# Recreational fishing monitoring and data collection: preliminary benchmarking for Queensland


David J. Welch and Matt Koopman

$C_2O$ Fisheries, August 2024

$C_2O$ Fisheries

Coasts | Climate | Oceans

Citing this document:
Welch, D.J. and Koopman, M. (2024) Recreational fishing monitoring and data collection: preliminary benchmarking for Queensland. Report to the Australian Marine Conservation Society, $C_2O$ Fisheries, Cairns, Australia.

Enquiries:
Simon Miller
Great Barrier Reef Fisheries Campaign Manager
Australian Marine Conservation Society, Yuggera Turrbal Country, PO Box 5815, West End QLD 4101
Mob: +61 429 042 124
E: simonmiller@amcs.org.au
w: marineconservation.org.au

Photo credit: Mick de Rooy and Andrew Doig, Townsville.

**DISCLAIMER**

The information contained in this publication comprises general statements based on scientific research and consultations with recreational fisheries stakeholders. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, the authors exclude all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

# Table of Contents

## About this report

Given the scale and complexity of the recreational fishing sector generally, the scope of this project topic is potentially very large. Further, monitoring of recreational fishing is often done across multiple dimensions including participation rates, catch and effort, social and economic. Given the current project terms of reference refer to sustainability and current methods that collect catch and effort data, and the limited project timeframe, this report primarily focuses on data collection methods with a focus on collecting information about fishing activity including catch and effort. Except for one exception, economic and social data collection survey programs are not assessed specifically. Further, while the interviews conducted with recreational fishers in Queensland was enlightening and useful, the project scope limited the number of interviews possible. Given these limitations, the findings in this report should be considered as preliminary.

## Project background

Queensland Fisheries are currently undergoing significant reforms as part of the Sustainable Fisheries Strategy 2017-2027. While much of the reform focus has been on the commercial fisheries, management changes to popular recreational species such as Spanish mackerel and snapper have also been implemented. Fisheries Queensland currently collects recreational fishing data via boat ramp surveys, phone surveys and recreational fishing diaries. Recreational fishing data is collected irregularly but is made available via interactive dashboards. Trials of voluntary app-based reporting are set to commence for Spanish mackerel later in 2024. However, with a focus on improving sustainability, particularly within the World Heritage Listed Great Barrier Reef, and with some species being predominantly caught by recreational fishers, including those subject to overfishing, there is a desire from all sectors for better recreational fishing data.

In response to this need, the Australian Marine Conservation Society (AMCS) has commissioned the consultant to conduct the review contained herein this report, with the following objectives:

1) Outline and compare the methods of recreational fishing data collection in each Australian jurisdiction.
2) Outline case studies of best practice recreational fishing data collection used internationally.
3) Understand and report on Queensland recreational fishing leaders and peak bodies attitudes and aspirations regarding data collection and identify any barriers to the uptake of best practice data collection.
4) Recommend a model for best practice recreational fishing data collection in Queensland.

## Recreational fishery data collection approaches

### International case studies

#### New Zealand

New Zealand undertakes regular recreational fishing surveys using a combination of face-to-face interviews, SMSs and Computer Assisted Telephone Interview and fish weight data from creel

surveys are used to multiply catch numbers up to weights. Surveys are undertaken every 5-6 years.

The National Panel Survey of Marine Recreational Fishers 2017–18 (Wynne-Jones et al., 2019) had three objectives:

1. To deliver a repeat of the 2011–12 National Panel Survey (Project MAF2010–01) in Fisheries Management Areas 1,2,3,5,7,8 and 9 during the period 1 October 2017 to 30 September 2018.

2. To estimate total amateur harvest by fish stock for all species recorded during the survey.

3. To collaborate with concurrent onsite survey project(s) to provide robust comparisons of harvest estimates for specified areas.

The survey covered marine waters of New Zealand excluding small offshore islands and uses census spatial mesh blocks as the areal frame (Figure 1). Mesh blocks with fewer than 6 homes were removed. There are 46,629 mesh blocks in NZ, and they are the smallest geographical unit for which statistical data is reported by Statistics New Zealand. Mesh blocks are stratified by Territorial Authority (TA) to ensure all TAs are included. Kish allocation method was used to allocate the sample mesh blocks to increase the sample size in small TAs. In the latest survey, a total of 1100 mesh blocks were covered as the primary sampling units, selected using a systematic probability proportional to size sampling scheme with the Census 2013 count of Private Permanent Occupied Dwelling used as the size measure. Secondary sampling units used were dwelling, with up to 32 dwelling selected in each mesh block.

A screening survey was undertaken by face-to-face interviews at every selected household to identify fishers aged 15 years and older of any avidity. From households, one fisher was randomly selected to become a panellist. Panellists were provided with an information brochure, instructions on SMS texting procedures and a URL with additional information including fishing areas and species IDs. Incentives for participation are provided (e.g. weekly draws for wine and major prizes of iPad Pros).

SMS or Computer Assisted Telephone Interviews are used to contact fishers at least once per month, but often weekly to find out if they fished or not, and if they did fish, information on those fishing events was obtained via telephone interviews. Notes pages are made available if participants choose to record information on fishing trips between interviews. Interviewers were trained over one day and issued with an interviewer manual. Up to five calls were made at each sampled home to attempt to contact the respondent. Days of week and times of day for these calls were varied to maximise contact. In the latest survey twenty percent of completed interviews were called back by supervisors to confirm the interview was done with the right person and to record interview duration.

Effort data collected included were: platform (e.g. boat, kayak, beach), area fished, fishing method, number of trips each day, launch site (e.g. boat ramp, marine, mooring), nearest town,

nearest land point, if diving, type of diving for either hand harvest or spearfishing and other people fished with. Catch data included were: no catch, catch and release/discard, caught and not released/discarded, why was catch different from average fishing trips.

To multiply catch numbers to catch weights, average weight of each species were obtained from creel surveys that were not a part of the telephone-based survey. Data were weighted up to obtain estimates for the whole of New Zealand. Finally, drop-in surveys of non-fishers were also undertaken to determine if any of them actually went fishing in the survey period.

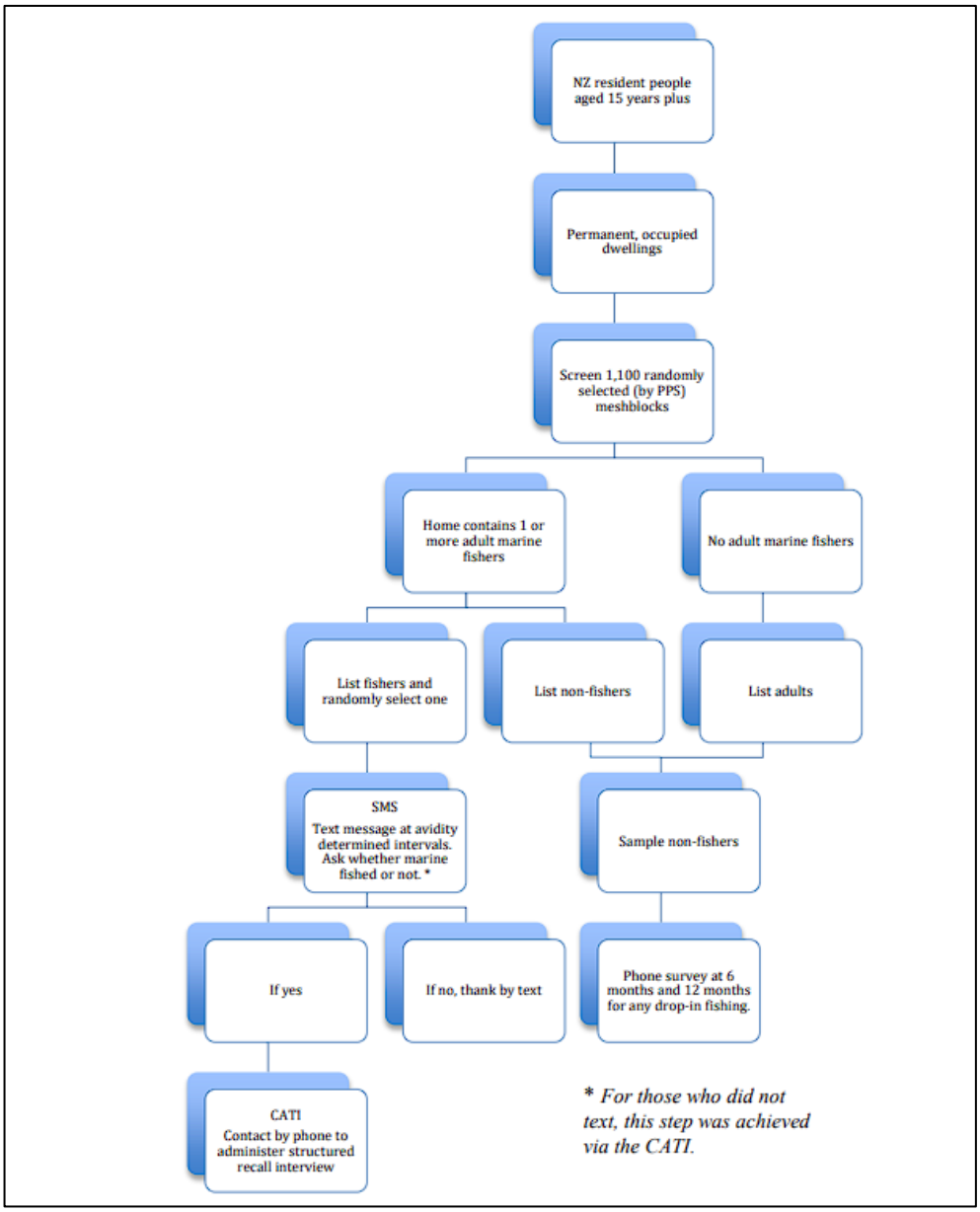


Figure 1. Overview of the New Zealand National Panel Survey of Marine Recreational Fishers 2017–18 (Source: Wynne-Jones et al., 2019).

## United States

Recreational fishing surveys in the US can align with a nationally administered program called the Marine Recreational Information Program (MRIP). This sets out standards to adhere to which are briefly described below. Surveys are conducted annually and use a combination of postal (previously phone) and access point face-to-face interviews to record catch, effort and biological data.

The U.S. National Oceanic and Atmospheric Administration (NOAA) runs the MRIP to collect recreational fishing data. The MRIP is a state-regional-federal partnership that produces standards for which fishing surveys can be based to estimate recreational catch and effort. These standards were designed to promote data quality, consistency, and comparability across the recreational fishing surveys administered and funded through the MRIP. There are seven standards, and any MRIP funded surveys need to meet all seven standards. The standards are:

Standard 1: Survey Concepts and Justification – this covers planning including prescribing what the survey objectives should include, legislation or executive orders that have mandated the data collection, adherence to Office of Management and Budget (OMB) requirements and intended users and uses, as well as how to comply with the Paperwork Reduction Act Compliance.

Standard 2: Survey Design

Sampling - the requirement for a sampling plan describing the target population, sample frame, sample unit, stratification and methods of sample selection.

Data collection – including the frequency and timing of data collection, data collection modes, survey protocols, data elements and survey instruments.

Estimation – describes how the data will be used to derive final estimates including a sample weighting plan and the methods that will be used to derive point and variance estimates.

Evaluation – describes the requirement for an evaluation plan to assess potential sources of non-sampling error, the effects of that error of survey estimates and how to mitigate or measure non-sampling error.

Standard 3: Data Quality

Processing, Editing and Quality Control – data processing procedures including how the data will be reviewed and edited to fix errors and how to compensate for non-response.

Quality Assurance – this outlines the requirement for a plan for each phase of the survey to promote performance monitoring and assessment including training and supervision and independent validation.

Standard 4: Transition Planning – a transition plan is required if new or improved sampling or estimation designs are to be implemented that are likely to result in a large change from historical estimates.

Standard 5: Review Procedures

Certification – all surveys need to be certified which requires peer review and review and approval from the MRIP Executive Steering Committee

Annual Reporting – annual reports must include data collection procedures, sample sizes, completed surveys, response/compliance rates, editing/corrective actions, modifications, quality assurance and process improvement. Annual reports must also include survey estimates

Peer Review – annual reports and information products will be peer reviewed.

Standard 6: Process Improvement

Process Improvement Plan – ongoing evaluation of survey designs to address emerging needs and incorporate current best practice

Unplanned Modifications – unanticipated changes to the survey design may be required for example if there are low response rates or budget shortfalls.

Standard 7: Access and Information Management -

Microdata – this includes the final data set post quality control and other edits that must be published online each survey year

Estimates – this includes key statistics (which are prescribed) and the measures of precision for estimates.

File Formats – this specifies that the required file format is CSV, while SAS format is also recommended.

Attribute Values and Formats – The questions and responses for the survey are prescribed, as are estimate required to be calculated including measures of precision for estimates

Information Management – this described how data can be and must be shared/disseminated in accordance with a number of NOAA policies.

The MRIP comprises a suite of three different complimentary surveys (National Marine Fisheries Service Office of Science and Technology, 2023):

1. Fishing Effort Survey (FES) – Random samples of households throughout the state are contacted via mail in each two-month survey period. Sampling is stratified geographically (by sub-region of the coast, state and sub-state region), and usually by angler licence status (except for the HAWAIʻI MARINE RECREATIONAL FISHING SURVEY which uses a randomly selected subset of all residential addresses). Samples sizes are determined using Neyman allocation for each stratum. A replication-based sample selection procedure is used to control the primary stage unit selection. FISs record information on effort to estimate the number of trips taken from shore and private boats. The survey uses a US Postal Service list of residential addresses matched to a database of licenced anglers (the sample frame) to ensure that more surveys are sent to fishing households, maximising the chances of obtaining a representative cross-section of all households. Two waves of sample collection are undertaken.

2. Access Point Angler Intercept Survey (APAI) – APAIs collect catch-per-trip data from shore-based, private boat-based and for-hire vessel based anglers. Trained staff visit marinas, boat ramps, beaches, piers and other public fishing sites to interview anglers at the end of their trip. Data collected include: location, mode of trip (eg shore, private boat…), general area fished, species, number and disposition of the catch and where possible, length and weight. No compliance role is played as a part of these surveys.
3. Large Pelagics Surveys (LPS) – This comprises three complimentary surveys (the Large Pelagics Intercept Survey, the Large Pelagics Telephone Survey and the Large Pelagics Biological Survey) designed to monitor fishing activity that targets large pelagic species and highly migratory species.

FES and APAI data are combined to produce an estimate of total recreational catch. Those data are then used in combination with commercial catch data, biological data and other information to inform stock assessments. Assessments results and then in turn used along with input from fishers, scientists and other stakeholders set put in place management arrangements to meet sustainable targets. An example of an application of the MRIP is the HAWAIʻI MARINE RECREATIONAL FISHING SURVEY (HMRFS - Hongguang and Ogawa, 2016).

The HMRFS is partially funded by and partnered with NOAA Fisheries through the MRIP. A postal FES survey is undertaken every two-months to random households throughout the state to estimate the number of fishing trips undertaken by shore-line and private boat fishers. The FESis stratified by coastal counties and collects information on fishing mode, method, state/country, date and time of return. Interviews cover fishing trips that occurred over the past 60 days. Data are used to estimate mean number of fishing trips in each wave (2-month period) by fishing mode. This is scaled up to the number of households with a landline telephone in each county to estimate the total number of fishing trips per state and adjusted for households not covered by the sampling frame.

At the same time, observers survey boat ramps, beaches, piers, and other publicly accessible fishing sites to interview fishers (APAIs). APAI data are used to estimate catch rates or the number of fish caught per fishing trip, while observers also record species caught, measure and weigh the catch and record released catches. APAI sampling sites are randomly selected but weighted by fishing effort. The sampling frame is a matrix of sites associated with fishing pressure categories and calendar days and is stratified by month and county. Site-day is the primary sampling unit for each stratum. The probability of sampling site-days is proportional to the expected number of fishing trips. The sampling unit within each primary sampling unit is an individual fisher-trip. APAI survey design is based on a stratified multi-cluster sampling with unequal selection probability for site days within a target population. Data are used to estimate the average number of fish caught per trip for a mode and area combination.

Mean catch per trip from APAIS data is multiplied by number of trips in a domain from CHTS data to estimate mode-, area-, and species-specific catches and catch rates and mode and area-specific effort. Catch weights are calculated from mean weights and numbers of fish caught.

## United Kingdom

A survey to estimate sea angling participation, effort and catches combined two separate surveys, a nationwide survey of UK residents to estimate how many people go fishing by fishing method (the Watersports Participation Survey -WPS), and a diary angler survey to record sea angling activities and catches (the Sea Angling Diary) (Hyder et al., 2021, Hyder et al., 2024).

The WPS is an annual survey that has been conducted since 2002 to estimate participation in watersports. This is a face-to-face survey of 12,000 households from 605 sample points selected from a sampling frame created from non-overlapping areas of similar population sizes within a single Government Office Region. Random systematic selection was undertaken from of sampling points stratified by Government Office Region and social grade. The survey was restricted to people 16 years or older. Equal gender ratios were selected in each sample. Interview questions included information regarding sea angling using rod and line from different platforms (e.g. boat, kayak, shore) and recreational fishing activities using other gears. Next, the level of fishing activity in the previous year and additional questions to profile their angling experience. At least 10% of surveys were validated by trained personal to ensure consistency of data collection and to record survey issues. Questionnaire responses were weighted to the entire population over the age of 16 using a breakdown of demographics from the Office of National Statistics.

The Sea Angler Diary has been undertaken since 2016. A variety of recruitment methods were used to recruit participants including in-line in response to promotional materials, contacting existing database of anglers via email, angling clubs, internet fora and articles in published media. Recruitment for the survey was also advertised at fishing clubs, fishing stores and in mailouts from Fishing Megastore. A sign-up survey collected information to profile potential diarists including age, gender, location, fishing avidity, fishing skill and experience, intention to fish in the following year and if they wanted to participate in the diary panel. Once recruited and after recording one month of data, diarists were provided with a fish ID book, tape measure and a waterproof notebook or phone holder. Instructions were given regarding recording requirements including retained and release catch by species, and length measurement of retained fish. Access to the online diary system and app was also given, so that diarists could record their data once per month. Instructional material was available on the mobile app and online tool called the Sea Angling Diary tool. To maximise completion rates, reminder emails were sent three times each month and reminder push notifications were sent to those with an app twice a month. Diarists with missing data were contacted via text message to record a no-fishing month, or if they had fished, were contacted by phone call to complete data about their fishing sessions.

Quantification of UK-wide catches combined effort from the WPS with catch-rates from the Sea Angler Diary program, and accounted for avidity, age, fishing platforms and other profiling information from the WPS. Fish weights were calculated from lengths recorded by the Sea Angler Diary program and used to scale up numbers of fish to weight.

## Australian jurisdiction approaches

### National

The National Social and Economic Survey of Recreational Fishers (NRFS) was undertaken over 2019-2021 (Moore et al., 2023). Because of ongoing investment by Australian states and territories in measuring their own recreational catch and effort, the NRFS did not estimate catch and effort, but rather focused on recording social and economic contributions of fishing across Australia and to examine the use of differing methods for conducting social and economic surveys of recreational fishers. The NRFS comprised three stages. The objectives and data collected at each NRFS stage are shown in Table 1.

Table 1. A summary of data collected at each NRFS stage (from Moore et al., 2023).

| | Objectives | Population studied | Social/economic aspects of fishing examined | Methods-related goals |
|---|---|---|---|---|
| Stage 1 | • Estimate fishing participation and avidity<br>• Evaluate difference in estimates resulting from samples recruited in different ways<br>• Wellbeing measurement | • Adult population of Australia (fishers & non-fishers)<br>• | • Fishing participation<br>• Fishing avidity<br>• Fishing motivations<br>• Wellbeing | • Evaluate suitability of different survey recruitment techniques |
| Stage 2 | • Measure social and wellbeing outcomes associated with fishing<br>• Measure economic contribution of fishing in Australia | • Adult recreational fishers<br>• Recreational fishers living in household | • Fishing avidity<br>• Fishing substitutability<br>• Physical activity<br>• Fishing motivations<br>• Social connection<br>• Barriers to/ enablers of fishing experience<br>• Wellbeing<br>• Fishing expenditure | • Evaluate suitability of different survey recruitment techniques |
| Stage 3 | • Measure social and wellbeing outcomes associated with fishing<br>• Economic evaluation – recall testing | • Adult recreational fishers<br>• Information on fishing activities of survey respondent's household | • Fishing expenditure<br>• Impacts of COVID-19<br>• Stewardship<br>• Use of fishing apps<br>• Wellbeing | • Evaluate use of online monthly recall surveys to measure expenditure |

Stage 1 estimated the proportion of Australians that participated in recreational fishing, characteristics of fishers, and examined the extent to which avidity and participation varied by survey recruitment method used. This stage also collected data to help evaluate wellbeing (in conjunction with data from Stage 2 and Stage 3). A risk identified in the Stage 1 survey was salience bias resulting from people with a particular interest in a topic being more likely to respond. To mitigate this risk, Stage 1 questions were included in the Regional Wellbeing Survey,

an ongoing 'omnibus' survey to examine wellbeing, resilience and liveability in Australia's rural and regional areas. Recruitment materials deliberately did not specifically identify recreational fishing as a particular focus of the survey.

The Stage 1 survey could be undertaken either on-line or using paper forms. Recruitment methods trialled during Stage 1 included the choice of population, the type of method used to select a sample (e.g random selection, stratified sampling, quota sampling) and recruitment communication method (e.g. email, flyer, letter, online ad). Three sample selection methods were used:

- Probabilistic-based Stratified random sampling from a postal address database where a sample is selected from different strata with higher sample sizes in regions or groups that have smaller populations;
- Quota sampling where sampling continues until a set quota of people from different categories (e.g. gender, age, regions) is reached;
- Opportunistic sampling used "word of mouth" to spread the message about the survey through work/social networks.

Five recruitment communication methods were used including flyers, and online survey panel, social media advertising, word of mouth and existing participation in the RWS, and prizes were offered as incentives to participate in the survey. The data collected were weighted to be representative of characteristics of the Australian adult population such as gender, age, farmer status and Regional Development Regions.

Stage 2 collected data to enable assessment of economic contributions of recreational fishing, analysis of social and wellbeing contributions of recreational fishing and to evaluate different survey recruitment methods to provide a cost-effective sampling program of Australian recreational fishers. Stage 2 focussed on recreational fishers. Smaller states/territories were deliberately over sampled to ensure sufficiently large samples were obtained from those areas. Results could then be statistically weighted to ensure results were representative of Australian recreational fishers. Consideration of three different sources of bias were addressed: non-response bias, salience bias and strategic bias, and attempts were made to minimise these biases.

Stage two surveys could be completed either online or by completing a paper form, and participants could opt for a short or long (more detailed) survey. Multiple recruitment methods were used, primarily involving non-probabilistic methods and included emails to Stage 1 participants, flyers to letterboxes, via recreational fishing organisations, friends and family, social media, traditional media, posters in tackle stores and an online panel. The survey aimed to achieve a sufficient sample size for each group to achieve enough fishers of different types to support weighting of the survey sample and to be able to report results for urban versus rural areas, avid compared to less avid fishers and for different states and territories.

Data collected during Stage 2 included recent fishing events, relative frequency of fishing in the past 12 months compared to previous years and reasons for the change, fishing effort in the past

12 months by water type and fishing platform, use of catch, the type of person the participant fishes with, importance of fishing for social connectivity, subjective well-being, life changing events over the past 12 months, engagement in physical activity, self-rated importance of fishing (and different aspects of fishing), factors that reduced the quality of fishing over the past 12 months, other hobbies undertaken, socio-demographic and geographic characteristics, expenditure, priorities for investing in recreational fishing, bait and burley use and knowledge, for non-participants what level of interest they had, the likely-hood of fishing in the following 12 months, how they heard about the survey and willingness to be contacted for future surveys.

Stage 3 aimed to collect data to understand how participation in fishing changed and what impacts COVID-19, the 2019/20 Black Summer bushfires and the subsequent floods had on recreational fishing activity. Data collected included event-based fishing activity and expenditure and wellbeing. Data was collected via online surveys that were sent to Stage 2 participants. Stage 3 collected data over an 18-month period, with a frequency of reporting of every two or three months.

Stage 3 had two different questionnaires, the first had questions repeated every survey regarding number of fishing trips per month, fishing expenditure, wellbeing and socio-demographic characteristics. The second survey also asked questions about a 'special topic' that was only asked about in that specific survey. Special topic questions included impacts of bushfires and flooding on fishing, impacts of COVID-19 on frequency and types of fishing done, how they kept in touch with people during lockdowns, substitution to other activities during lockdowns, use of fishing apps, accessing fishing information, engagement in fishing stewardship activities and use of tackle box app. A washup survey was held at the end of Stage 3.

### New South Wales/ACT

New South Wales' Recreational Fisheries Monitoring Program (RFMP) was initiated in 2017 and involves a telephone-diary survey of recreational fishers undertaken every two years, and an onboard observer program on charter fishing boats (Murphy et al., 2023). The survey comprises two main phases. A screening survey of fishers that hold a NSW recreational fishing licence where they are asked if they intended to fishing in the following year, and a diary survey of fishers who intended to fish that collected more detailed information on catch and effort.

The screening survey comprises a telephone interview on a stratified random sample of individual long-term recreational fishing licence holders but collects information on all household members 5 years and above. Information recorded includes past fishing activity, intention to fish in the following 12 months, and profiling information for members of the household. Depending on the outcome of an eligibility criteria, interviewees are invited to participate in the diary survey. The stratification for the screening survey occurs across 12 ABS Statistical Area classification (Level 4 (SA4)).

Diary survey participants are given a diary kit containing a diary card, a colour fish identification booklet and a covering letter providing further details about the survey. The diaries are intended to be a memory jogger, with the responsibility for data collection resting with the survey

interviewers rather than the participants. Regularity of phone contact is determined by avidity, but contact is made at least once per month. Data recorded include duration, location, fishing method, amount of fishing gear used, number of fish retained and released, and reason for release. Catch weights were obtained by multiplying catch numbers from this survey, with average weighs obtained from a variety of sources reported in Murphy et al (2020).

A non-intending follow-up survey is conducted for screening survey households that indicated no intention to fish in the following 12 months to check if recreational fishing did in fact occur. Where it did occur, further details of fishing activity were recorded.

Other NSW fishing surveys include:

- NSW Research Angler Program – this program has different components including donations of fish frames for biologicals, and the Keen Angler Diary which is a diary program that records catch, effort and size of Mulloway and Dusky Flathead, and a fish tagging program.

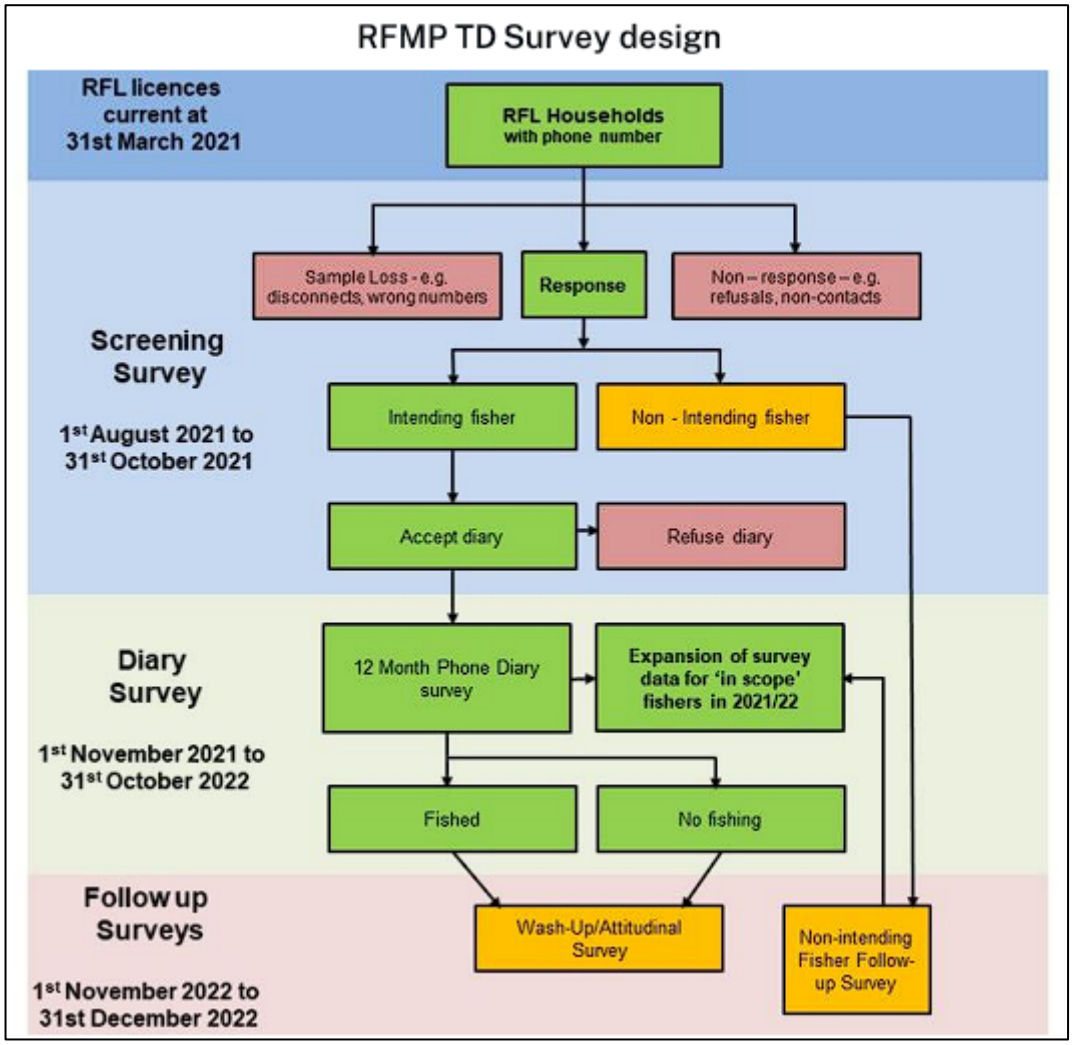


Figure 2. Flowchart of the process for conducting the NSW RFMP. Source: Murphy et al (2023).

## Victoria

Victoria's last state-wide recreational fishing survey was conducted as a part of the 2000/01 National Recreational and Indigenous Fishing Survey, however Ryan et al., (2009) undertook a survey of recreational fishing in coastal Victoria in 2006/07. This survey comprised a screening survey, phone-diary survey, wash-up survey, calibration survey and on-site surveys (Figure 3).

The screening survey was undertaken over telephones to find Recreational Fishing Licence (RFL) holders who intended to fish during 2006/07. Types of fishing activities included all recreational fishing methods, while species included any aquatic species. The sampling frame was people who bought a one- or three-year Victorian RFL in 2004/05, restricting the age range to 18-69 years old. Two different screening surveys were undertaken. One was to provide a sample of all anglers (avid and non-avid) and the other to just provide a sample of avid fishers. These fishers were invited into the phone-diary survey.

The phone-diary survey aimed to quantify recreational fishing effort in hours and days fished, catch numbers by species retained and released over 12 months. Fishing area, target species, fishing method and fishing platform was also recorded. This survey only included line fishing methods in Victorian marine waters. Anglers recorded data on a simple diary-card which served as a memory jogger during phone interviews.

The wash-up survey was undertaken after the phone-diary survey during the final telephone contact. It recorded attitudinal information on fisheries-related issues, perceptions of where the diary angler fished more or less than the previous year. These data were used for avidity profiling, expansion and calibration.

A calibration survey was also undertaken after the phone-diary survey and was similar to the screening survey. It aimed to quantify the participation of one- and three-year RFL holders and record profiling information to calibrate results from the phone-diary survey. Fishers were asked to recall retained binary catch of key species and attitudinal information on fisheries-related issues. This survey was stratified by city/country. An individual RFL holder was the sampling unit and the sampling frame was one and three year RFL holders in 2006/07.

On-site surveys were undertaken at boat ramps in Port Phillip Bay and Western Port during the phone-diary survey. Sampling was confined to daytime. It was aimed to provide representative samples of size frequency data from which to calculate mean weights to scale up the catch number data from the phone-diary survey. On-site surveys were also used to assess species identification skills of anglers and compare catch, effort and catch rate data to compare with phone-diary survey results.

Other recreational fishing data collection programs that are undertaken in Victoria, some of which are used to assess fish stock status (Bell et al., 2022), are the:

- Diary angler program – this program was established in 1998 and is undertaken by anglers classified as either 'general anglers' or 'research anglers' who record different types of information used to assess the health of fish stocks. General anglers record

information about their regular fishing trips including effort, catch, locations, gear types and targeting preference, while research anglers are required to target specific species in specific locations with specific gear. All catch is measured and some fish are aged. These are a more robust timeseries about the catchability of fish, and the relative abundance of different size and age classes, and are used in assessment of fish stocks. More information can be found in Conron et al (2012) and Conron and Bridge (2004).

- Onsite surveys – onsite surveys have been undertaken since 1995, conduction interviews at boat ramps when fishers return after fishing trips. Data collected includes fishing effort and numbers of fishers, catch composition, fish length (through measurements on site), fish targeted, gear used and some fisher details. Boat-trailer surveys, which involved a simple count of empty boat trailers at each ramp, are also conducted. These surveys provide a representative survey of what recreational are catching, when and where.
- Recreational rock lobster catch reporting – mandatory reporting of recreationally caught Southern Rock Lobster via the a tagging/reporting program has been required since 1st July 2017. Reporting was initially through a smartphone app web portal. Since November 2023, tagging was no longer required, but reporting catches is still mandatory via the GoFishVic RL app. Reporting includes date, zone and number of retained Southern Rock Lobster. Reporting additional information is optional. While we could not find a review of the success of mandatory app reporting, the Victorian Fisheries Authority report that the app has significantly changed over time based on feedback from recreational fishers and continues to be mandatory (https://vfa.vic.gov.au/recreational-fishing/fisheries-management/tagging-of-recreationally-caught-rock-lobsters#:~:text=Reporting%20your%20catch%20is%20mandatory,bag%20limits%20and%20possession%20limits).
- Quantifying the recreational catch of southern bluefin tuna off the Victorian coast (Green *et al*., 2012) - this survey used creel surveys to estimate the catch of Southern Bluefin Tuna from Warrnambool, Port Fairy and Portland. The use of boat ramp cameras was considered, but the data was found to be unreliable.
- Utilisation of boat ramp cameras to estimate recreational fishing catch and effort in key Victorian fisheries (FRDC Project 2021-008) - this project has not been completed, and aims to calibrate boat ramp camera infrastructure, extrapolate fishing effort derived from boat ramp cameras to boat ramps without cameras and combine that fishing effort with creel survey data to estimate fishing effort and snapper landings in Port Phillip Bay, total recreational catch in Corner Inlet and catch of Black Bream in the Gippsland Lakes.

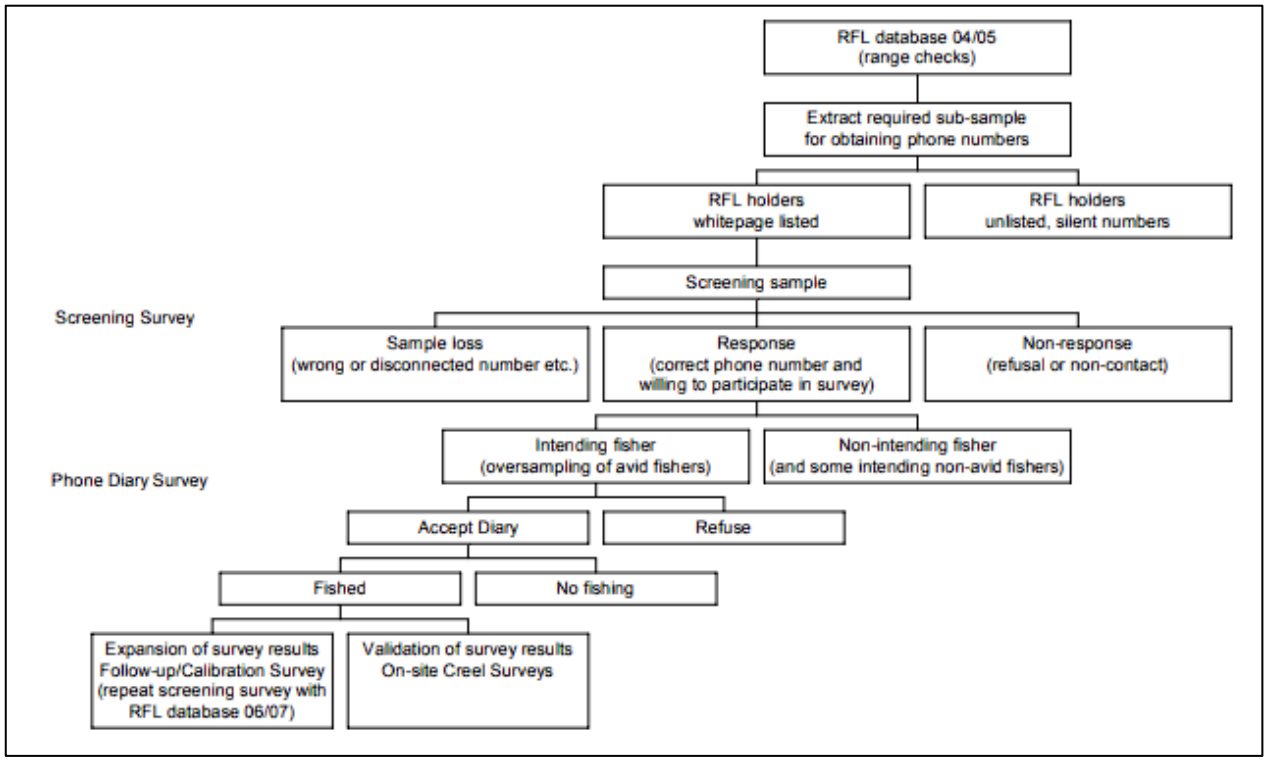

Figure 3. Overview of the Victorian coastal fishing survey (Ryan et al., 2009)

## Tasmania

Tasmania have undertaken recreational fishing surveys during 2007/08 (Lyle et al 2009), 2012/13 (Lyle et al 2014) and 2017/18 (Lyle et al 2019). While they were undertaken every five years, it does not appear one has been undertaken since 2017/18. The survey population includes the private-dwelling population of Tasmania, aged five years and older. The survey is a two-phase design with an initial screening phase and an intensive, diary survey phase.

The screening phase collected profiling information on household members and to assess the eligibility to participate in the survey. The screening survey is regionally stratified, with a random sample of numbers taken from the SamplePages database. Stratification was undertaken at the Statistical Area Level 4 (SA4), but a finer spatial scale at the SA3 level was monitored to make sure that the proportional breakdown of the sample numbers do not differ significantly to the proportions of dwellings based on available ABS data. For each household, demographics and recreational fishing avidity were recorded. Eligibility for further involvement in the survey was for at least one member to express the likelihood of fishing during the following 12 months. The response rate for the screening survey was 44.8%.

The intensive, diary survey phase was used as a "memory jogger" and that the responsibility for data collection was with the interviewers rather than the diarists. The level of fishing activity determined frequency contact but, respondents were called at least once a month even if no fishing was planned. Data reported in diaries included trip date, fishing location, start and finish times, and catch and release numbers of each species encountered, while more detailed information including target species, fishing method, platform (boat or shore), water body type

(river, lake, estuary, coastal, offshore, etc), and reason(s) for release were recorded for each fishing event during interviews. The response rate for the diary survey was 60.1%, while the effective diary completion rate was 78.1%.

Non-intending fisher callbacks were also made to include people that didn't intend to fish but did. A random sample of households that reported no intention to fish during the survey period were contacted near the end of the sampling period to record if fishing did in fact take place. If fishing did take place, further details about those fishing events were recorded.

A range of data sources was used to estimate average weights to allow a calculation of total recreational catch weights as well as numbers including research fishing, research angler logbook, commercial catch sampling and other research

A wash-up survey was undertaken at the end of the diary survey to record data on motives, attitudes, experiences and expenses related to recreational fishing. The wash-up survey had a 86% completion rate.

Table 2. Overview of the data collected using the state-wide Tasmania recreational fishing survey. Source: www.imas.utas.edu.au. *Note that in some cases, weight or volume were reported (e.g. for Whitebait). To scale catch number up to catch weight, average weights were derived from a variety of sources. +While catch and effort were recorded, catch rates were not calculated.

| Survey method | Data collected | | | | | |
|---|---|---|---|---|---|---|
| | Participation | Effort | Catch | Average weight | Catch rate | Fishing activity |
| Phone-diary | Yes | Yes | Yes | No* | No+ | Yes |

Other Tasmanian fishing surveys include:

- Offshore recreational fishing in Tasmania – this survey focuses on offshore waters where fishers target gamefish, pelagic sharks, mid-depth reef associated fish and deep-water shelf-edge associated species. The survey used a two-phase longitudinal telephone diary survey (TDS) design.
- Rock Lobster and Abalone recreational fishing survey – this survey targets fishers with recreational rock lobster and recreational abalone licences. Survey method includes contacting a random sample of licence-holders who are invited to participate in a phone-diary survey to monitor their rock lobster and abalone fishing activity.
- National recreational fishing survey of Southern Bluefin Tuna – Because of the large spatial extent of the fishery and a suit of data collection methods were required. Data from privately-owned vessels were recorded through on-site (boat ramp) surveys in Victoria and South Australia and off-site (telephone) surveys in Tasmania and New South Wales. Charter boats completed mandatory logbooks in South Australia and New South

Wales and in Victoria and Tasmania, charter boats recorded data in incentivised voluntary logbooks.

- Research Angler Logbook Program (RALP) - this program is to provide size composition information for key species from a range of fisheries including game fishing, offshore, inshore, estuarine line, potting, netting and diving. Avid, voluntary fishers record fishing location, fishing type, effort, gear details and catch numbers, lengths and estimated weights of each species caught.
- Tassie Fish Frame Collection Program – this program asks recreational fishers to donate fish frames from which biological information can be obtained.
- Recreational rock lobster catch reporting – mandatory reporting of recreationally caught Southern Rock Lobster has been required since December 2023. Reporting is done via the Fishing Tas app (or telephone if you don't have the app) and data includes fishing method, location and number of retained and discarded Southern Rock Lobster. Reporting additional information is optional. We could not find a review of the success of mandatory app reporting, and this is likely because it has only been in operation for a few months at the time of writing this report.

### South Australia

The 2021/2022 South Australian (SA) recreational fishing survey was based on the methods of Henry and Lyle (2003) and the data analysis was based on the methods of Lyle et al. (2010). The previous recreational fishing survey was undertaken in 2007/08, The survey population was resident private-dwellings of SA aged five years and older (Beckmann et al., 2023). All recreational fishing methods, aquatic animals and all SA waters (freshwater, estuarine and marine). Non-residents were considered out of scope. A multi-phase design (Figure 4) that included a telephone-diary survey was used.

Phase 1 (screening phase) calibrated responses against population benchmarks, characterised the sample population and identified the likelihood of fishing in the following 12 months from a sample of the population. If they indicated they were likely to fish in the following 12 months, they were eligible to participate. Stratified random sampling of households was undertaken at the Australian Bureau of Statistics (ABS) Statistical Area Level 3 (SA3) spatial scale. A total of 29,860 households were contacted.

In phase 2 (the longitudinal survey), participants were provided a diary kits and were contacted at-least monthly in most cases, but regularity was guided by avidity over a 12 month period. For each participating household, fishing activity for all household members over the age of five years was monitored. The diary kit provided included a diary, a colour species ID guide and a survey cover letter. Diaries were used to recorded basic information, while phone calls were used to obtained more detailed information such as target species, fishing method, fishing platform, water body type and reason for release of fish.

Phase 3 (non-intending callback survey) was done at the at the end of 12 months to account for unexpected fishing activity. This phase targeted non-intending fishers identified in Phase 1 to

account for unexpected fishing activity. Where fishing was reported, demographic information of household members was obtained, as well as household members had fished in SA and/or interstate, water body type, and number of days fished in the previous 12 months.

Phase 4 (the wash up survey) was targeted at phase 2 participants to assess motivations, awareness and attitudes. A random sub-sample of phase 2 participants was questioned, first to confirm that the data recorded for each household member was complete and to record changes in fishing activity compared to the 12-month period prior to the diary survey.

On-site sampling was also undertaken to provide length and weight data to convert catch numbers to catch weight. An average weight was obtained from surveys at boat ramps and other access points during peak fishing activity times in daylight hours. Fishers were approached at the end of fishing trips and surveyed about their fishing event including fishing body type and gear used. Fish retained were identified to species and measured.

Other SA fishing surveys include:

- Mandatory Snapper reporting – catches of Snapper must be reported via either the Fishwatch 24-hour hotline or the SA Fishing app. Reports must be made before fish are landed (boat fishing) or before leaving the fishing location (shore-based fishing).

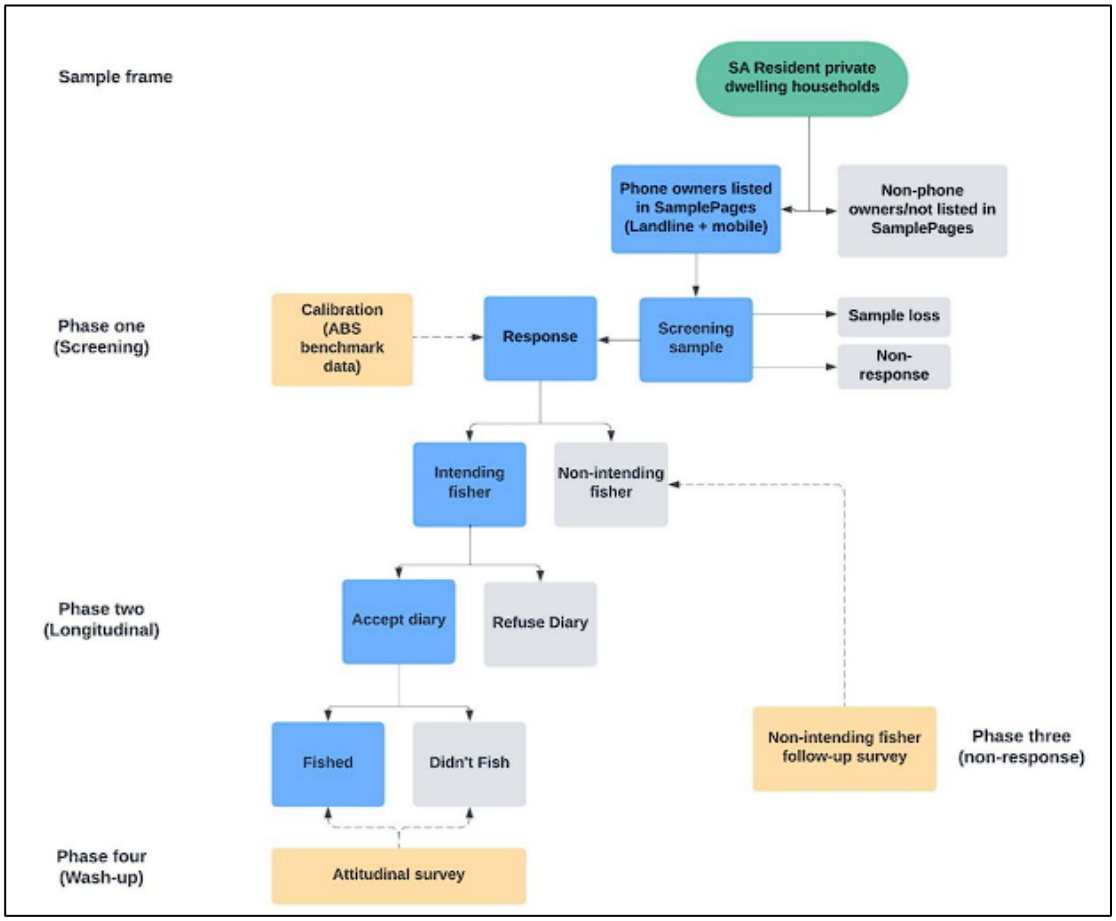


Figure 4. Overview of methods used during the South Australian 2021/2022 recreational fishing survey.

## Western Australia

The Western Australia Department of Primary Industries and Research Development (DPIRD) conducts monitoring of recreational fishing using two programs and four main methods (Table 3):

i) Statewide recreational fishing survey that uses a combination of telephone, diary, boat ramp and remote camera surveys to collect data across the entire state, and

ii) Metropolitan monitoring program that boat ramp surveys, creel surveys and remote camera surveys that focuses on metropolitan and selected high-use areas.

### Statewide recreational fishing survey

*Phone-diary surveys*

The off-site telephone component of the Statewide Recreational Fishing Surveys is conducted by the Survey Research Centre at Edith Cowan University on behalf of DPIRD and is done every 2–3 years. This survey uses interviews to collect information from recreational fishers about the frequency and location of their fishing activity, the species they catch and how many were kept and released, as well as other social and economic questions (see Ryan et al 2022 for full details). Interviews use Computer-Assisted Telephone Interview (CATI) technology, which is cost-effective and efficient. The primary sampling frame used is fishers that hold a Recreational Boat Fishing Licence (RBFL) and holders are contacted randomly using a regionally stratified approach. Further, a minimum age of 5 years was applied to the surveys. During these initial screening telephone surveys past and intended fishing activity is established to identify avidity, and the proportion who fished from shore are identified and reported separately to boat-based fishing. The main intent of the phone surveys is to identify fishers intending to fish in the next 12 months who are willing to participate in a 12-month fishing phone-diary program (Figure 5).

The Phone-Diary survey is conducted over a 12-month period and collects data to estimate effort (boat days and hours fished) and catch for all species (total, kept and released, by number). Other information such as fishing method, fishing location (bioregion, habitat), target species, and reasons for release are also collected. Resources provided in a Diary kit are designed to maximise data quality and includes instructions for data collection, a species identification guide, and 'Diary card' and a fishing location and habitat guide (Ryan et al 2022). All fishing diary information is collected using monthly telephone interviews.

Following the diary phase a washup survey is conducted by contacting diary participants to collect further information including confirmation they completed the diary program, opinions and attitudes relating to recreational fishing issues, and basic economic information. A non-intending fisher survey is also conducted at this time, randomly contacting fishers from the initial screening survey who indicated they were not likely to fish during the 12-month period of the diary program. This was to identify those who fished "unexpectedly" during the survey period. Finally, a benchmarking survey is conducted (Figure 5). This is essentially a repeat of the screening survey but with the sampling frame being fishers who obtained a RBFL during the survey period and was

used to calibrate and more accurately expand result from the Phone-Diary survey (Ryan et al 2022).

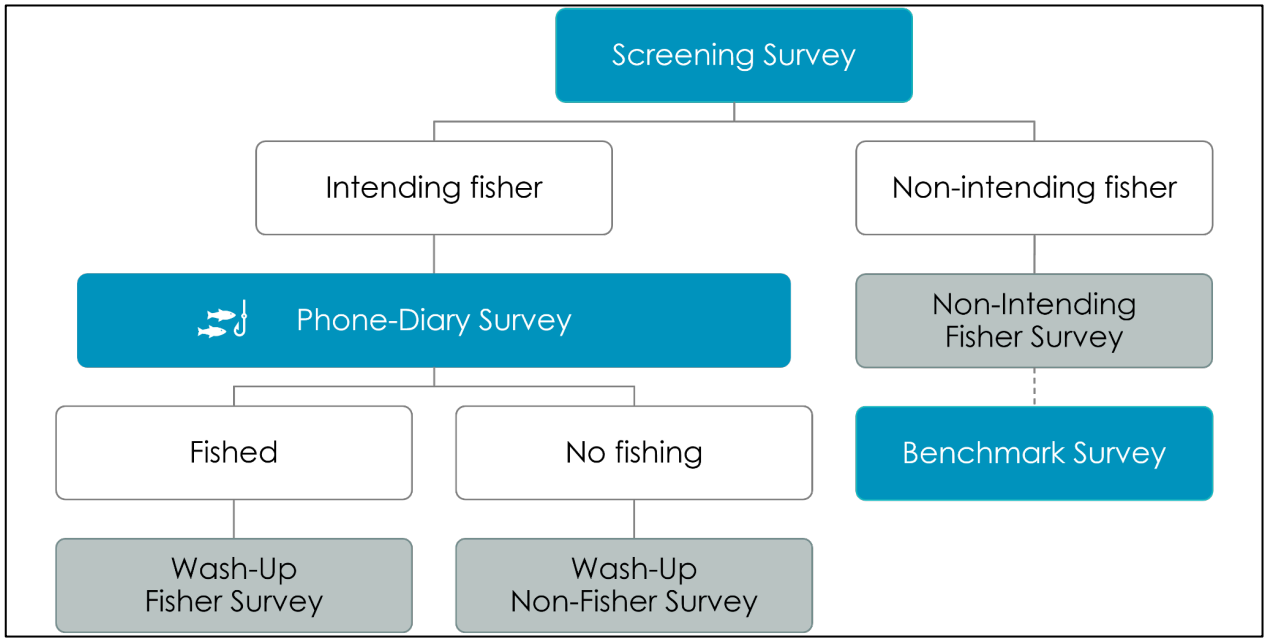


Figure 5. Flowchart of the process for conducting the telephone component of the Western Australia statewide recreational fishing survey program. Source: Ryan et al (2022).

*Boat Ramp Surveys*

While boat ramp surveys collect a range of catch and effort data, they are designed primarily to obtain length and weight information from catches which are used to convert the numbers caught estimated from the Phone-Diary Survey to be converted to catch by weight. Surveys are continuous each year and follow a restricted spatio-temporal design whereby key boat ramps in the Perth metropolitan area are preferentially targeted, and times are selected to target peak activity (i.e. season, day type and time of day) to maximise data collection. The target population includes boat-based recreational fishers who retrieve their vessels at key boat ramps where research staff conduct face-to-face interviews with recreational fishers. The primary sampling unit is sample day, and the secondary sampling unit is fishing party, which could include both RBFL holders and non-licensed fishers. Spatial stratification for the Biological Survey includes regions and zones. Temporal stratification was based on peak fishing periods.

*Remote Camera Surveys*

The use of remote video cameras as a cost-effective alternative to other methods has been explored in Western Australia for over a decade (Wise and Fletcher, 2013). This has culminated in the development of a framework for the integration of remote camera surveys with other recreational fishing surveys (Steffe et al. 2017), with remote camera surveys currently in use in the state. They are used at key boat ramps to monitor recreational boating activity and are operated 24 hours a day. Data collected assist with corroborating and validating estimated effort

from the Phone-Diary Survey. Ongoing research and improvement to analysis software is providing constant improvement in the cost-effectiveness of this passive method.

*Shore-based surveys*

On-site shore-based surveys are conducted to complement the main program that only covers boat owners with a RFBL and to provide a more complete sample. These are done using face-to-face interviews with recreational fishers while they are fishing on beaches, groynes and reef platforms in a limited coastal zone covering the highly populated region of Perth and Fremantle (Tate et al, 2022). This survey is run annually and collects data on recreational fishing effort, catch, average weight and catch rate, primarily for nearshore species, but also some demersal species. The size of the fishing party, number and type of gear used, and the number of species caught and released are recorded and a random sample of the retained catch is measured.

This survey uses a probability-based, stratified and randomised survey design to collect data with surveyor's travel along a predetermined route, stopping at each location for a designated wait time, and count the number of active fishers at each site. The day type (weekend/public holiday or weekday), time of day, start location and direction of travel are randomised to reduce bias in data collected. Research survey officers record the size of the fishing party, number and type of gear used, the number of species caught and released, and then measure a random selection of the retained catch.

Table 3. Overview of the data collected using the different survey methods used to monitor recreational fishing activity in Western Australia. Source: www.fish.wa.gov.au).

| **Survey method** | **Data collected** | | | | | |
|---|---|---|---|---|---|---|
| | **Participation** | **Effort** | **Catch** | **Average weight** | **Catch rate** | **Fishing activity** |
| Phone-diary | Yes | Yes | Yes | No | Yes | Yes |
| Boat ramps | No | No | No | Yes | Yes | No |
| Remote cameras | No | No | No | No | No | Yes |
| Shore-based | No | Yes | Yes | Yes | Yes | No |

*Other*

DPIRD uses other complementary surveys to monitor specific resources. For example, the Perth Metropolitan Roe's abalone recreational fishery attracts a significant amount of effort in a very short fishing season. This fishery is monitored using a shore-based access survey to collect catch and effort data and an aerial survey to collect effort data. A phone-recall survey is also occasionally used to estimate the Statewide recreational abalone catch.

DPIRD is also using and/or exploring other newer technologies and first assessing for biases that may need to be accounted for. For some surveys, researchers use iPads to record data from

interviews with fishers, and smartphone apps for fishers have been developed for fishers to self-report their fishing data.

## Northern Territory

The primary method for recreational fishing data collection in the Northern Territory (NT) is an off-site telephone-diary approach (West et al 2022; Figure 6). This is coordinated and conducted by an independent consulting firm, Kewagama Research. It is not clear how often the telephone-diary survey approach is used in the NT with the last one conducted during 2018-19 and the next most recent one conducted during 2009-10. Households are the primary sampling unit (PSU) and while previous surveys used the White pages as the sample frame, the most recent survey used the *SamplePages* data base which includes both landline and mobile phone number. Regionally stratified and random sampling is confined to households comprised of fishers who are non-Aboriginal residents aged 5 years and older. Information collected during the telephone screening phase includes an index of avidity (as opposed to participation rates) and demographic profiles and identifies households eligible and willing to participate in the diary program.

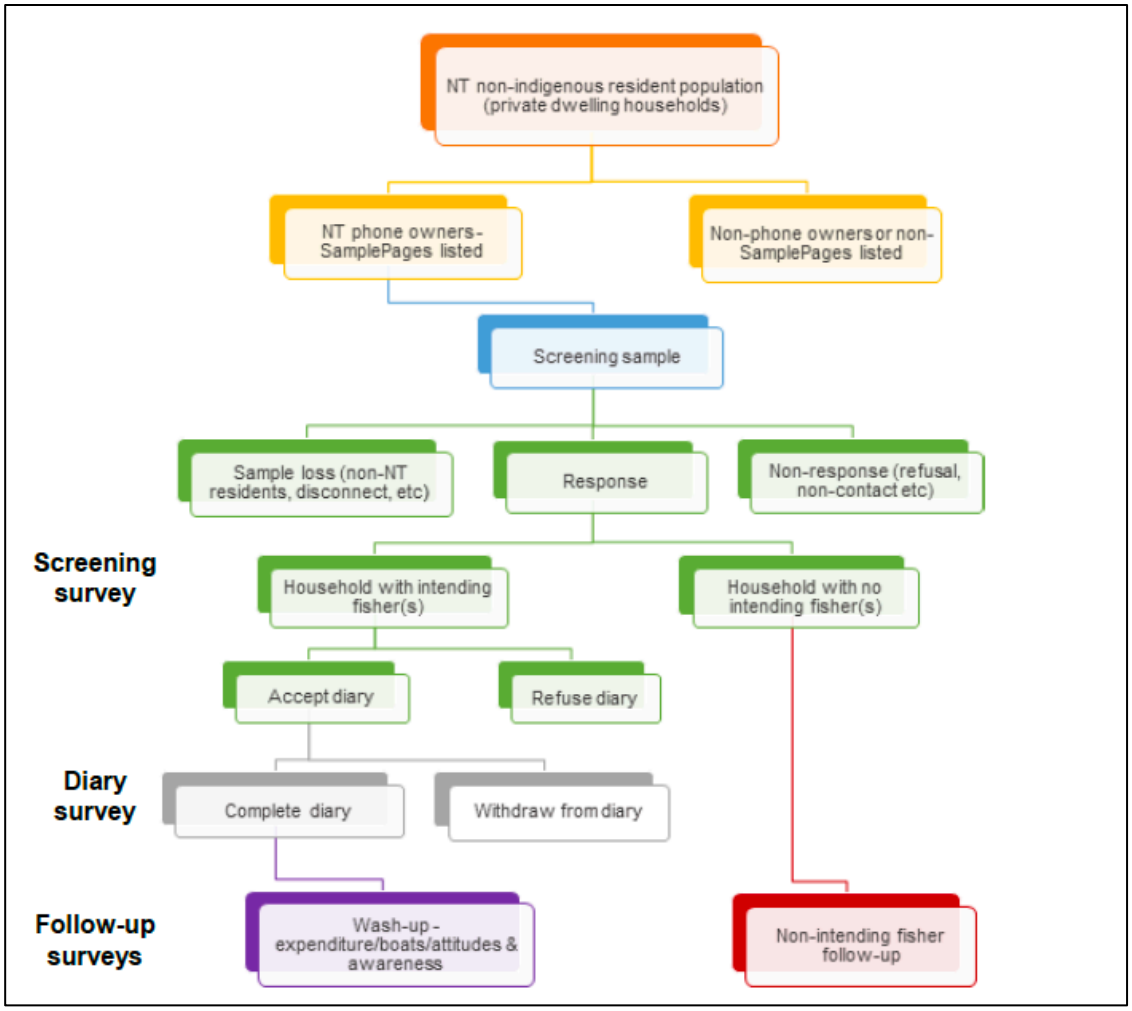


Figure 6. Flowchart of the process for conducting the Northern Territory recreational fishing survey. Source: West et al (2022).

The diary phase was 12 months in duration whereby participants were asked to record details about their fishing activity (species; catch - caught, kept and released; effort – date, time fishing, location, method, platform), and this was complemented by regular contact by the interviewers thereby improving data completeness and accuracy. At the completion of the diary phase diarists were contacted for a "wash-up" survey to confirm diary completions and to obtain additional data such as boat ownership, expenditure, opinions and attitudes. Finally, a sample of the households from the screening survey that reported no intention to fish in the coming year were re-contacted at the end of the diary period in a non-intending fisher follow-up survey to identify and account for any unexpected fishing (Figure 6).

From 2014-17 annual boat ramp surveys were conducted in the Greater Darwin area and again during 2022. West et al (2022) reported that a separate and independent recreational fishing study of selected boat ramps and accommodations had been conducted that would provide information on non-resident fishing activity. Further, the Amateur Fishermen's Association of the Northern Territory (AFANT) periodically conducts the NT Recreational Fishing Experience Survey (http://afant.com.au/nt-recreational-fishing-experience-survey/).

### Queensland

The Queensland Department of Agriculture and Fisheries (QDAF) adopts two main types of monitoring approaches for recreational fishing in Queensland including.

1. Boat ramp surveys, and
2. Statewide recreational fishing survey (SRFS).

More recently, QDAF outsourced an independent company to estimate the economic contribution of recreational fishing in Queensland to inform the development of economic indicators (BDO 2021). This study primarily used economic data from the SRFS program. It is not clear if and how information collected across the different approaches are integrated into the management process. Regional stratification by residential regions is used for conducting surveys and fishing regions for presenting catch data. Data and further details of the monitoring is available through online dashboards (https://www.daf.qld.gov.au/business-priorities/fisheries/monitor/rec).

#### Boat ramp surveys

The Boat Ramp Survey (BRS) program began in 2006 and has expanded over time. Since 2015 it has been statewide in coverage with more than 50 ramps surveyed. Fishers are surveyed at boat ramps as they return from a fishing trip. Surveys are done at each ramp five times in each month that includes three weekday and two weekend shifts. Each shift is four hours duration in either the morning or afternoon, with the day and shift time randomly allocated in each month for each ramp. This results in over 2,900 surveys conducted each year.

Data is recorded on the number of individuals caught, kept and released for 43 species of fish and crustaceans, and the length is also recorded for 40 species. Data are used to examine temporal trends in several indices derived from the surveys, such as effort, CPUE, fish length and the value of recreational fishing.

QDAF also has a Fish Aggregating Device (FAD) program operating in the southeast region and the Gulf of Carpentaria. Two questions in the BRS serve to specifically monitor fishing catch and effort on FADs.

Statewide recreational fishing survey (SRFS):

The SRFS was last conducted for 2019/20 and was outsourced to an independent Australian social research company, The Social Research Centre. The SRFS collects data on recreational fishing for households using a fishing diary over a one-year period. The program is conducted in three phases comprising seven stages (Figure 7). Phase 1 is a screening phase that seeks to randomly identify participating households for the diary. This uses a tri-sample sampling frame of i) listed mobile numbers, ii) random digit dialed (RDD) landline phone numbers and iii) RDD mobile numbers. Call recipients are asked if the fished recreationally in the last 12 months, and, if they intend on fishing recreationally in the next 12 months. Households intending to fish are invited to be part of the 12-month diary of fishing activity. The information collected during Phase 1 is used to estimate statewide participation rates.

During phase 2, participating fishers (aged 5 years or more) record their fishing activity shortly after fishing trips, either over a phone call using Computer Assisted Telephone Interviewing (CATI) or via an online survey portal. Using the screening phase information, a contact schedule is developed based on the fishers expected fishing avidity (i.e. how many times a year they go fishing). Although there is the option to modify the contact schedule according to changes in fishing activity from the expected, it is still possible that many fishers will not be contacted many months after a fishing trip meaning that recall bias may be highly variable (Misson et al., 2020). Fishers also record basic expenditure.

Phase 3 is comprised of an exit interview for diary participants to collect "…household information on economics, awareness, attitudes and other data related to recreational fishing in Queensland, not otherwise collected in the 12-month diary." Also, as part of Phase 3, households from the screening stage who indicated they were not likely to fish in the next 12 months and agreed to be recontacted, were contacted after the diary phase and asked to complete a brief survey, apparently to establish if they did or did not fish during the 12 months as expected.

Data collected are:

**Catch** – by the number of individuals of each species; caught, retained, released.

**Effort** – locations fished; duration of fishing; how many fishing; types of fishing methods; recorded as an effort day, for any fishing on a given day.

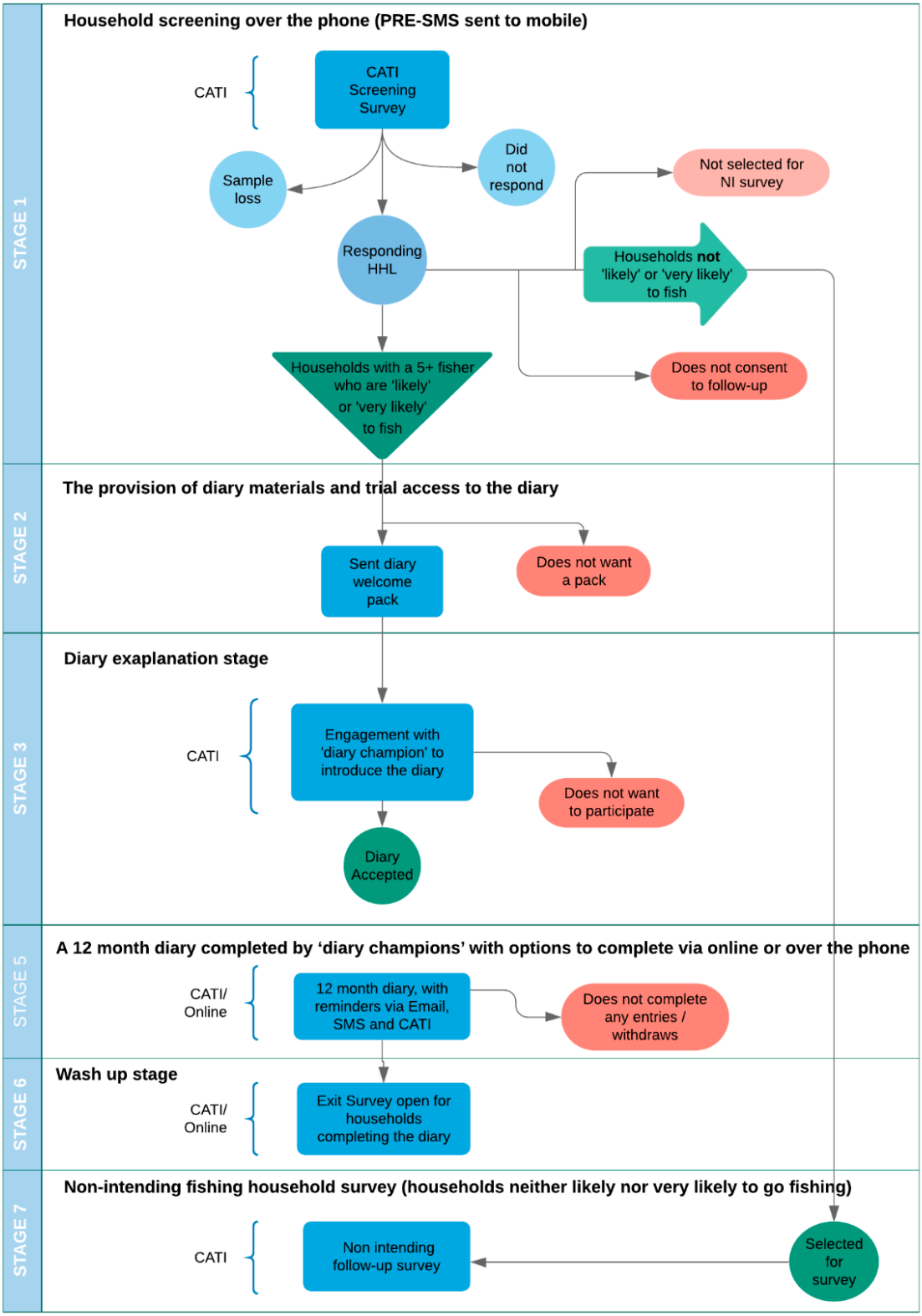


Figure 7. Flowchart of the process for conducting the Queensland statewide recreational fishing survey. Source: Misson et al., 2020.

Data are weighted to the total Queensland population using benchmarks provided by the Australian Bureau of Statistics and following procedures of Lyle et al (2010) and Misson et al

(2019). Previous SRFS were done in 2013/14 and 2010/11; it is not clear what the intended frequency is for the SRFS. Also, estimates reflect Queensland resident fishing activity only, not interstate or overseas visitors.

Other monitoring approaches

- Fish frame donation - QDAF involve recreational fishers through the Keen Angler program whereby volunteer fishers provide fish frames of key target species. These frames are used to collect species size, sex and age data to support stock assessments.
- Voluntary app-based reporting - In October 2020 QDAF released its Qld Fishing 2.0 app and in 2023 underwent significant upgrades based on feedback from recreational fishers. More recent was the introduction of a feature that allows recreational fishers to record information about their fishing trips following a state-based recreational catch reporting survey that showed that most fishers prefer the use of a smartphone app over other options (https://www.qld.gov.au/recreation/activities/boating-fishing/rec-fishing/app/my-fishing#:~:text=The%20Qld%20Fishing%202.0%20app,monitoring%20activities%20for%20several%20years). Data recorded is voluntary and includes fishing platform, location, number of fishers, species caught and numbers kept and released, fishing method and information about depredation. While QDAF reports that there has been over 100,000 downloads of the app we could not locate information about the data collected, participation and utility of the data so far.
- Remote video cameras - A current trial is underway using remote video cameras at selected boat ramps as an independent method for estimating recreational fishing effort.

## Summary

The notion of 'best practice' for a recreational fishing monitoring program is not straight forward largely due to the highly complex characteristics usually encountered with this fishing sector, as well as other factors including method/s used and survey objectives. The main challenges are the sheer number of individuals, their diversity across multiple dimensions (e.g. geography, social, accessibility, avidity, etc), and accessing them using a sampling frame and sampling design that is robust while also being cost-effective. This potentially results in many elements that are needed to ensure outputs from monitoring is valid. Further, it also needs to be acknowledged that, even the most robust system, is likely to generate estimates with high levels of uncertainty. Such is the difficulty in collecting data from this sector, that a recent report on monitoring systems in Australia stated "…. *there is unlikely to be a single survey design that can provide accurate and precise estimates of recreational catch and effort for all species*." (Beckmann et al., 2019).

Another recent Australian Government report applied a series of criteria to assess different recreational fishing survey methods based on elements of survey design, data quality and cost-effectiveness, with a view to improving national recreational fishing surveys in Australia (Georgeson et al., 2015). We used some of their criteria, and adapted others, and drew on other sources, to identify a selection of 'characteristics' we consider to be indicative of a best practice

system (Table 4). This provided a framework to assess and benchmark existing data collection programs including the current Queensland system. The development of this preliminary framework was also informed by the review of current Australian and international data collection systems and interviews conducted with recreational fishers, during the current project.

Globally and across all Australian jurisdictions, the general approach to surveys of recreational fishing uses off-site surveys as the main approach with many using on-site surveys to complement and validate off-site survey data. A generic approach to developing and conducting off-site surveys is adopted globally (see Appendix 2; Beckmann et al, 2019). This generic approach is also applied across all Australian jurisdictions and many of the best practice characteristics refer to this.

Generally, recreational fishing monitoring programs across Australian meet, or partially meet, almost all of the characteristics with key areas lacking being: sampling frames are often not representative of, or effectively provide access to, the target population; the frequency of surveys are often variable and only conducted every 4 years or more; and, while off-site methods are the most routinely used, the use of on-site methods to provide complementarity and validate data collected is sometimes lacking. Almost all monitoring programs assessed are lacking concerted efforts that maximises public knowledge of the data collection program and relevant resources, or other strategies that help build trust.

### New technology

New and emerging technology has the potential to provide cost-effective alternatives for the collection of recreational fishing data. This potential in increasingly being recognised globally with several tools being trialled and used in formal monitoring programs. All methods of monitoring come with bias and new technologies are no exception. Therefore, while some new tools are being adopted in some places, research is a necessary precursor to their use to understand their biases and to optimise their use. As documented above, Australia is starting to use new technologies in recreational fishing monitoring programs however their use is not widespread (Table 5).

Their limited use in Australia is largely due to the inherent biases in each new method and the need to understand these prior to implementation to ensure their use is an improvement to the system. While research on new technologies continue, here we conducted a preliminary assessment of the potential viability of a range of new technologies for collecting recreational fishing data (Table 6). With further research and development, it can be expected that these new tools and methods will improve over time. Despite this, at least in the short-medium term, the utility of these new and emerging tools will likely be best done in conjunction with other methods to validate and/or augment data collected.

Table 4. An assessment of the Australian and selected international recreational fishing monitoring program examples using a framework of 'best practice' characteristics and how well each jurisdiction meets these characteristics. A detailed description for each characteristic is provided in Table A1 in the Appendices. This framework should be considered preliminary. P = Partial, U = Unknown.

| **Characteristics of a 'best practice' recreational fishing monitoring program** | **Queensland** | **NSW/ACT** | **Northern Territory** | **South Australia** | **Tasmania** | **Victoria** | **Western Australia** | **Australia[1]** | **New Zealand** | **United States** | **United Kingdom** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Sampling frame covers the target population | P | Yes | P | P | P | Yes | P | Yes | Yes | Yes | Yes |
| 2. Survey scope covers the entire jurisdiction | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | No | No | No |
| 3. Sampling is probability based (random) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 4. The frequency of surveys is adequate | P | Yes | No | Yes | Yes | No | Yes | No | Yes | Yes | Yes |
| 5. An estimate of precision (SE) is given | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 6. Mechanisms are in place to maximise response rates and data accuracy (e.g. telephone follow-ups and species identification material) | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 7. The primary sampling unit is well documented | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 8. Strata are well defined, stable and not over-stratified | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 9. The recall period is appropriate | P | Yes | Yes | Yes | Yes | U | Yes | Yes | Yes | P | Yes |
| 10. On-site and off-site methods are used to provide complementarity and value-add to data collected (e.g. to off-size data (convert to weight) | Yes | No | Yes | Yes | No | Yes | Yes | No | Yes[2] | Yes | No |

[1] The latest Australian national recreational fishing survey focused only on social and economic characteristics to avoid duplicating the predominantly catch and effort surveys conducted in all states and territories. See Moore et al (2023).

[2] Provided from a separated/complementary survey – Davey, N., Hartill, B. and Carter, M. (2019). Mean weight estimates for recreational fisheries in 2017-18. New Zealand Fisheries Assessment Report 2019/20.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11. Details of the survey design and statistical methods used are available and accessible | P | Yes[3] | P | Yes[4] | Yes[5] | Yes | Yes | Yes | Yes | Yes | Yes[6] |
| 12. Statistics used are appropriate to the survey design | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 13. Kept and released catch is clearly identified | Yes | Yes | Yes | Yes | Yes | Yes | Yes | NA | Yes | Yes | Yes |
| 14. Weighting adjustments are made for non-response/avidity bias | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No[7] | Yes |
| 15. Monitoring program results are readily accessible | Yes | Yes | P | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 16. An effective strategy is implemented that maximises public knowledge of the data collection program and relevant resources (e.g. results) | P | U | U | U | U | No | U | Yes | Yes | Yes | Yes |
| 17. Strategies are in place that engender trust in the monitoring program | P | U | U | U | U | U | P | Yes | U | No | Yes |

[3] In other reports – See page 18 of multiple references in Murphy et al 2022.

[4] See Lyle, J.M., Wotherspoon, S.J. and Stark, K.E. (2010). Developing an analytical module for large scale recreational fishery data based on phone-diary survey methodology. University of Tasmania. Report. https://hdl.handle.net/102.100.100/504094

[5] See Lyle, J.M., Wotherspoon, S.J. and Stark, K.E. (2010). Developing an analytical module for large scale recreational fishery data based on phone-diary survey methodology. University of Tasmania. Report. https://hdl.handle.net/102.100.100/504094

[6] In separate reports: Hyder, K., Brown, A., Armstrong, M., Bell, B., Bradley, K., Couce, E., Gibson, I., Hardman, F., Harrison, J., Haves, V., Hook, S, Kroese, J., Mellor, G., MacLeod, E., Muench, A., Radford, Z. and Townhill, B. (2020). Participation, catches and economic impact of sea anglers resident in the UK in 2016 & 2017. Cefas, Lowersoft UK. 170pp.

[7] Non-response is accounted for, not avidity.

Table 5. Overview of recent technologies used in Australian jurisdictions as part of their recreational fishing monitoring programs, and the stage of their use.

| Jurisdiction | New and emerging technology used | Stage of use |
|---|---|---|
| **Queensland** | 1. App (voluntary), 2. Remote video cameras | 1. Implemented, 2. Trial underway |
| **Northern Territory** | Not aware of any | n.a. |
| **Western Australia** | 1. Remote video cameras, 2. App (voluntary), 3. Fixed-wing aircraft | 1. Implemented, 2. Research underway, 3. One-off monitoring project (Taylor et al. 2021) |
| **South Australia** | App (mandatory) | Implemented since 2021? |
| **Victoria** | 1. App (mandatory), 2. Remote video cameras | 1. Implemented since 2023, 2. Research underway |
| **Tasmania** | App (mandatory) | Implemented since 2023 |
| **New South Wales/ACT** | Not aware of any | n.a. |

Table 6. A preliminary assessment of selected technologies that may be used for collecting data on recreational fishing activities. For each method we indicate the data they can collect as well as an appraisal of their pros and cons. Sources used are also given.

| Method | Data | Pros | Cons | Sources |
|---|---|---|---|---|
| **Remote video cameras** | Able to collect effort data that can be used to validate and augment catch and effort estimates derived using other methods such as off-site surveys. | • High level data collection<br>• Can assist creel surveys to target peak trip return to maximise fishing interviews<br>• 24-7 coverage (apart from breakdowns)<br>• Improve estimates of effort<br>• Relatively low implementation cost | • Intensive data processing requirements (storage, interpretation & analysis)<br>• High costs of data recording and analyses<br>• Long-term service costs<br>• Might not be able to detect non-fishing trips<br>• Prone to technical faults and power outages<br>• Not useful as a standalone method | FRDC Project 2021-008[8]; Afrifa-Yamoah et al. (2021); Lynch et al. (2020); Dutterer et al. (2020); Steffe et al. (2017); Taylor et al. (2021); Hartill et al. (2019); Wise and Fletcher (2013) |
| **App (mandatory)** | Able to provide data that can complement | • Reduces data collection costs<br>• Automated data entry and analysis | • Deliberate misreporting<br>• Unwillingness to comply | NOAA[9]; Midway et al. (2020); |

[8] https://www.frdc.com.au/project/2021-008
[9] https://www.fisheries.noaa.gov/recreational-fishing-data/recreational-electronic-reporting-glance

| | | | | |
|---|---|---|---|---|
| | and/or validate estimates derived from other surveys | • Can provide accurate data if biases known<br>• Can be paired with other methods to generate accurate data | • Unknown accuracy of the data collected<br>• Unknown representativeness of the data collected<br>• Biases difficult to overcome<br>• Costly to overcome biases<br>• Not useful as a stand-alone method | |
| **App (voluntary)** | Able to provide data that can complement and/or validate estimates derived from other surveys | • Reduces data collection costs<br>• Automated data entry and analysis<br>• Can provide accurate data if biases known<br>• | • Low participation and retention rates<br>• Unknown representativeness of the data collected<br>• Only successful trips may be reported<br>• Biases difficult to overcome<br>• Costly to overcome biases<br>• Not useful as a stand-alone method | Johnston et al. (2022); FRDC Project 2020-056[10]; Midway et al. (2020); Skov et al. (2021) |
| **Drones** | Can provide effort data to validate and/or augment other methods | • Time effective<br>• Improved accuracy and precision of fishing effort<br>• High-resolution permanent data records<br>• Cheaper than fixed-wing aircraft<br>• Post-processing can be automated | • Use and post-processing can be labour intensive<br>• Aviation restrictions<br>• High capital equipment costs<br>• Suitable skill and qualification requirements<br>• Not a replacement for traditional methods | Dalnys et al. (2022); Provost et al. (2020) |
| **Fixed-wing aircraft** | Can provide effort data to validate and/or augment other methods | • Time effective<br>• Objective high-resolution digital records for re-assessment | • Use and port-processing can be labour intensive<br>• Aviation restrictions<br>High capital equipment costs | Taylor et al. (2021) |

[10] https://www.frdc.com.au/project/2020-056

## Queensland recreational fisher survey

### Survey approach

To complement the review of recreational fishing monitoring programs, we also conducted a survey with recreational fishers in Queensland. This was to gather views of recreational fishers to further inform recommendations for future Queensland monitoring program approaches arising from the benchmarking process. Therefore, the goals of the fisher surveys were to seek to understand:

- views about the current approach to collecting recreational fishing data in Queensland and perceptions about how the data are used, identifying any major concerns.
- fisher views on the most important aspects of managing recreational fisheries that should be informed by recreational fishing data, and
- their aspirations for future monitoring approaches.

The project scope limited the number of recreational fishers that could be interviewed, and our approach was to include a cross-section of fishers that covered as much of Queensland as possible as well as including different types of fishers. Fishers were approached by email or telephone based on a list provided by AMCS of peak body representatives and prominent fishers involved in advocacy. This contact list was complemented by contacting additional non-affiliated fishers through the consultant's networks. Interviews were conducted in-person, by telephone or via Zoom using a standardised set of survey questions that included three sections containing multiple choice and ranking questions as well as open-ended questions (see Appendix 3). The three sections were: 1. Fisher history and characteristics; 2. Experience and views on the current Queensland recreational fishing monitoring program; and 3. Views and suggestions for future Queensland monitoring approaches. All interviewees were provided with a project summary and a basic overview of the current Queensland monitoring program prior to being interviewed. Results of these interviews are presented below in summary form and interviewee details have been kept anonymous.

### Survey results

#### Characteristics of interviewees

A total of 14 recreational fishers were interviewed with a geographical spread covering the majority of Queensland. Most were male with 1 female interviewee, with an overall average age of 63 years that, on average, have been fishing for 57 years with their primary method being hook and line (Table 7). There was a diverse mix in terms of their involvement with recreational fishing with representatives of fishing club, various fishing organisations and networks, fishing-related businesses and some with no affiliations. Half of the interviewees are current members of organisations and/or networks that represent recreational fishing in Queensland. Most interviewees fish in estuarine/river areas, followed by coastal/nearshore and reef-based fishing (Table 7). On average the interviewees each went fishing approximately 45 days in the past 12 months.

Table 7. Summary of the characteristics of recreational fishers expressed as a % of the fishers surveyed: primary fishing method, current recreational fishing affiliations (N.B. fishers can have multiple affiliations), and the preferred areas of fishing (primary + secondary preferences).

| **Fishing method (primary)** | | **Affiliation** | | **Fishing area** | **Primary or secondary** |
|---|---|---|---|---|---|
| Hook and line | 86% | Club member | 36% | Estuarine/rivers | 82% |
| Spear | 14% | Organisation/rep* | 50% | Coastal/nearshore | 64% |
| Both | 36% | Fishing business# | 29% | Reef-based | 31% |
| | | Non-affiliated | 29% | Impoundment/freshwater | 16% |
| | | | | Bluewater/offshore | 7% |

*Includes working group and fishing network members.

#Includes charter operators/fishing guides and a fishing school.

## Experience and views on the current Queensland monitoring program

### *Previous experience*

Most of the interviewees (71%) had previously participated in a Queensland recreational fishing survey, and almost all of those were boat ramp surveys. Almost all expressed that they had some familiarity with the current Queensland recreational fishing monitoring program, and there was a relatively even mix of who had accessed or attempted to access recreational fishing data online in Queensland, and of those who had, most (67%) agreed it was relatively accessible while all agreed or strongly agreed it was easy to understand.

### *Views of the current system*

While most of the interviewees (64%) disagreed or strongly disagreed that the current monitoring methods used were suitable for informing management decisions, there were even numbers who agreed or disagreed/strongly disagreed about the suitability of the data collected for informing management decisions. The main reasons given for why the methods were not suitable included that current methods under-represent the best fishers and that fishers lie — this collectively results in data that are inaccurate and not representative. These views may reflect a lack of understanding of the statistical methods used in Queensland recreational fishing surveys that use weighting adjustments for non-response and avidity bias to account for differences in fisher types that provide data.

For the suitability of current data collected, many agreed that catch and effort data was appropriate, however that estimates of these currently generated are inaccurate with too much uncertainty. The other main criticism of data collected was that there was not enough emphasis on the collection of social and economic data.

## Views and suggestions for future Queensland monitoring approaches

### *What data should be collected*

When asked what data should be collected, other than that currently collected, interviewees had a range of suggestions. A common opinion was that data on shark depredation is needed, reflecting this as an increasingly important issue. Many also suggested that more data on social and economic characteristics of the sector are needed. Other suggestions included the collection of data on cultural aspects of fishing, data to inform the calculation of fisher environmental footprints, a distinction between lure, fly or bait fishing and fisher wellbeing.

### *How data should and shouldn't be used*

There were variable responses to these questions, and many interviewees suggested that, as long as the data are robust, all available data should be used to inform management-decision making in Queensland. Similarly, several suggested that data from multiple sources/methods should be used rather than a single set of data. Other comments were that data should be used to inform fish population trends and stock assessments, however others expressed distrust in the accuracy of the data and that they shouldn't be used in stock assessments.

### *Current challenges to recreational fishing data collection in Queensland*

There were two main challenges identified by the interviewees: 1. A lack of trust in government/data collectors, and 2. Obtaining data that is accurate and representative. The lack of trust was strongly expressed by more than half of the interviewees as the single biggest challenge. Other key challenges identified were that the lag period between data collection and the availability of results was far too long, the use of telephone databases as a sampling frame was not representative enough especially with an increasing distrust of people to answer calls of an unknown origin, and also the cost of monitoring.

### *Best methods for collecting accurate data*

The main method that interviewees suggested would collect the most accurate recreational fishing data was using an app. Other suggestions were to use multiple methods simultaneously, to use a fishing licence as a sampling frame, for greater involvement of fishers in the process through a co-management approach and to target the best fishers for data collection. Interviewees also thought new and emerging technologies, such as drones, remote video cameras and satellite imagery, should be explored and used if they improve the monitoring system and data quality.

When asked for suggestions of any other improvements to data collection, responses included:

- To coordinate with other similar programs and integrate data collections where possible and where they value-add (e.g. Infofish, club records).
- Develop and use a recreational fisher register (as opposed to a licence).
- Data need to generate estimates with acceptable levels of uncertainty.
- More focus on social data (e.g. satisfaction, Maximum Experiential Yield - MExY).
- Strategies for improving trust in the monitoring system should be explored.

### *Support for a recreational fishing licence in Queensland*

In the context of providing an improved sampling frame that facilitates the collection of more accurate data on recreational fishing, while also improving the cost-effectiveness of the monitoring program, the level of support was sought for a recreational fishing licence in Queensland. The vast majority (93%) of interviewees were in strong support or supportive with caveats (Figure 8).

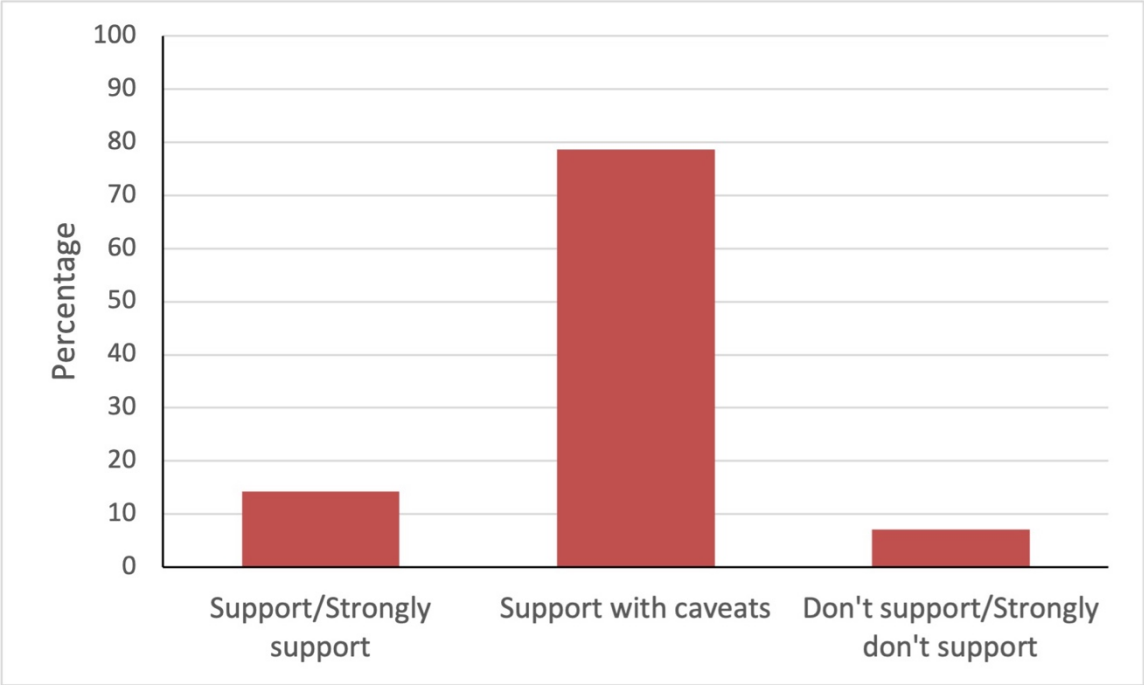


Figure 8. Level of support of interviewees for a recreational fishing licence in Queensland expressed as a percentage of responses (n = 14).

Overwhelmingly the main caveats that interviewees indicated as being important for the introduction of a fishing licence were that any revenue should be used only for enhancing recreational fishing (e.g. fish stocking, FADs, buyout of inshore commercial fishers, boat ramp upgrades, support a representative body, etc.) and should be held in a trust. Further, suggestions indicated that the funds should be managed, and activities implemented using a co-management approach with recreational fishers having an important role in driving decisions. One interviewee also suggested that it should be labelled something other than a "licence" due to the perception that there were polarising views on this across Queensland.

### *Ownership of data collected on recreational fishing*

Most interviewees (64%) agreed or strongly agreed that any data collected from recreational fishers about their fishing belonged to the fishers. Despite this, all interviewees strongly agreed, agreed or agreed with caveats that fisheries managers should be able to freely use recreational fishing data for management purposes. The main caveats identified were that there needs to be quality assurance processes that provides accountability and ensures managers use the data

appropriately, that data used are robust, and that there should be more involvement of recreational fishers in the management processes that use the data.

### *Preferred method for being surveyed*

Fishers were also asked to indicate the top three survey methods they would preferentially participate in, from a provide list. The two methods preferred the most were face-to-face methods at boat ramps and the collection of recreational fishing data using an app (Figure 9).

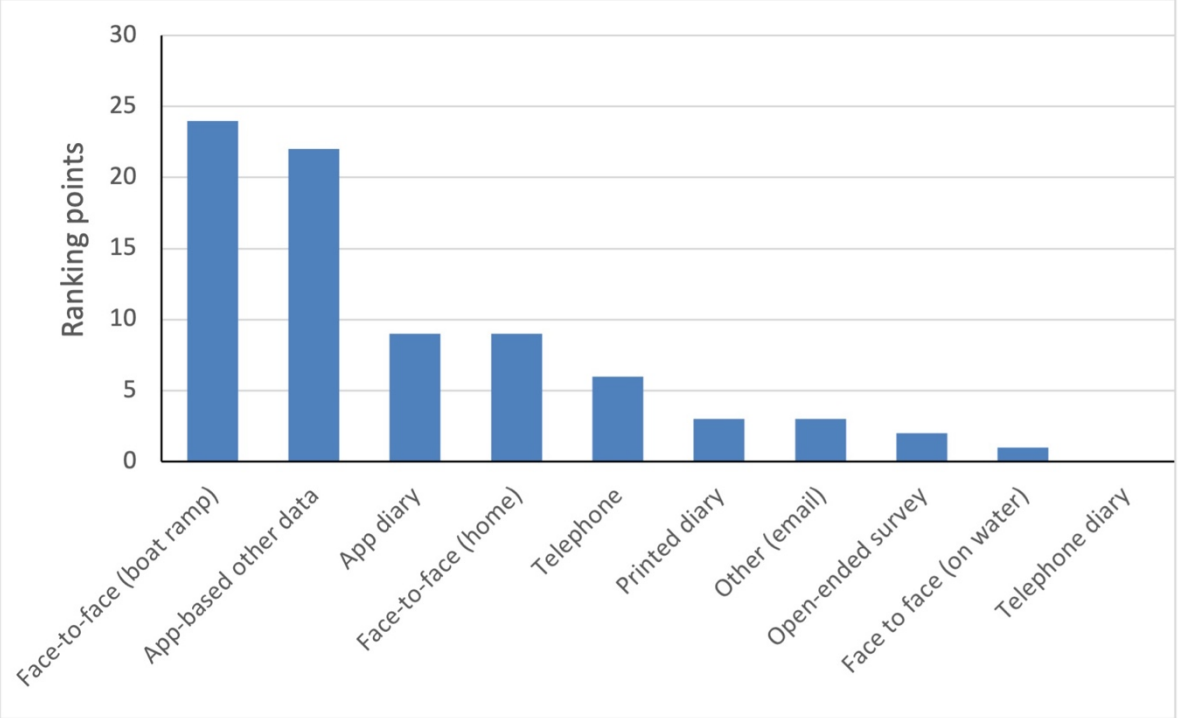


Figure 9: Recreational fishing survey methods and their relative preference for participation as indicated by interviewees. The top three methods in order of preference were provided and are ranked here based on: 3 points for 1st ranking, 2 pts for 2nd ranking, 1 point for 3rd ranking (not all interviewees provided a 3rd ranked method).

## Conclusions

The Queensland recreational fishing monitoring program generally follows approaches used globally and across Australia that are considered as best practice. While a recent Australian study provided criteria that they considered should be part of a best practice system (Georgeson et al. 2015), these criteria and other similar workshop reports mainly consider elements of survey design. We have included specific characteristics that relate to the extent that fishers are involved in the process, largely due to an apparent lack of understanding and awareness of monitoring programs and the extent of distrust by fishers; these characteristics are linked. Although the number of interviewees was low, it was apparent through the fisher interview process that these characteristics may have significant influence on the overall success of all aspects of the

management process, including monitoring programs. In particular, the interviews revealed that even the most experienced, avid and involved fishers have a limited understanding of issues with sampling, statistics, stock assessments and the associated processes, and the use of data for management. Through the inclusion of these fisher 'social' characteristics as part of a best practice monitoring system, we are therefore advocating for continued use of current approaches but with additional inclusion and emphasis on fisher engagement throughout the process.

Based on the review of the Queensland recreational fishing monitoring program using our best practice characteristics, there was a lot that the system is doing well but several areas where there is scope for improvement:

- Sampling frame – the current sampling frame is the best available and uses telephone number databases. The instigation of a state-wide register of recreational fishers, such as a recreational fishing licence, would provide a more accurate and representative sampling frame. At a recent international workshop on recreational fishing surveys held in western Australia, all the states and territories in Australia without a licence system identified this as a major challenge to having a sampling frame that more accurately and cost-effectively accesses the target population (Marks et al., 2020). Future continued use of telephone databases as a sampling frame may be impacted by the increasing threat of fraud and hacking through the use of telephones, potentially meaning increasing non-response rates. The interviews also revealed strong support (with caveats) for a recreational fishing licence in Queensland that would improve the sampling frame.
- Frequency of surveys – while on-site boat ramp surveys are conducted annually the last two off-site SRFS were conducted during 2013-14 and 2019-20. It is not known when the next SRFS will be conducted or of the future intended frequency. It would be useful for QDAF to develop and document a future schedule for the SRFS program; this would demonstrate transparency and enhance trust. Based on the criteria we use here (see Table A1), we recommend that the SRFS should be conducted every 2-4 years as a minimum.
- Recall period - for the 12-month diary program participants are contacted on a schedule based on how often they indicated they went fishing at the start of the program. This reminder to prompt them to enter their fishing data was simply an email or SMS for those participating online, or by telephone for offline participants. Although there are mechanisms in place to increase the frequency and method of contact where logbook activity appears to be slow, this approach makes it possible that recall periods will be variable among participants. Based on the criteria we use here (see Table A1), we recommend that the recall period for reporting catches, as is asked in the diary program, is limited to one month to meet best practice. We acknowledge however that striking a balance between the frequency of reminders and minimising recall bias with not overburdening occasional fishers with too frequent reminders is a major challenge. The current program employs fairly comprehensive processes in establishing this balance (see Section 3; Misson et al, 2020).
- Survey design and statistical methods – details of the survey design are well documented in multiple reports however, apart from weighting methods, the statistical methods used to analyse the data and derive estimates were lacking detail (see Teixeira et al., 2020).

Responses from interviews suggested a lack of knowledge of statistical approaches and their rationale, which is to be expected given the technical nature. Despite this, making available greater detail in the statistical methods to derive estimates, in a simple user-friendly form would likely further demonstrate transparency and enhance trust (see below).

- Strategy to maximises public knowledge of the program – Queensland has produced numerous reports explaining the program and methods, with some resources online that help with an overview of the program (e.g. online video, data dashboards). However, the reports several in number and are duplicative without a single resource that provides a layperson's explanation. Further, while from a limited sample size, the interviews conducted with recreational fishers during this project suggested a lack of knowledge of the monitoring program and the available resources. Importantly, the apparent lack of knowledge, understanding and awareness of elements of the Queensland monitoring program are a significant source of distrust in the program itself (see below).
- Strategies to improve trust in the monitoring program – while many recreational fishers sit on government-led working groups as representatives with the opportunity for input into management processes and are exposed to elements of the recreational fishing monitoring program (e.g. receiving results), there are no mechanisms that explicitly involve them in the program steps nor input into these. Further, direct engagement is challenged by there being no single unified peak body in Queensland. Trust emerged as the biggest challenge during the fisher interviews conducted during this project. It was also acknowledged that trust is needed but solutions require a long-term outlook. Maintaining the involvement of recreational fishers on working groups and committees and exploring mechanisms that involve representatives and the sector more generally throughout the process, are strategies that are likely to help improve trust. However, we suggest that a more comprehensive and inclusive consultation process that includes fisher interviews and workshops, and with a longer-term outlook, is needed to best identify and develop strategies that will help improve trust.
- Use of new and emerging technology – the exploration and use of new and emerging technologies for collection recreational fishing data is relatively young, even globally. This is also the case within Australia with Western Australia leading the way, although Queensland has become relatively active in this space in recent times. Despite this, there are several limitations in the use of currently available options, in particular biases that are difficult to quantify and therefore correct, as well as low participation and reporting bias for tools such as apps. These limitations are likely to improve as more research is done and trials are conducted, however, in the short-medium term, the utility of these new and emerging tools will likely be best done in conjunction with other methods to validate and/or augment data collected.
- While this project was limited in scope due to limited time, we believe the scale of the topic, along with insights and interest from the current project, calls for a scaled-up Queensland-wide project. Larger scale efforts have been adopted through projects and/or workshops at the national and state-level in Australia (e.g. Georgeson et al., 2015; Beckmann et al., 2019; Marks et al., 2020). Such a project should include activities that involve strong engagement

with recreational fishers (e.g. interviews, workshops), and generates a forward-looking strategy for monitoring recreational fishing in Queensland that ensures best practice is continued, and could include: a review of a Queensland fishing licence or register, drawing on lessons learned elsewhere (e.g., NSW, Vic and WA); more involvement of recreational fishers in monitoring processes; discussion for moving towards a single unified representative body, with lessons from elsewhere (e.g., RecfishWest); and exploration of effective strategies for improving fisher trust. Further, the use of new and emerging technologies that provide cost-efficient improvements in data collection should be explored and adopted where possible.

## References


Afrifa-Yamoah, E., Taylor, S. M., & Mueller, U. (2021). Trade-off assessments between reading cost and accuracy measures for digital camera monitoring of recreational boating effort. Fisheries Research, 233, 105757.

BDO (2021) Economic contribution of recreational fishing by Queenslanders to Queensland: A Report to Queensland Fisheries. Prepared by BDO, Brisbane, Queensland, Australia. 86pp.

Beckmann, C.L., Tracey, S., Murphy, J., Moore, A., Cleary, B. and Steer, M. (2019) Assessing new technologies and techniques that could improve the cost-effectiveness and robustness of recreational fishing surveys. Proceedings of the national workshop, SARDI, Adelaide, South Australia. 54p.

Beckmann, C.L., Darante, L.M., Graba-Landry, A., Stark, K.E. and Tracey, S.R. (2023). Survey of Recreational Fishing in South Australia 2021-22. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Insitute (Aquatic Sciences), Adelaide. SARDI Publication No. F2022/000385-1 SARDI Research Report Series No. 11691. 185pp.

Bell, J. D., Ingram, B. A., Gorfine, H. K. & Conron, S. D. (2022). Review of key Victorian fish stocks — 2021. Victorian Fisheries Authority Science Report Series No. 29. Victorian Fisheries Authority.

Conron, S., Bridge, N., Oliveiro, P. and Bruce, T. 2012, Angler diary monitoring of recreational fishing in selected Victorian waters during 2010–11, Recreational Fishing Grant Program Research Report R/09/10/04

Conron, S. and Bridge, N. 2004, Voluntary Angler Diary Program in Victoria 1997- 2003, Marine and Freshwater Systems Internal Report No.15, Fisheries Victoria, Queenscliff, Victoria.

Dutterer, A.C., Dotson, J.R., Thompson, B.C., Paxton, C.J. and Pouder, W.F. (2020), Estimating Recreational Fishing Effort Using Autonomous Cameras at Boat Ramps versus Creel Surveys. North Am J Fish Manage, 40: 1367-1378. https://doi.org/10.1002/nafm.10490

Georgeson, L, Moore, A, Ward, P, Stenekes, N, Kancans, R, Mazur, K, Curtotti, R Tracey, S, Lyle, J, Hansen, S, Chambers, M, Finn, M and Stobutzki, I (2015) A framework for regular national recreational fishing surveys, ABARES, Canberra, November. CC BY 3.0.

Green, C., P. Brown, K. Giri, J. Bell and S. Conron (2012). Quantifying the recreational catch of southern bluefin tuna off the Victorian coast., Department of Primary Industries, Victoria, Recreational Fishing Grant Program - Research Report, 29pp.

Hartill, B.W., Taylor, S.M., Keller, K. and Welterbach, M.S. (2020) Digital camera monitoring of recreational fishing effort: Applications and challenges. Fish and Fisheries, Vol. 21(1): 204-215. https://doi.org/10.1111/faf.12413

Hongguang, M. and Ogawa, T.K. (2016). Hawaii Marine Recreational Fishing Survey : a summary of current sampling, estimation and data analyses. http://doi.org/10.7289/V5/TM-PIFSC-55

Hyder, K., Brown, A., Armstrong, M., Bell, B.,Hook, S., Kroese, J. and Radford, Z. (2021). Participation, effort, and catches of sea anglers resident in the UK in 2018 & 2019. Centre for Environment Fisheries and Aquaculture Science.

Hyder, K., Brown, A., Bell, B., Bradley, K., Edwards, W., Hook, S., Mills, R., Kroese, J. and Radford, Z. (2024). Participation, effort, catches, and impact of COVID-19 of sea anglers resident in the UK in 2016-21. Centre for Environment Fisheries and Aquaculture Science.

Johnston, F.D., Simmons, S., van Poorten, B. and Venturelli, P. (2022) Comparative analyses with conventional surveys reveal the potential for an angler app to contribute to recreational fisheries monitoring. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 79, Number 1. https://doi.org/10.1139/cjfas-2021-0026

Lyle, J.M., Tracey, S.R. Stark, K.E. and Wotherspoon, S. (2009). 2007-08 survey of recreational fishing in Tasmania. Tasmanian Aquaculture and Fisheries Institute Report, 97p.

Lyle, J.M., Stark, K.E. and Tracey, S.R. (2014). 2012-13 survey of recreational fishing in Tasmania. Institute for Marine and Antarctic Studies Report, 128p.

Lyle, J.M., Stark, K.E., Ewing, G.P. and Tracey, S.R. (2019). 2017-18 survey of recreational fishing in Tasmania. Institute for Marine and Antarctic Studies Report, 128p.

Lynch, T.P., Foster, S., Devine, C., Hegarty, A., McEnnulty, F., Burton, M. and Lyle, J.M. (2020). Trail camera video systems: investigating their utility in interpreting patterns of marine, recreational, trailer-boat fishers' access to an offshore Marine Park in differing weather conditions, *ICES Journal of Marine Science*, Volume 77, Issue 7-8, December 2020, Pages 3110–3126, https://doi.org/10.1093/icesjms/fsaa209

Ma, H. and Ogawa, T. (2016). Hawaii Marine Recreational Fishing Survey: A Summary of Current Sampling, Estimation, and Data Analyses. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-55, 43p.

Marks, R., Desfosses, C. and Tate, A. (2020) International Workshop on Recreational Fishing Surveys. Fisheries Research Report No. 300 Department of Primary Industries and Regional Development, Western Australia. 52pp.

Moore, A, Schirmer, J, Magnusson, A, Keller, K, Hinten, G, Galeano, D, Woodhams, J, Wright, D, Maloney, L, FRDC, ABARES, UC, 2023, National Social and Economic Survey of Recreational Fishers 2018-2021, February. CC BY 3.0.

Midway, S.R., Adriance, J., Banks, P., Haukebo, S. and Caffey, R. (2020) Electronic Self-Reporting: Angler attitudes and behaviors in the recreational red snapper fishery. North American Journal of Fisheries Management, Vol. 40(5): 1119-1132. https://doi.org/10.1002/nafm.10472

Misson, S., Phillips, B., Rawding, C. and Siow, E. (2020). Statewide recreational fishing survey 2019-20: Methodological report. Report prepared for the Queensland Department of Agriculture and Fisheries, by The Social Research Centre, Melbourne, Australia. July 2020. 43pp.

Murphy, J. J., Ochwada-Doyle, F. A., West, L. D., Stark, K. E., and Hughes, J. M., 2020. Survey of recreational fishing in NSW, 2017/18. NSW Department of Primary Industries, Nelson Bay, Fisheries Final Report Series No. 158. 221p.

Murphy, J. J., Ochwada-Doyle, F. A., West, L. D., Stark, K. E., Hughes, J. M., Taylor, M.D. (2023). Fisheries Final Report Series | No. 161 Survey of recreational fishing in NSW, 2019/20 – Key Results. NSW DPI – Fisheries Final Report Series No. 161. NSW Department of Primary Industries.

National Marine Fisheries Service Office of Science and Technology. 2023. Marine Recreational Information Program Survey Design and Statistical Methods for Estimation of Recreational Fisheries Catch and Effort. Silver Spring, MD

Provost, E.J., Butcher, P.A., Coleman, M.A. and Kelaher, B.P. (2020) Assessing the viability of small aerial drones to quantify recreational fishers. Fisheries Management and Ecology, 27: 615–621. https://doi.org/10.1111/fme.12452

Ryan, K., Morison, A. and Conron, S. 2009, Evaluating methods of obtaining total catch estimates for individual Victorian bay and inlet recreational fisheries, Final report to Fisheries Research and Development Corporation, Project No. 2003/047

Skov, C., Kieran Hyder, Casper Gundelund, Anssi Ahvonen, Jérôme Baudrier, Trude Borch, Sara deCarvalho, Karim Erzini, Keno Ferter, Fabio Grati, et al. (2021) Expert opinion on using angler Smartphone apps to inform marine fisheries management: status, prospects, and needs. ICES Journal of Marine Science, Volume 78 (3): 967–978, https://doi.org/10.1093/icesjms/fsaa243

Steffe AS, Taylor SM, Blight SJ, Ryan KL, Desfosses C, Tate AC, Smallwood CB, Lai EK, Trinnie FI, Wise BS (2017). Framework for Integration of Data from Remotely Operated Cameras into Recreational Fishery Assessments in Western Australia. Fisheries Research Report No. 286, Department of Primary Industries and Regional Development, Western Australia. 36pp.

Tate, A.C., Rudd, L.J., and Smallwood, C.B. (2022) Shore-based recreational fishing in the Perth Metropolitan area: 2022. Fisheries Research Report No. 326 Department of Primary Industries and Regional Development, Western Australia. 53pp.

Taylor, S.M., Smallwood, C.B., Desfosses, C.J., Ryan, K.L. and Jackson, G. (2021) Corroborating catch estimates to inform monitoring of a small-scale marine recreational fishery in a World Heritage property. ICES Journal of Marine Science, Volume 78, Issue 5, August 2021, Pages 1887–1899, https://doi.org/10.1093/icesjms/fsab095

Teixeira, D., Janes, R. and Webley, J. (2020) 2019–20 statewide recreational fishing survey: key results. Fisheries Queensland, Department of Agriculture and Fisheries, Brisbane, Queensland. 18pp.

West, L.D., Stark, K.E., Dysart, K and Lyle, J.M. (2022) Survey of recreational fishing in the Northern Territory: 2018 to 2019. Northern Territory Fisheries, Department of Industry, Tourism and Trade, Darwin, Northern Territory. 112pp.

Wise, B.S. and Fletcher, W.J. (2013) Determination and development of cost-effective techniques to monitor recreational catch and effort in Western Australian demersal finfish fisheries. Final Report for FRDC Project 2005/034 and WAMSI Subproject 4.4.3. Fisheries Research Report No. 245. Department of Fisheries, Western Australia. 168pp.

Wynne-Jones, J.; Gray, A.; Heinemann, A.; Hill, L; Walton, L. (2019). National Panel Survey of Marine Recreational Fishers 2017–2018. New Zealand Fisheries Assessment Report 2019/24. 104 p.

# Appendices

## Appendix 1

Table A1. Descriptions of the 'best practice' characteristics used as a framework to assess and compare Australian and selected international recreational fishing data collection programs. Adapted from: Georgeson et al. (2015).

| 'Best practice' characteristics | Description |
|---|---|
| 1. Sampling frame covers the target population | **Yes** = The sampling frame fully covers all sectors contributing to the total catch. **Partial** = The sampling frame covers most of the target population, but there are some exceptions, e.g. non-complete coverage of target population due to missing or non-listed phone numbers. An example is a telephone survey that does not cover people that do not own (or are not listed) in the directories/databases used to select samples. Some surveys use face-to-face sampling in addition to the telephone method to quantify the proportion of people not listed. In this case the response to this question would be 'yes'. **No** = The sample frame does not fully cover the target population. **Unknown** = It is not clear in the referenced literature if the target population is fully covered. |
| 2. Survey scope covers the entire jurisdiction | **Yes** = The survey is collecting information defined in the project objectives at a jurisdictional level, this may include, participation demographics, effort, catch, expenditure, etc. **Partial** = At least some of the information listed above is collected at a jurisdictional level, but some other information may be collected from a smaller spatial scope. **No** = The survey was not designed to collect data at a jurisdictional level, often these surveys are designed to collect information from a large region of interest. |
| 3. Sampling is probability based (random) | **Yes** = Sample selection is randomly stratified from the target population, providing data suitable for expansion to the total population and calculation of precision. **No** = The sample selection is not randomised. |
| 4. The frequency of surveys is adequate | This will be dependent on local capacity and resourcing that balances the need for timely provision and update of data to inform management. The current description applies to the Australian context. **Yes** = On-site surveys are conducted every 1-2 years and larger-scale off-site surveys are conducted every 2-4 years. **Partial** = On-site surveys are conducted every 1-3 years and larger-scale off-site surveys are conducted every 4-6 years. **No** = On-site surveys are conducted less frequently than every 3 years or not conducted and the frequency of off-site surveys is > 6 years or not at all. |
| 5. An estimate of precision (SE) is given | **Yes** = The referenced literature reports some form of appropriate precision metric for the expanded estimates. **No** = There is no reporting of precision estimates in the referenced literature. |
| 6. Mechanisms are in place to maximise response rates and data | **Yes** = Jurisdictions that have few target species and/or species are well known, or that, where applicable, species data is pooled to higher taxa to minimize potential misidentification, or that species identification |

| | |
|---|---|
| accuracy (e.g. telephone follow-ups and species identification material) | materials are provided. Or where catch was determined solely by an onsite survey conducted by trained interviewers. For telephone-based surveys repeated efforts are made to follow-up on non-responses and for telephone diaries repeated and regular (at least monthly for a 12-month diary) contact by data collectors is maintained. **Partial** = Species identification materials are provided. Or where catch was determined solely by an onsite survey conducted by trained interviewers. For telephone-based surveys some repeated efforts are made to follow-up on non-responses and for telephone diaries repeated and regular (every 6 months) contact by data collectors is maintained. **No** = None of the above mechanisms are in place or it is not clear if they are. |
| 7. The primary sampling unit is well documented | **Yes** = the primary sampling unit (PSU) is either obvious or documented in the survey methodology. **No** = It is not clear what the PSU was and it is not documented in the referenced report. |
| 8. Strata are well defined, stable and not over-stratified | **Yes** = The strata are either well defined in the referenced literature or obvious in the survey methodology. It was also a requirement of this category that the strata were not too numerous (over-stratified), leading to issues with precision. **No** = It is not clear what the strata were, or they were over-stratified. |
| 9. The recall period is appropriate | This is dependent on the information requested and the approach used. **Yes** = If the respondent is reporting catch, a 1-month recall period is considered acceptable, if they are reporting days (effort) 2-months is considered acceptable, if they are reporting participation (e.g. did you fish) and/or expenditure a 6-month recall is considered acceptable. **Partial** = 2-month recall for catch, 6-month for effort, 6-month for expenditure, 12-month for participation. Where recall periods may be variable for different data, they are assumed as partially having the characteristic. **No** = >2-month recall for catch, >6-month for effort, >6-month for expenditure, >12-month for participation. |
| 10. On-site and off-site methods are used to provide complementarity and value-add to data collected (e.g. to off-size data (convert to weight) | **Yes** = Both on-site and off-site methods are used to collect data that provides more complete information and/or to validate relevant data. For example, off-site methods often collect catch estimates in numbers only and on-site methods can collect size data that facilitates the estimation of catch by weight, making the data more comparable with the commercial sector. Also, off-site methods rely on a respondents recall of catch data and their ability to identify species while on-site methods can collect more accurate data that can be compared with off-site data. **No** = Only a single type of method is used or, where multiple types are used, data are not used to provide more complete and/or accurate information. |
| 11. Details of the survey design and statistical methods used are available and accessible | **Yes** = A comprehensive and user-friendly description that explains the survey design, statistical methods used and transparently documents their rationale, is documented and readily accessible. **Partial** = The survey design and statistical methods are documented and accessible but have insufficient detail. **No** = The survey design and statistical methods used are not documented or it is unknown if they are documented. |
| 12. Statistics used are appropriate to the survey design | **Yes** = A statistical method is applied and is appropriate to the survey design. **No** = The statistical design is inappropriate for the survey design. **Unknown** = There is insufficient information in the referenced literature to determine if the analysis is appropriate for the survey design. |

| | |
|---|---|
| 13. Kept and released catch is clearly identified | **Yes** = Catch data collected includes whether it was landed catch or released. **No** = Catch data collected does not discriminate between landed and released, or it is not clear if it does. |
| 14. Weighting adjustments are made for non-response/avidity bias | **Yes** = non-response and avidity bias have been estimated and weighting adjustments made, or the biases are fairly reported as not to be of a magnitude that require adjustment. **No** = non-response and avidity bias is likely to have occurred and either has not been reported or no adjustments are made. |
| 15. Monitoring program results are readily accessible | **Yes** = monitoring results are made available publicly through readily accessed published reports and/or on-line dashboards. **No** = results are not made publicly available or are difficult to access. |
| 16. Effective strategies are implemented that maximise public knowledge of the data collection program and relevant resources (e.g. results) | The use of fisher surveys may be required to accurately assess this. **Yes** = Extension strategies are implemented that provide education and awareness of monitoring, the methods used, the results and how they can be accessed, and there is evidence they are effective. **Partial** = Strategies are used that provide some education and/or awareness of monitoring, the methods used, the results and how they can be accessed, however these are incomplete and or only likely to be partially effective, or there is evidence they are partially effective. **No** = Limited or no effort is made that educates and raises awareness about the monitoring program. **Unknown** = No evidence of any strategies in place. |
| 17. Strategies are in place that engender trust in the monitoring program | This 'characteristic' will be more effectively achieved with achievement of some related characteristics (e.g. #18 and #19). **Yes** = Strategies are in place that effectively build and/or maintain trust between fishers and data collection actors. These may include using a co-management approach or at least involving fishers in the different stages of the monitoring program (design, data collection, analysis and reporting) through strong communication and engagement. All relevant recreational fishing 'sectors' are explicitly included (e.g. peak bodies, regional organisations, clubs, individual non-affiliated fishers). This may also include the use data collectors who are independent of the implementing management agency. **Partial** = Some of the above strategies are utilized to some extent but are likely to have partial or limited effectiveness in establishing trust. **No** = No strategies are in place that are designed to, or likely to result in, improve trust between fishers and data collectors. **Unknown** = No evidence of any strategies in place. |

## Appendix 2

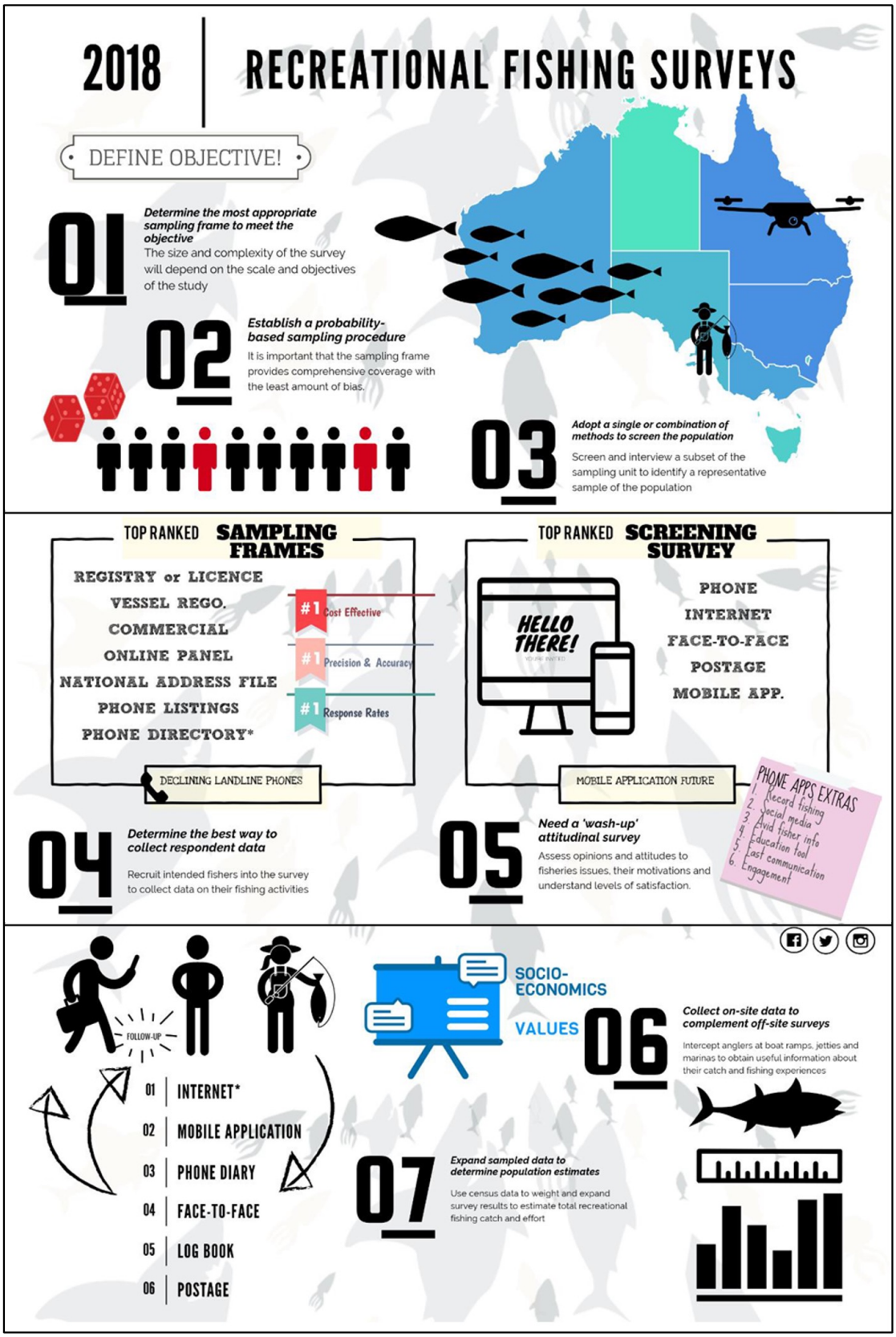


Figure A1: The generic approach to developing and conducting off-site surveys and applied across all Australian jurisdictions. Source: Beckmann et al. (2019).

# Appendix 3

## Interview form used for surveys with Queensland recreational fishers

**Queensland Recreational Fisher Survey Form:**
**Recreational fishing data collection and monitoring**

| Date: | Time: | Interviewer: | ID: |
|---|---|---|---|

SURVEY GOALS:

- seek to understand views about the current approach to collecting recreational fishing data in Queensland and perceptions about how the data are used, identifying any major concerns.
- understand fisher aspirations on the most important aspects of managing recreational fisheries that should be informed by recreational fishing data, and how.
- Perceptions and views will also be sought on data ownership, what they see as the major barriers and suggested future data and/or approaches, including new technology.

---

**1. FISHER HISTORY AND CHARACTERISTICS**

***First, we just need a few details about you and your fishing:***

1) a) Are you based in Queensland? _____

b) What is your age? _____ years

c) How long have you been fishing? _____ years

2) Are you a (tick all applicable boxes):
- ☐ line fisher
- ☐ spear fisher
- ☐ fishing club member
- ☐ tackle shop owner/operator
- ☐ fishing charter operator/fishing guide
- ☐ fishing organisation member (please name) _____
- ☐ Other _____

3) What type of fishing do you engage in most (TOP 3):
- ☐ impoundments/freshwater
- ☐ estuarine/rivers
- ☐ coastal/nearshore
- ☐ reef-based
- ☐ bluewater/offshore

4) Approximately how many DAYS did you fish in the previous 12 months?

_____

---

**2. EXPERIENCE AND VIEWS ON THE CURRENT QUEENSLAND RECEREATIONAL FISHING MONITORING PROGRAM**

***Now I'd like to understand your knowledge of and experience with the current approach to monitoring recreational fishing in Queensland:***

*The current Queensland recreational fishing monitoring program uses two main methods:*

*i. Boat ramp surveys (on-site method), and*

*ii. Statewide recreational fishing survey (SRFS) (off-site method).*

*Both methods are statewide in spatial coverage and the 2nd component includes telephone surveys complemented by a 12-month fishing diary program. Collectively these methods provide data on recreational catch (species, # caught,*

*kept, released, lengths), effort (location, duration, how many, methods) and some social and economic characteristics. Boat ramp surveys are conducted every year while the phone and diary surveys are done every few years.*

5) Have you ever participated in a Queensland recreational fishing survey?
   ☐ Yes
   ☐ No

6) How familiar are you with the current recreational fishing monitoring program in Queensland?

| Very familiar | Somewhat familiar | Not familiar | Unsure |
|---|---|---|---|
| | | | |

7) Have you ever accessed/attempted to access Queensland recreational fishing survey results?
   ☐ Yes
   ☐ No

If yes,

a) Did you find the information readily accessible?

| Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Unsure |
|---|---|---|---|---|---|
| | | | | | |

b) Did you find the information easy to understand?

| Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Unsure |
|---|---|---|---|---|---|
| | | | | | |

8) The current monitoring primary methods used in Queensland are a combination of telephone surveys, a 12-month fishing diary and boat ramp surveys. Do you think the methods used in the current Queensland recreational fishing monitoring program are suitable for informing management decisions about recreational fishing in Queensland?

| Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Unsure |
|---|---|---|---|---|---|
| | | | | | |

*Why/Why not?*

_____
_____
_____
_____
_____
_____

9) The primary data currently collected on recreational catch includes catch (species, # caught, kept, released, lengths), effort (location, duration, how many, methods) and some social and economic characteristics. Do you think the data collected in the current Queensland recreational fishing monitoring program are suitable for informing management decisions about recreational fishing in Queensland?

| Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Unsure |
|---|---|---|---|---|---|
| | | | | | |

*Why/Why not?*

_____
_____
_____
_____
_____
_____

## 3. VIEWS AND SUGGESTIONS FOR FUTURE QUEENSLAND MONITORING APPROACHES

10) What data do you think should be collected on recreational fishing in Queensland, and why?

_____

_____
_____
_____
_____
_____
_____

11) How do you think data collected on recreational fishing in Queensland should be used in management-decision making?

_____
_____
_____
_____
_____

12) How do you think data collected on recreational fishing in Queensland should not be used in management-decision making?

_____
_____
_____
_____
_____

13) What do you think are the current challenges to the collection of recreational fishing data in Queensland?

_____
_____
_____
_____
_____

14) What do you think are the best methods to collect accurate recreational fishing data in Queensland (e.g. diaries, voluntary or mandatory app-based reporting, drones, etc.)?

_____
_____
_____
_____
_____

15) What other improvements would you like to see in the Queensland recreational fishing monitoring approach?

_____
_____
_____
_____
_____

16) One of the biggest challenges for monitoring recreational fishing is obtaining data that is representative of the entire recreational fishing population. A recreational fishing licence system could facilitate the collection of more accurate data while also being more cost-effective. What would best describe your level of support for a recreational fishing licence in Queensland?

| Strongly support | Moderately support | Support with caveats | Don't support | Strongly don't support |
|---|---|---|---|---|
| | | | | |

If 'Support with caveats', list them:

_____
_____
_____
_____
_____

17) Some other jurisdictions are using fishing licences, voluntary app-based reporting, drones and remote video cameras to collect a recreational fishing data, including a current trial of video cameras at boat ramps in Queensland. What are your thoughts on using these types of approaches in Queensland?

_____
_____

_____
_____
_____

18) To what extent do you agree with the following statements:
    a) Ownership of data collected from recreational fishers about their fishing activity belongs to recreational fishers.

| Strongly agree | Agree | Agree with caveats | Disagree | Strongly disagree | Unsure |
|---|---|---|---|---|---|
| | | | | | |

    b) Fisheries managers should be able to freely use recreational fishing data for management purposes.

| Strongly agree | Agree | Agree with caveats | Disagree | Strongly disagree | Unsure |
|---|---|---|---|---|---|
| | | | | | |

*Any further comments about data ownership:*

_____
_____
_____
_____

19) Which survey methods would you be most willing to participate in (number in order of preference the TOP THREE):

☐ Telephone
☐ Telephone diary
☐ Printed diary
☐ App diary
☐ App-based
☐ Face-to-face (at home)
☐ Face-to-face (boat ramp)
☐ Other_____

**Any other issues**

*Is there anything else you would like to comment on about recreational fishing data monitoring in Queensland?*

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

***Many thanks for your time and information.***


C2O Fisheries
Coasts | Climate | Oceans