surveys (focused primarily on marine parks) from 2007-2009.
- Richmond and Clarence Rivers Recreational Fishing Surveys in 1988/89, primarily undertaken to compare the catches of the commercial and recreational fisheries to resolve inter-sector conflict.
- Recreational prawn catches in Southeastern NSW estuaries, which involved nighttime surveys between 1991-1994, commissioned to compare the catches of the commercial and recreational fisheries to resolve inter-sector conflict.

Community monitoring programs

- An overview was provided on non-governmental ‘citizen science’ community monitoring programs related to recreational fisheries. The programs were primarily confined to regional areas of central and northern Queensland and Northern Territory and include:
 - Suntag – a tagging program run in association with the Australian National Sportfishing Association holding records for 665,000 tagged fish.
 - Crystal Bowl – a regional based monitoring program responsible for 43,000 tagged Barramundi.
 - CapReef – an ongoing regional survey since 2005 that collects information in relation to the effect of changes of the zoning of the GBR marine park on recreational fishers.
 - King Ash Bay – a regional community-driven recreational fishing survey.
- The monitoring programs (Crystal Bowl, CapReef and King Ash Bay) were described to collect catch (retained/released) and effort (time on water and number of fishers) data using boat ramp surveys from 2005-2012 and had collectively surveyed ~20,000 fishing trips.
- The community programs were described to link through the Infofish 2012 database that incorporates ancillary information (e.g. environmental data) to produce real-time data that are publicly available.

Session 3: Development of an analysis approach

The third session of the national recreational fishing data workshop resulted in the group condensing the list of NRFS species to 48 species/species groups (Table 2) and the top 20 species that had national importance to recreational fishing stakeholder groups and resource managers were selected for further analysis.

Table 2: List of recreationally important species/groups, as determined by numbers of individuals in the 2000/01 National Recreational Fishing Survey. Numbers are arbitrary scores of perceived importance (2 = medium, 3 = high) to recreational fishers and resource managers for individual State and Territory jurisdictions.

Taxa	NSW	QLD	NT	WA	SA	TAS	VIC	Score
Sharks	2	3	3	3	3	3	3	20
Squid/cuttlefish	3	2	3	3	3	3	3	20
Flathead	3	3		3	3	3	3	18
Rock Lobsters	3	2		3	3	3	3	17
Tuna	3	2		3	3	3	3	17
Bream	3	2		2	3	3	3	16
Abalone	3			3	3	3	3	15
Snapper	3	3		3	3		3	15
Mulloway/jewfish	3	2	3		3		2	13
Trevally	3	2	2	2	2		2	13
Whiting	3	2	2	3	3			13
Blue swimmer crab	3	3		3	3			12
Yellowtail kingfish/Samson/Amberjack	3	2		2	3		2	12
Cod (various)	2	3	3	3				11
Golden perch	3	2			3		3	11
Mud crab	2	3	3	3				11
Australian salmon	2				3	3	2	10
Murray Cod	3	2			2		3	10
Emperors		3	3	3				9
King George whiting				3	3		3	9
Sea perch/snappers (Lutjanids)		3	3	3				9
Trout/salmon	3					3	3	9
Barramundi		3	3	2				8
Crayfish (freshwater)	3				3		2	8
Mackerels		3	2	3				8
Prawns (saltwater)	3	2		3				8
Tailor	3	3		2				8
Threadfin salmon		3	2	3				8
Billfish	3	2		2				7
Australian herring				3	3			6
Dolphinfish	2	2						4
Barracouta								0
Blue mackerel								0
Coral trout								0
Elephant Fish								0
European carp								0
Flatfish								0
Garfish								0
Grunters/trumpeters								0
Leatherjackets								0
Luderick								0
Macrobrachium/cherabin								0
Morwong								0
Mullet								0
Pike								0
Prawns (freshwater)								0
Scads/mackerel								0
Scorpionfish/gurnard								0

Identification of key reporting regions

The outcomes from the workshop group discussions in Session 3 regarding spatial extent of reporting regions are detailed below.

- Concern was raised as to the level of detail that would be available via the data portal, since non-scientists may wish to create data summaries and not understand, or even ignore, the quality of estimates (and their associated error) generated by their queries. It was agreed that data would only be available in summarised form at the lowest resolution provided by the source survey. For example, a portal user would not be able to generate catch estimates for a species in a particular state if a survey for the species was conducted only in a single estuary where catch could not be extrapolated.
- It was proposed that the reporting resolution of data would need to be species-specific since the geographic distribution of each species will differ, and therefore incorporate different proportions of the spatial extent of jurisdictional-specific surveys. For example, a wide-ranging species may cross several jurisdictional boundaries and therefore a national estimate of catch would involve combining catch estimates from several jurisdictional surveys (or parts thereof). Therefore, there would be a number of spatial scales at which catch estimates that could be provided: i) the finest regional scale strata reported within each jurisdictional survey, ii) jurisdictional-wide, iii) stock-level estimates combining relevant regional strata sampled within each of the jurisdictions, and iv) national level estimate comprising all jurisdictional estimates. Two examples are provided in Figure 14 for the multi-jurisdictional stocks of east Australian Salmon and southern Rock Lobster.
- In discussing the possible framework for reporting specific components of the datasets, it became clear that two reporting formats would be required for the data portal. These are: i) species queries (e.g. catch, effort) for individual species, and ii) fishery queries (e.g. participation, demographic profiles, expenditure).
- Lengthy discussions were undertaken as to how the fishery-level data could be reported, specifically with respect to qualitative or semi-quantitative social data. Suggestions were made to again seek the input from recreational fishing stakeholders and resource managers as to the specific questions they wish to answer before exploring the datasets. However, the point was made that this project was not about collecting new data and can therefore only draw from the data that is already available. Although it would be ideal to ‘fit the data to the question’, in this project it may only be possible to pose questions that can be fitted to the data. Nonetheless, the project team agreed to seek the input from stakeholders and managers to best try to answer their questions with the data available.
- A lengthy discussion was undertaken as to the most appropriate reporting units for the final report and the data portal. This was considered important for being able to make quantitative comparisons across methods and jurisdictions. It was acknowledged that catch per unit effort (CPUE) had very different meaning between different studies, even of the same species, due to the different ways that effort data were collected or reported. For example, some studies might consider it appropriate in their situation to report in number of fish per fisher hour, while others may report in number of fish per day. It was agreed that the most appropriate unit of measure is “fisher day” since data collected at a finer resolution (e.g. per hour) may be converted to fisher days based on the average trip length per fisher.

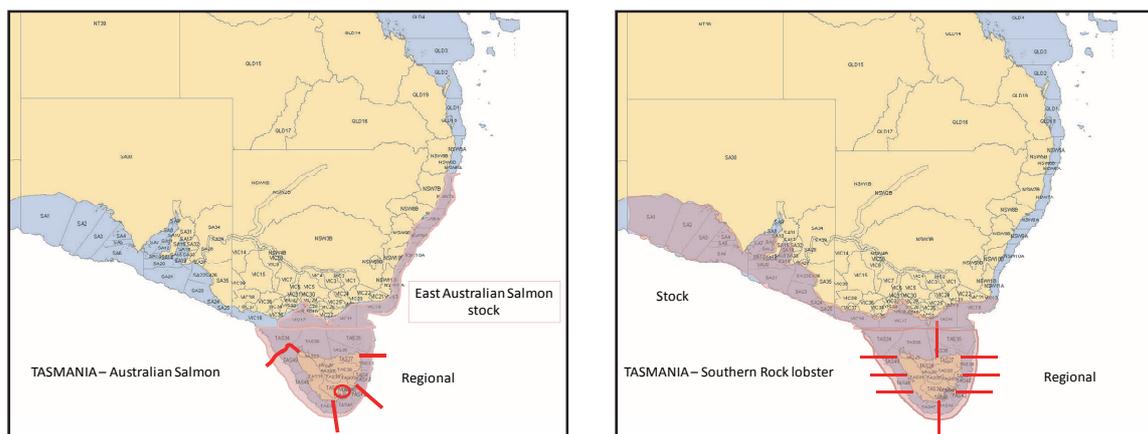


Figure 14: Proposed levels of reporting when providing ‘best possible’ catch estimates for multi-jurisdictional species through a national data portal for recreational fisheries data. Red lines indicate availability of regional-level estimates in Tasmania, while pink shaded area indicates availability of jurisdictional and stock-level estimates for east Australian Salmon (left panel) and Southern Rock Lobster (right panel).

Workshop conclusions

The workshop group successfully met all five workshop objectives, beginning with information exchange between State, Territory and Federal jurisdictions, as well as recreational fishing stakeholders; creating linkages between recently completed, current, and proposed projects; and concluding with a framework by which available recreational fishing data may be most appropriately aggregated and made available to stakeholders at regional, jurisdictional and national levels. Some specific conclusions from the workshop are provided below.

- There is a clear need for the best available recreational fishing data to be available to recreational fishers, researchers and resource managers to allow its timely use in helping address issues such as sustainability of recreationally-important species and resource allocation of species shared with commercial and indigenous sectors.
- Where feasible, national estimates will be produced for the highest priority species in the current project, as well as the framework for a public recreational fishing data portal. However, the construction of the portal, its population with up-to-date data, and ongoing management are issues for consideration in future work.
- A total of 91 recreational fishing surveys were identified nationally, comprising a heterogeneous national mosaic of recreational fishing in space and time. Since the 2000/01 NRFS, most states and territories have undertaken or plan jurisdiction-wide surveys, or at least large-scale regional surveys, generally employing the phone-diary survey methodology. With the appropriate statistical treatment, it may be possible to aggregate these surveys to produce regional, jurisdictional, stock-level, and national estimates.
- Of the 50 most important taxa identified from the 2000/01 National Survey, 30 were selected to produce national estimates. However, further input into the final selection is required from recreational fishing stakeholders and resource managers taking into account factors such as stock and/or conservation status, resource allocation, legislative requirements, iconic value, participation trends, economic and/or social benefits.
- Before social and economic data can be mined from the datasets, further clarification needs to be sought from recreational fishing stakeholders and resource managers as to the specific questions they would like answered at jurisdictional and national levels. However, if

information has not been collected in the first instance then this project will not be able to answer the key questions, and therefore, be identified as an information gap.

- For some species, it was likely that data aggregation would be possible across multiple jurisdictions although the minimum spatial reporting resolution will be species-specific (and possibly survey specific). Potentially, four levels of spatial reporting would be available: i) the finest regional scale strata reported within a given survey, ii) state-wide, iii) stock-wide, and iv) national.
- Reporting units for effort and catch rates in the project and the data portal will be “fisher day”, in order to allow quantitative comparisons between regions and methods.

Identification of national priority species and data harvesting from identified datasets

A total of 41 species and 17 species groups were identified by jurisdictional researchers, fishery managers and recreational peak bodies as priority species for estimating 'best available' estimates at the national level and are shown in Table 3.

Table 3: List of the 41 species and 17 species groups identified by jurisdictional researchers, fishery managers and recreational peak bodies as priority species for estimating 'best available' estimates at the national level.

Species group	Species	Species group	Species
SALTWATER FINFISH			
Australian Salmon	Eastern Australian Salmon	Tuna	Albacore
	Western Australian Salmon		Australian Bonito
Barramundi	Barramundi		Longtail Tuna
Flathead	Dusky Flathead		Southern Bluefin Tuna
	Southern Sand Flathead		Yellowfin Tuna
	Tiger Flathead		
Jewfish	Black Jewfish	FRESHWATER FINFISH	
	Jewfish - unspecified	Golden Perch	Golden Perch
	Mulloway	Murray Cod	Murray Cod
Sharks and Rays	Gummy Shark	CRUSTACEANS	
	School Shark	Blue Swimmer Crab	Blue Swimmer Crab
	Shorfin Mako	Mud Crab	Giant Mud Crab
	Tiger Shark	Rock Lobster	Southern Rocklobster
	Whaler & Weasel Sharks		
Snapper	Whaler Sharks	MOLLUSCS	
	Snapper	Abalone	Blacklip Abalone
Whiting	King George Whiting		Brownlip Abalone
	Sand Whiting		Greenlip Abalone
	Trumpeter Whiting		Roe's Abalone
Tailor	Tailor	Squid and Cuttlefish	Cuttlefish
Tropical Snappers	Golden Snapper		Gould's Squid
	Mangrove Jack		Southern Calamari
	Red Emperor		
	Red Snappers		

Workshop 2 – Assessment of requested recreational fishing datasets for statistical analyses

The National Recreational Fishing Data Workshop presented summarised data for the 30 projects that contained catch and/or effort estimates for the identified priority species. These were primarily jurisdictional surveys, some with regional breakdowns, using similar sampling methodologies as the NRFS telephone-diary approach.

All jurisdictional fishery agencies had undertaken jurisdiction-wide recreational fishing surveys since the 2000/01 NRFS (see Figure 11), which included collection of data for species identified by researchers and managers in each respective jurisdiction.

With the exception of Rock Lobster and Abalone, which each had a dedicated survey in most relevant jurisdictions; no finfish species on the list of priority species had survey data available for more than four surveys in any jurisdiction since 2000. To illustrate the extent of fragmentation in the survey data available to the project, we herein use three of the highest priority recreational species; Snapper, Murray Cod, and Australian Salmon. For each of these species it would be assumed that catch estimates would be available for the entire geographic distribution of each species from the NRFS, but clearly, this is not the case. This is primarily due to low effort and/or insufficient sampling in some NRFS reporting regions. However, it is expected that catch of these species was very low in the regions where NRFS estimates were not available.

For example, for Snapper there are large regional areas in South Australia and southwestern Western Australia where catch estimates are absent (Figure 15). This is similarly the case for Australian salmon, with some regional gaps in Western Australia, South Australia and New South Wales. Nonetheless, if the 2000/01 NRFS provides a survey benchmark, clearly there are enormous spatial gaps created by the lack of surveys in some jurisdictions, and temporal gaps created by the infrequency of surveys in particular jurisdictions.

In the case of Snapper, there is comparable spatial coverage in Western Australia in 2001 and 2011, with some overlap in survey areas in 2006, while the same regions were surveyed in South Australia in 2001 and 2008 (Figure 15). In contrast, there is almost no spatial overlap in surveys for Murray Cod in 2001, 2007, 2008 and 2011 (Figure 16). This is because all jurisdictions within the distribution of the species undertook surveys in 2001, but only Victoria undertook surveys in 2007 and 2008, South Australia in 2008 and Queensland in 2011 as part of each jurisdictional survey. Similar to Murray Cod, data for Australian Salmon is highly fragmented, with most states except South Australia and parts of Tasmania having data available for the same regions for more than one survey (Figure 17).

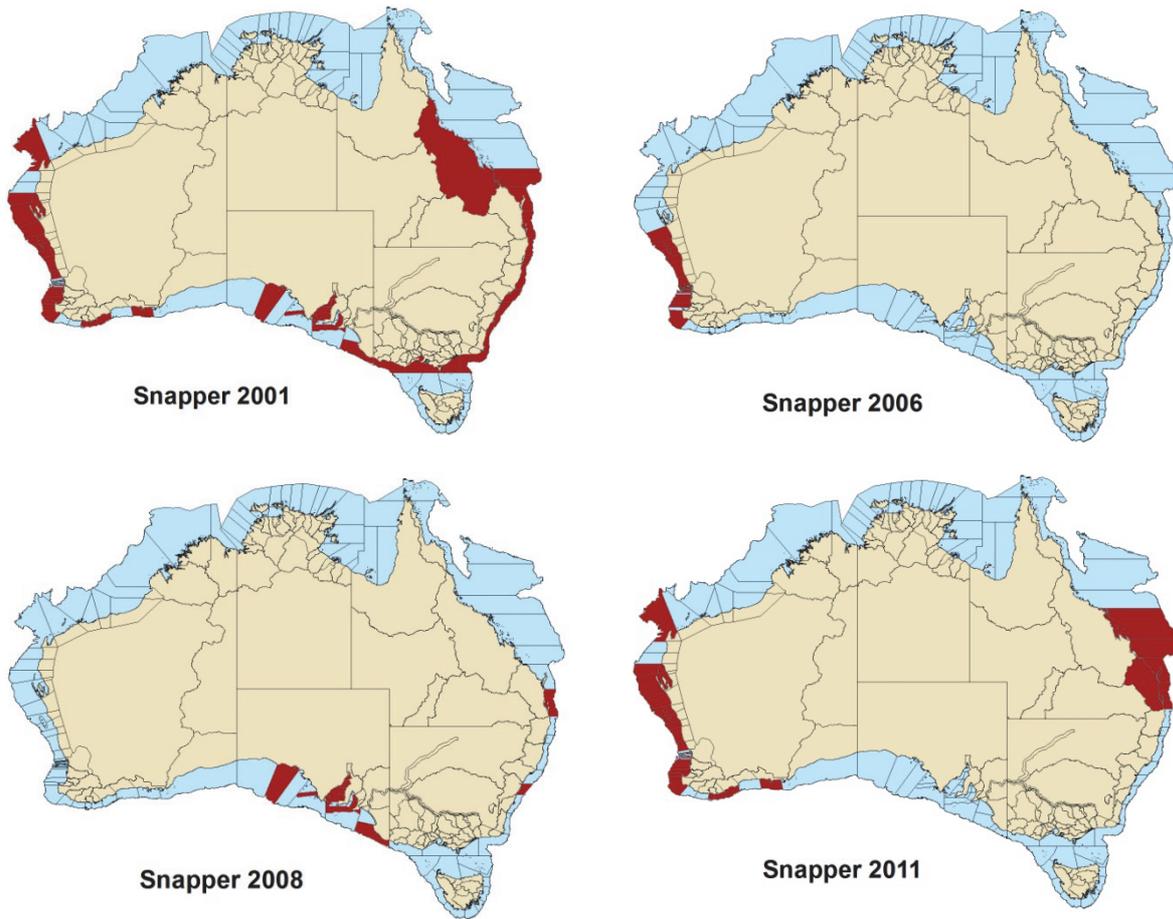


Figure 15: Maps showing the spatial availability of catch data provided by each jurisdiction for Snapper.

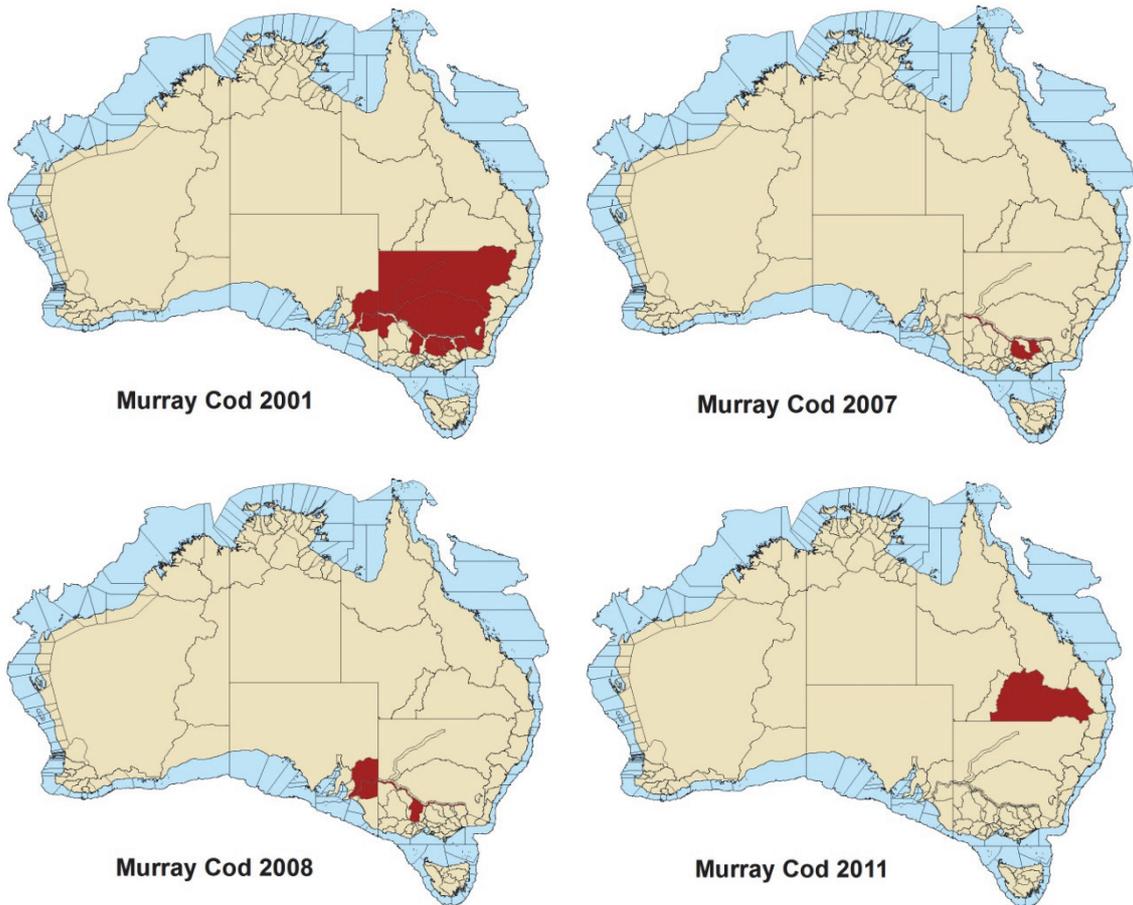


Figure 16: Maps showing the spatial availability of catch data provided by each jurisdiction for Murray Cod.

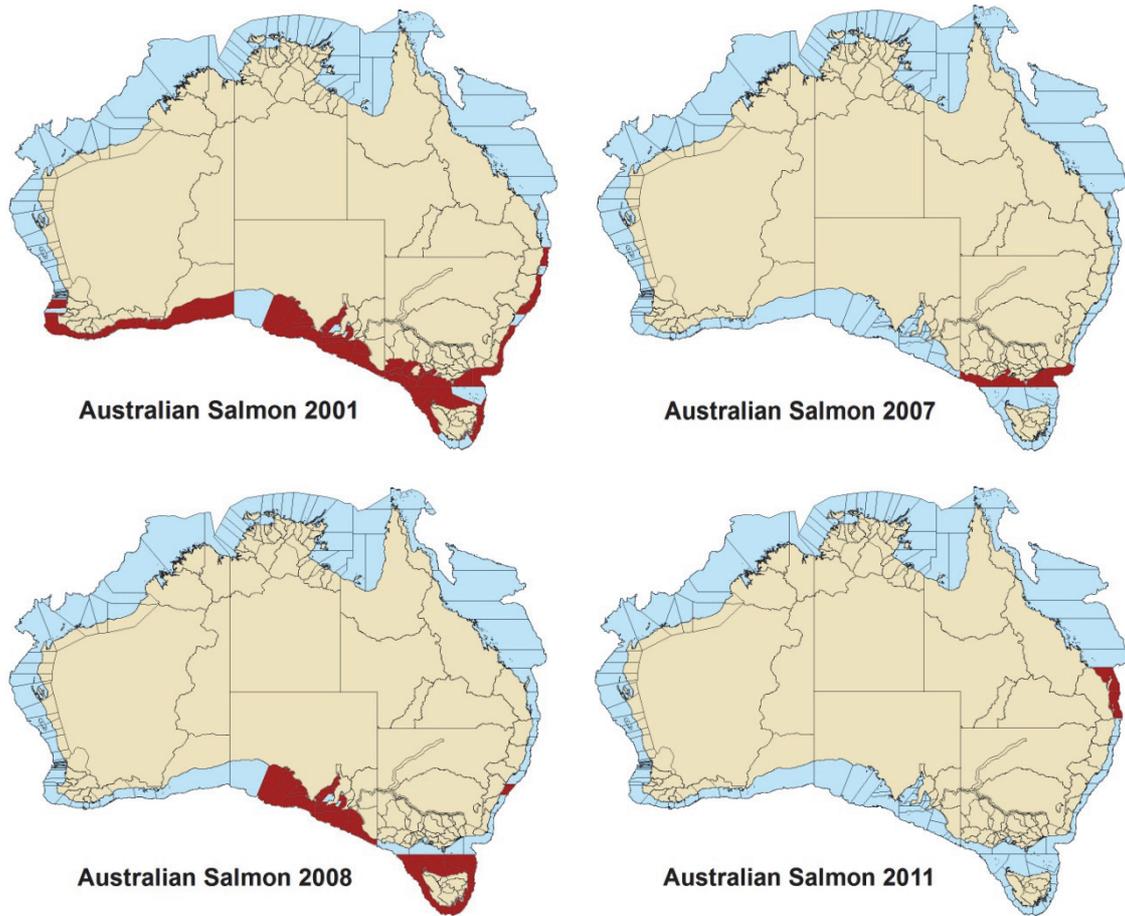


Figure 17: Maps showing the spatial availability of catch data provided by each jurisdiction for Australian Salmon.

Statistical analyses of available datasets

Western Australian Recreational Rock Lobster Fishery

Description of the dataset

The Western Australian recreational Rock Lobster fishery data reported by Melville-Smith and Anderton (2000) was in a highly aggregated form, reported as totals of catch (in numbers and tonnes) and effort (in fisher days per fisher) for the entire state and for each year. Since each ‘annual’ survey straddles two calendar years due to the fishing season primarily extending from October to February, survey year will hereafter be referred to as “fishing season”. No regional breakdowns in catch or effort were available from the report and annual aggregate estimates were provided for catch and effort, separately for seasons 86/87 to 98/99, inclusive. Values for pot and dive fishing modes were reported separately. Each of the four seasonal responses also had associated variances, reported as standard error.

Figure 18 shows the annual estimated catch and effort data (with 95% confidence intervals) for both the pot and dive collection methods, while the number of recreational Rock Lobster licence holders is shown in Figure 19. In contrast to catch and effort data, the number of licence holders is accurately known from licence sales and are not estimated from surveys. Melville-Smith and Anderton (2000) estimated the number of active licence holders (by fishing mode) using data from ancillary surveys and could have been used in this instance to marginally improve effort. However, we used total licence sales as this would be the only data that would likely be available for most finfish species in most jurisdictions for back-filling.

The licence numbers had a period of relatively stable numbers, namely between seasons 88/89 and 96/97. There was a large relative increase in licence numbers between 87/88 and 88/89 and a relatively steady growth from 96/97.

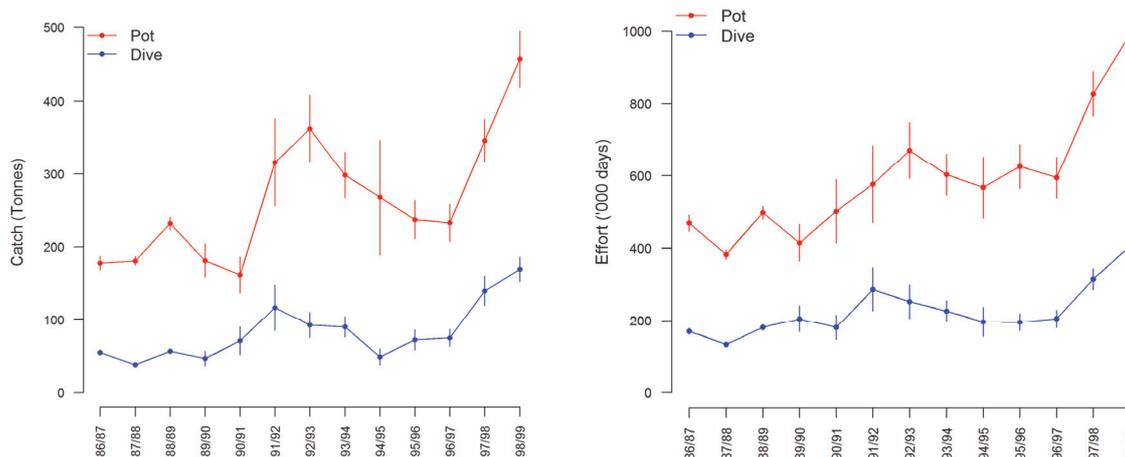


Figure 18: Western Australian Rock Lobster recreational fishery annual catches (left) and effort (right) estimates (with 95% confidence limits) for both pot and dive collection methods. Data were derived from Table 2 in Melville-Smith and Anderton (2000).

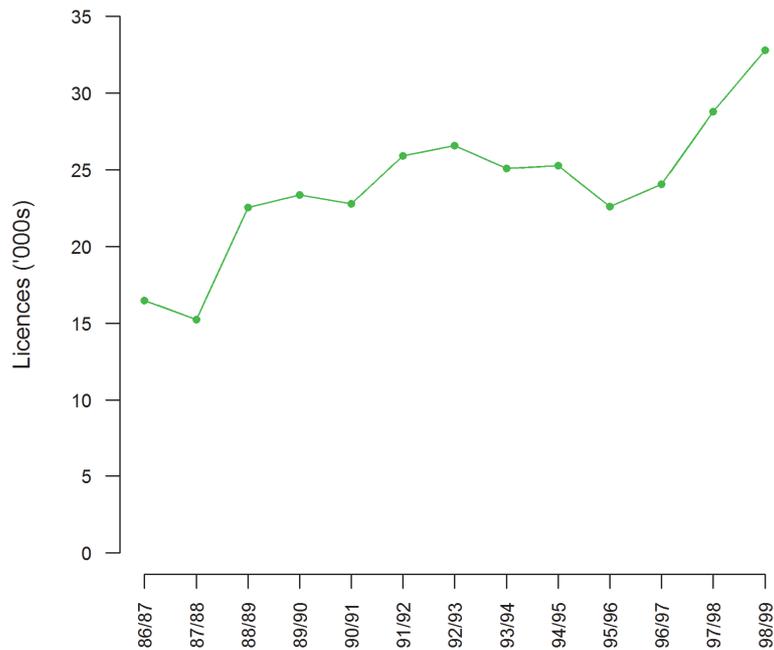


Figure 19: Western Australian Rock Lobster recreational fishery annual aggregate licence sale numbers. Data were derived from Table 2 in Melville-Smith and Anderton (2000).

Statistical modelling

We began by studying the extent to which the data itself may be captured by statistical modelling techniques. If this modelling proved to be successful, then further models could be developed to estimate catch and effort data for years where no survey data are available by using continuous time series data, such as licence numbers or boat owner numbers, as a proxy of effort.

An initial exploratory model

Figure 20 shows a flexible estimate of the way that each of the four measures, catch (pot and dive) and effort (pot and dive), depend on the two available predictors, namely elapsed time (“season”) and licence number. In these analyses, catch, effort and licence numbers were all measured in the log scale, for technical reasons.

Since these estimates were based on a sample of only 13 seasons, with the two determining variables time and licence numbers being clearly very connected, this phase of the analysis must be regarded as exploratory. If the sample size is further reduced, as we intend to do to mimic the effect of less frequent surveys, the models we fit will also have to be simplified.

We used various forms of Generalised Additive Models (GAMs), although each of the models has the same mathematical form, and these may be generically described as follows:

$$\log R = s(T, \log L) + E, \quad E \sim N(0, \sigma^2) \quad (1)$$

where R is one of the four response variables, T is the elapsed time in years, L is the licence numbers and $s(., .)$ is a bivariate tensor spline, where the knot structure and smoothness are determined by cross-validation, using the generalized additive model algorithm.

The general suggestion to come from these analyses was that for (notionally) fixed licence numbers most response variables tend to decrease with time (Figure 20). The only clear exception was dive effort, which appeared to have a general increase with time, but the relationship is complex. The ‘twists’ in the surface plots shown in Figure 20 indicate an interaction between elapsed time and licence numbers.

The results of modelling using the original data are shown in Figure 21. The models performed very well in capturing the general signal, although there were some seasons where the model deviates from the measured response fairly strongly, such as 89/90, 91/92 and 94/95. The multiple correlation estimates from these models, which have to be regarded as overly optimistic, are summarised as follows:

	Catch (Pot)	Catch (Dive)	Effort (Pot)	Effort (Dive)
Flexible model:	0.80	0.64	0.86	0.89

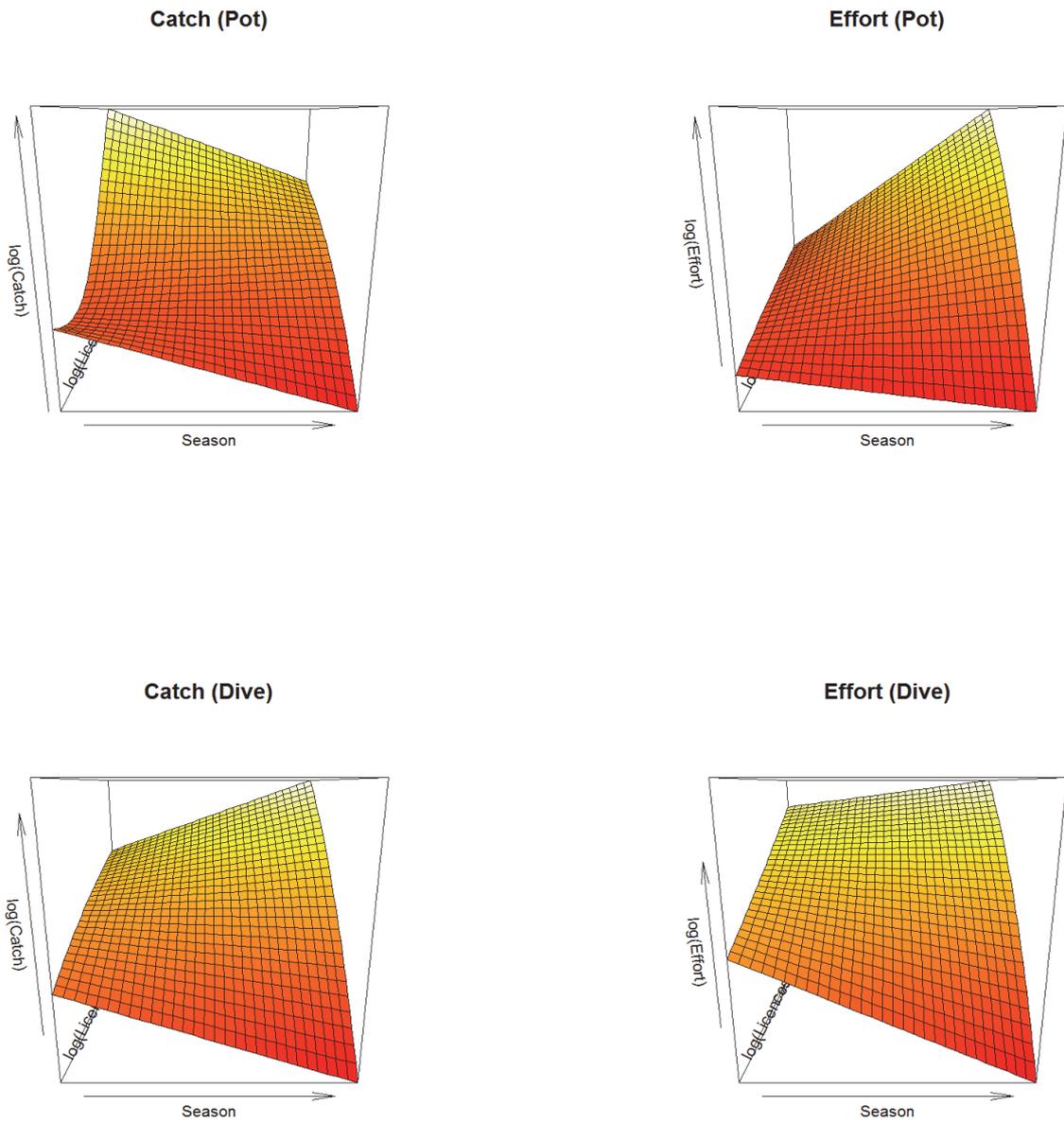


Figure 20: Flexible estimates of the relationship of catch and effort with season and licence numbers for the Western Australian Rock Lobster recreational fishery using Generalised Additive Models based on the entire 13-year dataset.

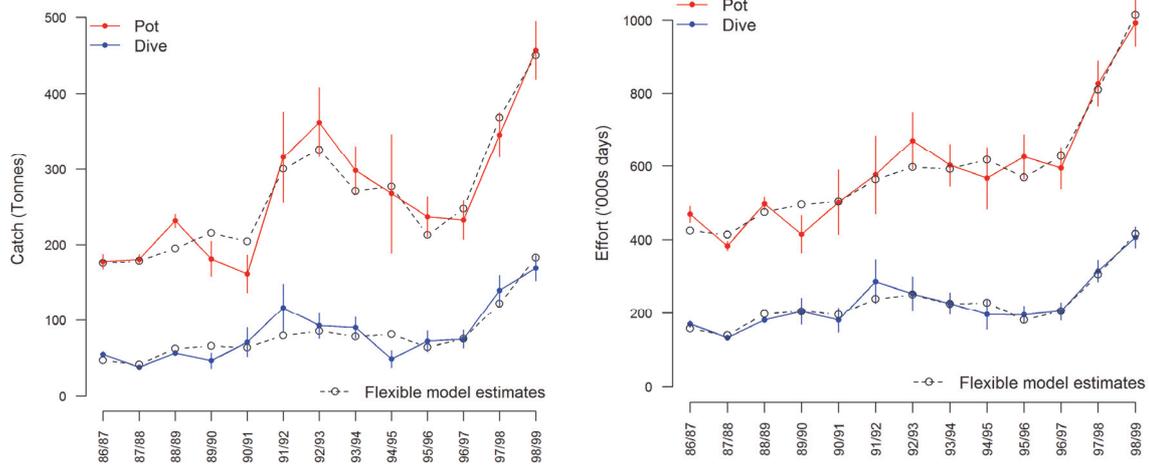


Figure 21: Annual catch (left) and effort (right) estimates (with 95% confidence limits) produced by the flexible model (open circles) for both pot and dive collection methods in the Western Australian Rock Lobster recreational fishery based on the entire 13-year dataset.

Simplified models

If the data are reduced, to more closely mimic the number of surveys undertaken for recreationally-important finfish, the complexity of the models we are able to fit is also reduced. We investigated the performance of a natural simplification of model 1 to an additive model, which assumes that the interaction effect between time and licence numbers is negligible. This simplified model is:

$$\log R = s_1(T) + s_2(\log L) + E, \quad E \sim N(0, \sigma^2) \quad (2)$$

where the variables have the same meanings, but now $s_1(\cdot)$ and s_2 are spline functions, with a limited number of knots. The model was again fitted using a generalized additive model algorithm, so the degree of complexity was again determined by cross-validation. The components of these additive models for catch and effort are shown in Figure 22 and Figure 23, while the joint components are shown in Figure 24.

The fit of these models are shown in Figure 25, while the notional multiple correlation estimates, which again must be taken as optimistic, are shown below:

	Catch (Pot)	Catch (Dive)	Effort (Pot)	Effort (Dive)
Flexible model:	0.80	0.64	0.86	0.89
Additive model:	0.74	0.65	0.86	0.89

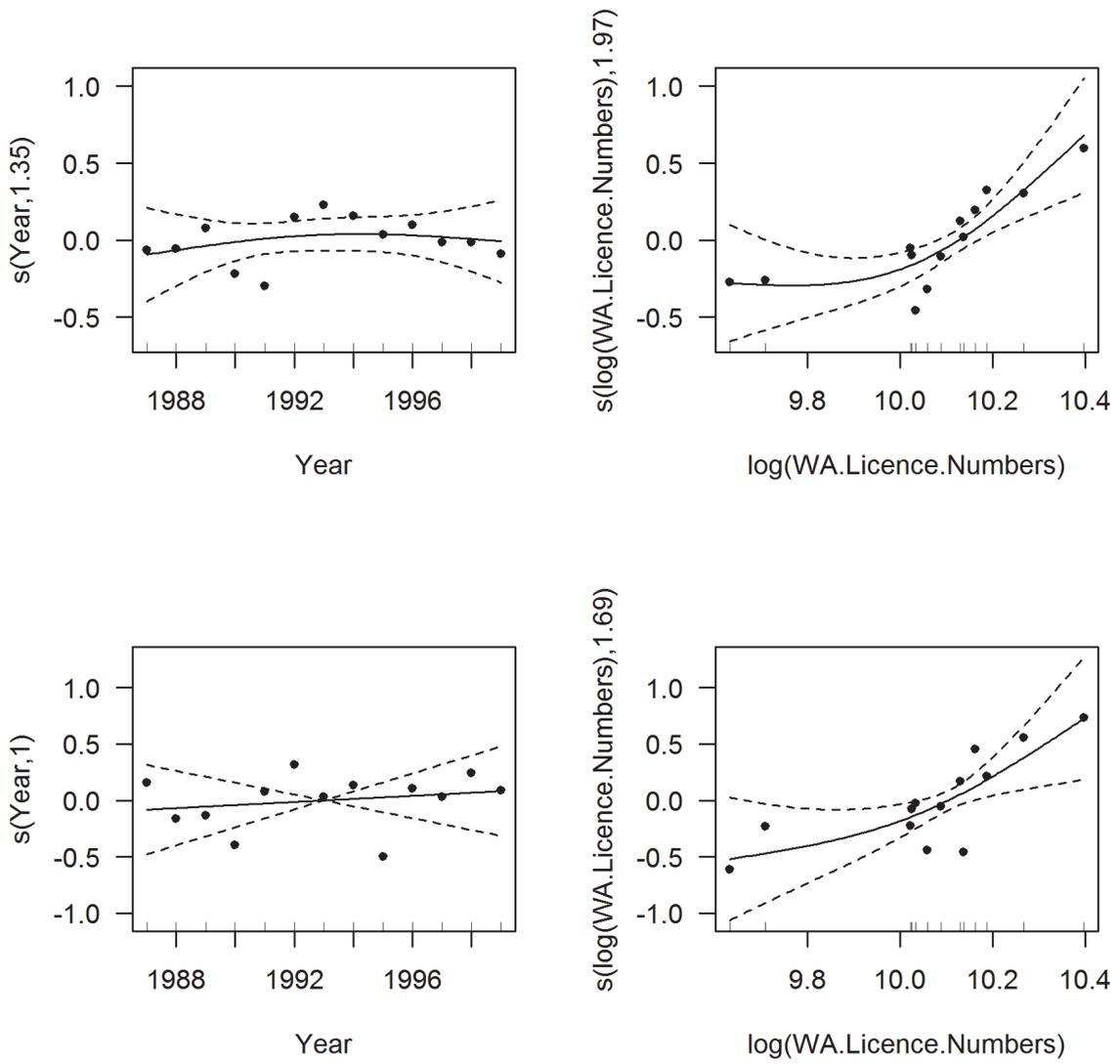


Figure 22: Model components of the simplified additive models for catch.

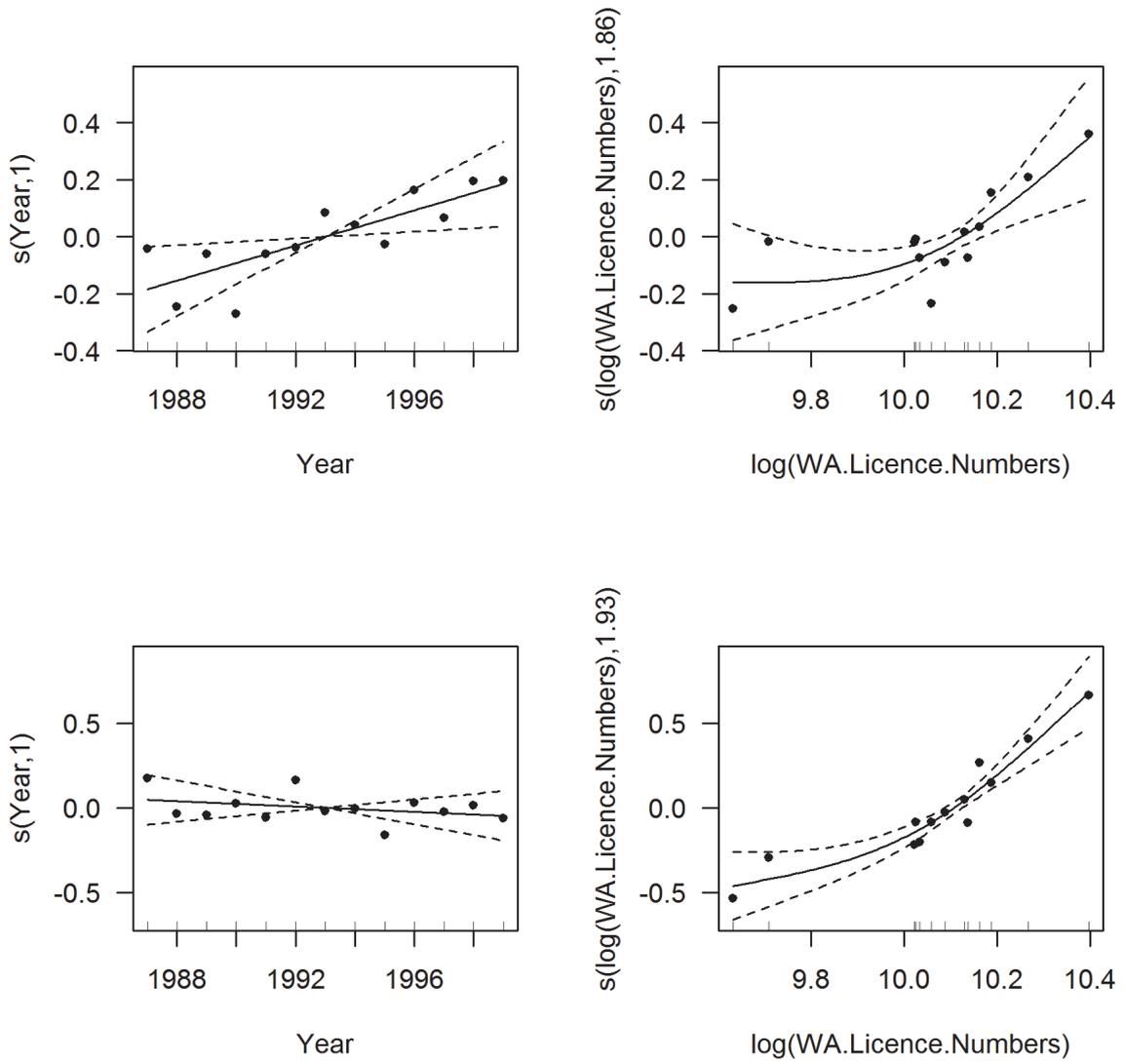


Figure 23: Model components of the simplified additive models for fishing effort.

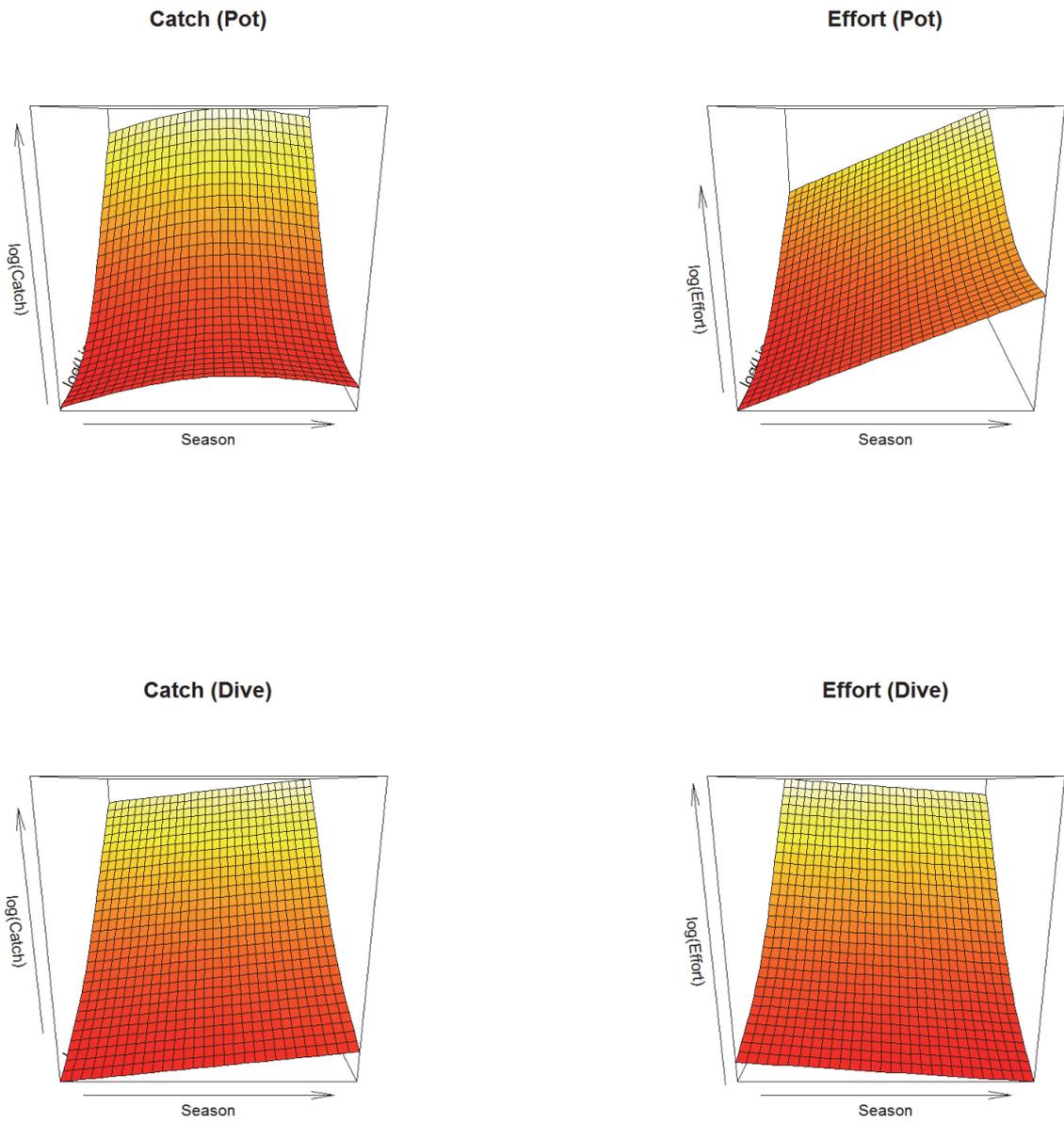


Figure 24: Additive model estimates of the relationship of catch and effort with season and licence numbers for the Western Australian Rock Lobster recreational fishery using Generalised Additive Models based on the entire 13-year dataset.

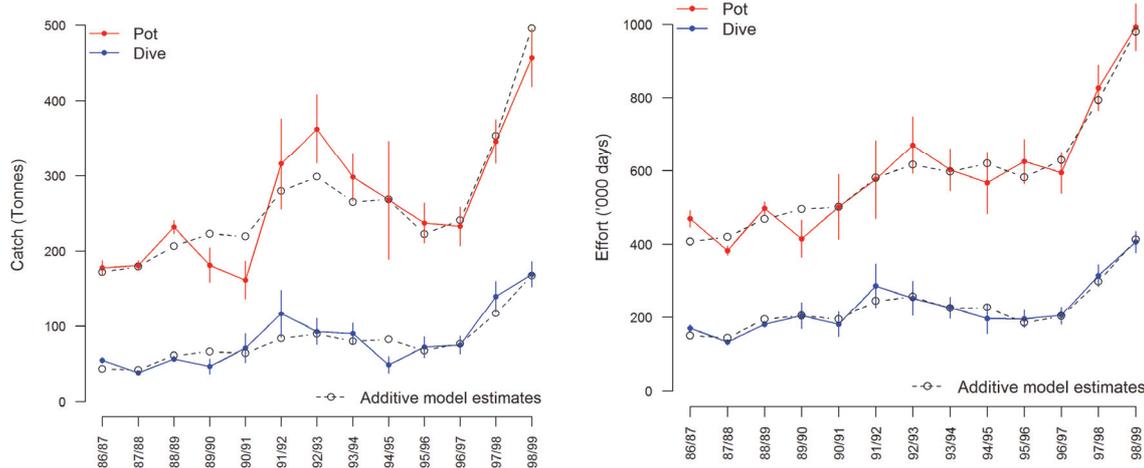


Figure 25: Annual catch (left) and effort (right) estimates (with 95% confidence limits) produced by the additive model (open circles) for both pot and dive collection methods in the Western Australian Rock Lobster recreational fishery based on the entire 13-year dataset.

Reducing the data

To simulate the effect of reducing the frequency of surveys on our ability to estimate catch and effort, we used licence numbers from every third year only to build models for the two catch and two effort variables, and compare the resulting model-based estimates for the entire series with the known survey results.

The results clearly show that by reducing the data not only reduces the information on which the predictive models are based, but it also reduces the complexity that such models are capable of capturing. The reduced data set forces the models to become simplistic. The components of these additive models for catch and effort are shown in Figure 26 and Figure 27, respectively. The joint components are shown in Figure 28, while the fit of these models are shown in Figure 29.

The notional multiple correlation estimates, which again must be taken as optimistic, are shown below. The second last line shows the internal estimate from the fitted model; the last line shows an analogue of the multiple correlation derived by computing the squared correlation between the model predictions and the variable itself for the whole data set (on the log scale).

	Catch (Pot)	Catch (Dive)	Effort (Pot)	Effort (Dive)
Flexible model:	0.80	0.64	0.86	0.89
Additive model:	0.74	0.65	0.86	0.89
Reduced data:	0.55	0.74	0.72	1.00
Predictive reduced data:	0.66	0.65	0.83	0.90

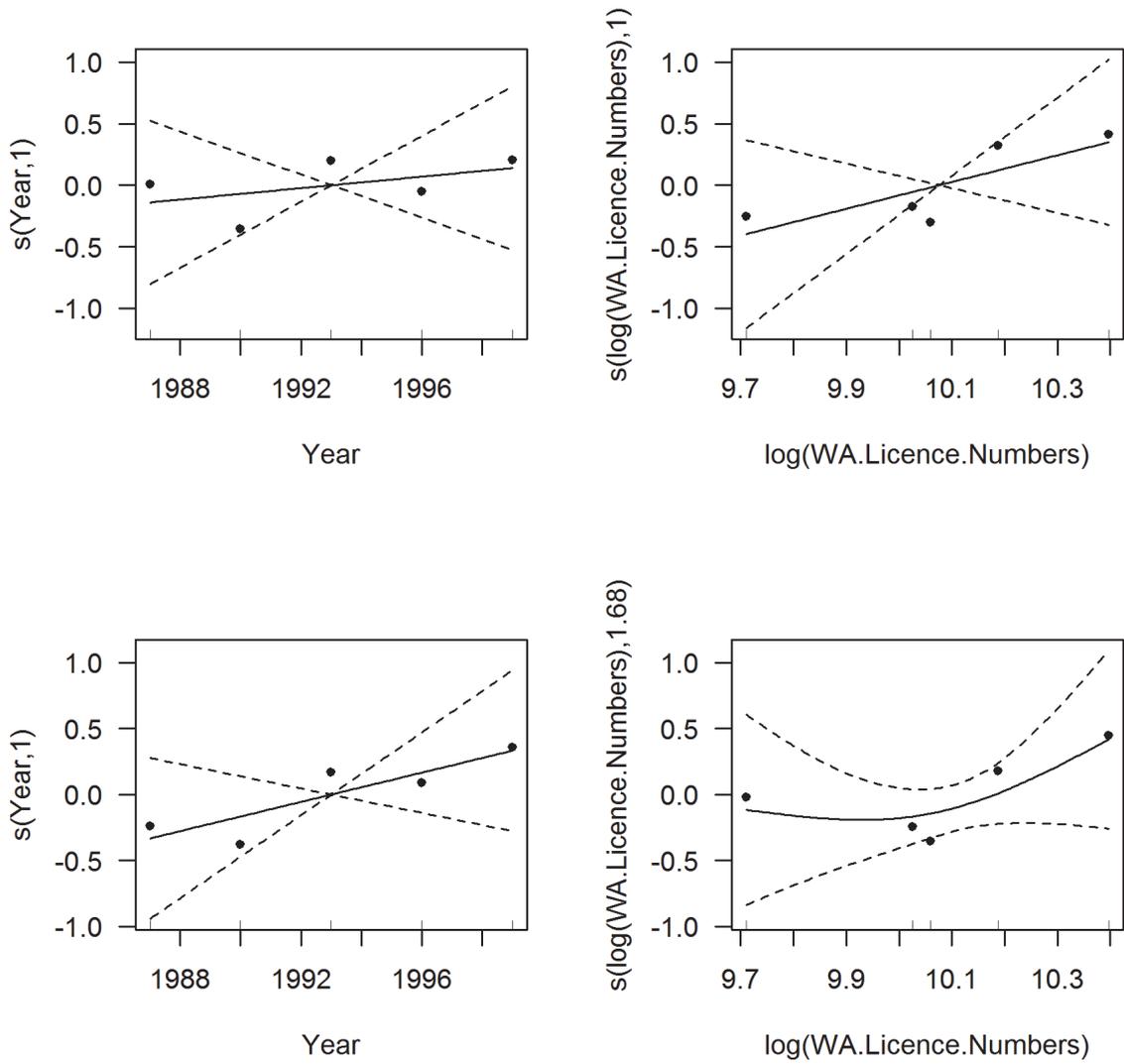


Figure 26: Model components of the simplified additive models, based on data from every 3rd season only.

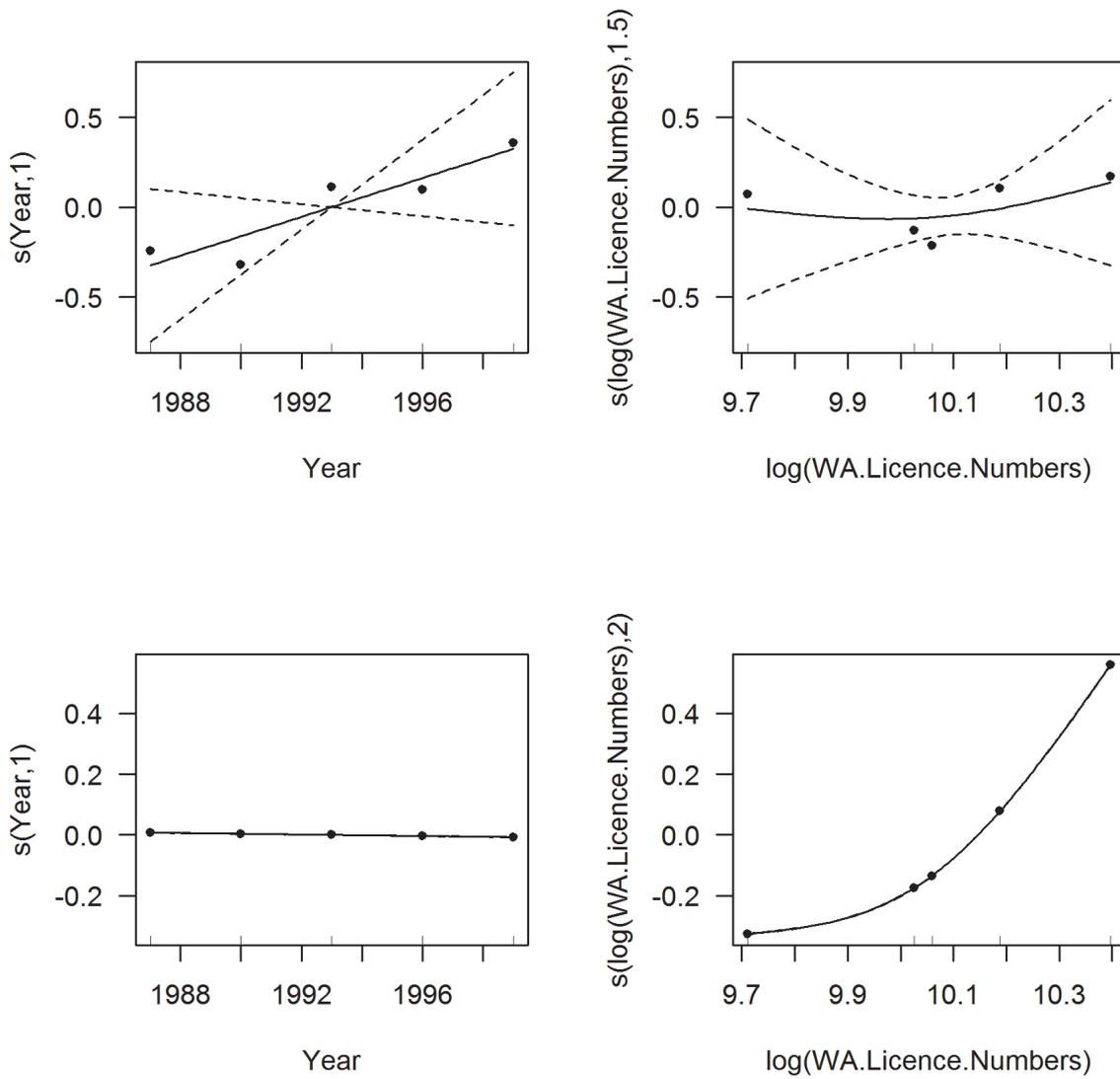


Figure 27: Model components of the simplified additive models for effort, based on data from every 3rd season only.

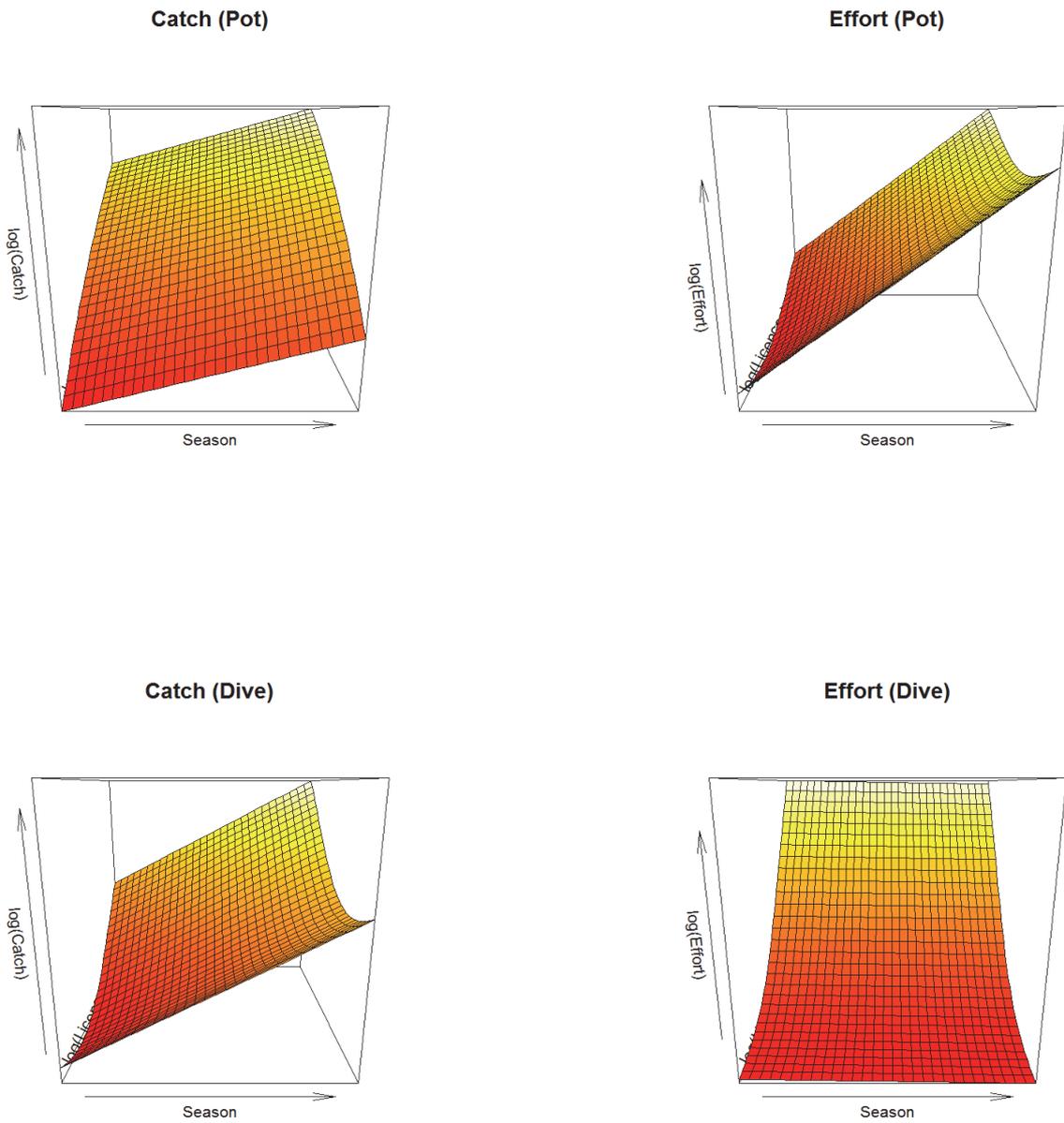


Figure 28: Additive model estimates of the relationship of catch and effort with season and licence numbers for the Western Australian Rock Lobster recreational fishery using Generalised Additive Models based on the reduced dataset. In this scenario, the model was constructed using data from only every fourth year of the 13-year time series.

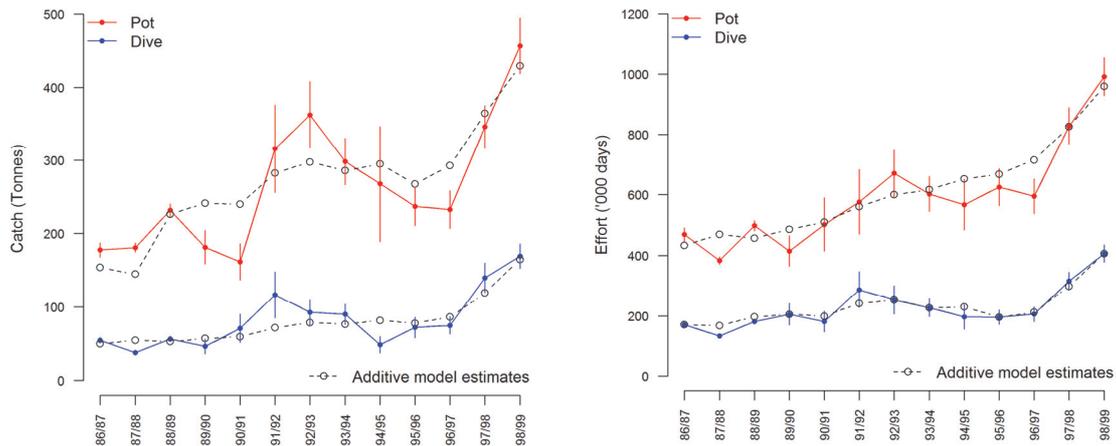


Figure 29: Annual catch (left) and effort (right) estimates (with 95% confidence limits) produced by the additive model (open circles) on the reduced dataset for both pot and dive collection methods in the Western Australian Rock Lobster recreational fishery. In this scenario, the model was constructed using data from only every fourth year of the 13-year time series.

Tasmanian Recreational Rock Lobster and Abalone fisheries

Description of the datasets

The key variables from the available data for these two related fisheries are shown in Table 4. Again, the primary goal for using these data was to develop reliable techniques for interpolating catch and effort assessments for the seasons, in this case 01/02, 03/04, 05/06, 07/08 and 09/10, for which surveys were not undertaken. The only data available for predicting catch and effort are the two predictor variables, namely time and licence number.

The complete dataset is however, slightly more extensive than this. The catch data are partitioned into eight regional areas. Relative standard errors and upper confidence limits are also provided but only for catch. The Rock Lobster licence numbers has additional information on dive, pot and ring endorsements.

Unfortunately, as will be detailed in the results section, none of this additional detail is useful in meeting the primary goal. Furthermore, the additional data are also not useful to seek regional interpolations of catch.

The annual estimated catch and effort data and number of licence holders is shown for the Tasmanian Rock Lobster fishery (Figure 30) and the Abalone fishery (Figure 31). Although the estimated catch and effort data provided were modelled, the number of licence holders is accurately known from licence sales and are not estimated from surveys.

In both fisheries, the data show a paradoxical result in that licence numbers increase throughout the time series, while both catch and effort decrease. This raises immediate concern for the ability to use licence number as a proxy for effort, given there is nearly an inverse relationship between the two. Nonetheless, in the absence of other effort proxy data, licence number was used.

In the Rock Lobster fishery, there was a very close relationship between estimated annual catch and effort. In contrast, estimated effort in the Abalone fishery declined dramatically by nearly 50% from 2000/01 to the next survey in 2002/03 (Figure 31). After this period effort continued to decline, but at a slower rate.

Table 4: Key variables from the Tasmanian recreational Rock Lobster (RL) and Abalone (A) fisheries data record, showing catch, effort (in fisher days) and licence number for each year.

	Season	Catch (RL)	Effort (RL)	Licences (RL)	Catch (A)	Effort (A)	Licences (A)
1	00/01	128219	100866	13265	108059	100866	7444
2	01/02			14206			8007
3	02/03	163454	125898	15580	133711	25342	9272
4	03/04			15024			8920
5	04/05	127987	109788	16710	112571	18185	10133
6	05/06			18780			11669
7	06/07	135275	113404	20008	105465	20900	12514
8	07/08			21383			13532
9	08/09	105538	103200	21351	81021	14444	12976
10	09/10			21512			13277
11	10/11	83472	87616	19519	60943	12117	11972

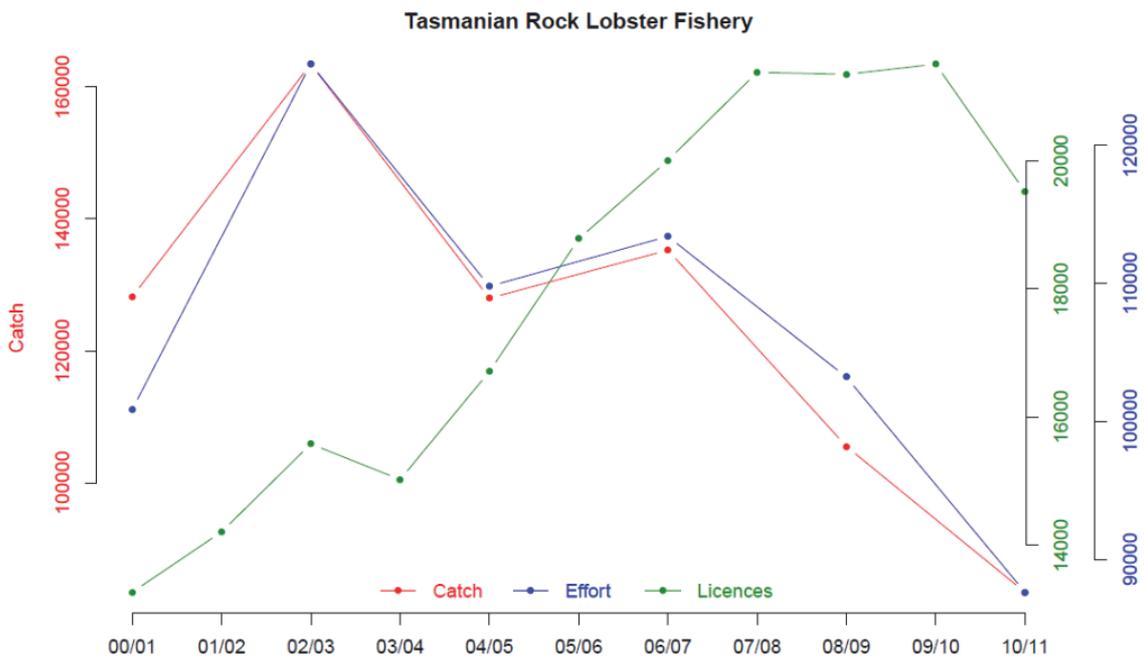


Figure 30: Catch, effort (in fisher days) and licence numbers for the Tasmanian recreational Rock Lobster fishery.

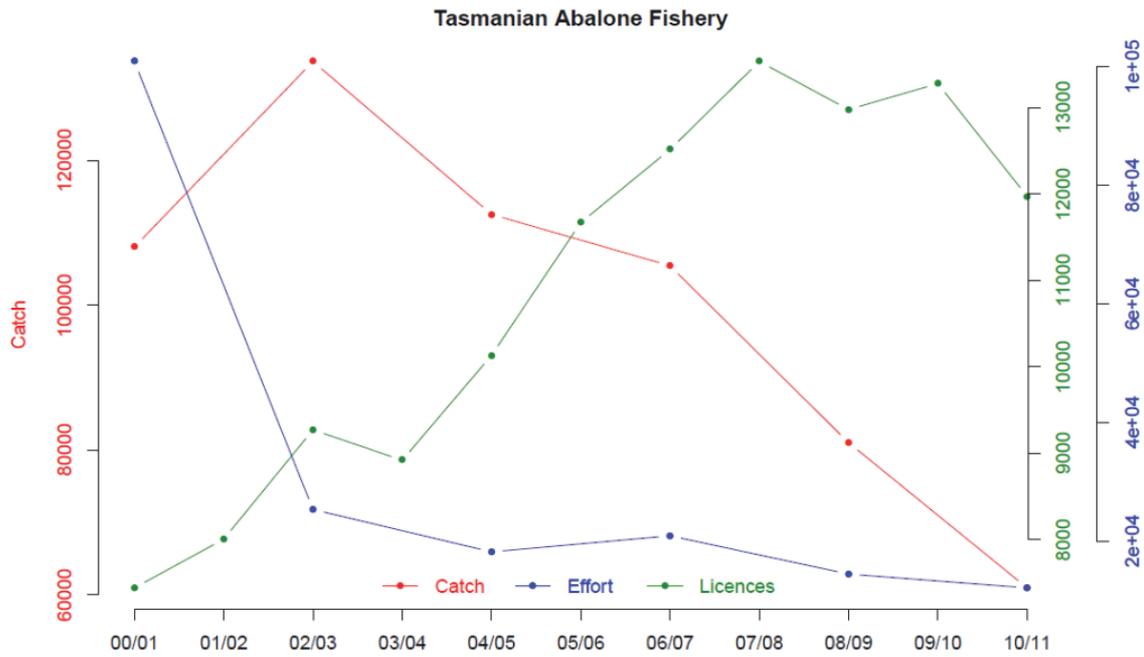


Figure 31: Catch, effort (in fisher days) and licence numbers for the Tasmanian recreational Abalone fishery.

Interpolation models

With only six seasons available on which to build an interpolation basis, only very simple statistical models were feasible, similar to the additive models used on the reduced dataset in the WA Rock Lobster fishery (e.g. Figure 28). Even a simple regression of catch on year and licences uses three degrees of freedom, leaving only three degrees of freedom to estimate the error, and hence assess the effectiveness of the model.

Nevertheless, we investigated such a model in an exploratory sense. For the same motivation as we had for the WA Rock Lobster fishery, the key variables were modelled in the log scale. Thus, our exploratory models both have the form:

$$\log Y = \beta_0 + \beta_1 t + \beta_2 \log L + \varepsilon, \quad \varepsilon \sim N(0, \sigma^2) \quad (3)$$

Where Y is the response (catch or effort), t is the time lapse (in years) and L is the number of licences.

Statistical results for model (3) are shown in Tables 5-8. In one case, the time predictor is significant, but in all other cases, neither variable appears to be useful. This indicates that the models with the most parsimonious fit are unable to reliably make predictions about catch or effort in either fishery with the available survey data and using licence number as an effort proxy.

Table 5: Regression coefficients, standard errors and significance for the simple regression model for Tasmanian recreational Rock Lobster fishery catch.

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-2.8413	6.4958	-0.44	0.6914
t	-0.1136	0.0320	-3.55	0.0380
log(RLobsterLicences)	1.4890	0.6648	2.24	0.1110

Table 6: Regression coefficients, standard errors and significance for the simple regression model for Tasmanian recreational Rock Lobster fishery effort.

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	1.0813	4.6407	0.23	0.8308
t	-0.0650	0.0228	-2.85	0.0653
log(RLobsterLicences)	1.0738	0.4750	2.26	0.1089

Table 7: Regression coefficients, standard errors and significance for the simple regression model for Tasmanian recreational Abalone fishery catch.

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-1.5534	4.1490	-0.37	0.7330
t	-0.1356	0.0256	-5.31	0.0131
log(AbaloneLicences)	1.4078	0.4480	3.14	0.0516

Table 8: Regression coefficients, standard errors and significance for the simple regression model for Tasmanian recreational Abalone fishery effort.

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	28.9821	19.8674	1.46	0.2407
t	-0.0686	0.1224	-0.56	0.6143
log(AbaloneLicences)	-2.0424	2.1451	-0.95	0.4113

For illustration purposes, the predictions from these equations are shown for the Rock Lobster catch (Figure 32) and the Abalone catch (Figure 33). For the Rock Lobster fishery, neither predictor (i.e. time or licence number) appears to be useful. The result is strongly dependent on a simple (and non-significant) time decay in catch, while licence numbers are virtually ignored by the model.

In contrast, for the Abalone catch, there does appear to be some predictive value at least in the time variable and to a lesser extent for licences. Both variables have some influence on the prediction – or back-casting in this case – although with such a small sample neither is able to even allow the model to reproduce the data very well.

With respect to effort, the model results for each fishery are qualitatively similar to the model results for catch, and are therefore not shown.

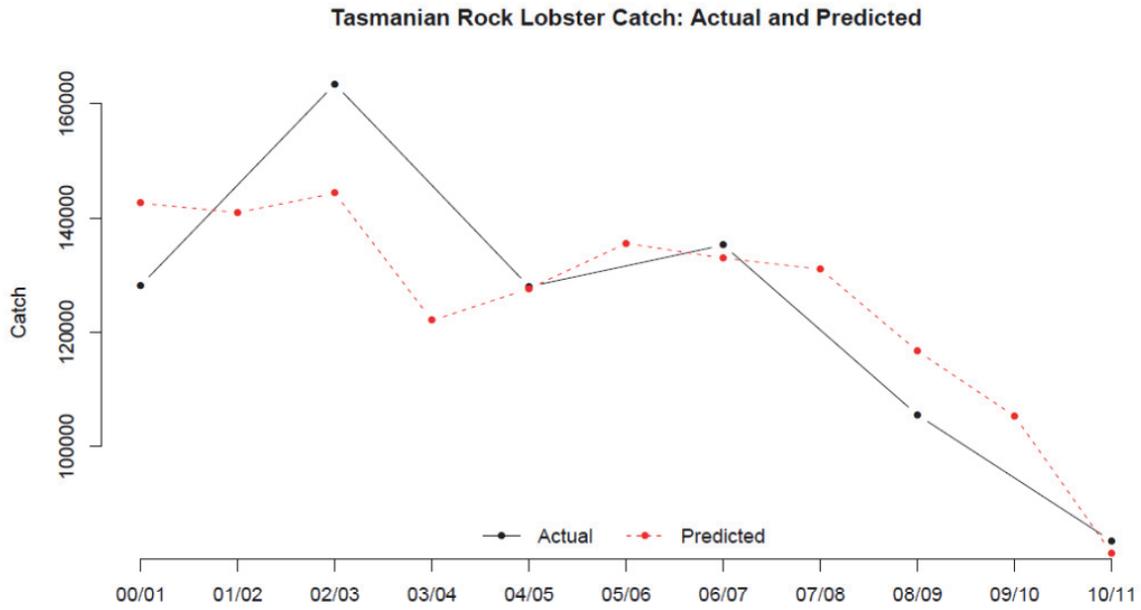


Figure 32: Predictions from the fitted simple regression model for the Tasmanian recreational Rock Lobster fishery catch data.

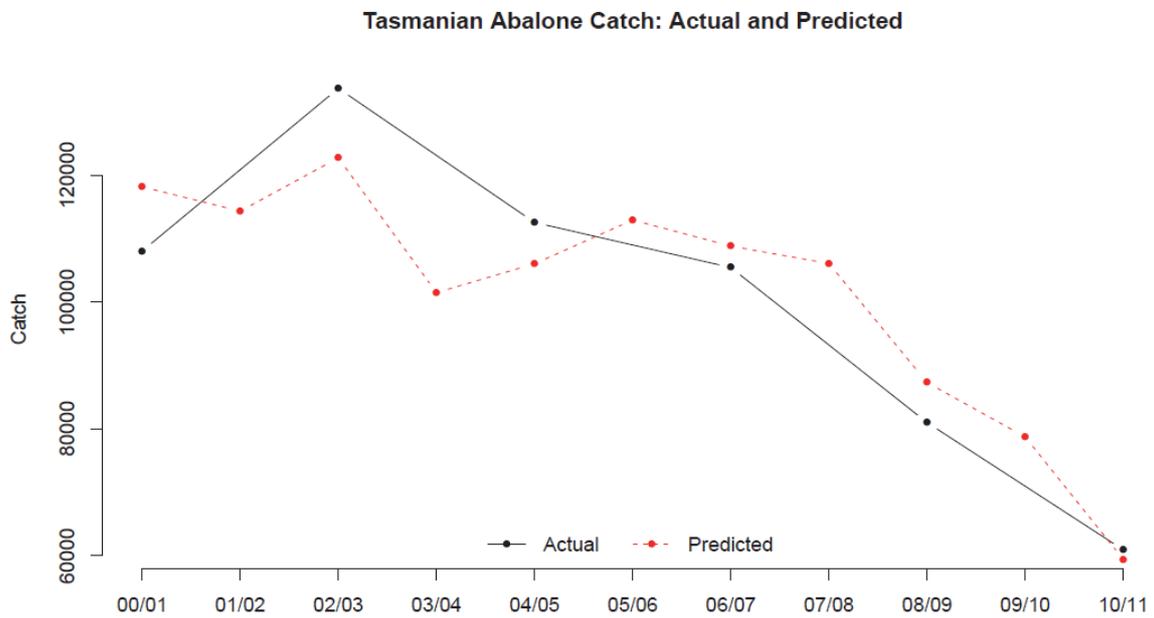


Figure 33: Predictions from the fitted simple regression model for the Tasmanian recreational Abalone fishery catch data.

Conclusions from statistical modelling

The Western Australian recreational Rock Lobster fishery has the most comprehensive survey data currently available in Australia. Our aim in these analyses was to investigate the extent to which the data record could reliably be reconstructed if only a subset of the data were available, as would be the case for most recreationally-important finfish species from the available state and territory recreational fishing surveys.

The variables that were required to be reconstructed in this fishery example were catch (pot), catch (dive), effort (pot) and effort (dive). The variables available as predictors were the annual licence numbers, and time, representing a possible time trend. For technical reasons, the predictive models were all on the log scale for the response, and the licence number as a predictor was also on the log scale. The fundamental reason for this is that changes are more likely to be simpler to represent if they are measured as proportional changes rather than absolute increments.

With the complete time series data in the model, we showed that it is possible to fit flexible models, which captured well the signal using the two predictors, time and licences. These indicate that the dependence of each of the variables on the two predictors is potentially complex, with the two variables interacting strongly, particularly in the case of dive effort.

When the data were reduced, only simpler models could be fitted. The natural simplification of the flexible model was to assume that the two predictor variables act additively, that is, each contributed a component to the prediction of the response separately, and that interactions were negligible. When such models were fitted to the entire data set, the performance was noticeably reduced, particularly for catch, but the models still captured, at least visually, some degree of the signal in each case.

Reducing the data to five seasons significantly degraded the predictive power, obviously by reducing the information base, but more subtly by restricting the complexity of the models that could be fitted. The potential for statistical models to capture the complexity of the processes was therefore severely compromised. This feature was evident in the plots of the fitted components for the reduced data models (Figure 26) and Figure 27). What had been noticeable curves in the complete data fits (Figure 22 and Figure 23) were simplified to straight lines in the reduced data fit. The multiple correlation coefficient also deteriorated noticeably as the model complexity and the dataset was reduced. More seriously, the catch and effort estimates deviated systematically from the survey, and systematically over long periods of time. The estimates extend far beyond the uncertainty ranges of the original survey estimates and indicate very poor predictive ability of these simplified models.

With respect to the Tasmanian recreational Rock Lobster and Abalone fisheries, we noted a paradox in that while licence numbers strongly increased over the data time series in both the Tasmanian recreational Rock Lobster and Abalone fisheries, both catch and effort actually decreased quite strongly in both fisheries. Resolving the issues behind this is clearly of some interest, but it is not likely to resolve the inability for our exploratory models to be able to make reliable predictions for catch or effort by using licence numbers as an effort proxy.

Given the extremely high heterogeneity of available datasets both in space and time for all three case studies, there is unlikely to be any statistically defensible way to allow interpolation, in any sense, of the gaps in both catch and effort. Both of these data types would be required to produce national or stock-level estimates, or to be used in even simple stock assessment models. Given the inability of the models to make reasonable predictions of catch or effort on the complete time series in each fishery, it is impossible to undertake further analysis in an attempt to partition interpolated catch estimates into regions.

The primary statistical concern of attempting to simply aggregate survey data collected across different years and regions is that this would almost certainly violate any assumptions of statistical independence. This is because the population from which the samples were attained are in a constant state of flux and it could not be assumed that the population in each region had not changed during the

intervening periods between surveys. Other sampling artefacts would also likely violate the assumptions of statistical models, such as simply using slightly different sampling methodologies in each survey, which introduces various sampling and non-sampling biases that cannot be corrected for without detailed and expensive ancillary surveys.

The overall conclusion from our exploratory modelling is that even by using data from recreational fisheries having among the longest datasets in Australia, it is clear that modelling of other jurisdictional survey data collected at less frequent intervals will be unsuccessful in producing statistically robust estimates of catch or effort. For example, the best models produced for the reduced dataset in the WA Rock Lobster fishery using five surveys spaced three years apart still produced poor catch and effort estimates. However, this reduced data set would still by far be the best available case for most recreationally important finfish species from any jurisdiction in Australia. For many jurisdictions, the only available data consists of one or two annual jurisdictional-wide surveys often widely separated, since the 2000/01 NRFS. With such highly fragmented datasets, both in space and time, it is impossible even to build models that can utilise information for even two predictor variables, time and licence numbers. In such cases, no reliable method of back filling is possible, unless more information on the missing years can be collected. Given that some jurisdictions do not have a long time series of licence holders, the ability to build predictive models is further compromised.

‘Best available’ recreational fishing estimates

The results of statistical modelling indicated the existing datasets could not feasibly be aggregated in a statistically defensible manner to produce current national estimates. Therefore, the most appropriate way to provide *best available estimates* was to bring together the *most recent jurisdictional estimates* for priority species.

On presentation of preliminary national catch and effort results in Workshop 2, it was requested by the invited workshop participants that the project team provide jurisdictional estimates, but not provide national estimates. The rationale behind this thought was that national estimates involve summing jurisdictional estimates that had been collected in surveys separated by up to 12 years. Furthermore, with the exception of the Northern Territory, surveys conducted since the 2000/01 NRFS did not take into account fishing by interstate visitors.

Another consideration was that management changes (e.g. bag and size limits, area closures) were likely to have affected catch and/or effort in the intervening period between surveys. It was felt by the participants at Workshop 2 that presentation of national data, which show apparent changes in catch and/or effort between two surveys may provide a misleading picture of the sustainability of target species or the status of the fishery if a thorough account of the management changes is not provided for each jurisdiction.

As a result of not accounting for interstate and international fishers, catch, effort and participation estimates were likely to be biased downward, but to an unknown and variable extent. It was believed that by providing national estimates based on summing data collected at different times and not taking into account non-resident fishers could misrepresent the actual state of recreational fishing in Australia.

Catch, effort and participation estimates from the most recent jurisdictional surveys in Queensland, Northern Territory, Tasmania and South Australia are only available for residents only. Therefore, in order to allow comparisons to be made with results from the NRFS within and between jurisdictions, in the following sections we present data for residents only in each jurisdiction.

Participation and effort

'Best available' estimates for participation and effort by jurisdiction are given in Table 9 and Table 10, respectively. It is important to note however, that although a statewide survey of boat-based recreational fishing was undertaken in Western Australia in 2011, data from this survey was not available to this project.

In the jurisdictions for which participation has been estimated since the NRFS (namely South Australia, Northern Territory, Queensland and Tasmania), the number of fishers has decreased (Table 9). Relative to 2000, significant declines have occurred in South Australia and the Northern Territory (27.95% and 27.64%, respectively), whereas in Queensland and Tasmania the declines have been more subtle (5.83% and 5.29%, respectively).

The most recent effort estimates indicate a substantial decrease in all jurisdictions where a jurisdictional-wide survey has been undertaken since the 2000/01 NRFS (Table 10). Effort decreased in South Australia, Queensland, Northern Territory and Tasmania by 45.78%, 43.87%, 24.09% and 21.42%, respectively.

Table 9: 'Best available' recreational fishing participation estimates for residents of each jurisdiction in Australia. For each jurisdiction, the table shows the most recent participation estimate (in number of individuals), the year for which the estimate was made, the participant number estimate from 2000 in the 2000/01 National Recreational Fishing Survey (NRFS) and the change in participant numbers and as a percentage since the NRFS. Changes denoted by "-" indicates there have been no participation estimate made since the NRFS. Jurisdictions marked with an asterisk indicate estimates provided represent a reanalysis of the NRFS data.

State	Year	No. of Fishers	NRFS estimate	Change in number	% change relative to 2000
NT* [#]	2010	31,790	43,932	-12,142	-27.64
Qld*	2011	703,020	746,619	-43,599	-5.83
NSW	2000	998,501	998,501	-	-
Vic	2000	549,803	549,803	-	-
Tas*	2008	118,399	125,017	-6,618	-5.29
SA*	2008	236,463	328,227	-91,764	-27.95
WA	2000	479,425	479,425	-	-
ACT	2000	53,467	53,467	-	-

[#] note a different population base was applied in 2010 – the non-indigenous resident population of the NT - whereas in 2000 the base included indigenous persons who were not residents of indigenous communities.

Table 10: ‘Best available’ recreational fishing effort estimates for residents of each jurisdiction in Australia. For each jurisdiction the table shows the most recent effort estimate (in fisher days), the year for which the estimate was made, the effort estimate in 2000/01 in the National Recreational Fishing Survey (NRFS) and the change in effort days and as a percentage since the NRFS. Changes denoted by “-” indicates there have been no participation estimate made since the NRFS.

State	Year	Effort	NRFS Effort	Change in Effort	% change relative to 2000/01
NT* [#]	2010	150,502	198,256	-47,754	-24.09
Qld*	2011	2,610,194	4,650,531	-2,040,337	-43.87
NSW	2001	5,585,059	5,585,059	-	-
Vic	2001	2,562,570	2,562,570	-	-
Tas*	2008	641,489	816,402	-174,913	-21.42
SA*	2008	1,054,200	1,944,450	-890,250	-45.78
WA	2001	3,260,343	3,260,343	-	-
ACT	2001	25,202	25,202	-	-

[#] note a different population base was applied in 2010 – the non-indigenous resident population of the NT - whereas in 2000 the base included indigenous persons who were not residents of indigenous communities.

Catch of priority species

'Best available' harvest and release estimates for priority species and species groups by jurisdiction are given in Table 11 and Table 12, respectively. Each table groups species as saltwater, freshwater, crustaceans and molluscs and provides the most recent harvest (retained) or release estimate (and error as relative standard error) in numbers and the year for which the estimate was made. The change in the harvest or released component (in numbers and as a percentage) since the 2000/01 NRFS is shown.

Saltwater finfish

For saltwater species where recent harvest estimates are available, the vast majority show a decrease in harvest in most jurisdictions, particularly for iconic species such as Tailor, Barramundi, King George Whiting, and Red Emperor (Table 11). In NT and Qld, Barramundi has decreased in harvest by 36% and 32% respectively. In Qld, the decrease in harvest of Barramundi was nearly exactly offset by a 33% increase in the number of releases, while in contrast, releases of Barramundi in NT decreased by 40% (Table 12). The harvest of Tailor in Qld decreased by 66%, while releases of Tailor in Qld also decreased markedly by 77%. Similarly, the harvest of Red Emperor in NT decreased by 26%, while releases also decreased by 84%. The harvest of King George Whiting in SA decreased by 40% while releases also decreased by 29%.

Relatively few priority species showed an increase in harvest since 2000/01, and was dependent upon the jurisdiction. The harvest of Dusky Flathead in Qld increased by 66%, but there was also a 168% increase in the number of released fish. The harvest of Snapper decreased by 67% in Qld, but increased by 13% and 29% in SA and Vic, respectively. The number of released Snapper decreased by 28% in Qld, increased by 16% in SA, but no release information was available for Vic since the NRFS. Black Jewfish harvest increased by 37% in NT, however the number of releases decreased by 47%. The harvest of Mulloway increased substantially in Qld by 2760%, which was accompanied by an increase of 611% in the number of released fish.

For popular shark species the harvest generally increased, which was generally accompanied by an increase in the number of released fish. For example in Qld and SA, the harvest of Whaler Sharks increased by 469% and 1563%, respectively, while the release numbers also increased significantly by 7188% and 102%. School Shark in SA also increased in harvest by 137%, but unfortunately, no release information was available.

With respect to more rarely encountered pelagic sportfish such as tunas, changes in harvest or release estimates could not be determined for the vast majority of priority species. This was primarily due to insufficient numbers being captured within each sampling stratum in jurisdictional surveys to allow reliable expansion to the population level. Reliable estimates were however, available for aggregated scombrid species (Table 11 and Table 12). In NT and Tas, the harvest of tuna increased by 15% and 248% respectively, whereas the number of released fish decreased by 48% in NT, but increased markedly by 4091% in Tas. In Qld and SA the harvest of tuna decreased by 14% and 28%, respectively, while the number of released fish decreased by 42% in Qld but increased by 8% in SA.

Freshwater finfish

With respect to the two priority freshwater species, Golden Perch and Murray Cod, harvest for both species has decreased substantially in all jurisdictions where a recent estimate is available (Table 11). For Murray Cod, harvest has declined in SA by 505 fish, or 50%, since 2000/01, but no change in harvest could be calculated for Qld since estimates were not available from the NRFS. The number of released fish dramatically increased since the NRFS in Qld (267%) and SA (45%). Similarly, the

harvest of Golden Perch declined in SA and Qld by 55% and 60%, respectively. However, the number of released fish also decreased in SA and Qld by 46% and 68%, respectively.

Crustaceans

Crustacean species, with the exception of Blue Swimmer Crab, all showed a decrease in harvest in the vast majority of jurisdictions since the 2000/01 NRFS (Table 11). The largest change was Mud Crab in NT and Qld, where harvest decreased by 55% and 45%, respectively. Similarly, southern Rock Lobster showed a decrease in harvest of 44% in SA but a 6% increase in Tas. Blue Swimmer Crab showed an increase in harvest in NT and SA by 448% and 9%, respectively, and only a 2% decrease in Qld.

Molluscs

For molluscs, all species and species groups have experienced marked declines in harvest since the 2000/01 NRFS (Table 11). The largest changes were in SA where there were declines in the harvest of Blacklip Abalone and Greenlip Abalone of 82% and 55%, respectively. Similarly, there was a 45% decrease in the harvest of Roe's Abalone in WA. SA also showed harvest declines in Cuttlefish and Southern Calamari by 79% and 49%, respectively.

Conclusions

For the jurisdictions where data were available since the NRFS, there has clearly been a considerable decline in number of participants as well as the total recreational fishing effort. No doubt this decline in participation is largely responsible for the congruent decrease in harvest for many of the priority species, however, these statistics should be viewed with caution.

There are many factors that may have influenced the results of the surveys undertaken since the NRFS. A decrease in harvest may therefore, not necessarily indicate a decline in the actual population of a particular target species. One factor might be that since 2001, regulations relating to bag, possession and size limits have been reviewed in most if not all jurisdictions, undoubtedly with implications for levels of recreational harvest. For some species, such as Murray cod and barramundi, declines in harvest certainly reflect increased release rates, influenced to some extent by programs such as the 'National Strategy for the Survival of Line Caught Fish' (Sawynok, 2004).

Table 11: 'Best available' harvest estimates for the 41 priority species and 17 species groups identified by jurisdictional managers, researchers and recreational peak body groups as being recreationally important at a national level. For each species in each jurisdiction, the table shows the most recent harvest estimate in numbers (and the year for which the estimate was made) for residents only, harvest estimate error (in relative standard error), and the change in harvest numbers and as a percentage since the 2000/01 National Recreational Fishing Survey. For species where no change in number or % is shown (denoted by "--") indicates no estimate was made for the species in the 2000/01 survey or there have been no surveys undertaken since the 2000/01 NRFS.

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
SALTWATER FINFISH SPECIES									
Australian Salmon	All Species	Harvest in no. (year)	110988 (2001)		1892 (2011)	303307 (2008)	110312 (2008)	541852 (2001)	41695 (2001)
		RSE	0.13		0.59	0.12	0.13	0.16	0.19
		Change in no.	-		-	-340579	-190144	-	-
		% Change in no.	-		-	-53	-63	-	-
	Eastern Australian Salmon	Harvest in no. (year)	110988 (2001)		1892 (2011)			149657 (2006)	
		RSE	0.13		0.59			-	
		Change in no.	-		-			-	
		% Change in no.	-		-			-	
	Western Australian Salmon	Harvest in no. (year)				303307 (2008)			41695 (2001)
		RSE				0.12			0.19
		Change in no.				-340579			-
		% Change in no.				-53			-
Barramundi	Barramundi	Harvest in no. (year)		40951 (2010)	59769 (2011)				22570 (2001)
		RSE		0.12	0.18				0.25
		Change in no.		-21247	-28036				-
		% Change in no.		-34	-32			-	-
Flathead	All Species	Harvest in no. (year)	2217059 (2001)	571 (2010)	208434 (2011)	38873 (2008)	1066293 (2008)	1219895 (2007)	79061 (2001)
		RSE	0.11	0.3	0.15	0.18	0.08	-	0.11
		Change in no.	-	-542	-171095	-18204	-170382	-2096176	-
		% Change in no.	-	-49	-45	-32	-14	-63	-
	Dusky Flathead	Harvest in no. (year)			174367 (2011)				
		RSE			0.17				
		Change in no.			69274				
		% Change in no.			66				
	Southern Sand Flathead	Harvest in no. (year)					1008282 (2008)		
		RSE					0.08		

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		Change in no.					-		
		% Change in no.					-		
	Tiger Flathead	Harvest in no. (year)	136852 (2001)	7810 (2010)	40979 (2011)	10171 (2008)	36570 (2008)	5421 (2001)	62928 (2001)
		RSE	0.16	0.15	0.24	0.31	0.2	0.55	0.24
		Change in no.	-	-6942	-11866	-14762	-	-	-
		% Change in no.	-	-47	-22	-59	-	-	-
Jewfish	Black Jewfish	Harvest in no. (year)		7810 (2010)	1023 (2011)				11214 (2001)
		RSE		0.15	0.91				-
		Change in no.		2371	-1440				-
		% Change in no.		44	-58				-
	Jewfish - unspecified	Harvest in no. (year)			17821 (2011)				
		RSE			0.4				
		Change in no.			1365				
		% Change in no.			8				
	Mulloway	Harvest in no. (year)	136852 (2001)		22134 (2011)	10171 (2008)		5421 (2001)	50724 (2001)
		RSE	0.16		0.3	0.31		0.55	-
		Change in no.	-		21360	-14762		-	-
		% Change in no.	-		2760	-59		-	-
Sharks and Rays	All Species	Harvest in no. (year)	30093 (2001)	1507 (2010)	6271 (2011)	9649 (2008)	8993 (2008)	39393 (2007)	24432 (2001)
		RSE	0.22	-	0.47	-	0.66	-	0.13
		Change in no.	-	-4061	-30444	-10202	-1252	-50030	-
		% Change in no.	-	-73	-83	-51	-12	-56	-
	Gummy Shark	Harvest in no. (year)			4443 (2008)	7634 (2008)		46053 (2001)	
		RSE			0.26	0.22		-	
		Change in no.			567	-		-	
		% Change in no.			15	-		-	
	School Shark	Harvest in no. (year)			1278 (2008)				
		RSE			0.31				
		Change in no.			738				
		% Change in no.			137				
	Shortfin Mako	Harvest in no. (year)			59 (2008)				
		RSE			0.96				

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		Change in no.							
		% Change in no.							
	Tiger Shark	Harvest in no. (year)			643 (2001)				
		RSE			0.75				
		Change in no.			-				
		% Change in no.			-				
	Whaler & Weasel Sharks	Harvest in no. (year)			4628 (2011)				
		RSE			0.62				
		Change in no.			3815				
		% Change in no.			469				
	Whaler Sharks	Harvest in no. (year)			1730 (2008)				
		RSE			0.51				
		Change in no.			1626				
		% Change in no.			1563				
Snapper	All Species	Harvest in no. (year)	334191 (2001)		83898 (2011)	97010 (2008)		612202 (2007)	130251 (2001)
		RSE	0.13		0.23	0.15		0.13	0.16
		Change in no.	-		-168331	11059		137323	-
		% Change in no.	-		-67	13		29	-
Tailor	Tailor	Harvest in no. (year)	1010943 (2001)		197612 (2011)		7480 (2001)	57428 (2001)	587041 (2001)
		RSE	0.17		0.23		0.33	0.31	0.1
		Change in no.	-		-380040		-	-	-
		% Change in no.	-		-66		-	-	-
Tropical Snappers	All Species	Harvest in no. (year)	67320 (2010)		317951 (2011)				86835 (2001)
		RSE	-		0.11				-
		Change in no.	-67637		-71361				-
		% Change in no.	-50		-18				-
	Golden Snapper	Harvest in no. (year)	38000 (2010)		21928 (2011)				
		RSE	0.12		0.35				
		Change in no.	-17518		-4148				
		% Change in no.	-32		-16				
	Mangrove Jack	Harvest in no. (year)	5362 (2010)		55708 (2011)				27747 (2001)
		RSE	0.26		0.15				-
		Change in no.	-4506		7100				-
		% Change in no.	-46		15				-
	Red Emperor	Harvest in no. (year)	2600 (2010)		34608 (2011)				18010 (2001)
		RSE	0.33		0.19				0.26

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		Change in no.		-1296	-12234				-
		% Change in no.		-33	-26				-
	Red Snappers	Harvest in no. (year)	14355 (2010)	68671 (2011)					
		RSE	0.23	0.2					
		Change in no.	-7598	-12927					
		% Change in no.	-35	-16					
Tuna	All Species	Harvest in no. (year)	140747 (2001)	1212 (2010)	9092 (2011)	2425 (2008)	26805 (2008)		28857 (2001)
		RSE	0.29	-	0.47	0.54	0.22		0.18
		Change in no.	-	160	-1467	-961	19111		-
		% Change in no.	-	15	-14	-28	248		-
	Albacore	Harvest in no. (year)					15408 (2008)		
		RSE					0.26		
		Change in no.					-		
		% Change in no.					-		
	Australian Bonito	Harvest in no. (year)	41502 (2001)		891 (2011)				
		RSE	-		0.82				
		Change in no.	-		-				
		% Change in no.	-		-				
	Longtail Tuna	Harvest in no. (year)		719 (2010)	6144 (2011)				
		RSE		0.29	0.61				
		Change in no.		-	5205				
		% Change in no.		-	554				
	Southern Bluefin Tuna	Harvest in no. (year)					1076 (2008)	19737 (2011)	
		RSE					0.37	0.14	
		Change in no.					-	-	
		% Change in no.					-	-	
	Yellowfin Tuna	Harvest in no. (year)	20664 (2001)		1214 (2011)				
		RSE			0.51				
		Change in no.	-		-				
		% Change in no.	-		-				
Whiting	All Species	Harvest in no. (year)	1791276 (2001)	1617 (2010)	1302705 (2011)	1342470 (2008)	14992 (2008)	980346 (2001)	2534889 (2001)
		RSE	0.25	0.74	0.17	-	0.4	-	-
		Change in no.	-	676	-2841351	-990729	-	-	-
		% Change in no.	-	72	-69	-42	-	-	-
	King George Whiting	Harvest in no. (year)				1249079 (2008)		705500 (2010)	408209 (2001)

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		RSE			0.11			0.25	0.18
		Change in no.			-819470			-269849	-
		% Change in no.			-40			-28	-
	Sand Whiting	Harvest in no. (year)			656866 (2011)				
		RSE			0.14				
		Change in no.			-1172425				
		% Change in no.			-64				
	Trumpeter Whiting	Harvest in no. (year)			645839 (2011)				
		RSE			0.28				
		Change in no.			-1110861				
		% Change in no.			-63				
FRESHWATER FINFISH SPECIES									
	Golden Perch	Harvest in no. (year)	542107 (2001)		87356 (2011)	39861 (2008)		142276 (2001)	
		RSE	0.09		0.17	0.21		0.48	
		Change in no.	-		-129317	-49140		-	
		% Change in no.	-		-60	-55		-	
	Murray Cod	Harvest in no. (year)	93973 (2001)		930 (2011)	507 (2008)		11943 (2001)	
		RSE	0.07		0.75	0.98		0.28	
		Change in no.	-		-	-505		-	
		% Change in no.	-		-	-50		-	
CRUSTACEANS									
	Blue Swimmer Crab	Harvest in no. (year)	412883 (2001)	751 (2010)	115437 (2011)	1144837 (2008)			2211466 (2001)
		RSE	0.28	0.54	0.87	0.12			0.1
		Change in no.	-	614	-2223	89736			-
		% Change in no.	-	448	-2	9			-
	Mud Crab	Harvest in no. (year)	51274 (2001)	30382 (2010)	366065 (2011)				100289 (2001)
		RSE	0.24	0.13	0.12				0.16
		Change in no.	-	-36417	-295583				-
		% Change in no.	-	-55	-45				-
	Giant Mud Crab	Harvest in no. (year)	51274 (2001)						
		RSE	0.24						

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		Change in no.	-						
		% Change in no.	-						
Rock Lobster	All Species	Harvest in no. (year)	10569 (2001)	297 (2001)		47875 (2008)	83472 (2011)	51228 (2001)	403833 (2001)
		RSE	0.34	-		0.22	0.07	0.4	0.17
		Change in no.	-	-		-37901	4909	-	-
		% Change in no.	-	-		-44	6	-	-
	Southern Rocklobster	Harvest in no. (year)				47875 (2008)		51228 (2001)	
		RSE				0.22		0.4	
		Change in no.				-37901		-	
		% Change in no.				-44		-	
MOLLUSCS									
Abalone	All Species	Harvest in no. (year)	35233 (2001)			5147 (2008)	60943 (2011)	10355 (2001)	214351 (2001)
		RSE	0.45			-	0.14	0.39	0.24
		Change in no.	-			-11883	-47116	-	-
		% Change in no.	-			-70	-44	-	-
	Blacklip Abalone	Harvest in no. (year)	35233 (2001)			1685 (2008)	3900 (2008)		
		RSE	0.45			0.39	0.34		
		Change in no.	-			-7600	-		
		% Change in no.	-			-82	-		
	Brownlip Abalone	Harvest in no. (year)							1610 (2007)
		RSE							
	Greenlip Abalone	Harvest in no. (year)				3462 (2008)	60522 (2008)		13230 (2007)
		RSE				0.33	0.23		-
		Change in no.				-4283	-		-
		% Change in no.				-55	-		-
	Roe's Abalone	Harvest in no. (year)							266000 (2011)
		RSE							
		Change in no.							-215300
		% Change in no.							-45
Squid and Cuttlefish	All Species	Harvest in no. (year)	154627 (2001)	16433 (2010)	12683 (2011)	490615 (2008)	5956 (2008)	199202 (2001)	216850 (2001)
		RSE	0.35	0.81	0.46	-	0.51	0.32	0.24
		Change in no.	-	16169	-56386	-493725	-6518	-	-
		% Change in no.	-	6125	-82	-50	-52	-	-
	Cuttlefish	Harvest in no. (year)				6159 (2008)			

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		RSE				0.48			
		Change in no.				-22952			
		% Change in no.				-79			
	Gould's Squid	Harvest in no. (year)				2000 (2008)	40525 (2008)		
		RSE				0.39	0.2		
		Change in no.				-	11052		
		% Change in no.				-	37		
	Southern Calamari	Harvest in no. (year)				484456 (2008)	73236 (2008)	132114 (2006)	
		RSE				0.14	0.15	-	
		Change in no.				-470773	63333	-	
		% Change in no.				-49	640	-	

Table 12: 'Best available' release estimates for the 41 priority species and 17 species groups identified by jurisdictional managers, researchers and recreational peak body groups as being recreationally important at a national level. For each species in each jurisdiction, the table shows the most recent release estimate in numbers (and the year for which the estimate was made) for residents only, release estimate error (in relative standard error), and the change in release numbers and as a percentage since the 2000/2001 National Recreational Fishing Survey. For species where no change in number or % is shown (denoted by "-") indicates no estimate was made for the species in the 2000/01 survey or there have been no surveys undertaken since the 2000/01 NRFS.

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
SALTWATER FINFISH SPECIES									
Australian Salmon	All Species	Released no. (year)	88108 (2001)		1356 (2001)	171410 (2008)	77915 (2008)	435461 (2001)	21854 (2001)
		RSE	-		0.99	0.14	0.14	-	-
		Change in no.	-		-	-42145	-27314	-	-
		% Change in no.	-		-	-20	-26	-	-
	Eastern Australian Salmon	Released no. (year)	88108 (2001)		1356 (2001)				
		RSE	-		0.99				
		Change in no.	-		-				
		% Change in no.	-		-				
	Western Australian Salmon	Released no. (year)			171410 (2008)				21854 (2001)
		RSE			0.14				-
		Change in no.			-42145				-
		% Change in no.			-20				-
Barramundi	Barramundi	Released no. (year)		106442 (2010)	218286 (2011)				50458 (2001)
		RSE		0.19	0.24				-
		Change in no.		-69783	53758				-
		% Change in no.		-40	33				-
Flathead	All Species	Released no. (year)	2051421 (2001)	804 (2010)	272727 (2011)	34246 (2008)	744940 (2008)	2657435 (2001)	101050 (2001)
		RSE	-	0.45	0.17	0.25	0.08	-	-
		Change in no.	-	615	-110112	-6880	76383	-	-
		% Change in no.	-	325	-29	-17	11	-	-
	Dusky Flathead	Released no. (year)			224692 (2011)				
		RSE			0.19				
		Change in no.			140774				
		% Change in no.			168				
	Southern Sand Flathead	Released no. (Year)				711171 (2008)			
		RSE				0.09			
		Change in no.				-			
		% Change in no.				-			

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
	Tiger Flathead	Released no. (year)					17726 (2008)		
		RSE					0.33		
		Change in no.					-		
		% Change in no.					-		
Jewfish	All Species	Released no. (year)	43678 (2001)	2969 (2010)	32731 (2011)	57868 (2008)		2232 (2001)	90278 (2001)
		RSE	-	0.28	0.35	0.38		-	-
		Change in no.	-	-4797	-17303	4240		-	-
		% Change in no.	-	-62	-35	8		-	-
	Black Jewfish	Released no. (year)		2969 (2010)	625 (2001)				12622 (2001)
		RSE		0.28	0.99				-
		Change in no.		-2201	-				-
		% Change in no.		-43	-				-
	Jewfish - unspecified	Released no. (year)			16703 (2011)				
		RSE			0.54				
		Change in no.			6416				
		% Change in no.			62				
	Mulloway	Released no. (year)	43678 (2001)		16028 (2011)	57868 (2008)		2232 (2001)	77656 (2001)
		RSE	-		0.44	0.38		-	-
		Change in no.	-		13775	4240		-	-
		% Change in no.	-		611	8		-	-
Sharks and Rays	All Species	Released no. (year)	257785 (2001)	26232 (2010)	130438 (2011)	41769 (2008)	31907 (2008)	191654 (2001)	101727 (2001)
		RSE	-	-	0.18	-	0.15	-	-
		Change in no.	-	-31165	-158027	-14330	-4915	-	-
		% Change in no.	-	-54	-55	-26	-13	-	-
	Gummy Shark	Released no. (year)				1971 (2008)	12990 (2008)	51332 (2001)	
		RSE				0.43	0.25	-	
		Change in no.				-1677	-	-	
		% Change in no.				-46	-	-	
	School Shark	Released no. (year)				806 (2008)			
		RSE				0.44			
		Change in no.				-			
		% Change in no.				-			
	Shorfin Mako	Released no. (year)			597 (2011)				
		RSE			1				
		Change in no.			-				
		% Change in no.			-				
	Tiger Shark	Released no. (year)			627 (2001)				
		RSE			0.75				

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		Change in no.			-				
		% Change in no.			-				
	Whaler & Weasel Sharks	Released no. (year)			45840 (2011)				
		RSE			0.35				
		Change in no.			45211				
		% Change in no.			7188				
	Whaler Sharks	Released no. (year)				422 (2008)			
		RSE				0.46			
		Change in no.				213			
		% Change in no.				102			
	Blue shark	Released no. (year)			127 (2011)				
		RSE			1				
		Change in no.			-182				
		% Change in no.			-59				
Snapper	All Species	Released no. (year)	1176413 (2001)		268217 (2011)	287067 (2008)		401036 (2001)	341716 (2001)
		RSE	-		0.24	0.18		-	-
		Change in no.	-		-102636	40040		-	-
		% Change in no.	-		-28	16		-	-
Tailor	Tailor	Released no. (year)	771847 (2001)		147099 (2011)		5899 (2001)	36843 (2001)	193020 (2001)
		RSE	-		0.21		0.42	-	-
		Change in no.	-		-488843		-	-	-
		% Change in no.	-		-77		-	-	-
Tropical Snappers	All Species	Released no. (year)		93696 (2010)	550644 (2011)				111211 (2001)
		RSE			0.14				-
		Change in no.		-27130	-224847				-
		% Change in no.		-23	-29				-
	Golden Snapper	Released no. (year)		42531 (2010)	16765 (2011)				
		RSE		0.13	0.47				
		Change in no.		-204	-23311				
		% Change in no.		-0.5	-58				
	Mangrove Jack	Released no. (year)		4129 (2010)	67586 (2011)				37201 (2001)
		RSE		0.26	0.23				-
		Change in no.		-1908	19861				-
		% Change in no.		-32	42				-
	Red Emperor	Released no. (year)		2990 (2010)	54773 (2011)				4569 (2001)
		RSE		0.43	0.2				-
		Change in no.		-377	-292847				-
		% Change in no.		-11	-84				-

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
Red Snappers		Released no. (year)	22375 (2010)	96332 (2011)					
		RSE	0.19	0.23					
		Change in no.	5673	35556					
	% Change in no.	34	59						
Tuna	All Species	Released no. (year)	18034 (2001)	1285 (2010)	6864 (2011)	2988 (2008)	18733 (2008)		22773 (2001)
		RSE	-	-	0.48	0.6	0.34		-
		Change in no.	-	-1181	-5008	210	18286		-
		% Change in no.	-	-48	-42	8	4091		-
	Albacore	Released no. (year)			5320 (2008)				
	RSE				0.42				
	Change in no.				-				
	% Change in no.				-				
	Australian Bonito	Released no. (year)	5461 (2001)		114 (2011)				
	RSE		-		1.28				
	Change in no.		-		-419				
	% Change in no.		-		-79				
	Longtail Tuna	Released no. (year)		447 (2010)	2762 (2011)				
	RSE			0.37	0.69				
	Change in no.			-	-				
	% Change in no.			-	-				
	Southern Bluefin Tuna	Released no. (year)				409 (2008)		6942 (2011)	
	RSE					0.9		0.21	
	Change in no.					-		-	
	% Change in no.					-		-	
	Yellowfin Tuna	Released no. (year)	1842 (2001)						
	RSE		-						
	Change in no.		-						
	% Change in no.		-						
Whiting	All Species	Released no. (year)	113429 (2001)	1482 (2010)	949333 (2011)	586462 (2008)	15573 (2008)	304049 (2001)	720815 (2001)
		RSE		0.52	0.14	-	0.34	-	-
		Change in no.	-	1110	-1678310	-257248	-	-	-
		% Change in no.	-	298	-64	-30	-	-	-
	King George Whiting	Released no. (year)			548069 (2008)			302701 (2001)	152396 (2001)
	RSE				0.11			-	-
	Change in no.				-219632			-	-
	% Change in no.				-29			-	-
	Sand Whiting	Released no. (year)			625695 (2011)				
	RSE				0.14				

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		Change in no.			-821191				
		% Change in no.			-57				
	Trumpeter Whiting	Released no. (year)			323639 (2011)				
		RSE			0.24				
		Change in no.			-337200				
		% Change in no.			-51				
FRESHWATER FINFISH SPECIES									
Golden Perch	Golden Perch	Released no. (year)	384887 (2001)		82494 (2011)	51669 (2008)		118783 (2001)	
		RSE	-		0.22	0.22		-	
		Change in no.	-		-71247	-108437		-	
		% Change in no.	-		-46	-68		-	
Murray Cod	Murray Cod	Released no. (year)	346439 (2001)		4604 (2011)	1346 (2008)		24421 (2001)	
		RSE	-		0.59	0.52		-	
		Change in no.	-		3349	419		-	
		% Change in no.	-		267	45		-	
CRUSTACEANS									
Blue Swimmer Crab	Blue Swimmer Crab	Released no. (year)	137611 (2001)	461 (2010)	245127 (2011)	731653 (2008)			1707276 (2001)
		RSE	-	0.59	0.93	0.11		-	-
		Change in no.	-	-	-31983	218443		-	-
		% Change in no.	-	-	-12	43		-	-
Mud Crab	All Species	Released no. (year)	45518 (2001)	14253 (2010)	1005933 (2011)				101193 (2001)
		RSE	-	0.21	0.14			-	-
		Change in no.	-	-34483	-910574			-	-
		% Change in no.	-	-71	-48			-	-
	Giant Mud Crab	Released no. (year)	45518 (2001)						
		RSE	-						
		Change in no.	-						
		% Change in no.	-						
Rock Lobster	All Species	Released no. (year)	5158 (2001)			58608 (2008)		13072 (2001)	524987 (2001)
		RSE	-			0.31		-	-
		Change in no.	-		24221			-	-
		% Change in no.	-		70			-	-
	Southern Rocklobster	Released no. (year)				58608 (2008)		13072 (2001)	
		RSE				0.31		-	

Species group	Species	Variable	NSW	NT	Qld	SA	Tas	Vic	WA
		Change in no.				24221		-	
		% Change in no.				70		-	
MOLLUSCS									
Abalone	All Species	Released no. (year)	3 6045 (2001)			1449 (2008)			26018 (2001)
		RSE	-			-			-
		Change in no.	-			-7485			-
		% Change in no.	-			-84			-
	Blacklip Abalone	Released no. (year)	3 6045 (2001)			222 (2008)			
		RSE	-			0.71			
		Change in no.	-			-78			
		% Change in no.	-			-26			
	Greenlip Abalone	Released no. (year)				1227 (2008)			
		RSE				0.55			
	Change in no.				-7407				
	% Change in no.				-86				
Squid and Cuttlefish	All Species	Released no. (year)	7 328 (2001)	387 (2010)	600 (2011)	9832 (2008)	7729 (2008)	13532 (2001)	21 509 (2001)
		RSE	-	0.66	0.87	-	0.37	-	-
		Change in no.	-	-1269	-9824	1826	-	-	-
		% Change in no.	-	-68	-50	31	-	-	-
	Cuttlefish	Released no. (year)				1551 (2008)			
		RSE				0.52			
		Change in no.				-5456			
		% Change in no.				-78			
	Gould's Squid	Released no. (year)				4364 (2008)			
		RSE				0.5			
	Change in no.				2841				
	% Change in no.				187				
Southern Calamari	Released no. (year)				8281 (2008)	9034 (2008)			
	RSE				0.69	0.25			
	Change in no.				-4368	-			
	% Change in no.				-35	-			

Social information

In addressing the objectives of this project it was important to consider social and economic aspects of the Australian recreational fishery, the NRFS demonstrated clearly that relaxation and sport were primary motivations in Australian's decision to go fishing (Henry and Lyle, 2003). In Workshop 1 and other recreational and commercial fisheries forums undertaken by other projects around the same time, a range of social indicators were identified as being important to the recreational fishery stakeholders in an attempt to communicate the importance of fisheries to fishery managers and politicians (Dichmont et al., 2012). Many of these indicators related to concepts of 'health' and 'well-being', implying that people who engaged in recreational fishing benefit from improved physical and mental health.

A recent FRDC funded study that attempted to identify the health and well-being benefits of recreational fishing (McManus et al., 2011) indicated that social studies of recreational fisheries require specifically designed surveys of user groups that cover the full 'knowledge' spectrum of recreational fishing (i.e. from little health benefit to a high benefit). Ideally, these surveys would involve a comparison of subjects who do not fish recreationally, who would be required to serve as a 'control' group.

In being able to make definitive conclusions about the actual social benefit of recreational fishing, and to easily convey the message to fishery managers or the general public, quantitative measures of indicators such as 'health' and 'well-being' are required. Since these elements are largely subjective and specific to each surveyed individual, demonstrating social well being from a specific activity or experience, even outside of recreational fishing, has been a difficult task for social scientists, even when using customised surveys (Innes and Surr, 2001; Helliwell and Barrington-Leigh, 2010).

During the current project, a concurrent FRDC project ("Developing and testing social objectives for fisheries management", project 2010/040) was being undertaken to develop indicators to measure social aspects of commercial, recreational and indigenous fisheries. The project defined a range of social objectives and specific indicators, which may be used to measure the social benefit of each objective (Table 13). However, as many of the indicators are qualitative it is therefore difficult to provide nationally consistent measures of the social benefits of recreational fishing.

The national data audit revealed that of 91 recreational fishing datasets only 33 contained some type of social information. Generally, these social data were basic demographic data such as age, sex, and motivations for fishing, but the data types varied considerably among surveys. Given that the development of social indicators for recreational fisheries have yet to be determined in a current project specifically dedicated to this issue (FRDC project 2010/40), the current project was unable to provide national statistics on the social benefits of recreational fishing.

Table 13: Social objectives and associated indicators to measure the relative social benefits of changing fisheries management, as defined within the current FRDC project 2010/040 “Developing and testing social objectives for fisheries management”.

Objective	Indicators
To maintain or enhance livelihoods	<ul style="list-style-type: none"> • Demographics – age/sex/income/number of licence holders • Qualitative descriptors of behaviour/impacts of regulation
Maximise lifestyle benefits	<ul style="list-style-type: none"> • Social capital • Lifestyle enjoyment/quality of life • Frequency of enjoyment/ or change in frequency of enjoyment (the act of recreational fishing) • Income support through consumption of fish
Ensure appropriate participation in decision making	<ul style="list-style-type: none"> • Proportion of stakeholders involved in decision making • Identification of and change in desired level of consultation • Satisfaction with level of participation
High level of trust in fisheries management	<ul style="list-style-type: none"> • Proportion of stakeholders with a positive view of fisheries management • Community perception of fisheries management
Minimise non compliance	<ul style="list-style-type: none"> • Number of reported infringements • Degree of awareness of regulations
Ensure transparency of decision making	<ul style="list-style-type: none"> • Fisher (or public) perceptions of transparency • Degree to which stakeholders feel their concerns have been taken into account
Equitable treatment and access to the resource	<ul style="list-style-type: none"> • Perception of treatment compared to other groups (commercial/indigenous/conservation) • Qualitative identification of basis of belief regarding treatment – anecdotal/scientific/changes in management designated access or boundaries, etc. • Relative share of catch allocation and/or the change of that
Increase capacity for stewardship	<ul style="list-style-type: none"> • Proportion of (management) costs used/received for education and awareness raising • Changes in number of training and educational opportunities • Number of volunteers in stewardship programs

Economic valuation

With respect to understanding the economic dynamics of recreational fisheries at the national level, similar difficulties exist as for understanding social elements, such as defining and quantifying appropriate measures. In many cases, economic and social indicators are interrelated, hence the common aggregation of the two disciplines into a general definition of ‘socioeconomics’ (Pitcher and Hollingworth, 2002).

In a recent review of economic valuation techniques, Colquhoun (2013) detailed seven approaches that may be applied to recreational fisheries. As can be seen in Table 14, the type of information required and the economic aspect being measured differ substantially between methods. There have been few economic assessments of recreational fisheries in Australia, and most have used different economic measures. For example, Li (1999) used a travel cost model to measure the economic value of Snapper to the recreational fishery in Port Phillip Bay, Rolfe and Prayaga (2007) and Prayaga (2010) used both the travel cost and contingent valuation to estimate values for recreational fishing in Queensland’s freshwater dams and the Great Barrier Reef, while the simple measure of expenditure has been used by a range of studies to measure economic value of recreational fishing (VRFish, 2009; Griffiths, 2012).

Expenditure has been the most widely used economic measure in recreational fisheries, since it is relatively easy to measure quantitatively, is conceptually simple to portray to lay persons, and can be easily collected during more common surveys of recreational catch and effort. The national recreational fishing data audit identified expenditure to be the most common economic data type collected across jurisdictional surveys, being collected in 18 of the 91 identified projects. Unfortunately, expenditure is not a reliable means by which to measure the economic value of recreational fisheries, since the importance of non-market values are not considered (Rudd et al., 2002).

As part of the RFIDS suite of projects, FRDC project 2012/214 has been dedicated to determining the most appropriate means by which to measure the economic value of recreational fishing in Australia. In a recent national workshop for the project, Colquhoun (2013) presented a range of economic measures (Table 14) and the stakeholder groups represented at that workshop agreed that GVP equivalent valuation – calculated as the estimated landed weight of fish multiplied by an estimated average value per kilogram – is the most feasible measure that can be used for comparing the respective value of commercial and recreational fisheries.

Although previous recreational fishing surveys in Australia have collected expenditure data, the specific information required to calculate economic value has not been consistently collected. Therefore, the current project was unable to provide jurisdictional or national estimates of the economic value of recreational fishing in Australia. Further development of valuation measures and a subsequent dedicated survey is required to provide this level of information.

Table 14: Indicators for measuring the economic value of recreational fishing, as defined by Colquhoun (2013) in a review paper for FRDC project 2012/214 “Measuring the economic value of recreational fishing at a national level”.

Method	Value type estimated
Single Site Travel Cost Method	Average non-market use value per trip per fisher or group. Travel cost information used to assess the recreational value of a specific site.
Multisite Travel Cost Method + Random Utility Modelling	Aggregate average value derived by recreational fishers from multiple fishing sites.
Hedonic Pricing Method	Value of site attribute, via willingness to pay for a specific outcome.
Contingent Valuation Method	Marginal willingness to pay for a policy/investment /resource use change.
Choice Modelling Method	Choice of preferred resource allocation proposal.
Expenditure Method	Total expenditure on the activity.
Benefit Transfer Method	Transfer benefits found in one study to a similar study.

Public access to recreational fisheries data

Status of recreational fishing information publishing

All of the significant recreational fishing surveys that were identified in the information audit component of this project have published reports providing participation, fishing effort, and catch statistics. Economic analysis of the expenditure data collected by some jurisdictional surveys has not yet been published, for example the 2007-2008 Tasmanian and South Australian statewide surveys.

Custodians of recreational fishing data have tended not to publish data sets or tools for visualising and analysing those data. The exception to this is the Queensland Government Department of Agriculture, Fisheries and Forestry, which allows users to tabulate catch estimates from the RFISH surveys. A new information portal has been developed by the Queensland DAFF and is due for public release mid 2013. This portal will allow tabulation of jurisdictional survey statistics from the 2010 survey and the NRFS.

Almost all survey reports published since 2000 are accessible in digital form but older reports usually require location of printed documents. There continue to be problems for the public in acquiring some digital versions of reports when they are removed from agency websites. Some agencies have created online repositories for historical documents but this tends to be the exception in the current situation.

User needs for access to recreational fisheries information

The presentation summary by Recfish Australia in Workshop 1 provided the recreational fisher's perspective on the need for access to recreational fisheries information. The primary need was for 'a central repository for available data that can be easily accessed and interrogated for catch, effort and economic information at various spatial and temporal resolutions'. Similarly, there was a request to 'make the data publicly available in a standardised format with user-friendly tools for data queries'.

In discussions with stakeholders at Workshop 2 there was a need expressed for information on management changes and the biological basis for their introduction. The introduction or changes to legal size limits, bag/boat/trip/possession limits was seen as essential historical background information that users should have access to when viewing time series of catch and effort to assist in interpretation of trends.

The provision of detailed participation, fishing effort and catch data, along with socioeconomic statistics is also desirable for researchers, natural resource managers and policy officers in government and NGOs. Therefore, recreational fisheries information may need to be published in a variety of forms or else the standard public data provided by custodians needs to be structured so that different information portals can present data in a variety of levels with respect to detail and user skills.

National Recreational Fishing Data Portal

One of the key objectives of the current project was to explore options for storing and allowing public access to data that can answer key questions relating to recreational fishing in Australia. Initially, ideas were developed around how statistical model-based queries from a large relational database in the back-end of a public facing website would make data available for large complex data queries. However, following the statistical analyses and considering the current fragmentary state of the datasets, it was clear that technically simplified approaches would be most useful to make data available to recreational fisheries stakeholders. For example, it may be more cost-effective and faster for the end-user if calculations for a large number of data query combinations were entered directly into the portal rather than performing complex model calculations on the fly.

With this in mind, the project team created a prototype of a data portal, with an emphasis being on recreational fishers being the primary end user. Therefore, we aimed to make the site simple and intuitive, but still capable of producing reasonably complex data outputs with error estimates that would be useful for researchers and managers. The functional prototype can be viewed at <http://www.nature.cc/recfish/index.html> and currently displays incomplete data for seven species for illustrative purposes only. The portal home page introduces fishers to the initiative and describes what information is available and how data are accessed. For example, the first screen provides options to obtain data for catch, effort, participation, social or economic data in saltwater, freshwater, and all waters combined. Where the catch button is clicked for example, the user can click on a species or species group (e.g. ‘tropical Snappers’) to perform a data query (Figure 34).

Data queries are set around a clickable map of Australia, where the user is able to click on one or more jurisdictions of interest. Once a jurisdiction is clicked, it is highlighted and the available catch data for that jurisdiction will be shown in a table. The catch data shown is harvest and released catch (with error where available), the year, and the data source. The user then has the option to save the query output to file, download the source reference, or be directed to a website link if a report is not available (Figures 35 and 36). In cases where regional data are available within a jurisdiction, the user can click on the data table for a breakdown by region.

We believe the data portal could be designed to become a national ‘one-stop shop’ for recreational fisheries information, which would include access to a range of information relating to the fishery and target species. For example, while a user may have been initially interested in obtaining catch data for pink Snapper, they might also be interested in the species’ biology. In our prototype portal, we display the latest biological information such as a length-weight curve where the user can move a simple slider bar to obtain an estimated weight from a length (Figure 35). We can also provide equations for these relationships to be useful for researchers, such as age-at-length conversions or von Bertalanffy functions. It is also possible to add the latest bag limits and minimum legal lengths for each jurisdiction (Figure 35). A participant in Workshop 2 suggested the usefulness of having the history of all regulatory changes for a particular species over time, which may aid users in the interpretation of changes in catch or effort over time in their data queries.

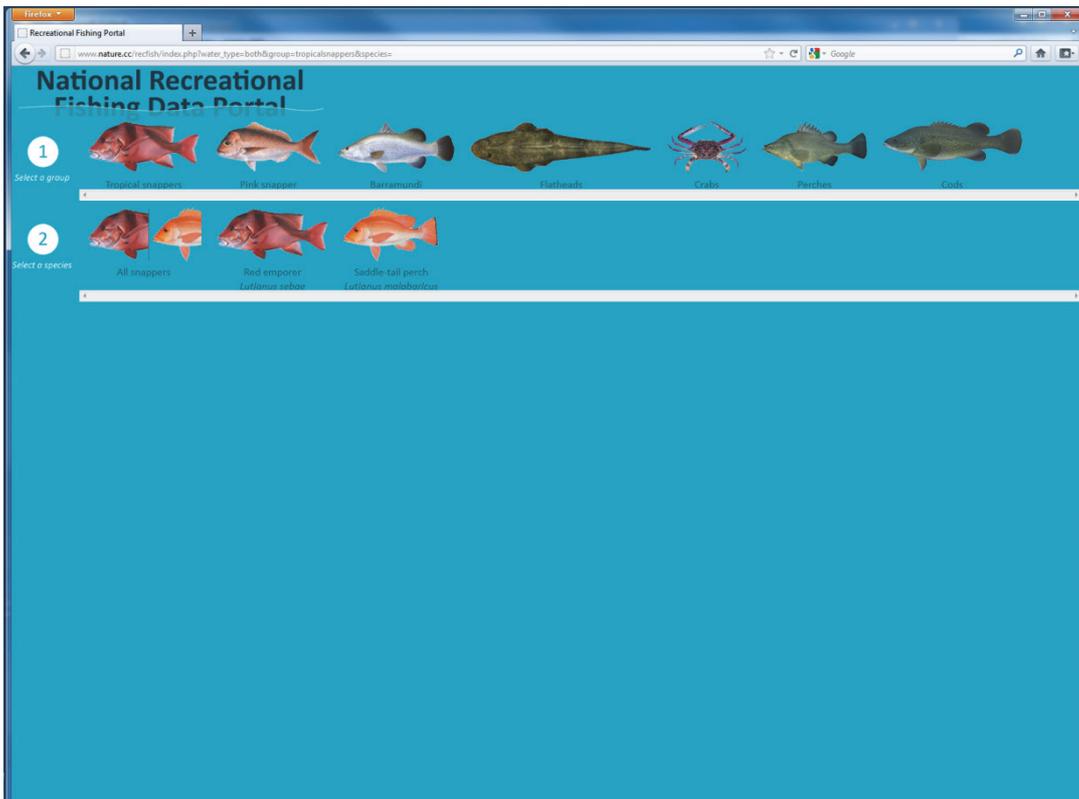
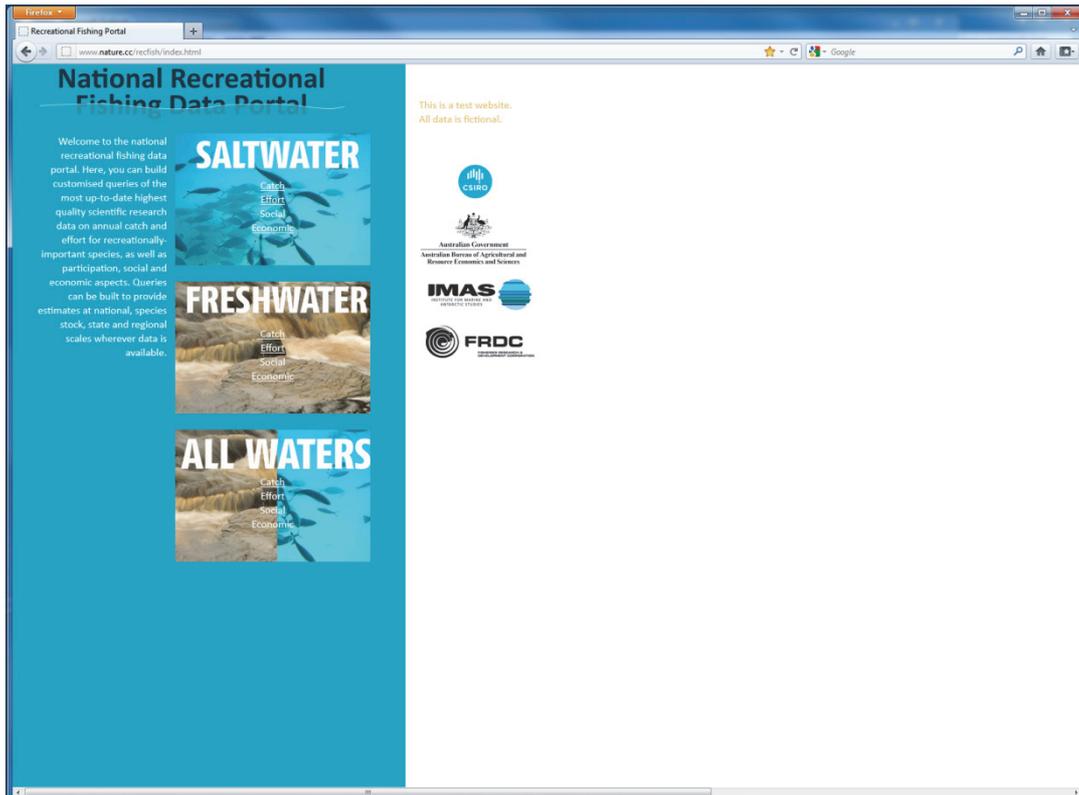


Figure 34: Screen shots of the home screen providing background to the national recreational fishing data portal (top) and a user-friendly screen of clickable species and species groups to allow users to perform catch queries (bottom). Although seven species groups are shown here for illustrative purposes, many more species can be added.

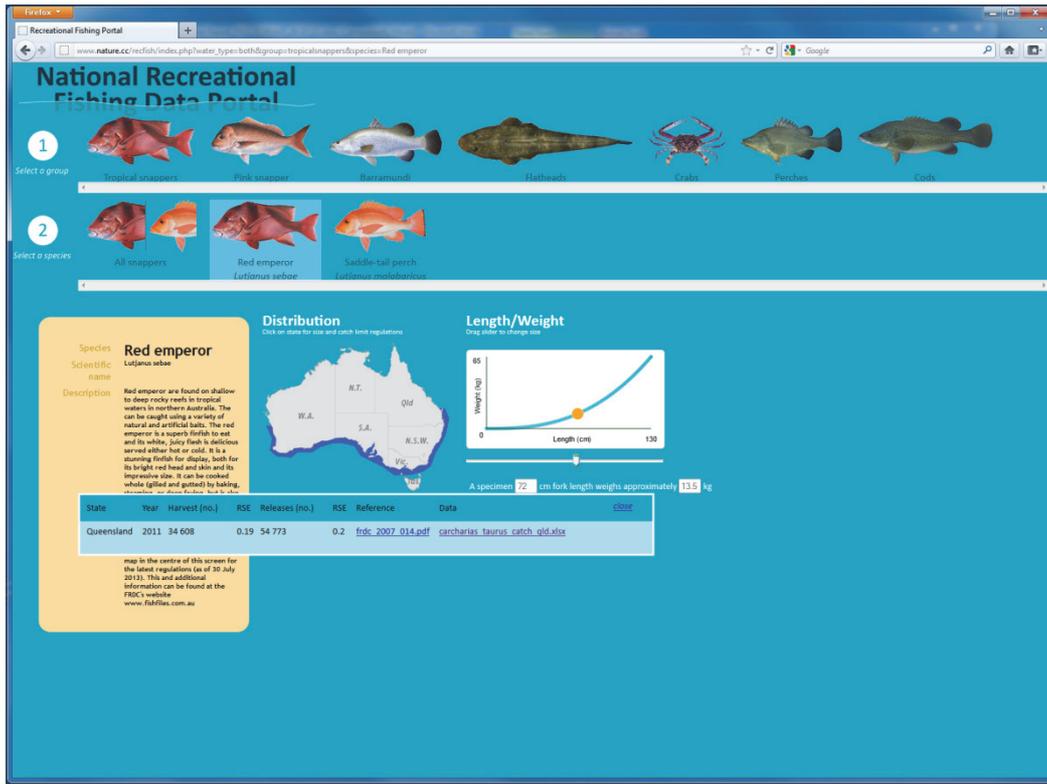


Figure 35: Screen shot showing a data query of red emperor catches in Queensland obtained by clicking the state on the Australia map, and a length-weight relationship for the species where fishers can use the slider bar feature to select the length of a fish to obtain an estimated weight.

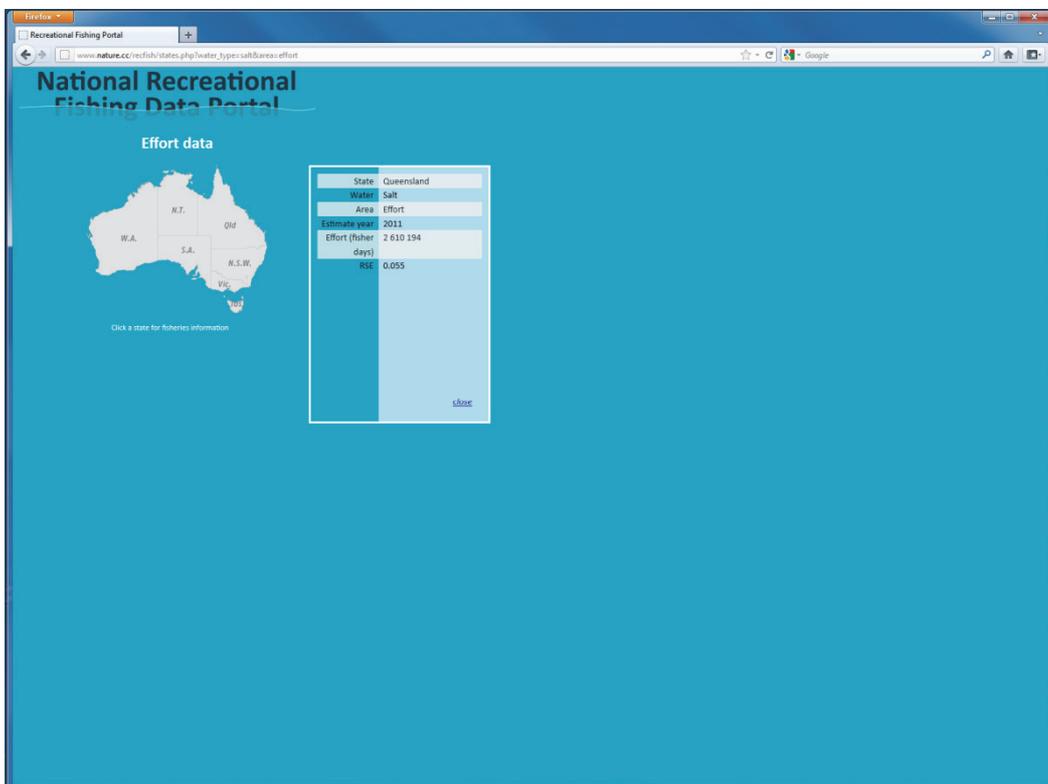


Figure 36: Screen shot showing an output table from a data query for fishing effort in Queensland. The data can be downloaded by the user as a CSV file.

Portal hosting, data custody and long-term data harvests

This project successfully proposed one possible framework for the national recreational data portal, which was well received by stakeholders. The next important step beyond this project is to develop and populate a fully functional portal that is accessible to the public. However, before this can happen there are several important considerations to be made, such as where the portal will be hosted, the agency/agencies responsible for storing and managing the available datasets, and the agency/agencies responsible for ongoing data harvest and analyses as new datasets become available.

There are several options for hosting the data portal. It can be integrated into other national data portals, or hosted on its own server, which may also be hardwired to other portals and websites. There are several advantages of integrating the national recreational fishing data portal with other existing portals, with the primary advantage being the saving of time and salary costs in designing a new portal. A list of some potential data portals are listed below with some commentary on the advantages and disadvantages of each.

FRDC Status of Australian Fish Stocks 2012

(<http://fish.gov.au>)

This website is a comprehensive resource describing the fishery, stock structure, catches, stock status, and biological parameters of key species of importance to commercial Commonwealth and/or State/Territory fisheries (Figure 37). The data for each species are usually reported at a spatial scale of a jurisdiction or stock. The website does not offer any customisable data queries, negating the need for any high performance statistical models in the back end to produce data outputs.

This website would be the most logical place to integrate the national recreational data portal since the site aims to provide a national picture of catches for commercial species and has been endorsed by the Australian Fisheries Management Forum (AFMF). The fact that some of the species on the site are also of recreational importance, provides strong justification for the integration of recreational data. However, there would need to be some re-organisation of the structure of the website in order to allow non-specific recreational data to be made available. For example, participation and effort, and well as social and economic components are generally not species-specific, so a separate section would be required for recreational fisheries.

The website is hosted and maintained by the FRDC, which is a stable corporation funded by the Commonwealth government and likely to be maintained in the long term. Therefore, there is a low risk of corporate knowledge being lost over time, or the hosting of the site being abandoned. Individuals responsible for the maintenance of the website have extensive experience in collaborating with the breadth of commercial fishery stakeholders and are respected for the role they play in fisheries research, development and extension in Australia. Such experience would allow a seemingly straightforward transition to the recreational fishing sector. Furthermore, the FRDC host the Recfishing Research group, which is a group of recreational fishery stakeholders who advise the FRDC on pertinent recreational fishing issues in Australia. As a result, the FRDC would have close ongoing contact with the group who can advise on what parts of the portal may need to be updated to meet the needs of stakeholders of the recreational fishing sector.

Dusky Flathead *Platycephalus fuscus*
 Anthony Roelofs*, Charles Gray* and Jodie Kemp*

Content | Images & Video | Reference

Table 1: Stock status determination for Dusky Flathead

Jurisdiction	New South Wales	Queensland	Victoria
Stock	EGF	ECIFFF	GLF
Stock status	Sustainable	Sustainable	Sustainable

Figure 37: Screen shot of a page from the FRDC Status of Australian Fish Stocks 2012 (<http://fish.gov.au>), showing a profile for the commercially and recreationally important species, dusky flathead.

Australian Ocean Data Network Portal (AODN)

(<http://portal.aodn.org.au/aodn/>)

AODN is an initiative created under the National Collaborative Research Infrastructure Strategy (NCRIS) involving six Commonwealth government agencies with responsibilities in the Australian marine jurisdiction including the Australian Antarctic Division, Australian Institute for Marine Science, Bureau of Meteorology, Commonwealth Science and Industrial Research Organisation (CSIRO), Geoscience Australia, and the Royal Australian Navy.

The AODN portal is a free, publically accessible resource where data, in various formats, are available for a range of oceanographic, biological, and environmental projects and real-time monitoring systems. Data formats range from simple metadata descriptions of datasets, requiring contact of custodians to access the data, to aggregated and raw data available for immediate export in user-definable file formats. There are limitations placed on some datasets due to confidentiality issues.

The functionality of the portal is quite simple, with simple hierarchical folders to the left of the web page frame, sorted by agency, project or broad data type (e.g. “satellite data”) (Figure 38). Although national recreational fisheries data could easily fit within this structure of AODN, it would not be considered a user-friendly interface for the average recreational fisher. However, once inside the correct folder structure, it would be possible to make access to the more common data queries quite easy. An additional consideration is that no other fisheries data are available in the portal. It would be a significant advantage to have recreational fisheries data alongside commercial fisheries data, so that users could query both datasets simultaneously for the same spatial and/or temporal strata.

An advantage for the more experienced user is that AODN has the capability of overlaying various datasets (e.g. sea surface temperature) simultaneously on a single map, or allowing download as a single file. The data can be presented in raw format, or model outputs can be displayed. However, this functionality does come at a cost, in that the data layers can be quite slow to load on a standard

residential internet connection. This would be a significant disadvantage for recreational fishers wishing to access data quickly.

NCRIS has provided funding from 2004/2005 to 2010-2011 to develop and maintain AODN. The Integrated Marine Observing System (IMOS) co-ordinated by the University of Tasmania and the CSIRO largely takes responsibility for the management of AODN and periodically acquiring new datasets from the various contributing agencies. Funding for AODN by NCRIS has ceased, and the level of funding for IMOS is uncertain after recent budgetary cuts. Therefore, there is some risk that the AODN portal may not continue into the long term.

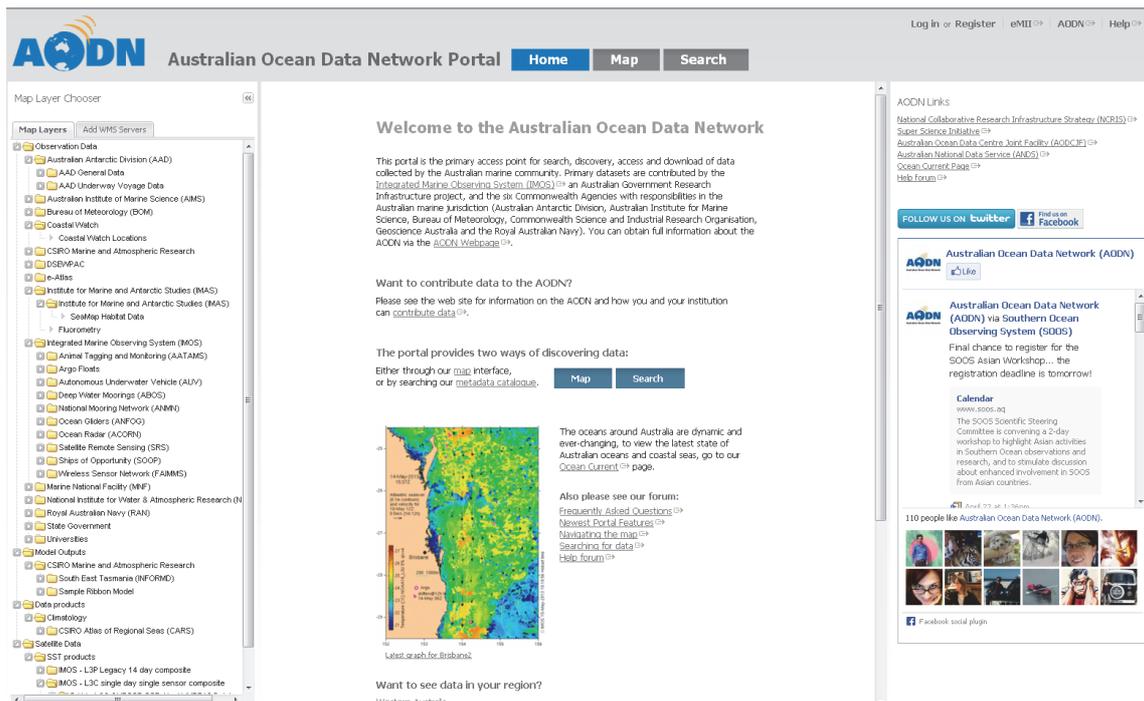


Figure 38: Screen shot of a page from the Australian Ocean Data Network (AODN) Portal (<http://portal.aodn.org.au/aodn/>), showing a hierarchical folder system to allow users to navigate datasets by agency or broad data type.

Coastal Habitat Resources Information System (Chrisweb)

(<http://chrisweb.dpi.qld.gov.au/chris/>)

The Queensland Government's Department of Agriculture, Fisheries and Forestry (DAFF) created the Coastal Habitat Resources Information System (Chrisweb) to make fisheries and habitat data freely available to the general public (Figure 39). The site only makes available data from Queensland so it would not be a suitable location to house a national recreational fishing dataset. However, Chrisweb serves as a good example of a framework and interface that is designed for a general non-scientific audience, such as recreational fishers.

The portal is undergoing a significant redevelopment, whereby technology will be implemented that will make complex data queries possible at a very rapid speed. However, as the site is structured at present, it allows the user to query commercial and recreational fishing data (but not simultaneously) by species for various temporal and spatial strata. The data queries are generally simple and rapidly displayed, which is likely to be sufficient for a general audience of recreational fishers. It also allows users to see the metadata of various related projects and well as interactive maps to display features such as fish habitat and marine protected areas.

Chrisweb demonstrates the advantage of having all information for recreational stakeholders in one location using a simple user interface. Recreational fishing stakeholders are able to acquire the vast majority of their data needs quickly for such needs as resource allocation discussions.

The screenshot shows the Chrisweb interface in a Windows Internet Explorer browser. The page title is "Coastal Habitat Resources Information System (CHRIS) - Queensland Government". The main content area is titled "Recreational Fishing Search" and includes a search form with fields for "Year" (set to 2005) and "Species" (set to "All (Listed)"). Below the search form is a "Search Results" section with a table of data. The table has columns for "Region", "Species", "Caught", "Harvested", and "Released". The data is sorted by Species (Australian Bass) and shows results for various regions in Queensland, including Logan City, Wide Bay-Burnett, Sunshine Coast, Redland Shire, Queensland Total, Northern, Moreton, and Wide Bay-Burnett (repeated).

Region	Species	Caught	Harvested	Released
Logan City	Australian Bass	6000	2000	4000
Wide Bay-Burnett Statistical Division	Australian Bass	13000	1000	12000
Sunshine Coast Statistical Sub-Division	Australian Bass	49000	8000	41000
Redland Shire	Australian Bass	1000	0	0
Queensland Total	Australian Bass	583000	73000	510000
Northern Statistical Division	Australian Bass	0	0	0
Moreton Statistical Division Balance	Australian Bass	166000	19000	147000
Wide Bay-Burnett Statistical Division	Australian Bass	41000	8000	33000

Figure 39: Screen shot of a page from the Queensland Government Department of Agriculture, Fisheries and Forestry Coastal Habitat Resources Information System (Chrisweb) (<http://chrisweb.dpi.qld.gov.au/chris/>), showing a simple data query for recreational catch data by year and region.

Marine Ecosystem Health Indicators (CSIRO)

(http://www.nature.cc/indicators/index_main.html)

The Marine Ecosystem Health Indicators portal is a simple website created for a national project run by the CSIRO that creates rapid outputs for user-defined data queries. It represents many simple data query government websites. The speed of queries is rapid because each possible combination of data output is pre-loaded as a flat file, rather than raw data being processed by models, such as in AODN. This portal may not be suitable for a national recreational fishing dataset, but is an example of a user-friendly, low cost and low maintenance portal.

The functionality of the portal is very simple, with simple dropdown menus and tick boxes to select strata of interest. It has an added advantage over some other portal such as Chrisweb, where users can click on maps of regions or fisheries and display specific data within the strata (Figure 40). The portal can be developed and populated rapidly and at very low development and ongoing hosting cost. The CSIRO host several similar sites for various project. There is an advantage that cost would be zero to maintain as it would be housed on a CSIRO secure server and maintained by long-term experienced staff funded through reliable CSIRO appropriation funding. Such sites would need a nominated person to periodically request and collate new data and ensure its timely upload to the site.

The advantage of having a standalone portal for recreational fishing data are that it can be completely customised to suit the target audience of recreational fishery stakeholders. Therefore, the interface can be designed with user-friendly features to allow the user to undertake the more common data queries, but also allow them to easily access the breadth of recreational fishing information that may not be easily displayed through other portals such as jurisdictional-specific regulations and biological information.



Figure 40: Screen shot of a page from a simple data website portal created by the CSIRO for the Marine Ecosystem Health Indicators project (http://www.nature.cc/indicators/index_main.html) showing a simple data query facilitated by dropdown menus and tick boxes.

Options for improving National recreational fisheries data

One of the key objectives of the project was to explore approaches for filling information gaps in recreational fisheries data at a national level. Specifically, this relates to the utility of alternate data collection methods such as community monitoring programs, better co-ordination of existing jurisdictional-wide surveys, the improvement of existing probability-based sampling methods using dual frames and ancillary data, and targeted surveys for 'rare event' or specialised components of the recreational fishery, such as game fishing, which are generally cost-prohibitive using traditional survey approaches. A recent review of recreational fishing sampling methods (Hartill et al., 2012) identified a range of survey approaches and concluded that the method needs to match the scale of the fishery. Here we make some recommendations for improving recreational fishing estimates at jurisdictional and national scales.

National licence frame or registry

This project has shown through the national audit of recreational fishing datasets that the vast majority of surveys that have been able to provide catch and effort estimates at scales that are of interest to recreational fishing stakeholders have applied the telephone-diary approach. We have also revealed the fragmentation of surveys through time, which has largely been a result of the high cost of undertaking these surveys on a regular and on-going basis. The telephone-diary method typically involves a general population screening survey based on stratified random sampling of telephone numbers to contact households in order to obtain the numbers of participating, or intending fishers, their demographic characteristics, and to recruit a panel of fishers to a longitudinal diary survey to obtain trip-specific catch and effort data. Given that the last national survey determined that about 20% of the Australian population fish recreationally, the sampling effort required to obtain a representative sample of fishers can be high and costly. The efficacy of telephone surveys is further diminished by the rising rate of non-response presumably due to the increasing prevalence of telephone marketing, coupled with coverage issues linked to the increasing reliance on mobile telephones (Brick, 2011).

A potential solution to improve the efficiency of surveys would be the implementation of a complete list frame of recreational fishers in Australia. Such a list could be created from licences issued by specific jurisdictions, or a national registry of recreational fishers. This would allow the number of licenced or registered participants to be known at any given time, and allow for more efficient contact to be made with fishers by telephone or mail to recruit to surveys. In some states where recreational fishing licences have been introduced, namely Western Australia and Tasmania, researchers have benefitted from a reduction in the cost of screening surveys, an increase in the speed of which the surveys are completed, and greater confidence in the outcomes. Not only can researchers benefit from the licence frame, but in states such as New South Wales and Victoria, the licence trust has helped to fund key research on recreational fisheries and the key target species (Steffe et al., 2005; Stewart et al., 2011).

However, there have been problems identified with using a licence list as a sampling frame in some states such as Victoria and NSW, where there are several exemption categories, such as for persons under 16 years of age, and persons on a pension. In these states, the large number of exempt fishers has required researchers to resort to other forms of general population surveys. In the most recent state-wide survey of Victoria, Ryan et al. (2009) estimated around 60% of surveyed fishers did not hold a licence due to an exemption. If licence frames are to be used as a statistically valid sampling frame, there is a need to either require previously exempt persons to take out a licence, possibly at a reduced or no cost, or introduce a supplementary compulsory registry for exempt fishers. This would allow for a complete list of participants to be compiled and used as a sampling frame at the jurisdictional level.

A review of recreational fishery survey methods in the USA by the National Research Council (2006) identified the high cost of general population surveys for accessing recreational fishers, and the growing non-response bias (i.e. refusals and non-contact) resulting from the growing proliferation of all forms of market surveys. This has created survey resistance, while non-coverage exists due to the increasing use of mobile phones. Such sampling issues that significantly reduced the reliability of estimates from surveys led to the recommendation of a US national saltwater fisher registry. The logistics of developing and maintaining such a registry in Australia has been suggested to be difficult and costly (Pepperell and Dominion, 1996). At present, implementation of the method has not proceeded, primarily due to the large number of states involved that are developing logistical mechanisms for dealing with compliance and exemptions within jurisdictions where various recreational fishing licences/permits are already in place. With fewer jurisdictions and the general agreement among fishery researchers and managers that complete list frames are required to lower survey costs and improve data reliability, a national register of recreational fishers may be a more feasible initiative to implement in Australia than the US. However, there would still be significant political and logistical issues to overcome in order for a registry to be successful.

Another valuable use for a complete list frame of recreational fishers is as a time series of a proxy for participation. The statistical modelling undertaken in this project showed the potential value of long time series of participants, whereby effort and catch could be reasonably estimated for years where survey data are not available. The statistical analyses showed that at least five surveys within a 13 year period would be required before any reliable models could be constructed using licence holder numbers as a proxy of effort. However, if surveys are repeated at the current rate, modelling approaches may be used in the next decade to cost-effectively estimate catch and effort from licence numbers alone. At this point, surveys may only need to be completed at less frequent intervals, significantly reducing costs to each jurisdiction's fishery agency.

Dual-frame or multi-frame sampling

Although a complete list of recreational fishers in Australia would be ideal for cost-effectively accessing a random sample of fishers, there are currently several political and logistical impediments to overcome before achieving this goal. An alternative approach, albeit more costly and less reliable, may be to use existing list frames to conduct multi-frame sampling. Dual-frame or multi-frame sampling is the utilisation of two or more separate, but overlapping, sample frames to access individuals from a population where a single complete list frame does not exist. For example, telephone list frames are becoming increasingly incomplete, particularly with the growing exclusive use of mobile telephones in the general population. Barr et al. (2012) reported that the proportion of mobile phone-only households in Australia has steadily increased over the past decade to around 20% in 2011. Furthermore, Grande and Taylor (2010) showed that mobile-only households in Australia have significantly different demographic characteristics to landline telephone households. Consequently, it is now common among telephone market survey companies to adopt dual-frame sampling approaches to use separate landline and mobile telephone number lists in order to reach a representative sample of households (e.g. Barr et al., 2012; Jackson et al., 2013).

In a similar vein, coverage and cost-effectiveness of the recreational fishing surveys may be improved by combining incomplete list frames such as recreational fishing licence holders and boat registries, with general population telephone lists. In a survey of the recreational Blue Crab fishery in Maryland, USA, Ashford et al. (2009) found that avid fishers from the licence frame and the general household telephone frame accounted for a similar proportion of the catch. Although they found response rates were similarly low for each list (~30%), the proportion of active fishers interviewed and the cost per successful survey was 13 and 15 times higher for the licence frame than the household frame.

Community monitoring – ‘Citizen Science’

Community monitoring has received widespread support amongst the recreational fishing fraternity in recent years. This development is consistent with the worldwide growth in 'citizen science' across a variety of fields. The support of fishers is based on a number of perceived limitations of traditional survey approaches used by fishery management and research agencies to answer some of the key questions asked by recreational fishers. Some of the limitations include:

- High cost of both offsite and onsite surveys, which limits their use both at the jurisdiction and regional scale;
- Lack of ownership of outputs of surveys for the recreational sector;
- Problems in accessing current data on the recreational fishery, due to time taken to develop, implement, analyse, and publish surveys;
- Difficulty in surveying specialised fisheries by traditional survey methods.

Community monitoring projects have specified a variety of objectives and collected a range of information within the recreational fisheries sphere. For a detailed review see Stenekes and Sahlqvist (2011). A number of projects have collected catch and effort data from recreational fishers through onsite interviews at fishing access points and through voluntary fishing diary programs.

An example of catch and effort monitoring - CapReef

CapReef (Capricorn Reef Monitoring Program) is a community monitoring program initiated by residents of the central Queensland coastal region in 2005 to collect information on the effects of management changes on fish populations and fishers (Sawynok et al., 2009). Initially, the program was responding to introduction of a new zoning plan for adjacent waters of the Great Barrier Reef Marine Park (GBRMP) but continued to collect data after the management changes were implemented, until 2009.

The CapReef program can be viewed as a successful community monitoring program and certainly has provided a great range of information on the following aspects of the fishery:

- Distribution of fishing effort within the study area;
- Catch rates;
- Species composition of catch;
- Size composition of catch;
- 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;
- specimens of key target species' retained catch for biological sampling;

CapReef monitored the fishery using the following methods:

- regular surveys of local fishers,
- boat ramp surveys and trailer counts,
- fishing trip reports provided by mail, fax, 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.

The CapReef program aimed to obtain a measure of the total fishing effort for the offshore component of the study region by combining data from a number of the groups listed above. The trailer parking capacities of all main boat ramps in the region were calculated and the two largest ramps servicing the inshore and offshore fishery were surveyed regularly (Platten et al., 2007). The addition of traffic counter records, weather records and interview results enabled the annual number of fishing trips to be estimated using a number of regression models that utilised the adjusted and expanded trailer count data. This allowed adjustment for non-fishing trips, patterns in usage due to day type (weekday or weekend), weather influences, and fish spawning closures.

The effort estimates were assumed to be for two loosely defined offshore areas, Rosslyn Bay and Gladstone. Earlier analysis of boat ramp characteristics indicated that these two ramps account for 66% of offshore fishing trips within the CapReef study area (Platten et al., 2007). The number of offshore fishing trips from Rosslyn Bay were estimated to have increased from 12,000 in 2005-06 to 14,000 in 2008-09 (Sawynok et al., 2009).

Catch composition data collected from boat ramp surveys and fishing trip reports at the two locations provided average total and retained catch values. Numbers of fish caught (i.e. harvested and released) offshore from Rosslyn Bay were estimated to have increased from around 164,000 in 2005-06 to 188,000 in 2008-09, while numbers of harvested fish increased from 65,000 in 2005-06 to 85,000 in 2008-09 (Sawynok et al., 2009). Numbers of fish caught offshore from the Auckland VMR ramp at Gladstone were estimated to have increased from 50,000 in 2005-06 to 58,000 in 2008-09, while numbers of harvested fish increased from an estimated 20,000 to 26,000.

It should be noted that CapReef, due to its design was unable to provide participation estimates for the central Queensland population. This probably was not critical to its purpose as there were regional estimates of participation available from the 2000-2001 NRFS.

Catch and effort estimation

The ability of community monitoring approaches to estimate population-wide fishing effort and catch (whether at the jurisdiction or regional scale) is the most critical point for discussion in this report. CapReef is the only community monitoring project that has attempted, or at least has published, estimates of total fishing effort and catch, albeit for a specific region (offshore waters). The data collected by CapReef was intended to inform debate on a number of issues, the most important to the local fishers was the importance of offshore reef areas to their activities and the likely impact of management changes. The fishing effort and catch rate statistics collected across the whole CapReef study area were suitable to describe the relative importance of fishing grounds. However, an effort was made to use the survey data to estimate the total catch from the offshore grounds so that the economic and social importance of the fishery could be determined.

The NRFS estimate of offshore finfish catch for the Rockhampton coastal waters region was 295,000 harvested and 249,000 released. This indicates that the CapReef estimate is plausible when other associated assumptions are accounted for, such as sampling only covering an estimated 66% of fishing trips. Despite this, there are a number of relevant considerations when the CapReef approach is evaluated as a possible method for catch and effort estimates at larger geographic scales:

- The standard error of the NRFS statistics can be calculated to provide a measure of precision. The precision of the CapReef estimate is unknown and possibly difficult to estimate;
- The CapReef catch and effort estimates were possible because the source data were being collected for the larger project and intended to inform a range of questions other than total catch and effort. Therefore, the costs (both in grant funding and volunteered time and in resources) were justified in the minds of the stakeholders;
- National statistics should require that the component participation, fishing effort and catch estimates are collected by comparable methods or at least methods that provide a required precision at a regional scale;
- Implementation of the CapReef approach in multiple regions would require considerable management overheads. CapReef is a good example of a community program that was successful due to the oversight of a few dedicated volunteers. There is not a community monitoring model currently operating that has provided that large-scale governance in the fisheries sector.

The primary problem for community monitoring in providing catch and effort estimates is achieving a rigorous sampling regime within a volunteer framework at a suitably large geographic scale. Large geographic scale surveys need a suitable sampling frame that is cost-efficient. While onsite survey methods can be implemented in a particular region for a specific fishery and still be cost-effective – for example, CapReef offshore boat fishers, or game fishing for Southern Bluefin Tuna in Victoria where only a few access points exist (Green et al., 2012) – when all members of a jurisdiction's recreational fisher population need to be sampled the onsite survey model becomes inefficient.

Community monitoring best suited to answering local (or regional) questions and is not suitable for large-scale data collection. However, in some instances, it can be used for validation of larger scale data collections. Catch composition, both in terms of species and size are important for disaggregating the catch estimates produced by offsite surveys and can be provided by suitably trained volunteers. Volunteer catch and effort diaries may also have a role where the reporting population can be accurately described in demographic characteristics to supplement data for specialist fisheries and cohorts within the population, such as highly avid fishers.

Surveying specialised recreational fisheries

Recreational fisheries in Australia and worldwide are rapidly diversifying in response to the increased availability and affordability of new technologies that allow the targeting of species that may not have been considered by recreational fishers. These fishers often target species using specialised techniques and generally represent a very small minority within the wider recreational fishing community. Because complete list frames do not exist for these small populations of fishers, from a sampling perspective, they can be considered a 'hard-to-reach' population. The prevalence of these rare or elusive components within recreational fisheries (e.g. sport fishers, fly fishers and spear fishers) presents fisheries researchers with an increasingly difficult problem of cost-effectively obtaining representative data using traditional probability-based sampling methods used by jurisdictional fishery agencies to obtain broad scale catch and effort estimates from the general recreational fishery.

The telephone-diary approach used in the NRFS has been criticised for not being able to provide reliable catch estimates for rare-event species, such as tunas and billfish. The survey was designed to gather broad-scale information of the overall recreational fishery, and did so by representatively surveying members of the wider community. Specialised recreational fishers comprise only a small fraction of the overall recreational fishery. Consequently, the NRFS approach collected information at a scale that is generally too coarse to collect representative data on specialised fisheries. There are

many aspects of specialised fisheries that differ from the general recreational fishery, and therefore, survey methods need to be specifically adapted to account for these differences.

For example, the gamefish fishery off eastern Australia is primarily boat-based, although a small land-based component of the fishery exists for Black Marlin, Longtail Tuna and neritic scombrids (Griffiths, 2012). Boats range in size from 4-5m that can be launched from many types of access points including boat ramps, sheltered bays, estuaries and ocean beaches, to large 10+ m vessels that may depart from private moorings and marinas. As a result, an on-site survey aiming to representatively sample the boat-based component of the fishery would need to employ sufficiently high sampling effort to stratify across all vessel departure point types. In most cases, such sampling intensity would be cost-prohibitive. However, for some species such as Southern Bluefin Tuna that has high conservation and commercial importance, surveying small specialised fisheries that probably account for the vast majority of the catch of the species is required. Therefore, alternative cost-effective methods may be required.

Two recent FRDC projects (Griffiths et al., 2010a; Griffiths et al., 2010b) aimed to explore new cost-effective survey methods for recreational fisheries and identified Respondent-Driven Sampling (RDS) and Time-Location Sampling (TLS) as two possible approaches for sampling hard-to-reach specialised fishers. Despite both methods not being previously used in fisheries science, they have been widely used in epidemiology and social science disciplines to access members of populations who are rare, hidden, or physically difficult to locate within the general population, such as the homeless, illicit drug users, HIV carriers and prostitutes (see reviews by Magnani et al., 2005; Griffiths et al., 2010c).

Respondent-Driven Sampling

RDS is a non-random statistical method that works by the researcher interviewing a set of initial subjects from the target population, who serve as “seeds” for an expanding chain of referrals. Subjects from each ‘wave’ recruit subjects for subsequent waves by providing a coupon that is redeemable for an incentive upon successful recruitment to the survey. This creates a chain of referrals or ‘snowball’ effect that continues until the sample reaches an equilibrium, that is, there the proportion of specific components of the sample (e.g. males and females) no longer varies by a predetermined amount (Heckathorn, 1997; 2002). The advantage of the method is that it can be cheap, rapidly completed, and capable of obtaining a representative sample from a population that would normally be difficult or cost prohibitive to sample using traditional survey approaches.

A current FRDC project is currently trialling the first application of RDS to recreational fisheries, using the Tasmanian recreational licensed set-line fishery as a case study. If successful, there may be options to further decrease the cost of RDS surveys using online implementation of RDS. A recent web-based application of RDS (termed “webRDS”) (Wejnert and Heckathorn, 2008) showed that this approach was as effective as traditional RDS methodology, and the study was also completed about 20 times faster. Despite the apparent efficacy of RDS approaches in other disciplines, of course these require thorough field trials to prove their efficacy in recreational fisheries before recommending widespread use.

Time-Location Sampling

Time-Location sampling is another method that may be used to cost-effectively sample hard-to-reach components of recreational fisheries. Many hard-to-reach populations tend to gather or congregate at certain types of locations at particular times. For example, epidemiologists found that hidden populations of illicit drug users tend to congregate at ‘shooting galleries’ or in other areas where drug or needle transactions take place, and often in the evenings. TLS capitalises on these types of predictable behaviours of the target population, whereby a researcher identifies aggregation sites in a geographic region of interest prior to a survey as a sampling ‘universe’ and a subset of the sites is chosen as a probability sample (Muhib et al., 2001; Stueve et al., 2001). The researcher then interviews individuals entering or leaving an aggregation location over a pre-defined period (e.g. a randomly chosen 3 hour interval on a randomly chosen day).

TLS is a similar concept to traditional recreational fishing access point surveys. However, access point surveys at boat ramps, for example, can only account for fishers who fish from vessels that can be launched from a trailer. Land-based fishers and fishers owning larger vessels berthed in marinas, on moorings or on private property are missed using boat ramp access point surveys. This may cause a significant bias in total catch and effort estimates for the overall fishery if the fishing characteristics of each component differ. In contrast, TLS may be used to sample the specialised component of the fishery if locations can be found where a representative cross-section of all fishers congregates. One such approach is to conduct a survey of customers at fishing tackle stores, since most fishers, regardless of ability, fishing experience, avidity or mode of fishing, need to purchase fishing tackle at some point. TLS was trialled in an FRDC project of a national survey of fishers who target Longtail Tuna (Griffiths et al., 2010b), as well as a survey of offshore sport fishers in southeastern Queensland (Zischke, 2013).

It is possible that tackle store customer surveys may under-represent certain types of fishers since there is an apparently increasing number of highly specialised and avid fishers who purchase their tackle through websites or overseas. This can be due to a lack of supply of specialised equipment in Australia and/or favourable foreign currency exchange rates. Nonetheless, Zischke (2013) found that these fishers still enter tackle stores on at least a monthly basis to purchase minor items, bait, or to simply view and handle particular products before purchasing the products online or by mail order. Therefore, if sufficient sampling is undertaken across a range of stores in a particular region, it may be possible to attain a representative sample of specialised fishers.

Although TLS could cost-effectively provide a representative sample of the catch and effort of recreational fishers targeting a particular species, TLS is unable to directly estimate population size in order to expand sample estimates to estimate the total catch. Zischke (2013) attempted to address this problem by using a mark-recapture approach by undertaking surveys at individual tackle stores on multiple occasions and recording whether respondents had been interviewed previously. Although he identified some potential sampling issues relating to multiple store visits and potential ‘avid shopper’ bias, further work on the TLS approach may uncover solutions to allow for such biases to be addressed.

Adaptive Sampling

Many of the specialised recreational fisheries in Australia often operate across heterogeneous spatial and temporal scales. For example, the eastern Australia boat-based recreational game fish fishery operates from a small number of major ports and several minor access points across several thousands of kilometres of coastline (Ward et al., 2012). In a temporal context, the fishing activity varies seasonally in response to the seasonally dynamic East Australia Current (EAC), which influences regional fisheries at different times as it extends southward during the austral summer and spring. Due to the formation of eddies and fronts that can form and dissipate quickly, the level of regionalised fishing activity can also be equally as sporadic. This means that stratified random on-site sampling

may not detect major localised peaks in fishing activity, and the catches of infrequently encountered species.

In dealing with a similar problem of surveying the recreational catch of Southern Bluefin Tuna in Tasmania, Morton and Lyle (2003) proposed a flexible adaptive sampling regime where sampling effort is increased when fishing activity increases during effort 'pulses' in the fishery. Such an approach is logical and has the potential to reduce survey cost, since sampling effort is expended primarily during times when fishing activity is high. However, the primary concern for using the approach in recreational fisheries is that it presents significant statistical difficulties due to the bias caused by disproportionately sampling periods of high effort (Smith et al., 2004).

Unfortunately, there have been few real world applications of adaptive sampling despite several theoretical simulation studies, and most have related to rare biological populations (see Thompson, 2003). However, Gallucci and Hariharan (2012) recently proposed an adaptive sampling approach to estimate the recreational catch and effort for Thresher Shark in California, USA, but it has not yet been tested in the field. Given the potential cost savings for sampling hard-to-reach or dynamic populations of specialised recreational fishers using adaptive sampling, this may be a key priority area of research in future.

Benefits and Adoption

The increasing efficiency of the recreational fishery and its diversification into specialised components that target species of multi-jurisdictional importance highlight the need for national estimates of catch, effort, participation, social and economic measures in order for fishery managers to ensure the sustainability of recreationally-important species and to ensure equitable resource sharing among commercial, recreational and indigenous sectors. Unfortunately, since the 2000/01 national survey, recreational fishing surveys in Australia have not been undertaken with a multi-jurisdictional focus in mind. Instead, jurisdictional and regional surveys have focused on addressing local issues, although they have generally used similar survey methodologies.

The primary benefit from this project has been to identify recreational fishing surveys undertaken in Australia since 1990 and bring metadata descriptions together in a single repository from which obvious gaps were identified. A further benefit from this process was collaborating with recreational fishery stakeholders and bringing these groups together in workshops to stimulate thinking around approaches to tackling national and cross-jurisdictional issues, and to identify species of national recreational importance.

The statistical assessments undertaken that highlighted available datasets cannot be aggregated to produce national estimates of catch, effort and participation was a key outcome of the project. The benefit of this work is that it provides managers and researchers a clear direction to either undertake another national survey if national statistics are required, or to better co-ordinate future jurisdictional surveys so cross-jurisdictional and national estimates can be generated. Furthermore, the analyses showed the benefit of having a continuous time series of ancillary data that could be used as a proxy of fishing effort (e.g. licence numbers) to track trends in catch and effort for years where survey data are unavailable. The benefits of having a complete licence, or registry, frame were also highlighted with respect to sampling efficiency and increasing the cost-effectiveness of future surveys.

A key benefit of this project was the collation of 'best available' estimates of participation and effort, and catch for priority species, which have not been updated since 2000/01. Although there are many caveats to these estimates due to the variation in survey methods (and associated biases) and periods of the datasets available, they are of benefit for recreational fishing stakeholders in having the most recent estimates available in one place. The national recreational fishing data portal that was proposed to house recreational fishery information, if adopted and developed will benefit recreational fishing stakeholders by allowing access to the most recent data in a user-friendly interface, as well as other information on recreational fisheries, such as regulations. Such a portal is likely to enhance communication of research results and promote engagement and understanding amongst recreational fishing stakeholders including jurisdictional fisheries agencies, universities, community groups, recreational fishers, fishery managers and policy makers.

Further Development

The primary objective of the current project was to identify datasets relating to recreational fishing in Australia, bring these data together for priority species identified by stakeholders, identify whether the existing data could be feasibly brought together and analysed in a statistically robust manner, and then provide updated national estimates that could be made available in a national public data portal. Whilst working through this process it became clear during the data analysis stage that the datasets currently held by jurisdictions in Australia are too fragmentary in space and time to allow aggregation to produce national estimates for recreational fisheries. Further development is therefore required in a number of areas, ranging from simple improved coordination of jurisdictional surveys to statistical tool development (e.g. dual frame sampling and adaptive sampling approaches), if the primary goal of producing reliable estimates for recreational fisheries at species stock (i.e. multi-jurisdictional) or national levels is desired.

Perhaps the first decision that must be made is whether there is a need in future or demonstrated cost savings to justify a repeat of the national survey, or whether national statistics should be derived by aggregating data provided by jurisdictional surveys. This latter approach requires coordination in the timing and scope of surveys, in particular how interstate fishing activity is taken into account. In relation to interstate fishing, it is encouraging to note that statewide surveys underway in New South Wales and planned for Queensland (and potentially Victoria) are moving to incorporate the reporting of interstate fishing by residents. Given the previous reluctance of most jurisdictions to commit significant funds to provide national statistics, it is far more likely that coordination of jurisdictional surveys holds the most potential to enable national statistics to be generated. It is worth highlighting that this was, in practice, the approach taken in the 2000/01 national survey, whereby national statistics were derived from concurrent jurisdictional surveys that were conducted using a standardised methodology.

Although most jurisdictional surveys conducted since the NRFS have been conducted using a similar 'Fishcount' telephone-diary approach (see Lyle et al., 2002) – with the exception of Western Australia's 2011/12 state-wide survey of licenced boat-based fishers – they have not been conducted concurrently. Given the interannual variability in fish species and fisher population dynamics, the amalgamation of datasets across multiple years would obviously yield biased and unreliable national estimates. Furthermore, jurisdictional surveys have focussed on the activities of residents and therefore, have not included the activities of interstate (and overseas) visitors. For some jurisdictions, these visitors can represent a significant component of the fishery. Given the similarities in jurisdictional surveys, it may only be a matter of fine-tuning survey methods and coordinating the timing of surveys in order for both jurisdictional and national objectives to be fulfilled. Coordination of jurisdictional survey timing requires agreement across state governments and is a strategy that could be initiated through the Australian Fisheries Management Forum (AFMF). In the case of the NRFS, a lead fisheries agency was tasked with the national project management function and this may be a suitable approach for future coordination of surveys.

In the event that jurisdictional surveys cannot be coordinated, further development will certainly be required in several areas in order for jurisdictional data to be aggregated to produce national estimates. One area for consideration is the development of complete list frame of recreational fishers in order for estimation of participation at national and jurisdictional levels to be achieved cost-effectively. This would also be of great benefit for accessing participating fishers for catch, effort, social and economic surveys, which is becoming increasingly problematic using traditional telephone screening (e.g. Keeter et al., 2006). Currently, recreational fishing licences are in place in New South Wales, Victoria, Tasmania, South Australia and Western Australia, but the licence frames either do not provide a complete list of participants due to various types of exemptions (New South Wales and Victoria) or apply to specific fisheries only (e.g. Tasmania, South Australia and Western Australia). One approach to build a complete list frame of participating fishers may be to introduce a national recreational fisher registry, whereby registration would be required for fishers if they do not require a fishing licence, or

are exempt for holding a fishing licence, in their jurisdiction of residence. Although this may go some way to reducing future survey costs, it would almost certainly introduce additional administration and compliance costs, and therefore, careful consideration would be required as to which government agency/agencies would be required to maintain the registry.

If complete list frames of participating fishers cannot be achieved, there is scope for the development of multi-frame survey approaches that may be able to combine incomplete frames to produce estimates or efficiently select fishers that are representative of a single population of fishers. Such an approach will only provide model-based estimates, and uncertainty, rather than absolute estimates from complete list frames, but it may assist researchers in reducing the costs of screening surveys.

Labour costs are the primary hindrance in undertaking recreational fishing surveys. This is because in the absence of complete list frames general population telephone screening surveys are required, which often result in a high number of non-fishers and non-respondents, while on-site access point surveys require field staff to attend the site to intercept fishers that infrequently return to shore. The use of community monitoring programs may be an area of further development, whereby the high labour cost of field scientists may be replaced by trained volunteers. Although there have been a few successful instances of community monitoring of recreational fisheries such as CapReef (Sawynok et al., 2009), other scientific surveys have suggested using volunteers can compromise the quality of data collection (Griffiths et al., 2010b). The primary issue with community-based monitoring programs is that they have not typically been designed to provide estimates of catch, effort or participation, and are usually localised in scale. However, with sufficient survey planning, training and careful guidance of volunteers, it may be possible to reduce costs of scientific surveys, and simultaneously empower recreational fishery stakeholders to become more involved in management of their resource. Closer collaboration between scientists and established future leader programs such as the “Next Generation of Leaders” program developed by Recfish Australia may help increase the trust between scientists and volunteers.

The increasing diversification and specialisation of recreational fisheries presents a significant challenge for researchers attempting to gather representative data from a relatively small number of fishers that have a disproportionate influence on the total catch of species of commercial or conservation importance, such as Southern Bluefin Tuna. The survey approaches we have discussed throughout this report relate primarily to providing broad scale data and thus what can be considered major fisheries in terms of numbers of participants and levels of effort. For highly specialised activities, such as game fishing and/or for species that are nationally significant such as Southern Bluefin Tuna, alternative survey methods that are specifically tailored to the particular fishery are required. As such, for fisheries that incorporate multiple jurisdictions it is critical that either the relevant states/territories recognise the need for information about the fishery as a whole and collaborate in collecting data or the Commonwealth facilitate targeted cross-jurisdictional surveys of species for which they have management responsibility.

The final area for further development follows on from the final objective of this project, to develop a public data portal for recreational fisheries data. We have discussed many of the issues throughout the report, but the primary areas for development are the design and functionality of the portal, custodians of the data and the portal into the long term, and ensuring its maintenance and timely update of new data. Given the multi-jurisdictional nature of the portal and the potential issues concerning data confidentiality, there may be many issues to resolve before the data portal will be fully operational. A major consideration for the development and longevity of a data portal is the availability of ongoing funding, which has been limited for recreational fisheries at the national level.

Planned Outcomes

On completion of the current project it was still too early to quantify the impacts that are likely to result from the outcomes of the project. However, the following details the project achievements in relation to the planned outcomes.

- **The primary outcome from this project will be an improved understanding of the available datasets relating to recreational fishing in Australia, and an estimate of the catch and effort at a national level.**

This project brought together researchers, fishery managers and recreational fishing group representatives from all jurisdictions across Australia to undertake a comprehensive audit of recreational fisheries datasets, identify data gaps, determine whether the various datasets could be aggregated to provide revised national estimates, and to develop a framework for making the most recent recreational fisheries data available to the public.

Two stakeholder workshops facilitated identification of the available recreational fishing datasets ranging from regional to jurisdictional scales and the prioritisation of key species in the recreational fishery at the national level.

Through three case studies, statistical modelling demonstrated that available datasets were too fragmentary in space and time to produce reliable national estimates, indicating a dedicated national survey or better coordination of jurisdictional surveys is required. However, analyses were undertaken at the jurisdictional level to provide updated recreational fishing estimates for participation, total catch and effort, and the catch of priority species, which collectively, enabled recreational fisheries stakeholders to obtain a better understanding of recreational fishing at the national level.

- **Improved access and updated information and data regarding recreational fishing in Australia, which may be used in management of specific fish stocks, marine bioregional planning, resource allocation for shared stocks, identification of regionally important areas and economies, and business and infrastructure planning through identification of growth trends.**

In collaboration with fishery managers, researchers and recreational fishing groups, the framework of a national recreational fishing data portal was developed in an attempt to make available the most up-to-date information for recreational fisheries stakeholders. This framework was then visualised through a web-based prototype of a data portal for priority species. Not only did the portal make available summarised recreational fishing survey data, but it also provided other key information for recreational fishers such as length-weight relationships for popular species, distributional maps and fishing regulations by jurisdiction.

- **The opportunity for recreational fishing groups to participate in information and data access management and collection**

The workshop format implemented in this project provided recreational fishing groups with ample opportunity to participate in the collection and management of information relevant to meeting the project objectives. The project team regarded the recreational fishing groups as key to the success of the project, since our objectives primarily revolved around servicing the data needs of recreational fishing groups. Although collection of new data was not undertaken in this project, strong collaborative relationships were established with several recreational fishing groups, which will no doubt be strengthened by collaboration in future projects.

- **Addressing a national need and an area identified as a high priority by stakeholders around the country and the Recreational Fishing Advisory Committee.**

The management of recreational fishing in Australia primarily occurs at the state or territory level. Therefore, there has been relatively little exchange of information or project collaboration between jurisdictions since the NRFS in 2000/01. This project was successful in its attempt to address a national need prioritised by recreational fishing stakeholders around Australia to enhance the collaboration between jurisdictions to produce national level statistics that can be made publicly available in an easily accessible way.

Conclusion

Recreational fishing is a popular social and leisure activity among Australians. Despite recent jurisdictional surveys of recreational fishing indicating that the participation rate of overall population and the total effort may be declining (e.g. Taylor et al., 2012; West et al., 2012), the total number of participants is still substantial. However, there is still the possibility of an increase in fishing effort towards particular species and recreational catches may be significant for fisheries management and raise issues around resource sharing. Since many species of recreational importance straddle several jurisdictions, reliable broad scale data on catch and effort needs to be available in order for stock and resource allocation assessments to be undertaken.

With the close collaboration of researchers from all Australian jurisdictions, fishery managers and recreational fisheries stakeholder groups this project was successful in bringing together available datasets to improve our current knowledge of the recreational fishery across Australia. The metadata analysis undertaken on these datasets highlighted obvious difficulties in aggregating the temporally fragmented regional and jurisdictional surveys to provide reliable national estimates of catch, effort, participation and social and economic aspects of the fishery. This was because the surveys were undertaken across different years using slightly different sampling methodologies and generally did not take into account fishing by interstate fishers.

A formal assessment of the feasibility of aggregating these datasets was undertaken using statistical modelling. Using the longest recreational fisheries catch and effort time series available, the models demonstrated that national estimates could not be reliably made by estimating catch or effort for a common time period across each jurisdiction where surveys have not been undertaken. The national data audit also uncovered several smaller regional surveys, in particular low-cost community-based surveys. Unfortunately, community-based projects could not be integrated with jurisdictional surveys since they either used different survey methods, or did not produce estimates of total catch and effort for discrete regions. Given the highly fragmented nature of recreational fishing data in Australia, there is a need for a second national survey to be undertaken, or at least well coordinated jurisdictional-wide surveys using standardised survey methods across common temporal scales.

The marked increase in the number of specialised recreational fishers targeting particular species in some regions, such as Southern Bluefin Tuna across southern Australia, raises issues around resource allocation. These developments have also raised concern among fishery managers, who have obligations to report on all mortality sources for species shared across multiple Australian jurisdictions and internationally. Unfortunately, telephone-diary surveys commonly used for broad scale jurisdictional surveys are sub-optimal and cost-prohibitive for sampling hard-to-reach specialised fishers. Alternative cost-effective targeted sampling approaches are required to be further developed for use in such situations.

This project provided options for a national recreational fishing data portal where the most up-to-date data can be stored to allow public access to data that can answer key questions relating to recreational fishing in Australia, such as participation and catch of popular species. The highly fragmented datasets available currently lend themselves to only rudimentary data queries, which can be easily integrated into existing national ocean, fisheries or environmental data portals, with some functionality restrictions. An alternative website simulation was proposed for an independent data portal, which could have greater capability to serve as a standalone online resource providing recreational survey data summaries as well as other information relating to recreational fisheries in Australia, such as the biology of key species and current fishing regulations. The next step beyond this project will involve discussions with recreational fishery stakeholders as to whether a recreational fishing data portal should be developed, potential funding sources for the development, the design specifications and functionality, the most appropriate location to host the data portal, and the agency/agencies that will assume responsibility for the maintenance, data management and future data harvests to ensure the longevity of this valuable resource.

References

- Ashford, J.R., Jones, C.M., Fegley, L., 2009. A license registry improves sampling efficiency for a marine recreational survey. *Transactions of the American Fisheries Society* 138, 984-989.
- Barr, M.L., Van Ritten, J.J., Steel, D.G., Thackway, S.V., 2012. Inclusion of mobile phone numbers into an ongoing population health survey in New South Wales, Australia: design, methods, call outcomes, costs and sample representativeness. *BMC Medical Research Methodology* 12, 177.
- Brick, M.J., 2011. The future of survey sampling. *Public Opinion Quarterly* 75, 872-888.
- Bromhead, D., Pepperell, J., Wise, B., Findlay, J., 2004. *Striped marlin: biology and fisheries*. Bureau of Rural Sciences, Canberra.
- Colquhoun, E., 2013. *Issues Paper: Measuring the economic value of recreational fishing at a national level*. A discussion paper drafted for FRDC project 2012/214. Ridge Partners, Brisbane, p. 21.
- Dichmont, C.M., Pascoe, S.D., Jebreen, E.J., Pears, R.J., Brooks, K.J., Perez, P., 2012. *Providing social science objectives and indicators to compare management options in the Queensland trawl planning process*. Final report for FRDC project 2009/100. CSIRO, Brisbane.
- Ferrell, D., Sumpton, W., 1998. *Assessment of the fishery for snapper (Pagrus auratus) in Queensland and New South Wales*. Final report for FRDC Project 93/074. Queensland Department of Primary Industries, Brisbane, p. 143.
- Gallucci, V., Hariharan, A., 2012. *An adaptive sampling design for the estimation of thresher shark catch and effort in a recreational fishery in California*. University of Washington, Seattle, WA, p. 42.
- Gartside, D.F., Harrison, B., Ryan, B.L., 1999. An evaluation of the use of fishing club records in the management of marine recreational fisheries. *Fisheries Research* 41, 47-61.
- Grande, E.D., Taylor, A.W., 2010. Sampling and coverage issues of telephone surveys used for collecting health information in Australia: results from a face-to-face survey from 1999 to 2008. *BMC Medical Research Methodology* 10, 77.
- Green, C., Brown, P., Giri, K., Bell, J., Conron, S., 2012. *Quantifying the recreational catch of southern bluefin tuna off the Victorian coast*. Recreational Fishing Grants Program research report. Department of Primary Industries Fisheries Victoria, Melbourne.
- Griffiths, S., Pepperell, J., Tonks, M., Fay, G., Venables, W., Lyle, J., Olyott, L., Sawynok, W., Edgar, S., 2010a. *Developing innovative and cost effective tools for monitoring recreational fishing in Commonwealth fisheries*. Final report for FRDC project 2007/014, CSIRO, Cleveland, Qld.
- Griffiths, S., Pepperell, J., Tonks, M., Sawynok, W., Olyott, L., Tickell, S., Zischke, M., Lynne, J., Burgess, J., Jones, E., Joyner, D., Makepeace, C., Moyle, K., 2010b. *Biology, fisheries and status of longtail tuna (Thunnus tonggol), with special reference to recreational fisheries in Australian waters*. Final report for FRDC project 2008/058, CSIRO, Cleveland, Qld.
- Griffiths, S.P., Pepperell, J.P., 2006. *A preliminary synopsis of existing recreational fisheries data sources and the potential for monitoring recreational fishing activities in Commonwealth fisheries*. Final report for AFMA project R06/822. CSIRO, Cleveland, Qld.
- Griffiths, S.P., Pollock, K.H., Lyle, J.M., Pepperell, J.G., Tonks, M.L., Sawynok, W., 2010c. Following the chain to elusive anglers. *Fish and Fisheries* 11, 220-228.
- Griffiths, S.P., 2012. Recreational catch composition, catch rates, effort and expenditure in a specialised land-based pelagic game fish fishery. *Fisheries Research* 127-128, 40-44.
- Hartill, B.W., Cryer, M., Lyle, J.M., Rees, E.B., Ryan, K.L., Steffe, A.S., Taylor, S.M., West, L., Wise, B.S., 2012. Scale- and context-dependent selection of recreational harvest estimation methods: the Australasian experience. *North American Journal of Fisheries Management* 32, 109-123.
- Heckathorn, D.D., 1997. Respondent-driven sampling: A new approach to the study of hidden populations. *Social Problems* 44, 174-199.
- Heckathorn, D.D., 2002. Respondent-driven sampling II: deriving valid population estimates from chain-referral samples of hidden populations. *Social Problems* 49, 11-34.

- Helliwell, J.F., Barrington-Leigh, C.P., 2010. Measuring and understanding subjective well-being. *Canadian Journal of Economics* 43, 729-753.
- Henry, G.W., Lyle, J.M., 2003. *The National Recreational and Indigenous Fishing Survey*. NSW Fisheries Final Report Series No. 48. for FRDC project 99/158. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, p. 188.
- Innes, A., Surr, C., 2001. Measuring the well-being of people with dementia living in formal care settings: The use of Dementia Care Mapping. *Aging & Mental Health* 5, 258-268.
- Jackson, A.C., Pennay, D., Dowling, N.A., Coles-Janess, B., Christensen, D.R., 2013. Improving gambling survey research using dual-frame sampling of landline and mobile phone numbers. *Journal of Gambling Studies* 2013, 1-17.
- Keeter, S., Kennedy, C., Dimock, M., Best, J., Craighill, P., 2006. Gauging the impact of growing nonresponse on estimates from a national RDD telephone survey. *Public Opinion Quarterly* 70, 759-779.
- Leigh, G.M., O'neill, M.L., 2003. *Stock assessment of the Queensland-New South Wales tailor fishery (Pomatomus saltatrix)*. Queensland Department of Primary Industries and Fisheries, Southern Fisheries Centre, Deception Bay.
- Li, E.a.L., 1999. A travel cost demand model for recreational snapper angling in Port Phillip Bay, Australia. *Transactions of the American Fisheries Society* 128, 639-647.
- Lyle, J.M., Coleman, A.P.M., West, L., Campbell, D., Henry, G.W., 2002. New large-scale methods for evaluating sport fisheries. In: Pitcher, T. J., Hollingworth, C. (Eds.), *Recreational fisheries: Ecological, economic and social evaluation. Fish and Aquatic Resources Series 8*. Blackwell Science, London, UK, pp. 207-226.
- Lyle, J.M., Morton, A.J., Forward, J., 2005. Characterisation of the recreational fishery for southern rock lobster, *Jasus edwardsii*, in Tasmania, Australia: implications for management. *New Zealand Journal of Marine and Freshwater Research* 39, 703-713.
- Magnani, R., Sabin, K., Saidel, T., Heckathorn, D., 2005. Review of sampling hard-to-reach and hidden populations for HIV surveillance. *Aids* 19, S67-S72.
- Mcmanus, A., Hunt, W., Storey, J., White, J., 2011. *Identifying the health and well-being benefits of recreational fishing*. Tasmanian Aquaculture and Fisheries Institute, Final report for FRDC project 2011/217.
- Melville-Smith, R., Anderton, S.M., 2000. Western rock lobster mail surveys of licensed recreational fishers 1986/87 to 1998/99. *Fisheries Research Report* 122, 1-39.
- Morton, A.J., Lyle, J.M., 2003. *Preliminary assessment of the recreational gamefish fishery in Tasmania, with particular reference to southern blue tuna*. Technical Report Series, Number 21, Tasmanian Aquaculture and Fisheries Institute, Taroona, Tasmania.
- Muhib, F.B., Lin, L.S., Stueve, A., Miller, R.L., Ford, W.L., Johnson, W.D., Smith, P.J., 2001. A venue-based method for sampling hard-to-reach populations. *Public Health Reports* 116, 216-222.
- Murray-Jones, S., Steffe, A.S., 2000. A comparison between the commercial and recreational fisheries of the surf clam, *Donax deltoides*. *Fisheries Research* 44, 219-233.
- N.R.C., 2006. *Review of recreational fisheries survey methods*. National Research Council, National Academy Press, Washington, D.C., USA.
- Pepperell, J.G., 1992. Trends in the distribution, species composition and size of sharks caught by Gamefish Anglers off South-eastern Australia, 1961-90. *Marine and Freshwater Research* 43, 213-225.
- Pepperell, J.G., Dominion, 1996. *Reconciling Australian recreational fishing surveys with particular reference to New South Wales*. Report to the NSW Recreational Saltwater Fishing Trust. Pepperell Research & Consulting and Dominion Consulting Pty Ltd.
- Pitcher, T.J., Hollingworth, C., 2002. *Recreational Fisheries: Ecological, Economic, and Social Evaluation*. Wiley-Blackwell.
- Platten, J., Sawynok, B., Parsons, W., 2007. *How much fishing effort is there? Patterns of fishing effort of recreational fishers offshore from Central Queensland*. Frenchville, Qld.
- Pollock, B.R., Williams, M.J., 1983. An assessment of the angling fishery for summer whiting, *Sillago ciliata* and *S. analis*, in Moreton Bay, Queensland from 1959 to 1980. *Proceedings of the Royal Society of Queensland* 94, 85-90.

- Prayaga, P., Rolfe, J., Stoeckl, N., 2010. The value of recreational fishing in the Great Barrier Reef, Australia: A pooled revealed preference and contingent behaviour model. *Marine Policy* 34, 244-251.
- Reid, D.D., Montgomery, S.S., 2005. Creel survey based estimation of recreational harvest of penaeid prawns in four southeastern Australian estuaries and comparison with commercial catches. *Fisheries Research* 74, 169-185.
- Rolfe, J., Prayaga, P., 2007. Estimating values for recreational fishing at freshwater dams in Queensland. *Australian Journal of Agricultural and Resource Economics* 51, 157-174.
- Rudd, M.A., Folmer, H., Van Cooten, G.C., 2002. Economic evaluation of recreational fishery policies. In: Pitcher, T. J., Hollingworth, C. (Eds.), *Recreational fisheries: Ecological, economic and social evaluation. Fish and Aquatic Resources Series 8*. Blackwell Science, London, UK, pp. 34-52.
- Ryan, K., Morison, A.K., Conron, S., 2009. *Evaluating methods of obtaining total catch estimates for individual Victorian bay and inlet recreational fisheries*. Final report for FRDC project 2003/047, Department of Primary Industries, Queensland.
- Sawynok, W., 2004. *National Strategy for the Survival of Released Line Caught Fish: Planning, project management and communications*. Report to the Fisheries Research and Development Corporation. Infofish Services.
- Sawynok, W., Platten, J., Parsons, W., 2009. *CapReef - Recreational Fishing and Fish Resources in Central Queensland 2005-09*. Infofish Services, Frenchville, Qld, p. 106.
- Smith, D.R., Brown, J.A., Lo, N.C.H., 2004. Application of adaptive sampling to biological populations. In: Thompson, W. L. (Ed.), *Sampling rare or elusive species*. Island Press, Washington DC, pp. 77-122.
- Steffe, A.S., Murphy, J.J., Chapman, D.J., Barrett, G.P., Gray, C.A., 2005. An assessment of changes in the daytime, boat-based, recreational fishery of the Tuross Lake estuary following the establishment of a 'Recreational Fishing Haven'. *NSW Department of Primary Industries Fisheries Final Report Series* 81, 70.
- Steneke, N., Sahlqvist, P., 2011. Community involvement in recreational fisheries data collection: Opportunities and challenges. *ABARES Technical report* 11.5.
- Stevens, J.D., 1984. Biological observations on sharks caught by sport fisherman of New South Wales. *Marine and Freshwater Research* 35, 573-590.
- Stewart, J., Hughes, J., Mcallister, J., Lyle, J., Macdonald, M., 2011. Australian salmon (*Arripis trutta*): Population structure, reproduction, diet and composition of commercial and recreational catches. Final FRDC report for projects 2006/018 and 2008/056. *Industry & Investment NSW - Fisheries Final Report Series* No. 129, 257.
- Stueve, A., O'donnell, L.N., Duran, R., San, D.A., Blome, J., 2001. Time-space sampling in minority communities: Results with young Latino men who have sex with men. *American Journal of Public Health* 91, 922-926.
- Taylor, S., Webley, J., Mcinnes, K., 2012. *2010 Statewide Recreational Fishing Survey*. State of Queensland, Department of Agriculture, Fisheries and Forestry, Brisbane, Qld.
- Thompson, S.K., 2003. Editorial: Special issue on adaptive sampling. *Environmental and Ecological Statistics* 10, 5-7.
- Vrfish, 2009. *Economic study of recreational fishing in Victoria*. Melbourne, p. 92.
- Ward, P., Mazur, K., Steneke, N., Kancans, R., Curtotti, R., Summerson, R., Gibbs, C., Marton, M., Moore, A., Roach, J., 2012. *A socioeconomic evaluation of three eastern Australian game-fishing regions*. Final report for FRDC project 2010/050. ABARES, Canberra, p. 218.
- Wejnert, C., Heckathorn, D.D., 2008. Web-based network sampling: Efficiency and efficacy of respondent-driven sampling for online research. *Sociological Methods and Research* 37, 105-134.
- West, L.D., Lyle, J.M., Matthews, S.R., Stark, K.E., Steffe, A.S., 2012. Survey of Recreational Fishing in the Northern Territory, 2009-10. *Northern Territory Government, Fishery Report* No. 109.
- Zischke, M.T., Griffiths, S.P., Tibbetts, I.R., 2012. Catch and effort from a specialised recreational pelagic sport fishery off eastern Australia. *Fisheries Research* 127-128, 61-72.
- Zischke, M.T., 2013. *Stock structure, biology, fisheries and status of wahoo off eastern Australia*. PhD Thesis. School of Marine Sciences. University of Queensland, Brisbane, Qld, p. 245.

Appendices

Appendix 1 – Intellectual property

None arising.

Appendix 2 – Metadata for surveys undertaken in Australia relevant to recreational fisheries

Project ID: A001 **Jurisdiction:** AUS

Short title: National recreational and indigenous fishing survey 2000-01

Data custodian: DAFF and jurisdictions

Start year: 2000 **End year:** 2001 **Spatial extent:** national

Survey method: telephone screening & diary

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** Yes **Species strata:** Yes

Participation estimates: Yes **Demographics:** participation/effort/catch

Residence region strata: SD **Sampling frame:** telephone subscribers

Social data: Yes **Economic data:** Yes

Project ID: N001 **Jurisdiction:** NSW

Short title: Macleay-Richmond Estuarine Surveys 2001

Data custodian: NSW DPI

Start year: 2001 **End year:** 2001 **Spatial extent:** locality

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained catch only **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes

Participation estimates: No **Demographics:** participation/effort/catch

Residence region strata: postcode **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Project ID: N002 **Jurisdiction:** NSW

Short title: Lake Macquarie daytime survey

Data custodian: NSW DPI

Start year: 1999 **End year:** 2000 **Spatial extent:** locality

Survey method: complemented (multiple methods)

Catch estimates: retained catch only **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes

Participation estimates: No **Demographics:** participation/effort/catch

Residence region strata: postcode **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Project ID: N003 **Jurisdiction:** NSW

Short title: Lake Tuross daytime survey

Data custodian: NSW DPI
Start year: 1999 **End year:** 2000 **Spatial extent:** locality
Survey method: complemented (multiple methods)
Catch estimates: retained catch only **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: No **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: No **Economic data:** No

Project ID: N004 **Jurisdiction:** NSW
Short title: NSW Gamefish Tournament Monitoring Programme
Data custodian: NSW DPI
Start year: 1993 **End year:** **Spatial extent:** locality
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: No **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: No **Economic data:** No

Project ID: N005 **Jurisdiction:** NSW
Short title: Offshore recreational fishery survey
Data custodian: NSW DPI
Start year: 1993 **End year:** 1995 **Spatial extent:** state-wide
Survey method: intercept survey (access point/roving creel/bus route)
Catch estimates: retained catch only **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: No **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: No **Economic data:** No

Project ID: N006 **Jurisdiction:** NSW
Short title: Saltwater Tournament-Angling Catch/Effort Data
Data custodian: NSW DPI
Start year: 2000 **End year:** 2007 **Spatial extent:** locality
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: No **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** club/association membership
Social data: No **Economic data:** No

Project ID: N007 **Jurisdiction:** NSW

Short title: Freshwater Tournament-Angling Catch/Effort Data

Data custodian: NSW DPI

Start year: 1988 **End year:** **Spatial extent:** locality

Survey method: complemented (multiple methods)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes

Participation estimates: No **Demographics:** participation/effort/catch

Residence region strata: postcode **Sampling frame:** club/association membership

Social data: No **Economic data:** No

Project ID: N008 **Jurisdiction:** AUS

Short title: Game Fish Tagging Program

Data custodian: NSW DPI

Start year: 1973 **End year:** **Spatial extent:** national

Survey method: other

Catch estimates: released catch only **Effort estimates:** No

NRFS regions: No **Fishing region strata:** latitude or longitude **Species strata:** Yes

Participation estimates: No **Demographics:** participation/effort/catch

Residence region strata: postcode **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Project ID: N009 **Jurisdiction:** NSW

Short title: Charter fishing logbook programme

Data custodian: NSW DPI

Start year: 2000 **End year:** **Spatial extent:** state-wide

Survey method: other

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes

Participation estimates: No **Demographics:** participation/effort/catch

Residence region strata: State/territory **Sampling frame:** license register

Social data: No **Economic data:** No

Project ID: N010 **Jurisdiction:** NSW

Short title: Greater Sydney Region recreational fishing surveys 2007-2009

Data custodian: NSW DPI

Start year: 2007 **End year:** 2009 **Spatial extent:** region

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes

Participation estimates: No **Demographics:** participation/effort/catch

Residence region strata: postcode **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Project ID: N011 **Jurisdiction:** NSW

Short title: Richmond-Clarence rivers recreational fishing survey 1995-96

Data custodian: NSW DPI

Start year: 1988 **End year:** 1989 **Spatial extent:** locality

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained catch only **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes

Participation estimates: No **Demographics:** participation/effort/catch

Residence region strata: Other **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Project ID: N012 **Jurisdiction:** NSW

Short title: Southern NSW recreational prawn fishery surveys 1991-1994

Data custodian: NSW DPI

Start year: 1991 **End year:** 1994 **Spatial extent:** locality

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained catch only **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes

Participation estimates: No **Demographics:** participation/effort/catch

Residence region strata: Other **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Project ID: Y002 **Jurisdiction:** NT

Short title: NT state-wide recreational fishing survey 2009-10

Data custodian: NT Fisheries

Start year: 2009 **End year:** 2010 **Spatial extent:** state-wide

Survey method: complemented (multiple methods)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes

Participation estimates: Yes **Demographics:** participation/effort/catch

Residence region strata: SD **Sampling frame:** telephone subscribers

Social data: Yes **Economic data:** Yes

Project ID: Y002 **Jurisdiction:** NT

Short title: NT state-wide recreational fishing survey 2009-10

Data custodian: NT Fisheries

Start year: 2009 **End year:** 2009 **Spatial extent:** region

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes

Participation estimates: No **Demographics:**

Residence region strata: Other **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Project ID: Y003 **Jurisdiction:** NT

Short title: Fishcount state-wide recreational fishing survey 1994-1996

Data custodian: NT Fisheries

Start year: 1994 **End year:** 1996 **Spatial extent:** state-wide

Survey method: complemented (multiple methods)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes

Participation estimates: Yes **Demographics:** participation/effort

Residence region strata: Other **Sampling frame:** telephone subscribers

Social data: Yes **Economic data:** Yes

Project ID: Y004 **Jurisdiction:** NT

Short title: Fishing tour operator logbooks

Data custodian: NT Fisheries

Start year: 1994 **End year:** 2012 **Spatial extent:** state-wide

Survey method: other

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** latitude-longitude **Species strata:** Yes

Participation estimates: Yes **Demographics:**

Residence region strata: State/territory **Sampling frame:** license register

Social data: No **Economic data:** No

Project ID: Y005 **Jurisdiction:** NT

Short title: McArthur River monitoring

Data custodian: Infofish Australia

Start year: 2009 **End year:** 2012 **Spatial extent:** locality

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** river catchment **Species strata:** No

Participation estimates: No **Demographics:**

Residence region strata: **Sampling frame:**

Social data: No **Economic data:** No

Project ID: Q001 **Jurisdiction:** Qld

Short title: Capricorn monitoring program (CAPREEF)

Data custodian: Infofish Australia

Start year: 2005 **End year:** 2009 **Spatial extent:** region

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** No

Participation estimates: No **Demographics:**

Residence region strata: **Sampling frame:**

Social data: No **Economic data:** Yes

Project ID: Q002 **Jurisdiction:** Qld
Short title: RFISH: Recreational fishing telephone/diary survey program 1996-2005.
Data custodian: DAFFQ
Start year: 1996 **End year:** 1997 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** No
NRFS regions: No **Fishing region strata:** other **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: SD **Sampling frame:** telephone subscribers
Social data: Yes **Economic data:** Yes

Project ID: Q002 **Jurisdiction:** Qld
Short title: RFISH: Recreational fishing telephone/diary survey program 1996-2005.
Data custodian: DAFFQ
Start year: 1998 **End year:** 1999 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** No
NRFS regions: No **Fishing region strata:** other **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: SD **Sampling frame:** telephone subscribers
Social data: Yes **Economic data:** Yes

Project ID: Q002 **Jurisdiction:** Qld
Short title: RFISH: Recreational fishing telephone/diary survey program 1996-2005.
Data custodian: DAFFQ
Start year: 2001 **End year:** 2002 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** No
NRFS regions: No **Fishing region strata:** other **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: SD **Sampling frame:** telephone subscribers
Social data: Yes **Economic data:** Yes

Project ID: Q002 **Jurisdiction:** Qld
Short title: RFISH: Recreational fishing telephone/diary survey program 1996-2005.
Data custodian: DAFFQ
Start year: 2004 **End year:** 2005 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** No
NRFS regions: No **Fishing region strata:** other **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: SD **Sampling frame:** telephone subscribers
Social data: Yes **Economic data:** Yes

Project ID: Q003 **Jurisdiction:** Qld
Short title: RFISH: Recreational fishing volunteer diary program 2007 onwards
Data custodian: DAFFQ
Start year: 2007 **End year:** **Spatial extent:** state-wide
Survey method: website trip reporting
Catch estimates: **Effort estimates:**
NRFS regions: **Fishing region strata:** **Species strata:**
Participation estimates: **Demographics:**
Residence region strata: postcode **Sampling frame:** other
Social data: No **Economic data:** No

Project ID: Q004 **Jurisdiction:** Qld
Short title: Commercial Fishing Tour Logbooks - ongoing
Data custodian: DAFFQ
Start year: **End year:** **Spatial extent:** state-wide
Survey method: other
Catch estimates: retained catch only **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** latitude-longitude **Species strata:** Yes
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:**
Social data: **Economic data:**

Project ID: Q005 **Jurisdiction:** Qld
Short title: Fishery assessment of the Burnett River, Maroochy River and Pumicestone
Data custodian: DAFFQ
Start year: 1997 **End year:** **Spatial extent:** region
Survey method:
Catch estimates: **Effort estimates:**
NRFS regions: **Fishing region strata:** **Species strata:**
Participation estimates: **Demographics:** participation/effort/catch
Residence region strata: **Sampling frame:** other
Social data: No **Economic data:** No

Project ID: Q006 **Jurisdiction:** Qld
Short title: Assessing the recreational fishery for Blue Swimmer Crab in Moreton Bay 2000
Data custodian: DAFFQ
Start year: 1998 **End year:** 1998 **Spatial extent:** locality
Survey method: intercept survey (access point/roving creel/bus route)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** other **Species strata:** Yes
Participation estimates: No **Demographics:** participation/effort
Residence region strata: postcode **Sampling frame:** other
Social data: No **Economic data:** No

Project ID: Q007 **Jurisdiction:** Qld
Short title: Survey of marine boat-based recreational fishing in south-eastern Qld
Data custodian: DAFFQ
Start year: 2007 **End year:** **Spatial extent:** region
Survey method: intercept survey (access point/roving creel/bus route)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: No **Demographics:** participation/effort/catch
Residence region strata: **Sampling frame:** other
Social data: No **Economic data:** No

Project ID: Q008 **Jurisdiction:** Qld
Short title: State-wide recreational fishing survey 2010
Data custodian: DAFFQ
Start year: 2010 **End year:** 2011 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: SD **Sampling frame:** telephone subscribers
Social data: Yes **Economic data:** No

Project ID: Q009 **Jurisdiction:** Qld
Short title: Fisheries biology and interaction in the northern Australian small mackerel fishery
Data custodian: DAFFQ
Start year: **End year:** **Spatial extent:** region
Survey method: telephone survey
Catch estimates: retained and released/discarded catch **Effort estimates:** No
NRFS regions: No **Fishing region strata:** other **Species strata:** Yes
Participation estimates: No **Demographics:** participation/effort/catch
Residence region strata: SD **Sampling frame:** telephone subscribers
Social data: No **Economic data:** No

Project ID: Q010 **Jurisdiction:** Qld
Short title: Baseline socio-economic data for Queensland east coast inshore and rocky reef stakeholders
Data custodian: JCU
Start year: 2008 **End year:** **Spatial extent:** region
Survey method: telephone survey
Catch estimates: **Effort estimates:**
NRFS regions: **Fishing region strata:** **Species strata:**
Participation estimates: **Demographics:** participation
Residence region strata: Other **Sampling frame:** telephone subscribers
Social data: Yes **Economic data:** Yes

Project ID: Q011 **Jurisdiction:** Qld
Short title: Impact of Moreton Bay Marine Park on human activity and patterns of fishing
Data custodian: DERM/CSIRO
Start year: **End year:** **Spatial extent:** locality
Survey method:
Catch estimates: **Effort estimates:**
NRFS regions: **Fishing region strata:** **Species strata:**
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:**
Social data: **Economic data:**

Project ID: Q014 **Jurisdiction:** Qld
Short title: Crystal Bowl
Data custodian: Infofish Australia
Start year: 2010 **End year:** 2012 **Spatial extent:** locality
Survey method: intercept survey (access point/roving creel/bus route)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** river catchment **Species strata:** No
Participation estimates: No **Demographics:**
Residence region strata: **Sampling frame:**
Social data: No **Economic data:** No

Project ID: Q015 **Jurisdiction:** Qld
Short title: CapReef Gladstone
Data custodian: Infofish Australia
Start year: 2011 **End year:** 2012 **Spatial extent:** locality
Survey method: intercept survey (access point/roving creel/bus route)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** No
Participation estimates: No **Demographics:**
Residence region strata: **Sampling frame:**
Social data: Yes **Economic data:** No

Project ID: S001 **Jurisdiction:** SA
Short title: Recreational Rock Lobster fishery survey 2001-02
Data custodian: PIRSA
Start year: 2001 **End year:** 2002 **Spatial extent:** State-wide
Survey method: telephone survey
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** other **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: postcode **Sampling frame:** license register
Social data: No **Economic data:** No

Project ID: S002 **Jurisdiction:** SA

Short title: SA state-wide recreational fishing survey 2007-08

Data custodian: PIRSA

Start year: 2007 **End year:** 2008 **Spatial extent:** state-wide

Survey method: complemented (multiple methods)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes

Participation estimates: Yes **Demographics:** participation/effort/catch

Residence region strata: SLA **Sampling frame:** telephone subscribers

Social data: Yes **Economic data:** No

Project ID: S003 **Jurisdiction:** SA

Short title: Recreational charter boat fishery logbooks

Data custodian: PIRSA

Start year: 2005 **End year:** 9999 **Spatial extent:** state-wide

Survey method: other

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** latitude-longitude **Species strata:** Yes

Participation estimates: Yes **Demographics:** participation

Residence region strata: postcode **Sampling frame:** license register

Social data: Yes **Economic data:** No

Project ID: S004 **Jurisdiction:** SA

Short title: Metropolitan boat fishing survey 1990-91

Data custodian: PIRSA

Start year: 1990 **End year:** 1991 **Spatial extent:** region

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained catch only **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes

Participation estimates: Yes **Demographics:** participation

Residence region strata: **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Project ID: S005 **Jurisdiction:** SA

Short title: Recreational Rock Lobster Fishery survey 1998/99

Data custodian: PIRSA

Start year: 1998 **End year:** 1999 **Spatial extent:** State-wide

Survey method: telephone survey

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** Other **Species strata:** Yes

Participation estimates: Yes **Demographics:** participation

Residence region strata: postcode **Sampling frame:** license register

Social data: No **Economic data:** No

Project ID: S006 **Jurisdiction:** SA
Short title: Recreational Rock Lobster Fishery Survey 2004/05
Data custodian: PIRSA
Start year: 2004 **End year:** 2005 **Spatial extent:** State-wide
Survey method: telephone survey
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** Other **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: postcode **Sampling frame:** license register
Social data: No **Economic data:** No

Project ID: S007 **Jurisdiction:** SA
Short title: Survey of recreational boat fishing 1994 - 96
Data custodian: PIRSA
Start year: 1994 **End year:** 1996 **Spatial extent:** region
Survey method: intercept survey (access point/roving creel/bus route)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: **Sampling frame:** time/location frame
Social data: No **Economic data:** No

Project ID: S008 **Jurisdiction:** SA
Short title: Pilot survey of social aspects of SA recreational fishery, 2012
Data custodian: PIRSA
Start year: 2012 **End year:** 2012 **Spatial extent:** region
Survey method: complemented (multiple methods)
Catch estimates: **Effort estimates:** No
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: No **Demographics:** participation
Residence region strata: postcode **Sampling frame:** Other
Social data: Yes **Economic data:** Yes

Project ID: T001 **Jurisdiction:** Tas
Short title: Tasmanian gamefish survey 2003
Data custodian: DPIPWE/IMAS
Start year: 2003 **End year:** 2003 **Spatial extent:** region
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: No **Demographics:**
Residence region strata: **Sampling frame:** other
Social data: No **Economic data:** No

Project ID: T002 **Jurisdiction:** Tas
Short title: Tasmanian recreational Scallop fishery surveys
Data custodian: DPIPWE/IMAS
Start year: 2005 **End year:** 2009 **Spatial extent:** region
Survey method: telephone survey
Catch estimates: not collected **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** No
Participation estimates: Yes **Demographics:** participation
Residence region strata: SD **Sampling frame:** license register
Social data: No **Economic data:** No

Project ID: T005 **Jurisdiction:** Tas
Short title: Tasmanian state-wide recreational fishing survey 2007-08
Data custodian: DPIPWE/IMAS
Start year: 2007 **End year:** 2008 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: SD **Sampling frame:** telephone subscribers
Social data: Yes **Economic data:** Yes

Project ID: T006 **Jurisdiction:** Tas
Short title: Inland Fisheries Service Trout fishery surveys
Data custodian: Inland Fisheries
Start year: **End year:** **Spatial extent:**
Survey method:
Catch estimates: **Effort estimates:**
NRFS regions: **Fishing region strata:** **Species strata:**
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:**
Social data: **Economic data:**

Project ID: T007 **Jurisdiction:** Tas
Short title: Survey of licensed fishing activity 1996-98
Data custodian: DPIPWE/IMAS
Start year: 1996 **End year:** 1998 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort
Residence region strata: SD **Sampling frame:** license register
Social data: Yes **Economic data:** No

Project ID: T008 **Jurisdiction:** Tas
Short title: Survey of recreational gillnet fishing 2010
Data custodian: DPIPWE/IMAS
Start year: 2010 **End year:** 2010 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: SD **Sampling frame:** license register
Social data: Yes **Economic data:** No

Project ID: T009 **Jurisdiction:** Tas
Short title: Preliminary survey of set-line fishing 2011
Data custodian: DPIPWE/IMAS
Start year: 2011 **End year:** **Spatial extent:** state-wide
Survey method: telephone survey
Catch estimates: not collected **Effort estimates:** no
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: SD **Sampling frame:** license register
Social data: Yes **Economic data:** No

Project ID: T010 **Jurisdiction:** Tas
Short title: Boat-based survey of offshore and game fishing 2011-12
Data custodian: DPIPWE/IMAS
Start year: 2011 **End year:** 2012 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: No **Demographics:**
Residence region strata: **Sampling frame:** boat registration register
Social data: Yes **Economic data:** Yes

Project ID: T011 **Jurisdiction:** Tas
Short title: Validation survey of the SBT fishery in south-eastern Tasmania 2012
Data custodian: DPIPWE/IMAS
Start year: 2012 **End year:** 2012 **Spatial extent:** region
Survey method: intercept survey (access point/roving creel/bus route)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: No **Demographics:**
Residence region strata: **Sampling frame:** other
Social data: no **Economic data:** No

Project ID: T004 **Jurisdiction:** Tas
Short title: Tasmanian recreational Rock Lobster and Abalone fishery surveys (biennial)
Data custodian: DPIPWE/IMAS
Start year: 2000 **End year:** 2001 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: SD **Sampling frame:** license register
Social data: Yes **Economic data:** Yes

Project ID: T004 **Jurisdiction:** Tas
Short title: Tasmanian recreational Rock Lobster and Abalone fishery surveys (biennial)
Data custodian: DPIPWE/IMAS
Start year: 2002 **End year:** 2003 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: SD **Sampling frame:** license register
Social data: Yes **Economic data:** Yes

Project ID: T004 **Jurisdiction:** Tas
Short title: Tasmanian recreational Rock Lobster and Abalone fishery surveys (biennial)
Data custodian: DPIPWE/IMAS
Start year: 2004 **End year:** 2005 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: SD **Sampling frame:** license register
Social data: Yes **Economic data:** Yes

Project ID: T004 **Jurisdiction:** Tas
Short title: Tasmanian recreational Rock Lobster and Abalone fishery surveys (biennial)
Data custodian: DPIPWE/IMAS
Start year: 2006 **End year:** 2007 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: SD **Sampling frame:** license register
Social data: Yes **Economic data:** Yes

Project ID: T004 **Jurisdiction:** Tas
Short title: Tasmanian recreational Rock Lobster and Abalone fishery surveys (biennial)
Data custodian: DPIPWE/IMAS
Start year: 2008 **End year:** 2009 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation
Residence region strata: SD **Sampling frame:** license register
Social data: Yes **Economic data:** Yes

Project ID: V001 **Jurisdiction:** Vic
Short title: On-site Recreational Fisheries Surveys
Data custodian: DPI Victoria
Start year: 1995 **End year:** **Spatial extent:** region
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** latitude-longitude **Species strata:** No
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V002 **Jurisdiction:** Vic
Short title: Western Port Elephant Fish survey
Data custodian: DPI Victoria
Start year: 2008 **End year:** 2008 **Spatial extent:** region
Survey method: intercept survey (access point/roving creel/bus route)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** latitude-longitude **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V003 **Jurisdiction:** Vic
Short title: Port Phillip Bay daytime surveys 1989 to 1994
Data custodian: DPI Victoria
Start year: 1989 **End year:** 1994 **Spatial extent:** region
Survey method:
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V004 **Jurisdiction:** Vic
Short title: Gippsland Lakes Survey 1995
Data custodian: DPI Victoria
Start year: 1995 **End year:** **Spatial extent:** region
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V005 **Jurisdiction:** Vic
Short title: Victorian Angler Fishing Diary Program
Data custodian: DPI Victoria
Start year: 1997 **End year:** **Spatial extent:** state-wide
Survey method: other
Catch estimates: retained and released/discarded catch **Effort estimates:** No
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** No
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:** other
Social data: **Economic data:** No

Project ID: V006 **Jurisdiction:** Vic
Short title: Pilot Telephone Diary Survey
Data custodian: DPI Victoria
Start year: 2006 **End year:** **Spatial extent:** state-wide
Survey method: telephone survey
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:** license register
Social data: **Economic data:**

Project ID: V007 **Jurisdiction:** Vic
Short title: Gippsland Lakes Bream fishery survey 1995-1996
Data custodian: DPI Victoria
Start year: 1995 **End year:** 1996 **Spatial extent:** region
Survey method:
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:**
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:** time/location frame
Social data: **Economic data:** No

Project ID: V008 **Jurisdiction:** Vic
Short title: Victorian Freshwater Creel Surveys 1993-ongoing
Data custodian: DPI Victoria
Start year: 1993 **End year:** Ongoing **Spatial extent:** region
Survey method:
Catch estimates: **Effort estimates:**
NRFS regions: Yes **Fishing region strata:** **Species strata:**
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:** time/location frame
Social data: **Economic data:**

Project ID: V009 **Jurisdiction:** Vic
Short title: Port Phillip Bay recreational Snapper fishery pilot survey 1994-95
Data custodian: DPI Victoria
Start year: 1994 **End year:** 1995 **Spatial extent:** region
Survey method:
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** Yes
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:** time/location frame
Social data: **Economic data:** No

Project ID: V010 **Jurisdiction:** Vic
Short title: Evaluation of changes to Dusky Flathead catch limits in Mallacoota Inlet
Data custodian: DPI Victoria
Start year: 2003 **End year:** 2008 **Spatial extent:** locality
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** No
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V011 **Jurisdiction:** Vic
Short title: Recreational Fishery Monitoring of Lake Tyers Fisheries Reserve
Data custodian: DPI Victoria
Start year: 2008 **End year:** 2009 **Spatial extent:** locality
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** No
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V012 **Jurisdiction:** Vic
Short title: Recreational Fishery Monitoring in the Hopkins River estuary
Data custodian: DPI Victoria
Start year: 2008 **End year:** 2010 **Spatial extent:** locality
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** No
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V013 **Jurisdiction:** Vic
Short title: Recreational Fishery Monitoring of Anderson Inlet Fisheries Reserve
Data custodian: DPI Victoria
Start year: 2006 **End year:** 2007 **Spatial extent:** locality
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** project-specific regions **Species strata:** No
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V014 **Jurisdiction:** Vic
Short title: Quantifying the catch of Southern Bluefin Tuna taken by the recreational
Data custodian: DPI Victoria
Start year: 2011 **End year:** 2011 **Spatial extent:** region
Survey method: complemented (multiple methods)
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: Yes **Fishing region strata:** latitude-longitude **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** time/location frame
Social data: Yes **Economic data:** No

Project ID: V015 **Jurisdiction:** Vic
Short title: Charter boat diaries
Data custodian: DPI Victoria
Start year: 1998 **End year:** 2002 **Spatial extent:** state-wide
Survey method: other
Catch estimates: retained and released/discarded catch **Effort estimates:** No
NRFS regions: Yes **Fishing region strata:** grouped NRFS regions **Species strata:** No
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** boat registration register
Social data: No **Economic data:** No

Project ID: V016 **Jurisdiction:** Vic
Short title: RFL Database
Data custodian: DPI Victoria
Start year: 2001 **End year:** **Spatial extent:** state-wide
Survey method: other
Catch estimates: **Effort estimates:** No
NRFS regions: No **Fishing region strata:** **Species strata:** No
Participation estimates: **Demographics:**
Residence region strata: **Sampling frame:**
Social data: **Economic data:**

Project ID: W014 **Jurisdiction:** WA
Short title: WA Rock Lobster Phone Diary Surveys
Data custodian: Dept of Fisheries
Start year: 2000 **End year:** 2009 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained catch only **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** No
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** license register
Social data: No **Economic data:** No

Project ID: W016 **Jurisdiction:** WA
Short title: WA Rock Lobster Mail Surveys
Data custodian: Dept of Fisheries
Start year: 1986 **End year:** 2012 **Spatial extent:** state-wide
Survey method: mail survey
Catch estimates: retained catch only **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** project-specific regions **Species strata:** No
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: postcode **Sampling frame:** license register
Social data: No **Economic data:** No

Project ID: W021 **Jurisdiction:** WA
Short title: WA Recreational Boat Fishing Survey 2011-12
Data custodian: Dept of Fisheries
Start year: 2011 **End year:** 2012 **Spatial extent:** state-wide
Survey method: telephone screening & diary
Catch estimates: retained and released/discarded catch **Effort estimates:** Yes
NRFS regions: No **Fishing region strata:** latitude-longitude **Species strata:** Yes
Participation estimates: Yes **Demographics:** participation/effort/catch
Residence region strata: Other **Sampling frame:** license register
Social data: Yes **Economic data:** Yes

Project ID: W021 **Jurisdiction:** WA

Short title: WA Recreational Boat Fishing Survey 2011-12

Data custodian: Dept of Fisheries

Start year: 2011 **End year:** 2012 **Spatial extent:** region

Survey method: intercept survey (access point/roving creel/bus route)

Catch estimates: retained and released/discarded catch **Effort estimates:** Yes

NRFS regions: No **Fishing region strata:** latitude-longitude **Species strata:** Yes

Participation estimates: Yes **Demographics:** participation/effort/catch

Residence region strata: Other **Sampling frame:** time/location frame

Social data: No **Economic data:** No

Appendix 3 – Project staff and workshop participants

Project staff

Name	Affiliation
Shane Griffiths (PI)	CSIRO
Jeremy Lyle (Co-PI)	Institute for Marine and Antarctic Studies
Phil Sahlqvist (Co-PI)	Australian Bureau of Agricultural and Resource Economics and Sciences
Bill Sawynok (Co-PI)	Recfishing Research
Bill Venables	CSIRO
Ken Pollock	Murdoch University

Jurisdictional collaborators

Jeff Murphy	New South Wales Department of Primary Industries
James Webley	Fisheries Queensland
Steve Matthews	Northern Territory Fisheries, Department of Resources
Karina Ryan	Western Australia Department of Fisheries
Tim Ward	South Australian Research & Development Institute
Simon Conran	Victoria Department of Primary Industries

Workshop 1 participant and invitee names and affiliations for the National Recreational Fishing Data Workshop held at the Gold Coast Convention Centre, Gold Coast on 14 June, 2012.

Name	Affiliation
Shane Griffiths (PI)	CSIRO
Jeremy Lyle (Co-PI)	Institute for Marine and Antarctic Studies
Phil Sahlqvist (Co-PI)	Australian Bureau of Agricultural and Resource Economics and Sciences
Bill Sawynok (Co-PI)	Recfishing Research
Ross Winstanley (Chair)	Winstanley Fisheries Management Services
Jeff Murphy	New South Wales Department of Primary Industries
Charles Gray	New South Wales Department of Primary Industries
James Webley	Fisheries Queensland
Phil Hall	Northern Territory Fisheries, Department of Resources
Karina Ryan	Western Australia Department of Fisheries
Tim Ward	South Australian Research & Development Institute
Natalie Bridge	Victoria Department of Primary Industries
Kate Brooks	FRDC Social Science Research Coordination Program
Russell Conway	Recfish Australia
Ewan Colquhoun	Ridge Partners
Invitations extended	
Allan Hansard	Australian Fishing Trade Association
Matthew Barwick	Recfishing Research
Evan Jones	Game Fishing Association of Australia
Anthony Hurst	Australian Fisheries Management Forum

Workshop 2 participant and invitee names and affiliations at the Recreational Fishing Data Assessment Workshop held at the Ecosciences Precinct, Brisbane on 16 April, 2013.

Name	Affiliation
Shane Griffiths (PI)	CSIRO
Jeremy Lyle (Co-PI)	Institute for Marine and Antarctic Studies
Phil Sahlqvist (Co-PI)	Australian Bureau of Agricultural and Resource Economics and Sciences
Bill Venables	CSIRO
James Webley	Fisheries Queensland
Steve Matthews	Northern Territory Fisheries, Department of Resources
Matt Barwick	Recfishing Research
Barry Pollock	Sunfish
Invitations extended	
Allan Hansard	Australian Fishing Trade Association
Bill Sawynok	Recfishing Research
Crispian Ashby	FRDC
Craig Ingram	Amateur Fishermen's Association of the Northern Territory
Evan Jones	Game Fishing Association of Australia
Anthony Hurst	Australian Fisheries Management Forum

Appendix 4 – Workshop agendas

National Recreational Fishing Data Workshop

14 June 2012

Gold Coast Exhibition and Convention Centre

Workshop facilitator: Ross Winstanley

Session 1: Overview of Recreational Fisheries and Management Needs in Australia

8.00	Shane Griffiths (CSIRO)	<i>Welcome address, housekeeping and attendee introductions</i>
8.05	Shane Griffiths (CSIRO)	<i>RFIDS and the National picture of recreational fisheries – why an update is needed</i>
8.15	Russell Conway (Recfish)	<i>The data needs of recreational fishers</i>
8.25	Jeremy Lyle (IMAS)	<i>Lessons learned from the National Survey</i>
8.35	Phil Sahlqvist (ABARES)	<i>Community monitoring</i>
8.45	Kate Brooks	<i>Social data in recreational fisheries</i>
8.55	Ewan Colquhoun	<i>Economic data in recreational fisheries</i>

Session 2: A National Review of Recreational Fishing Datasets

9.05	Jeremy Lyle (IMAS)	<i>Recreational Fishing Surveys in Tasmania</i>
9.15	James Webley (DEEDI)	<i>Recreational Fishing Surveys in Queensland</i>
9.25	Natalie Bridge (Vic DPI)	<i>Victorian Recreational Fishing Studies</i>
9.35	Karina Ryan (WA Fish.)	<i>Western Australia Update</i>
9.45	Morning Tea	
10.00	Phil Hall (Fish. Div. NT)	<i>Northern Territory Recreational Fishing Data</i>
10.10	Tim Ward (SARDI)	<i>Data sets on South Australian Recreational Fishing Surveys, 1990/91 – 2010/11</i>
10.20	Jeff Murphy (NSW DPI)	<i>NSW Recreational Fisheries Research</i>
10.30	Bill Sawynok (Recfishing Res)	<i>Citizen Science: Community monitoring of fish and fishing</i>

Session 3: Development of an Analysis Framework

10.40	Phil Sahlqvist	<i>National recreational fishing data audit</i>
11.10	Shane, Jeremy and Phil	<i>Identification of key species by jurisdiction</i>
11.30	Shane, Jeremy and Phil	<i>Identification of key reporting regions or species stock boundaries</i>
12.00	Lunch	
1.00	Shane, Jeremy and Phil	<i>Proposing a draft framework for reporting</i>
1.30	Shane, Jeremy and Phil	<i>What data needs to be reported in the final report and a data portal to meet the needs of fishers and managers?</i>
2.00	Shane, Jeremy and Phil	<i>How will the data be reported that will be acceptable to data custodians?</i>
2.30	Afternoon Tea	
3.00	Shane, Jeremy and Phil	<i>Discussion of any specific issues</i>
3.45	Shane	<i>Wrap up and closure of meeting</i>

Recreational Fishing Data Assessment Workshop 2

16 April 2013

Ecosciences Precinct, Boggo Road, Brisbane

Project Principal Investigator: Dr Shane Griffiths

Workshop facilitator: Dr Shane Griffiths

- | | | |
|-------|--------------------------------------|---|
| 9.00 | Shane Griffiths (CSIRO) | <i>Welcome address, housekeeping and attendee introductions</i> |
| 9.05 | Shane Griffiths (CSIRO) | <i>RFIDS and the National picture of recreational fisheries – why an update is needed</i> |
| 9.30 | Jeremy Lyle (IMAS) | <i>Lessons learned from the National Survey</i> |
| 10.00 | Phil Sahlqvist (ABARES) | <i>National Recreational Fishing Data Audit
Key outcomes from Workshop 1
Identification of national priority species</i> |
| 10.30 | Morning Tea | |
| 10.45 | Bill Venables (CSIRO) | <i>Statistical analyses of existing datasets</i> |
| 11.15 | Shane Griffiths | <i>'Best available' national estimates of catch for key priority species
National estimates of recreational fishing effort and participation</i> |
| 11.30 | Shane Griffiths | <i>A proposed framework for a national data portal for recreational fisheries data</i> |
| 12.00 | Lunch | |
| 12.45 | Shane Griffiths | <i>Discussion of optimising project outcomes for rec fishing stakeholders</i> <ul style="list-style-type: none">- <i>Statistical analyses</i>- <i>Data portal issues – design, custodian(s), timely updates of new survey data</i>- <i>Other key issues</i> |
| 1.30 | Shane Griffiths | <i>Discussion for improving national-level recreational fishing data</i> <ul style="list-style-type: none">- <i>Future surveys</i>- <i>Co-ordination of state surveys</i>- <i>Rec licences/ registry for improving cost effectiveness of surveys</i> |
| 2.00 | Concluding remarks and meeting close | |

CONTACT US

t 1300 363 400
+61 3 9545 2176
e enquiries@csiro.au
w www.csiro.au

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FOR FURTHER INFORMATION

Division of Marine & Atmospheric Research
Dr Shane Griffiths
t +61 7 3822 5927
e shane.griffiths@csiro.au
w www.csiro.au