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Review of self-reporting tools for recreational fishers

New Zealand Fisheries Assessment Report 2016/06

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Most of the data used to inform fisheries management has been derived from either quantitative surveys or from statutory catch effort returns that all commercial fishers are required to submit. Recreational fishers offer another potential source of information, and while many record or self-report aspects of their fishing activity, there is no compulsion to do so.

This report provides a review of existing and developing tools and approaches that recreational fishers can and do use to self-report their fishing activity and catch. Existing, developing and potential reporting tools that are reviewed include: a competition creel survey conducted by the Hawke's Bay Sport Fishing Club, competition records provided by the Pania Surf Casting Club, club and interclub competition weigh in records, a billfish logbook scheme, the New Zealand Cooperative Gamefish Tagging programme, the West Australian Research Angler Programme, Australia's Range Extension database and Mapping project, smartphone apps, the use of fishfinders and GPS plotters as electronic hubs, smart watches, and commercial competition data. Although this review is not exhaustive, it covers a diverse range of initiatives and technologies that recreational fishers have used to record information. We have highlighted issues that should be considered if such data are to be used by fisheries managers. We note that some of the data sources we review have already been used by fisheries management, specifically in relation to gamefish fisheries. Others data sources have the potential to provide useful information if relatively simple changes are made to current methods.

Current and future recreational self-reporting tools can take a wide variety of forms depending on: the purpose for which data are collected; the support and resourcing available to support any initiative; and the technology used to collect and store any data that is provided.

The development of a general approach to evaluating the diverse range of existing self-reporting tools considered here (and those that may emerge in the future) is problematic. Universally applicable prescriptive protocols are likely to lack sufficient specificity in all contexts and two alternative evaluation approaches are proposed. The first of these is a checklist of Critical Success Factors that can be used to evaluate the extent to which the self-reported information provides key and relevant information. An alternative and perhaps more rigorous evaluation procedure that we recommend is to directly compare self-reported data with that collected concurrently and independently by traditional and accepted scientific onsite survey methods.

Two comparative test scenarios are described here. The first of these is a direct comparison of catch per trip data currently collected by a fishing club in Hawke's Bay with that provided by a creel survey currently conducted by NIWA at the same club boat ramp. The second scenario describes a design driven approach, whereby club members and researchers jointly design a self-reporting tool which is used over the following year, alongside a creel survey conducted by an experienced research provider at the same club ramp.

We recommend that any data that are self-reported by fishers should be provided in an electronic format accessible via a standardised Application Programming Interface (API), such as that developed and described in this report. The development of a recreational catch API can assist in the solution of two goals: improving the quality of data collected by non-government programmes so that it is more useful for scientific purposes, and facilitating an engagement strategy allowing MPI to support community based recreational fishing groups. A prototype API has therefore been developed as part of this programme.

OBJECTIVES

This project has four objectives:

1. To document the range of potential existing tools available for self-reporting by recreational fishers.
2. To identify and document the range of potential developing and near-future tools for self-reporting by recreational fishers.
3. To evaluate the tools identified in specific objectives one and two above against agreed critical success factors.
4. To design robust protocols to pilot test the most promising tools identified in the evaluation in specific objective three above.

1. INTRODUCTION

Most of the data used to inform the management of New Zealand's inshore fisheries comes from either research commissioned by the Ministry for Primary Industries (MPI) or from commercial fishers who are required to complete statutory fishing returns. Research data provided to MPI must meet the Research and Science Information Standard for New Zealand Fisheries (Ministry of Fisheries 2011), and analyses are peer reviewed through a formal working group process.

Research data are usually collected by researchers or fishery independent observers. They follow scientific sampling methods that have been designed to provide a statistical sample that can be used to describe wider fishery processes and states. This allows for both the magnitude of effects and the associated statistical uncertainly to be adequately described.

Commercial fishers also provide important information to help manage fisheries, via statutory catch and effort reporting. Their reports provide a near complete description of both the level of fishing effort and subsequent harvest. Commercial catch/effort data are self-reported and can be prone to human and other recording errors. There is, however, an extensive and integrated compliance and audit system in place that largely ensures the veracity of these data. This is backed by a schedule of penalties that non-compliant fishers risk if they are found to misreport.

Recreational fishers offer another potential source of data that could be used to inform fisheries management. Many recreational fishers or fishing clubs keep records for their own purposes, but there has been no compulsion for them to record their effort and catch, and those who choose to do so are self-selecting and may not represent the wider fishery.

Although recreational self-selecting self-reporting programmes could potentially provide valuable information, uncertainty around representativeness and scaling mean that this information should be used to augment rather than replace existing data sources. In particular, recreational fishers may be able to provide information that is otherwise difficult or expensive to obtain by formal research surveys – especially if recreational reporting systems are well designed from the outset.

Examples where recreational fishers could potentially provide new or improved insights are:

- Providing longitudinal fisher specific catch-per-unit (CPUE) data. This would allow relative standardised indices to be developed that take the fisher effect into account – similar to the vessel effect that typically explains much of the resolvable variance associated with commercial CPUE data;
- Helping to characterise shore-based recreational fisheries and shellfish species (such as rock lobster and paua) that are difficult to survey cost effectively;

- Providing biological information (e.g., length-weight data from club weigh-ins). This may allow the collection and updating of biological data that is not currently available for many inshore fish species;
- Providing insights into the nature and distribution of recreational catch and effort that that could be used to inform the design of a formal research survey of a given fishery.

The development of self-reporting systems (and the generation of regular standardised reports back to individuals or fishing communities) has several potential benefits. The recreational fishing community has often been sceptical about the information used to manage their fishery, because they have not participated in the data collection process, or because they do not fully understand how research surveys are conducted. The development of a stakeholder driven data collection processes could lead to a greater engagement in the data collection process, and an understanding of the rigor with which data should be collected. If sufficient and rigorous data are provided by fishers, they will also be able to directly compare their documented experiences (and those of their fishing community) with trend data provided independently by existing research surveys, which may result in greater confidence in the latter.

The purpose of this study was to explore, review and evaluate existing and potential self-reporting tools for self-selecting fishers, explore how the data they provide could be used to inform fisheries management, and to propose protocols that could be used to evaluate the utility of any such data.

2. REVIEW OF EXISTING SELF-REPORTING TOOLS AND INITIATIVES

Individual anglers and groups of fishers often keep records of their catch for their own interest or for competition purposes. But the availability and utility of these data is often unknown or overlooked by fisheries managers. Early recreational angler records were kept on paper. Therefore these are often less discoverable and accessible than other information sources, such as research provider and commercial catch effort data which have to be routinely entered into structured and maintained databases for immediate and future use.

Recreational fishers are not required to keep records of catch or effort. This means that very few self-reported data have been collected, often in a disparate and *ad hoc* fashion, and with limited thought given to how these data might be used by others. This situation is gradually changing, as more sophisticated and commonly used electronic platforms become available to fishers and clubs. To some extent the increasing availability and range of electronic platforms has coincided with a growing recognition by recreational stakeholders of the value of self-reported data and how it can be used to demonstrate the value and changing state of their fisheries. Although sophisticated technologies offer a seductive means of rapidly capturing data, any emerging tools will need to be carefully evaluated to ensure the maximum benefit of any data collected.

Various stakeholder groups and individuals have developed self-reporting systems for a range of purposes, with differing degrees of rigour. Classification of stakeholder driven reporting initiatives is therefore problematic, and the following review provides a broad but indicative overview of potential sources of information recorded by recreational fishers and the issues that would need to be considered if these are to be used by fisheries managers in the future.

2.1 Hawke's Bay Sports Fishing Club creel survey

The Hawke's Bay Sports Fishing Club started to collect catch and effort data from its members in 2006, following concerns about the state of the local fishery. This initiative is ongoing and NIWA is also collecting creel survey data at the same club ramp with the cooperation of club members. A small number of dedicated club members have been conducting interviews on competition days since 2006, and data are now available from eight consecutive summers. Boat-based parties participating in fishing

competitions have been interviewed at the end of their fishing trip to provide information on the name of the competition they participated in, date fished, boat name, number of anglers fishing from the boat, fishing type (bottom fishing, trolling, bottom longlining etc.), and the number of each species caught and released.

Interviews have been conducted on competition days only, to maximise the number of interviews completed per hour on the ramp. Returning competition entrants have been approached during 5–17 summer competitions per year (115 competitions in total) but interviews were not conducted at other times and the results are therefore unlikely to be representative of all fishing conducted during any given year. Between 455 and 2700 fishers have been interviewed each summer, and data from a total of 14 744 fisher trips (4561 boat trips) had been collected by the end of the 2013–14 summer.

None of the data collected on paper forms to date has been entered into an electronic database, although annual catch totals have been manually collated for at least the five most commonly caught species. Greater use of these data could be made if they are entered into an electronic database, for example, to track the bag frequency distribution for commonly caught species per fisher trip per year (based on the average catch across all fishers within each boat).

In order to reduce respondent burden, fish have not been measured. This means that no information is available on changes in the size composition of commonly caught species. Another limitation of these data is that no information has been collected on number of hours fished or the target species.

The collection of information on target species is of particular interest in this region, as club members commonly target different species. This includes targeting groper in deeper waters, and pelagic species such as kahawai by trolling, in addition to gurnard which is the more commonly targeted demersal species. Changes in targeting behaviour over time can influence apparent catch rate trends, but there is currently no means of determining when a given species was targeted and hence more likely to be caught during a trip. There is therefore no way of confidently ascertaining if changes in catch rates are representative or if they reflect changes in targeting behaviour (species and areas fished) over time. Trip information recorded on "fishing type" may provide some indication of target species, depending on the level of ambiguity associated with these method definitions and the consistency of their use. However, trends seen in catch rate indices derived from this club's data may reflect changes in localised abundance, as they are similar to those seen in Pania Surf Casting Club completion records (see the next section).

Competition rules can potentially influence the number and landed size of a given species. It is not currently clear whether any competition rules have been in force during these events, such as minimum size limits for particular species, and if so, whether there have been any changes to these rules over time. Landed fish are weighed on competition days, but these data are not retained. It may be possible to reconstruct some of the rules from yearbooks or other club documents.

This initiative by the Hawke's Bay Sportfishing Club therefore could provide some useful data on recreational fishing in an area for which very few data are available, although the utility of that data is limited. The collection of additional data on the size of fish landed and hours spent targeting different species would be useful. In addition, the randomised selection of survey days would help ensure that any data collected are representative and not focused on competition fishing. This would improve the likelihood that these data are used for management purposes, as originally intended by club members.

Grassroots initiatives such as this demonstrate sustained stakeholder support for citizen science programmes that may be of value to fisheries managers, but regular reviews and feedback are required to ensure that any data that are collected are fit for purpose. Research conducted by research providers benefits greatly from MPI's working group review process, but there is currently no such peer review process for citizen science undertaken by clubs such as this, despite the limited experience that volunteers may have in designing and implementing such surveys.

2.2 Pania Surf Casting Club competition records

The Pania Surf Casting Club (current membership of 60–70 anglers) has kept competition catch records since 1955, which have been recorded electronically since 2006, using a variety of software. The club currently holds competitions on 12 weekends and 10 weekday evenings ("twilight" events) per year. The weekend events run from 5 am Saturday until 12 noon the next day, when a weigh-in takes place in Napier. All fishing must take place between Mahanga, north of Napier, and Herbetville to the south. Individual fish weights are recorded for each fisher weighing in a catch and a record is also made of those present at the weigh in who did not land any fish. MPI minimum legal size limits apply for most species, but there are some club size limits Most of the club limits have not changed for many years. Club minimum size limits include: snapper – 30 cm; kahawai – 45 cm (no more than 5); and lemon fish (rig) – which must be landed in a trunked state that is at least 65 cm long (no more than 3 fish). In addition, all landed fish must weigh at least 500 g.

The records kept by the Pania Surf Casting Club have been recorded for their own purposes. The declining trends in catch rates recorded since 2006 for species such as snapper and red gurnard are similar to those seen in the competition data collected by the Hawke's Bay Sports Fishing Club in the same area. Club records as far back as 1955 could be digitised if they were available, but this task could be time consuming if they are recorded in a variety of formats, as seen in recent years.

It is likely that other recreational fishing clubs in New Zealand have kept competition catch records (such as the North Shore Surf Casting Club which has kept paper based club day records since 1968). There may be some merit in exploring the availability and nature of these records through some form of informal snowball survey. Resourcing will be required if club records are to be collected and collated, as most records will probably be only available in paper form. One option could be for MPI to develop a web portal that clubs could use to upload data. This would allow online data range checks and validation rules to be used to help assist in improving data accuracy. The Application Programming Interface (API) being developed by Dragonfly Science as part of this project could provide a basis for such a portal.

Club competition records can provide a localised indication of trends in abundance or availability for commonly caught species in nearby waters. These may or may not agree with trends seen in commercial catch rates for the wider stock. This is because recreational fishers tend to fish closer inshore in general, and local abundance will be influenced by both stock status and the availability of those fish to recreational fishers in shallower waters. These trends may therefore highlight issues such as localised depletion. Any interpretation of catch rate trends inferred from club data should, however, carefully consider the manner with which these data have been collected, and whether they can be corroborated by other data sources, including records kept by other clubs (such as the competition data collected by the Hawke's Bay Sport Fishing Club) or by localised commercial catch effort data.

2.3 Kingfish club competition weigh in records

Landings of kingfish are infrequently encountered during the research provider creel surveys commissioned by MPI, and competitions can provide a targeted source of data on recreational landings. The annual Bay of Islands Yellowtail Tournament provides a good opportunity to measure appreciable numbers of kingfish in a relative short period of time. Blue Water Marine Research have measured and weighed fish at this competition since 2010. Between 90 and 173 fish have been measured annually. These data can be used to characterise changes in the size composition of the local population. Individual fish weight data are also available from this tournament since the late 1970s and from club records for the month of June as far back as 1959.

Blue Water Marine Research has recently asked entrants of the 2015 Heavy Metal Jigging and Topwater Tournament to provide measurements for any kingfish they catch, as part of a MPI funded kingfish catch sampling programme that provides length measurements and collects heads for ageing purposes

from charter boat operators. Contestants were provided with a data form as part of their starter packs, and were asked to record the lengths of any kingfish greater than 65 cm. Data were provided by about a third of the 30 teams that entered.

Catch sampling from events such as these potentially provides a useful data source for some fisheries, especially for those species infrequently encountered during creel surveys, but better results may be obtained if an independent event observer is present.

2.4 National competition records

Some sectors of the recreational fishing community hold annual fishing competitions which are often known as "Nationals", where entrants from around the country, and sometimes from overseas, regularly compete for titles during events which often run over several days. Examples of these competitions are the New Zealand Sport Fishing Council Nationals and the New Zealand Spearfishing Nationals, which are team based events. In the case of the spearfishing nationals, a team can be a pair of spear fishers, or for an international event, a country (with up to two pairs per country).

Spearfishing national catch records are kept on a daily basis for each team, with points given for the weight of each species taken by the team (with minimum fish weights set for each species), the total catch weight of all species combined, and for "highlight" fish which are especially large. Daily catch records of the number and weight of each species caught by teams entering the spearfishing nationals have been kept on separate standardised Excel spreadsheets since about 2005. These data are therefore available electronically, but some effort would still be required to collate these data into a single spreadsheet or a relational database.

The purpose of these records is to record and compare the achievements of competition entrants, but there is limited further use for these data given the limited number of entrants and the specialised expertise of those involved.

2.5 Gamefish club weigh station records

Gamefish clubs in New Zealand have routinely kept records of fish passing through their weigh stations since 1925–26 and also records of tagged and released gamefish since 1975. Weigh-in records usually include information on: the species of fish caught, its weight and the name of the angler and vessel used (Holdsworth et al. 2014). Landings of some fish are not recorded if the catch was not made within IGFA (International Game Fish Association) or club line and gear rules, or if the fish were not larger than a club's minimum length or weight limit. The voluntary minimum weight limit for striped marlin is 90 kg, and club limits for shark species vary between 40 and 70 kg depending on location fished. Contest rules may also apply. Almost all billfish passing through weigh stations are recorded, although landings of less iconic species such as skipjack tuna, albacore, kingfish and sharks are less likely to be recorded because there is less benefit for club members to have these fish weighed. These records therefore provide information on changes in the size composition of iconic gamefish species landed over a 90 year period from the majority of anglers targeting these species.

This data source would be of further utility if fish specific data were also recorded on the species targeted when a fish was caught, time spent fishing, and on location fished. No associated information is available on fishing effort, although landed catches per trip could be potentially inferred from some records. However, no information was available for trips from which there was no landed or weighed catch. This means there is no way to reconstruct catch rate indices from these records.

The additional collection of information on target species and location fished would also be beneficial, as these both have a direct bearing on the probability of a species being caught and the size of that fish. Species assemblages, catch rates and size compositions can vary considerably between areas.

Gamefishing vessels associated with a club or originating from a port can range over a wide area. Some species such as kingfish are commonly targeted and caught at "hotspots" such as at White Island or the Ranfurly Banks, and any interpretation of catch rates would need to take this into consideration.

Most of these data are currently held as paper records, although clubs are increasingly keeping electronic records.

2.6 Billfish Logbook Programme

The Billfish Logbook Programme is a voluntary scheme that has collected daily catch and effort logbook data from vessels targeting billfish since 2006–07 (Holdsworth & Saul 2013). The programme is funded by MPI, and logbooks are distributed to vessels intending to go game fishing for at least 10 days per year. About 1000 fishing days and catch of 300 to 400 billfish are reported each season. Although the logbooks are paper based, they are sent in on a regular basis for electronic data entry and the forms are scanned before they are returned to the skippers for their personal records.

The programme was initially designed to continue and expand the 30 year time series of striped marlin catch and effort data reported by some gamefish charter boats. Logbook data are collected from vessel skippers who submit a simple end of year postal survey, on which they record the number of days fished and striped marlin catch off East Northland. The Billfish Logbook Programme now includes charter and private vessels from all regions and collects data on other billfish, tuna and shark species such as yellowfin tuna, and mako. The 56 fishing clubs affiliated to the New Zealand Sport Fishing Council provide catch records for most of the billfish and pelagic sharks landed or tagged by sport fishers in New Zealand waters, and these are also summarised by region and nationally as part of this programme.

In 2010 the Government introduced a compulsory charter boat registration and reporting scheme (Amateur Charter Vessel – Activity Catch Returns; https://www.mpi.govt.nz/travel-and-recreation/fishing/charter-fishing-vessel-operators/). Charter boat operators are required to complete returns on gamefish fishing activity (effort) as part of this compulsory reporting programme, but they are not currently required to report catches of billfish or shark species.

2.7 New Zealand Cooperative Gamefish Tagging Programme

The billfish logbook programme is complemented by a long established gamefish tagging programme that relies heavily on fisher self-reported catch/tag release data and club reporting requirements (Holdsworth & Saul 2014). The New Zealand gamefish tagging programme was first established in the mid-1970s, and focuses primarily on striped marlin, mako shark, blue shark, yellowfin tuna, and kingfish. Tag release and recapture data from this programme have been used to infer the migratory behaviour of large gamefish and shark species, and kingfish growth rates. This programme collects data on the date and location fished, and size information for 2000 to 3000 released fish per year and 50 to 60 recaptures from around the southwest Pacific Ocean.

Data provided by all three of these sources of information on New Zealand's gamefish fishery (the gamefish tagging and billfish logbook programmes and the club weigh station data) are provided to the Western and Central Pacific Fisheries Commission to assist with southwest Pacific stock assessment for striped marlin. These programmes provide good examples of how a targeted self-reporting programme can provide data to address a specific management need. This is in part possible because for the relatively structured and defined nature of this fishery, which is centred on sport fishing club organisations with a long history of recording and publishing individual fish weights, starting in 1925. Most other recreational fisheries are much less structured and definable.

2.8 West Australian Research Angler Programme (RAP) logbook

The RAP logbook programme was introduced in March 2004 to maintain fishery data collection in estuaries following their closure to commercial fishing. The programme was subsequently extended throughout Western Australia and currently provides the only source of information on some recreational fisheries in some areas. Fishers are asked to record daily trip data on times spent fishing, depths fished, locations fished, fishing gears used, bait type, fish species, sizes of fish caught, and whether a fish was released. These data are used to monitor relative trends in catch rate and catch size composition. In recent years the scope of this programme has been extended to include the reporting of recaptures of tagged fish, the collection of fish frames for fish ageing purposes, and a juvenile tailor reporting programme used to monitor the recruitment strength variation of this commonly caught species. Catch cards are also provided for tournament events.

A variety of approaches are used to promote the programme including radio media, posters, pamphlets and word-of-mouth. Levels of participation vary over time, but in 2005–06 for example, there were 146 active participants throughout Western Australia. Ongoing effort is required to maintain a network of reporting fishers, and incentives are given to promote ongoing participation.

Although the collection of data by this approach is somewhat *ad hoc*, and reports are provided by a non-representative sample of avid fishers, the collection of fisheries data throughout a state as large as Western Australia is especially challenging, and this programme provides information for fisheries which would otherwise be unavailable. This approach is probably not cost effective in the New Zealand context.

2.9 REDMAP (Range Extension Database and Mapping) project

REDMAP is a web based Australian citizen science project that invites members of the public to share sightings of marine species that are uncommon in an area. The intention is to use these sightings data to track changes in the distribution of marine taxa in response to climate change. The project was started in Tasmania in 2009 and was rolled out throughout Australia in 2012, with over 1060 sightings logged across all taxa by the beginning of October 2014. About 30% of these sightings were regarded as uncommon at the sighting location.

Although this project is not specifically dedicated towards recreational fishers, it is aimed primarily at fishers and divers, and provides a useful insight into the potential benefits of this web based approach to collecting recreational fisheries data. The REDMAP website (www.redmap.org.au) provides an engaging, professional and easy to use portal that participants can use to both upload their sightings and view sightings provided by other participants, with associated summary statistics. A free smartphone application is also available which can be used to easily capture and log images of sightings in addition to information such as fish size and depth. There are also over 5100 followers of the programme on Facebook (www.facebook.com/RedmapAustralia) and 1200 individuals have signed up for a quarterly electronic newsletter. A web based survey has also been conducted of individuals and groups in Tasmania, which has been used to evaluate the programme and further randomised surveys are envisaged in the future.

There is widespread support for this programme within the science community, with funding provided by five federal/state agencies, and scientific and logistical support provided by at least another 11 institutions. These institutions include science and resource management agencies, universities and museums. To date 58 scientists are associated with the programme, many of whom will provide taxonomic expertise.

One of the attractive features of the REDMAP website is that it is not just a citizen science information upload site. Members of the science community can also upload articles and other sources of information to inform the public, which are readily downloadable. This reciprocal information sharing

approach creates a common portal for understanding the issue of climate change and its effect on the distribution of marine species. Although extra and ongoing resourcing is required for this aspect of the programme, it is potentially beneficial nonetheless, especially given the contentious nature of climate change debate.

The resources that have gone into setting up and maintaining this programme are considerable, but an initiative such as this is more likely to produce useful results and to endure if it is properly maintained and supported. At this early stage the level of resourcing is high compared to the utility of the data currently available, but the value and quantity of information obtained will increase as time goes on. Methods have already been developed to assess the data collected via this portal, which have been used to interpret data collected in Tasmanian waters since 2009 (Robinson et al. 2015), which demonstrate the utility of this data source.

2.10 Smartphone apps

The first smartphone applications (apps) were developed in 2008, and since that time a proliferation of apps have been made available through online app stores and dedicated web sites. Most apps are written to run on either iPhones or Android smartphones, and many of these can be accessed through related devices such as iPads or Android tablets. The most commonly used apps are available in both Apple and Android systems. Software is available that can be used to develop apps for Apple and Android systems simultaneously, and systems to assist development and migration between platforms are continuously improving.

Only a minority of apps are widely used, with many servicing a niche market. Unpopular apps are commonly withdrawn or not developed further after a short period, because they have attracted little interest or because the developers have been unable to find a way of monetising their investment.

The development of an app requires considerable skill and experience. Ongoing costs, such as those associated with the curation of data or the need to update the app so that it is compatible with later model phones, must be covered in some way. Some apps such as MPI's NZ Fishing Rules app (www.mpi.govt.nz/travel-and-recreation/fishing/fishing-rules/get-fishing-rules) have been developed and are maintained because they provide other non-commercial benefits, such as outreach and education. In these cases the funding is not provided by the app itself. Careful consideration therefore needs to be given to the design and likely uptake of an app, and the information that it may provide, to make sure that its development and support is warranted.

Three New Zealand recreational fishing apps have been identified as part of this review, but only one is currently extant. Sparks Interactive created a prototype fishing diary app in 2013, but subsequently decided that there was no way of reliably monetising their product, and halted further development and its public release (Hayden Judd, Senior Interactive Producer, pers comm.). Another app that was available until recently was Fishing Bro, which provided information on fishing locations and species, but did not have any facility for uploading data.

The only fishing diary app designed for recreational fishers in New Zealand fishers that is currently available is the Fish4All app. This was initially developed for iPhone users and was beta tested by approximately 20 fishers before it was publicly released in December 2014. An Android version of the app is now available, which appears to be more popular than the iPhone version. The app is free to users, and the intention is that revenue will be generated from advertising. Approximately 1000 copies of the app had been downloaded by the end of January 2015. Users have been asked to comment on the app so that changes may be made before the app is widely used. A cursory examination of summary statistics reported by app users to date suggests that fishers are currently exploring how the app works, and that some of the data collected at this stage is experimental rather than real.

The Fish4All app is easy to use. App users are initially asked to choose default settings which define their normal mode of fishing. Fishers are then asked to log four types of information for all subsequent trips: the number of each species harvested and number released (for 18 commonly caught finfish and 7 commonly caught shellfish species); area fished (pre-classified zones defined by landmarks); type of fishing activity (from boat, from the shore, by diving, or by hand); and time spent fishing (in half hourly bins). Fishers can log a zero catch trip, however, only if they select a species and note down that the number caught was zero. Fishers can also upload photos of their catch and share these images and their data with other fishers if they wish.

The intention is that any data collected by this app will be controlled by a recreational fishing trust that is independent of the government, with the data used to support the interests of the recreational fishing sector. Data uploaded by fishers using the Fish4All app is currently stored in a dedicated database. An alternative approach would be to store the data on a database, using the API developed as part of this MPI project. The benefit of this would be that any data collected would be compatible with that collected by other self-reporting systems, insofar as the data would have to meet the same field definitions and pre-set data validation rules. The independence of the data collected by the recreational fishing trust could be maintained by providing the trust with its own copy of the data collected, rather than requiring the trust to lodge their data on a database that is accessible or owned by MPI.

The development of this app has been supported by Tony Craig and John Murphy. They created it for two purposes: to collect data that can be used to inform fisheries management; and as a means of generating revenue to support a recreational fishing trust. Tony Craig proposes that the data collected by this app could be used to quantify recreational harvests; to augment harvest estimates currently provided intermittently by formal scientific survey methods, and perhaps to overcome the need to conduct these surveys in the long term. However, app data can only be used to quantify the recreational harvest taken from a given fishery if all fishers faithfully report all of their catch via this app. Unless uptake improves rapidly, and catches are reported accurately, this is unlikely. Older generations are unlikely to adopt app technology and some will always be unwilling to go to the effort of reporting their catch and effort, especially those who fish infrequently and have only limited interest in fishing. Reporting apathy is also likely to some degree, especially over the long term. The author discussed this app with an avid fisher who had been enrolled as a beta tester, and they stated that although the app was easy to use, they had not used it to log all of their trips.

An alternative method of estimating total recreational harvests from the data provided by this app is to scale up the catch data logged by those members of the fishing public who use the app to account for that taken by those who do not use the app. However, this approach is not considered viable. This is because fishers using the app are likely to be self-selecting, non-representative, and skewed towards avid fishers. Further, there is no readily available sample frame that could be used to inform any scaling process, especially given the fact that app users do not provide any personal information about themselves, such as where they live.

Catch and effort data reported by a partial sample of fishers using this app might still be used in a relative sense, however, to provide information on trends in catch rates for fisheries which are not currently covered by current surveys. One advantage with app-based data is that a proxy fisher identity would be available for any catch rate standardisation. This is broadly analogous to the "vessel" effect that is often one of the first terms selected when commercial catch rate data are standardised. There are, however, two limitations with fisher catch rate data provided by this app. First, while the app is designed to record catch data, there is likely to be a significant under-reporting of zero catch trips. The incidence of zero catch trips in self-reported data is usually much lower than that seen in onsite surveys, and the incidence of these events is likely to be even lower given the current design of this app. There is no explicit prompting to record zero catch trips. To do this you have to record a count of zero against at least one species before you can save data for a zero catch trip. A simple solution to this would be to provide an initial option for "no species caught or released whatsoever". The second limitation that would need to be considered is the broad categorisation of fishing effort by this app. Boat based fishing, for example, can take many forms, and the lack of definition on fishing methods used (i.e., lure fishing

versus bait fishing) and species targeted during a trip could prove problematic. This limitation would be less of a problem for some fisheries as the definitions currently used in the app could still be used to broadly characterise some fisheries, for example rock lobster or paua if the available data are assumed to be broadly representative.

The veracity of any trends inferred from data provided via this app could be evaluated by comparing app and survey trend data in other situations where both are concurrently available. Protocols for testing the accuracy of self-reported data are discussed elsewhere in this report and some form of validation testing should be undertaken before data such as this are accepted as substantially more reliable than anecdotal information. Before self-reported, app-based records can be accepted as constituting scientific data, the collection framework and protocols would have to be assessed against the Research and Science Information Standard for New Zealand Fisheries (http://www.fish.govt.nz/en-nz/Publications/Research+and+Science+Information+Standard.htm).

In summary, the Fish4All app is designed to be easy to use, so that additional data can be collected to inform the management of recreational fisheries for the benefit of recreational fishers. We suggest that full catch reporting by the recreational sector via such an app is unlikely, as an undefinable proportion of the fishing community will not use it to record any or all of their catch. The challenges with this approach are largely behavioural rather than technological. Other potential uses of logged data should be considered, such as monitoring trends in catch rates, but some modifications would be required to the app design to facilitate this. Careful consideration should be given to whether and in what manner zero catch trips are to be logged, and whether or not more detailed data are collected on fishing methods and target species. These recommendations should not result in an app that is significantly harder to use.

3. POTENTIAL AND DEVELOPING SELF REPORTING TOOLS AND APPROACHES

Self-reporting tools use combinations of technologies and applications. The technologies that members of the fishing public and stakeholder organisations currently use to provide and collect data are primarily traditional paper based forms (which are sometimes also entered electronically), electronic logbooks, websites, and apps written for multifunctional smartphones. It is likely that these technologies will be the main means of collecting data from members of the public in the foreseeable future, but the way in which these technologies will be applied is less certain. This is because the motivations of those creating self-reporting tools, the resources available, and the nature and scope of the data they wish to collect will at least partially determine which technologies are most applicable and how they are used.

There is, however, an inevitable trend towards collecting or storing data electronically. Discussions with fishing club representatives suggest that there has been a gradual transition from paper based to electronic record keeping at many fishing clubs, but the benefits of electronic data capture have yet to be fully realised. Most clubs and individuals collect data electronically for their own purposes, with limited thought given to how these data could be used for fisheries management purposes (although gamefishing clubs have demonstrated the benefits of a collective approach). Data may therefore have been collected by clubs in the past, which is potentially informative, but some form of support from MPI will probably be required to collate and review the suitability of these data for management purposes.

One of the main impediments to stakeholder adoption and adaptation of existing and emerging technologies is the technical (and hence financial) resourcing required to develop and maintain these approaches. Although individuals and clubs can readily create spreadsheets and simple databases to store information on, the development of websites, smartphone apps and other technology based approaches usually requires technical expertise which is beyond the scope of most non-commercial stakeholder organisations. Most of the sectorial resources that are currently directed towards interactive technologies are orientated towards building and maintaining stakeholder organisations, such as Legasea (www.legasea.co.nz/), as an immediate payback is required to justify the adoption and development of

any electronic resource. Experience in New Zealand and Australia to date suggests that the most viable and enduring self-reporting initiatives are those that receive some form of government support, especially given the resources required to maintain and update the rapidly developing technologies on which these initiatives rely.

Only two developing and potentially applicable technologies have been identified as part of this review, which offer limited potential to collect data provided by recreational fishers: boat based electronic hubs built around existing fish finder/GPS plotter devices, and more recently, smart watches.

3.1 Fish finder/GPS plotters as electronic hubs

The cost of fish finder/GPS plotters has steadily decreased as their functionality has increased, and these devices are being developed into electronic hub for boats, in a similar fashion to smartphones which provide an electronics hub for individuals. These devices can now be used to: simultaneously plot bathymetry, detect fish, as a GPS plotter that provides boat position data plotted over a marine chart background, to download weather maps which can be superimposed on a GPS plot, to plot radar data, and to store and plot echo sounder data which are used to render an approximated three dimensional image of the sea floor.

These devices can be controlled by smartphones and tablets which can also be used to upload and store data, but full and direct connectivity with the internet is not currently available. The increasing capability and functionality of these devices has, however, yet to reach a point where they could be used to provide data that could be used to inform the management of recreational fisheries. In the long term it may be possible to centrally track the movements of large numbers of boats, to monitor spatial trends in boating effort, but the management utility of this information would be limited.

3.2 Smart watches

Smartphones have revolutionised interactive communications, and the advancement of this technology has led to the development of smart watches which have become widely available in 2015. The surface area of a smart watch is relatively small, however, and this means that users interact with their watches in a very different manner than they would with their smart phones. Apple is advising app developers to design apps that can be used very briefly and frequently, to convey relatively little information at a glance. Smart watches currently have much less capability than smartphones and tend to be designed to be used in tandem with smartphones to extend their functionality, such as through location tracking. The potential uses of this technology will become apparent only with time, but their size will at least partially limit their potential utility.

3.3 Recreation fishing competitions run by event promoters

Recreational fishing competitions that are run by event promoters for commercial purposes offer a source of information which has not been explored to date. New Zealand's largest recreational fishing competition is the Century Batteries Beach and Boat Fishing Competition which is run by Odds On Promotions every February at Ruakaka. Competition entrants are asked to download a smartphone app (http://www.beachandboat.co.nz/ – iPhone and Android versions available) which they can use to take a photographs of any fish caught and retained or released. Entrants can upload images only during the two day event, and measuring mats are given away to the first 400 entrants. Information collected by the app includes entrant name, address and contact details, age, sex, descriptors of the boat used, date and time at which each image was taken, and the location of any fish caught.

A similar app is being developed for a larger Million Dollar Snapper Challenge competition (https://www.snapperchallenge.co.nz/) that Odds On Promotions intend to run for the first time in the

Hauraki Gulf, in May 2015. Both of these apps have therefore been created for a specific and limited commercial purpose and the information that they could potentially provide is probably of very limited use beyond their immediate purpose. Any data collected during a competition over a relatively short period cannot be considered typical of the wider fishery.

One incidental opportunity that competitions such as these provide is the chance to collect biological information such as paired length-weight measurements that could be used to inform a length-weight relationship (for example for use in scaling up National Panel Survey harvest estimates or in fish stock assessments). Competition weigh-ins provide an opportunity to measure large numbers of large fish which are usually (but not always) in a reasonably fresh and unfrozen condition. Odds On Promotions are happy for science staff to measure and weigh any fish behind the scenes. All fish landed during the competition are sold through a Licenced Fish Receiver, with the proceeds going to charity.

3.4 Utility of self-reported data provided within a licence based sample frame

One of the greatest limitations of data provided by self-reporting fishers is that there is no way of reliably scaling up data provided by a sample of fishers to account for the harvest taken by all fishers participating in a fishery. This is because the total number of fishers participating in the fishery is unknown, and because fishers who report voluntarily are self-selecting and unlikely to be representative of the wider fishing population. A licencing (or registry) system could be used to partially overcome this limitation, as a licence database can be used to estimate the total number of fishers in a population.

Although the authors consider it unlikely that New Zealand will ever require marine fishers to hold a licence, freshwater fishers are required by New Zealand Fish and Game (NZF&G) to hold a fishing licence. NZF&G have concluded, however, that data provided voluntarily by licenced fishers cannot be used in a statistically rigorous sense, and telephone-based survey methods are used to estimate harvests of trout, with participating fishers drawn from a licence based sample frame (Steve Terry, Fish & Game officer, pers comm.). This experience suggests that the availability of a licence frame does not, by itself, mean that self-reported data can be used to estimate recreational harvests from a fishery.

4. PROTOCOLS FOR EVALUATING SELF-REPORTING TOOLS

The fisheries research and data collection that is commissioned by MPI to inform fisheries management is assessed against the Research and Science Information Standard for New Zealand Fisheries (RSIS, see http://www.fish.govt.nz/en-nz/Publications/Research+and+Science+Information+Standard.htm, Ministry of Fisheries 2011). This document sets out fundamental principles and processes to ensure the quality and integrity of the information used by fisheries managers, and defines the responsibilities of both MPI science managers and research providers. Core elements of the Standard include the rationale for a formal peer review process and a description of how that is to be conducted, and a list of principles that scientific information must meet (peer-review, relevance, integrity, objectivity and reliability). These principles must be met before any information is accepted by fisheries managers as constituting reliable scientific information.

Research proposals are usually evaluated before implementation, with consideration by MPI given to the project design, methodology proposed, associated scientific levels of expertise, the track record of the proposed provider, data management procedures and capabilities, and research quality assurance systems. Approved research proposals are subsequently peer reviewed through science working groups convened by MPI, and occasionally through other forms of review process such as participatory workshops, specialist technical review workshops, and independent peer reviews by appointed experts.

The RSIS also specifies criteria that the peer review process must consider including independence and expertise of reviewers, the need for a balance of expertise that covers the range of required skills,

inclusiveness, transparency and openness, relevance to fisheries management objectives, timeliness of reviews, the management of any conflicts of interest, the need to reporting of any uncertainty or risk, and the need for staged technical guidance at appropriate stages of a programme.

Most of the self-reporting initiatives reviewed in this report, however, have been initiated without input from MPI or recognised research providers, and any evaluation of these programmes and the data provided is usually retrospective. The most robust means of evaluating a data source is to compare it with independent data collected concurrently over a limited period of time by a method specifically designed for that purpose, following scientific principles. Comparative tests are commonly used to objectively assess information provided by formal fisheries research programmes, with a relevant example being Edwards & Hartill (2015). Quantitative comparisons of two sources of data collected concurrently over a relatively short period can provide a more objective and informative assessment of a data source that a subjective or inward-looking review of a data source in isolation.

Descriptions of two approaches that could be used to comparatively assess data provided by stakeholders follow. The first of these considers data provided by an existing programme designed by members of a fishing club, which has subsequently been offered to MPI as evidence of localised depletion. A second scenario considers how a self-reporting tool could be designed with the collaboration of members of a fishing club before it is implemented, alongside a research provider run survey specifically designed to evaluate that data. The methods proposed here are only indicative, however, as a diverse range of self-reporting tools can be applied in a diverse range of contexts, and the development of evaluation protocols that are generic enough to be broadly applicable, yet specific enough to be informative is highly problematic.

4.1 Scenario one – evaluation of an existing programme

The Hawke's Bay Sports Fishing Club has been collecting catch per trip data from club members participating in fishing competitions since 2006. This data source is potentially useful as almost no creel survey data are available from this part of the country, but the reliability of these data is currently unknown and untested. A comparative evaluation is possible in this instance because catch per trip data is still being collected from club members on competition days, and because NIWA has also recently initiated an ongoing creel survey at the same club ramp (as part of a web camera/creel survey monitoring programme). The methods used in the NIWA survey already conform to the RSIS and this data source therefore provides an independent and concurrent data source that could be used to assess the veracity and representativeness of the information provided by the club survey. In particular, to assess whether the declining catch rate trends seen by club members during summer competition days over the past eight years are indicative of those that would have been experienced by all fishers using the same ramp throughout the year. Data would have to be collected concurrently by both programmes for at least two years so that relative catch rate trends from the two programmes could be compared. Catch rate comparisons could be made for a range of commonly caught species such as red gurnard, snapper and kahawai, although the power of any statistical comparison will be limited for most other species, as they are infrequently landed.

Data from the NIWA survey could also be used to investigate potential issues associated with the limited scope of questions asked during the club's creel survey. With the club survey the catch of all fishers in each boat is aggregated, no information is collected on hours fished or species targeted, and only four broad fishing method classifications are used. With the NIWA survey fishers are asked which species they targeted during the trip, which area they fished, which methods were used (which are more specifically defined than in the club survey), and how many hours each fisher fished for. Further, when more than one fishing method is used in a trip or more than one species is targeted, the fishing effort and catch associated with each fishing mode is determined and recorded. Members of the fishing party are also asked who caught which fish by which fishing method — although the attribution of a group's catch to individual fishers may be poor in reality.

Catch rate indices could therefore be calculated from NIWA data that is aggregated and generalised so that it resembles data collected according to the club's questionnaire format, and from the full NIWA data set which would focus on just those trips where a limited number of species were targeted by a limited number of commonly used methods. Comparisons could be made to determine whether or not the limited scope of questions asked during the club survey could result in catch rate indices which are misleading because, for example, when fishing events from multiple modes of fishing are aggregated into a single catch rate index. Fish are also measured during interviews conducted by NIWA, and these data could be used to demonstrate how catch rate indices based on numbers of fish caught can differ from indices based on weight of fish caught. Any quantitative assessment of the club data will not be possible, however, until these data are available in an electronic format. When this is done, an initial non-comparative assessment of the potential utility of the catch rate index data will also be possible, given the Critical Success Factors specified in the following section of this report.

4.2 Scenario Two – evaluation of a future self-reporting programme designed in consultation with fishers

Under this scenario a self-reporting tool could be designed in collaboration with a distinct group of recreational fishers, with the management use of that data in mind from the outset. NIWA currently conducts creel survey interviews at the OBC Northland club ramp at Parua Bay as part of an existing MPI project (MAF2014/04). This launching facility is literally ring fenced, and is only accessible by club members with a swipe card to access the ramp. The club could be approached and asked if they are interested in collaboratively designing a self-reporting system, which club members would be invited to use over the following year. Catch and effort data self-reported by this readily defined group of fishers could then be compared with data collected from all club members as part of the NIWA creel survey at the club ramp.

The limited scope of such a pilot test is desirable as it is theoretically limited to the same distinct group of fishers, with the difference being that one data source is self-reporting and self-selecting (not all club members may wish to use the self-reporting tool), whereas all club members are potentially intercepted during the NIWA creel survey. Comparisons would be restricted to those trips which returned to the club ramp to ensure that both data sources considered a common potential sample frame. Data could be collected from both sources for a 12 month period or more, as self-reporting fatigue may occur, which will take time to manifest itself.

This proactive and collaborative approach to designing and testing a self-reporting tool has several advantages. Fishers are more likely to use a self-reporting tool if they have been involved in its design, as they should then find it more intuitive and easy to use. Experienced researchers should also be involved in the design of the self-reporting tool from the outset, which will help to ensure that the data collected are fit for purpose. Another advantage with this design driven approach is that the API for self-reporting tools developed as part of this project could be considered from the outset, which is desirable as the data provided by the self-reporting tool should ultimately be available in an electronic format (and ideally be reported on some form of electronic platform). Further, the self-reporting tool could be designed with comparative tests in mind, as it would be useful if more than one form of reporting platform were made available to club members. This would allow comparison to see which reporting tool was more popular, and if or how the results may be biased when relative to data collected during the creel survey.

Another advantage with this approach is that underlying biases, such as avidity and demographic bias, can be directly assessed. This is possible only because the club-membership provides a finite and definable population of fishers. Further, the NIWA creel survey is likely to be ongoing for some time, and the potential exists for a longitudinal test which could be used to assess the level of long term support and interest for self-reporting.

The final field component of this programme would be a wash up survey at the end of a 12-month self-reporting period. Here, participating and non-participating club members could be asked about the strengths and shortcomings of the self-reporting tool that they have helped to design, and how it could be improved in the long term.

Possible comparative tests that could be undertaken given the data provided by the NIWA creel survey and the self-reporting regimes are as follows.

- Contingency table test comparisons of demographic profiles, claimed fishing avidity profiles, species distributions, fishing method distributions, and target species distributions.
- Pairwise comparisons of seasonal trip catch rates for commonly caught species via t-tests or exploratory regression tree comparisons, for example using numbers of fish harvested per trip and for the proportion of trips resulting in a positive catch. These could include possible explanatory factors such as fisher demographics, stated avidities, areas fished, methods used and target species, following, for example, methods similar to those used by Edwards & Hartill (2015).
- Comparisons of length frequency distributions for commonly caught species by the Kernel Density Estimate model approach described in Langlois et al. (2012).

These tests, or similar, could be used to infer:

- whether a subset of fishers of a given demographic group (or groups) is more likely to adopt a self-reporting system when multiple technological options are available (e.g., web site versus app);
- whether avid fishers (as claimed) are more likely to either participate in a self-reporting system, and to continue to participate;
- whether self-reporting fishers are just as likely to report zero catch trips (previous comparisons of panellist data with creel survey data suggests not – see Edwards & Hartill, 2015);
- whether self-reporting fishers report all of their catch or are more likely to report catches of key species or larger fish;
- whether self-reporting fishers potentially report the catch of co-fishers;
- whether one form of self-reporting regime provides more representative data than another (e.g. web site versus app).

Comparative evaluations, such as the two scenarios discussed above, are not always possible. This is because the data being evaluated are no longer collected and concurrent comparison is no longer possible, or because there is no cost effective means of collecting comparative data. In these cases the only remaining option is to evaluate the data itself and Critical Success Factors for self-reported data are recommended in the following section. In these instances biases, such as those associated with non-representative sampling, may have occurred and often cannot be determined from one source of data alone.

5. CRITICAL SUCCESS FACTORS FOR SELF-REPORTED DATA

The accuracy and integrity of the data collected by a tool is important in the design of the tool. Data should be collected with its ultimate use in mind from the outset, to ensure that it is fit for purpose. Stakeholder driven self-reporting programmes are often initiated without input from MPI (or any MPI approved researcher) as these programmes were often initiated for other purposes. It is not surprising that data provided by stakeholders has sometimes been unsuitable for management, but timely and constructive intervention could improve this situation. It is highly unlikely that interest groups, such as fishing clubs, are aware of the RSIS standard as much of its content is pitched towards specialised

researchers who have the capability, capacity and commercial motivation to meet these standards from the outset. Further, the RSIS document describes higher level principles that do not adequately describe specific issues that recreational interest groups could consider if they are collecting data to inform fisheries management.

Table 1: Critical Success Factors which should be considered when evaluating types of information which can be used to inform the management of recreational and shared fisheries.

Estimates of total recreational harvest	Harvest data available from all fishers who report all of their catch.
	Alternatively, subsample of catch per trip data collected within a scalable and defined sampling frame (temporal or population based frame).
Catch rate index	Able to discriminate between different types of fishing that may result in differing catch rates for different species (target species, area, fishing platform type, and fishing methods adequately defined).
	Meaningful measure of effort available (although by trip may suffice if the number of fishers in each party is recorded).
	Specific provision given to reporting zero catch trips and plausible levels of zero catch reporting observed in the data.
	Minimum level of catch aggregation at the boat level (boat catch/number of fishers in boat).
	Adequate sample size over time and preferably the ability to track catch rates of individual fishers.
	Records kept of club or competition specific landing rules if they were applied when the data were collected.
	Representative of wider fishery and records kept of club or competition size and weight limits and when they were applied.
Length or weight frequency data	Measurements made with reasonable precision and with no apparent peaks occurring at coarser rounded measurements (such as to the nearest 5 cm).
	All fish from each landing measured or protocols in place to ensure that measurer does not preferentially select large or small fish.
	Records kept of club or competition specific size limit rules if they were applied when the data were collected.
Bag size data	Minimum level of catch aggregation at the boat level (boat catch/number of fishers in boat).
	Records kept of club or competition specific bag size rules if they were applied when the data were collected.
Release data	Distinction made between released fish which are less than or greater than the minimum legal size (and not some other higher limit such as that imposed by a club).
	Counts of released fish thought to be broadly accurate without approximate reporting, e.g. ideally not to nearest 5 fish.
Spatial or temporal distribution of fishing effort	Some form of continuous sampling needed from a representative sample of the fishing community.
Biological data	Measurements made with reasonable accuracy and precision.
	Reasonably accurate and calibrated tools used to make measurements.
	Measurements made from fish in a reasonably fresh state.
General Critical Success Factors	All data available, in an electronic format.
	Data available in a raw and unsummarised form.
	Detailed description provided of the methods used to collect the data.
	Extent of sampled fishery defined (spatial coverage, types of fishing platform used, general public or finite group such as club).
	Dates, times and locations recorded in a consistent manner.
	Sufficient data collected to ensure that estimates can be calculated with reasonable precision.

Key among these issues is that of relating the sampled population (of fishers, months, years, or places) to wider or entire populations.

Critical Success Factors (CSFs) are therefore proposed, that could be used when evaluating specific types of information that recreational stakeholders should consider from the outset when collecting data (Table 1). These CSFs cover issues which are easily overlooked when designing a recreational data collection programme, but need to be considered. Stakeholders should still be aware of the peer review process documented in the RSIS standard, however, as any data that they provide would need to undergo peer review.

6. DEVELOPMENT OF AN APPLICATION PROGRAMME INTERFACE

As already shown, recreational fishing groups throughout New Zealand collect a range of data for a number of purposes, including environmental monitoring, demographic and participation information of regular fishing activities, and sport fishing competitions. Although these self-reported data provide some information about recreational fishing, they are difficult to use in the context of fisheries management, as they generally lack a systematic and independent data collection framework. In particular, data are not typically collected following the research and science information standard for New Zealand Fisheries (Ministry of Fisheries 2011), and are not peer reviewed through a formal MPI working group process or similarly rigorous process.

A programmable Application Interface (API) has therefore been considered which would create a way for recreational fishing groups to self-report their data electronically, while facilitating improvements to the data collection. An API is a software interface for connecting computer systems; in this case, connecting software developed by recreational fishing groups for the collection of self-reported data to a database managed by MPI. Figure 1 shows how the API fits into the context of data collection. Interaction with the database is facilitated through software systems that have network access to the API, and can be developed independently of the API.

The Ministry for Business, Innovation and Employment (MBIE) has established the "Better for Business – Result 9 programme" that aims to "make it easier and cheaper for business customers to deal with Government" (Ministry of Business, Innovation and Employment 2015). In particular, this programme identified the use of APIs as a valuable mechanism for organisations to interact with government agencies. While MBIE has focused on the requirements of businesses, the notion of facilitating and improving data transfer to government agencies also applies in a recreational fishing context. As part of the programme, the Result 9 team have identified the 18F API standard, produced by a United States federal government agency (see de Levie & Mill 2014), as the recommended standard to follow. The present study followed the recommended standard when developing an API for recreational fisheries.

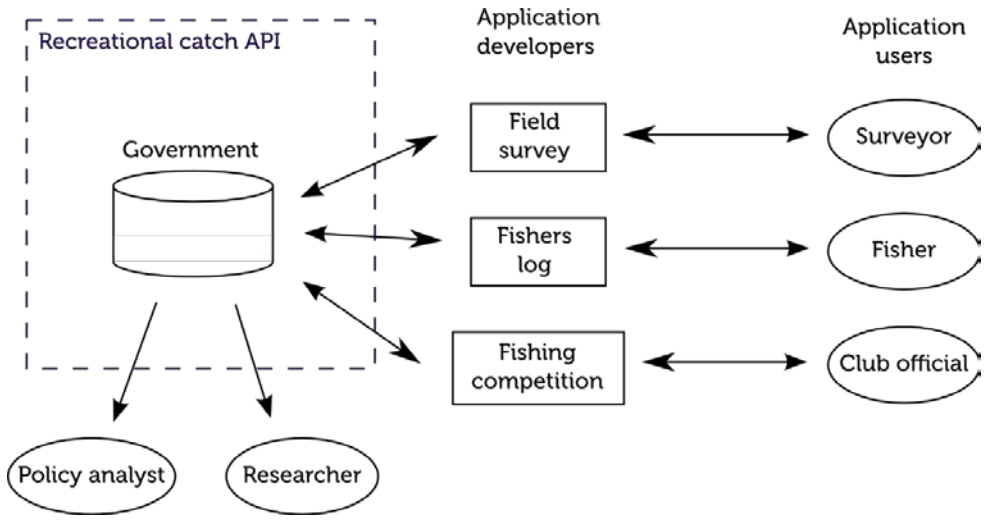


Figure 1: A diagram showing how an API fits into a data collection system. The rectangles represent software systems, the ovals represent people or roles. Arrows indicate how data flows through the system.

To understand requirements and make recommendations for developing the API for recreational fisheries, a matrix of general requirements and usage scenarios was considered. Each general requirement was reviewed in the context of a particular scenario to gain knowledge of the specific requirements. From the resulting matrix of requirements, a broad set of recommendations was developed.

In addition to the recommendations, a prototype system was developed to confirm that the proposed recommendations were feasible. Nevertheless, the prototype was not fully developed to become a functional system, because any further development should be undertaken with real world applications in mind.

6.1 General requirements

A range of functional requirements for the API were considered, while non-functional aspects such as data ownership and access policies were also included in the investigation. Each scenario was considered in the light of these general requirements.

The central functional requirement of the API centres on the sequence of interactions with the API. These make up an access and transaction pattern that can be very different between the different scenarios. For example, mobile devices make it possible to make frequent *ad hoc* updates, while more transactional processes can be imposed where appropriate, such as in a formal interview setting. The access pattern could be considered as the *verbs* of the API; the particular instructions that API users require to be supported. Conversely, the transaction structure represents support for sequences of accesses, such as starting and stopping a survey.

In view of potential differences in the purpose of data collection and database schemas (i.e., the collection of database objects), the scenarios considered here were chosen to be intentionally diverse. For most scenarios considered, the purpose of the data collection was incidental to the potential scientific value of the data. Also included in the present study were data schema that were developed to describe how data can be stored and transferred. The presentation of these schema is illustrative only and was not intended to be exhaustive.

To understand how provided data can be used, the current study examined the organisational and governance structure of different usage scenarios to determine potential policy issues associated with the data transfer via the API. For example, it is important to consider how fields that link fishing to

individuals is processed in the database, and at what resolution data can be provided to researchers or to members of the public. The various scenarios considered also illustrate a range of expectations and requirements around licensing and re-using the data.

6.2 Usage scenarios

Three different case studies for collecting data were used to develop an understanding of API requirements, and to cover a range of usage scenarios. The case studies included scientific boat ramp surveys, the use of a mobile application (app) by individual fishers, and fishing competitions run by fishing clubs.

6.2.1 Scientific boat ramp surveys

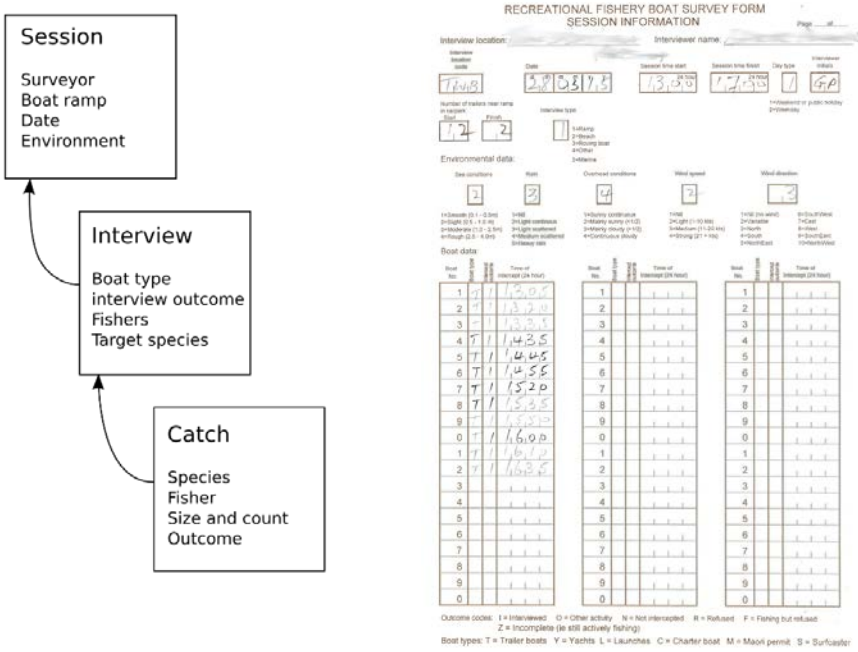
The scientific boat ramp surveys are commissioned by MPI (and usually conducted by the National Institute of Water and Atmospheric Research, NIWA) to collect data on recreational fishing activities. For these surveys, data are collected on paper forms by researchers who talk to recreational fishers as they return to a boat ramp following their fishing activities at sea. These interview data are subsequently keyed into the rec_data research database. The usage scenario considered here would use the API to facilitate the data collection and transfer through a tablet application that would replace the paper forms currently used. Although this scenario does not involve self-reported data by a recreational fishing group, it does provide insight into the level of detail the API needs to support. Under this scenario, usage of the API would require the development of an application that can run on a tablet device. All data from the boat ramp surveys would then be entered directly into the device, which in turn would directly communicate with the API to transfer data.

To this end, the application and API need to support a nested transactional workflow, reflecting the structure of the existing forms (Figure 2). The top layer in this workflow consists of a transaction that reflects each survey session. A session represents a continuous period of time when the researcher is actively collecting data at the boat ramp. Data collected at this level includes the location, the identification of the researcher, the date, time, and some environmental information.

When the researcher approaches a fishing boat and/or skipper, a second transaction level is started. At this level, survey data include information about the vessel, details about the participants, species targeted, and the outcome of the interview outcome. The final transaction level consists of details for each fish caught, such as the fisher, species, size and count, and outcome for the fish (e.g., kept or released).

The boat ramp survey data are collected as part of a scientific survey series, and need to conform to the standard schema as defined in the rec_data research database. A (greatly) simplified description of the schema shows its organisation as a three-level hierarchy (see Figure 2). The current research database schema incorporates the requirements of these data. Although there is additional complexity involving different lookup tables, the rec_data schema is essentially a three-tier hierarchy.

The boat ramp survey data do not include identifying information of the fishers, with the exception of a phone number that is used to link records if fishers have been approached multiple times. The expectations of the survey participants are that the data are being collected for research purposes, and that their identities will not be revealed.



(a) Simplified database schema (b) Example of a paper form used in boat ramp surveys

Figure 2: Simplified schema diagram of data collected during boat ramp surveys, and an example of the forms used to collect information of recreational fishing in New Zealand.

Data collected for research purposes in New Zealand are generally accessible under the Official Information Act (OIA). This accessibility means that data can be requested from MPI, and must be provided to the requester, as appropriate for a public good data project, such as the boat ramp surveys. This aspect makes it important that the database can be easily accessed, which would be easily facilitated by the API. To protect the name of the surveyor, a person key may be created by the tablet application, and the key provided to the API. This puts the responsibility of ensuring that surveyor keys are correctly allocated on the developers of the tablet application.

6.2.2 Mobile applications

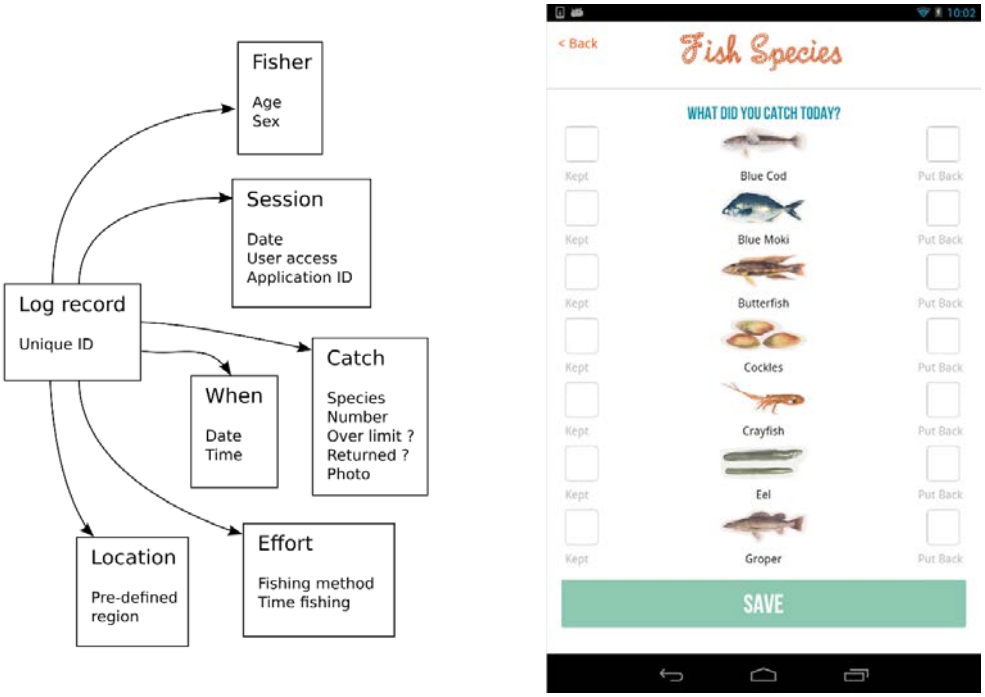
Another way of collecting self-reported data involves the use of mobile apps, as a number of relevant apps are currently available to recreational fishers internationally. The apps represent an electronic log book, recording the fishing effort and catch data for the benefit of the individual fisher. For this reason, collected data are likely to be more detailed than necessary for fishery management purposes by MPI. Support for these applications would need a high degree of flexibility, as the mobile apps need to add support for the API, and provide controls for the fisher to decide which data to share.

There are a number of mobile apps available to recreational fishers that provide virtual diaries, or virtual logbooks. Under this scenario, the current study focused on the "Fish4All" mobile application, developed in New Zealand (by Tony Craig and John Murphy), with about 500 downloads (at the end of June 2015) (Figure 3). This app is a user-friendly virtual logbook, enabling recreational fishers to record fishing activities, including their catch.

As the purpose of this app is to "enhance fisheries management", the data collection is aimed at providing information of recreational fishing activities at local, regional and national scales. Although this aim is considered to be the main motivation for fishers to use the app, it also includes features that

are not part of the data collection but are aimed at making the app attractive to users, such as the option to share images and data with other users of the app.

Once downloaded, the setup of the app on a mobile device involves the setting of preferences for the location and type of fishing (see Figure 3 for the data schema involving this app). For the location, the user is expected to select one area from a few large, predefined areas. Similarly, the type of fishing is set to one of a few general options, such as “off a boat” or “hand gathering”.



(a) Simplified data schema

(b) Selecting the fish caught

Figure 3: Simplified data schema and screen shot from the Fish4all mobile application that allows recreational fishers to self-report fishing data.

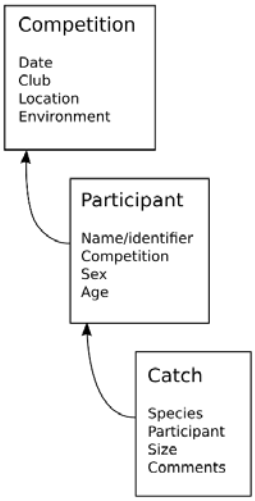
The catch is recorded by setting the species caught, including the number of fish caught that were kept or returned, and the time spent fishing. The location and type of fishing can be set to be different from the preferences, but otherwise both types of information will return to the preference settings entered at the beginning. Time information is derived from the clock of the mobile device used.

The Fish4All app stores data on a central database accessed over the mobile network. The contributed data are then managed by a nominated non-profit trust, which makes decisions on how to release and use the data stored. One possible use of the data is to share it with MPI. For the purposes of this scenario, it is assumed that the decision to share data with MPI is made by the app user. This sharing would be facilitated by enhancing the app with a function that allows the user to “share with MPI”. If selected, this function would allow the user’s catch information to be sent through the API to the MPI database. For this data transfer, the API receives a single transaction for each log record. As there is currently no feature for deleting or updating records, the API needs to accept single transactions, i.e., one transaction for each log record. The Fish4All app has a predefined list of species; however, other fishing logbook apps allow the user to specify the species caught. It is expected that the Fish4All app will need to be enhanced to support the inclusion of species other than those that are predefined. For this function, the API should provide a standard lookup feature to search for valid species codes. The app developer can then use this feature as a resource to ensure that species codes submitted to the API are valid, and that they accurately identify the species caught. Other information can also be treated in this way, such as codes for defined areas or fishing gear definitions. Providing standard lookup features for these types of information make the resulting data more consistent.

Governance of the data collected is complex because of potential commercial aspirations of mobile app developers. Most recreational fishing apps are released free of charge by the developers, who plan to make use of the data collected. For the Fish4All app, it is intended that the data be used by a non-profit trust. Regardless of the intended uses of the data, it is important that access to the data is fully understood by the user of the app. For this reason, it is necessary to add a license or statement about the terms of use, and that this license agreement would be provided through the API.

6.2.3 Fishing competitions

Recreational fishing data are also collected at sport fishing competitions run by individual fishing clubs. Data are collected on paper forms, and include the number of participants and catch information. These data are currently keyed into spreadsheets or web-based systems. For these data, access to the API could involve a bulk upload functionality through a web-based system. The example used in this scenario is the long running Pania Surfcasting Competitions run on the beaches near Napier (Figure 4). The Pania Surfcasting Club in Napier has run regular fishing competitions since 1955. The competitions award prizes for the heaviest fish of a given species caught on a single day, off the beaches near Napier.



(a) Simplified database schema

(b) Selecting the fish species targeted in a fishing competition

Figure 4: Simplified data schema and advertisement of a fishing competition organised by the Pania Surfcasting Club in Napier that involves the collection of recreational fishing data.

Data have been collected electronically since 2006, including the name of each fisher, some demographics such as age and gender, and details of the catch such as species and size. The data collection has made an effort to record all the registered competitors, even if they do not catch any fish.

Data are primarily collected for determining the winners in the competitions. Nevertheless, these data consist of a long time-series of relatively high-quality, local fishing data. Furthermore, Pania Surfcasting Club is interested in sharing the data with MPI.

Under this scenario, the API can be accessed through a website that the club can access. The data entry via this website would include details about the competition and the uploading of a spreadsheet with

the competition results. The website server would be required to process the spreadsheet, and post the results to the API, in the form of a bulk import.

The Pania Surfcasting Club is interested in providing data to MPI that are valuable for the management of local fisheries, and is not expected to have commercial interests. Nevertheless, the competition data contain personal information such as the names of participants, and access to this identifying information needs to be protected or at least restricted. At the same time, the value of the competition data is greatly increased by including this identifying information, as it allows tracking of individual fishers across competitions and over time. For this reason, the API needs to provide tools that support the data management of individuals that preserve privacy.

6.3 Recommendations for future development of an API

6.3.1 Follow the 18F API standard for open data and API guidelines

The 18F API standard covers a range of general and specific recommendations (see de Levie & Mill 2014). These recommendations are well considered, and endorsed by New Zealand Government and the United States federal government. While this investigation focused on a few of the guidelines, it recommends that all of the guidelines are followed in the design and development of the API.

One of the recommendations is that the design of the API occurs in parallel with an accompanying integration of the API, whenever feasible. In particular, any future project to develop a more complete implementation of the API should be accompanied by a project that uses the API. For example, this integration might be in the context of a comparative test (see Section 4).

More specific recommendations involve technological choices, such as the selection of specific open standards that facilitate sharing data and integrating systems. The technologies involved include:

- Use of the REST (representational state transfer) standard for communications over the hypertext protocol. This standard is a simpler system to work with and replaces other messaging protocols, including SOAP (Simple Object Access Protocol) and WSDL (Web Services Description Language).

- Use of the JSON-embedded (Javascript Object Notation) language as it defines a convenient and human-readable format for transferring structured data.

- Use of the UTF-8 (Unicode Transmission Format 8) character encoding as it involves the most popular character encoding. It is also sufficiently flexible to support a wide range of language specific features, such as the use of macrons in te reo Māori.

- It is recommended that all internet traffic be over encrypted channels. The HTTPS (Secure Hypertext Transfer Protocol) standard provides convenient encryption to the hypertext protocol.

6.3.2 All data should be maintainable through the API

The API acts as an interface to a database managed at MPI. The applications that use the API create a way for third parties, such as fishing clubs or individuals, to directly manage a record of fishing activity on the database. It is always possible that data are entered incorrectly, or as part of innocent experimentation. The user should feel they have control of the data recorded in the MPI database.

One of the underlying notions of the API is to provide a different kind of data transfer than other transfer types that involve Government. For example, data transfers typically involve information in the form of a formal declaration (e.g., tax returns), with implications in terms of compliance and/or regulation.

The recreational catch data API is different as it provides the data provider with control of the data stored. As such, the API is providing a data storage service rather than a mechanism for formally declaring fishing catch.

Specifically, the data submitted to the API would need to have an associated identity. This identity is established through the creation of a session, and could possibly be associated with an authentication service such as RealME®. This authentication would mean that the identity is established by providing an 8 cryptographic authorisation token with each access to the API. Holding the token enables the API to accept updates and deletions.

The database itself can implement the data storage in a way that logs changes. This feature is useful for understanding interactions with the API that might help improvements for future uses, with the key idea that the API should preserve all information provided.

6.3.3 Use of the NZGOAL license framework for releasing data stored

Recognising the value of sharing government data with members of the public, the Department of Internal Affairs (DIA) has developed a licensing framework for use by all government agencies, the New Zealand Government Open Access and Licensing (NZGOAL) framework. Version 2 of NZGOAL framework was released in December 2014 (New Zealand Government 2014). The stated goals of the framework are:

- that individuals, and non-profit and commercial organisations can access government-held data for creative, cultural and economic growth, improved environmental sustainability, greater productivity, and the wider public benefit; and

- that experts and others can contribute to improved policy development and more efficient financial performance by government through being able to access, manipulate and provide feedback on government-held data.

The proposed recreational catch API has very similar objectives, restricted to the context of recreational fisheries. For this reason, it is recommended that the NZGOAL framework be used directly. The framework has sufficient flexibility to cover the scenarios considered here, and tends to encourage users towards public access and terms that allow re-use of data. The NZGOAL framework has been developed by adapting and refining the Creative Commons (CC) licensing framework, which is internationally recognised, simplifying explanation of the data use framework.

Generally, the NZGOAL provides guidance to government agencies that hold data resources to encourage them to make data freely available under the NZGOAL license, and to ensure that data can be easily re-used by individuals, non-profit, and commercial organisations. The recreational catch API is intended to accept data from a wide range of data sources, both organisations and individuals. For this aspect, it is important that users contributing data understand the license agreement, and select a license where necessary. Based on the importance of the license agreement, it is recommended that a license is associated with all data provided, and that the license options are restricted to one of the options provided by NZGOAL. These options have some flexibility, are easily comprehensible, and are recommended by the DIA. The specific clauses for the NZGOAL licenses (in the context of data usage) are:

Attribution - Data users must credit the original creator of the shared data. All Creative Commons and NZGOAL licences require users to provide attribution.

No derivatives - Data users can share the shared data, but they must not change it. Note that users still have the range of use rights granted to them under the Copyright Act 1994.

Non-commercial - Data users may not share, adapt or reuse the shared data if their use is primarily intended for commercial advantage or monetary compensation.

Share-alike - Data users who adapt or remix the shared data must use the same or equivalent Creative Commons license on any derivative works they share.

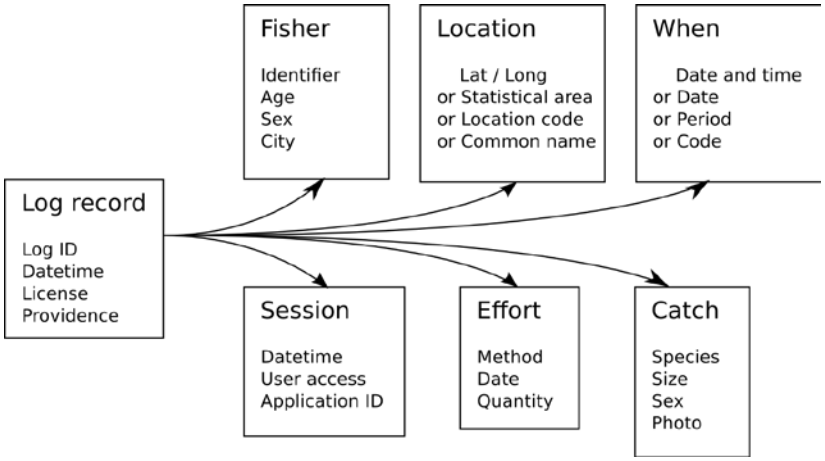


Figure 5: Simplified diagram of a star schema, applied to a recreational fishery context.

The database supporting the API should store a reference to one of these licenses above. Any data requested from the database can then have a terms-of-use document referencing the appropriate license. Based on the above options, six possible licenses can be created, and they are nested in that they can combine content with different licences by selecting the more specific of the two options.

6.3.4 Use a star schema structure for data and entity structure

The recreational catch API requires a data model to be defined. The model reflects real-world concepts in the recreational fishing context, such as location, time, fish species, and other concepts arising from the use of the API itself, such as sessions, transactions, access tokens and license terms of use. Between the concepts in the data model there are references, and the combination of all concepts and references represents a conceptual schema.

It is recommended that a star schema structure be used for the recreational API (see Figure 5). The centre of the star, holding references to all the other structures, is the concept of a log record. The flexibility of a star schema allows the other, hierarchical structures to be supported as views on the data. Star schema are used in a number of data-warehousing contexts, and for reporting systems (Adamson 2010).

6.3.5 Use the documentation of the API to communicate requirements

There are standard, machine and human readable representations of RESTful APIs, such as the Swagger representation standard (http://swagger.io/). Potential users of the API, and the developers writing applications to access it, can use the reference as a way of clearly communicating good practice. This includes expectations around what data should be provided, how the data transactions should be sequenced, and non-functional aspects such as forcing a decision around licensing and terms of use. Ideally, the documentation can be produced automatically from the software tools used to develop the API, ensuring tight consistency with implementation.

Scientific recommendations can also be embedded into the API documentation ensuring that both the API developers, and application developers, are aware of the any important considerations that effect the utility of data collected, such as the format of standard fields such as dates and fishing method codes.

7. DISCUSSION

The review of existing and potential stakeholder supported reporting initiatives presented here is by necessity not exhaustive, but it has broadly covered the types of programmes and technologies that could be used to inform the management of New Zealand's recreational fisheries in the future. Stakeholder supported reporting regimes can be broadly classified into two groups: those that are initiated by stakeholder organisations themselves, for a purpose which may not be directly related to resource management; and those implemented and supported by a government agency or third party, to address an existing management need and to engage with relevant stakeholders.

Most of the existing data collection programmes that have been reviewed here have been initiated by stakeholders for their own purposes, who may not have considered how the data could be used by fisheries managers. In addition, fisheries managers are often unaware that these sources of information exist, and even when they are, they may not be available for public use.

In many cases the management utility of these stakeholder driven data sources could be improved considerably if further thought were given to the types of information collected and if data collection protocols were improved. For example, fishing clubs rarely if ever record information on effort by target species, and effort associated with unsuccessful trips is often ignored. This compromises the wider use of the data collected. The additional collection of fish length measurements would also be beneficial. Another common limitation of data collected by recreational stakeholder organisations is that the collation of data is usually paper based, although some organisations are starting to record their data electronically. Electronic data entry both increases the likelihood that data will be available and used in the future and provides a basis for the grooming of any data collected. The Fish4All smartphone app that has been recently released provides a good example of how stakeholders could use readily available technology to collect data, but some changes have to be made before the data it collects can be used to inform fisheries management.

Recreational fishers are often frustrated that the information they provide is not used by fisheries managers. Fisheries managers and researchers are often concerned about data representativeness and data quality problems. This situation could be addressed proactively by frank, constructive and ongoing discussions about how and why data are collected, and how they could and could not be used. Fisheries research conducted by experienced researchers has benefitted greatly from peer review processes, especially that provided by MPI working groups. However, grass roots data collection initiatives have been undertaken in isolation, with very limited opportunity for informed feedback that could improve the utility of the data they collect. Most members of the public are not aware of the rigour with which formal fisheries research is reviewed in New Zealand and do not understand the benefits of this process for all concerned. Also, many research providers are not aware of MPI's Research and Science Information Standard for New Zealand Fisheries and it is not at all surprising that members of the public outside of the research community are also unaware of this document, despite the fundamentally important principles it codifies.

Although most of the data collected by recreational stakeholders and organisations has not been used by fisheries managers, the gamefish sector has provided some notable examples of cases where the recreational sector has provided valuable data that has informed fisheries management. Information provided by the New Zealand Cooperative Gamefish Tagging Programme, and associated data provided by the New Zealand Big Gamefishing Council and Billfish Logbook Programme, have been used in

assessments of the southwest Pacific striped marlin stock undertaken by the Western and Central Pacific Fisheries commission (Davies et al. 2012). Data from these programmes are reviewed by an MPI Working Group on a regular basis and the availability of these data is widely known.

The development of self-reporting tools for recreational fishers by third parties such as government agencies is much less common. However, these may become more common as emerging communication technologies improve the potential to collect data from fisheries that are hard to assess by standard survey methods. Agency initiated programmes are more common in Australia, such as the REDMAP and RAP programmes, but the ongoing resourcing to maintain these programmes is considerable. One of the challenges with maintaining third party initiated programmes will be building and maintaining the interest of participating recreational fishers, as the use of the data they provide may be less evident than it would be for a programme maintained by their own fishing club or association. Regular feedback would be required to demonstrate the value of the data collected, which will also require resourcing.

In a related experience, CSIRO researchers worked with recreational fishing representatives in an attempt to develop a volunteer assisted Time Location Sampling programme to collect catch effort data on infrequently caught commonwealth species such as longtail tuna (Griffiths et al. 2010). The authors concluded, however, that

> *"It may be possible for this method to be undertaken using community involvement of recreational fishing groups to significantly reduce labour and travel costs, although this is unlikely to be successful in all reporting regions in the long-term. A significant effort was made in the present study to engage the recreational sector in the current research, since the project directly deals with a 'recreational-only' species for which we suspected there would be substantial support. Unfortunately, significant difficulties were encountered with recruiting volunteers and reliability issues with non-scientific personnel, which indicates that full scientific quality control is required for this method to be implemented unsuccessfully."*

Recreational stakeholders may also be sceptical about how others intend to use data that they provide. The intended use of any data and resulting benefits will need to be clearly demonstrated to stakeholders. The REDMAP website programme in Australia provides an exemplar of how this has been done. Participants can both upload their data to the site and download related research provided through existing channels. This creates an engaging, information sharing environment. Thought should be given to how a self-reporting programme for recreational fishers could be introduced and maintained, as well as the level of resourcing required.

The rationale for developing a self-reporting programme that recreational fishers can use to provide data to inform fisheries management is not necessarily aligned with their motivation for going fishing in the first place. For many, recreational fishing is a release from the rigours of society, and any request for them to consistently provide data could be seen as an unnecessary imposition. The origins of any self-reporting system shapes both the means by which data are collected and the motivations for reporting any data that are provided. Data collection programmes initiated by recreational fisher stakeholder organisations have mostly been established for social purposes, to record the achievements of club members or for competitive purposes. These data are collected solely for the benefit of participants, which provides a motive in itself. The protocols associated with data collection programmes initiated for scientific purposes tend to be more rigorous than those initiated by stakeholder organisations, however, because greater emphasis is placed on describing processes in a more representative, complete and consistent fashion. The reasoning behind this scientific rigour is not necessarily apparent to those who are asked to provide data, and protocols often appear to be needlessly onerous, which lessens the motivation for participation.

The most productive approach may be to identify those areas where there is a management need for information, and an existing community of recreational fishers who are either collecting data for their own purposes, or where there is a strong commitment for a new stakeholder driven initiative. Research

providers could work collaboratively alongside stakeholders from the outset, and perspectives shared. Information provided by these programmes could be channelled through an API, the development of which has started as part of this project. A recreational catch API would provide a way for non-governmental organisations to easily provide data to MPI, and to engage with the fisheries management process. The API documentation would provide direction to the groups in terms of the kinds of data that should be collected, and how they would need to be encoded. The API would create a technical contact point, lowering the communication and training requirements. By following open standards, and using common guidelines recommended by other government agencies, accessing and using the API can be self-directed. The software development skills available in the community can be directly engaged, significantly lowering the cost of starting this process. An important consideration is that the API needs to be supported by a database, which can also provide a useful support for projects. As recommended in this report, the API should allow users to maintain any data they have provided.

The NZGOAL licensing framework provides support to community organisations by clearly recommending particular licensing options that enhance and encourage sharing and re-use of data. The API, by building the licensing framework into the system, would directly guide the fishing community to adopt these open licenses. The NZGOAL framework is part of a larger initiative across Government to support open access and open data projects.

As the recreational catch API would provide only a data transfer channel to the government, it would not automatically result in the creation of high-quality data. Although it would provide a mechanism to ensure data consistency, the provenance of data provided would need to be reflected through tools supporting the system, such as data catalogues. Evaluating the quality of data collection projects would be aided by the API through the provision, or referencing, of documents that make it possible to carry out the evaluations. As recommended, the API should be supported by a project that can adequately develop the accompanying documentation and engage with potential users. Support would also be required so that the stakeholder organisation providing the data could present their information to MPI, and especially to MPI's Marine Amateur Fisheries Working Group. This would allow feedback to be provided in a similar manner to that given to other fisheries research.

Methods and Critical Success Factors are proposed that can be used to evaluate self-reporting tools for recreational fishers and the information they provide. A comparative approach to assessing a tool is recommended, as there is often not possible to determine whether a data source is biased from the available data itself. A second concurrent data source provides a "second look" at the same fishery. This should be independent of the data source it is being used to assess, and ideally designed using scientific methods with comparative purposes in mind from the outset. The methods proposed in this report are only indicative, as the context that any self-report tool is created in will at least partially determine the best evaluation approach.

Comparative tests will not always be possible. Either because the data being evaluated are no longer collected or because there is no cost effective means of collecting comparative data. In these cases the only remaining option is to evaluate the data itself. The proposed Critical Success Factors can be used to help determine if data provided by recreational fishers can be used for a specific purpose.

Finally, there are other considerations that will have to be considered if recreational self-report data are to be used for management purposes, which fall outside of the scope of this project, which we will document here nonetheless. These are:

- Who owns self-reported data and who will have access to these data and in what format?
- Will the data be stored in a centralised database or will it be held in a distributed form (remotely) on third party databases?
- Will information provided by fishers be available to them in return, and how will this be done?

- Will any data provided by third parties be subject to Official Information Act requests (OIAs); or are these data deemed to be private; or should such requests be denied because they may undermine the future provision of such data?
- What resources will be required from MPI to maintain fisher participation?
- What resources will be required from MPI to maintain any system or data repository over the long term?
- How are questions phrased when questions are asked and how consistent is this phrasing across differing programmes?
- When is proxy reporting (by someone other than the fisher) acceptable?
- How does early adopter thinking affect uptake of any programme and influence its evolution?
- What happens when data are provided but they are deemed unusable and how will MPI manage expectations?

In most cases better and more consistent outcomes will be achieved if these questions are considered from the outset when developing such programmes.

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