Measuring non-commercial fishing catches (traditional fishing) in the Torres Strait

In order to improve fisheries management and promote sustainable livelihoods

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In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

Cover photo: Mabuiag workshop. Photo credit: Tim Skewes

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Abbreviations

ABS	Australian Bureau of Statistics
AFMA	Australian Fisheries Management Authority
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies
AI	Artificial intelligence
API	Application programming interface
ATSI	Aboriginal and Torres Strait Islander
BoM	Bureau of Meteorology
CDU	Charles Darwin University
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
EMSA	Ecological Monitoring System Australia
FFRAG	Finfish Resource Assessment Group (PZJA)
FRDC	Fisheries Research and Development Corporation
GBK	Gur A Baradharaw Kod (Peak PBC body for Torres Strait PBCs)
GBRMPA	Great Barrier Reef Marine Park Authority
IMAS	Institute for Marine and Antarctic Studies
NPA	Northern Peninsula Area
IP	Intellectual Property
PBC	Prescribed Body Corporate
PIRSA	Department of Primary Industry and Regions South Australia
PNG	Papua New Guinea
PZJA	Protected Zone Joint Authority
QDPI	Queensland Department of Primary Industries
RNTBC	Registered Native Title Body Corporate
SARDI	South Australian Research and Development Institute
SPC	Secretariat of the Pacific Community
TERN	Terrestrial Ecosystem Research Network
TIB	Traditional Inhabitant Boat
TO	Traditional Owner
TRL	Tropical Rock Lobster (*Panulirus ornatus*)
TSI	Torres Strait Islander
TSSAC	Torres Strait Scientific Steering Committee (PZJA AFMA)
TSIRC	Torres Strait Island Regional Council
TSRA	Torres Strait Regional Authority

Glossary

Aboriginal	The term 'Aboriginal' in this study will represent the first people of Australia and 'Torres Strait Islander' will represent the first people of the Torres Strait Islands. It is acknowledged that these broad terms reflect culturally and linguistically diverse groups of people.
App	An application, especially as designed and downloaded for a mobile device such as a smartphone.
Commercial fishing	Fishing activity that is undertaken with the goal of selling the catch.
Desktop application	A software program that runs locally on a computer device; is not accessible from a browser and requires installation on a personal computer.
Indigenous peoples	'Indigenous' refers to global communities that reflect many heterogenous cultures, nations and diversity across the globe (after Cubillo *et al.* 2023).
Kai kai	Torres Strait community word for food or eating.
Native app	A software program that's custom-made for a particular type of device or operating system. They are built to work on specific platforms, like iOS for Apple devices or Android for Android devices. They are usually fast and efficient because they're designed to make the most of the device's abilities. They can also interact with the features a phone or tablet, such as the camera, GPS, and motion sensors.
Non-commercial fishing/fisheries	Broadly defined as fishing for food, customary purposes, or leisure but excluding the sale of fish or marine products.
Recreational fishing	Broadly refers to fishing for leisure, exercise or competition in the context of the Torres Strait and NPA area by people who are not considered Traditional Inhabitants as per the Torres Strait Treaty. Note: for the purposes of this report, this does not include traditional fishing.
PZJA	Protected Zone Joint Authority, comprised of the Commonwealth Government Minister responsible for Fisheries (the Chair), the Queensland Minister responsible for Fisheries and the Chair of the TSRA. The PZJA is responsible for management of commercial and traditional fishing in the Australian area of the Torres Strait Protected Zone (TSPZ) and designated adjacent Torres Strait waters (Quoted from Nakata 2018). PZJA agencies include the Australian Fisheries Management Authority, the Torres Strait Regional Authority and Fisheries Queensland. These agencies are responsible for advising the PZJA on all aspects of Torres Strait fisheries management.
Sex and gender	"Sex and gender are related but different. Sex refers to biological attributes which are used to categorise people as female, male or intersex. Gender, rather than being biological, refers to the social attributes, roles, activities, and responsibilities which are associated with being men and women in a particular community at a given time. These are determined by social norms, power, and institutions. There are a wide variety of gender identities between and beyond the binary of men and women" (Quoted from House *et al.*, 2022).
TIB fisher	Traditional Inhabitant fishing commercially under a Traditional Inhabitant Boat, or TIB licence.

TIB licence	Traditional Inhabitants in the Torres Strait require themselves and their vessel to be licenced under a Traditional Inhabitant Boat, or TIB licence to fish commercially (for sale). TIB licences are endorsed for specific fisheries (e.g. Spanish Mackerel, Reef Line and Tropical Rock Lobster).
Traditional fishing	The Torres Strait Treaty describes traditional fishing as "the taking, by Traditional Inhabitants for their own or their dependants' consumption or for use in the course of other traditional activities, of the living natural resources of the sea, seabed, estuaries and coastal tidal areas, including Dugong and Turtle" (*Torres Strait Treaty*, 1985).
Traditional Inhabitant	The Torres Strait Treaty defines a Traditional Inhabitant, in relation to the Australian jurisdiction, as "persons who (i) are Torres Strait Islanders who live in the Protected Zone or the adjacent coastal area of Australia, (ii) are citizens of Australia, and (iii) maintain traditional customary associations with areas or features in or in the vicinity of the Protected Zone in relation to their subsistence or livelihood or social, cultural or religious activities" (*Torres Strait Treaty, 1985*).
Non -Torres Strait Islander	People who are not considered to be 'Traditional Inhabitants' as per the *Torres Strait Treaty (1985)*.
Torres Strait Islander	Generally, refers to people living or originating from the Torres Strait region and who are the Indigenous Melanesian people of the Torres Strait Islands.
Torres Strait region	The Torres Strait stretches 150 kilometres northwards from Cape York Peninsula to Papua New Guinea and up to 300 kilometres from east to west. This 48,000 km^2 area includes more than 270 islands and reefs. It covers 17 inhabited islands of the Torres Strait and two communities of Bamaga and Seisma on the Northern Peninsula Area of mainland Australia. It includes the area known as the Protected Zone area as per the Torres Strait Treaty and communities adjacent on the mainland of Australia. The Region is complex with many different overlapping jurisdictional and legislative boundaries.
Torres Strait traditional Fishery	Broadly, the participants, gear, habitats and species that are subject to traditional fishing in the Torres Strait. In Torres Strait this includes up to ~200 species, including dugong and turtle (which are also treated separately as a sub-fishery with specific management arrangements) and also including some species that are managed as commercial fisheries (such as the Torres Strait Torres Strait Spanish Mackerel Fishery, the Torres Strait Finfish (Reef Line) Fishery (both sub-fisheries of the Torres Strait Finfish Fishery), and the Torres Strait Tropical Rock Lobster Fishery.
Traditional Owner	Traditional Owners – Native Title Holders or claimants. Relating to Torres Strait research, Traditional Owners are most commonly engaged through the relevant Registered Native Title Body Corporate (RNTBC) (Nakata 2018).
Web-based app	A form of software that lets users connect with a remote server via a web browser. It is accessed using a web browser and is delivered on the World Wide Web to users with an active network connection. It differs from a standard website because its outer appearance and functionality resemble those of a native application more than a website.
Zenadth Kes	Zenadth Kes is an alternative term for Torres Strait acknowledging all the five cluster groups in the region.

Executive summary

Introduction

Traditional fishing in the Torres Strait Region has, and continues to be, important for livelihood sustainability for all Torres Strait Islander communities, providing a source of *kai kai* or food, nutrition and other social, cultural and spiritual benefits. Protection of the marine environment and maintenance of traditional activities, such as traditional fishing, are key pillars of the *Torres Strait Treaty (1985)*.

The long-term sustainability of all fisheries in the Torres Strait region requires reliable catch data from all sectors, including commercial and non-commercial (traditional and recreational). This data is not only a priority for managing key commercial species, such as Spanish Mackerel (*Scomberomorus commerson*), Coral Trout (*Plectropomus* spp) and Tropical (Ornate) Rock Lobster (*Panulirus ornatus*), also caught by traditional and recreational sectors, but also for the many other traditionally fished species that communities rely on. Commercial fisheries have management programs in place and data contributes to assessments that are central to management decisions. However, fish catches from the traditional and recreational fishery sectors are largely unquantified, except for some historic snapshot surveys and are either currently not monitored, or only in a very limited way. Torres Strait Islanders have expressed concern for their traditional fisheries and the need to protect them to ensure food security needs. Monitoring traditional fishing catches from both traditional and recreational fishing sectors has also been identified as a high priority in numerous Protected Zone Joint Authority (PZJA) fisheries committees over recent years. This project aims to contribute knowledge to support a future monitoring program to address these data gaps.

Background

A scoping study conducted in 2021 (Bedford *et al.*, 2021) showed that: i) a non-commercial fishery information system is supported by many Torres Strait Islander leaders; ii) a technology-based, self-reporting tool, such as a smartphone app, is likely to be the most cost-effective option to meet the needs of Torres Strait Islanders to record catches; and (iii) a fishery information system would provide many benefits to Torres Strait communities.

Torres Strait Island communities desire information to manage their local traditional fisheries. A monitoring program could substantially contribute information to assist in locally based management as well as allow for medium to longer term responses to impending changes in fish populations from climate change or other threats. The need for monitoring and managing traditional and customary Indigenous fisheries is of significant national interest in all State and Territory jurisdictions. This report provides foundational information through a Torres Strait case study to further support this national agenda for Indigenous fisheries. The Fisheries Research and Development Corporation (FRDC) co-funded this research with the Australian Fisheries Management Authority (AFMA) due to the national significance of the project. This project addresses the next stage of foundational research in developing a traditional fishing monitoring program in the Torres Strait as recommended and supported by the PZJA Torres Strait Scientific Steering Committee (TSSAC).

Objectives

The aim of the project is to share information and collate the views of Torres Strait community members and other stakeholders about a traditional fishing catch recording system.

The project addressed three main objectives:

1. Collate and review existing and new information about the potential options for a non-commercial fishery monitoring program as recommended by Bedford *et al.* (2021).

2. Assess the level of community need and support (or otherwise) for a non-commercial fishery monitoring program through a comprehensive and equitable community consultation and participation process throughout Torres Strait and Northern Peninsula Area communities.
3. Develop cost and performance options for a non-commercial fishery monitoring program and its components (e.g. self-reporting web-based tool/app platform; data management, storage and access; complimented surveys) to allow for an assessment of value (e.g. meeting needs, ease of use, maintenance and data use in stock assessments).

Method

The project was implemented by a multidisciplinary team of four people with an Indigenous project leader. We undertook a series of multi-staged phases and activities during 2022-24 including planning and preparation, community workshops, app design and development and final reporting, communication and engagement. The project carried out community engagement throughout the Torres Strait and NPA (Northern Peninsula Area) to assess the level of community need and support for the implementation of a fishery monitoring app and co–design of its key features. We were able to carry out 15 of the planned 17 community workshops, with two communities not visited for reasons beyond our control. A total of 142 workshop attendees were engaged (106 male and 36 female), though turnout at some of the workshops was limited by community members having other commitments and general community workshop fatigue in the region.

The community engagement approach applied a strong ethical process, with Free, Prior and Informed Consent obtained from community members followed by the sharing of community workshop summaries with participants immediately after the workshops. This approach has been recognised as valuable for future TSSAC supported research in the region with our resources already being requested by another recently funded TSSAC supported project.

At each community visited, we followed a set 2–3 hour workshop agenda (during a weekday) with sessions and corresponding information elicitation exercises on:

- non-commercial fishery monitoring needs and community support;
- local community's non-commercial fishery monitoring priorities;
- community views about implementing a monitoring app; and
- co-design of the app (e.g. outputs, features, barriers and incentives to use and governance).

Methods to review current fishing apps and app design development options included a brief review of published and unpublished literature and web site information on existing apps, key issues, best practice, app design and development options relevant to Indigenous and recreational fishing contexts. We also conducted semi structured interviews with current fishing app custodians and technology and app developers.

Results

Review of fishing apps, costs and options

A review of current fishing apps demonstrated that they are fast becoming the main monitoring tool in Australia and globally for recreational fishing. All Australian States and the Northern Territory government have developed fishing apps to support recreational fishers. While all recreational fishing apps provide useful information for fishers, not all collect fishing data. A range of private/non-government fishing apps also exist for both information provision and for collecting catch data (e.g. to support fishing competitions). However, there are no fishing apps specifically designed for traditional fisheries. Although in some countries in coastal communities, apps have been developed to support commercial fisher businesses or as a fishery independent data collection tool.

Interviews with Australian app custodians and app or technology developers, along with reviews of the literature and websites provided useful advice for designing a traditional fishing app in the Torres Strait. In general, the results covered a range of similar app features and app development principles aimed at motivating fishers to use the app into the long-term. App features and design principles focused on a range of key issues including:

- Ease of use (e.g. simple display, few button clicks, simple or automated data entry);
- Provision of useful information (e.g. weather reports and safety alerts, fishing information etc);
- Provision of fishing record (e.g. personal catch records and analytics, fishing spot geolocation);
- Having an engaging experience (e.g. links to social media, periodic introduction of new features); and
- Data privacy (e.g. secure but simple private login, data privacy agreements).

The information collated from the development and use of current apps can be used in conjunction with the information from Torres Strait communities during the co-design workshops to guide the development of a bespoke fishing app to help monitor traditional fishing.

Our research into current apps also revealed that, although apps are being used to monitor recreational fishing, there are substantial challenges in data interpretation. Self-reporting of fishery data inevitably contains biases based on the representativeness of the fishing behaviour of people more likely to use the app. To this end, there is research underway in Australia to better understand these biases and to translate self-reported fishing app data into catch data that is representative of the whole fishing population.

Obtaining information on the costs of developing a fishing app was a challenge without being able to commit to a possible business partnership. As a result, the costing information we collated varies in terms of their proposed scopes, their accuracy or generality and the engagement and business strategy being used by each expert, and consequently, the costs provided.

The Queensland Department of Primary Industries (QDPI) have recently developed the *QLD fishing 2.0* app for monitoring recreational fisheries in Queensland. We do not recommend that the *Qld fishing 2.0* is used to monitor the Torres Strait traditional fishing due to substantial trust issues that Torres Strait Islanders expressed for government agencies holding their personal fishing data, as well as the need for bespoke design of a range of app features that will create a stronger sense of understanding and ownership by fishers and leaders. However, we do recommend that the *QLD fishing 2.0* app is suitable for monitoring recreational fisheries in the Torres Strait by way of a collaboration between the PZJA and QDPI to promote and, if possible, stipulate the use of the *QLD fishing 2.0* app by recreational fishers while fishing in Torres Strait waters.

Community co-design and support

Despite the challenges, the community consultation, in our view, provided a comprehensive view of Torres Strait Islander people's needs and attitudes to the implementation of a non-commercial fishery monitoring app. Overall, we found strong support among workshop attendees for the implementation of a non-commercial fishery monitoring app underpinned by a range of individual and community needs, with the broadly expressed caveats that the information provided must be suitably protected and sensitively handled. There was also concern about potential negative consequences and some apprehension about possible prosecution. These concerns, along with some small levels of general mistrust and local fisher apathy highlight the need for a significant and targeted communication and behavioural approach program to accompany any app rollout, and that it will be difficult to get complete app user coverage of the non-commercial catch, emphasising the importance of a complementary data collection program to scale up the app data.

The data custodian was acknowledged as an important aspect of the app rollout without any strong preference being identified. There were some views expressed that a new community-based organisation

would be appropriate – and some made the comment that it should not be "government". Whoever is eventually tasked with this will need to establish trust that the information is sufficiently protected and handled sensitively.

The workshops collated a broad range of species (>94 species or species groups) that underpin the traditional take, with large regional differences. However, the commercial species - Spanish Mackerel, Coral Trout and Tropical Rock Lobster - were often listed among the highest priorities for monitoring by community members, which is consistent with the original goals of the monitoring program to provide information for the sustainable management of these species.

A wide range of outputs and features were recommended from the workshops, mostly related to individual and community level information needs; the most common being information about the catch and local and regional management rules. Providing this information will be a critical value proposition for the successful implementation of a fishing app. A broad range of barriers and incentives were also compiled, most of which have been integrated into the governance and best practice principals.

Recommendations

We make two primary recommendations. The first applies to the development and support of a pilot program for a bespoke traditional fishing app in the Torres Strait (separate from the recreational fishery program); and the second, to support concurrent promotion of the Queensland Government recreational fishing monitoring app (currently using the *Qld fishing 2.0* app) program to monitor the Torres Strait recreational fishery.

Recommendation 1: Implement a two-to-three-year Torres Strait traditional fishing monitoring app pilot program with the following components:

a. A governance structure and agreement that includes:
   i. Consideration of a trusted, Indigenous-focused implementing agency/entity (or interim arrangement initially if required) to carry out the pilot program rollout. The implementing organisation should have experience in managing projects and collaborating with Indigenous communities. This entity could outsource the app design and build.
   ii. A trusted, Indigenous-focused primary data custodian to hold the data and carry out analytics. This agency/entity should be identified and resourced to carry sufficient digital hardware and analytical capacity for ongoing program support. This entity could be the same as the implementing agency above.
   iii. Agreement between the primary data custodian and individual fishers using the self-reporting app (including with Free Prior and Informed Consent) required to facilitate app sign on to the fishing app. This agreement should include plain Language English and community approved local language text; an explanation of provisions for explicit opting in for sharing data, a privacy statement ensuring privacy of data, and stipulation that any information collected will not be used against that individual but may be used to guide regional commercial fishery management.
   iv. Agreements with community organisations to support the program, research activities and to receive aggregated fishery catch data for local needs.
   v. Agreements with regional fisheries agencies for receipt of aggregate data for use in stock assessment and catch allocation requirements.
   vi. Provision of local support personnel and local champions (men, women and other genders where appropriate) to encourage and facilitate app use.

b. Set up app user sign on, protection and authorisation provisions that include:
   i. Individual private sign on and password protection for users to manage membership and regulate data upload, access and usage.

      ii.   Explicit and regular informed authorisation for inclusion of individual data for community and regional catch summaries.

     iii.   Consideration of age usage guidelines to ensure youth data representation.

c. Bespoke app design with priority features, including:

      i.   Basic demographic information at sign-on (e.g. gender inclusive, age, community affiliation).

      ii.   Ability to record daily catches by individuals or small fisher groups (e.g. family group or fishing trip group), either through input fields (e.g. for species identification and numbers caught) and/or photographic evidence.

     iii.   Use of local language where appropriate in the app, including for fish names, cross referenced with the FRDC Australian Fish Names Standard (for species and species groups) to support a common species identification for reporting and fishery stock assessments.

     iv.   Ability for fishers to report their app record completeness (e.g. estimate fishery app record completeness monthly).

      v.   Fisher-catch information summaries shared/accessible to the fisher/user at self-selected time periods (e.g. daily, weekly, monthly, yearly).

     vi.   Access to biological and ecological information on catch species (e.g. key species identification criteria, size at maturity, breeding season, sexual dimorphism characteristics, feeding habits, age at length information).

     vii.   Ability for users to share catch information with other users (e.g. through a range of social media platforms such as Facebook, Instagram, X, Snap Chat, WhatsApp or other community approved platform sharing).

     viii.   Access to local and regional fishery management regulations.

     ix.   Ability for users to record observations (e.g. provision for notes) in the app to document issues of importance or concern to users, for example, environmental or biosecurity information (which could also be available for broader information sharing with other local app users, community or regional organisations).

      x.   Ability for users to provide feedback about using the app or the program's processes; and should include ability to prompt users to provide this feedback, update the app at regular intervals in response to feedback, and follow up with the user.

     xi.   Weather, sea conditions and other warnings or marine safety alerts.

     xii.   Ability to report issues with app usage – i.e. trouble shooting features.

d. Design and implement a complementary data collection program to accompany the app pilot program to:

      i.   Collect data from a randomly selected and adequate sample of individual community members to provide data to estimate:
- how many fishers are participating in the program out of the total community fishing population.
- how well the app participation group represents the average fisher in the community (e.g. avidity and representativeness of all social and gender groups); and
- estimate of how well an individual's app catch data represent their actual catches.

      ii.   Use the complementary data to adjust and expand the app data to produce catch estimates for the target community.

     iii.   The data collection method could include phone interviews and, in cases where this is not possible, face-to-face interviews with community champions.

     iv.   Make recommendations for improving the utility of the complementary data collection program to reliably achieve the above objectives

e. Finalise the app design process with at least two or three diverse communities (as a minimum), who agree to host the pilot program, including:

      i.   Engagement with relevant community stakeholders to identify the most suitable pilot program communities to work with to develop and trial the monitoring app.

      ii.   Adequate planning with two or three selected communities to (i) discuss and clarify the proposed app governance model and expectations, (ii) identify local community champions for the app trial and, (iii) design the necessary and bespoke app features for each community, including the use of locally identified cultural and language considerations.

  f.   A Communication and Behavioural Approach Program to support and increase pilot app uptake, and share information including:

      i.   Communication strategies and tools community co-designed and approved with local champions, consistent with community attitudes, cultural protocols, language, and gender inclusivity.

      ii.   Key messages designed and delivered on:

- how data is being used and the benefits of the program (e.g. local management and fisheries sustainability);
- debunking fears of IP loss and prosecution, and provision of Indigenous Knowledge (approved to be shared);
- removing other barriers to usage;
- sharing feedback from individual users and community;
- celebrate achievements, and
- evaluation of success

      iii.   Implementing program components including:

- establishing local community champions (training and ongoing support) to help promote the program, assist fishers to use the fishing app and assist with the complementary data program.
- incentives (e.g. competitions, give aways, awards)
- regular information sharing posts and updates on the app usage, upgrades, advertising to promote sign up of new users;
- school-based program to support youth and,
- other gender specific activities to support use by different social groups of men and women (and youth) users.

  g.   Design of a data analytic and feedback process that delivers individual and grouped (e.g. community or Torres Strait level) catch data summaries back to app users, community organisations and external agencies.

  h.   Pilot program participatory evaluation which includes identifying key indicators and assessing outcomes with key governance stakeholders and communities to evaluate the pilot program outcomes.

  i.   Establish a Traditional fishery monitoring program advisory forum or group:

      i.   Provide feedback and guidance on the Traditional fishery monitoring program, especially the Communication Program (and potentially other Traditional fishery issues) and promote effective communication with Torres Strait communities

      ii.   Membership could include Torres Strait representative bodies (e.g. GBK, TSIRC, TSRA) and at least one representative from each cluster (including inner islands and NPA regions)

      iii.   The advisory forum could be part of the existing PZJA committee structure or, a new standalone advisory body.

Recommendation 2: Implement a Torres Strait non-Indigenous recreational fishing monitoring program using the existing QDPI recreational fishery monitoring app with the following activities:

a. PZJA collaborate with the QDPI recreational fishery monitoring program to coordinate fishery communication activities and data flow/accessibility into the PZJA assessment processes.

b. Promote and/or specify (e.g. through existing community visitor sign-in arrangements) the use of the *QLD fishing 2.0* recreational fishing app (in partnership with QDPI) for recreational fishers in Torres Strait communities through the community visitation agreement.

c. Facilitate provision of annual, species-specific, non-Indigenous recreational fishing catch data from the QLD *fishing 2.0 app* to the PZJA for fishery assessments.

Keywords

Torres Strait, fishery monitoring, traditional fishing, fishing app, community co-design, recreational fishing, community fisheries.

Introduction

Torres Strait and Fisheries Monitoring

The Torres Strait Region is located between Cape York Peninsula in North Queensland on the Australian mainland and southern Papua New Guinea covering approximately 300 kilometres from east to west, 48,000 km^2 in area includes more than 270 islands and reefs. Of these there are 17 inhabited islands in the Torres Strait and two communities of Bamaga and Seisma on the Northern Peninsula Area of mainland Australia. Approximately 4,124 people reside in the region (ABS, 2022). The region includes the Protected Zone area as per the *Torres Strait Treaty (1985)* as well as many different jurisdictional, fishery and legislative boundaries overlapping, including recent Torres Strait extensive areas of native title sea claim determinations.

Traditional fishing in the Torres Strait Region has, and continues to be, important for livelihood sustainability of all Torres Strait Islander communities and genders, providing a source of food, nutrition and other social, cultural, and spiritual benefits (see Bedford *et al.*, 2021 and citations therein) (Figure 1). Protection of the marine environment and traditional activities such as traditional fishing for food or other cultural purposes are key pillars of the *Torres Strait Treaty (1985)*. Recreational fishing (non-commercial fishing by non-Torres Strait Islanders) for food and leisure purposes is a popular sport and social activity and has been identified as a growing concern on traditionally fished resources in the region (AFMA Finfish Resource Assessment Group Meeting, pers comm, 2021).

Figure 1. Traditional fish catch from Warraber in the Torres Strait (Photo: David Brewer).

Many Torres Strait islanders also fish commercially and are engaged in a range of commercial fisheries and associated trade in the region. Commercial fisheries also provide substantial livelihood and wellbeing benefits. The commercial fishery sectors operating in the Torres Strait Protected Zone Joint Authority (PZJA) region have compulsory monitoring programs in place (for example through fisher and operator logbook and/or catch disposal records) (Figure 2). These data contribute to fishery stock assessments that are central to the regions' fishery management decisions.
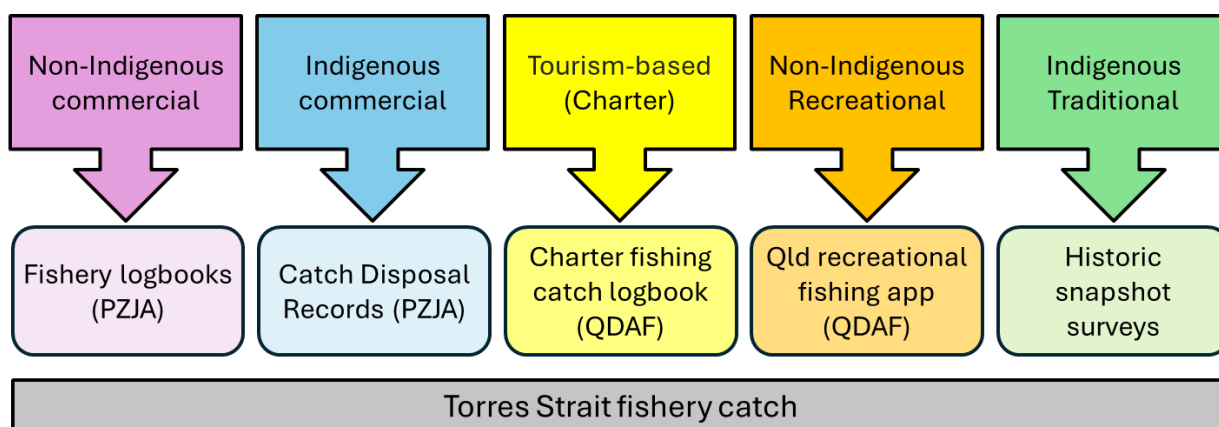
Figure 2. Fishery catch sectors in Torres Strait and data collection programs. PZJA – Protected Zone Joint Authority, QDPI – Queensland Department of Primary Industries.

However, fish catches from the traditional and recreational (non-commercial) fishery sectors are largely unquantified. For the Torres Strait traditional fishing sector, there have been some historic snapshot surveys (see Bedford *et al.,* 2021 for an overview of past monitoring of traditional and recreational sectors). However, this sector is not monitored and there is no agency that focuses on management of this fishery. This results in broad estimates being made within some PZJA management committees for the take of commercially managed species by traditional fishing, usually based on out-of-date, limited scope studies or some other derived estimate (e.g. Figure 3).

The Queensland Department of Fisheries (QDPI) have responsibility for managing Queensland's recreational fishing sector, including the Torres Strait. For recreational fisheries, current monitoring in the Torres Strait is limited to remotely based surveys by phone on a prorated population size basis, as part of the broader Queensland program. However, recent monitoring of Torres Strait recreational fishers showed low numbers of fishers being engaged (resulting in low confidence in the results for this region (QDAF, 2019). This recreational fishing monitoring approach has also previously been assessed as an inappropriate method for monitoring traditional fishing in the Torres Strait region (Bedford *et al.,* 2021).

Consequently, the assessments for commercially important species, such as Spanish Mackerel (*Scomberomorus commerson*), Coral Trout (*Plectropomus* spp) and Tropical Rock Lobster (TRL) (*Panulirus ornatus*)[1], have substantial information gaps regarding the total take from each fishery. For example, the Torres Strait Finfish Resource Assessment Group (FFRAG) currently estimates that 20 tonnes of Spanish Mackerel in Torres Strait is taken by the non-commercial sectors (Figure 3) and this value is subsequently allocated to these sectors from the Recommended Biological Catch assessment. However, this estimate is based on information from historic data estimates (derived two decades ago from a small number of islands) and annually updated based on FFRAG Traditional Inhabitant members personal assessments. As discussed in the results section below, the 20 tonne estimate of traditionally fished Spanish Mackerel was discussed in most community workshops during this project and prompted a range of views ranging from being way too high to way to low, thus highlighting the need for more accurate estimates of catches from the traditional fishing sector. The trends in population status for an extensive range of other species fished for food and local trade in the Torres Strait are also largely unknown, either at the community, cluster or larger spatial scales covering the entire Torres Strait.

Therefore, if catches from traditional and recreational fishing in Torres Strait fish can be estimated effectively, the stock assessments for commercially important species will be substantially improved

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[1] The Tropical Rock Lobster (TRL) Fishery in Torres Strait is almost solely based on the Ornate Rock Lobster, *Panulirus ornatus*. Several other species of spiny rock lobster (Palinuridae) do also occur in Torres Strait (in lower densities) and are sometimes taken in the traditional fishery. While Ornate Rock Lobster is the accepted name for the main fishery species, it is locally referred to as Tropical Rock Lobster (TRL). Thus, we use TRL throughout the report.

through the increased certainty in the total mortalities (AFMA Finfish Resource Assessment Group, pers comm, 2023).
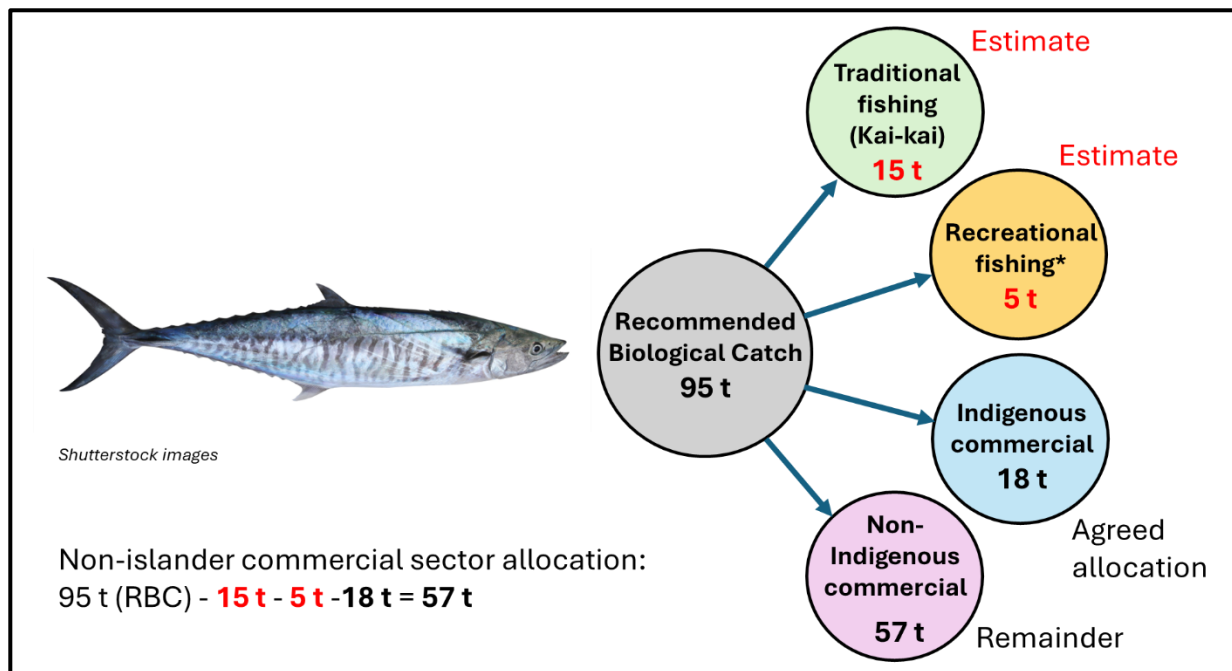
Figure 3. An example from 2022-23 of how catch sharing is allocated amongst the four fishing sectors including the estimated non-commercial catch sectors (in red). RBC – Recommended Biological Catch, Rec – Recreational fishing, TIB – Traditional Boat Inhabitant.

The long-term sustainability of all fisheries in the Torres Strait Region requires reliable catch data from all fishery sectors, including commercial and non-commercial (traditional and recreational). This data is not only a priority for managing key commercial species, such as Spanish Mackerel, Coral Trout and Tropical Rock Lobster, also caught by traditional and recreational sectors but also for the many other traditionally fished species that communities rely on (Harris *et al.*, 1995; Busilacchi *et al.*, 2013; TSRA, 2016). Consequently, there is a strong need to develop a culturally appropriate monitoring program with Torres Strait Traditional Owners to improve traditional fishing catch monitoring for ensuring sustainable fisheries management and food security needs (Moyle *et al.*, 2020; Nyboer *et al.*, 2022).

Background

In 2021, a recently completed scoping project funded by AFMA through the PZJA Torres Strait Scientific Advisory Committee (TSSAC) focused on developing an approach for monitoring non-commercial fishing in Torres Strait (Bedford *et al.*, 2021). The project reviewed past approaches and methods, carried out a broad consultation with Torres Strait community leaders and Islander representatives through a project steering committee and in a range of fishery fora (e.g. Torres Strait Resource Assessment Group and Working Group meetings), collated stakeholder needs, and completed an assessment of potential monitoring tool options. The team provided recommendations to the TSSAC which included implementing a phased approach to design and development of a future program. This scoping report and consultation resulted in strong and broad support for traditional fishery monitoring program for the Torres Strait, based on a community co-designed approach, for a self-reporting app and management system. To achieve this, the TSSAC recommended 5 steps to further design and implement a monitoring program. The next step should include a comprehensive community engagement and co-design process for the design of the monitoring program; scoping and costing the digital monitoring system (e.g. self-reporting app platform) and data management and protocols with pilot program activities leading to full regional implementation (Figure 4). The second phase forms the results of this report. As noted in the TSSAC committee meeting 79 minutes of June 2021, during the presentation of the scoping results study, the traditional fishing

monitoring project was an initiative of the quota working group subcommittee of the Torres Strait Regional Authority Board and identified as a priority by the Traditional Inhabitants (AFMA 2021). In particular, the minutes stated members "identified a need to improve estimates of non-commercial catch of commercial species to inform stock assessment and set sustainable catch levels, as well as determine the catch sharing between the sunset sector, and how much to keep for community consumption" (AFMA 2021:6), to protect traditional non-commercial catches and help ensure sustainable management.
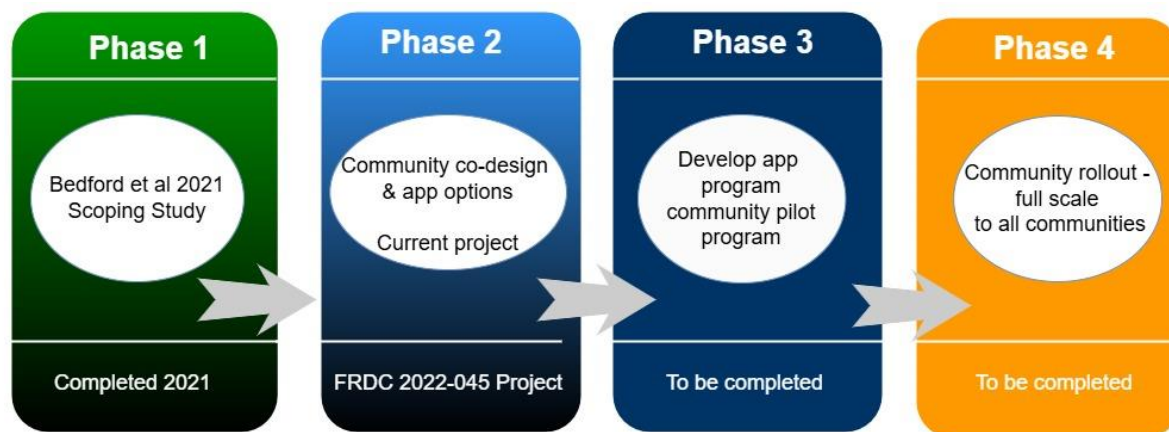
Figure 4. Phased approach to design and implement a traditional fishery monitoring program in the Torres Strait (adapted from AFMA 2021).

This project addresses the next stage in developing a monitoring program to complete a comprehensive and equitable community engagement program throughout all Torres Strait and Northern peninsula communities. To help design a digital monitoring tool for fish catches that will be appropriate for Torres Strait Islanders. As previous research has also shown, Torres Strait Island communities desire information to manage their local traditional fisheries (Bedford *et al.*, 2021). A monitoring program could substantially contribute information to assist in locally based management as well as allow for medium to longer term responses to impending changes in fish populations from climate change, or other threats from pollution or overfishing. The need for monitoring and managing traditional and customary Indigenous fisheries is of significant national interest in all State and Territory jurisdictions. This report provides foundational information through the Torres Strait case study to further support this national agenda for Indigenous fisheries.

Objectives

The aim of the project is to share information and collate the views of Torres Strait community members and other stakeholders about a traditional fishing catch monitoring program. Gathering data about traditional fishing catches in the Torres Straits will assist local communities and other organisations in their stewardship of fisheries resources for food security, livelihoods and wellbeing. This is not only a priority for key commercially fished and managed species, such as Spanish Mackerel, Coral Trout and Tropical Rock Lobster, but also for the many other traditionally fished species that communities rely on in the Torres Strait for food security, wellbeing and customary practices. This information will also support balancing traditional, recreational and commercial fisheries management in the region. The long-term goal of any future traditional fishing catch monitoring strategy is to *Reduce the risk of declining marine populations by using reliable estimates of catches*. If achieved, this will help to ensure that marine species will be available to fulfill the needs of traditional fishing into the future.

The project had three main objectives and associated performance indicators:

1. Collate and review existing and new information about the potential options for a non-commercial fishery monitoring program as recommended by Bedford *et al.* (2021)

Performance indicators:

    a. The design of a monitoring data collection tool (self-reporting web-based tool/app platform), database and analysis procedures;
    b. Policies for data collection, storage, management and access; and
    c. Agreement for complementary household surveys and indicative topics; and the potential inclusion of social and environmental data collection.

2. Assess the level of community need and support (or otherwise) for a non-commercial fishery monitoring program through a comprehensive and equitable community consultation and participation process throughout Torres Strait and Northern Peninsula Area communities.

Performance indicators:

    a. Descriptive summary of the community engagement activities to co-design the monitoring tool regarding the level of community need, support (or otherwise) and views by stakeholder, community and gender group for a non-commercial fisheries monitoring program; and
    b. Identification of potential communities for pilot program activities, and duration, to test the program.

3. Develop cost and performance options for a non-commercial fishery monitoring program and its components (e.g. self-reporting web-based tool/app platform; data management, storage and access; complementary surveys) to allow for an assessment of value (e.g. meeting needs; ease of use; maintenance and data use in stock assessments).

Performance indicators:

    a. Descriptive summary of the comparison of technologies, costs and outputs for a non-commercial fishery monitoring program and its components which meets the information needs of various stakeholders (e.g. ease of use, upkeep and maintenance, data use in stock assessment etc).

Achievement of project objectives provides a critical step in the development and implementation of a comprehensive, co-designed system for monitoring traditional fishing and providing guidance for monitoring the recreational fishery sector in the Torres Strait.

Terminology used in Project Objectives

The project proposal and objectives refer to 'non-commercial fishing catches (traditional fishing) in the Torres Strait'. We acknowledge some issues with these terms used in the project proposal, and what is commonly used among broader fisheries stakeholders in the Torres Strait and the *Torres Strait Treaty*. In general fishing for 'non-commercial' purposes – that is for food, customary purposes, or leisure is conducted by people who are traditionally fishing (as per Treaty), recreational fishing by Non-Traditional Inhabitants mostly non-Indigenous, and by the fishing charter sector fishing. However, in all these sectors, commercially managed species such as Spanish Mackerel, Coral Trout and Tropical Rock Lobster are also caught in addition to hundreds of other species of marine resources. Concerns over accounting for these commercially caught species as part of traditional and recreational fishery sectors by the PZJA Research Advisory Groups initially led to the previous project (Bedford *et al.*, 2021). However, many other traditionally fished species are caught by Torres Strait Islanders and protecting these food resources is a key priority that has been raised through various fisheries forums.

For clarity, in this report, we have modified our terminology in reporting of results in this project by using 'traditional fishing', rather than 'non-commercial fishing', consistent with the Treaty definition of "traditional fishing" meaning "the taking, by Traditional inhabitants for their own or their dependants' consumption or for use in the course of other traditional activities, of the living natural resources of the sea, seabed, estuaries and coastal tidal areas, including dugong and turtle"; with 'traditional activities' defined as those "performed by the Traditional inhabitants in accordance with local tradition as the variety of marine resources accessed and used for food and other livelihood benefits (e.g. cultural, social)" (*Torres Strait Treaty, 1985*).

A Traditional (rather than non-commercial) fishing monitoring program thus refers broadly to a program of activity to be developed which includes monitoring fish catches caught for traditional purposes as per the Torres Strait Treaty. The use of the term traditional fishing was adopted for our community workshops (see methods section below).

Report Structure

In the following sections we present the overall research approach to address the objectives, including coverage of the research team, the research stages, and the methods and analysis applied to achievement of the project objectives. A section on ethical research process and approvals is also provided particularly pertinent as this is an Indigenous focused research project.

The report is then structured broadly around the three project objectives. The first section presents on information needs commercial fisheries managers require to account for traditional catches of commercially caught species, a brief overview of development of fishing apps as a monitoring tool and a desk top review of apps relevant to an Indigenous fishery monitoring program.

The results of the community co-design phase of activity undertaken through community workshops are then presented as compiled information from all workshop consultations. Individual community responses to some of the workshop topics is presented in the Report Appendices (see data analysis section below). Information on specific identification of potential communities for a pilot program (Objective 2), and duration, to test the program is not specifically covered in this report. Due to the issues outlined in the results section on cost and performance options and challenges, we were not able to provide information on identification of potential communities to participate in a pilot monitoring program. We discuss this issue further in the discussion section.

The results section presents cost and performance information for supporting a high-performance Indigenous-led app scenario, including information required by fishery management and communities, key design principles and potential app features. Support and management needs are also presented. Cost scenarios are also presented and described, including their limitations and key learnings. We also provide a section on complementary data collection to support app usage and validation.

We present a brief discussion and conclusion section followed by recommendations for progressing to the next phase of the monitoring program development for a pilot program as recommended by the PZJA TSSAC. This includes recommendations for monitoring recreational catches in the Torres Strait through QLD fisheries monitoring program.

Method

Research Team, Roles and Positionality

The project comprised of a multidisciplinary team of four people. Kenny Bedford is a Torres Strait Traditional Owner (TO) from the Meuram Clan of Erub, fisher, and leader, with a deep knowledge of Torres Strait fisheries and Indigenous community engagement experience. Kenny was the Indigenous Project Leader and led all stakeholder engagement and community workshops visits. Natasha Stacey, a marine social scientist from Charles Darwin University (CDU) was the Administrative Project Leader for the project, with responsibility for overall project management, ethical research approach and contributed to development of supporting materials for community workshops and participated in some community workshops. Tim Skewes is a fisheries ecologist who provided expertise on community fisheries and engagement approaches and materials for community workshops, participated in most community workshop visits, and took responsibility for community data analysis. David Brewer, a fisheries research and management expert, and took the lead on app information materials for the community workshops, review of fisheries monitoring and app design and participated in some of the community workshop visits.

As a team we acknowledged our positionality with three team members being non-Indigenous but all with extensive experience working in Indigenous and Torres Strait Fisheries or related research contexts. We deferred to the leadership of the Indigenous team member to provide final advice and oversight of the Indigenous aspects of the research approach and activities. We worked closely and collaboratively as a team to co-design and implement the project through all stages (see Figure 5). Our collaborative team approach was supported through fortnightly one-hour online meetings over the project duration (December 2022 to August 2024). We also held three in person team meetings during key stages of the research (project planning in December 2022; finalisation of community workshop approach and package in July 2023 and final report drafting in June 2024).

Overview of the Research Approach and Project Design and Stages

A summary of the research approach, multi-staged activities and time frame of research is provided (Figure 5) with further elaboration on main activities provided in following sections.

Overview of the Research Approach & Activities

**Planning & Preparation
(December 2022 to July 2023)**

- Project Inception Meeting

- Community engagement & participation approach

- Drafting of Community Workshop Package Materials

- Planning the APP development process

- Review of draft Project Stakeholder Engagement & Communication Plan

- Stakeholder consultation & engagement

- CDU Human Ethics Application & Approval

Community Workshops & Engagements (Aug. 2023 – July 2024)

- Project team workshop

- Pilot of workshop approach in one community

- Clustered community & island visits scheduled, conducted and completed

- Community workshop reports distributed

- Compilation & analysis of data from community workshops

- Meetings with APP developers and other fisheries organisations

- Stakeholder Consultation & Engagement

- Annual ethics report

**App Design & Development
(July–Aug. 2024)**

- Team workshop

- Additional literature, compilation & review of APP & monitoring initiatives

- Interviews with public & private APP/software developers

- Analysis of APP data

- Annual ethics report

Final Reporting, Communication & Engagement (Aug. 2024 – ongoing)

- Drafting of final report

- Distribute final report, summary outputs

- Submission of final ethics report

Figure 5. Summary of project research approach, multi-staged activities and time frame.

Ethical Approach and Principles followed in the project

The aim of the project is to share information and collate the views of Torres Strait community members and other stakeholders about a traditional fishing catch monitoring system that can provide information to individuals, community and other stakeholders to sustainably manage marine resources and livelihoods.

A requirement of this project as part of our ethical approach is to ensure:

- Any Indigenous Knowledges that may be discussed during the project relevant to achieving the project objectives are respected and protected;
- Clear guidelines and principles as to how the project research team may treat any such information communicated by stakeholders during workshops or other meetings to the research team follow the projects' ethical requirements and consent process;
- To continue to build and support Torres Strait people's engagement, decision-making, and leadership in fisheries management to protect food, culture and livelihoods for future generations; and
- To build collaborative relationships and trust between the project research team, stakeholders and communities who may participate in the project or have an interest in its outcomes.

We developed an internal Protocol (See Appendix A) to support and guide project implementation activities, community consultations and data management for the Project. This supplemented the ethical research approaches approved by the CDU Human Ethics application (H23056), Project Flyer (Appendix B) and Consent forms (Appendix C) consistent with the *National Statement on Ethical Conduct in Human Research (National Statement)* (*2023) PZJA TSSAC Procedural Framework for Researchers in the Torres Strait* (2018) and *AIATSIS Code of Ethics for ATSI Research (2021)*.

The research team applied the following guiding principles[2] in implementing this project.

1. We agree to abide by National Human Ethics Research principles and Guides and the ethical and cultural protocols of Traditional Owners groups.
2. We will have collaborative and respectful relationships with Torres Strait people.
3. We respect the Torres Strait Aboriginal governance processes at the local and regional levels.
4. We recognise the Aboriginal and Torres Strait Island people own their knowledge and their intellectual property.
5. We respect the confidentiality of culturally sensitive Aboriginal knowledge/s and when requested by TOs this is strictly observed.
6. Traditional ecological and/or cultural knowledge and Western science and are accorded equal value.
7. We support capacity building and empowerment of Torres Strait Island people in carrying out this research.
8. We acknowledge People have the right to participate appropriate to their skills and experiences in relevant projects and processes.
9. We will follow the principles of free, prior, and informed consent at all times.
10. We report back to community and stakeholders regularly about the project progress and outcomes and allow people an opportunity to review our work.
11. We ensure funders and other stakeholders make provision for long term access to research reports that are created from this project.
12. This study was approved by Charles Darwin University Human Research Ethics Committee and we will report annually on any ethical issues arising during the study.

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[2] List of principles are adapted and modified from Witt *et al.* (2023) and KLC (2011) - See Appendix A.

Appendix A protocol provides further explanation of the type of knowledge and information that may be shared or communicated during the workshops and recording of such information.

Data requirements for commercial fishery management

The type of data and information required from any traditional fishing monitoring program in Torres Strait will be driven by the needs and uses of that data. To identify information needs consistent with a monitoring app, we collated information needs from both the community level (from community workshops) and by interviewing several key Torres Strait Fisheries Managers and Scientists involved closely in Fisheries Management assessments in the region for finfish and Tropical Rock Lobster (TRL hereafter), which are commercially important species populations that are also fished by traditional and recreational fishers. We confirmed the form of data required for their population assessments. These species are considered priority species by the PZJA TSSAC and other fisheries stakeholders as important to monitoring in the context of commercial fisheries. This information is considered alongside the broader app design and development information to ensure that design of a traditional fishing catch program can also meets the data needs required for commercial fisheries management.

Review of fishing apps, features and design options

Three main methods were used to review current fishing apps and app design development options. These were:

(i)   A brief review of published and unpublished literature and web site information on existing apps, including key issues, best practice, app design and development options especially in or relevant to Indigenous and recreational fishing contexts;

(ii)   Interviews with current fishing app custodians; and

(iii)   Interviews with technology and app developers.

The review of current apps provides demonstrations of the progress and ubiquity of fishing apps, including their objectives, the scope of information that they provide and the data they aim to collect, as well as the features that are being used to facilitate app uptake. Interviews with current fishing app custodians were conducted to gain in-depth knowledge about the drivers, issues and pitfalls associated with designing fishing apps to streamline the design and minimise the risk of failure for any new Torres Strait fishing app(s). Interviews with technology and app developers were also conducted to gain further insights into the app development design issues and options to provide a way forward for decision making for a new fishing app. The options provided by the reviews of current apps and from detailed information from app custodians and technology developers can then be used in conjunction with the app co-design process with Torres Strait communities to plan for a relatively cost-effective fishing app that meets the needs of fishing communities and fishery managers in the Torres Strait.

Review of apps

We conducted a targeted national and global review of existing apps and of app design and development options (using literature searches, web-based searches, app store searchers and AI generated searches using key words) for three main categories of apps:

i)   Fishery apps, including recreational fishery apps

ii)   Indigenous apps with a relevant environmental or cultural heritage component or program

iii)   Biodiversity/Environmental Management monitoring apps (including those which were Indigenous and citizen-science focused).

In doing so, we noted there are hundreds of apps available which fit into these broad categories and thus we selected a sample of the most relevant apps to assess app features which provide learnings to

developing or implementing a program using an Indigenous owned or led traditional fisheries monitoring app.

These apps were summarised according to several categories including app name/web link, managers/owners, objectives, scope and target users, key features, data management, outputs/information that can be produced for users, and possible relevance or interest to a TSI app.

Interviews with current fishing app custodians and app developers

Interviews with four selected custodians of current Australian fishing apps were completed to provide information on current experiences, app features, costs and associated management and maintenance needs – see Table 1. A series of questions was developed for interviews with experts (coded for anonymity) to guide this information collection (available on request). The interview information was recorded on individual proformas then summarised along with any other information available about the app gleaned from other sources.

Table 1. List of fishing app custodians or experts (anonymised with codes for referencing throughout the report) that participated in interviews, their app name and hosting agency.

App custodian interview code	App name	Agency
AC1	*QLD fishing 2.0* app	Queensland Department of Agriculture and Fisheries
AC2	*Fishing Tas* app	IMAS research institute
AC3	Multiple Australian fishing apps	IMAS research institute
AC4	*SA Fishing app*	South Australian Research and Development Institute

We also identified and interviewed nine app and technology development experts and service providers and or information sourced from their relevant websites to find out about experiences and learnings on app development and performance – see Table 2. These interviews aimed to obtain information on app development processes, costs, management and implementation, and to help minimise common pitfalls with poor app design, especially in their early stages. We also sought to gather a range of information about app design criteria including technical aspects of app development, app platforms, technology, operational factors, data management and user access principles and procedures to help guide a cost-effective way forward for the design of a Torres Strait fishing app(s).

This interview process was curtailed when we reached a reasonable level of information saturation (Morse, 1995; Hennink *et al.,* 2017), where little new additional information was being gained from the process. These learnings helped inform the potential design and functionality of a Torres Strait self-reporting fishing app. Although oral consent was gained from all custodians and app developers (see below) to participate in an interview about their experiences and to use the information they provided, a written consent was not completed. We have anonymised all interviewees throughout the report when referring to information collated from interviews (Table 1; Table 2). The interview guides used for either online, phone or semi-structured conversations are available on request.

The learnings from the app custodian interviews were collated with information from selected app websites and interviews with technology and app developers (see below) to provide a wider brief of information on app features and design processes reported in the results. The results of these discussions were collated, summarised and integrated into a summary narrative and summary tables of information presented in the report results and recommendations.

Table 2. List of app developer information (interviewees and informed gleaning from websites).

Interviewee code	Agency	Type of data collection
AD1	Technology developer 1	Extended interview
AD2	Technology developer 2	Extended interview
AD3	Technology developer 3	Extended interview
AD4	Technology developer 4	Short interview
AD5	Technology developer 5	Short interview
AD6	Technology developer 6	Email response
AD7	Technology developer 7	Website information
AD8	Technology developer 8	Email response
AD9	Technology developer 9	Website information

Community consultation workshops

We planned to carry out community consultation by visiting communities in each of five cluster regions in the Torres Strait and the Northern Peninsula Area (NPA), including all the outer island communities, and with one workshop for the Inner islands and two for the Northern Peninsula Area (NPA) (Table 3). By project end, we were able to carry out 15 community consultation workshops, with two communities not visited (Table 3, Figure 6).

Table 3. Communities of Torres Strait identified for community consultation.

Community	Other name	Nation	Cluster	Date visited
Saibai	Saibai	Guda Maluialgal	Top Western	23/1/2024
Boigu	Boigu	Guda Maluialgal	Top Western	23/7/2024
Dauan	Dauan	Guda Maluialgal	Top Western	22/7/2024
Injinoo	Injinoo	Injinoo	NPA	21/8/2023 and 30/5/2024
Ngurupai	Horn Island	Kaiwalagal	Inner	27/5/2024
Mer	Murray	Kemer Kemer Meriam	Eastern	24/4/2024
Ugar	Stephens	Kemer Kemer Meriam	Eastern	26/4/2024
Erub	Darnley	Kemer Kemer Meriam	Eastern	25/1/2024
Poruma	Coconut	Kulkalgal	Central	30/1/2024
Warraber	Sue	Kulkalgal	Central	30/4/2024
Iama	Yam	Kulkalgal	Central	24/7/2024
Masig	Yorke	Kulkalgal	Central	Not held
Badu	Badu	Maluilgal	Western	9/7/2024
Kubin	Kubin	Maluilgal	Western	10/7/2024
Wug	St Pauls	Maluilgal	Western	Not held
Mabuiag	Mabuiag	Maluilgal	Western	12/7/2024

We were unable to visit two communities due to various issues. Planned community visits were cancelled on several occasions (sometimes at very short notice). Some of the issues that caused community workshop cancellations included:

- 24/1/2024 – Visit to Dauan cancelled due to bad weather
- 1/2/2024 – Visit to Warraber cancelled due to sorry business
- 23/4/2024 – Visit to Masig cancelled due to transport cancellations
- 11/6/2024 – Visit to St Pauls cancelled due to representative commitments
- 11/6/2024 – Visit to Masig cancelled due to sorry business
- 25/6/2024 – Visit to Masig cancelled due to sorry business
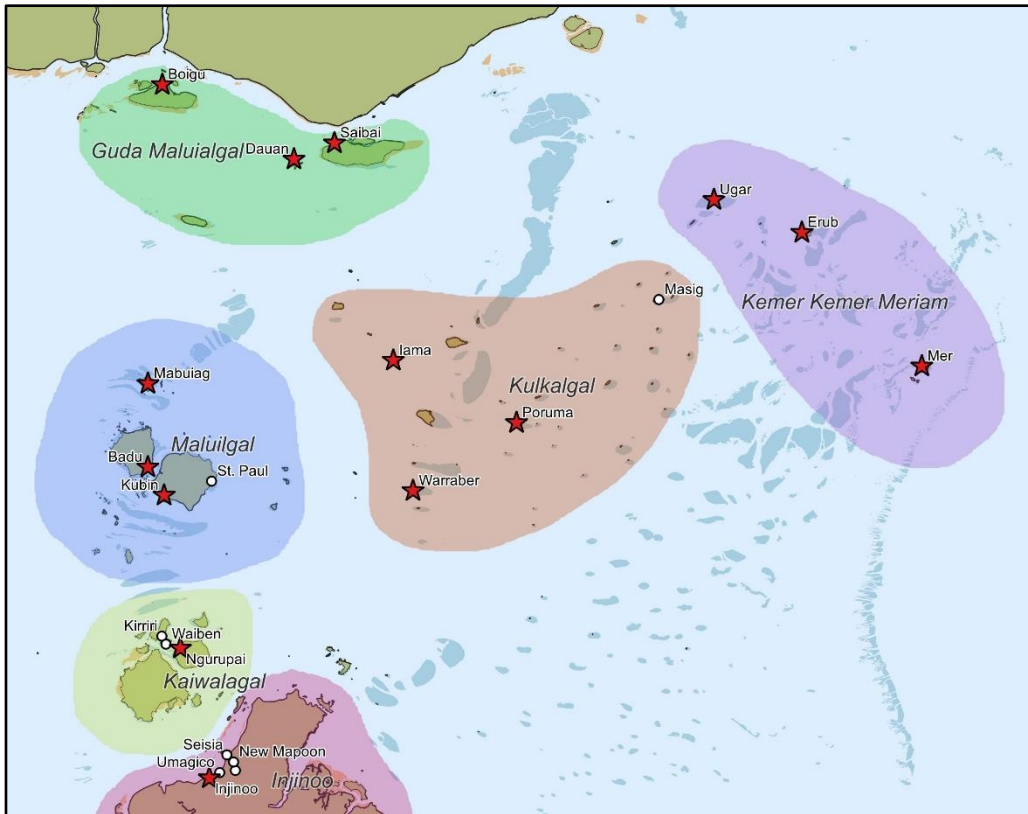
Figure 6. Communities visited for consultation workshops. Also shown are the island nation groups.

Figure 7. Community workshops (Photos: Tim Skewes).

Overall, 142 community members attended a community workshop, or about 1.7% of all community members in the study area (assuming an Indigenous population of the study region of 8,380; ABS, 2021). About three quarters of attendees were male and one quarter female (Table 4). The age spread of attendees was relatively even, though slightly skewed towards older people (>50 yrs old) (Table 5), likely reflecting the ability to attend midweek workshops during working hours.

Table 4. Attendee numbers at community workshops.

Attendees/gender	No.
F	36
M	106
Total	142
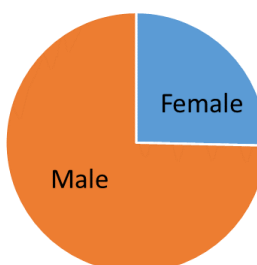
Table 5. Attendee age groups proportions.

Age group	%
18*-35 years	32.8
35-50 years	28.1
>50 years	39.1
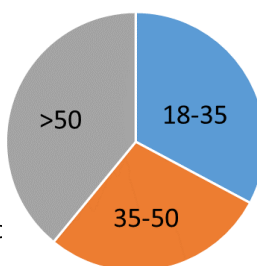
* Under 18 participants excluded due to ethics consideratic

Pre-workshop consultation and engagement

Prior to commencing community workshops, important regional representative and management organisations were contacted to inform them about the project (e.g. by email, phone or attending in person meetings) and to seek approval to carry out community consultation visits. This included:

- Gur A Baradharaw Kod (GBK, the peak PBC body for Torres Strait PBCs);
- Torres Strait Island Regional Council (TSIRC);
- Torres Strait Regional Authority (TSRA) board;
- TSRA Land and Sea management unit;
- TSRA Fisheries section; and
- Australian Fisheries Management Authority (AFMA) Thursday Island office.

Prior to each community visit, the relevant local community leaders were contacted by the lead Indigenous project team member (KB) to seek permission and provide guidance on logistics of the visit. This was conducted by e-mail and followed up by phone. Emails included community notice, a workshop agenda and a project flyer (see Appendix B, D and E). Community message board notices were sent to local TSIRC offices to put on local notice boards advertising the workshop. Local contacts included:

- Torres Strait Island Regional Council (TSIRC) Councillors for each community;
- Torres Strait Regional Authority (TSRA) board member for each community;
- Community PBC Chair; and
- Community fishing association chair (where available).

Community Workshop and Participation

Our community workshop approach applied the five degrees of inclusion framework (Johnson *et al.*, 2021) (Figure 8), which provides guidance to researchers and facilitators to move from consultation to decision-making. The framework shows the range of degrees from attendance, understanding, sharing, being valued to inclusion in decision-making. To the extent possible within a 2–3-hour mixed gender co-design workshop we sought to apply the five degrees to the 'highest' level. Inclusion in decision-making was of lesser relevance for this project as per the project objectives, which we would be necessary to occur in Phase 3 follow-on project (see Project background section above).

At each community, we followed a 2–3-hour workshop agenda (during a week-day) with the following sessions and corresponding information elicitation exercises (*in italics*) (See example agenda at Appendix E).

1. Background to non-commercial fishery monitoring needs
   - *Does non-commercial catch monitoring have broad support in the community?*
2. Background to monitoring the traditional fisheries of Torres Strait
   - *What are the local community's non-commercial fishery monitoring priorities.*
3. Introduction to monitoring apps
   - *What do community members think about implementing a monitoring app?*
4. Codesign of the app
   - *What are the outputs and features people want in the app?*
   - *What are the barriers and potential incentives for an app implementation?*
   - *Who should/could run the app?*
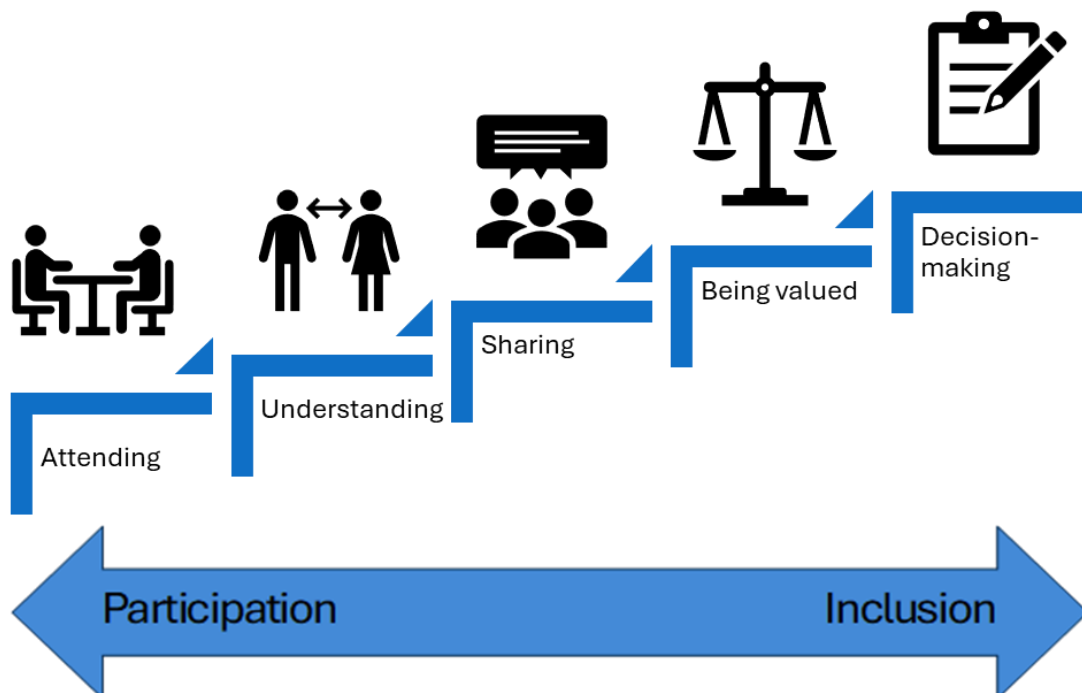
Note: As Johnson et al. (2021) emphasise community participation does not necessarily progress in a linear fashion as per this diagrammatic representation and much depends on local context or the type of community-based management.

Figure 8. Five degrees of inclusion, ranging from attendance to inclusion in decision-making guiding our community workshop participation and approach (source: adapted from Johnson et al., 2021:8, after Kleiber et al., 2019).

Some key principles were applied in line with ethical protocols supporting community workshops (Refer section above and See Project Knowledge Protocol (Appendix A) prepared to support the team's ethical approach). At the start of community workshops, the research team explained the ethical consent process and the consent forms (Appendix B), why they are needed and asked each participant to review and complete the form to obtain informed consent to participate in the workshop and share information.

Our workshop facilitation approach sought to ensure that all participants regardless of gender had an opportunity to be heard through various facilitated participatory activities. We were conscious of the problems of community level workshop 'consultations' and Indigenous research fatigue among communities thus designed our workshops agenda to have active discussions and information sharing with participants. We also shared the results on the workshops to all participants by email soon after workshops were held.

Our results do 'count' gendered participation at each workshop, but this is not used as a measure of gender equity. Approximately one third of all workshop participants were women. However, women's voices and concerns were represented in many of the community workshops (see results). We acknowledge that women are often excluded from fisheries management and can face constraints in attendance at such workshop forums. Women play important roles in traditional fisheries in the Torres Strait as fishers and providers of food caught through traditional fishing and will be primary stakeholders of any future fishing app or monitoring program. This project did not have the resources available to facilitate separate meetings with women which might have contributed to greater female attendance. A Phase 3 project will require more focus on gender inclusive strategies (see Kleiber *et al.*, 2019). (see also the Discussion).

At each workshop participants were asked to register their names and contact details so we could share a summary of the workshop discussions back to each attendee. Supporting materials (project flyer and workshop agenda) were made available to all participants. Charts of the island were also used for participants to refer to places and locations. Except for the first project workshop at NPA where all four team members were present, most workshops were delivered by two team members with the lead Indigenous team member present at all workshops. The workshop sessions and discussions were led by the lead Indigenous researcher with accompanying PowerPoint presentations for main agenda items.

After a brief presentation, participants were invited to share information through participatory brainstorming activities, mostly facilitated by the Indigenous team member. Acknowledging that workshop participants were a self-selected subset of community members and potentially biased in their views, attendees were encouraged to consider the 'entire community' in their responses during the elicitation exercises. The only exception was the app questionnaire, which represented their own personal opinions – though we also included a question that reflected individuals view of the proportion of the entire community that would use the app.

Other elicitation activities included (i) voting for fishery species importance and monitoring priorities on butcher's paper and using coloured stickers to identify specific priority food species, and priority species for monitoring (Figure 9), and (ii) (in most workshops) completion of a one-page questionnaire to garner additional individual written views on app use and mobile phone access.
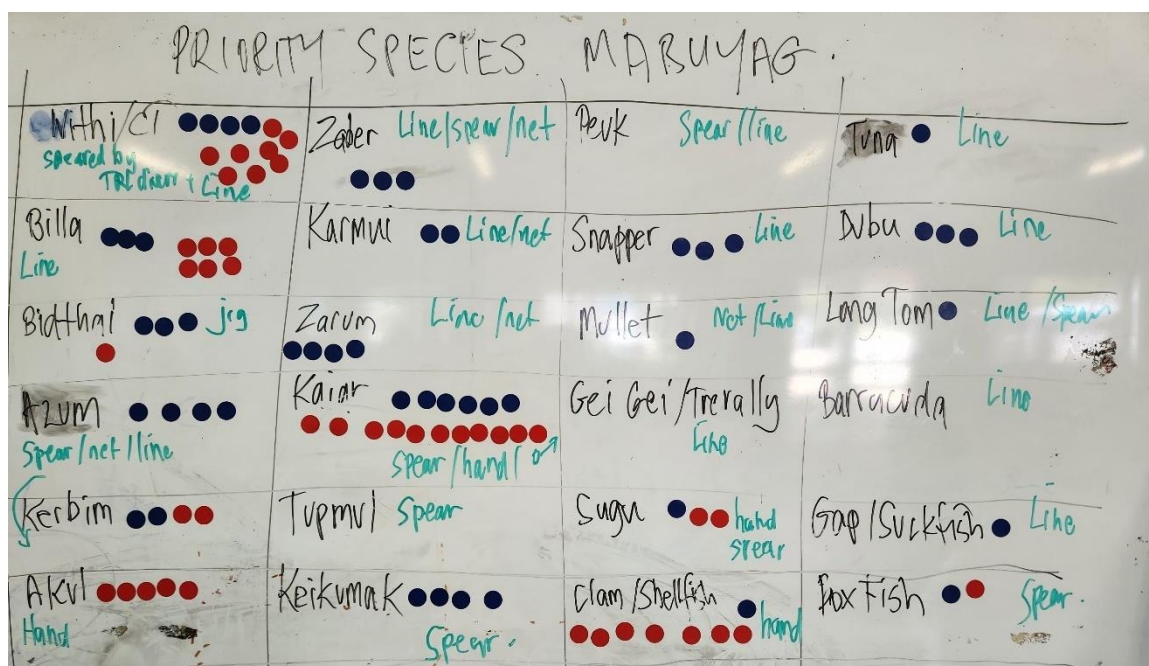
Figure 9. Example of species prioritisation exercise. Blue dots represent votes for species importance; red dots represent species priority for monitoring.

Figure 10. Community workshop activities - species prioritisation exercise. Photos: Kenny Bedford.

Data analysis of community workshop information

The information provided from the workshops were compiled and reported on under the following topics:

a. Community attitudes to non-commercial fishery monitoring
   - Does non-commercial catch monitoring have broad support in the community?
   - What are the local non-commercial fishery monitoring priorities?
b. Community attitudes to app implementation
   - What do community members think about implementing a monitoring app?
   - App questionnaire results (subset of workshops).
c. App codesign
   - What are the outputs and features Community members want in the app?
   - What are the Barriers and Incentives for an app implementation?
   - Who should/could run the app?

Comments from participants during brainstorming sessions were recorded and categorised for analysis. The comment categories are represented numerically and the main themes summarised. Generally, a single comment relates to something expressed by a single person, however sometimes supported by several people in the group - dissenting voices are noted in the results as separate comments. Voting for species importance and monitoring priority, and questionnaire responses are represented numerically.

Most of the information from the workshops is compiled and presented at Torres Strait wide level, however some is also summarised into cluster level (e.g. fisher species priorities). The Appendices F to M provide detailed community level information from each of the 14 community workshops on priority species listings, community attitudes to monitoring, community views on fish species importance and priorities, app implementation comments, outputs and features and barriers to app implementation.

Performance and cost options for monitoring program

Information relating to cost and performance options for app development and support was collated to aid the design of a Torres Strait self-reporting fishery app and guide future decision making about the next stages of a Torres Strait self-reporting fishery app. This included identifying potential app features, key principles and cost scenarios, as well as technological support/maintenance and data management requirements. This information was sourced from (i) current fishing app custodians, (ii) app technology experts, and iii) the community workshops and iv) published information. Information on cost scenarios for app development, maintenance and management was difficult to collect as most sources were either unaware of the app development cost details, were not able to provide the information (e.g. some government agencies due to commercial in confidence principles), or could only provide a broad range of scenarios due to the specific nature of costings for each business product. Information from each of the above sources is brought together in the results to provide an app design and management planning scenario.

Results

Review of Fishery Information Needs

The research to support implementation of a non-commercial fishery monitoring program was initiated by the need to fill data gaps in the assessments of commercially important species that the traditional sector also interacts with. However, community consultation identified needs by Traditional Owners, that have broadened the focus to ensure that all traditionally fished species are included in the planning and recommendations for a traditional fishery monitoring program; or at least those key species identified as priority for monitoring by Traditional Owners/island communities (see below). Thus, the information needs for the traditional fishery sector are for the data for all species. However, a monitoring program should also fulfill the needs of the commercial fishery management for the Spanish Mackerel, Coral Trout and Tropical Rock Lobster. We discuss this further in the report/recommendations.

The main fisheries data required from traditional fishers for management of Torres Strait commercial fisheries is listed in Table 6. These species are fished commercially, and hence a priority for the PZJA and other fisheries stakeholders but are also fished by traditional fishers. However, catch data from the traditional sector is estimated (see example in Figure 3), prompting the need for a comprehensive, real-time fishery monitoring program for this sector.

Traditionally fished species

Traditional Owners involved in community management of their natural resources indicated during community workshops that they would benefit from a range of information about the status or health of traditionally fished populations. They also desire information about the environment or conditions that support fisheries resources. Information requested (as shown in Figure 15, Figure 18) included temporal trends in fish catches and by recording of observations, such as spawning times of year, or potential threats from invasive species, or pollution.

Commercially fished species

A small number of species are fished commercially in Torres Strait and managed by the PZJA; mainly Spanish Mackerel, four Coral Trout species, TRL and several sea cucumber species. All except the sea cucumbers are also fished for non-commercial purposes (food, trading, recreation) by traditional or recreational fishers (Natalie Couchman, AFMA, pers comm 2022). Here we identify the type of data required for conducting population assessments for these commercially fished species to feed into the monitoring app design.

The fisheries management assessments for these commercially fished species in the Torres Strait primarily require data on the numbers of each species caught (Table 6). Numbers caught annually is currently used directly in the assessment models for the mackerel and Coral Trout finfish species (Dr Michael O'Niell, QDPI, pers comm, 2023). Fish length data is also used to improve the annual assessments but may be of secondary importance from the non-commercial sector as it is currently collected from the commercial sectors in a specific program. However, length information may be able to be generated from traditional catch photos and included in the commercial assessments. Tropical Rock Lobster assessments currently assume that the number of lobsters taken for kai kai purposes is a constant proportion of the total commercially fished catch (Dr Eva Plaganyi, CSIRO, pers comm, 2023). However, the provision of more accurate data on the numbers caught would provide a substantial information upgrade to the currently used approach (Dr Eva Plaganyi, CSIRO, pers comm, 2023). The current model used in lobster assessments and management would also benefit from information on the sizes of lobsters caught, as well as other observations that help with the interpretation of population dynamics, such as whether eggs are present on females.

Table 6. Summary of the key information required by Torres Strait fishery custodians and managers for fisheries management (traditional and commercial fisheries).

Information manager /custodian	Key information desired for fisheries management
Traditional Owners	All traditionally fished species • Changes in catches over time for individual species • Information linking to seasonal calendars such as fish spawning times • Biosecurity threats such as invasive species • Ability to report illegal activity (Source: Community workshops)
Fisheries managers	**Finfish** (Spanish Mackerel - *Scomberomorus commerson*; and four Coral Trout species - *Plectropomus leopardus*, *P. maculatus, P. areolatus* and *P. laevis*): **Primary data:** • Annual total numbers of fish caught or discarded, by species. **Secondary data:** • Fish lengths – either measured total/fork lengths, or via fish photos, where length is estimated from the whole fish photo or jaw size (e.g. see Trappett *et al.* (2024) for relationships). • Average fish weight can also be derived from the lengths. (Source: Dr Michael O'Niell, QDPI, pers comm, 2023) **Tropical Rock Lobster** (*Panulirus ornatus*): **Primary data:** • Annual total number of lobsters caught or discarded, by species. **Secondary data:** • Lobster size class (e.g. from photos using AI) • Useful observations (e.g. females with eggs) (Source: Dr Eva Plaganyi, CSIRO, pers comm, 2023)

Review of apps for monitoring fisheries

Technology and advanced computing have caused a rethink of the data collection and sampling methods for gathering fishery information to guide policy decisions (Brick *et al.,* 2021). Fishing apps first started to appear in the early 2010s, as the popularity of smartphones and mobile apps grew. The adoption of mobile applications, or apps used on phones, tablets has been viewed favourably in the last decade as a significant opportunity to support fisheries managers in monitoring and management through provision of fisher supplied data (e.g. Bedford *et al.*, 2021).

Most fishing apps are designed with recreational fishers in mind, or for monitoring commercial fishing, mainly in developed countries. However, 90 percent of the world's fisher and fish worker population operate in small-scale, traditional fishing; and about half of the world's total fish catch come from these fishers, indicating that their impact on catch statistics is substantial (Irby, 2017).

The developments in fisheries monitoring apps have mostly occurred in the recreational fishing sector reflecting the rapid uptake of digital technology among these users. Apps have been developed by government agencies and private companies (see below) and can allow fishers to report information about fishing trips and catches and can be a relatively low-cost and real time source of monitoring data (see below) used in the management of recreational fisheries (Papenfuss *et al.*, 2015; Gundelund *et al.*, 2020).

In Australia, all States and the Northern Territory have recently developed recreational fishing apps. These are being used to help fishers enhance their fishing experience and make more informed decisions (e.g. fishing regulations or safety advice) through the app platform's ability to provide multiple sources of information in a simplified form to users (Cordwell *et al.,* 2020). The development of fishing apps has also allowed fishers to access a wide range of information and tools, such as weather forecasts, fishing reports, maps, and social features to connect with other anglers. Most current recreational fishing apps allow users to provide information on their activities (fishing trips, catch, etc.) and link users to other fishers through maps, catch reports, or numerous other ways (Table 7). A subset of these also allow for entry of catch data for reasons such as:

- fishing competition management;
- sharing catches with social networks; and
- management of recreational and/or commercial fishing by government.

Most government-led apps in Australia (*Qld Fishing 2.0* app, *SA fishing* app, *Fishing Tas* app, *FishSmart NSW* app and *GoFishVic app*) request fishers to provide catch data to be used in management. With 87% of the Australian population estimated to own a smartphone by 2026 (Statistica Inc. 2024) there is a real opportunity to substantially improve self-reported catch monitoring by recreational and Indigenous fishers in Australia.

The success of fishing apps as a monitoring tool is still being evaluated, due mainly to their relatively recent introduction and the complexities associated with using data from potentially biased sources (Beckmann *et al.*, 2024) for reliable decision making. Benefits of fishing apps include that fishing data can be collected close to real time compared to more traditional phone, diary or other surveys that usually provide data far less frequently due to cost constraints (AC1, AC2, AC4, pers comm). Apps also have the potential to cost-effectively sample many fishers. However, one of the main issues with app-collected data is how well the data collected from participants represents catches from all fishers (e.g. Beckmann *et al.*, 2024; AC2, AC3, pers comm).

With these relatively strong drivers in place most apps are tailored to try and enhance the attractiveness of apps to users. A recently completed study in South Australia (Beckmann *et al.*, 2024) is looking at how to adjust recreational fishing app data to improve its utility as a quantitative monitoring tool. A recent study by Beckmann *et al.*, (2024) evaluated the *SA Fishing app* in comparison to a conventional state-wide phone survey found that most participants in the trial used the app primarily to gain information to enhance their fishing experience, rather than to provide data to fishery managers. However, most participants in the study were also interested in accessing their personal fishing data but were reported to be less interested in sharing data on social media. They also found that the people with high education levels in the survey were more likely to use the app (Beckmann *et al*, 2024).

A review of Australia's fishing apps by Cordwell *et al.,* (2020) revealed more than 100 technology-based products directly related to or tailored for the fishing and seafood communities. Most of these apps are targeted at the recreational sector and reflect the rapid uptake of digital technology among these users. Examples of the broad suite of fishing apps related to the seafood sectors across Australia can be seen at https://airtable.com/shrJnFoU3AwdSI3cD. A similar suite of apps relating to South Pacific communities is demonstrated by the SPC Community Fisheries, Aquaculture and Marine Ecosystems Program can be accessed at Tools and apps | FAME.

Recreational fishing apps

As smartphone apps become more sophisticated and widely available, they are increasingly being used to record recreational fishing activity (Beckmann *et al.,* 2024). Consequently, there are a wide range of recreational fishing apps currently available in Australia and overseas.

A selection of fishing apps, including their objectives, scope and key features is listed in Table 1 and Table 7). All coastal Australian States and the Northern Territory have developed a recreational fishing app. Most aim to gather catch data to support sustainable fisheries. However, the *Recfishwest* app (WA) and *NT Fishing & Boating Mate* app are currently limited to providing useful information to support recreational fishers. These apps vary in their stages of development, with most being on an improvement trajectory since their instigation. For example, the *GoFishVic* app has been through three redevelopment stages since 2017 and is now used as the main data source for recreational and commercial catch data and management.

Most of the data collection in recreational fishing apps is voluntary. However, in some regions there is mandatory catch logging for certain species, such as for Snapper in south-eastern South Australia (using the *SA Fishing app*, where snapper remains open to fishing); and rock lobster in Tasmania (using the *Fishing Tas app*).

There are also independent (non-government) recreational fishing apps in Australia. The *Track my fish* app is tailored to help manage fishing tournaments and provide users with a platform to log their fishing catches. This information can also be used to help manage fish stocks, especially, for example, in impoundments. The *Tackle Box* app, provides fishers with a range of resources to log and improve their fishing experience, and allows them to submit catch information to inform citizen science projects (Cordwell *et al.*, 2020).

There are a very large number of recreational fishing apps in other countries. A small selection is also listed in Table 1. For example, *Fishbrain* (Fishing App and Fishing Tools (fishbrain.com)) is an international fishing app developed in Sweden and launched in 2013. The *Fishbrain* app website currently claims to have 15 million recreational fishers worldwide. It integrates weather forecast data, catch information from users, recommended catch times and bait for target species, combined with a social media news feed and the ability to stay up to date with the latest fishing efforts of others (Cordwell *et al.*, 2020).

Indigenous fishing apps

Australian recreational fishing apps do not typically distinguish between Indigenous and non-Indigenous fishers. We were unable to find any apps that were specifically designed for self-reporting of Indigenous fishing catches in Australia. Australian app custodians interviewed were also unaware of any Indigenous fishing apps. However, (non-fishing) apps have been developed specifically for Indigenous communities in Australia for other topics (e.g. traditional language apps) (Table 8). These vary in their objectives and subject matter, but for example include:

- Support the preservation and revitalization of Indigenous languages in Australia;
- Provide culturally sensitive information sources about Indigenous culture and history;
- Provide culturally appropriate information about Indigenous health;
- Connect Indigenous Australians with job opportunities, activities and services; and
- Provide a platform for documenting information about a community's land and sea country.

Most of these are desktop apps (based on websites) and not available for download onto smartphones. And although they generally do not aim to collect data like a fishing app, they can provide a valuable source of information for Indigenous communities, especially in sharing language and cultural information. Some of the apps may provide lessons for language and cultural knowledge as part of a fishing app but we were not able to access any specific information from Indigenous app developers.

Indigenous fishing apps also appear to be rare worldwide. Our internet searches and AI-based searches revealed very little information on apps designed for Indigenous communities. It may be that they exist, but are relatively bespoke, limited to community use and without a website presence. One exception is the *OurFish* app ([OurFish - Apps on Google Play](#)) which was designed for small-scale fishing communities in countries such as Honduras, Belize, Myanmar and Indonesia (Table 7). This app is described as 'data-light and user friendly' (e.g. based on icons and images) and provides a relatively simple tool for fishers and fish buyers. Its value to stakeholders includes delivering basic information to fishers, buyers and managers, by providing: (i) fishers with the basic information on fish sales and purchases to support individual households and business decision making; (ii) buyers with an income history to help manage their businesses and household finances, including monitoring of their purchase costs and income from sales and other financial obligations such as debt relationships with fishers; and (iii) managers with data to help identify and define fishing activity, socioeconomic status, impact metrics, and more ([OurFish - Apps on Google Play](#)). The *Abalobi* app ([ABALOBI • About](#)) is a similar product used in South Africa (Table 7). Besides catch data monitoring and information provision (e.g. weather forecasts), this app includes User-specific in-app analytics, catch reporting analytics and visualisations from an administration base and user-owned data with full control of permission-based secure access.

Citizen science, natural history and project apps

Worth also noting are the wide range of apps developed for collecting information about the natural environment and biodiversity, usually to assist conservation efforts (Table 9). These apps are making participation in citizen science and other data collection easier for nature enthusiasts, environmental custodians or project teams. They also offer a form of educational learning for keen users. These apps demonstrate (i) that biological, ecological, or other environment-focused data collection apps are being used voluntarily by individuals or by project teams and (ii) the range of features that enhance data collection from citizen science groups. For example, the *Tails* app (SPC) was developed for Pacific Island communities to allow fisheries staff to collect real time tuna and reef fish catch monitoring information from small-scale fishers in remote locations. Similarly, the *Ikasavea* app (SPC), also used in Pacific communities, allows fisheries surveyors to collect market, landing and socio-economic survey data while in the field and offline (which is later synchronized to a web portal once they return to mobile coverage). Like some recreational fishing apps, *Tails* and *Ikasavea* apps collect data on fished species through use of photos (albeit requiring the photo to be take on a measuring board) that are analysed automatically to read the length of the fish, then determine its weight and the identification of the species. Automated catch recording from photos was mentioned in the community co-design conversations and may also enhance usability of a fishing app designed to minimise button clicks.

There are also several fishing apps in the south Pacific region that provide useful information for fishers, but do not have the functionality to collect data, such as the 4FJ Fish Smart app in Fiji ([4FJ Fish Smart App — 4fjmovement.org](#)).

The *Monitor* app (TERN Australia (unpublished)) is designed as an ecological monitoring system for Australia. It enables field data collection using mobile devices when following the Ecological Monitoring System Australia modules and protocols and includes provision for sound and audio recording data to be collected. Sound recording data collection was mentioned as a potential favourable design feature in the Mer community co-design workshop (Appendix J) and may also enhance usability of a fishing app designed to minimise button clicks.

Another is the *Lukim Gather* app (PNG), a mobile app pilot tested in Kimbe Bay, West New Britain in 2022. It provides templates for reporting on local environmental incidents or illegal activities ([Lukim Gather: a bridge for people and planet | United Nations Development Programme (undp.org)](#)), both of which are concerns for Torres Strait islander communities.

Table 7. Table of fishing apps to demonstrate the scope of fishing apps currently in Australia and the region.

App name/Web link	Objectives	Scope (region, target communities	Key features
QLD fishing 2.0 app (QDPI) [QLD Fishing 2.0 by Department of Agriculture, Fisheries and Forestry (appadvice.com)](#)QLD Fishing 2.0 by Department of Agriculture, Fisheries and Forestry (appadvice.com) (>180,000 downloads)	To gather better recreational catch data to support sustainable fisheries.	Qld recreational (and commercial) fishers	• Record, access and share personal fishing information • AI-based and pictorial fish identification guide • Provides fish biological and population information • Weather and tide information • Fishing rules, closures, FAD and impoundment information.
SA Fishing app [SA Fishing app for recreational fishers – PIRSA](#)	Provision of information for recreational fishing in South Australian	South Australian recreational fishers	• Record and access personal fishing information • Mandatory reporting of snapper catches (Pagrus auratus) • Pictorial fish identification guide • Fishing regulations, closures etc • Weather and tide information • Report illegal fishing
Fishing Tas App [Fishing Tas App](#)	Improved sustainable management of rock lobsters	Tasmanian recreational fishers	• Record and access personal fishing log • Pictorial fish identification guide • Fishing rules and information • Weather and tide information • Sub-app for compulsory reporting rock lobster catches
Recfishwest app [Recfishwest fishing rules app – Recfishwest](#)	Provision of recreational fishing rules	Western Australia recreational fishers	• Pictorial fish identification guide • Fishing regulations and information • Maps of fishing infrastructure and boundaries
FishSmart NSW app [FishSmart app (nsw.gov.au)](#)	Provision of information for recreational fishing in New South Wales	New South Wales recreational fishers	• Record and access personal fishing log • Pictorial fish identification guide • Rules, limits and closures • Maps of fishing infrastructure and boundaries

App name/Web link	Objectives	Scope (region, target communities	Key features
			• Fishing weather, tide, moon etc information • Report illegal fishing
GoFishVic app GoFishVic - Your angler diary app available now! - VFA	Building capacity to maintain a healthy fishery for recreational and commercial fishers	Victorian fishers	• Record, access and share personal fishing information • Fishing rules and information • Weather and tide information • Fishing events information
GoFishVic RL app Rock lobster reporting program - VFA	Building capacity to maintain a healthy fishery for recreational and commercial fishers	Victorian rock lobster fishers	• Similar to the GoFishVic app, but tailored for rock lobster fishing • Can record species, size, sex and location of rock lobsters caught • Replaces plastic tag use for lobsters
NT Fishing & Boating Mate NT Fishing & Boating Mate on the app Store	Provision of fishing rules and safety information in Northern Territory	Northern Territory recreational fishers and boaters	• Access fishing regulations and information • Reporting of fishing and marine issues • Weather and tide information
Track my fish app Track My Fish for Tournaments on the app Store (apple.com)	Managing fishing tournaments; helping to ensure sustainable management of fish stocks	Australia-wide	• Record and access personal fishing log • Maintains access to catch records • Records water observations • Provides maps of caught fish • Display live competition scoreboards
Tackle Box app 5 Million Recreational Fishers Empowered By Mobile App Technology - VRFish	Optimise sustainability and engagement of recreational fishers in Commonwealth Marine Parks on a national scale	Australia-wide	• Intended initially for use in fishing events • Marine Park mapping information • Record and access personal fishing log • Provides information about ocean currents and water temperatures • Access to fishing tournament data

App name/Web link	Objectives	Scope (region, target communities	Key features
			• AI-based and pictorial fish identification guide • Fishing/social science surveys
Fishbrain app [The Fickle World of Fishing Apps - The Fishing Website](#) [Fishing app and Fishing Tools (fishbrain.com)](#)	Promote and share sustainable fishing practices	New Zealand (and global) recreational fishers	• Record and access personal fishing log • AI-based and pictorial fish identification guide • Saves locations and records paths (GPS) • Fishing and weather forecasts/alerts • Saves catches, creates logs and shares images and experiences
OurFish app [Tracing Fish and Finances – Rare](#)	To help small-scale fishing communities to easily record and understand their catch data. Partners with the *Ourfish Rare - Fish Forever* program to protect rare fish species and promote sustainable fisheries management	Honduras, Belize, Myanmar, small pilot in Indonesia.	• Record and access personal fishing log • Can enter fisher name, species, weight, payment method and receipt (for business transactions) • AI-based and pictorial fish identification guide • 'Data-light and user friendly' • Easily adaptable to local language and literacy rates • Based on icons and images • Data owned by each user • User manual (OF-Ambassador-Manual.pdf (rare.org)
Fishing Points app [Fishing Points - Fishing app – Apps on Google Play](#)	Promote sustainable fishing practices	Recreational fishing tool Aus, NZ, global	• Save and find (GPS) favourite fishing places and paths • Fishing forecasts of fish activity • Weather forecasts and tide charts
Abalobi app	To elevate small-scale fishing communities for social, economic and ecological sustainability	South African based	• Catch reporting and traceability • Weather forecasts • Business transaction recording

App name/Web link	Objectives	Scope (region, target communities	Key features
			• Multi-language capability • User-specific in-app analytics • Admin catch report data visualisations • User-owned data with full control of permission-based secure access
FishingBC app Home | FishingBCApp	To provide a platform for anglers to access information on fishing while promoting sustainable fishing practices and conservation efforts	Canada – recreational fishers	• Stores fishing licence information • Record and access personal fishing log – including on-screen ruler, units converter, and fish weight estimator • Access fishing regulations and information including interactive maps • AI-based and pictorial fish identification guide

Table 8. Table of Indigenous apps (non-fishing) showing the scope of Indigenous apps currently in Australia and including a selection from other regions.

App name/Web link	Objectives	Scope (region, target communities)	Key features
First Languages Australia app First Languages Australia Desktop app	To support the preservation and revitalization of Indigenous languages in Australia	Australia-wide	• Recording and teaching tools • Language maps • Knowledge sharing
Deadly Questions app HOME — Living Culture Desktop app	Provides informative and culturally sensitive answers to questions about Aboriginal and Torres Strait Islander culture and history	Australia-wide	• Allows users to receive answers from questions asked about Aboriginal and Torres Strait Islander culture and history • Educate and raise awareness • Culturally sensitive responses and engagement
BlackCard app Home - The Black Card Desktop app	Provides culturally appropriate mental health support and resources for Indigenous Australians	Australia-wide	• Provides access to counselling services and mental health information • Mental health support • Tailored to the needs of Indigenous people
Common Ground app Get to Know the Common Ground App: 6 Perks to Improve Your Workflow - Common Ground Desktop & mobile app	Connects Indigenous Australians with job opportunities, cultural activities, and support services in their local community	Australia-wide	• Platform to access resources and opportunities relevant to specific locations and cultural backgrounds • Explore job opportunities • Find cultural activities • Networking with individuals and organisations • Resource hub for education, health and employment resources

App name/Web link	Objectives	Scope (region, target communities)	Key features
Mapeo app [Mapeo: Monitor and document the world around you - Earth Defenders Toolkit](#) Desktop & mobile app	To easily document environmental and human rights information and to collect data about their land	Global, including Peru, Kenya, Ecuador, Thailand.	• Can be customised/translated into any languages • Mobile and desktop apps (synchronized) • Gather evidence, take photos, record GPS points (mobile app) • Organise data, visualise, edit and create reports (desktop app) • For individual or team projects • Uses icons and limited number of features for ease of use

Table 9. Table of citizen science and project apps to demonstrate the scope of apps currently in Australia and selected other regions.

App name/Web link	Objectives	Scope (region, target communities)	Key features
Monitor (DCCEEW) [Ecological Monitoring System Australia (EMSA) - DCCEEW](#) https://www.tern.org.au/field-survey-apps/	Support 'Ecological Monitoring System Australia' (EMSA) – to collect long-term ecological monitoring and improve ecological data collection	NRM agencies and their subcontractors	• Web-based app • Field survey modules and data systems for ecological monitoring • Shares and combined your data with similar data in the biodiversity data repository • Modules for different ecological systems • Web app (desktop), Android, iOS • Assists with field surveys • Ties data entry to standardised vocabularies. • Reduces time and errors associated with manual data entry • Streamlines the data collection process • Collections location, time and date information automatically • Enables photos, videos and sound records to be attached to data fields • Uploads data to a secure server
Tails (SPC) ([Tails	FAME (spc.int)](#))	To collect real-time monitoring data (including while offline) on artisanal fish stocks by fishery surveyors to improve fishery sustainability	Western Pacific Ocean region (including Fiji, Samoa, Papua New Guinea, Kiribati, Solomon Islands, and Vanuatu)	• Fisheries staff can log their catch data on the app, including details such as species, quantity, size, and location • Use fish photos (on a measuring board) to identify species, record length and estimate their weight • Provides information on local market prices for different fish species, helping fishers make informed decisions on where to sell their catch

App name/Web link	Objectives	Scope (region, target communities)	Key features
			• Tools to help fishers comply with regulations, such as size limits, gear restrictions, and fishing quotas • Records information on the supply chain, from catch to sale to supports traceability of seafood products • Uses data analytics to provide insights on fish stocks, market trends, and fishing behaviour
Ikasavea (SPC) ([Ikasavea	FAME (spc.int)](#))	To collect real-time monitoring data (including while offline) on artisanal fish stocks by fishery surveyors to improve fishery sustainability	Western Pacific Ocean region (including Fiji, Papua New Guinea, Solomon Islands, and Vanuatu)	• Identification of fishing grounds. • Weather forecasting. • Communication tools for fishers to share information. • Provides information fishing techniques, regulations, market prices. • Ability for fishers to track and report illegal fishing activities. • Requires very little bandwidth to send and receive data.
Lukim Gather mobile application in Kimbe Bay, West New Britain ([Lukim Gather: a bridge for people and planet	United Nations Development Programme (undp.org)](#))	Targets Protected Area community leaders and members to collect environmental information which can benefit conservation monitoring and management plans.	PNG	• Provide an annual baseline about the condition of values and threats in the protected area. • Empowers communities to quickly - and anonymously - report on local environmental incidents, including illicit activities such as illegal logging.
Cybertracker software (Paul *et al.*, 2016)	Improve women's roles in fisheries management.	Quiwia, Mozambique	• Community-based mapping of intertidal fishing grounds and locations of important species in their village.

App name/Web link	Objectives	Scope (region, target communities)	Key features
	Develop a combination of local ecological knowledge and scientific knowledge to fisheries management.		
AirRater app ([Air Quality Monitor & Allergy Symptom Tracker - AirRater](#))	Air quality information.	Australia-wide	• Various
Biocollect app ([https://www.ala.org.au/biocollect/](#))	Biological data collection for projects.	Australia-wide	• Various
ClimateWatch app (*[About the ClimateWatch App - ClimateWatch Australia- Citizen Science App](#)*)	Record data about animals and plants.	Australia-wide	• Various
Critterpedia app ([Critterpedia: an AI-powered app to identify insect and snake species – Imaging and Computer Vision (csiro.au)](#))	Identify insect and snake species.	Australia-wide	• Various
EyeonWater app	Drinking water monitoring.	Global	• Various

App name/Web link	Objectives	Scope (region, target communities)	Key features
([EyeOnWater Australia (csiro.au)](#))			
iNaturalist app ([A Community for Naturalists · iNaturalist Australia (ala.org.au)](#))	Record data about animals and plants.	Australia-wide	• Various
Shark Trust app ([Shark Trust App](#))	Record shark sightings.	Global	• Various

Community consultation workshops

The results for each key topic discussed at the 15 community consultation workshops held between January and July 2024 including responses from 142 workshop participants are presented below.

Community attitudes to non-commercial fishery monitoring

During each workshop, participants provided comments concerning individual and community attitudes to community level non-commercial fishery monitoring. Most comments were made during Session 1 - "Background to non-commercial fishery monitoring needs". All comments were compiled, categorised and presented below.

Comments regarding community need and managing pressures made up about half of all comments (Figure 11; Appendix G). Community needs included:

- Traditional fishery data needs for current local programs (e.g. Rangers);
- Implementation of local management;
- Educating and raising awareness among local community members; and
- Information needs for external agencies (e.g. Great Barrier Reef Marine Park Authority [GBRMPA], TSRA).

The pressures that required management included:
- Fishing by external fishers (e.g. PNG, recreational fishers, TVH fishers, prawn trawlers);
- Greater local fishing pressure (especially due to increasing use of larger boats and technology);
- Environmental changes (e.g. seagrass decline and climate change).

Ways to help implement the monitoring program made up 13.4% of comments (Figure 11; Appendix G). They included:
- Involving the local school;
- Learning from the dugong and turtle project;
- The need for educating community members about the importance of monitoring; and
- Using language (e.g. local fish names).

The Spanish Mackerel example used in the workshop (see Figure 3) generated quite a few comments from participants (10% of total) and reflected concern over the uncertainty of the estimates of non-commercial fishery catch. Concerns about fishing of Spanish Mackerel by other sectors (e.g. recreational fishers) were also common.

The potential to use the information from monitoring traditional fish catches to promote new commercial fisheries for TIB fishers was also a common comment (8.4% of all comments).

There were several other fisheries-related issues raised during the workshops, including: control, compliance, and enforcement of recreational and cross border fishers; and the desire for more local control - "*Meet us halfway*". More involvement and knowledge of external research providers was also mentioned.
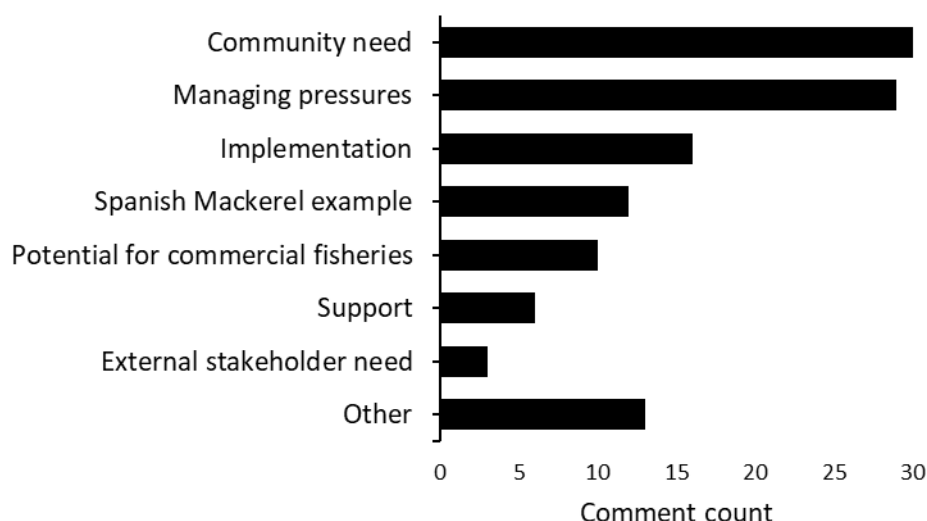
Figure 11. Comment count for categories regarding attitudes to non-commercial fishery monitoring for all workshops.

Non-commercial fishery species priorities

Overall, workshop participants identified 152 unique traditional fish catch names representing 94 species (or species groups) over all workshops (for a full list of species types and names, see Appendix F), though it was made clear by participants at most workshops that the list was not comprehensive (for examples of traditional catch, see Figure 14).

The most important species, in terms of food, health and culture (but not income) to communities in Torres Strait overall was the Golden-lined Spinefoot (*Siganus lineatus*) (Figure 12), which was also the case in the early 1990s (Harris *et al.*, 1995). A mixed species group of tuskfish (*Choerodon* spp.) and parrotfish (Scaridae) were second, and Tropical Rock Lobster (kaiar) third.

Species that were also commercially fished, including Coral Trout (*Plectropomus* spp.), Spanish Mackerel (*Scomberomorus commerson*) and Mud Crab (*Scylla serrata*) were all in the top 10 species importance overall (Figure 12).

In terms of priorities for monitoring, the highest votes were made for TRL, reflecting its dual importance as a traditional and commercial species in Torres Strait. Golden-lined Spinefoot was second, reflecting its importance for community subsistence and culture, and concerns about the status of populations in many areas of Torres Strait (Appendix H). Clams (Tridacna spp.) were ranked third and also reflect concerns about population status.

Two important commercial species, Spanish Mackerel and Coral Trout were the next two highest priorities for monitoring, again reflecting their dual importance as a traditional and commercial species. 'Sardines' (a mixed group of inshore schooling fish of the family Atherinidae and Clupeidae) were the next highest priority reflecting their acknowledged importance as lower trophic "foundation" species and as a food species, but also some concerns about population status due to lower abundances in some recent seasons.
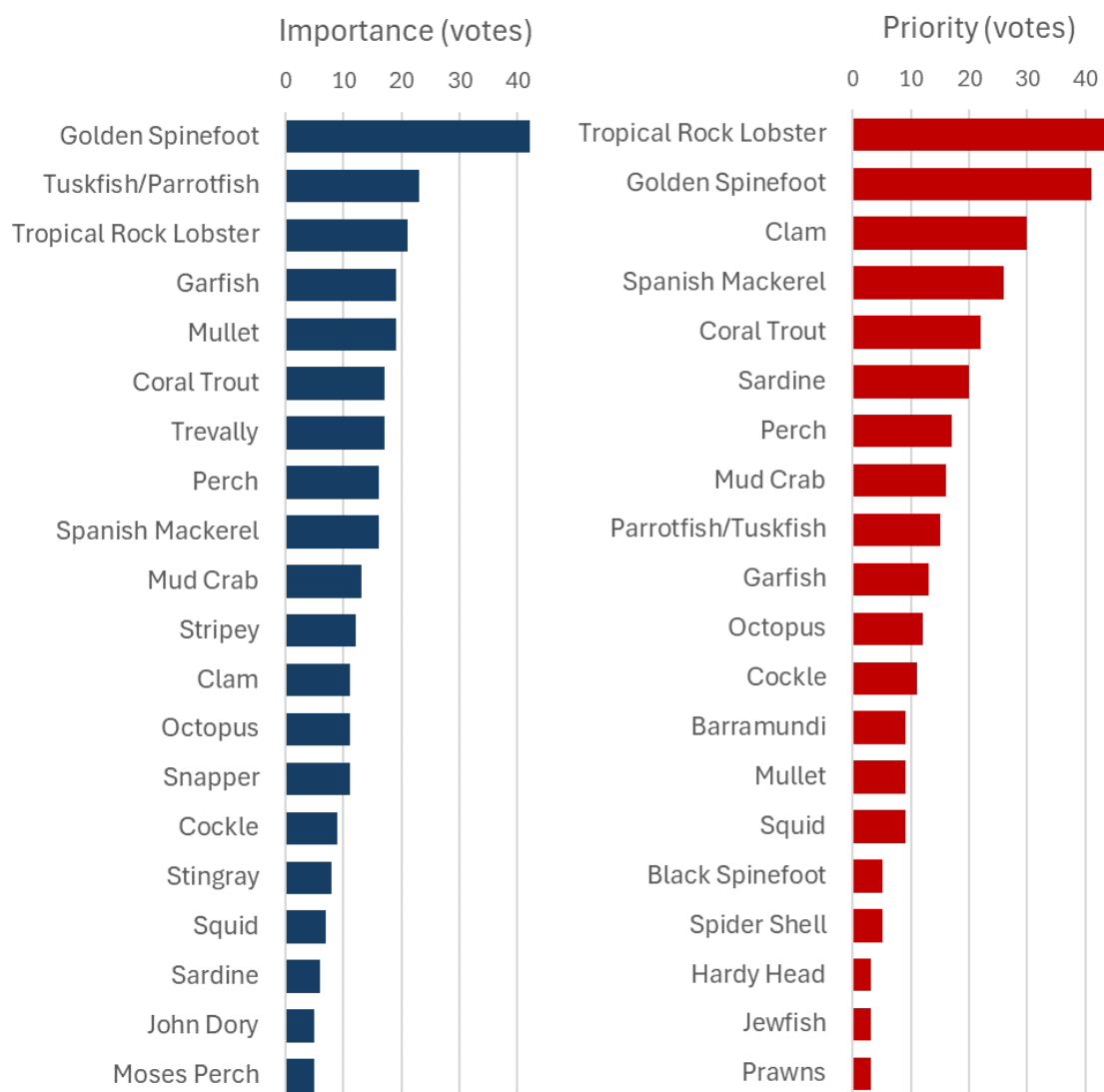
Figure 12. Species importance and monitoring priority for Torres Strait traditional (kai kai) catch for all communities sampled (Top 20 only).

There were some differences in species importance and monitoring priority between nations (cluster groups) (Figure 13), reflecting species geographical distribution patterns and differences in species targeted. Mud crabs (*Scylla serrata*) and Barramundi (*Lates calcarifer*) were both important and a monitoring priority in Guda Maluialgal (Top Western); TRL and Coral Trout similarly in Maluilgal (Western); spinefoot, tuskfish and TRL in Kulkalgal (Central); spinefoot, sardines and Spanish Mackerel in Kemer Kemer Meriam (Eastern); mullet (likely *Crenimugil buchanani*), spinefoot and Coral Trout in Kaiwalagal (Inner Islands); and Black Jewfish (*Protonibea diacanthus*), mullet and TRL in Injinoo (NPA) (Figure 13).

Figure 13. Species importance and monitoring priority for traditional (kai kai) catch for nations (cluster groups) (Top 10 responses only).

Figure 13. (cont.)

Kemer Kemer Meriam (Eastern)	
Kaiwalagal (Inner Islands)	
Injinoo (NPA)	
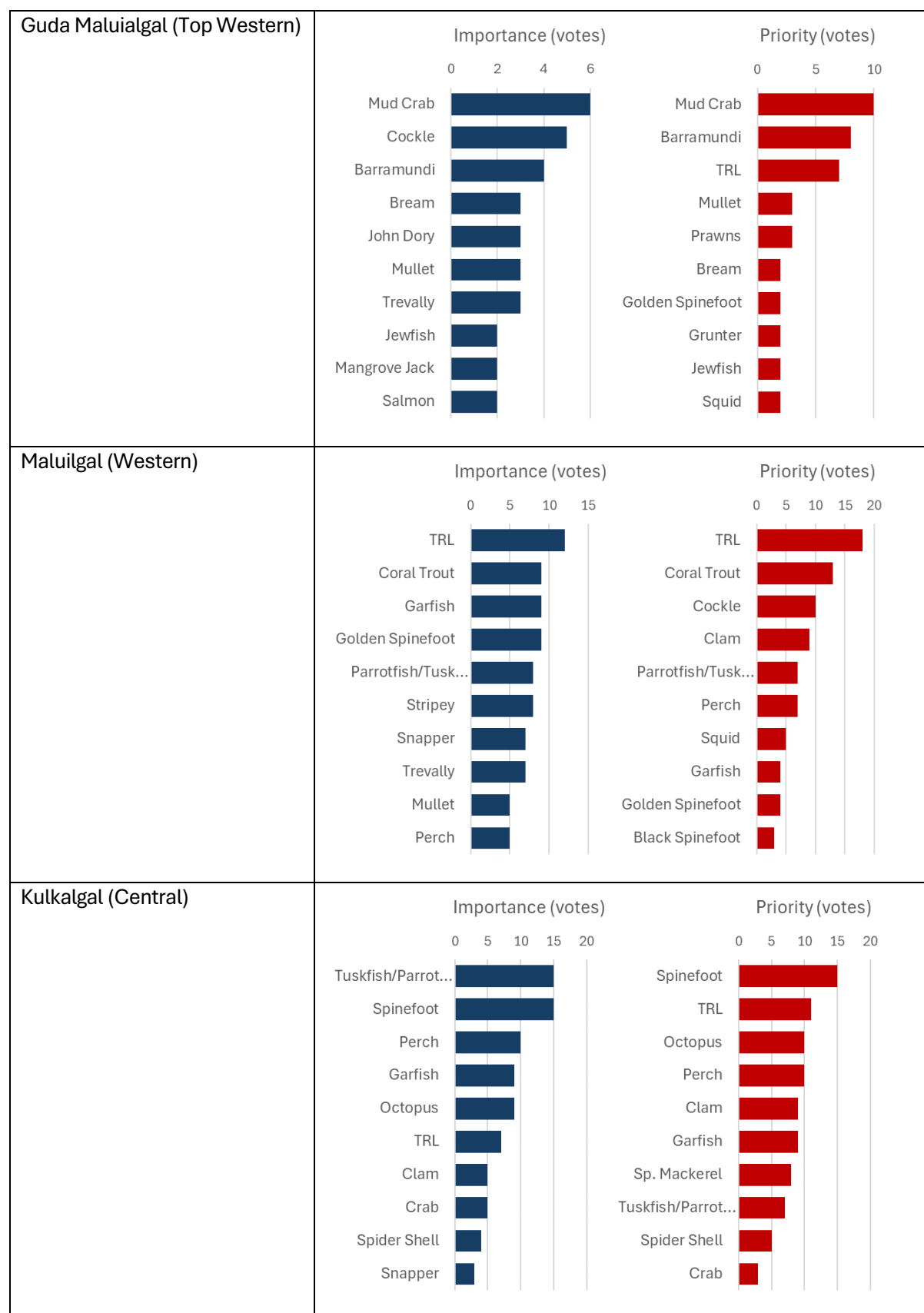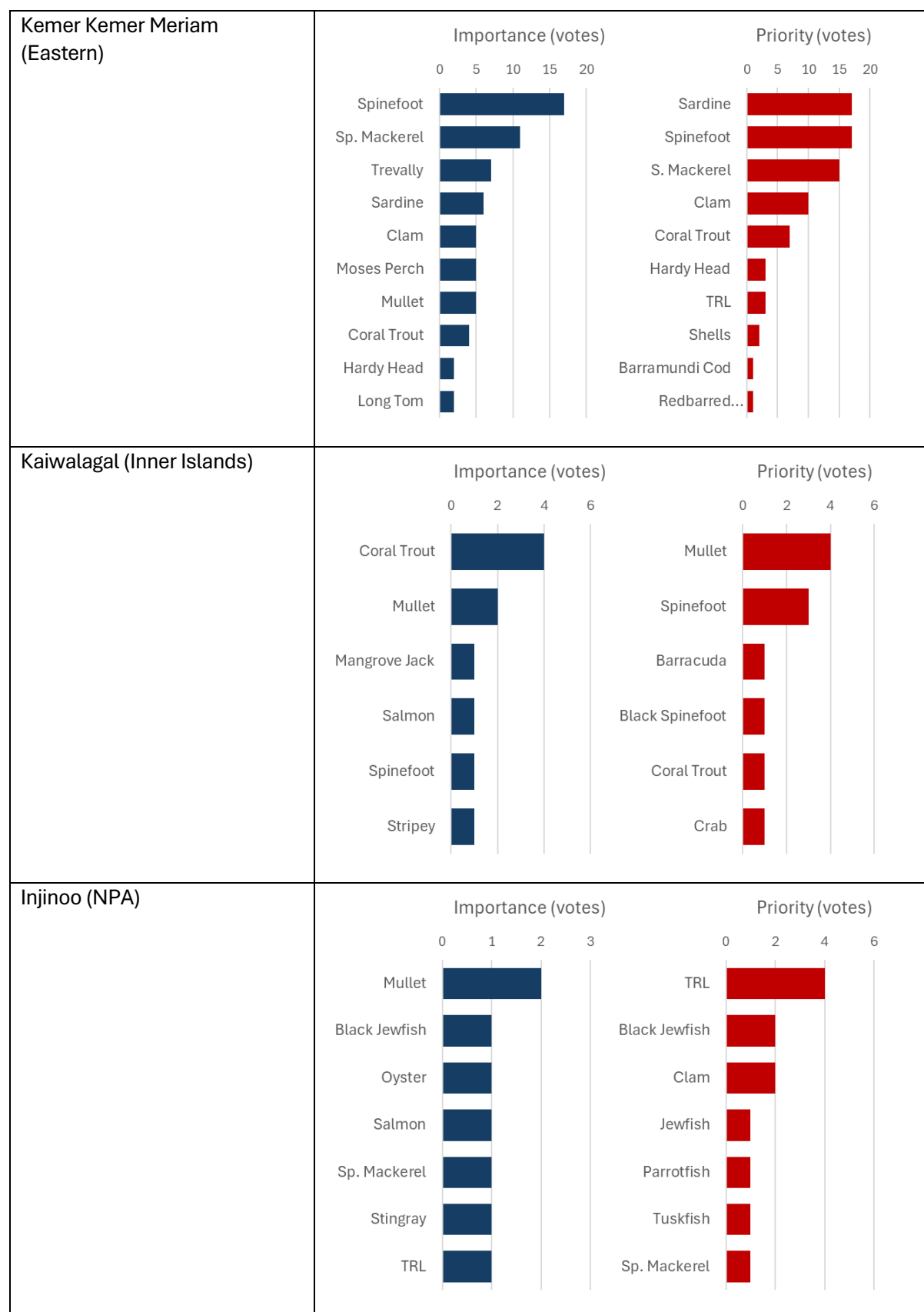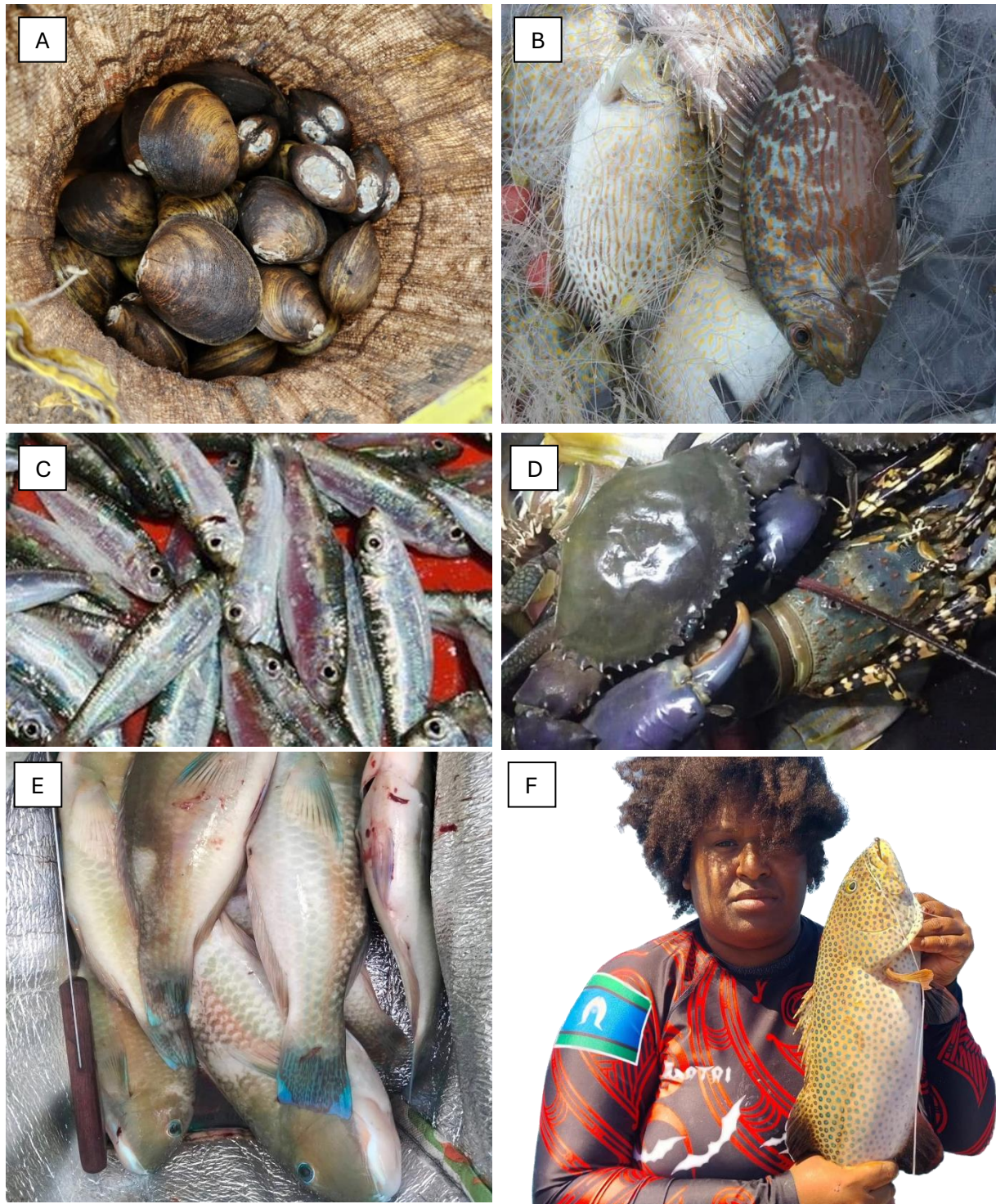
Figure 14. Traditional fishing and catches in Torres Strait. A. Mangrove clam, Geloina expansa (No Standard Name available for members of that genus), photo by Kenny Bedford; B. Mixed Rabbitfish, photo by Lala Gutchen; C. Mixed catch including Sardinella, Sardinella sp., photo by Kenny Bedford; D. Stone fish-trap harvest, photo by Fred Kiwat; E. Blue Tuskfish, Choerodon cyanodus, photo by Ivy Faiud; F. Coral Trout, photo by Lala Gutchen. See Appendix F for traditional indigenous names noted from this study.

The majority (65%) of comments regarding species importance and monitoring priorities related to specific species and particular issues or concerns associated with those species (Figure 15; Appendix H). Comments ranged over:

- Concerns over population status (e.g. clams);
- Local overfishing, especially by use of nets (e.g. Spinefoot);
- Multiple pressures (e.g. species targeted by commercial, recreational and illegal fishers such as Spanish mackerel and TRL); and
- Concerns over community trading and transportation of fish out of the region (e.g. Spinefoot and Spanish Mackerel).

At most workshops (10/14 communities), a comment was made that all traditionally caught species are important to monitor (Figure 15; Appendix H). Several comments by participants reflected on the different suite of species fished by women (15% of overall comments), including the need for monitoring those species specifically, mostly focused on inshore species and not species that are usually caught commercially (Appendix H).
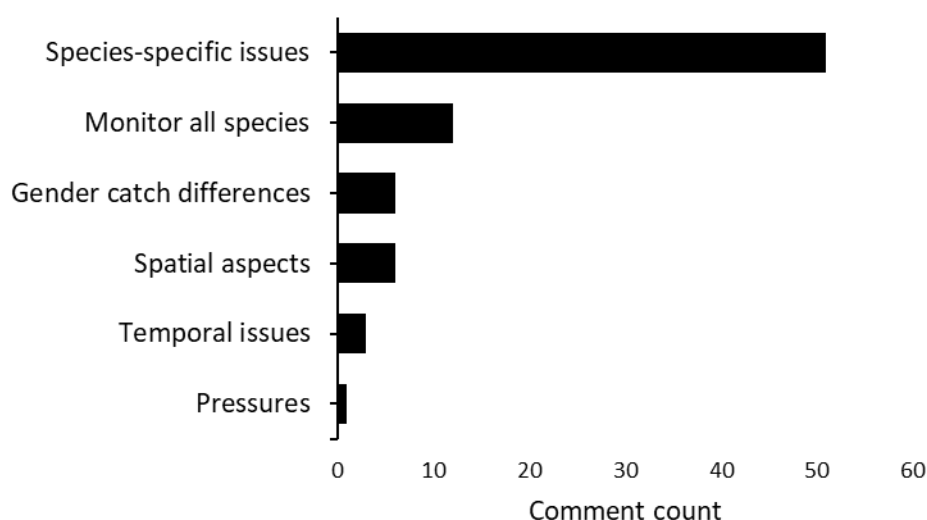
Figure 15. Comment count for categories regarding species importance and monitoring priorities for all workshops.

Community attitudes to implementing a monitoring app

The following outputs relate to comments made during all workshop sessions (but especially during session 3 - Introduction to monitoring apps) by workshop participants related specifically to implementing a non-commercial fishery monitoring app for their community. Many (46% overall) comments related to the implementation process of the monitoring app (Figure 13, Appendix I). These included:
- The need for a significant communication and incentive campaign to raise awareness and address concerns and barriers to uptake;
- Targeting youth and capturing older community members;
- Providing sufficient incentives; and
- Providing devices that are available for community use.

Community members also shared some information/views on design aspects of the app in general including:

- Keeping it simple to use;

- Making sure is has useful information for the user (including species and environmental information and local management);
- Including social media principals; and
- Using local language.

Most workshops (10/15) included comments strongly supporting the implementation of an app as a good idea at the right time that will provide useful information for managing local fisheries.
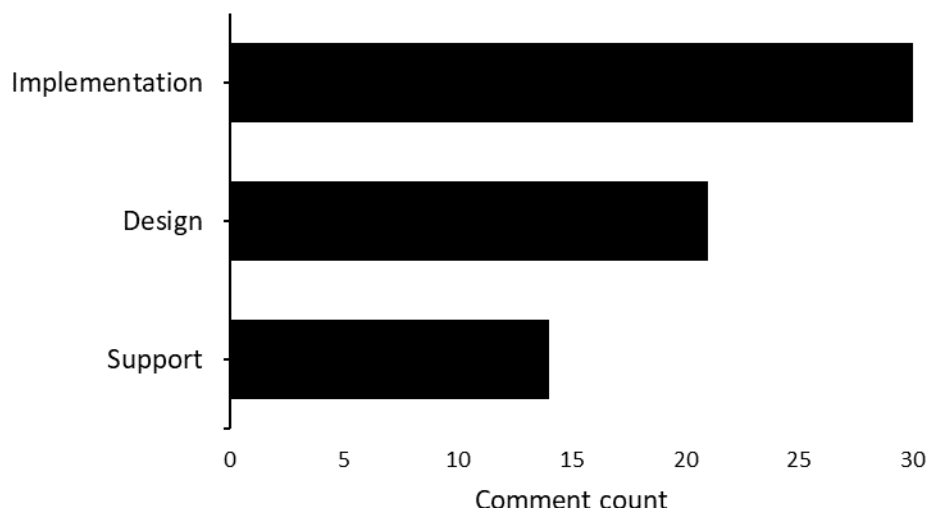
Figure 16. Comment count for categories regarding to implementing a monitoring app for all workshops.

App questionnaire responses

At nine (out of 15) workshops (logistical and time constraints prevented this activity being completed at all workshops), participants were asked to complete a brief one-page questionnaire with six questions. This resulted in about half (64/142) of all workshop participants completing the questionnaire.

The questionnaire responses indicated strong support for the implementation of a monitoring app, with 83% of respondents saying they would use an app to record their catches (). Almost a quarter of respondents (24%) indicated that they had used a fishing app in the past (unfortunately we did not get more details of this app use, though some of the "yes" respondents were from Erub where a tablet-based catch recording system was trailed in 2014; see also French *et al.*, 2014). Encouragingly, almost all (92%) respondents indicated that they would be willing to learn how to use a fishing app. About one third of respondents indicated that they did not have access to a smart phone, illustrating the challenge of making a smartphone-based app available to all community members.

We acknowledge that the positive response rate of workshop participants may be biased in relation to overall community attitudes – it is likely that workshop attendees are more likely to be engaged and willing to participate in a community based catch monitoring program as reflected by their attendance at the workshop (though there were some who were negative or not sure - Figure 17). To assess this, we also asked workshop participants who completed the questionnaire to estimate the proportion of the community that they think will use app (initially at least). The mean estimate across all communities was 46.7%, and although there was considerable variation between individual residents, the average for each community was remarkably consistent. This illustrates the challenge with short to medium-term app uptake and retention for community members using the app and reflects the experience of other app programs where uptake and retention rates are variable but modally around half of sampling frame expectations (Skov *et al.*, 2021).

Figure 17. App Questionnaire responses - Percent of overall responses (n=64).

1.	Would you be comfortable using an app to record your fishing catches?	Pie chart — Yes: 83.1, No: 3.1, Not sure: 13.8
2.	Are you prepared to learn how to use an app?	Pie chart — Yes: 92.4, No: 3.0, Not sure: 4.5
3.	Have you used a fishing app?	Pie chart — Yes: 24.2, No: 72.7, Not sure: 3.0
4.	Do you own or have access to a smart phone?	Pie chart — Yes: 65.2, No: 33.3
5.	Does your community have mobile phone coverage?	Pie chart — Yes: 92.3, No: 3.1, Not sure: 3.1
6.	Do you have mobile phone service where you fish?	Pie chart — Yes: 61.2, No: 13.4, Not sure: 25.4

Codesign process - what outputs and features should be in an app?

There were a wide range of outputs and features recommended from the workshops, some that were mentioned at nearly every workshop (e.g. personal catch information which was the highest ranked response category at 13% of all comments) to some that were mentioned only once (e.g. fish processing information and shark depredation) (Figure 18, Appendix J). When it came to who could access personal catch information, several respondents indicated that this should be available to the community and even regionally – though several people also expressed a strong view that this information should be private, at least for details such as fine scale spatial and temporal information.

Information about the biology of catch species was the second highest requested output (12% of all comments), especially information about breeding times – reflecting a broad understanding among fishers that protecting breeding individuals is a good basic strategy for sustainable use. Community level and regional level management (9% and 10% respectively) and catch (9% each) rounded out the top six most recommended app outputs, mostly referring to use at the community level but also to regional organisations (generally in an aggregated form). Cultural information (7%, mostly local language species names), weather/tides (6%) and environmental information (5%, e.g. coral and seagrass dynamics and climate change) were also recommended at multiple workshops. Species identification (3%) was not a highly recommended feature, likely reflecting the high level of species knowledge among workshop attendees.
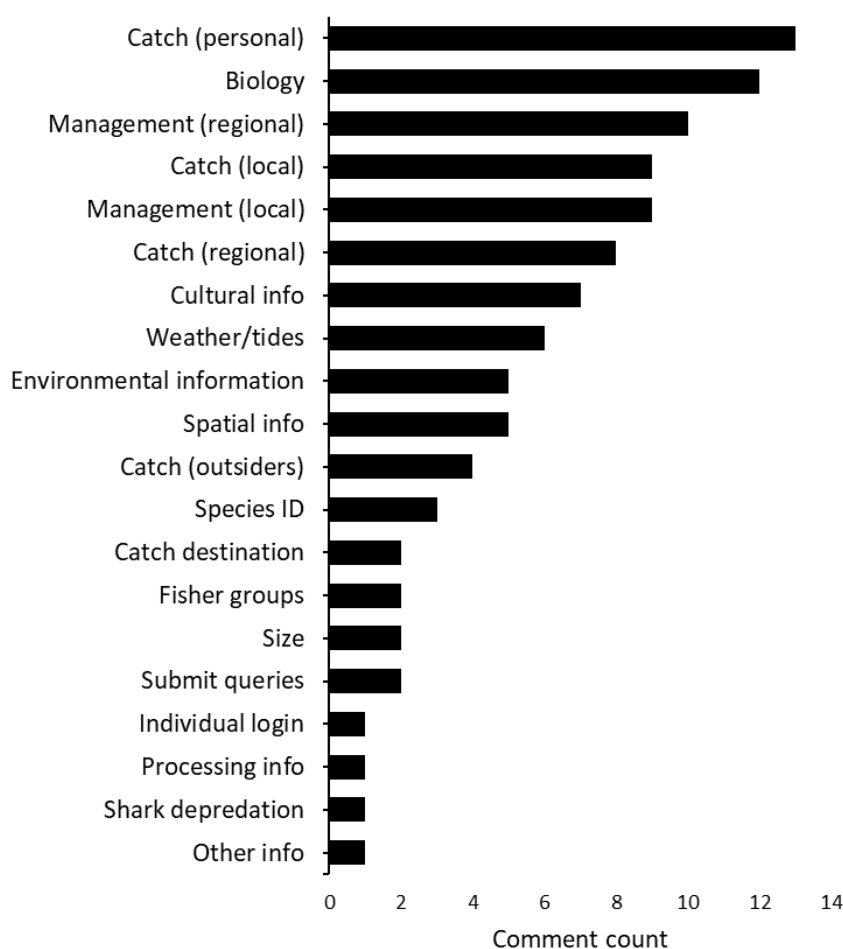
Figure 18. Comment count for categories regarding app outputs and features recommended from community workshops.

Codesign process - what are the barriers to app implementation?

The greatest barrier to app implementation was a fear of prosecution for app users (27% of all comments, Figure 19, Appendix K), especially relating to a perceived belief that size limits and other fishery regulations apply to the traditional catch, even though there are generally few limitations on traditional fishing in the Torres Strait. This is one element that a communication and behavioural change program can address, which will be essential for promoting app uptake among users. Although this will need to be balanced with messages around sustainability, given the potential increase in catch if there are no perceived limits.

The perceived potential loss of personal intellectual property (IP)(15% of all comments) such as fishing location was also identified as an important barrier. Protection of this information will be important to consider in any app design and rollout in Torres Strait.

Not having a smartphone to access an app and keeping the app simple to use were the next two important barriers (15% of all comments each) – factors that were mentioned in the attitudes to app implementation previously. Access to devices will need to be addressed in a future program. Some solutions suggested included providing devices to either individuals or communities for use with the app, and nominating family members with devices that can provide multiple logins for family members that lack a device (especially older members of the family).
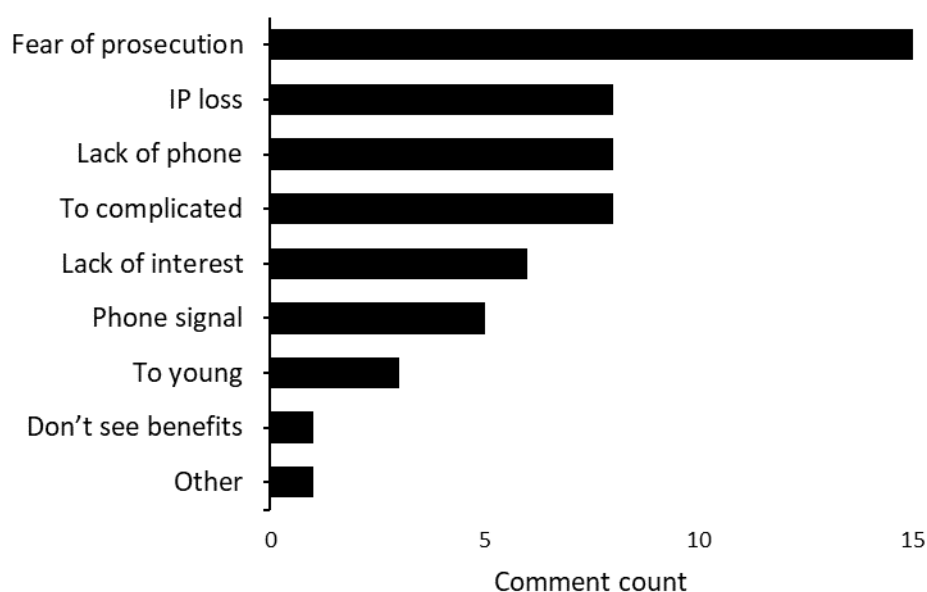
Figure 19. Comment count for categories regarding barriers to app implementation for all workshops.

Codesign process - what are the incentives for app implementation?

The most important incentive identified by workshop participants was to provide information that is useful to app user (28% of all comments), mostly focused on their own individual information needs but also for the community (Appendix L). This generally mirrored the information categories identified in the "outputs and features" section (see above), which indicated a high priority for individual catch information, but also community and regional level catch and management as desirable outputs.

In this workshop exercise, the capacity of the app to assist with species identification and size estimation was also a commonly mentioned information related incentive (Appendix L).

The ability for the user to share information (e.g. photos of catch) with selected family and friends was the second most common incentive identified (22% of all comments). This relates to the currently common practice of community members sharing catch information using social media – a trend that could be used to support user uptake in the rollout of a new app.

Torres Strait culture has a strong foundation of natural resource management and sea country ownership and stewardship, something that was mentioned by participants as being somewhat eroded by 'modern' culture. However, these powerful cultural practices are considered a strong incentive for community members to participate in a monitoring program and app rollout. However, any messaging associated with local stewardship would need to be supported and implemented by community elders/leaders to be effective (Figure 20).

Prizes, raffles or payment (either as cash or merchandise) were also identified as useful incentives for increasing app uptake and use (13% of all comments); though there would be a need to ensure that this doesn't encourage misreporting. Commenters often pointed out that the value of the award would not have to be large to be effective.
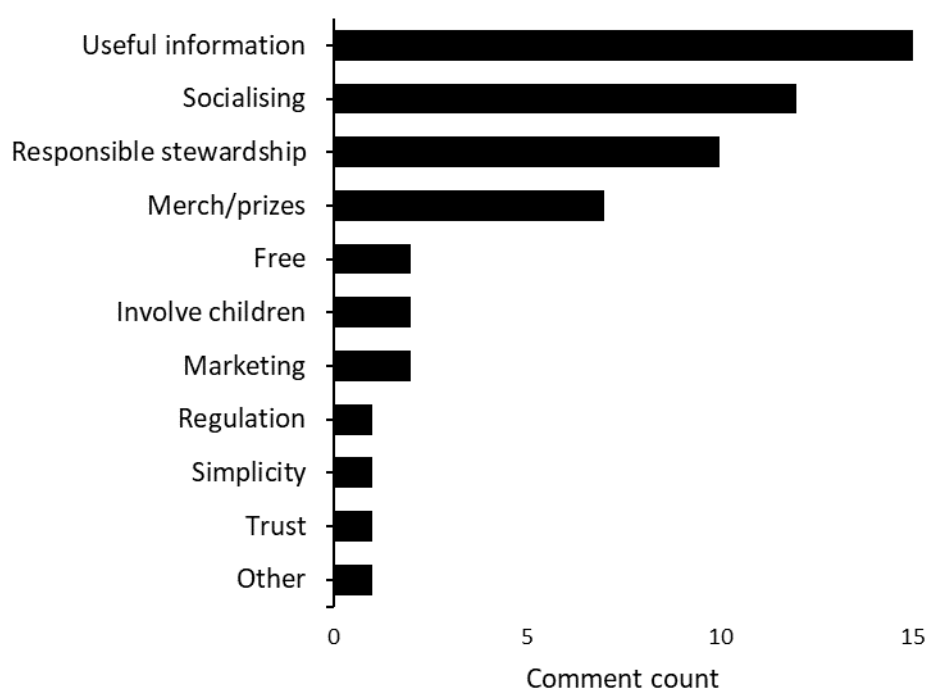
Figure 20. Comment count for categories regarding incentives for an app implementation for all workshops.

A common response was that using local messaging about resource stewardship will be very powerful with some communities already promoting similar messaging such as Poruma (see Figure 21).

Figure 21. Porumalgal community message: "The land is yours, look after it. The sea is yours, look after it" Porumagal Elder.

Codesign process - who should/could run the app?

Overall, there were relatively few comments or opinions regarding suitable app custodian from workshop participants (only 11 comments over all workshops). When prompted, participants agreed that it was an important aspect of the app rollout, and that trust would be critical for initial uptake and ongoing app use. Identifying an acceptable data custodian will likely require some additional consultation to reflect community attitudes about this important aspect of the app pilot program and full-scale roll-out.

The most common suggestion was that a community-based organisation would be the best custodian of local data (36% of all comments), either an existing community fishery corporation or new local body (Figure 22; Appendix M). There were a couple of suggestions for the Rangers and a new regional body (18% each). No one suggested an existing government body as the appropriate custodian (though the ranger program is at this time operated by the TSRA).
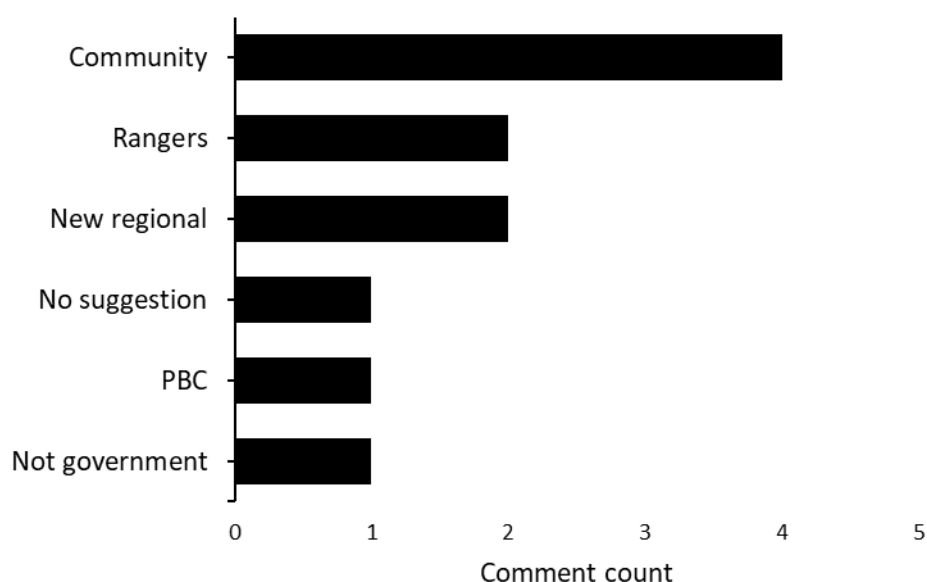
Figure 22. Comment count for categories regarding who should/could run the app for all workshops.

Performance and cost options

Developing a cost-effective approach and design for a fishing app(s) for use by Torres Strait Island people that will aim to collect robust fish catch data from recreational and traditional fishers is a substantial challenge. This is because of the complex array of issues that need to be considered, including the specific needs for Torres Strait communities and preferences for monitoring their traditional fishery catches, design principles and app features that can impact uptake and ongoing use by residents; and the fact that there are limited precedents regarding app-based Indigenous fisheries monitoring programs to draw on in Australia.

Cost options pose a complex issue given that the design (and full implementation) of fishing apps has been described by experienced app developers we interviewed as 'a journey'; and that costs are usually prescribed after initial engagement and commitment between app custodians and developers – a process that cannot be completed in this research project where no commitment can be given to a commercial app developer to go ahead with specific design, implementation and ongoing development of a traditional fishery monitoring app for the Torres Strait. This means that any indicative costing (e.g. in a quote) is limited, as a formal relationship between app developer and custodian does not yet exist.

We have managed these challenges within the timeframe of the project by identifying and compiling a wide range of design options, along with advice from current app experts (custodians and developers). However, this process has limited our cost estimates to broad-scale estimates only.

Below, we provide guidance on a high-performance app scenario, based on maximising app uptake and ongoing use, while collecting the data and information required by fishery management and desired by Indigenous communities. This guidance is summarised as (i) key information required by management and communities (above), (ii) key app design principles and (iii) potential app features. Support and management needs, as well as cost scenarios are also presented and described, including their limitations and key learnings.

App design principles

Building on the results of the interviews with app developers, Table 10 provides a summarised list of design principles considered important to the design of a Torres Strait fishing app(s). These principles are based on learnings from past activities by app designers. Custodians of the *GoFishVic* app noted a substantial increase in catch recording after engagement with users on their experiences who found the earlier versions too hard and complicated to use. For example, this app used a multiple-species recording feature in earlier versions, but this was simplified to single species recording (separate entry into the app for each species) following user feedback. Another example of app co-design was a process used for the *QLD fishing 2.0* fishing app. This involved co-design with a recreational fishing focus group, existing fisher networks, and fisher representatives on planning committees, as well as one-on-one extended interviews with about 50 fishers.

One app custodian interviewed noted that, for small communities, the benefit of local and open lines of communication (e.g. through expert user groups or representatives) and co-design provided increased confidence in an app and allows for easier adjustments when needed.

The 11 key app design principles identified (Table 10) are based on their relevance to the current project setting, assuming a bespoke, community-based app for the Torres Strait traditional fishery. The community co-design consultation identified that the provision of useful information and users' ability to share/socialise information are strong incentives for potential app use. Similarly, trusted and responsible stewardship, trusted data custodians and information privacy were also identified by community groups as critical to app success in the Torres Strait. These principles, as well as good app

support, are also broadly recognised by app experts as important to app uptake understanding and ongoing use. Torres Strait communities are potentially well set up for such a scenario with local governance and community expertise in environmental monitoring (e.g. community land and sea Indigenous ranger groups in most/each island/community).

Culturally appropriate app design and language has also been flagged by community leaders as important for building trust with Indigenous fishers (Table 10). These features also build a feeling of ownership of the process and indirectly supports the community's vision for long term sustainable fishing. Simplicity of use, including its visual amenity and app navigation, are also widely recognised as key app performance criteria.

Table 10. List of app design principles for a Torres Strait traditional fishing app collated from community co-design, interviews with app experts and published information.

App feature	Issue	Solution
Trusted login	A government or unfamiliar site login is seen as too risky by some fishers	Make login simple and personal, e.g. email address and password only
Anonymity of reporting	Fear of their data being used against them, or some other unforeseen interaction with app management	Make login simple and personal, e.g. email address and password only Use unique IDs for users and transactions with users
Clear privacy options	Fear of their data being used against them, or some other unforeseen interaction with app management	Users should be able to understand how their data is being used and have control over their privacy.
Strong data protection	Fear of their data being used against them, or some other unforeseen interaction with app management	Acceptable and trusted data custodian Formal data custodian agreements Data encryption Multifactor authentication provides an extra layer of security for users Ongoing explicit and informed consent for data to be used by other agencies
Trusted, local management	A government or unfamiliar site login is seen as too risky by some fishers	App governance based at the community level
Visual features	The more visual the app processes, the easier it is to use	Build into the app design, e.g. use icons instead or written words where appropriate
Culturally appropriate design	Non-Indigenous culture does not evoke a trusted process as well as local Indigenous culture Although English is spoken throughout Torres Strait, each community uses local language names for fish species and potentially other subjects	Use local language names where possible, and especially for commonly used local naming such as fish and place names Use culturally attractive app design, including logos, artwork, other visual design features
Simplicity of use	The simpler the app is to use the more likely fishers will continue to use it Too many bottom clicks and too many questions/data fields to fill out deter app users	Design for fewer button clicks, fewer data input needs and clear button labelling Minimise cascading menu searches e.g. keep to <4 or 5 button clicks Simplify and minimise the number of data requests

App feature	Issue	Solution
	Some operating system providers recommend that users need to be able to record data within 30 sec – 1 minute to minimise this type of annoyance factor	
Gender-neutral language	Commonly used patriarchal language may deter many potential users	Use gender-neutral language throughout the app design process and for app features
Start simple	Complex apps are more difficult to use and manage	Start with a minimal viable product for simplicity of use, design and management while fishers get used to it, then build on this as needed
App support and maintenance	Apps require early software adjustments and users benefit from ongoing evolution of app features	Plan for some level of ongoing app support and maintenance capability Should be able to get help quickly and easily, e.g. Chat support and callback function Include a trusted subject matter expert in the app support group Push notifications can keep users engaged by providing timely updates and reminders
Make app use interesting and fun	People are more likely to engage in technology and data provision if fun elements are part of the process	Include information of interest to encourage app use (e.g. weather and tide, fish biology and ecology, fishing tips and regulations Include sharing, gaming and other useful features that support the fishing experience (e.g. personal data summaries, environmental information)

App design features

The common features of recreational fishing apps are useful for the design of a Torres Strait fishing app. Eayrs (2022) noted that the principle of 'what's in it for me' can be an important driver of change in fishers and is likely to apply in app design. Such features either provide information that is highly valued to the fisher, for example, in terms of their safety and ability to catch fish, or they incentivise use of the app using specific strategies. For example, Goldsmith *et al.* (2023) suggest that reporting compliance from fishing app users can be increased by: (1) providing incentives; (2) providing behavioural "nudges," such as reminders; (3) better educating anglers on the benefits of self-reporting; (4) increasing the user-friendliness of the reporting technology; and (5) the reframing of norms through leveraging leaders in the fishery. Table 11 provides a summarised list of app features considered important to the design of a Torres Strait traditional fishing app. The features also include key information which ensures that the required data for management of commercially important species – total catch numbers, by species - is captured. However, inclusion of additional information about catch effort, fish sizes, habitat fished, fishing gear used etc, can allow for more detailed assessments of the health/status and change dynamics of fished species. Such information can serve as the basis for informed local decision making about local fishing behaviour to help support management decisions for long-term fish sustainability. However, 'nice to have' app features may also compromise the key principle of 'simplicity of use' which is deemed important to maximise app uptake and ongoing use. Hence, a balance in how app design features are included is important.

A range of data capture features can also be auto-generated to minimise user inconvenience through additional and unnecessary typing of information and button clicks. For example, fishing location can be autogenerated with an algorithm that links with a smartphone or tablets geolocation software; noting that geolocation can be switched off by fishers if desired.

Log in and identification data

Most apps use log in and identification data to provide entry into the app. This unique identifying information is usually key to a range of app functions such as managing individual data privacy, collection of fisher-level catch data or provision of tailored catch analytics back to the fisher. However, developing a secure authentication system adds to development time and costs by requiring additional coding and security measures and may also need to comply with privacy regulations. It will require a suitable backend database to store user credentials and profile information. Setting up, managing, and maintaining this backend infrastructure, which includes databases and secure connections, is a complex undertaking that will require significant funding and ongoing support, including for user management features such as password recovery, account verification, and account locking. Log-in details can be simplified to usernames and passwords and include commonly used approaches such as email address or an alias name. Some of these data can be auto-generated to make app use simpler, such as date, time and place. Other potentially less important identification data could include trip name, who fished (numbers and/or demographic information), depending on the needs of preferences of the user group or app custodian.

A login interface may also be useful as a gateway into the app to enhance community-based management. Community leaders may want to manage local fishing impacts using information about the number of users and their relative impacts and fishing practices (e.g. habitats fished, species targeted, gears used etc). However, although the login may be specific to individual it can be anonymous to app custodians.

Catch data

The majority of Government-sponsored recreational fishing apps aim to collect catch information and provide fishers with a suite of useful fishing support information. Most allow for the collection of catch data about individual fish, including number, size and species and most of these apps also provide user access to their personal fishing log (see 'analytics', below) as a major incentive to app use (Table 11). In some applications, catch data can be automatically generated from a photo. Fish species can be identified using identification software developed by QDPI and others based on a trained AI matching process between the new photo and a bank of stored photos for each species (AC1, pers comm). In the *Qld Fishing 2*.0 fishing app example, the software provides results from the photo matching with degrees of certainty for each species option that the fisher can easily select from. The fisher-submitted photo is also potentially able to estimate the length and weight of the fish (e.g. as in the *Ikasavea* and *Tails* apps – Table 9). Manual species identification data entry should also be an option for those not built into the stock of stored photos used for matching with the catch photos. Advice from app experts is that such AI-based features will continue to revolutionise this type of app functionality at a rapid pace in the very near future.

Species identification guides

Species identification guides are often provided as a pictorial guide and information list. However, some invite uploaded photos of fish and use AI-assisted species identification. These use a pictorial features matching guide by comparing the fishers' photo with a suite of stock photos of known species identification. Such photo identification guides are currently being used by a range of fishing apps including the *QLD Fishing 2.0* app, and the SPC *Ikasavea* and *Tails* apps. However, these guides

require many different stock photos of each fish species (e.g. >50 images) to ensure accurate species matching and identification (AC1, pers com).

In the case of Torres Strait, the stock photos could be accumulated over time, improving matching and identification accuracy as photos accumulate. Alternatively, it may be possible to start with a developed system, e.g. the *QLD Fishing 2.0* app stock photos and identification software - given that there is some overlap in the range of species occurring in Torres Strait and northern Queensland waters. This system could be reshaped for Torres Strait as users continue to submit new photos.

Geolocation

Geolocation of fishing events is also a common feature of fishing apps. These can be linked into smartphone geolocation software of an API (application programming interface) such as google maps and used for a range of purposes, such as recording previous fishing locations or avoiding areas closed to fishing. An example is given by Weir *et al.* (2022) who used GPS data from apps to look at the relationship between angler movement and prediction of aquatic invasive species across large geographical networks. Geolocation or geofencing could also be used as part of a notification system (e.g. by using an Ecological Momentary Assessment mobile tracking tool (Shiffman *et al.*, 2008)), whereby if the fisher leaves their home and relocates to a beach or at-sea location, they would receive a notification to remind them to record any fishing catches on their app. This works well in social science surveys where the location of survey participants is part of the data collection.

Ability to report issues of concern

Ability to report issues of concern is a feature of some apps (e.g. *SA Fishing app, Fishsmart NSW* app). This can be important where there are concerns about issues such as invasive species, illegal activity or pollution events. Apps can provide either a typed comments field(s) and/or ability to log photographic evidence of issues of concern. For example, the *Mapeo* citizen science app has specific provision for recording environmental and human rights information by community members in a range of countries who are involved in monitoring their local natural landscapes (Table 9).

Local languages

Most fishing apps are designed for broad community use and measure their success by the numbers of users. High uptake means more representative and reliable data and/or higher revenue for the app owner. These drivers also translate into apps using the main language in the region. However, more bespoke apps, such as one designed for Torres Strait community use, could suffer from poor uptake if local language is not used appropriately. For example, the *OurFish* app (above and Table 7) has some different features that can support communities with local languages. It has a 'multi-Language' support feature that makes it easily adaptable to local language and literacy rates.

The co-design process for a Torres Strait traditional fishing app (above) found that use of local languages, e.g. for fish species names, is likely to be an important feature for this app. Many Torres Strait community fishers are more familiar with the local language names of fish, and using different names could be a major disincentive for the ongoing use of this app.

Analytics

Analytics features typically summarise data back to the user (Sarker, 2021). These are highly valued by fishers as personal catch information repositories ranging from a single fishing trip to interannual catches. They could also provide community-level fish catch trend information to fishers and community custodians of the resource which can indicate whether species are becoming harder to catch or when migratory or invasive species enter their local waters.

App experts and the community co-design process emphasised that an analytics function, where information about a fisher's own catch is highly valued and can be presented back to the fisher (see above). For an Indigenous fishing app, where catch data may be curated at the community level, these analytics could also feedback community-level statistics if required. These features could provide summary catch information ranging from a single fishing trip to interannual catches; and in the latter case, provide valuable fish catch trend information to community custodians of the resource. Such information can provide new insights into the status of fished resources at the community level and any trends that may be occurring, which can then support local intervention into fishing effort on selected species, should it be required to help protect diminishing stocks.

Third party information providers

Third-party features are common in fishing apps. These link in external sources of information and allow user-access to a tailored, real time information source via the app. For example, most fishing apps link to tide and weather information and alerts (e.g. Qld Fishing 2.0 links to the BoM; AC1, pers comm) which can be a critical source of safety information. These can be incorporated into apps via third party agreements (e.g. with the BoM), often for an annual fee to the app provider (below).

Information on species biology and ecology has also been noted in the Torres Strait community workshops as an important and desired app output (see Community consultation section). This is also most likely to come from a third-party information source.

Other third-party information than can help incentivize app use includes how and where to fish, fishing regulations (e.g. size limits) and spatial and temporal closures to fishing. These are particularly important for recreational fishers. However, In Torres Strait, where Traditional Owners have Native Title Rights to the fishing resources, this type of information could be restricted to any local community guidelines or regulations.

Native V Web-based apps

There are several software platforms that are currently used in this type of digital information interaction space. Mobile apps can be broken into 2 top level categories (native and non-native apps). Then within the non-native apps, there are various sub-categories (e.g. hybrid-apps, cross-platform apps). Native apps are developed for a single operating system running, such as Android, iOS or Windows Phone. The app functions only with that operating system on the designated platform. They have fast performance and have highly customizable options.

Web-based apps are mobile versions of responsive websites. They can be dedicated (works on a specific platform) or generic (works on all mobile devices). Applications are not directly installed onto the mobile device but is hosted on the web browser and accessed through the WebView. They can be less expensive than Native apps, but do not have off-line access (cannot be filled out if user is offline/out of connectivity) or access to other device utilities (which add additional capabilities). They require an internet connection for the features to work fully, are less interactive and may have slow performance if the internet connection is slow. In Torres Strait, recreational and traditional fishing can occur in remote locations, which may affect the utility of web-based apps.

Hybrid apps have cross-platform compatibility similar to a generic web-based app and functionality that is similar to native apps, so they are basically a combination of the two. However, by 2025, nearly all mobile apps will be built on common sets of frameworks and standards, which would make native mobile app development obsolete (McHugh, M. 2024; AD3, pers comm). Hence. for the purposes of this report and the recommendations around these app categories, the options for this design feature are unlikely to be an issue.

Table 11. Traditional fishing app features collated and distilled from (i) co-design community workshops in Torres Strait, (ii) recreational fishing app features research (expert interviews), (ii) app design features research (expert interviews).

App feature	Priority	Details
'About this app' information	High	• Could inform fishers about why to use the app • To assist with app use, e.g. like a user guide
Log in page/unique user ID/private, secure data space	High	• User ID such as email address and password
Provision of (periodic) informed consent to share data summaries	High	• Clear plain language agreement between individual fishers and the primary data custodian during onboarding. • Ongoing consent provisions for inclusion of individual data in catch summaries.
Fishing episode identifier (Trip name, date, time	High	• Could include user defined trip name. • Date, time auto-generated should suffice for one days fishing effort.
Fishing site location	Medium	• This could vary from the location where the data is entered, e.g. due to data being entered after the event or variable mobile coverage • Location could be a GPS point of the fishing place or a region/community categorical designation • Could be auto-generated using suitable APIs (e.g. Google maps) to improve simplicity of use • Should be protected from external access (e.g. at least for high resolution data if there are privacy concerns) unless active permission is granted to share. • This data can help manage impacts on fish populations between neighbouring community's.
Fishing method	Low	• Handline, rod and reel, gillnet, trap, etc
Is the catch a shared catch?	High	• Recommended sampling unit is an individual fisher. • Where the catch is "shared" (the catch represents the fishing effort of more than just the app respondent), then the catch needs to be identified as a "shared catch" • The number and type of people that shared the catch also needs to be captured (so that the catch can be scaled for use later in the analysis), including perhaps the number of females and males, and number under 18 (to help with modelling the catch later).
Time fished	Medium	• Important for assessing fishing effort if that is required • Could be entered as 'start time' and 'end time'
Number (and sizes) of fish	High	• Numbers caught within each species • Could include records of fish kept and fish released • Sizes could be autogenerated from catch photos • Fish lengths and weights could be generated or measured from catch photos (e.g. *Tails* app, or photographic method described in Andrew *et al.* (2020))
Ability to submit catch photos	High	• From uploaded photos of individual or groups of animals • Use fish photos (on a measuring board) to identify species, record length and estimate their weight (e.g. *Tails* app)

App feature	Priority	Details
Species identification via photo guide	High	• Submit catch photo from which species identification is prompted • Could be a species or species group – linked to species catalogue • Using local names and national standards names (i.e. the FRDC Australian Fish Names Standard for species or species groups)
Species ID image recognition function (third party)	High	• Used to assist species identification • Uses AI to match a submitted photo with known species photos
Use of local Indigenous fish names	High	• Helps tailor the app for each community • Some information already exists, but others may need to be entered by users
Habitat type	Medium	• Shore, reef flat, reef edge, offshore ocean, etc
Local names	High	• Use local names for places, species etc to help develop trust and ownership; and to overcome any language barriers
Provision of information on species biology and ecology (e.g. spawning times, size at maturity)	High	• Could be from a third-party provider • Can foster more sustainable practices by allowing fishers to avoid fishing at times where species are more vulnerable)
Ability to share with other individuals	Medium	• Via social media
Analytics - Personal catch summaries - Community catch summaries	High	• Information option • Could be auto-generated, e.g. per trip, month and/or per year • More effective and accurate if delivered in conjunction with data adjustment and expansion using complementary data collection program
Weather, tides, warnings	High	• Predictions of tide, wind strength and direction, rainfall, temperature, moon phase, wave height etc • Useful safety feature • Provided via an annual subscription with BoM (for example)
Access to local and regional fishing information/rules	High	• Could be from a third-party provider • Any enforcement related information could block good catch data collection
Community notifications, e.g. closures, codes of conduct, size limits, reminders to participate	Medium	• Information option • Developed/fostered with local community oversight
Ability to report issues of concern (e.g. illegal fishing, invasive species)	Medium	• Apps can provide fields for miscellaneous or specific reporting and photo uploads of new species
Add comments	Low	• Comments option for users to make specific notes for each catch record and/or trip

Support and management of a fishing app

The cost and performance of a fishing app will be directly influenced by how an app and associated monitoring program is supported and managed. Any app will need to be hosted and managed by an appropriate agency. For a Torres Strait traditional fishing app, the app management agency will need to have strong and trusted relationships with Torres Strait islanders (i.e. community leaders, community rangers, fishers) (discussed above) and either have or be able to build the capability to provide the required app services, and secure long-term resourcing.

Data ownership and management

Data ownership is a growing issue as digital devices and expectations from these services become more widespread. Fishing app monitoring programs in Australia have demonstrated that a proportion of recreational fishers are happy to share their data with external custodians, such as government or fisher user groups, where they see that it will be used to help manage for the long-term sustainability of the resource that they are enjoying.

Most recreational fishing apps collect catch data with the goal to assess and manage impacts on fished populations, though few have achieved this as the data that comes from apps is not generally representative of the broader population. They often use large databases and provide feedback to fishers about their personal catches, as well as for overall assessments at the scales of fishing communities and fish populations. For most state-sponsored recreational fishing apps the data is likely to be owned by the funding government. There is also likely to be a user agreement in the fine print. (AC3, pers comm).

An exception to this data ownership model is the *Deckhand pro* app ([Deckhand Pro on the App Store (apple.com)](apple.com)). This was designed for commercial fishers and on-board tablet data entry. The deckhand app allows for fishers to own, use and manage their data, with options to send reports and data to regulators ([Deckhand Platform - Deckhand® (deckhandlogbook.com)](deckhandlogbook.com)). This app demonstrates a potentially useful data-ownership model for Indigenous communities that may want to limit access to traditional fishing data in order to encourage the development of a new monitoring culture to help them self-manage their traditional, local fish resources.

Traditional fishing communities may not fit the standard fishing app management models well. They have a history of self-managing their local fish resources, often based on unwritten knowledge accumulated over many thousands of years. In Torres Strait, traditional fishers also target many species that are not commercially fished, and current recreational fishing apps do not include most of these species (e.g. in their photo/identification guides). Furthermore, Torres Strait islanders have full Native Title rights over local fished resources and our co-design consultation (above) shows that the data ownership and management issues of any monitoring program will need to include a trusted model where data ownership is maintained by communities and data management is with a highly trusted agency.

In a community-based fishery management model, an analytics function that provides data feedback to users is also a critical part of a data collection programs agenda and its potential success (see examples above). It allows communities to easily identify species that are targeted most frequently and monitor how these catches change over time. This supports the implementation of community-led management to re-focus attention on different areas and different species to allow those of highest pressure to recover' (e.g. [OurFish – Rare :: Fish Forever Data Portal](#)).

The *OurFish* app supports traditional fisheries in Honduras, Belize, Myanmar and Indonesia (above) and includes a leading-edge database capacity. This app partners with the *Fish Forever – Rare* program to make recording and sharing catch data relatively easy. It pushes analysed data directly

back to the individual users on the app itself (see above). The information underpins decision-making to strengthen the sustainable management of coastal fisheries and builds the pathway for fisher households to participate in the formal economy (e.g. *Tracing Fish and Finances – Rare*).

Data management for fishing apps should follow the same basic, best-practice principles as other private databases. The database structure should be well planned for organising and linking all collected information from personal details to auto-generated catch information. Security measures must be in place to protect sensitive data, potentially including encryption, authentication, and limited access controls.

Appropriate and accurate sharing of data among community fishing custodians, individual fishers and other stakeholders is also critical. These processes should ensure that the selected data flow to fishers (e.g. for their personal catches) and to fisheries management (i.e. of specific catch data for the commercially important species) has protocols in place to ensure that data flow is and tightly controlled and accurate. Hence, a process for designing, running and maintaining a data analyses component of data management will also be required to enable data summary analytics to be generated and fed to the appropriate stakeholders. This may be able to be largely autogenerated from the database once well established. However, some ongoing oversight and expertise will likely be needed.

Archiving data for long-term storage and future analysis, including regular backups, metadata preservation can help to ensure the data remains accessible and usable over time. The data and database issues are likely to require some specific, ongoing expertise and an appropriately sized server. However, a Torres Strait traditional fishing app is not likely to require a large server in the same way as a State-run fishing app program.

Complementary data collection

While monitoring fisheries via a mobile app can cost-effectively engage and collect data from a large proportion of fishers, direct estimates of total catches from app data often includes a range of biases due to the fact that not all fishers will participate in app-based reporting, and that app users may not be representative of the total fisher pool or even their own individual catch history (Bedford *et al.*, 2021; Beckmann *et al.*, 2024). App users may differ from other community fishers in their fishing frequency, targeting preferences, or success rates, skewing the data toward a particular demographic or catch. For example, fishing apps are prone to the risk of self-selection avidity bias by recreational fishers, meaning that only the most active recreational fishers are using the app. This can skew the data and make it difficult to accurately represent the overall fishing population (Beckmann *et al.*, 2024). Gundelund *et al.* (2020) found that information about potential biases in app data from the *Fangstjournalen* citizen science app, such as the representativeness of user demographics and retention patterns, was largely lacking. They found that app users were younger, more specialised, and had higher catch rates than non-users. However, sustained users (> three months) were older and ascribed a higher importance to fishing compared to those who stopped using the platform within three months.

Johnston *et al.* (2022) compared results from a mobile-phone app (*MyCatch* app) to results from three types of fisheries surveys (mail, creel and gillnet) and found that an app (and website) can provide catch rate estimates that are similar to those from other fisheries-dependent surveys. However, the app was not a suitable tool for estimating fish abundance and relative community composition of catches without further research.

An app trial by QDPI, found that catch metrics collected by the fishing app were within 5-10% of data collected from a complementary traditional survey (AC1, pers comm). They include a user trust score, based on easily evaluated data fields (location, species, length), which provides different weightings to

data from users with different trust scores. This can help guide their data analyses and manage catch biases, for example, by down weighting low-trust data.

The *Fishing Tas App*, when used for surveying lobsters in a compulsory fashion, still underestimated total catches by 50% (due to poor compliance) compared to the probabilistic survey (AC3, pers comm). This may have been due to poor compliance but demonstrates the potential need for data validation.

Beckmann *et al.* (2024) recently compared data from a statewide, probability-based recreational fishing survey (based on a random stratified design and selection process) to app collected survey data. Their three main findings were:

1. App-based data was subject to a range of self-selection biases and under reporting and required adjustments and expansions to enhance its accuracy;
2. Recruitment and retention of app users was critical to ensure data quality; and
3. Broad-scale probability-based surveys currently provide the best available benchmarks.

Other useful findings from the Beckmann *et al.,* (2024) study app custodian interviews included:

- Fishers found it easy to use the app and enter data;
- Most app participants participated in the app-based trial to gain information from the app;
- Fishers were interested in accessing their fishing data;
- Most people did not report on fishing days where there was no catch;
- Fishers typically reported all species caught, although 20% only reported fish that were kept; and
- The app was good for reducing recall bias issues.

They addressed the app data biases and under reporting issues in two ways. To correct for differences in reporting behaviour—such as fewer zero-catch days and lower ongoing participation in app-based data—a correction factor (called coefficient q) was calculated to adjust the app data. This factor helped improve accuracy for two main aspects: the average catch rate (the number of fish caught per fishing event) and the number of trips reported per fisher. They then explored various statistical methods (such as raking, propensity scores, statistical matching, and model-based techniques) to adjust and expand the app data to produce species-specific estimates of total catch and effort. These adjusted estimates were then compared to those from a statewide study to check their accuracy. Most models did a good job at converting the app-based estimates (of catch), with 89% of species falling within the confidence intervals of the statewide survey following the modelled adjustment of their app data. These corrections also brought most species catch estimates to within 20% accuracy of the statewide survey. The modelled adjustments were less effective for effort data with 46% of species falling within the confidence intervals of the statewide survey.

Beckmann *et al.* (2024) made five recommendations relevant to this study to help guide any future fishing app development:

1. Biases and accuracy: Apply adjustment and expansion statistical techniques to enhance the accuracy of app-based data;
2. Participant engagement: Maximise recruitment and retention to ensure data quality;
3. Benchmarking: Adopt broad-scale probability-based surveys to provide the best available benchmarks.
4. Data adjustment and expansion techniques: Refine model-based estimates and investigate more advanced models (e.g. via machine learning and AI); and

5. Catch quantification: If only total catch is needed, (and not catch and effort data) a census survey may suffice (as compared to a full probability survey), as this simplifies the analysis approach and data needs somewhat.

The last recommendation infers that, for traditional fishery monitoring in Torres Strait, adjustment and expansion of app-based data may not require a full probability-based catch survey as its baseline. Instead, establishing the sampling frame (estimating the fisher proportion in the population), and applying this percentage to census data, then using the demographic proportions to adjust catch data collected via the app may be adequate. This process, done at the community level, in conjunction with a census around fishing activity, will be much simpler but effective way to provide an app data adjustment and expansion tool.

QDPI use a full year-round boat ramp survey as the complementary validation method. They found a range of biases as above, but also noted that outlier validation can be used for some data issues to help address incorrect data for things such as time, date, location, or any unrealistic catch information; and that much of this can be built into front end; (AC1, pers comm). Validation of (*GoFishVic* app) catch data was estimated through a probability-based phone surveys over a two-week period, plus three questionnaire surveys (AC2, pers comm). They found that the validation survey and app data was very similar.

The information above about the need for and type of validation of app data varies depending on fishery and app implementation. However, overall, we conclude that, using voluntary app-collected fishing data requires that relationships between self-reported data and quantitative fisheries data are evaluated, and that potential biases are assessed and adjusted for (e.g. Jiorle *et al.*, 2016; Brick *et al.*, 2022; Johnston *et al.*, 2022).

Approach for the Torres Strait

It was previously highlighted by Bedford *et al.* (2021) in their review and characterisation of past approaches to monitoring the catch of non-commercial fishery resources relevant to Torres Strait that traditional creel and household surveys were (increasingly) difficult to implement. Reasons for this include research fatigue, costs and other logistical challenges (Bedford *et al.*, 2021). Therefore, while we do acknowledge the benefits of comprehensive placed based locally contextualised information, we do not recommend using these approaches (i.e. full validation surveys) to provide an alternative baseline to compare with the traditional fishery app data. This could be reassessed after the pilot program phase. However, it is unlikely that an app based self-reporting data collection activity will capture 100% of the fishing catch. Therefore, to quantify the annual catch, the following parameters will need to be collected as a complementary monitoring activity:

1. Community level app participation rates.
   - *How many fishers are participating in the app data collection program out of the total community fisher population?*
   - *Does the participation group represent the total community fisher profile (e.g. avidity and representativeness of all social and gender groups)?*
2. Individual fisher's app catch record completeness.
   - *How well does the individuals app catch data represent their actual catches?*

There are a range of possible approaches that could be used to supply this information. Eliciting information using phone interviews has been shown to be an effective approach to gathering suitable data to verify and complement self-reporting data (Beckman *et al.*, 2024; Bedford *et al.*, 2021). Monthly (or at least quarterly) phone interviews, with an adequate randomly selected sample of community members to assess their catch and app use history, could serve the purpose of answering both app participation rate and individual catch completeness data needs, and provide suitable

information for app data adjustment and expansion. For those community members that are not suitable for phone interviews, in person interviews may be carried out by trained local community champions. We anticipate that this combined approach would result in a high return rate for this information.

To assess community level participation rates, interviewees would be asked if they had engaged in traditional fishing in the previous survey period, and whether they used the app and other basic demographic information. Estimates of community app participation rates for appropriate fisher avidity/demographic categories could then be calculated from census data and other locally available demographic data.

For individual fishers catch record completeness an appropriately sized representative sample of individual fishers is interviewed monthly (or at least quarterly) to elicit information about their catch history and estimate of the completeness of their app fishing record and usage. To maintain data resolution and integrity, we recommend only information on the previous week's (7 days) catch history be used to assess catch data completeness. Individual fishers could also be asked to rate the completeness of their own catch record monthly in the app. Various analysis approaches for applying the complementary data to adjust and expand the app data (including model-based techniques) could then explored to produce species-specific estimates of total catch.

While the above approach will likely provide sufficient data to adjust and expand the app data to produce overall catch estimates, it may still not fully capture the behaviours and catch patterns of non-users, particularly occasional fishers or certain demographics who may remain underrepresented. Potential biases such as selective reporting (e.g., not reporting low-catch trips) and recall bias (e.g. overestimating previous catches) will also need to be assessed. The full complementary data collection program should be the focus of assessment and recommendations during the pilot program phase.

Communications and Behavioural Approaches Program

While it is well recognised that strategic communications are essentially in supporting fisheries programs, behavioural change approaches drawing on social marketing principles have also been used in many disciplines including environmental, health and nutrition and fisheries programs for decades to promote behavioural change. Some NGOs such as RARE[3] have implemented behavioural change approaches in their global Fish for Future programs including "Pride" campaigns aimed at encouraging people to be more active in stewardship of their resources and encourage positive change using various tools. Recently in the Pacific Islands region a scoping project was completed to support a regional wide intervention to support behavioural change among Pacific Island communities to increase consumption of tuna and other pelagic fish species with a focus on key messaging through various communication methods (Edwards and Radway, 2024). In Madagascar social marketing campaigns have been used to stop destructive fishing practices (Andriamalala *et al.*, 2013). In Australia recreational fisheries in Australia a 'Fishing for Change' project in Queensland used a social marketing approach to engage stakeholders to codesign, implement and evaluate solutions to voluntarily change people's recreational fishing behaviour (Clayton & Currie, 2022). A recent NESP program in QLD has also been applying behavioural change approaches with recreational fishers (NESP, 2024). Social marketing is a globally recognised and evidence-based discipline that provides a practical framework for design of behaviour change interventions. Most successful behaviour change interventions include a mix of four "levers" (Steve Menzies, Flinch Marketing, NZ pers comm):

1. Control (penalties or incentives)

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[3] See RARE for examples of approaches https://rare.org/research-reports/behavior-change-for-nature/

2. Support (direct guidance from trained peers)
3. Design (changes to the physical environment)
4. Communication (the provision of relevant messaging)

Figure 23, for example, provides a brief outline of how such levers may be used in a traditional fishery monitoring program.

1. Control	2. Support
Using incentives to support app use e.g., give aways, competitions etc to encourage initial changes in use etc. Penalties in this case are certainly not nay form of punishment, but could base around a "fear of missing out" of vital information supplied by the app.	Training key community influencers (or champions) who can actively show, teach or role-model the behaviours that we want community members to adopt e.g., use the app to report catches.
3. Design	4. Communication
Designing the app and creating the physical environment (support and training) that makes it as easy for communities to access and use the app.	For example, we could explore the creation of local relevant brands that highlight the key family and community benefits of using the app for the sustainable livelihood of Torres Strait people.

Figure 23. An outline of four levers that can be used to create behavioural change (Source: adapted from Flinch Marketing, New Zealand).

Audience research or in the case of the Torres Strait monitoring program, community co-design, would be used to*:*

- Define very specific and measurable behaviour uptake objectives, messages and audiences;
- Understand the key barriers/motivators and support measures that will be required to ensure the sustainable adoption and maintenance of the desired behaviours/norms (uptake and use of an app); and
- Design integrated interventions that support the adoption of the new behaviour(s) within existing social, cultural and environmental contexts.

Ongoing communication activities and tools are critical for maintaining or improving use of fishing apps, and minimising attrition of app use over time (AC3, pers comm). A communication and behavioural program will support good initial uptake, but without ongoing resourcing, natural attrition from a program is likely to occur, especially where use is voluntary.

Communication strategies can be very useful for selling the vision and need for an app, but behavioural change approaches can also be useful for removing barriers to app use. For example, fishers are often concerned that providing data will be used against them. However, good messaging can describe how the data will be used and link users with a trusted app custodian or champion.

A robust and well-resourced communication program associated with the monitoring program will need to:

- Identify practical ways to communicate about the monitoring program – operations, benefits and fishery information;
- Address barriers to uptake including mechanisms to support behavioural change/uptake;
- Identify some key indicators to assess change/removal of barriers during the pilot involving key governance stakeholders and agencies to monitor the pilot program outcomes.

Cost scenarios

Cost scenarios of development and implementation of a fishing app vary as it was not easy to engage technology development companies when we could not provide an intention to go ahead with any work. However, we have put together a range of costing scenarios and what they would deliver, to provides some guidance (Table 12). We have also gained some information and scenarios on costs for different components of app development, namely: (i) back-end development and testing, (ii) ongoing development and maintenance and (iii) third party features (Table 13).

App development and ongoing costs

Cost scenarios vary widely depending on the requirements, features, and testing involved. Some general principles regarding cost and performance of apps include:

- Investing more in the development of an app leads to higher quality, functionality and scalability and greater chances of success (AD1, pers comm);
- App complexity, such as the number of screens and integration requirements, influences both development time and cost;
- It is important not to focus too much on specific features that will only be used by a small proportion of stakeholders, as they can significantly increase costs; and
- Features like push notifications, offline mode, and augmented reality require experienced developers are likely to result in additional costs.

Main sources of costs include:

- Developer engagement expenses (e.g. wages and developer account fees): The time required to develop an app varies, with developer engagement time being a significant factor;
- Ongoing developer updates/maintenance: Estimated to be an ongoing cost of about 15%-20% of the app development budget;
- Third-party information tools/services.
    - e.g. geolocation, species identification, weather information software, language options, voice recording.
- Back-end infrastructure
- Data storage and server fees: Not costed in these scenarios; however, data storage fees appear to be relatively cheap. For example, if the app hosting management agency had its own server, costs may be negligible; purchase of a server may be around $5 K; or the cost of cloud storage could be estimated at ~$5 per month per TB, or $0.026 per GB per month ([Pricing examples | Cloud Storage | Google Cloud](#); [Cloud Storage Pricing Guide: 13 Options Compared In 2024 (cloudzero.com)](#));
- Communication and marketing costs: Depending on the number of communities, frequency of visitation, this will be a significant component of the app rollout;
- Analytics costs where fishing/catch summaries are provided back to users will have a salary cost;
- Testing and maintenance;
- Complementary app usage data collection activity; and
- User management and support.

The type of app desired will also impact the cost of the project. For example, creating web-based apps are cheaper than native apps. While a native iOS app is cheaper than developing a mobile hybrid app, which is in turn cheaper than building native apps for both iOS and Android. However, as noted above, these platforms are likely to be integrated in the very near future.

Table 12 lists some examples of app development costs, acquired from interviews with app developers and app custodians, as well as general cost scenarios from company websites or email responses. These cost scenarios highlight the variability between companies and between app scenarios and services that they are prepared to quote for, with different companies quoting for a different suite of services.

For a Torres Strait traditional fishing app, we would not expect the app development costs to be the same as for a large commercial app. Similarly, the number of app features would likely be closer to a simpler app design than a complex app design; both for reasons of 'simplicity is better' (see above), and because only a limited range of key information is needed compared to complex apps with large business scopes.

To this end, a reasonable cost scenario to build the back-end app may be like a hybrid scenario between the *Synergyap.com* quote to build the back-end app (e.g. $50 K) and the *Go Source* small app quote of $15 K per month for ongoing development and maintenance. Hence, the Torres Strait app to build the back-end app might be around $30 K.

Ongoing development and maintenance costs may be like a hybrid scenario between the *Go Source* small app quote of $15 K per month and *Aviato Consulting* ongoing costs (e.g. $5 K + $7 K ongoing). Hence, the Torres Strait ongoing costs for development and maintenance might be around 10 K/month.

Third-party 'plug-in' features (e.g. BoM, social media links etc) (Table 13) are also a likely cost, as described above. They vary, but as an indication they may cost between $100–$500 per month (as described above, AC1, pers comm)). These are difficult costs to estimate with any accuracy without knowing the app needs in detail. However, one reasonable scenario for three third party features may cost ~$250/month ($750/month = $9000/year), although it may well be substantially less than this.

A fishing app data validation process would involve independent fishing data collection and a comparative analysis, potentially guided broadly by the guidance from app custodians mentioned above. We have not done any detailed costing for such a process but have used a broad-brush estimate of $100 K per year, partly based on the authors project experience. A more detailed and appropriate costing should come from the proponents of any future Torres Strait traditional fishing app project or trial.

Communication and behavioural program costs are difficult to finalise without supplier estimates or confirmation of possible in-kind support from participating agencies. But it is important to ensure a budget is included as part of a pilot program. Cost (cash or in-kind) include activities for designing an overarching communications strategy (and culturally inclusive), maintaining regular social media activity; working with local community champions, any incentive campaigns and school-based education activities.

The cost estimates described above are summarised in Table 14. However, a detailed app costing process for a Torres Strait traditional fishing app has not been conducted with any app development businesses and so these estimates should be read with appropriate caution.

Table 12. Examples of app development costs.

App provider	Development cost ($A)	Details
1. Large apps		
AD1	$400 – 500 K	- A public sector technology service provider - Rough costing for a large app build and ongoing service provision - Quote includes 3 team months to go to Alpha phase (to show people the initial design and idea) ~75% into features and enhancements and 25% went into maintenance
AD8	>$1 M	- A private technology design & development agency - Large projects: 20+ screens, multiple personas, fully native design, integration into multiple platforms, complex features
2. Smaller apps		
AD1	$ 15K/month	As above, except quote estimate is for smaller app
AD2	$50 – 60 K	- A private sector technology service provider - Quote is to build the back-end app (2 people over 3 months)
AD3	$5 K	- A private digital design and development company (oversea based) - Build the back-end app (5 people over 3-4 months) - Capabilities for both mobile app and web panel - Local (Australian) administration cost additional $2 K - Ongoing maintenance costs not quoted - Detailed quote available
AD4	< $65 K	- A private sector technology service provider - Quote is for app scoping only
AD6	$2.5 K Alternative: $6.9 K/month	- A private sector technology service provider - Quote ~$2.5 K to build full back-end app prototype $6.5 K for ongoing monthly billing model for app development and maintenance - Via website chat brief 'interview'
AD7	$150 – 200 K	- A private sector technology service provider - Quote is for standard custom app (larger app will cost more) - Web site estimate provided
AD8	>$170 K	- A private technology design & development agency - Small projects: ~$200 K (5-8 screens, single platform) - Medium projects: $200 - 600 K (10-15 screens, cross-platform integration, simple features)
AD9	$45 K - $240 K	- AD9 is a website that partners with small and large companies to provide technology services - Web site estimate provided

Table 13. Examples of third-party information tool costs.

Third party tool	Cost	Information source
BoM subscription	Set-up fee (~$1200) then ~$1600/year	AC1
Fish ID tool	No data	One State built their own and this version may be easily adaptable to a Torres Strait fishing app.
Fish regulations etc	No data	Could be managed using Community In-Kind knowledge and time; or linked to a relevant website.
Links to social media	No data	

Table 14. Estimated costs of app development and ongoing maintenance for a pilot testing program based on general cost scenarios from app technology experts and app custodians. NB a detailed, comprehensive app costing process for a Torres Strait traditional fishing app has not been conducted with any app development businesses and so these estimates should be read with appropriate caution and will range widely between app development and maintenance businesses/agencies.

Cost source estimate	Initial annual cost estimate	Ongoing annual cost estimate beyond year 1
Planning with two or three selected communities to design app features and plan aspects of the app trial	$20 K (two communities, two visits each; once off)	nil
Development of the app (includes database design and setup, API development, security and user authentication, server infrastructure)	$30 K	$0 K
Ongoing development and maintenance, including server and database costs and user support	$120 K ($10 K/month)	$80 K
Third-party plug-in features	$9 K	$9 K
Implement complementary survey, including statistical analyses	$100 K	$100 K
Program reporting and recommendations	$50 K	$50 K
Communications and behavioural program	$100 K	$60 K
Total	$429 K	$299 K /year in subsequent years

Guidance for monitoring non-Indigenous recreational fishing

The focus of the current study was on monitoring the Torres Strait Islander traditional fishing component of the non-commercial fishery in Torres Strait. However, there is a significant take of fish by non-Indigenous recreational fishers in Torres Strait, including by residents and visitors.

The impact of the recreational fishing sector in the Torres Strait is largely unknown (Bedford *et al.*, 2021). However, the view of industry representatives on the PZJA Finfish Resource Assessment Group was that "the recreational boat numbers have increased over time, with a lot more contractors' resident in Torres Strait taking boats out to communities to fish in their spare time" (e.g. Fin Fish

Resource Assessment Group No 8, meeting minutes, November 2020). Recreational fishing effort in Torres Strait can also be expected to increase in future as population size, fishing technology and fishing infrastructure increase (e.g. the planned major upgrade of the road into Bamaga allowing easier access to the region for trailer boats).

QDPI currently runs a Queensland-wide recreational fishing monitoring program, including in the Torres Strait. However, previous survey methods have not had enough sampling intensity to provide robust estimates of catches from this sector (Bedford *et al.*, 2021). But, as described above, QDPI has recently introduced a recreational fishing app (*QLD fishing 2.0*). This app is specifically designed for recreational fishers and can capture the same data required by fisheries management in Torres Strait for the commercially important species – total numbers, by species (see above).

Rather than develop a new, specific app for the non-indigenous recreational fishery in Torres Strait, we recommend that the PZJA collaborate with QDPI to:

- Promote and if possible, specify, the *QLD fishing 2.0* app to monitor the recreational fishing catch in Torres Strait; and
- Facilitate provision of annual species-specific recreational fishing catch data in Torres Strait for fishery assessments (Figure 24).

These data could also potentially be provided to Indigenous community leaders to assist with their ongoing management of their local sea country. Note that the *QLD fishing 2.0* app would likely need to develop capacity to record whether participants are indigenous or participating in traditional fishing (to prevent double counting). Fishery monitoring app use by recreational fishers in Torres Strait could be incentivised and encouraged in several ways, such as:

1. Include a targeted communication strategy that encourages and guides recreational fishers to use the app while fishing in Torres Strait waters,
2. Amend local community by-laws (for outer Islands at least) to stipulate that recreational fishers must record their catches in the *QLD fishing 2.0* app while resident in communities; and
3. Include an Ecological Momentary Assessment tool (Shiffman *et al.*, 2008) in the *QLD fishing 2.0* app which notifies recreational fishers that they are in Torres Strait waters and prompts them to follow any new bylaws and use the *QLD fishing 2.0* app for any fishing effort.
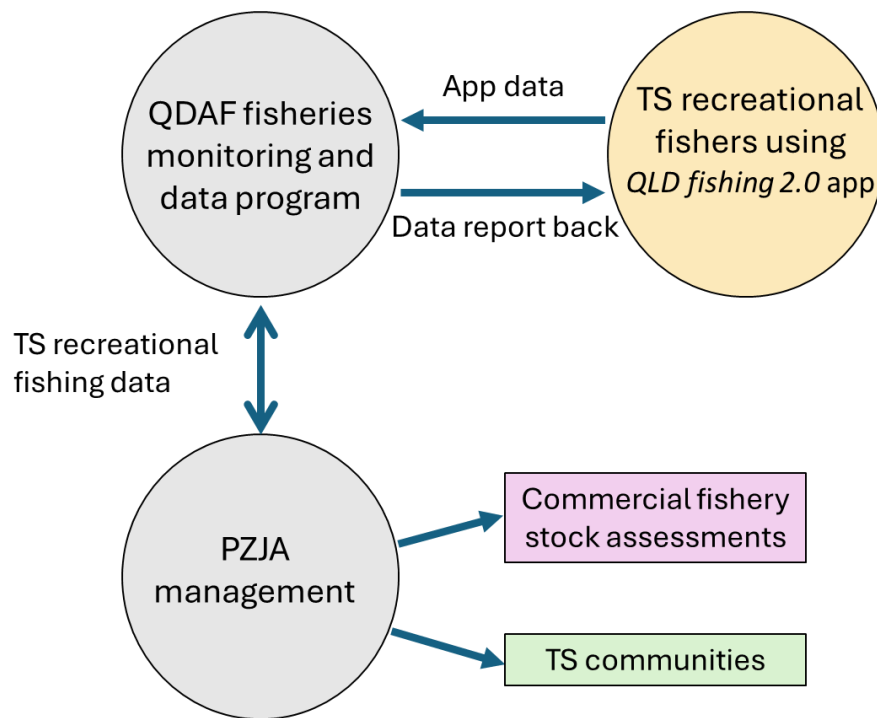
Figure 24. Conceptual diagram of a recreational fishing data collection and management scenario using the 'QLD Fishing 2.0' app.

Discussion

This project sought to provide information to underpin the implementation of a fishery monitoring app in the Torres Strait region of Northern Australia, building on Phase 1 activities (Bedford *et al.,* 2021). This included undertaking comprehensive community consultation and engagement throughout Torres Strait to share information, assess the level of community need and support (or otherwise), and co-design the non-commercial fishery monitoring program. We also reviewed Smart Phone app design, development and cost options for a fishing catch monitoring app that could effectively fill a data gap for commercially managed species and other key species caught for non-commercial purposes (traditional and recreational fishing). Drawing on these findings, we make a series of recommendations for a Phase 3 Project to develop a self-reporting app platform, associated data management and governance with two or three pilot program communities as part of an iterative, learning process to the scale up to Phase 4 to all communities.

While the project was specifically focused on the Torres Strait, and the need to provide data for commercial fishery management and Traditional Inhabitant livelihoods in the region, the findings are important within the broader Northern Australian and national (and international) context. This is because no Indigenous fishing monitoring program using an app currently exists in Australia (only recreational fishing apps). There is a growing national agenda to develop strategies and programs for enhancing First Nations involvement on sea country and for greater participation in fisheries management. This includes greater sharing and equitable ownership of data to enable government and stewardship of fisheries resources for food security, livelihoods and wellbeing. The Anthropocene has also created new challenges between the human and natural world that did not previously exist such as climate change, maintaining and applying Indigenous Knowledges, enforcement and adjustments of dynamics of traditional management practices and changing livelihoods which highlight the need for new approaches for managing fisheries into the 21st century.

In this section we reflect on our response to the project objectives, share the research findings and provide commentary in five topics: community engagement; digital app technology, principles and best practice approaches for a Monitoring program, limitations/challenges of the research and broader implications and opportunities of this foundational scoping research project for the Torres Strait or other Indigenous contexts.

Community Consultation

This project sought to undertake a comprehensive community consultation and engagement process throughout the Torres Strait and NPA to assess the level of community need and support for the implementation of a fishery monitoring app and co–design its basic features. While we had originally proposed to visit 18 communities, the Indigenous lead for the team made a consciousness decision, drawing on past engagement experience in the region, to undertake a total of 17 workshops in 16 locations, including workshops on all the outer island communities, but only one workshop for the Kaiwalagal nation (Ngurupai) in the inner islands, and two workshops in the NPA.

Part of the difficulty in deciding on the number of communities/workshops for the region is that it is challenging to accurately define what constitutes an appropriate target community in the Inner islands and NPA. This is due to a range of factors including variability in existing governance structures (e.g. TSRA, regional councils and native title representation) responsible for different regions often related to the ongoing impacts of colonisation and movements of people from the outer islands to the inner islands and NPA. This issue may have some implications for the implementation of the monitoring app where community membership is a likely app feature – careful consideration and consultation will be required.

By project end, we were able to carry out 15 of the planned 17 workshops. Two communities were not visited for reasons out of our control, due to weather, sorry business, and sensitivities associated with the 2023 Voice Referendum. In addition, turnout at some of the workshops was limited by community members having other commitments and general community workshop fatigue in the region. Overall, 142 community members attended a community workshop, or about 1.7% of all community members in the study area. About one quarter were female, and the age spread of attendees was relatively even. Acknowledging the potential for bias in the workshop group, we encouraged participants to consider the "entire community" in their responses.

The community engagement approach applied a strong ethical process (see Methodology section), with Free, Prior and Informed Consent obtained from community members followed by the sharing of community workshop summaries with participants immediately after the workshops. This approach has been recognised as valuable for future TSSAC supported research in the region with our resources already being requested by another recently funded TSSAC supported project.

Despite the challenges, the results, in our view, provide a comprehensive view of Torres Strait Islander people's needs and attitudes to the implementation of a non-commercial fishery monitoring app, and give confidence that we have captured a sufficiently broad array views to guide most aspects of a fishing app program.

Overall, we found very strong support for the implementation of a traditional fishery monitoring app among workshop attendees, underpinned by a range of individual and community needs, with the broad caveat that the information provided must be suitably protected and sensitively handled. The fear of adverse consequences and (usually unfounded) fears of prosecution for "breaking fishery rules" were common and will need to be addressed in any future communication program implemented alongside the app. These concerns, along with some small levels of general mistrust and local fisher apathy indicate that it will be difficult to get complete app user coverage of the catch and highlight the importance of a complementary data collection activity to assess the validity of the app data.

As for who the most appropriate custodian for the data would be, this was recognised as an important question but with few actual suggestions. Some views were expressed that a new community-based organisation would be appropriate – and at least one attendee made the comment that it should not be "government". When prompted, participants agreed that it was an important aspect of the app rollout, and that trust in the data custodian would be critical for initial uptake and ongoing app use.

The workshops identified a broad range of species (>94 species or species groups) that underpin the traditional catch, with large regional differences. However, the commercial species (Spanish Mackerel, TRL and Coral Trout) were often listed among the highest priorities for monitoring by community members, which is consistent with the original goals of the monitoring program to provide information for the sustainable management of these species.

A wide range of outputs and features were recommended from the workshops, mostly related to individual and community level information needs, the most common being information about the catch and local and regional management rules. Providing this information will be a critical value proposition for the successful implementation of a fishing app. Further, use of the app may support future community-based management in the region. A broad range of barriers and incentives were also identified from the research, which have been integrated into the governance and best practice principals (see below).

Apps and Digital Technology

Fishing apps are a recent and fast-growing data collection tool for fisheries management. All Australian States and the NT have functioning government supported recreational fishing apps and there are a range of non-government fishing apps in the Australian market. A number of globally focused fishing apps are also available to fishers and there are a range of fishing apps that have been developed to support small commercial or artisanal fisheries in the Pacific region. However, we were unable to find a fishing app focused on traditional fishing used by Indigenous communities.

The pace of development and uptake of fishing apps over the last few years is likely to continue as the move to digital monitoring increases in many environmental and fisheries contexts. However, their voluntary nature and potential to collect unrepresentative and/or biased data provide ongoing challenges for fishery managers looking to use the data to make quantitative assessments. Regardless of these challenges, the implementation of fishing apps to collect cost-effective fishery data appears to be growing and hence, tools to manage for data biases will continue to develop.

Literature and website reviews, along with interviews with current State app custodians and app developers in Australia, found that most recreational fishers were happy for involvement in monitoring programs to facilitate sustainable management of resources. However, this enthusiasm varies across different segments of the fishing community. Those with a stronger conservation ethic, or who fish more avidly, are more inclined to engage. However, challenges persist in engaging less avid fishers, occasional participants, or those concerned about data privacy and reporting burdens. Effective communication and participation strategies must therefore consider these diverse perspectives, addressing barriers like convenience, perceived relevance, and privacy concerns to broaden support for monitoring programs across the full spectrum of the recreational fishing community. Encouraging uptake and longer-term use of a monitoring app has typically involved a complex suite incentives and functionality which we have collated to aid the development of a fishery monitoring app for Torres Strait. They include:

- Convenience of a one-stop-shop on their smart phone;
- Data privacy and security;
- Ease of use in terms of data entry (e.g. few button clicks, fish photo identification);
- Provision of data analytics which summarise their catches back to them;
- Provision of relevant information such as weather alerts and forecasts, species information or links to social media or other information sharing portals; and
- A strong communication and behavioural approach program to support engagement on the existence and benefits of using the app, including addressing barriers, the engagement of local app/fishing champions to encourage and support app users.

Other Indigenous specific issues to consider include specific cultural protocols, and traditional knowledge and language use. For most users, an app must make their activities more efficient and informed, allowing them to spend more time fishing – whether as a sport, leisure activity, a job (Cordwell *et al.*, 2022) or cultural activity. Many users in this study indicated that they are more likely to engage with an app where information is shared both ways. They are also more likely to continue using an app when users can see an outcome from the information provided.

Despite the benefits of using apps for non-commercial fishery monitoring there are challenges regarding managing the biases associated with data representation and interpretation (see section on complementary data collection supporting app usage in previous section).

Program Governance

One of the issues in designing and implementing a new app based traditional fishery monitoring program for the Torres Strait region is to firstly identify the key stakeholders, data custodians, implementing agencies (and or other key experts or organisations) to be involved and secondly to design an effective governance model among those various organisations, people and partners. The institutions, organisations and or stakeholders to be potentially involved in a traditional fishery data collection and management program and their roles (see Figure 25) include:

- Traditional fishers
    - Join program and agree to app conditions;
    - Input fishing data, other observations as designed;
    - Prove annual consent for data to be used in data summaries; and
    - Participation in program activities, including events involving communication of monitoring data, and other incentive-based campaigns.
- A trusted data custodian
    - Holds and manages the data;
    - Provide data agreements with individual fishers and other stakeholders (where appropriate) including plain English and local language text. It should include a statement ensuring data privacy, an explanation of provisions for explicit opting-in for sharing data, and stipulating that any information collected will not be used against that individual;
    - Carry out data analytics and provision of information products to fishers and other stakeholders; and
    - Provides ongoing training and app support.
- Local community organisations
    - Manages fisher membership to a community group;
    - Requests and receives community level catch summaries (for local management); and
    - Provides local management rules for dissemination to fishers.
- Fishery management agencies (e.g. TSRA, AFMA, QDPI)
    - Receives summary (regional scale) information on catches (after agreement) for stock assessments and sustainable management; and
    - Provision of analysis results for dissemination to fishers and other stakeholders.
- A trusted Indigenous-focused implementing agency (Note: this agency sits outside the formal governance structure but will be fundamental to implementing the app and monitoring program. The implementing agency and the trusted data custodian could be the same agency)
    - Implement the governance model as above;
    - Design and carry out a strategic communication and behavioural program;
    - Design, develop and make available the monitoring app (Note: app design and building could be outsourced to a specialist app developer);
    - Design and carry out the complementary data collection program;
    - Visit pilot program communities to:
        - Co-design local bespoke app components for each pilot program community
        - Train local champions and support personnel
        - Manage the local complementary data collection process
    - Problem-shoot; and
    - Provide learnings and recommendations for full scale rollout.
- A Traditional fishery monitoring program oversight and advisory forum to:
    - Provide feedback and guidance on the implementation of the Traditional fishery monitoring program, including the communication and behavioural approach

activities, potentially other Traditional fishery issues, and to promote effective communication from and back to Torres Strait communities;

- o Membership could include appropriate Torres Strait representative bodies (GBK, TSIRC, TSRA) and one representative from each cluster (including inner islands and NPA); and

The group could be part of the existing PZJA committee structure or, a new standalone oversight/advisory body.
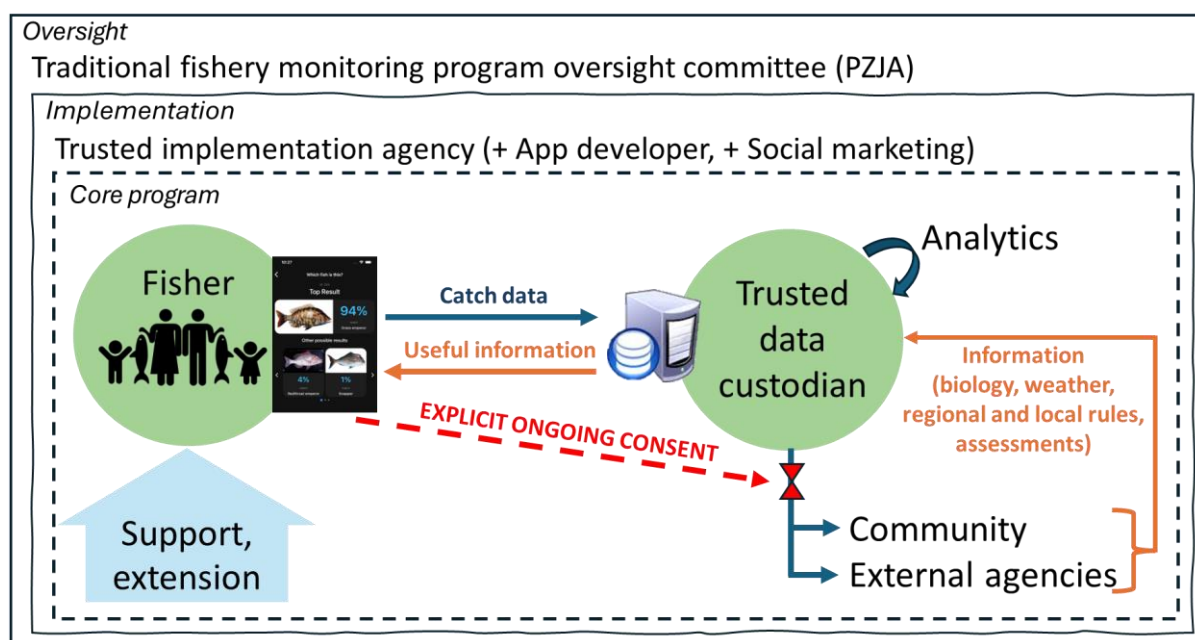
Figure 25. Potential governance structure of a Torres Strait Traditional fishery monitoring program (inside dashed line), including information flow (solid arrows) and an information control point that will require explicit fisher consent (in red).

Principles and best practice approaches for a traditional fishing monitoring program

Given the limited research into Indigenous fishing apps in Australia, the extent of community engagement in this project (compared with for example a single community or stakeholder group) and the ever-changing digital landscape we summarise principles and best practice approaches arising from the project results for a traditional fishing monitoring program in Table 15. These are consistent with the recommendations provided in the next section. Some of the core areas highlighted in the research included the need for careful consideration of design, striving for simplicity where possible and engagement of a trusted agency to conduct any pilot program app trial.

Table 15. Principles and best practice approaches for app development.

Best practice approach	Justification
Indigenous agencies/organisations leadership in app development and management	• Greatly enhances ownership, trust and uptake/usage • Trust of government agencies with personal data is low
Use an ongoing communication and behavioural change campaign to increase reporting rates; noting that incentives can lead to data quality risks, incentive fatigue, misalignment with conservation goals, budget constraints and inclusivity issues	• To raise support user engagement in the app, build trust focussing on 'what's in it for me' • Involve fishers in a transparent process of collecting and using their data in support of their fishery • Provide incentives to recruit, maintain and reward users help towards justification regarding the need for fishing monitoring and sea country management
Ongoing explicit and informed consent	• Clear plain language agreement between individual fishers and the primary data custodian is required during onboarding to promote trust and protect fishers rights. • Ongoing consent provisions are required for inclusion of individual data in catch summaries to maintain trust and app usage.
Include social media links to provide share options (linked to communication)	• Creates an engaging aspect to help attract and retain users through Likes, comments, photos
Include a grassroots effort recruiting champions and ambassadors from gender groups	• Promotes local buy-in, raises awareness and trust at a local level • Champions can demonstrate benefits and support to remove local barriers to use • Champions can help frame the issues to locally relevant contexts and promote new behaviours
Apply a gender and age inclusive lens and approach	• A gender equity and social inclusive lens and approach into all aspects of a monitoring program (including communications), including the design, activities, tools, and results (e.g. sex disaggregated data to represent all users and support community-based management and decision making)
Maximise simplicity and minimise the data collection burden to improve usage rates	• Minimise compulsory fields, options, button clicks, scrolling, typing, information requirements
Automate data collection to improve usage rates	• Similar justification to simplicity (above) • A range of data fields can be auto-generated to maximise simplicity of use (see app design parameters table above) • Could include hands-free logging such as voice recording for some fields
Access to fish ID library and function	• To assist species identification and educate users

Best practice approach	Justification
	• May be accessible via other apps (e.g. Qld Fishing 2.0)
One-stop-shop for other information (e.g. via third party links)	• Weather conditions, regulations, safety, social media apps etc
Provide customer support tools (FAQs, tutorials, Contact us, etc)	• To support users and improve and maintain user experience
Leverage combined data from individual users to provide higher quality information back to users, e.g. catch trends at a range of scales from individual user to local community, to clusters or regions (and sex-disaggregated)	• Provides users and other key stakeholders with access to timely and bigger picture information than just their personal catches • Builds trust, interest and loyalty to the program by seeing catch data being used to provide big picture assessments of their resource
Launch app via alpha, beta etc stages	• Maintains users via a one-step-at-a-time approach • Minimises errors • Fosters improvement and innovation (and ownership through co design with users)
Improve and innovate over time	• Allows for a simple start up version which is best for user retention • Can enhance user satisfaction for current users • Can improve stakeholder benefits

Limitations of the Study and Future Opportunities

Noting the challenges outlined in community engagement in the region, there were other limitations arising from the research that are relevant to the next phase of a pilot program to enable greater success in an ongoing monitoring program over time. The engagement of specific gender/social groups in the pilot program co-design phase especially women, who also fish and have a key role in household food provisioning, will need additional attention during the pilot program design and implementation. More gender inclusive strategies will be needed. Engaging youth and the elderly in a future pilot program will also be a key consideration, with the opportunity for greater involvement of monitoring program and information sharing.

For various reasons our project had limited engagement and participation of with Land and Sea Rangers groups (managed by TSRA or NPA PBCs) in the community workshops, but these groups are key stakeholders, and potential champions.

The TSSAC funded research has a strong focus on Torres Strait Islander active engagement in research capacity building. Despite our best intentions, we were not able to engage a TSI student in our work as a capacity building opportunity, due mostly to the challenges experienced in implementing this project (remote travel, specific funding, timelines, the Voice and logistical difficulties). Dedicated support and discussions in Phase 3 program concept development with educational institutions could offer for formal opportunities for High School/VET or Tertiary student opportunities.

Eliciting specific costings and app development workplans from app specialists was difficult, due in part to commercial and IP considerations. This was doubly difficult as no existing Indigenous traditional fishing apps were available to learn from.

Implications

This project provides information and recommendations to address the next stage in developing a monitoring program to complete a comprehensive and equitable community engagement program throughout all Torres Strait. Torres Strait Island communities desire information to manage their local traditional fisheries (Bedford *et al.*, 2021) and nationally this has also been highlighted in recent fora (e.g. Keynote address by Bo Carne, Aboriginal Sea Country Conference, Darwin, September 2024). A traditional fishery monitoring program could substantially contribute information to assist in local community-based management as well as allow for medium to longer term responses to impending changes in fish populations from climate change, and other threats. The need for monitoring and managing traditional and customary Indigenous fisheries is of significant national interest in all State and Territory jurisdictions. This report provides foundational information through a Torres Strait case study to further support this national agenda for Indigenous fisheries.

There is an opportunity for a novel and innovative fishing monitoring program which builds on past traditional monitoring approaches by applying Indigenous led and co-designed monitoring program combining digital technology tools and opportunities for accessing real time data by all users and stakeholders, alongside an equally well resourced and robust communication program. Such a strategy must move away from traditional 'education and awareness' raising approaches to include an active behavioural change component, social media and other strategies such as local champions and incentives. Given nothing of the kind currently exists in Australia, there is a real opportunity for investment in such an approach.

A major theme which came through from the community workshops was that things cannot remain like they used to – in that the environment and fishing behaviour is changing and locally led management is needed to accommodate these challenges and changes. This is where a monitoring program can address locally led management as exists in other Asia-Pacific counties such as through the Locally Managed Marine Areas program (https://lmmanetwork.org/). Communities' have the provision in most cases to introduce local by laws or other rules to manage traditional fishing and a monitoring program and data can support such initiatives.

Fishing monitoring has traditionally been a top-down costly approach. A self-reporting community supported monitoring program in the Torres Strait with an appropriate governance structure and data sharing will foster well needed relationship and trust building and partnerships between Traditional Owners, Indigenous organisations and government managers. It is now well accepted in the scientific literature that that fishers hold valuable knowledge and insights about the behaviour, distribution and populations of fish species and this knowledge if shared, respected and used appropriately can fill key information gaps for future management of marine resources.

While the impact of this project is foundational there is no doubt that a pilot program and later full-scale program, if properly designed and resourced can deliver impact in future years. The data that will flow from this program will provide the most reliable estimates to date of catches from the non-commercial fishery sector in Torres Strait. These data will then be used for a range of needs including: 1) Providing data into Recommended Biological Catch estimates for several fisheries; 2) Provide new information on catches of non-commercially important species from these sectors; 3) Over time, provide relatively robust information about spatial and temporal dynamics of catches from these sectors; and 4) Support locally led management of sea country and resources.

These new data will feed directly into fishery management processes and community decision-making and are critical to the sustainable management of fisheries in Torres Strait, for healthy and strong communities and for the wellbeing and economy of the Torres Strait region.

Conclusion

Monitoring fishing using smartphone app technology is well under way in Australia and globally. Fishing apps are seen as a cost-effective way of sampling the catches from a relatively large population of fishers. However, there are no such monitoring systems in place for Indigenous traditional fishing in Australia. The consultation on traditional fishing completed in Torres Strait for this study allowed for a broad array of views and information to guide a fishing app development program, including the key design features, performance and principles. We found that Torres Strait Islanders broadly supported the implementation of a Torres Strait traditional fishery monitoring app in order to help manage for long-term sustainability of fished species. However, the successful introduction of a fishing app will need an appropriate value proposition to participate, including a need to address concerns about data security. A pilot program will allow for novel testing of what is possible to support sustainable fisheries and livelihoods in future decades.

We recommend proceeding with a 2-year pilot program (Phase 3) for the development and use of a fishing app for traditional fishing in Torres Strait. Two (or three) communities, from different Island cluster groups, would provide a threshold level of diversity and provide adequate opportunity for identifying design issues and solutions. An ideal, but far more expensive pilot program phase, would include trialling and developing an app template across six communities, one in each of the cluster Island communities (Western, Top Western, Central, Eastern, Inner, NPA). However, we suggest that it be far more effective to work with at least two, but ideally three diverse and cooperative communities to lay the foundational tracks of an app template with language, cultural and species diversity that can be ultimately improved over time and use with broader application across the region.

The pilot program should be resourced and supported for a long enough period to create the community confidence and key learnings associated with a new program and app, and to support a region-wide scaling up to a Torres Strait-wide program with confidence of its ongoing success. A complementary activity should be part of the app pilot program to assess the coverage of and scale up the app data as part of the pilot.

The *Qld fishing 2.0* app is not recommended for use in the Torres Strait traditional fishery due to substantial trust issues that Torres Strait Islanders expressed for government agencies holding their personal fishing data, as well as the need for bespoke design of a range of app features that will create a stronger sense of understanding and ownership by traditional fishers.

Recommendations

We make two primary recommendations. The first applies to the development and support of a pilot program for a bespoke traditional fishing app in the Torres Strait (separate from the recreational fishery program); and the second, to support concurrent promotion of the Queensland Government recreational fishing monitoring app (currently using the *Qld fishing 2.0* app) program to monitor the Torres Strait recreational fishery (Figure 26).
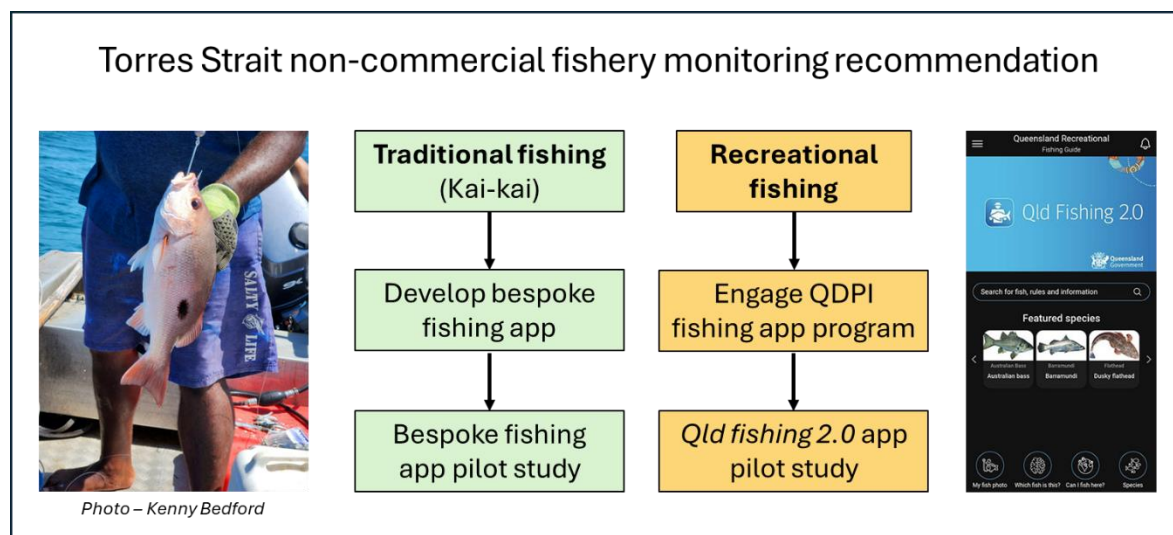
Figure 26. Summary recommendation for non-commercial fishery monitoring in Torres Strait: (i) develop and pilot a bespoke fishing app for traditional fishing; and (ii) Partner to pilot the QDPI recreational fishing app (Qld fishing 2.0).

Recommendation 1: Implement a two-to-three-year Torres Strait traditional fishing monitoring app pilot program with the following components:

    a.   A governance structure and agreements that includes:
   - i. Consideration of a trusted, Indigenous-focused implementing agency/entity (or interim arrangement initially if required) to carry out the pilot program rollout. The implementing organisation should have experience in managing projects and collaborating with Indigenous communities. This entity could outsource the app design and build.
   - ii. A trusted, Indigenous-focused primary data custodian to hold the data and carry out analytics. This agency/entity should be identified and resourced to carry sufficient digital hardware and analytical capacity for ongoing program support. This entity could be the same as the implementing agency above.
   - iii. Agreement between the primary data custodian and individual fishers using the self-reporting app (including with Free Prior and Informed Consent) required to facilitate app sign on to the fishing app. This agreement should include plain Language English and community approved local language text; an explanation of provisions for explicit opting in for sharing data, a privacy statement ensuring privacy of data, and stipulation that any information collected will not be used against that individual but may be used to guide regional commercial fishery management.

iv. Agreements with community organisations to support the program, research activities and to receive aggregated fishery catch data for local needs.

v. Agreements with regional fisheries agencies for receipt of aggregate data for use in stock assessment and catch allocation requirements.

vi. Provision of local support personnel and local champions (men, women and other genders where appropriate) to encourage and facilitate app use.

b. Set up app user sign on, protection and ongoing consent provisions that include:

i. Individual private sign on and password protection for users to manage membership and regulate data upload, access and usage.

ii. Provision for regular reaffirmation of explicit and informed consent for inclusion of individual data for community and regional catch summaries.

iii. Consideration of age usage guidelines to ensure youth data representation.

c. Bespoke app design with priority features, including:

i. Basic demographic information at sign-on (e.g. gender inclusive, age, community affiliation).

ii. Ability to record daily catches by individuals or small fisher groups (e.g. family group or fishing trip group), either through input fields (e.g. for species identification and numbers caught) and/or photographic evidence.

iii. Use of local language where appropriate in the app, including for fish names, cross referenced with the FRDC Australian Fish Names Standard (for species and species groups) to support a common species identification for reporting and fishery stock assessments.

iv. Ability for fishers to report their app record completeness (e.g. estimate fishery app record completeness monthly).

v. Fisher-catch information summaries shared/accessible to the fisher/user at self-selected time periods (e.g. daily, weekly, monthly, yearly).

vi. Access to biological and ecological information on catch species (e.g. key species identification criteria, size at maturity, breeding season, sexual dimorphism characteristics, feeding habits, age at length information).

vii. Ability for users to share catch information with other users (e.g. through a range of social media platforms such as Facebook, Instagram, X, Snap Chat, WhatsApp or other community approved platform sharing).

viii. Access to local and regional fishery management regulations.

ix. Ability for users to record observations (e.g. provision for notes) in the app to document issues of importance or concern to users, for example, environmental or biosecurity information (which could also be available for broader information sharing with other local app users, community or regional organisations).

x. Ability for users to provide feedback about using the app or the program's processes; and should include ability to prompt users to provide this feedback, update the app at regular intervals in response to feedback, and follow up with the user.

xi. Weather, sea conditions and other warnings or marine safety alerts.

xii. Ability to report issues with app usage – i.e. trouble shooting features.

d. Design and implement a complementary data collection program to accompany the app pilot program to:

i. Collect data from a randomly selected and adequate sample of individual community members to provide data to estimate:

- how many fishers are participating in the program out of the total community fishing population.

- how well the app participation group represents the average fisher in the community (e.g. avidity and representativeness of all social and gender groups); and
- estimate of how well an individual's app catch data represent their actual catches.

ii. Use the complementary data to adjust and expand the app data to produce catch estimates for the target community.

iii. The data collection method could include phone interviews and, in cases where this is not possible, face-to-face interviews with community champions.

iv. Make recommendations for improving the utility of the complementary data collection program to reliably achieve the above objectives

e. Finalise the app design process with at least two or three diverse communities (as a minimum), who agree to host the pilot program, including:

i. Engagement with relevant community stakeholders to identify the most suitable pilot program communities to work with to develop and trial the monitoring app.

ii. Adequate planning with two or three selected communities to (i) discuss and clarify the proposed app governance model and expectations, (ii) identify local community champions for the app trial and, (iii) design the necessary and bespoke app features for each community, including the use of locally identified cultural and language considerations.

f. A Communication and Behavioural Approach Program to support and increase pilot app uptake, and share information including:

i. Communication strategies and tools community co-designed and approved with local champions, consistent with community attitudes, cultural protocols, language, and gender inclusivity.

ii. Key messages designed and delivered on:
- how data is being used and the benefits of the program (e.g. local management and fisheries sustainability);
- debunking fears of IP loss and prosecution, and provision of Indigenous Knowledge (approved to be shared);
- removing other barriers to usage;
- sharing feedback from individual users and community;
- celebrate achievements, and
- evaluation of success

iii. Implementing program components including:
- establishing local community champions (training and ongoing support) to help promote the program, assist fishers to use the fishing app and assist with the complementary data program.
- incentives (e.g. competitions, give aways, awards)
- regular information sharing posts and updates on the app usage, upgrades, advertising to promote sign up of new users;
- school-based program to support youth and,
- other gender specific activities to support use by different social groups of men and women (and youth) users.

g. Design of a data analytic and feedback process that delivers individual and grouped (e.g. community or Torres Strait level) catch data summaries back to app users, community organisations and external agencies.

h. Pilot program participatory evaluation which includes identifying key indicators and assessing outcomes with key governance stakeholders and communities to evaluate the pilot program outcomes.

i. Establish a Traditional fishery monitoring program advisory forum or group
    i.   Provide feedback and guidance on the Traditional fishery monitoring program, especially the Communication Program (and potentially other Traditional fishery issues) and promote effective communication with Torres Strait communities
    ii. Membership could include Torres Strait representative bodies (e.g. GBK, TSIRC, TSRA) and at least one representative from each cluster (including inner islands and NPA regions)
    iii. The advisory forum could be part of the existing PZJA committee structure or, a new standalone advisory body.

Recommendation 2: Implement a Torres Strait non-Indigenous recreational fishing monitoring program using the existing QDPI recreational fishery monitoring app with the following activities:

a. PZJA collaborate with the QDPI recreational fishery monitoring program to coordinate fishery communication activities and data flow/accessibility into the PZJA assessment processes.

b. Promote and/or specify (e.g. through existing community visitor sign-in arrangements) the use of the *QLD fishing 2.0* recreational fishing app (in partnership with QDPI) for recreational fishers in Torres Strait communities through the community visitation agreement.

c. Facilitate provision of annual, species-specific, non-Indigenous recreational fishing catch data from the QLD *fishing 2.0 app* to the PZJA for fishery assessments.

Extension and Adoption

During project implementation we communicated information about the project during start-up phase and implementation to a wide range of stakeholders including regional Torres Strait agencies, Fisheries Committees and Groups, and funding agencies. We also presented information about the project in progress at several national fora including Indigenous and Recreational Fisheries Conferences. The project was also featured in FRDC Fish News in the first year and we anticipate a final article in FRDC Fish News and CDU E News pending finalisation of all project outputs. Regular updates have been provided the PZJA TSSAC including at their last meeting in August 2024. A CDU, Torres Strait and potentially one other national webinar will be presented in early 2025 to share the results with a wider number of fisheries, Indigenous and other academic stakeholders. A final presentation to the TSSAC (and other PZJA Fisheries Committees) will also be made in early 2025. A summary of the project (a fact sheet/flyer) will also be promoted and shared through social media (e.g. QR Code) and other PZJA and regional stakeholders for Torres Strait Island communities, and particularly those participants who attended community workshops.

Stakeholder Presentations and Engagement during project implementation

- Project update to FFRAG November 2022;
- Project Introduction and support for consultations to TSRA, April 2023;
- Verbal Project Introduction to ZKF and Ned David, April 2023;
- Project Presentation to Torres Strait Island Regional Council 23rd May 23;
- Progress Report shared with FRDC IRF Chair, Stan Lui, April 2023;
- Project Presentation Update to TSSAC on 23 August 2023;
- Project update to TSI HCRAG/WG in October 2023;
- Project update to FFRAG November 2023;
- Project update to FFWG December 2023;
- Project Presentation Update to TSSAC on 28 August 2024; and
- Project update to the FFRAG October 2024.

Conference Presentations

- Bedford, K. 2023 Presentation to the 2023 AFEC Conference in Adelaide, 5 May 2023 (on invitation from Matt Read from SA Department of Primary Industries and Regions);
- Bedford, K and N. Stacey 2023 Measuring non-commercial fishing catches in the Torres Strait, Presentation at the World Recreational Fishing Conference 20 Feb, Melbourne, 2023;
- Bedford, K and N. Stacey 2024. A community co-design approach to develop a phone APP for monitoring traditional fishery catches in the Torres Strait region of Northern Australia. Presentation to Encountering Maritime Northern Australia: Fisheries, Sea Country and Livelihoods Symposium, CDU, 8 April, Darwin; and
- Bedford, K and N. Stacey 2024. A community co-design approach to develop a Smart phone APP monitoring program for traditional fishery catches in the Torres Strait region of Northern Australia. Presentation to Australian Sea Country Conference, Darwin, 25 September.

Project media and online coverage

- FRDC Fish News 23 January 2023: https://www.frdc.com.au/closing-data-gaps-torres-strait-traditional-fishing; and

- Project listings on FRDC and CDU RIEL websites [https://www.frdc.com.au/project/2022-045 and https://www.cdu.edu.au/riel/research/research-groups/communities-livelihoods-natural-resources.

Indigenous engagement and ethical approach

- The ethical approach adopted in this project, with Human Ethics approval and Free, Prior and Informed Consent obtained from community members followed by the sharing of community workshop summaries with participants immediately after the workshops has been recognised as valuable for future TSSAC supported research in the region with our resources being requested by another recently funded TSSAC supported project in mid 2024.

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Project materials developed

In addition to the Community Engagement Package Materials provided in the Appendices several other products will be prepared to accompany this final report:

- Project Summary Results Flyer (Hard copy and online version)– *to be completed* for TSSAC and wider sharing pending finalisation of this report in early 2025; and
- Journal Article: Kenny Bedford, Tim Skewes, David Brewer & Natasha Stacey (In Prep) A community co-design approach to develop a traditional fishery monitoring program in the Torres Strait region of Northern Australia. *Maritime Studies* Journal. As part of a Topical Collection of Papers on Encountering Maritime Northern Australia: Sea Country, Fisheries and Livelihoods (Guest Editors; Natasha Stacey and Kylie McKenna, CDU).

Appendix A. Project Knowledge Protocol

Traditional Fishing Project: Knowledge and Data Protocol and Principles

Introduction

This protocol has been developed to support and guide the project team and implementation activities, community consultations and data management for the Torres Strait Traditional Fishing Project funded by AFMA and FRDC and supported by Regional stakeholder organisations.

The aim of the research project is to share information and collate the views of Torres Strait community members and other stakeholders about a traditional fishing Catch Recording System that can provide information to individuals, community and other stakeholders to sustainably manage marine resources and livelihoods.

A requirement of this Project as part of our ethical approach is to ensure:

- Any Indigenous knowledges that may be discussed during the project relevant to achieving the project objectives are respected and protected;
- Clear guidelines and principles as to how the project research team may treat any such information communicated by stakeholders during workshops or other meetings to the research team follow the projects' ethical requirements and consent process;
- To continue to build and support Torres Strait peoples engagement, decision-making, and leadership in fisheries management to protect food, culture and livelihoods for future generations; and
- To build collaborative relationships and trust between the project research team, stakeholders and communities who may participate in the project or have an interest in its outcomes.

Ethical principles to be followed in this project

This document supplements ethical research approaches applied in the project as per the approved CDU Human Ethics application (H23056), Project Flyer and Consent forms consistent with the *National Statement on Ethical Conduct in Human Research (National Statement)*, *PZJA TSSAC Procedural Framework for Researchers in the Torres Strait* (2018) and *AIATSIS Code of Ethics* and principles for ethical research (2021).

At the start of any community workshops, the research team will explain the Workshop Consent Process and the Consent forms (see Appendices) and why they are needed and ask each participant to review and complete the forms to ensure informed consent to participate in the workshop and share information.

The research team will also follow the following guiding principles[4] in implementing this project.

1. We agree to abide by National Human Ethics Research principles and Guides and the ethical and cultural protocols of Traditional Owners groups
2. We will have collaborative and respectful relationships with Torres Strait people
3. We respect the Torres Strait Aboriginal governance processes at the local and regional levels

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[4] List of principles have been adapted and modification from Witt *et al.* (2023) and KLC (2011).

4. We recognise the Aboriginal and Torres Strait Island people own their knowledge and their intellectual property
5. We respect the confidentiality of culturally sensitive Aboriginal knowledge/s and when requested by TOs this is strictly observed.
6. Traditional ecological and/or cultural knowledge and Western science and are accorded equal value
7. We support capacity building and empowerment of Torres Strait Island people in carrying out this research.
8. We acknowledge People have the right to participate appropriate to their skills and experiences in relevant projects and processes.
9. We will follow the principles of free, prior, and informed consent are followed at all times
10. We report back to community and stakeholders regularly about the project progress and outcomes and allow people an opportunity to review our work.
11. We ensure funders and other stakeholders make provision for long term access to research reports that are created from this project.
12. This study was approved by Charles Darwin University Human Research Ethics Committee, and we will report annually on any ethical issues arising during the study.

What kind of Indigenous or Traditional Knowledge may be communicated during the project community consultation activities?

During workshops or meeting, the research team will present information on publicly available traditional fisheries information (where available) from each island community or cluster.

Workshop discussions may involve participants discussing specific information about traditional fishing. Such information may include:

- Presentation of information about the traditional fishery catch in the selected communities (based on known publicly available sources of information such as in reports or publications);
- Group discussions to elicit information about traditional fisheries to rank most important species, their trends and status in the community or region; and
- Gather spatial information about traditional fishing in the communities and regions (e.g., by gender, location, species and gear type) using participatory mapping techniques.

What kinds of other information may workshop participants share during the workshop?

During workshop discussions participants may share information about their perspectives and opinions on a phone APP to record and monitor traditional fishing. Researchers will be recording this information.

Participants may also identify some of the information they would like to record as part of a monitoring APP.

People may also identify some names of organisations who they think might want to be able to access some information collected from an APP at a future time for specific purposes with the right approvals and data sovereignty protections in place in the future (but not part of this project).

And participants may also provide their opinions on why some people may or may not want to use or be able to the APP and some ideas for improving more people to use an APP in the future.

What will happen to the results of the information developed and discussed at the workshops?

The researchers will only record, and document information discussed at the workshop with permission to do so for the purpose of the Project only. As noted above, permission will be obtained from participants at the start of the workshop as part of the Information and Consent process required under national Human Ethical guidelines and other principles for research with ATSI peoples.

The researchers will collate information from the workshops and return that information in a community workshop report back to the Community leaders and workshop participants. This will be done by email, phone messages and print outs. The research team will ask participants to tell the researchers if any information is incorrect, should not be included or if they want to add more information.

Later the research team will prepare a written report for the FRDC and AFMA funders and an overall summary report to share with all communities based on the results of all workshops and discussions with other regional stakeholders. Some information in that report may also be used for a research paper, a newsletter article, a conference or workshop presentation and some social media posts about the project achievements.

The final report and community report and any other outputs from the project will be shared back with AFMA and PZJA TSSAC to make them publicly available via their websites.

As part of the research agreement between the researchers (CDU) and the FRDC who funded the project, the FRDC own the report produced from the project, but they permit the researchers to use that publicly information for some of the purposes above.

Acknowledgements

This protocol has drawn on several Indigenous best practices guides and protocols particularly Witt *et al.* (2023) and KLC (2011).

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Appendix B. Project flyer

PROJECT INFORMATION SHEET FOR PARTICIPANTS

Understanding Traditional Fishing in Torres Strait

Project goal: *Co-design a Traditional Fishery information system with NPA and Torres Strait communities.*

This project will share information and collate the views of NPA and Torres Strait community members about a long-term, fishery information system to underpin sustainable fisheries and livelihoods. The project will also summarise information about options for development of a phone APP or similar system.

Why are we doing this project?

Monitoring non-commercial fish catch from both Traditional and recreational fishing has been identified as a high priority in PZJA fisheries committees over recent years.

A scoping study conducted in 2021 showed:
- (i) a non-commercial fishery information system is supported by many Torres Strait Islander leaders
- (ii) a technology-based, self-reporting tool, such as a phone APP, is likely to **be the most cost**-effective option to meet the needs of Torres Strait Islanders to record catches; and
- (iii) an information system would provide many benefits to Torres Strait communities. More detailed information can be found in the project report (Bedford et al., 2021 available at https://www.pzja.gov.au/research/developing-approach-measuring-non-commercial-fishing-torres-strait-order-improve-fisheries).

The next stage is to complete a comprehensive and equitable community engagement program throughout all Torres Strait and Queensland Northern Peninsula Area communities to seek views and support for a digital fish catch recording tool and monitoring system that will work for Torres Strait Islanders.

Photos courtesy of Lala Gutchen

Planned Activities for 2024

- Ensure a free, prior and informed ethical consent process is followed for anyone participating in project activities.

- Obtain and collate the views of Torres Strait Islander women, men and other community social groups to co-design a tool and system.
- Identify the cost and performance options for the information gathering tool based on how they will be used by communities.
- Respect and protect Traditional Knowledge and information gathered through strict information access control, negotiated with individuals, communities and organisations.
- Identify some communities to test the tool in a future project.
- Communicate the results of the project to all communities and stakeholders.
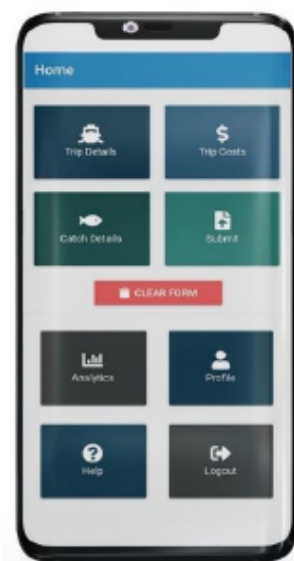
Community benefits

- Ownership of information about trends in Traditional (non-commercial) Fishing catches for self-management.
- Accurate information about the impact of recreational fishing.
- Improved long-term sustainable management of traditional seafood resources through enhanced knowledge and community ownership.

We are seeking Community views

- The project team will contact community representatives in 2023/4 to arrange consultation visits for all Torres Strait communities.
- Community members will be asked if they would like to participate in workshops, meetings or interviews. Participation is voluntary.
- We will meet with men and women in each community through workshops, meetings and/or interviews to seek community feedback and support for a new phone APP or web-based information system. The time commitment may be from 1-3 hours.

Contacts: Community members are encouraged to contact their TSRA representative, the project team or AFMA to find out more about the proposed project or to express your views.

Kenny Bedford, Co-project leader
(kenny@iiiconnect.com.au, 0408 848 761)
Natasha Stacey, Co-project leader, Charles Darwin University
(Natasha.Stacey@cdu.edu.au)
Tim Skewes, fishery scientist (timskewes@outlook.com)
Dave Brewer, fishery scientist (david.brewer52@outlook.com)

Appendix C. Consent form

CHARLES DARWIN UNIVERSITY

Understanding Traditional Fisheries the Torres Strait islands Project

Record of Consent

Type of Participation (tick which is applicable)

❑ <u>Workshop</u> attendance
❑ <u>Interview</u> with project team members

❑ I understand this project is to obtain views about a non-commercial fishery monitoring project.

❑ I consent to participating in project activities.

❑ I consent to the researchers using information I provide for the purposes of the study.

❑ I know that I am free to withdraw from the project activities at any time with no adverse consequences for me.

❑ I understand the researchers will not record my name in any publicly available documents or reports about the study results.

❑ I consent to photographs being taken during the workshop.

❑ I give permission for the images to be used in reporting about the study.

❑ I want to receive a summary of the findings at the end of the project.

Contact address or email...

I have read this Informed Consent Form and I agree with all the points listed above

Signed: _____

Full name printed: _____

Date: _____   Location: _____

✂ -

Project team contacts:

Kenny Bedford: kenny@iiiconnect.com.au, 0408 848 761
Natasha Stacey: Charles Darwin University, Natasha.Stacey@cdu.edu.au

If you have any questions or concerns that you do not want to direct to the researcher, you are invited to the contact the Ethics team of the Charles Darwin University Human Research Ethics Committee Application ID H23056 on (08) 89466063, on the toll free number, 1800 466 215 or by email, ethics@cdu.edu.au. The Ethics team can pass on any concerns to appropriate officers within the University.

Appendix D. Example of a Workshop notice

Yumi fish, Yumi future

Wis way them kai kai fish blo yumi?

Can we manage these resources better?

You are invited and welcome to join an important yarn and workshop about designing a phone APP information system to help yumi community and region better manage our local and regional fish resources, for kai kai, for recreation, for sustainability.

Yumi fish, Yumi future.

Wednesday, 24th July
Iama RTC - Museum
9.30am to 12.30pm
Refreshments provided

FRDC Project website: https://www.frdc.com.au/project/2022-045

Contact: Kenny Bedford, Project leader   e: kenny@iiiconnect.com.au m: 0437 868 817

Appendix E. Community Workshop agenda

Understanding Traditional Fishing in Torres Strait

Community co-design workshop

Workshop objective
To introduce, co-design and determine level of support for a *Traditional Fishing Catch Recording System* that can provide information to individuals, community and other stakeholders to sustainably manage marine resources.

AGENDA

Time	Session	Activity
30 mins	Welcome, introductions, background, and formalities	• Official welcome and prayer • Introductions from team and participants • Background to project • Workshop Objectives • Questions and Consents
30 mins	The Traditional Fishery of Torres Strait	• What is known about traditional fishing in Torres Strait? • Community catch information priorities
30 mins	Introduction to catch recording apps	• Presentation and Q&A on what catch recording apps can do • Questionnaire on app use
15 mins	Morning tea	
45 mins	Co-design process – what information to feed back?	• What information would community like to see come out of the App (OUTPUTS) and, • Who should be allowed access to that information (ACCESS)
45 mins	Co-design process – will communities use a traditional fishing app?	• What are the things that will encourage use of the App? (INCENTIVES), • What reasons might stop people from using the App? (BARRIERS) • How can we improve usage and uptake of the App? (SOLUTIONS).
15 mins	Workshop close	• Thanks • Next steps, communicating results of project back to communities and other stakeholders • End of meeting prayer

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Appendix F. Full species list from prioritisation activities at 14 community workshops

Compiled list of priority species identified by participants at 14 community workshops.

Common name	Community workshop name	Importance (votes)	Monitoring priority (votes)
Bailer shell	Bailer shell		
Baitfish	Baitfish		
Banded Sweetlip	Meiwap		
Bar Tailed Grunter	Maizab	1	
Barracuda	Barracuda		1
Barramundi	Barramundi	4	9
Barramundi Cod	Gorom	1	1
Black Jewfish	Black Jewfish	1	2
Black Spinefoot	Kibim	2	4
Black Spinefoot	Kibim/Mabal	1	1
Black Spinefoot	Mabal		
Blackfish	Ibai	2	
Blue Swimmer Crab	Blue Swimmer Crab		
Boxfish	Boxfish	3	1
Bream	Bream	3	2
Butterfish	Butterfish		
Butterfish	Masau		
Catfish	Catfish	1	
Clam	Clam	6	24
Clam	Mi	3	3
Clam	Selpis	2	3
Clam	Shark		
Mangrove clam	Akul	9	11
Cod	Cod		
Cod	Siar		
Cone shells	Kirit/Waurid		
Coral Cod	Coral Cod		
Coral Trout	Coral Trout	9	7
Coral Trout	Mamam Lar	1	5
Coral Trout	Pakor	3	2
Coral Trout	Withi	4	8
Cowrie	Mokepu		
Eagle Ray	Pebisor		
Eel	Kunu		
Eeltail Catfish	Eeltail Catfish		
Estuarine Cod	Estuarine Cod		
Finger Mark	Fingermark		

Flat Tail	Flat Tail		
Garfish	Garfish		
Garfish	Matakui	1	
Garfish	Warib		
Garfish	Zab		
Garfish	Zab/Matakui	1	4
Garfish	Zaber	17	9
Giant Trevally	Geigi		
Golden Spinefoot	Azum	9	4
Golden Spinefoot	Erar	17	17
Golden Spinefoot	Parsa	16	20
Goldspot Sweetlip	Teur		
Grouper	Grouper		
Grouper	Tekei		
Grunter	Grunter		2
Hardy Head	Koss		
Hardy Head	Tup	2	3
Herring/Sardine	Herring/sardine		
Jewfish	Jewfish	2	3
John Dory	John Dory	1	
John Dory	Karmoi	4	
Kuki Shell	Kuki shell		
Long Tom	Long Tom	1	
Long Tom	Padis		
Long Tom	Paris	2	
Mangrove Jack	Mangrove Jack	3	2
Mantis Shrimp	Mantis Shrimp		
Moses Perch	Teneb	5	
Mother-in-law Fish	Peku		
Mother-in-law Fish	Peuk		
Mud Crab	Crab	9	11
Mud Crab	Mud Crab	4	5
Mud Whelk	Blue Bums	1	
Mud Whelk	Mud Whelk		
Mullet	Mullet	15	9
Mullet	Wiri	4	
Nanagai	Nanagai		
Octopus	Arti	1	
Octopus	Arti/Sugu		
Octopus	Octopus	1	
Octopus	Sugu	9	12
Oyster	Oyster	1	
Parrotfish	Parrotfish		1
Pearlshell	Pearlshell		
Perch	Zarum	16	17

Perch/Fingermark	Perch/fingermark		
Periwinkle	Periwinkle		
Pipi	Pipi		
Pipi	Pipi shells		
Pipi	Sider		
Pipi	Silel		
Pipi/Cockles	Pipi/Cockles		
Prawns	Prawns	1	3
Queenfish	Papei	1	
Queenfish	Queenfish	1	
Rabbitfish type 2	Manal		
Rainbow Runner	Irgair	2	
Rays	Rays		
Red Emperor	Red Emperor	1	
Redbarred Rockcod	Pellet		1
Redbarred Rockcod	Pillit		
Rock Cod	Garom	1	
Rock Cod	Rock cod		
Salmon	Salmon	3	1
Salmon	Salmon (Bluefin)	1	
Sand Bass	Nightfish		
Sandfish (Sole)	Sandfish (Sole)		
Sardine	Ariari	1	11
Sardine	Sardine		3
Sardine	Tup/Koss/Ari ari	5	6
Shellfish/Clam	Shellfish/Clam		1
Shells	Kaip		
Shells	Keret		1
Shells	Maub		
Shells	Shells		
Shells	Shells (Spider shells etc)		1
Shovel Nosed Shark	Bopor		
Silverfish	Wapa fish		
Small white clam	Awidh		
Snapper	Snapper	11	
Spanish Mackerel	Dabor	11	15
Spanish Mackerel	Duboi	4	9
Spanish Mackerel	Gaigai		
Spanish Mackerel	Spanish Mackerel	1	2
Spider Shell	Asor		
Spider Shell	Spider Shell	4	5
Spotted Spinefoot	Bodo		
Squid	Bidai	3	2
Squid	Guli		
Squid	Squid	4	7

Stingray	Stingray	1	
Stingray	Tupmul	7	1
Stripey	Kuikimak	10	2
Stripey	Maizar		
Stripey	Stripey	2	
Suckerfish	Gap	1	
Sweetlip	Sweetlip		
Sweetlip/Snapper	Sweetlip/snapper		
Trevally	Mek mek	3	
Trevally	Trevally	10	
Trevally	Whitefish	4	
Trochus	Kabar	1	
Trochus	Nazeer		
Trochus	Trochus		
Tropical Rock Lobster	Crayfish	6	8
Tropical Rock Lobster	Kaear		
Tropical Rock Lobster	Kaiar	15	36
Tuna	Tuna	1	
Turtle eggs	Turtle eggs	1	
Tuskfish/Parrotfish	Bila	23	15
Unicorn Fish	Sabei	2	
Whiting	Whiting		

Appendix G. Community attitudes to non-commercial fishery monitoring

Compiled individual comments from community workshop participants regarding attitudes to non-commercial fishery monitoring and grouped into categories.

COMMUNITY	MONITORING COMMENT	COMMENT CATEGORY
NPA1	Timely Project as islands and National Park (Jardine) handback, and rename to Atamapaya. So we have to employ rangers to manage NP and IK will grow our footprint.	Community need
NPA1	Ipima – people have 18 licenses – not TIB licences but similar. New fisheries officer has to record catch.	Community need
NPA1	Ipima – we have responsibility for land and sea - would be good to show on a map.	Community need
Erub	Net management including bans are needed for some traditional species.	Community need
Erub	There is no education about the sustainable use of these species to young people.	Community need
Erub	Concern about over-harvesting and pressure on Erar.	Community need
Erub	Fish traps were a traditional fishing method, because only what was needed for kai kai (food) was taken and what was left survived in tidal pools. There was no waste.	Community need
Ngurupai	People noted changes in species availability in their lifetime.	Community need
Ngurupai	People want to know what locals are catching and what people from outside are catching.	Community need
NPA2	There has been an increase in concern by Traditional Owners in relation to a minority of (younger) individuals who are not hunting and fishing responsibly, including overfishing, 'ego-fishing', wasting catches.	Community need
NPA2	Difficult for local TOs to report illegal fishing by other TOs or people.	Community need
NPA2	Noted that in 2000 the community introduced a ban on jew fishing to help stocks recover (Injinoo Report).	Community need
NPA2	A similar problem happened with Jewfish and when everyone became aware of a secret breeding spot for Jewfish that resulted in overfishing at that particular site.	Community need
Badu	Netting is a big issue locally. It would be good to have some information to address this.	Community need
Kubin	People already exert control of fishing practices by peer pressure and netting restrictions.	Community need
Kubin	Good to re-educate people about what to use – and how to use it as a group.	Community need
Kubin	Local rules are important, but Torres strait wide rules also important to implement.	Community need
Kubin	Important for community to get control of local waters – to implement local rules.	Community need

COMMUNITY	MONITORING COMMENT	COMMENT CATEGORY
Kubin	Fishing for food is very important to the community.	Community need
Mabuiag	Could the information be used to indicate annual catches so the fisher can apply for bank loans? Or be used at tax time?	Community need
Mabuiag	Finfish commercial closure affects Mabuiag, but for kai kai, finfish is the most important component.	Community need
Mabuiag	How can some "traditional" compliance be integrated into the system?	Community need
Mabuiag	Important that community resources taken out of our local area are accounted for.	Community need
Mabuiag	Management decisions need to be made locally.	Community need
Mabuiag	Good to trail net ban.	Community need
Boigu	Life cycle information about Barramundi would be useful.	Community need
Boigu	So must leave fisheries for kai kai due to commercial pressure and climate change.	Community need
Boigu	Empowering TSI to manage fisheries is good.	Community need
Saibai	Rangers should already be doing this kind of work.	Community need
NPA1	NPA to report to GRMPA? Will this information collected through the monitoring program?	External stakeholder need
Mabuiag	How will the TRL non-commercial catch data be used? Will it be used in the stock assessment? This would be good to know.	External stakeholder need
Ugar	What happens to the data for the different catch types?	External stakeholder need
Saibai	Need to split commercial catch from kai kai catch.	Implementation
Saibai	There are pictures of fish with local names at the local school which will be useful for identifying fish using local language.	Implementation
Erub	Need to learn lessons from dugong and turtle management.	Implementation
Erub	Need to educate the community about "why to collect data" and why it's important for sustainability and for community benefit.	Implementation
Ngurupai	Good potential to involve school kids in any program as they go fishing with mums and dads.	Implementation
Ngurupai	Different species are targeted at different times of the year – so seasonality is a big issue and men and women target different species.	Implementation
NPA2	Needs to be more education about important fish and food species.	Implementation
NPA2	Education and campaigns will be important in promoting stewardship of the environment and fisheries.	Implementation
Badu	The ideas of "community empowerment" and "stewardship" are not at the forefront of what most people think about. You will need to put something in it for them personally.	Implementation
Boigu	Good idea to provide catch data back to fishers.	Implementation
Boigu	Getting the message to families important.	Implementation

COMMUNITY	MONITORING COMMENT	COMMENT CATEGORY
Boigu	Commercial TIB fishers should count their kai kai catch for full account of fishing.	Implementation
Iama	What happens if there is undersize fish in the catch. Will I get into trouble?	Implementation
Iama	The school program for dugong and turtle is a good example. People did understand that.	Implementation
Iama	Get the children involved.	Implementation
Iama	Build on things like the IPA.	Implementation
Saibai	Proximity to PNG will be an important factor for local traditional fisheries.	Managing pressures
Saibai	Monitoring needed for illegal activity and external factors, especially for barramundi, crayfish and mud crabs.	Managing pressures
Ngurapai	Participants noted concerns about the types and amount of kai kai species taken by people from PNG communities – the same species taken by Torres Strait Islanders.	Managing pressures
Ngurupai	Participant also asked how a monitoring program would support PNG participation.	Managing pressures
Ngurupai	More traffic out to the reefs than in the past.	Managing pressures
Ngurupai	People using different technology than in the past and can access fishing grounds – reefs further and faster which is impacting fish stocks.	Managing pressures
Ngurupai	Increase in crocodile numbers in coastal areas means people fishing less in these areas and going offshore.	Managing pressures
Ngurupai	No control over recreational fishing in native title waters and not benefitting financially from any activity.	Managing pressures
Ngurupai	People concerned about wastage from recreational fishing, compared with locals who tend to eat and cook all of the fish than just fillets only.	Managing pressures
Ngurupai	Technology means we can go fishing in shorter periods of time.	Managing pressures
Ngurupai	But fishing is also more like a sport these days compared with the past when it was important for food.	Managing pressures
Ngurupai	A lot of activity in Horn island region and growing from year to year, everyone has a dingy – need to be able to understand the level of activity.	Managing pressures
NPA2	There is increased fishing activity happening East of the 'the tip' and South to Escape River due to a growing number of 6m vessels e.g. Hooker Dories, that are being powered by bigger outboard motors up to 250 HP. This is in contrast to the outboard motors that have been 90 HP and less for decades until recently.	Managing pressures
NPA2	Complex in NPA with TOs, other Indigenous residents and visitors (not TOs), tourists and recreational/charter fishing business and that the area is experiencing increase in tourism and thus fishing demand and activity.	Managing pressures
NPA2	A new and upgraded highway to the NPA is a significant factor increasing fishing.	Managing pressures

COMMUNITY	MONITORING COMMENT	COMMENT CATEGORY
NPA2	Concerns over fish wastage and waste management due to overharvesting, expiration of stored catches in freezers and the dumping of these surplus catches including illegal dumping along the coastline by commercial fishers.	Managing pressures
NPA2	Concerns over levels of fishing by non TO Indigenous people in the region and black-market sales of fish which contravenes native title rights of local TOs.	Managing pressures
NPA2	People doing the wrong thing e.g. Targeting tupmul and other fish for selling and over-hunting, are unlikely to report catches.	Managing pressures Implementation
NPA2	Incident shared of illegal Barra gill-netting in Escape River and of no response to reports of this incident and others, including targeting of BDM on the NE side of Albany Island.	Managing pressures
Badu	We are trying to do the right things but what about poaching and recreational fishing – makes you feel a bit helpless.	Managing pressures
Kubin	Some people are fishing and selling on the black market.	Managing pressures
Kubin	Important to see how the traditional fishery interacts with the commercial fishery.	Managing pressures
Kubin	Monitoring priorities are most important for fish that are being fished by outsiders. This is causing declines.	Managing pressures
Mabuiag	Link to environmental monitoring, seagrass and coral.	Managing pressures
Boigu	Why do you need to know information about kai kai species? Commercial fisheries do all the damage.	Managing pressures
Boigu	PNG fishing is happening including illegal fishing for Spanish Mackerel. Also fishing for crab and selling to Indonesian buyers – and to locals as well. Some barramundi netting also going on.	Managing pressures
Boigu	Climate change will impact fisheries here.	Managing pressures
Iama	There have been changes but we don't know what's causing them.	Managing pressures
Iama	Bycatch from prawn trawlers needs to be taken into account.	Managing pressures
NPA1	There are opportunities to support small scale commercial fishing for communities in the Cape York. Monitoring might help this.	Potential for commercial fisheries
Ugar	How does this help economic development?	Potential for commercial fisheries
NPA2	There are plans underway for IPAC to establish an Indigenous led commercial fishing licenced enterprise to support Indigenous fisheries in QLD.	Potential for commercial fisheries
Kubin	Line closure – what is happening with that? Future economic opportunities will be opened up with information from the program.	Potential for commercial fisheries
Mabuiag	For commercial species, Tropical Rock Lobster is the most targeted commercial species. Coral Trout is an emerging TIB fishery and gets fished more than Spanish Mackerel.	Potential for commercial fisheries

COMMUNITY	MONITORING COMMENT	COMMENT CATEGORY
Boigu	Not much commercial fishing going on at the moment.	Potential for commercial fisheries
Boigu	Barramundi is potentially an important fishery in Boigu.	Potential for commercial fisheries
Boigu	Aquaculture will be important in the future.	Potential for commercial fisheries
Boigu	Commercial fishing on a bigger scale is going to happen soon.	Potential for commercial fisheries
Iama	More commercial (TIB) fishing will be happening soon – for Coral Trout, Crabs, Spanish mackerel.	Potential for commercial fisheries
Iama	Recreational fishing occurs in the community – should be a condition of entry that this gets recorded.	Recreational (non-Islander) fishing
Erub	Quite a few participants thought that 15 tonne estimate for traditional (kai kai) catch of Spanish mackerel is too low.	Sp. Mackerel example
Poruma	15 tonne estimate of Spanish mackerel – some say higher some say lower.	Sp. Mackerel example
Mer	Some concerns were raised from a participant about the interaction between the Qld East Coast Spanish Mackerel fishery and that of the Torres Strait.	Sp. Mackerel example
Mer	Meriam/Torres Strait Islanders can take as many Spanish mackerel as they like as the TS stock is more than enough to allow for this.	Sp. Mackerel example
Ugar	There were some concerns about the interaction between the Qld mackerel fishery and its management.	Sp. Mackerel example
Warraber	There was an opinion raised that the 15 tonne estimate allowed for TS kai kai in the TAC allocations is too high, especially based on what is caught and consumed at Warraber.	Sp. Mackerel example
Badu	The 15 tonne estimate for kai kai of Spanish mackerel is very hard to estimate, especially across the region of Island communities with differing experiences of catch rates – some say higher some say lower.	Sp. Mackerel example
Kubin	The 15 tonne estimate for kai kai of Spanish mackerel is very hard to estimate – some say higher some say lower. Kubin is not really a place where people get a lot of Spanish mackerel to eat.	Sp. Mackerel example
Kubin	Take more recreational, and less traditional catch of Spanish mackerel – but some doubt about this among the group.	Sp. Mackerel example
Mabuiag	Can't really estimate catch on a Torres Strait wide basis – need to estimate on a community-by-community basis.	Sp. Mackerel example
Iama	We don't know the Spanish Mackerel catch for kai kai. But TIB probably a lot less than 18t.	Sp. Mackerel example
Iama	The Spanish Mackerel population graph reflects what has been happening at Iama well.	Sp. Mackerel example
Badu	This project could be really beneficial for us.	Support Community need

COMMUNITY	MONITORING COMMENT	COMMENT CATEGORY
Erub	There was general acknowledgement that the traditional fisheries need to be protected.	Support
Erub	Several people commented, all agreed, that recording the catch of kai kai fish would be a good idea.	Support
Ugar	A high level of mistrust from one elder who thought that this concept could lead to restrictions on traditional take and use of resources.	Support
Warraber	Really need to monitor species – where money/trade/personal gain is involved.	Support
Ngurupai	People noted concerns about fishing not only around the jetty area but also offshore.	Support
Iama	This is important for our future. It's not only fishing, its climate change as well.	Support Managing pressures
Erub	There is some uncertainty about who controls the commercial and recreational fisheries.	Other
Erub	How does this relate to the sampling for fish frames that is happening now [This is the AFMA funded "Biological sampling project" for Coral Trout and Spanish mackerel].	Other
Ngurupai	No bag limits for kai kai species.	Other
Ngurupai	Also nowadays we have to ask people for fish when a big event on rather than go catch it ourselves.	Other
NPA2	Need to make sure there are enough quota for food and commercial fisheries.	Other
NPA2	If enforcement such as fisheries compliance was in place it could act as a disincentive to do the wrong thing. Something needs to address this abuse.	Other
NPA2	In NPA region there has been less participation in PZJA consultative committees over the years than in Northern Torres Strait Island communities.	Other
Boigu	Assessment of current research by independent researcher is needed. CSIRO and others have been bullshitting about fishing data.	Other
Iama	Recreational take of kaiar is important to know.	Other
Iama	Recreational fishing currently needs to be given a verbal consent.	Other
Iama	Compliance of recreational (non-islander) catch and have a local to check for recreational catch e.g. bag limits and size limits.	Other
Iama	Some kai kai fish being taken by TVH fishers. Need compliance officers on island – in collaboration with Rangers. "Meet us half way".	Other
Iama	Compliance is a big problem here.	Other

Appendix H. Community views on fish species importance and monitoring priorities

Compiled comments from community workshops participants regarding fish species importance and monitoring priorities and grouped into categories.

COMMUNITY	SPECIES COMMENT	COMMENT CATEGORY
NPA2	Men and women target different species – but women are also changing their practice in some places with women going on boats and being in charge of driving the dingy.	Gender
NPA2	Women don't fish crayfish.	Gender
Kubin	Women do fish off the jetty.	Gender
Kubin	Women fish more for kai kai more than men.	Gender
Mabuiag	Everyone fishes every day. Men use spear.	Gender
Iama	Bila, Zarum, Spider shell, Squid, Sugu all fished by women and children.	Gender
Saibai	Monitoring all species will be useful but especially those ones that are under "external" pressure.	Monitor all species
Erub	There are many more species than the ones listed.	Monitor all species
Poruma	There are many more species than the ones listed.	Monitor all species
Ugar	There are many species that require monitoring.	Monitor all species
Ngurupai	Different species are important to different communities across the region.	Monitor all species
Badu	There are more species than the ones listed.	Monitor all species
Badu	They are all important.	Monitor all species
Badu	Some species are being smashed.	Monitor all species
Kubin	There are more species than the ones listed.	Monitor all species
Mabuiag	Every fish needs monitoring!	Monitor all species
Boigu	Some difference in importance between different people in the group.	Monitor all species
Iama	This list is the common and favourite ones.	Monitor all species
Saibai	Use of camp/primary harvest areas by PNG fishers out of sight of main community is an issue.	Pressures
NPA1	Different groups fish different parts of the Cape -e.g. Lockhart River fish eastern area, Seisia people go north.	Spatial aspects
Warraber	There are no significant geographically-based fishing issues, other than different habitats hold different resources etc.	Spatial aspects
Warraber	There are favoured places where nets are used/dragged.	Spatial aspects
NPA2	Most of the NPA traditional fishing occurs between just South of Seisia, north along the Coastline to Possession Island.	Spatial aspects
Kubin	There are some differences in fishing between Kubin and St Pauls communities.	Spatial aspects
Boigu	Clans own the different swamp areas.	Spatial aspects

COMMUNITY	SPECIES COMMENT	COMMENT CATEGORY
Saibai	Crayfish, barramundi and mud crab are all priorities for monitoring as they are being targeted by PNG fishers therefore, they are likely under a lot of pressure.	Species specific issues
Erub	Sardine (Herring and Hardyhead). They have a wide range of uses for bait and food. They can be caught by net and wastage and misuse of the resource is a concern. They are also important food for other fish species so are the basis of the food chain.	Species specific issues
Erub	Erar. Easy to catch. Very widely distributed. Important food species. Lots of effort in them by community members. Sometimes sold within the community. Nets can catch a lot. Concern with population size and status. They seem to be generally smaller than they used to be. Net mesh size is a concern and suggested solution.	Species specific issues
Erub	Clam. Some is being sold. Seeing empty shells on the reef and smaller shells being taken. Sokoro is a delicacy made form the muscle – highly sought after. Giant clam and all species being taken. Clams are important filter species for the reef, so important for reef health. They can also take a long time to grow. Awareness needed, especially with young people. They are becoming a rare commodity. They are also potentially a tourist attraction on the reef. Concern too many giant clams have been taken for larger muscle and will take too long to recover.	Species specific issues
Erub	Dabor. Spanish mackerel are a priority, and there is some being sold within the community. Selling within the community not being picked up by commercial monitoring. Size is also an important aspect of fished animals. Accurate data important. Biology important. Leaving enough for kai kai/accurate data is important.	Species specific issues
Erub	Shells. Diminishing resource, therefore a concern.	Species specific issues
Poruma	Sardine disappeared some time ago, maybe when the new jetty was put in. No netting is allowed in the community.	Species specific issues
Poruma	Bila/Parsa. Bila and Parsa closely related, but fished in different ways. Important kai kai and cultural species. Bila probably OK. Parsa there is a lot of concern about overfishing. Fished every day and including netting. Some seasonal variation as well. More information is required for local level management, and probably also at cluster level.	Species specific issues
Poruma	Kaiar. Important for kai kai and also for TIB. Catch for kai kai could be greater than people think on this island. Lots of people fish, especially around Christmas time, and this could be a problem.	Species specific issues

COMMUNITY	SPECIES COMMENT	COMMENT CATEGORY
Poruma	Dubor. Big pulses of effort sometimes – might be too much. Lots of variability on annual and seasonal cycles. Shark depredation sometimes a problem. Important kai kai and TIB species. Community would like to know other communities catches so they can manage their own catch. Need information to make decisions.	Species specific issues
Poruma	Clams. Worried about taking too many. Climate change could also be a problem for clams. There is a decrease in numbers and probably at least local depletion. Its becoming a delicacy lately, so more people fishing, including for big ones. Need local management to allow them to grow, which can take a long time.	Species specific issues
Poruma	Squid. Some concerns about effort here.	Species specific issues
Poruma	Shells. Concern about people trading (selling) some shells especially spider shells and bailer shells.	Species specific issues
Mer	Different species are targeted for different purposes, e.g. kaiar (crayfish) are targeted for Tombstone Opening feastings and other important ceremonies/cultural events; long tom are used for certain medicinal purposes.	Species specific issues
Mer	Some species, such as queenfish and barracuda have different names for fish of different sizes of the same species. This will be important to differentiate in any app.	Species specific issues
Mer	Some concern about an increase in shark populations and their impact on sardines/herrings.	Species specific issues
Mer	No commercial TRL fishing at Mer. An example that resources are still more culturally important and a priority over commercial fishing.	Species specific issues
Warraber	Parsa are important local kai kai, concern over sustainability.	Species specific issues
Warraber	Matakui and Zarum are caught in nets and used for bait and kai kai. There is some concern for these species due to the numbers caught by this method (TSRA Ranger).	Species specific issues
Warraber	Dubor – caught for kai kai but not commercial. There are fewer Mackerel in recent times and fishers have to travel further to catch them.	Species specific issues
Warraber	Noticeable increase in Shark numbers and having to race them to land fish.	Species specific issues
NPA2	Mullet are important food species, often targeted at Escape River.	Species specific issues
NPA2	Concern about the targeting of yellow-tail mullet and noticeable drop in numbers.	Species specific issues
NPA2	Crayfish are important for kai kai but are also being harvested for selling (raw and cooked as is Clam meet (sokoro) and Tupmul (stingray) for event catering.	Species specific issues
Badu	Clamshell have been pretty much fished out.	Species specific issues
Badu	Tupmul (stingray) has a high cultural importance on Badu.	Species specific issues

COMMUNITY	SPECIES COMMENT	COMMENT CATEGORY
Badu	Crayfish a monitoring priority as they are also commercial and are in decline.	Species specific issues
Badu	Spanish mackerel, only about 100 per year caught. Not a lot of people fish them. They are good to eat though.	Species specific issues
Badu	Small black Rabbitfish are caught only occasionally.	Species specific issues
Badu	Akul (Mangrove clam) can be overfished at times.	Species specific issues
Badu	Bidthai (squid) has seen a decline lately – could be related to climate change. Usually you have a big rain and then they breed, but this has changed now. Lots of concern in the community.	Species specific issues
Badu	Zarum (perch) has medicinal properties.	Species specific issues
Kubin	Squid is important to people. They like eating them, local delicacy.	Species specific issues
Mabuiag	Keikumak (Stripey) highly sought. Good to eat.	Species specific issues
Mabuiag	For Spanish Mackerel, shark predation is a problem.	Species specific issues
Mabuiag	Billa (Parrot/Tusk Fish) good to monitor for overall ecosystem health, coral reef health.	Species specific issues
Mabuiag	Smaller Billa are good to eat (sweet).	Species specific issues
Mabuiag	Withi (Coral Trout) need to monitor especially during breeding season.	Species specific issues
Mabuiag	Kaiar important cultural species as well. Mostly undersize ones caught for kai kai during commercial fishing so would be good to understand catch levels.	Species specific issues
Mabuiag	Awidh, a small white clam are slow growing, a bit down on numbers, have an important role on the reef.	Species specific issues
Mabuiag	Akul (Mangrove clams) are an easy target, and there have been changes recently. May be due to climate change. Not sure what's there.	Species specific issues
Mabuiag	Blue bums (Mud whelk) not found here anymore.	Species specific issues
Mabuiag	Small pearlshell (Awidh) also not around anymore. Good food for Kaiar as well.	Species specific issues
Boigu	Crab are an important food species.	Species specific issues
Boigu	Crab are important to count. High catches and probably unsustainable.	Species specific issues
Boigu	Parsa and squid – how many are being fished during pulses in fishing?	Species specific issues
Boigu	Useful to better manage crab.	Species specific issues
Iama	Squid are less now than before.	Species specific issues

COMMUNITY	SPECIES COMMENT	COMMENT CATEGORY
Iama	Spider shells are going down.	Species specific issues
Iama	Kaiar important to monitor because it's a commercial species.	Species specific issues
Iama	Sugu (Octopus) and Parsa numbers are dropping, especially locally.	Species specific issues
Mer	Certain species occur at Mer seasonally, such as the current example of visiting trevally schools that was mentioned.	Temporal issues
Badu	Some species are seasonal.	Temporal issues
Boigu	Most fish are seasonal. Seasonal catch information important.	Temporal issues

Appendix I. Implementing a monitoring app

Compiled comments from community workshop participants regarding implementing a monitoring app grouped into categories.

COMMUNITY	APP COMMENT	COMMENT CATEGORY
NPA1	Turtle monitoring with hand-held device. New app this year.	Design
Erub	The app must be simple to use.	Design
Erub	The app must provide useful information to people who use it.	Design
Erub	They are doing it on Facebook now (show off catches), then they can use the app.	Design
Poruma	If the app could ID a fish and tell you the local rules that would be very useful. Connected with local language names.	Design/ Support
Poruma	Using local messaging about stewardship will be very powerful.	Design
Mer	Some species, such as queenfish and barracuda have different names for fish of different sizes of the same species. This will be important to differentiate in any app.	Design
Ugar	Have an app that is easy for Elders to use and understand.	Design
NPA2	People use Facebook at Instagram to post pictures of their catches.	Design
Badu	Some kind of scanning systems at the wharf could be a good additional monitoring.	Design
Badu	The fishers will need to get something out of it personally, this is critical!	Design Implementation
Kubin	Social media sharing of catches is already happening.	Design
Mabuiag	App needs to be tailored to community priorities.	Design
Mabuiag	Cultural appropriateness of the app will be important.	Design
Mabuiag	A community organisation/entity should control app design and application.	Design Implementation
Mabuiag	How can people from other communities be registered to different areas that they fish?	Design
Mabuiag	An example is the TEK information system administered by TSRA. Access is approved by the PBC. Consultation on the TEK information system is happening soon, to be finished by mid next year. With GBK.	Design Implementation
Mabuiag	Include environmental information, seagrass and coral.	Design
Boigu	Social media driver will be important.	Design
NPA1	Social marketing, advertising, tap into tourism industry and charter, can show respect to be on TO lands and seas to use the APP.	Implementation
NPA1	Target the young generation that are more tech savy.	Implementation
Erub	There will need to be a significant effort to educate the rest of the community to get them involved. How will this happen? Especially for the women and kids?	Implementation
Erub	Word of mouth promotion and using examples of the benefit will be very important.	Implementation

Erub	Need to reach a certain threshold number of users in the community or it won't be worth it.	Implementation
Erub	There is some experience with apps in the community through the previous catch recording project [Dan French community freezer monitoring project] and with language app development [Erub Mer Language Project].	Implementation Design
Erub	The Erub Mer Language project, happening in collaboration with the Australian Literacy and Numeracy Foundation, is using cutting edge technology to build an online interactive language dictionary and resources. The community is very aware and supportive of the project and have been contributors to the development of the resourced. The language data is also managed so that only Traditional Owners can access the resource that requires levels of Traditional Owner sign off before information can be logged and shared.	Implementation Design
Erub	Suggestion that if you could get a device that only has the app on it, that might be available for community members use would increase participation.	Implementation
Poruma	Getting most of the community to use the app will take a lot of education and awareness.	Implementation
NPA2	There is a perception among some community members that through an APP program it might be seen as the government coming to stop us doing what we want.	Implementation
NPA2	Older people less likely to use the app and some specific family groups (e.g. 2-3 families) might also not use the APP in this region (out of fear or unless they saw a benefit).	Implementation
Badu	It will probably get some uptake early as being "the new toy" but will need some work to embed it in the long terms.	Implementation
Badu	Behaviour change will be needed.	Implementation
Badu	Of the 800 people on Badu, maybe about 50 fish on a regular basis, and only a proportion of them will use the app.	Implementation
Badu	Incentives will be very important. Something like the cash for containers scheme that was implemented locally. It was only a small incentive but it had a big impact on behaviour.	Implementation
Badu	Behaviour change will be needed.	Implementation
Kubin	People do generally want to share their catch information, but you have to be careful you don't scare people.	Implementation
Mabuiag	Cannot force people to record their catches.	Implementation
Boigu	Mobile signal is good here.	Implementation
Boigu	The local fishing corporation will have its own app – but could use this app as well.	Implementation
Iama	Needs to be an incentive for people to use it.	Implementation
Iama	It might work but people will not use it.	Implementation
Iama	We have to be committed. Will need a campaign to convince people.	Implementation/ Support
Iama	Collecting and analysing the data within the school curriculum. Tagai college involvement. School very important to get involved.	Implementation
Iama	Our fishing association best to get the data.	Implementation

Iama	Use to educate young people about cultural information and the rules.	Implementation
Iama	Need to be confident that the information is secure.	Implementation
NPA1	Good way to reduce time and data entry costs for monitoring.	Support
NPA1	Fantastic idea.	Support
Erub	Broad support for the app implementation – seen as important.	Support
Mer	This idea is pretty good.	Support
Warraber	This app network may be a more effective way in future to share fisheries management information as well as to consult fishers/community.	Support
Warraber	It would be very good to have the app.	Support
Badu	I think the app would be great!	Support
Kubin	App is a good idea. It puts the information in peoples hands.	Support
Mabuiag	Everybody will use it! Initially at least.	Support
Mabuiag	App use will gradually increase over time if at least some people are using it.	Support/ Implementation
Boigu	App is a good idea to monitor catches.	Support
Boigu	This will definitely work.	Support
Iama	I reckon it will work. Better than dugong and turtle – that is not working. Data is not being collected.	Support
Iama	This is finally putting meat on the bones of looking after the kai kai fish.	Support

Appendix J. App outputs and features

Compiled comments from community workshop attendees regarding app outputs and features grouped into categories.

COMMUNITY	OUTPUTS/FEATURE	ACCESS	CATEGORY
Saibai	Biological information e.g. barra lifecycle.	Everyone	Biology
Erub	A better understanding of biology is important for management; growth, breeding timing and size of breeding.		Biology
Erub	Biological information, when they bite.	Everyone	Biology
Poruma	Biology of fishery species.	Everyone	Biology
Mer	Fish biology.		Biology
Warraber	Biological information.	Everyone	Biology
Badu	Biology (breeding times etc).	The fisher and communities	Biology
Kubin	Biology (breeding times etc).	The fisher and communities	Biology
Mabuiag	Biological information (breeding times etc).	The fisher and communities	Biology
Boigu	Life cycle information about Barramundi would be useful.	Everyone	Biology
Iama	Breeding times.	Everyone.	Biology
Ngurupai	What locals are catching and what people from outside are catching.		Catch (local) Catch (outsiders)
Mabuiag	Catches by all people (including outsiders) within the community area.	Each community that has control of that area.	Catch (local) Catches (outsiders)
Kubin	Monthly or 3 monthly catch summaries.	Communities, through the rangers.	Catch (local)
Mer	What is caught by charter and foreign boats.		Catch (outsiders)
Ngurupai	The types and amount of kai kai species taken by people from PNG communities.		Catch (outsiders)
Mer	Catch and release data of recreational fishers, including species lost to sharks.		Catch (outsiders)
Saibai	Annual catch of commercial species.	Yourself, Community, AFMA/TSRA	Catch (personal) Catch (local) Catch (regional)

COMMUNITY	OUTPUTS/FEATURE	ACCESS	CATEGORY
Poruma	Annual reports of catch.	Yourself, community members. Total annual catch to regional agencies.	Catch (personal) Catch (local) Catch (regional)
Badu	Annual catch summaries.	The fisher and communities	Catch (personal) Catch (local)
Saibai	Fine scale record of catches.	Yourself only	Catch (personal)
Erub	Quantity and size of catch.	Everyone	Catch (personal)
Erub	When catch the most.	Everyone	Catch (personal)
Poruma	How many fish you caught.	Yourself and community	Catch (personal) Catch (local)
Mer	Quantity and size of fish.	Depends on information	Catch (personal) Size
Mer	Catch data – individual, regional.	All islanders	Catch (personal) Catch (regional)
Kubin	What you use, and what the community uses.	Community members	Catch (personal) Catch (local)
Boigu	Catch data.	Families	Catch (personal)
Boigu	Seasonal catch information.	Individuals and Communities	Catch (personal) Catch (local)
Saibai	Quantity and size.		Catch (personal) Size
Ngurupai	Which species are important to different communities across the region.		Catch (regional)
NPA2	Information from other communities and islands especially given people in NPA have strong linkages and travel regularly between NPA and islands in TSI.		Catch (regional)
NPA2	Catches from 'zones' or clusters.		Catch (regional)
Iama	Cluster level catch information.	Clusters.	Catch (regional)
Iama	Torres Strait wide information.	All levels.	Catch (regional)
Saibai	Destination (family kai kai, community, barter, ceremony, send down south). How shared?	Yourself, community.	Catch destination
Poruma	Destination of catch (family, community, send down south).	Everyone (Summary)	Catch destination
Erub	Cultural information.	Tightly controlled	Cultural info
Poruma	Language name of local species.	Everyone	Cultural info
Mer	Some species, such as queenfish and barracuda have different names for fish of different sizes of the same species. This will be important to differentiate in any app.		Cultural info

COMMUNITY	OUTPUTS/FEATURE	ACCESS	CATEGORY
Mer	One app idea was to include voice recording so fishers can voice record their catch and hear language names pronounced correctly.		Cultural info
Warraber	Cultural information.	Warraber community	Cultural info
Warraber	Use island or cultural fish names.		Cultural info
NPA2	Language information would also be important and useful. The Injinoo Ikya is one of three 3 languages that TOs have decided to use as a common language in the region.		Cultural info
Erub	Environmental changes. E.g. Loss of sea grass along foreshore caused by runoff; changes to populations from climate change.	Everyone	Environmental information
Poruma	Environmental information.	Everyone	Environmental information
Mabuiag	Environmental changes (seagrass and coral). Information going both ways.	The fisher and communities	Environmental information
Boigu	Climate change information.	Everyone	Environmental information
Saibai	Who is catching? Especially outside.		Fisher groups
Saibai	Recreational catches in community area.	Everyone.	Fisher groups
Erub	A question raised was how the log-in system was going to work. As an individual? Security will be important (like the languages apps that are being developed).		Individual login
Saibai	Fishery management information (local and regional).	Everyone	Management (local) Management (regional)
Poruma	Local regulations (Poruma community).	Everyone – so they know	Management (local)
Poruma	Spatial management, Poruma, Kulkalgal.	Everyone – so they know	Management (local)
Poruma	GPS location and associated rules of that place.	Everyone	Management (local)
Badu	Local rules.	The fisher and communities	Management (local)
Kubin	Local and Torres Strait wide rules.	Everyone	Management (local) Management (regional)
Mabuiag	Local information should be made available to fisher when they are in that area: breeding areas, local rules, seasonal calendar, local safety regulations etc.	Everyone	Management (local) Spatial info

COMMUNITY	OUTPUTS/FEATURE	ACCESS	CATEGORY
Boigu	Closures and local management information.	Everyone	Management (local)
Iama	Local rules, like using nets at certain times.	Community members, especially young people.	Management (local)
Erub	For Pakor (Coral Trout), information on size limits would be useful so they can be left to grow to proper size.		Management (regional) Biology
Erub	Other closures (other communities, regions).	Everyone	Management (regional)
Poruma	Information about regulations (Torres Strait wide).	Everyone	Management (regional)
Poruma	Rules for fishing in other places.	Everyone	Management (regional)
Poruma	Rules for other species not caught at Poruma.	Everyone	Management (regional)
Mer	Interactions/differences with other regions.		Management (regional)
Mer	Size/catch limits for recreational fishing.		Management (regional)
Warraber	Information to inform the commercial sector management.	Other communities in the cluster	Management (regional)
Boigu	First aid information.	Everyone	Other info
Erub	How to process catch.	Everyone	Processing info
Poruma	Shark depredation sometimes a problem. Need to consider including this in any monitoring app.		Shark depredation
Kubin	GPS location and associated rules of that place.	Everyone	Spatial info
NPA1	We have responsibility for land and sea - would be good to show on a map.		Spatial info
Saibai	Location.	Yourself, Community, AFMA/TSRA	Spatial info
Erub	Where caught.	Specific to you; general areas to everyone	Spatial info
Erub	Species identification and size from photo.	Everyone	Species ID
Poruma	Fish species identification.	Everyone (but local language for community especially)	Species ID
Ugar	Have an app where you just take a photo and the app does the rest; e.g. measures, quantity, identity.		Species ID
Mer	Ability to ask priority questions.		Submit queries

COMMUNITY	OUTPUTS/FEATURE	ACCESS	CATEGORY
Iama	A way to record any concerns you have within the app.	Everyone.	Submit queries
Saibai	Tidal information.	Everyone	Weather/tides
Saibai	Weather.	Everyone	Weather/tides
Erub	Being able to access tidal, moon charts and fish biting times would be very beneficial as well as personal catch data.		Weather/tides
Erub	Weather and tides, lunar.	Everyone	Weather/tides
Mer	Weather, tides.	Schools	Weather/tides
NPA2	Access to seasonal weather patterns, tides, locations and other environmental factors.		Weather/tides Environmental information

Appendix K. Barriers to app implementation

Compiled individual comments from community consultation workshop attendees regarding barriers to app implementation.

COMMUNITY	BARRIERS	SOLUTIONS	CATEGORY
NPA1	People might not understand the benefits.		Don't see benefits
Saibai	Fear of penalty for doing something wrong.	Education, awareness	Fear of prosecution
Erub	Fear of penalty for doing something wrong.	Education, awareness, protect people from getting into trouble	Fear of prosecution
Poruma	Fear of information being used to stop them fishing.	Awareness, education campaign. Demonstrate security	Fear of prosecution
Mer	Shame.		Fear of prosecution
Ugar	Introducing new regulations (e.g. size limits) along with this?		Fear of prosecution
Ngurupai	People talked about fear of data collection and that this may be used against people.		Fear of prosecution
NPA2	Fear of people being identified		Fear of prosecution
NPA2	An APP program it might be seen as the government coming to stop us doing what we want.		Fear of prosecution
NPA2	People doing the wrong thing are unlikely to report catches.		Fear of prosecution
NPA2	Some specific family groups (eg 2-3 families) might also not use the APP in this region (out of fear or unless they saw a benefit).		Fear of prosecution
Badu	If someone over-catches they won't use the app, for fear of consequences.		Fear of prosecution
Kubin	People are frightened of being restricted.	Needs promotion, like on social media.	Fear of prosecution
Iama	What happens if there is undersized catch? Will AFMA growl us for undersize?	Explain to fishers that there are no minimum legal size for traditional fishing.	Fear of prosecution
Iama	If you give information away it attracts attention.		Fear of prosecution
Erub	Information use (other people using your information).	Security, passwords, confidence/trusted custodian	IP loss

COMMUNITY	BARRIERS	SOLUTIONS	CATEGORY
Erub	Un-Trusted data custodian.	Link with Rangers program. Extension of turtle and dugong program. Make it part of their duties	IP loss
Mer	Greed.	Education	IP loss
Ugar	Trust. Since this comes from the outside.	The issue needs to be well explained for it to be accepted as it is a sensitive and complex topic	IP loss
NPA2	People don't want to report their location or Traditional Knowledge of good fishing locations or their catches especially if taking too much fish to sell – fear of people being identified.		IP loss/ Fear of prosecution
NPA2	People don't want to report their location or Traditional Knowledge of good fishing locations.		IP loss
Kubin	Some people will be unhappy seeing what others are fishing.	Peoples' catches will not be open for everyone to see.	IP loss
Iama	Information and knowledge is private and people don't want to share it. Like Traditional Knowledge.	Need to convince people to share it and that it will be protected.	IP loss
Poruma	Slack, lazy.	Awareness, education, campaign, positive examples	Lack of interest
Mer	Laziness/lethargy.	Feedback of information	Lack of interest
NPA2	NPA region there has been less participation in PZJA consultative committees over the years.		Lack of interest
Badu	Small mindedness in people will generally be a problem.	Need education and awareness to get over this.	Lack of interest
Badu	Biggest barrier will be lack of interest.	Behaviour change program.	Lack of interest
Iama	People will not use it.		Lack of interest
NPA1	Not everyone has a smart phone.		Lack of phone
Saibai	Not everyone has a device.	Having a phone supplied and credit	Lack of phone

COMMUNITY	BARRIERS	SOLUTIONS	CATEGORY
Erub	Not everyone has a device.	A device that only has the app on it, that might be available for community members use would increase participation.	Lack of phone
Poruma	Don't have phone.	Nominate other family members	Lack of phone
Mer	Accessibility (all phone types).		Lack of phone
Mer	No access to phone.	Community phone that can be used by individuals	Lack of phone
Warraber	Some don't have access to smart phones.		Lack of phone
Mabuiag	Cost of phone data may be a problem for some people.	Make sure you have an off-line version	Lack of phone
Ngurupai	Participants wondered if people would report their catches accurately or be honest in their catch numbers.		Other
NPA1	Lack of signal or black spots.	Upgrade network. Make app work offline. Like iTracker remains pending until in signal.	Phone signal
NPA1	Unable to upload immediately might deter people from using.	Educate/awareness	Phone signal
Saibai	Poor phone signal.		Phone signal
Poruma	Poor phone signal.		Phone signal
Mer	Some fishing spots have no mobile signal.		Phone signal
NPA1	To complicated.	Make flexible/easy to use.	To complicated
Saibai	Technology, especially older people.	Education, awareness, ease of use.	To complicated
Erub	Technology, especially older people.	Education, awareness	To complicated
Erub	App design.	The app must be simple to use	To complicated
Poruma	Elderly people.	Make family members able to log in for elderly	To complicated
Warraber	Folk not good at using smart phones.	Education	To complicated
Warraber	Folk won't understand the app.	Education	To complicated
NPA2	Older people less likely to use the app.		To complicated
Saibai	Young children unlikely to use the app.	Include in a school program. Benefits include cultural learning and responsibility.	To young

COMMUNITY	BARRIERS	SOLUTIONS	CATEGORY
Erub	Young children unlikely to use the app.	Include in a school program. Benefits include cultural learning and responsibility	To young
Mer	Young children unlikely to use the app.	Include in a school program. Benefits include cultural learning and responsibility.	To young

Appendix L. Incentives for app implementation

Compiled individual comments from community consultation workshop attendees regarding incentives for an app implementation.

COMMUNITY	INCENTIVES	SOLUTIONS	CATEGORY
NPA1	Free app.		Free
Warraber	Free app.		Free
Ngurupai	Involve school kids in any program as they go fishing with mums and dads.		Involve children
Iama	Get the school children involved.		Involve children
Ngurupai	Incentives, (e.g. phone credit) especially for young people but all people are important, as is marketing and communications will be important in supporting people to use the app.		Marketing Merch/prizes
Ngurupai	Drawing on previous research projects in health sector where small incentives like hats, towels, footballs.		Merch/prizes
Ngurupai	Rewards may also be part of a program.		Merch/prizes
Badu	Small payment for each data entry. Like cash for containers scheme.	Implement in program.	Merch/prizes
Badu	Raffle prizes. Things like a new GPS could also be a good incentive.	Implement in program.	Merch/prizes
Kubin	Entice with competitions.	Implement in program.	Merch/prizes
Mabuiag	Some reward system would be good.	Make interactive (ability to reward with likes, praise). Ask people what they would like.	Merch/prizes
Warraber	Phone signal is ubiquitous		Other
Ngurupai	There was discussion about potential option of a permit system, if you register to fish for kai kai this could also include a commitment to record your catch.		Regulation
NPA1	Awareness and education of not sustaining our fisheries for the future.	Educate young people and they can educate the home.	Responsible stewardship
Poruma	Respect for place.	Messages that support local custodianship. Local branding.	Responsible stewardship

COMMUNITY	INCENTIVES	SOLUTIONS	CATEGORY
Mer	As it will help preserve knowledge.	Feedback of information	Responsible stewardship
Mer	If it's making a difference.		Responsible stewardship
Mer	Provides awareness and education.	Education	Responsible stewardship
Ngurupai	Monitoring traditional catches and local fisheries is an important issue now with new native title sea rights and responsibilities to manage.		Responsible stewardship
NPA2	Promoting stewardship of the environment and fisheries.	Education campaigns	Responsible stewardship
Kubin	Promote as local management.	Education and promotion campaign.	Responsible stewardship
Mabuiag	Information about how the data will be used in assessments e.g. TRL.	Get summaries from PZJA.	Responsible stewardship
Iama	Everyone must understand the concept. Education important.	Education campaign.	Responsible stewardship/ Marketing
NPA1	Make it simple to use		Simplicity
Saibai	Seeing others use it.		Socialising
Erub	Seeing others use it.	Make sure you have some local people trained. Local champions.	Socialising
Erub	Show-off catches to friends and family.	Include ability to share catches. Like social media.	Socialising
Poruma	Seeing the app being used by others.	Support core user group in community.	Socialising
Mer	Seeing other Traditional Inhabitants use it.		Socialising
Mer	Seeing recreational fishers and others using it		Socialising
Ngurupai	Young people use social media to brag about their large catches of kai kai fish – a sign of pride too.		Socialising
Badu	Pictures. Ability to be able to show off catches and responsible behaviour. People love to take pictures.	Implement in app.	Socialising
Kubin	Include photos and video, like on social media.	Implement in app.	Socialising
Boigu	Use social media drive to get people to use the app.		Socialising

COMMUNITY	INCENTIVES	SOLUTIONS	CATEGORY
Erub	Trusted data custodian.	Link with Rangers program. Extension of turtle and dugong program. Make it part of their duties	Trust
Saibai	Record of catches e.g. location.	Provide capability in app	Useful information
Saibai	Species identification and size from photo.	Include photo ID and measurement capability in app	Useful information
Erub	If they can see benefits, then others will participate.	Demonstrate and communicate benefits	Useful information/ Socialising
Erub	Information use/ Useful feedback/ access to cultural knowledge/ biological knowledge.	Security, passwords, confidence/trusted custodian systems required.	Useful information
Erub	Record of catches e.g. location.		Useful information
Mer	For it to be relatable information, e.g. language.		Useful information
Mer	Species identification and size from photo.	Include photo ID and measurement capability	Useful information
Ugar	Clarify/emphasise any contributions this will make to economic development.		Useful information
Warraber	Access to useful information about fish.	Provide information about species life histories and vulnerabilities (e.g. octopus fecundity)	Useful information
Warraber	An app could be a whole-of-management tool – survey, engagement, information.		Useful information
Warraber	Better information about levels of fishing in the area.		Useful information
Warraber	Better than learning about what people catch from Instagram posts.		Useful information
Warraber	People can see how fish are being used (e.g. cultural events).	Allow access to what outsiders are taking to avoid overfishing	Useful information
Warraber	Widespread knowledge about the program, its function and benefits.		Useful information/ Socialising
Ngurupai	Being able to see all catches or individual catches or by cluster regions, because different species are available in different regions.		Useful information

Appendix M. Who should/could run the app

Compiled individual comments from community consultation workshop attendees regarding who should/could run the app.

COMMUNITY	CUSTODIAN COMMENT	COMMENT CATEGORY
NPA1	Community owned and developed best.	Community
NPA1	IK (local organisation) will hold the data and store the data.	Community
Mabuiag	Need to identify a community body to take and use the data.	Community
Boigu	Local community corporation to take and use the data.	Community
Ngurupai	It was an important question about who is going to take ownership of the APP and reporting.	No suggestion
Badu	Probably not the PBC holding the data, nor the rangers. The rangers could be good for supporting it though.	New
Boigu	There should be a new organisation to collect the data – for all Zendath Kez.	New
Iama	Should be owned by our people, not government.	Not government
Ngurupai	Trusted sources – PBC.	PBC
Mer	Trusted data custodian. Link with Rangers program. Extension of turtle and dugong program. Make it part of their duties.	Rangers
Ngurupai	The ranger program can play a role in any monitoring activities.	Rangers