
Final Report

Torres Strait Regional Authority Project CA 2017-00046

Development of a Bait Fishing Industry in the Torres Strait

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Executive Summary

The development of a bait industry as part of the Torres Strait Finfish Fishery (TSFF) was identified in the Torres Strait Finfish Action Plan and subsequently a scoping study was commissioned by the Torres Strait Regional Authority (TSRA). This study examined current bait supply and demand in the finfish fishery and assessed the feasibility of developing a Torres Strait bait industry.

This was done using a combination of on- and off-site methods, including desktop analyses, community meetings and site inspections on Mer, Warraber, Masig and Erub islands. Traditional Inhabitant Boat (TIB) fishers, non-traditional inhabitant licence lessees (NTI), prawn-trawl operators and fisheries suppliers and wholesalers were surveyed regarding bait use and supply in the region. Community perceptions and concerns were also evaluated.

It was estimated that the current annual total bait use in the TSFF is around 6 tonnes of garfish and 21 tonnes of sardine, with an estimated total wholesale value of \$120,000 per annum. These levels of bait use are substantially less than those estimated for traditional food harvests. For example, it was estimated that the annual traditional food harvest included 40 tonnes of garfish on Warraber Island, and 20 tonnes of sardines on Mer Island.

Most TIB fishers catch (at very little expense) their own bait for subsequent use. Sardine and garfish are readily available and accessed around island foreshores. No specialised bait fishers or suppliers were identified and there appears to be little within- or among-island demand for the purchase of bait among TIB fishers. It was noted, however, that bait species are regularly traded among traditional communities for food and ceremonial purposes. The bait used by the NTI fishers was supplied from sources in north-east Queensland, with very little being obtained from within the Torres Strait. NTI fishers expressed interest in purchasing bait from Torres Strait suppliers if supply and quality was guaranteed and it proved cost-effective. There was common acknowledgement that prawn-trawl bycatch could be utilised by traditional communities and NTI fishers if available. The IBIS organisation expressed interest in attaining locally caught bait product for resale throughout its chain of stores.

The communities on Warraber and Masig islands supported development of garfish-based bait fisheries, but with different approaches. The Warraber community proposed a line-only community-based fishery where all members could contribute product to a central facility for on-selling. In contrast, the Masig community sought a more entrepreneurial-orientated bait fishery that supplemented existing businesses or new stand-alone businesses. There was no support for developing a bait fishery on Mer Island and no consensus could be made for Erub Island.

All communities voiced strong concerns about the potential impacts of expanded bait harvests on traditional food resources and associated ecological/cultural interactions. Future bait fishery development must be precautionary and adhere to community expectations. This is particularly important as there is a shortage of biological and ecological information on the garfish and sardine species harvested in the Torres Strait to develop quantitative stock assessments.

All communities acknowledged that bait fishery development could provide greater employment and economic opportunities to traditional inhabitants. The supply of bait to fulfil current local markets (< 10 tonnes garfish, < 25 tonnes sardine per annum) would only support small-scale business and employment opportunities and initially most likely best supplement existing fishery businesses. Initial investments in bait fishery development would need to be minimal to ensure economic viability. Notably, infrastructure investments would be synergistic across fisheries and the current infrastructure and services audit project would guide appropriate investments across the Torres Strait. Small-scale bait fishery development at the scales identified should have negligible impact on stock sustainability.

The longer-term development of an economically viable and sustainable commercial bait industry that would support fishery growth and employment throughout the Torres Strait is dependent on securing external markets for bait (and potentially food). Substantial improvements in fishery support infrastructure, training and mentoring schemes will be required. Only then can the essential investment, business and cultural decisions concerning commercial bait industry development, viability and sustainability be made.

In conclusion, this project identified opportunities for the development of a bait industry as part of the Torres Strait Finfish Fishery, particularly for garfish. Garfish appear to be readily available and abundant throughout the Torres Strait to initially support small-scale fishery development to supply local markets. This would be an important first step in developing a broader bait industry throughout the Torres Strait, which in the long-term could render significant employment and economic benefits to traditional inhabitants and communities.

Key Recommendations:

Business and Markets

Short-term:

- Prospective individuals and communities engage with management to initiate steps for a small-scale garfish fishery to supply local markets,
- Implement quality control standards for a bait fishery,
- Investigate the market potential to develop a food-grade fishery for garfish,

Long-term:

- Develop and secure external markets for Torres Strait bait product in Australia and Asia.

Methods and Training

Short-term:

- Source and test appropriate fishing gears and practices for sustainable harvesting of bait species,

Long-term:

- Identify and implement training and mentoring programmes for fishing, processing and business practices for bait fishers.

Data collection

Short-term:

- Implement a simple system to monitor bait fishing activities and catches,
- Undertake a snapshot study to determine key demographic parameters (length-at-age, growth, size/age at maturity, spawning period, spawning mode) of each bait species,

Long-term:

- Introduce an appropriate on-going monitoring and assessment strategy concordant with fishery expansion.

1. Background

The Torres Strait Regional Authority (TSRA) is an Australian Government statutory authority charged with strengthening the economic, social and cultural development of the Traditional Inhabitants of the Torres Strait. The TSRA's Fisheries Programme initiates actions and activities to advance successful commercial activities for Torres Strait Islanders and Aboriginal people within the fishing industry.

The development of a bait industry in the Torres Strait could enable more efficient and cost-effective access to bait supplies for commercial and recreational fishing, potentially facilitating increased employment and income in the Torres Strait region.

In the Torres Strait, bait species, including garfish, sardines and herring, are reportedly caught in large numbers using basic line and net fishing methods from or near the shoreline. Populations of such species are generally resilient to reasonable levels of fishing mortality and, if abundant in the Torres Strait, could supply not only local needs but also markets on mainland Australia. However, any development and operation of a formal bait industry must be sustainable and appropriate from a biological, ecological, financial and social/cultural perspective. But very little is known about the bait species and associated fisheries currently occurring in the Torres Strait. The development of a sustainable, commercial bait industry was identified in the Torres Strait Finfish Action Plan (Cobalt MRM 2016), leading to this current scoping study.

2. Torres Strait Finfish Fishery and Bait Harvesting Overview

2.1. Finfish Fishery

The Torres Strait Finfish Fishery is 100 per cent owned by the Traditional Inhabitants of the region. The fishery is managed under the *Torres Strait Fisheries Act 1984* and the Torres Strait Finfish Fishery Management Plan was finalized in 2013. has a licenced traditional inhabitant commercial boat sector (TIB) that provides open access to all traditional inhabitants living in the region. This includes an open access subsistence sector. The TSRA also leases access to the fishery through temporary (sunset) licences to non-traditional inhabitant fishers (NTI). This is done to generate income to invest in developing the TIB sector and keep markets open for Torres Strait finfish products (TSRA 2013).

The TSFF can be split into two broad components: (1) the Torres Strait Spanish Mackerel Fishery (TSSMF) and (2) the Torres Strait Finfish (Reef Line) Fishery (TSFRLF). Narrow-banded Spanish mackerel (*Scomberomorus commerson*) is targeted primarily by trolling lines with baited hooks or lures (Begg et al. 2006). Byproduct, mostly comprised of other mackerel species, is a minor component of the catch. The reef-line sector mostly targets four demersal species of coral trout, red emperor and barramundi cod using lines with baited hooks, with up to 50 by-product species (Williams et al. 2007, 2008). The traditional subsistence sector uses a variety of gears including nets, traps and spears to target a variety of fish species (Busilacchi et al. 2012, 2013).

Traditional inhabitants mostly fish from small (< 6 m) dories with limited holding capacity and generally return their catch to their port of origin and/or island community freezer facilities on a daily basis. In recent years, some TIB primary vessel-style operations have also accessed the fishery. The NTI fishers primarily operate small tender dories out of larger (10-20 m) primary vessels that have freezer capabilities allowing them to store product and stay at sea for extended periods (Williams et al. 2011). The mackerel catch is primarily processed into fillets that supply the Queensland fish and chip market, whereas processed reef fish also serve the export market.

The TSFF is primarily based out of the four north-eastern islands of Mer (Murray), Erub (Darnley), Ugar (Stephen) and Masig (Yorke) Islands (Williams et al. 2007). This is primarily due to the localised abundance of suitable fish habitat in the east. Anecdotally, Ugar TIB fishers primarily target mackerel, Erub fishers target both mackerel and coral trout, and Mer fishers primarily target coral trout. NTI fishers are excluded from fishing with 10 nm of each of the 4 main islands, but due to their ability to remain at sea, NTI fishers generally fish broader regions than the TIB fishers. There is also weather-related temporal partitioning of reef-line fishing between the TIB and NTI fishers (Williams et al. 2008). Much of the mackerel catch is seasonal (spring-summer), targeting spawning aggregations occurring in the waters surrounding Bramble Cay and Black Rock (Begg et al. 2006).

In terms of numbers of TIB fishers, there were 210 mackerel endorsed licences and 194 reef-line endorsed licences in 2014/15 (ABARES 2016). In comparison, there were 5 mackerel and 2 reef-line NTI permits during the same period. However, numbers of TIB fishers fluctuate from year to year, and do not necessarily reflect participation levels in the commercial fishery. The annual leasing of NTI licences is undertaken through an open Expression of Interest, through which applicants tender for the amount of catch entitlement they wish to lease and a proposed price per kilo. In recent years, there has generally been 4 of these lessees for mackerel and 3 lessees for coral trout. The TIB sector has priority access to the fishery; only unused capacity is made available for lease to NTI fishers.

Catch reporting is not mandatory for TIB fishers, therefore the number of active fishers, fishing effort and total harvests are uncertain. In contrast, NTI fishers are mandated to report catches and fishing effort via compulsory logbooks. There is a voluntary docket book system that could be used to help estimate TIB catches and fishing effort (Williams et al. 2008). The combined catch across both sectors in 2014/15 was estimated to be 84 and 18 tonnes for mackerel and coral trout, respectively (ABARES 2016). Busilacchi (2008) reported that the Islander subsistence catch was similar in quantity to the combined TIB and NTI sectors, but the actual catch composition differed and did not include large quantities of mackerel and coral trout (Busilacchi et al. 2013). In 2014/15, fishing effort by NTI fishers was reported to be 394 operational days and 721 tender days for the mackerel fishery, and 157 fishing days for the reef-line fishery (ABARES 2016).

As documented in the Torres Strait Finfish Action Plan (Cobalt MRM 2016), freezers are important items to support fisheries development in the region. Currently, the community freezer at Erub Island is the only operational community freezer servicing the eastern islands. Mer, Ugar and Masig islands also have community freezer facilities, however these have not been operational for a number of years. There are a few private freezers

elsewhere throughout the Torres Strait that support fisheries, notably on Iama, Poruma, Badu, Warraber and Mer Islands. The Erub community freezer currently carries a small amount of bait to supply local TIB fishers, but they have expressed a desire to increase supplies for more widespread trade with other TIB and NTI fishers.

2.2. Bait Fishery

Bait fishing in the Torres Strait is managed as part of the TSFF. Mackerel and reef-line TIB fishers are permitted to collect bait using a bait net, namely: (1) a cast net not more than 6 m in diameter and having a mesh size of not more than 28 mm, and (2) a mesh or seine net not more than 400 m in length and having a mesh size of at least 12 mm but not more than 45 mm (Torres Strait Fisheries Management Instrument No. 8). They are also allowed to harvest bait by line fishing. Importantly, mackerel TIB fishers can only collect bait for their own use, whereas reef-line endorsed TIB fishers are permitted to on-sell bait product. Although it is generally presumed that the majority of TIB fishers collect their own bait, it is unknown whether there are specialised bait fishers who on-sell or trade their product with other fishers. In general, there is currently a dearth of information concerning bait usage, supply- and demand-lines, the costs associated with catching, processing and storing bait, and the value and sale prices of bait throughout the Torres Strait. Current information on bait prices is limited to bait sold in the local supermarket (IBIS) and convenience stores/service stations (e.g. SeaHops). These sales are primarily aimed at recreational/traditional fishers and product is sourced from mainland suppliers.

The species composition, harvest levels (in numbers or weights) and usage of bait in the Torres Strait have not been quantified and there are no mandatory or voluntary methods currently engaged to collect such information. Nevertheless, the principal bait species identified are garfish for the mackerel fishery, and hardy head and herring (collectively locally known as sardines) for the demersal reef line-fish sector. Squid and other by-product from prawn trawlers that are based at Masig Island may potentially be used as supplementary bait by TIB reef-line fishers. It is also assumed that the by-product from bait collection is utilised by the traditional fishers. NTI fishers bring bait (e.g. garfish, sardine, pilchard) from mainland (e.g. Cairns, Innisfail) suppliers, and some supplement their bait supply by harvesting additional bait in-situ.

It is understood that the eastern islands of Ugar, Erub and Mer have large numbers of sardine and herring present year-round that supply local TIB fishers and communities. The distribution and harvest locations of garfish are not defined, but Warraber Island is renowned for large quantities of garfish that appear to be available throughout the year. Because of their association with aquatic vegetation (seagrass), there are likely to be other areas where garfish are quite prolific throughout the Torres Strait. Notably, at least 10 species of garfish have been recorded in the Torres Strait and/or adjacent waters (Collette 1974, FishBase accessed May 2017), and thus several species are probably captured as part of the current subsistence fishery.

As mentioned above, it is unknown how many fishers currently target these bait stocks, the quantities harvested nor their overall value. There have been no biological or fisheries-related studies on local stocks of baitfish in the region and a previous observer and research logbook program in the reef-line fishery did not include recording data about bait catch and

usage (Williams et al. 2008). It is known, however, that garfish and sardine are an important component of the traditional subsistence fish catch (Busilacchi 2008).

An identified priority for TIB fishers for finfish fishery development (Torres Strait Finfish Action Plan, Cobalt MRM 2016), is whether the harvesting of garfish stocks could be expanded to potentially form the basis of a sustainable commercial bait industry to supply not only local TIB and visiting NTI fishers, but also mainland markets.

Under current management arrangements, the development of a bait fishery is restricted to TIB fishers operating east of the Western Closure Line. The Protected Zone Joint Authority (PZJA) has raised the potential removal of the Western Closure Line within the Torres Strait Finfish Working Group, which could potentially allow for the development of a broader bait fishery in the inner, western and top western islands of the Torres Strait.

3. Project Terms of Reference

1. Undertake a review of the current bait supply in the Torres Strait and assess the feasibility of a Torres Strait bait fishery. The overarching objectives of the project must align with the objectives of the Fisheries Programme which are:

- improved wealth of Indigenous people in the region
- a sustainable fishing industry owned and operated by Indigenous people
- sustainable management of natural resources.

The outcomes of the project should aim to:

- increase Traditional Inhabitant participation in the fishery
- increase Torres Strait Islander and Indigenous employment in fishing and related industries
- advance successful commercial activities in the finfish fishery
- ensure the sustainability of any proposed bait fishing industry.

2. Conduct an audit of current bait supply and collection in the Torres Strait, including

- increase Traditional Inhabitant participation in the fishery
- currently utilised and potential bait species for the Torres Strait Finfish Fishery
- current bait access costs to fishers (financial and/or time), and
- avenues for supply of bait across the region.

3. Complete a review of operations of other bait industries in Australia, including:

- fishing methods
- processing operations, and
- distribution strategies.

4. Provide recommendations on the feasibility and potential business models for the development of a bait industry in the Torres Strait; recommendations should take ecological sustainability into account.

5. Recommend a precautionary management strategy to ensure harvest levels are sustainable.

4. Project Data Requirements and Acquisition

This scoping study required quantitative and qualitative information on social, economic and biological aspects of current bait use, fisheries dynamics and associated support systems in the TSFF for the purpose of assessing future directions regarding the development of a bait industry in the region. Specifically, the operational scale of the current bait fishery and associated support systems, supply and demand lines, and costs need to be understood in order to identify any logistic and economic constraints and the needs for expansion of the fishery. Biological and ecological aspects of the fishery require assessment, including the current composition, quantities and sizes of bait harvested, fishing gears and habitats fished, and how these vary among individual fishers/operations, among islands and throughout time. Moreover, the perspectives and future aspirations of each community with regards to a bait industry need to be considered in a cultural and economic context.

In consultation with the TSRA, it was determined that the focus of data collection for this project would be on key eastern islands where the TSFF is most concentrated and TIB and NTI fishing activity is the greatest.

To obtain relevant information, we used a combination of: (1) site visits that included community meetings, in-situ discussions with TIB, other commercial fishers and key community members, the inspection of fishing operations and catches to identify species and fisheries-related infrastructures (such as freezers, processing and transport systems); and (2) off-site phone interviews with NTI lessees, prawn trawl operators and wholesale fish suppliers. At these meetings, interviews and inspections, we obtained information concerning current bait use and supply, fishing and business operations and capacities, ecological impacts, and fisher and community perspectives regarding future bait fisheries in the TSFF. Such information was required so that appropriate and suitable levels of fishery development, operations, business models, and management and monitoring plans can be developed.

4.1. Focus Islands

In agreement with the TSRA, the focus islands for data collection were: Erub (Darnley), Mer (Murray), Warraber (Sue) and Masig (Yorke) islands.

Erub Island was considered essential as it has an operational community freezer and the community had previously expressed interest to the TSRA in developing a bait industry (Cobalt MRM 2016). This island has both TIB mackerel and reef-line fishers and is an important link with transient NTI fishers.

Mer Island was also considered highly relevant as the TIB fishers currently use local sardine for bait in their reef-line fishing activities. Moreover, sardine is a 'totemic' species of great cultural significance and an important food resource for the traditional inhabitants (Busilacchi 2008).

It was determined it would also be profitable to visit Warraber Island, where the supply and harvesting of garfish was thought to be plentiful. Although Warraber has no commercial

finfish fishery, there reportedly has been discussions concerning Warraber Island supplying garfish to Erub Island as bait.

It was also considered important to visit Masig Island to gain a better understanding of current and potential utilisation of prawn trawl by-product as bait, and to assess the level of community interest in participating in such a business activity.

4.2. Site Visits and Community Meetings

Community meetings that were previously advertised were held on the four islands; Erub, Mer, Warraber and Masig. Two TSRA staff (John Mathews and Charles David) and one consultant (Charles Gray) attended each meeting. TSRA staff arranged all aspects of these visits including meeting schedules, travel and accommodation itineraries. Each meeting included a brief overview of the project, including its origin, aims and the information being sought from community members to help achieve its outcomes. Informal discussions concerning the project and any other fisheries-related issues were also held with interested persons. Either before or after each meeting, we did inspections of fisheries-associated infrastructure and facilities such as freezers, product processing and storage areas, boats and port facilities. Where possible, local bait species were also caught for identification.

The schedule of the site visits was:

Mer Island: Monday 28 August, 2017

Warraber Island: Tuesday 29 August, 2017

Masig Island: Wednesday 30 August, 2017

Erub Island: Thursday 31 August, 2017

The number of attendees at each community meeting was:

Mer Island: 7 persons

Warraber Island: > 20 persons

Masig Island: 5 persons

Erub Island: nil

4.3. Non-traditional Inhabitant Licence Lessee Fishers (NTI) and Bait Suppliers

Six of the seven 2017/18 NTI lessees were contacted and information sought about their fishing activity (in terms of trips, effort, catch), bait use (species, quantities, costs), supply lines and bait-relevant interactions with traditional inhabitants. Two prawn trawl operators were contacted and surveyed regarding current and potential utilisation of by-product and discard species by traditional inhabitants and any associated management implications of such use. The names and contact details of the NTI lessees and prawn trawl operators were provided by the TSRA. Wholesale bait suppliers in north Queensland were contacted and surveyed regarding current and potential bait supplies to and from the Torres Strait. The Islanders Board of Industry and Service (IBIS) was also contacted to assess potential cold chain distribution and retailing systems that could be used within a Torres Strait bait fishery.

5. Report on the Project's Terms of Reference

5.1. Determination of Current Bait Use, Collection and Supply in the Torres Strait Finfish Fishery

5.1.1. Traditional Inhabitant Boat (TIB) Bait Use

Based on information supplied at the community meetings, it was estimated that 0.5-1.2 tonnes of gold-spot herring (*Herklotsichthys quadrimaculatus*) (locally known as 'ari ari' sardine) are harvested per annum by TIB fishers for use in the commercial finfish fishery on Mer island. These fishers target coral trout.

Equivalent data were not able to be obtained for the other 3 islands. No TIB commercial finfish fishery exists on either Warraber or Masig islands, and at the community meetings on each of these islands, there was no knowledge of any on-going bait collection for supply to TIB fishers located on other islands or to visiting NTI fishers.

No persons attended the meeting on Erub Island, despite the island having both mackerel and reef-line TIB fishers. Nevertheless, bait harvesting and subsequent use in the commercial TIB fishery is expected to be significant on Erub. Members from this island have previously expressed to the TSRA their desire to develop a bait fishery on the island to serve TIB and NTI fishers. Notably, the Erub Fisheries Management Association purchased 1 tonne of garfish from a Cairns wholesaler to sell to local TIB fishers (some of this product was observed in the community freezer facility during the site visit). It was further reported that some TIB fishers purchase garfish for use as bait from the local IBIS store. These observed and anecdotal reports highlight a potential market for bait on this island.

5.1.2. Traditional Use of Bait Species

On Mer Island, it was determined at the community meeting that between 5-20 tonnes of sardine were harvested for traditional use (primarily for human consumption) per annum. This corresponds well to a previous study that estimated the traditional take of sardine on Mer as 20 tonnes per annum (Busilacchi 2008).

It was estimated that around 40 tonnes of garfish (identified species: short-nose garfish, *Hyporhamphus quoyi*) are harvested per annum for human consumption by traditional inhabitants on Warraber Island.

No information was supplied concerning levels of harvesting of 'bait' species for traditional personal use, including human consumption, for either Masig or Erub Islands. Nevertheless, it was noted at the community meeting on Masig Island that garfish (spotted gar - *Hemirhamphus far*, and at least one other species) are abundant around the island and on several adjacent reefs/islands and that some (unquantified) previous harvesting of these species using purse-seine like nets has occurred. One meeting attendee noted that some 'bait' species are collected on the fringing reef for human consumption. Similarly, whilst visiting Erub Island it was noted that the island's array of traditional fish traps is used to harvest many species of fish, including bait species such as sardine and garfish. Busilacchi

(2008) reported the annual traditional harvest of fish on Erub included approximately 4.7 tonnes of sardine and 420 kg of garfish, of which 376.3 kg were *H. far*.

5.1.3. Non-Traditional Inhabitant Licence Lessee Fishers (NTI) Bait Use

Based on phone discussions with NTI fishers, it was estimated that the NTI fishers contacted (4 mackerel and 2 reef-line endorsed) use approximately 5 tonnes of garfish and 15 tonnes of sardine per year as bait in the Torres Strait Finfish Fishery. The majority of this bait is sourced from wholesale bait suppliers, and for garfish, from individual commercial fishers in north-east Queensland. NTI fishers generally do not purchase any bait from TIB fishers, nor do they source large quantities of bait *in-situ* from any suppliers in the Torres Strait.

Nevertheless, the current NTI fishers stated they would purchase bait from Torres Strait suppliers under certain conditions; notably if the product was of a guaranteed supply and of equal or better quality and value than current mainland sources. It was noted that NTI fishers could not afford to travel to the Torres Strait and have the bait supply unavailable or of poor quality.

Some NTI mackerel-endorsed fishers catch their own garfish bait (primarily black barred *H. far* and three by two garfish *H. robustus*), mostly from eastern Queensland. At times, these fishers catch garfish using seine-type nets in the Torres Strait to supplement their bait supply locally, but the quantities reportedly captured are low; < 0.25 tonnes in total per annum. Most often this is done opportunistically when an adequate school of garfish is present. Ideally, fishers do not want to spend time searching for garfish.

NTI fishers noted that some species of garfish were more preferred for use as bait, including black-barred (*H. far*) and the three by two garfish (*H. robustus*), and added that the short-nose (*H. quoyi*) and snub-nose garfish (*Arrhamphus sclerolepis*), are not preferred bait species. Consequently, these species command lower market prices than the other garfish. Preferred slot sizes of garfish for bait use in the mackerel fishery were reported to be 150-300mm total length (medium grade).

5.1.4. Bait Utilisation of Prawn Trawl By-product and Discards

Prawn trawl operators acknowledged that some (but very little in quantity) by-product (e.g. squid, octopus, damaged prawn) were obtained by traditional inhabitants on Masig Island (which is used as a base by the prawn trawl fleet). The operators were unable to specify, however, the actual species, quantities and financial transactions involved and whether the product obtained was intended for use as bait or human consumption.

The community meeting on Masig Island failed to resolve these issues, but it was noted that prawn trawl by-product is, on occasion, utilised, and it was suggested that there is potential for greater utilisation of discard species (e.g. herring, pinkies – *Nemipterus* spp.) that could benefit traditional inhabitants, both for food and bait. NTI fishers stated they would also potentially be interested in utilising prawn trawl discards as bait for reef-line fishing, but it depended on species, quality, price and availability.

The trawl operators noted that the current commonwealth prawn trawl fisheries management arrangement bans the landing and sale of 'discard' species. There may be

potential to include certain species (e.g. pinkies) as prawn trawl by-product, which would then allow such species to be utilised by traditional inhabitants and NTI fishers for bait use.

5.1.5. Alternative Bait Species

Both TIB and NTI fishers noted that sardine was not the natural prey for most targeted demersal reef fish (e.g. coral trout), but other small forage species, such as fusiliers (*Caesio* spp. and *Pterocaesio* spp.), were. It was suggested that such species would be ideal bait in the reef-line sector, and that the harvesting of such species could reduce any potential conflicts among traditional inhabitants concerning impacts of increased bait harvesting on supplies of sardine used for human consumption, as fusiliers are not a current food source for traditional inhabitants. Although some fusilier species are harvested as part of the tuna bait fishery in tropical regions of the Pacific (<http://www.fishbase.org/summary/932>), appropriate small-scale fishing gears would need to be developed to catch such species by Torres Strait's Traditional Inhabitants.

It was also suggested on Masig Island that other species, notably octopus and mullet, could be included in the development package of a bait industry. However, no information was provided about either the availability or the quantities of these species currently harvested for bait use or human consumption by the traditional inhabitants.

5.1.6. Bait Supply Lines

The trading and supply of bait among TIB fishers, both within- and among-islands, appears inconsequential as most fishers reportedly catch their own bait. On Mer Island for example, there was no identified within-island trading and supply of bait (sardine), as it is extremely plentiful and readily accessed from the shoreline by the community. Further, there were no reports of bait specialists or bait suppliers. The general lack of community (and private) freezer facilities would limit the trading of bait among island communities.

The only evidence that some TIB fishers may not catch all (or some) of their bait was on Erub Island, where 1 tonne of garfish had been sourced from the Australian mainland with the view to sell to local TIB and visiting NTI fishers. This product was priced at \$10 per kg, and over a six-month period (as of August 2017), approximately 500 kg had been sold to TIB fishers. On this island, there were also reports of bait purchases from the IBIS store, which sells packaged garfish bait at \$20.50 per kg. The total quantities of bait product purchased by both TIB and non-TIB fishers could not be quantified.

Although there was no mention of trading or selling of bait among island communities, it was identified that inter-island trading and supply of bait species (garfish and sardine) for human consumption regularly occurs – but the actual levels were not specified. Busilacchi (2008) previously reported such occurrences among distant communities.

The costs (in terms of time and fishing gear) to obtain bait on Mer Island are insignificant as bait species are readily available, abundant and easy to harvest using a simple cast net along the shoreline. It was noted, however, that Mer Island TIB fishers travelled to Erub Island to catch sardine at certain times of the year. Elsewhere, bait capture may be more significant in terms of costs as fishers may need to travel and use larger and more expensive fishing

gears (both to purchase and maintain). Unfortunately, the costs of collecting bait could not be determined for TIB fishers on Erub Island.

As stated above, the source of bait for NTI fishers was almost entirely from north Queensland. Minimal quantities were sought (by catching or purchasing) from within the Torres Strait.

5.1.7. Bait Value

Wholesale rates for bait-sized garfish in north-east Queensland generally range between \$7-8 per kg, whereas retail shops obtain higher prices of around \$10 per kg. In comparison, larger garfish destined for human consumption can get even greater prices of \$10-15 per kg. NTI fishers quoted an average price of \$7.50 per kg for garfish purchased as bait. In the Torres Strait, garfish bait product sells for \$10.00 per kg at the Erub freezer and \$20.50 per kg in IBIS stores. Wholesale prices of sardine sourced by NTI fishers from north-east Queensland range between \$3-4 per kg, with imported sardines costing \$0.5-1 less than Australian sardine. The IBIS stores sell sardine bait at \$18.75 per kg.

No information could be obtained on the value (or potential value) of prawn trawl by-product and discard utilisation as source.

Based on the estimated quantities of bait used by NTI fishers and average wholesale prices (\$7.50 for garfish and \$3.50 for sardine), the corresponding approximate value of the NTI bait use in the Torres Strait Finfish Fishery would be around \$37.5K for garfish and \$52.5K for sardine each annual fishing season (Table 1).

Given that NTI fishers take approximately 85% of the declared mackerel catch and 70% of the reef-line catch in the finfish fishery, it could be assumed that the combined TIB and NTI garfish bait supply for the mackerel component is 6 tonnes, and sardine for the reef-line component 21.5 tonnes per annum (Table 1). The corresponding total value (based on wholesale values) of both sectors would be approximately \$45k for garfish and \$75k per annum for sardine across the whole Torres Strait Finfish Fishery. The basic information provided below in Table 1 can help prospective fishers determine appropriate markets, levels of investment and expected revenue from bait fishing.

5.1.8. Bait Markets

There is limited local demand for bait among TIB fishers (1 tonne garfish, 6 tonne sardine), with most TIB fishers that target reef-line species catching their own bait. No specialised bait fishers or suppliers were identified in the site visits. The identified current total market for bait within the Torres Strait Finfish Fishery is relatively small (see Table 1). A small (1 tonne garfish) bait market exists on Erub Island and it was noted that this island has the only operational community freezer among the eastern islands. There is expected to be some demand for bait from Ugar-based fishers when the community freezer on that island is repaired, but the likely amount and local availability is unknown.

The IBIS organisation, which supports the development of Torres Strait industries, expressed particular interest in attaining locally caught bait product for resale throughout its chain of stores. IBIS currently spends around \$35-40K per annum on bait product (prawn, squid,

garfish, sardine, mullet), which is primarily sourced from suppliers in Cairns. Across all stores, it sells approximately 500 kg of garfish bait and 240 kg of sardine (pilchard) bait per annum.

Another potential local bait market is the NTI sector, which currently purchases a total of 5 tonnes of garfish and 15 tonnes of sardine for bait use in the TSFF. As stated above, some NTI fishers expressed interest in purchasing bait directly from Torres Strait suppliers.

External markets for bait (and bait species) exist throughout mainland Australia, with those in north Queensland being the most relevant and in closest proximity to the Torres Strait. There are also several large companies that specialise in supplying bait throughout Australia. These companies source bait Australia wide. Queensland wholesalers source sardines from eastern, southern and western Australia as well as imported product from South America. Likewise, bait-graded garfish are sourced from local and distant (e.g. New South Wales) suppliers. The wholesalers contacted on the mainland expressed some interest in purchasing Torres Strait product, particularly garfish.

Whilst garfish are a desired bait and food product along eastern Australia, and potentially throughout Asia, there is currently no identified or guaranteed market for Torres Strait caught garfish. Some garfish fisheries tend to display cycles of 'boom or bust' because catches are often environmentally driven (Stewart et al. 2005, Gillson et al. 2009) and markets and subsequent prices can fluctuate according to supply and demand. Notably, some of the Queensland wholesalers contacted stated that over recent years there has been an oversupply of garfish, with some wholesalers noting they are currently overstocked with bait.

Table 1. Summary of estimated quantities and potential value to fishers of the identified current bait markets in the Torres Strait.

	Estimated Market (Kg)	Estimated Total Value (\$)
Garfish (\$7.50 per kg)		
TIB	1,000	\$7,500
NTI	5,000	\$37,500
IBIS Stores	500	\$3,750
ERUB Freezer	1,000	\$7,500
Total	7,500	\$56,250
Sardine (\$3.50 per kg)		
TIB	6,500	\$22,750
NTI	15,000	\$52,500
IBIS Stores	240	\$840
ERUB Freezer	0	\$0
Total	21,240	\$76,090

5.1.9. Social and Cultural Considerations and Perspectives

Both sardine and garfish are important traditional foods throughout the Torres Strait (Busilacchi 2008) and this was clearly articulated at all attended community meetings we held. In particular, sardine is considered ‘totemic’ to the Mer Island community.

Each community expressed concerns regarding the sustainability of bait species associated with any future development of a bait fishery, potential negative impacts on traditional food supplies, and broader ecological/cultural impacts of such a fishery. For example, on Mer Island passionate concerns were raised about the sustainability of sardine stocks and potential impacts on cultural-ecological interactions concerning sardines. Notably, the shoreline-schooling sardines: (a) provide a readily accessed and routine food supply for all community members, (b) attract other larger predatory fish species (such as trevally), which in turn are fished by the community for food and (c) are involved in ecological interactions of immense cultural and aesthetic values (including those that affect tern abundance and activity) – these are of priceless value to the community.

Similarly, the Warraber Island community not only had concerns regarding impacts of increasing catches of garfish (for bait) on traditional food supplies, but expressed concerns about impacts of net fishing on bycatch species and local habitats. Nets are currently only used to catch fish when large quantities are required for ceremonies and when visiting other islands yet a dedicated bait fishery would probably involve more regular and widespread uses of relatively non-selective nets.

Notwithstanding these concerns, attendees at the community meetings on Mer, Warraber and Masig islands all agreed that a bait fishery could provide valuable employment opportunities to traditional inhabitants and therefore may have positive economic benefits to communities. Further, each community expressed a desire for some basic science concerning the biology of each bait species be done to assist fishery development.

5.1.10. Community Support for the Development of a Bait Industry

The community meetings identified positive interest in the development of a bait fishery for garfish on Warraber and Masig islands, but each using different approaches.

The Warraber Island community favoured the development of a line-only, community-based bait fishery for the locally abundant short-nose garfish (*H. quoyi*). The model presented was one where all community members could participate in the fishery, catch garfish, deposit catches at a central landing depot, with the product pooled for processing and on-selling. This way the flow of benefits would be shared among the community and not be isolated to a few families. Attendees at the community meeting were against the outright use of nets, except when significant quantities of garfish were required for ceremonial and other special occasions. In particular, as noted above, community members were concerned about the impacts of nets with small meshes on other incidentally-caught species and local habitats. It was proposed that the precautionary development of a line-only fishery would ensure sustainability of stock and habitat.

In contrast, Masig Island fishers that attended the community meeting, and who currently target rock lobster and beche-de-mer, sought a significantly more entrepreneurial and business-orientated bait fishery that also targeted garfish. Their vision involved a net-based fishery that caught sufficient quantities of product per trip to make it efficient, cost-effective and profitable in the long-term either as a sideline to current fishing practices, or as a primary, stand-alone business. If bait fishing complemented other fishing operations, it may mean that bait stocks would not be targeted year-round but only during the closed seasons for lobster and beche-de-mer, which would provide some temporal protection to the stock. Further, the fishers suggested that different reefs could be fished on a rotational basis, and some reefs could be totally closed to fishing, further enhancing a sustainable fishing regime.

Attendees at the community meeting at Masig Island also viewed the development of a bait fishery as a positive way to provide employment to young people (including women) in fisheries. This not only included the actual fishing, but processing and management aspects of the industry. It was noted that appropriate training in certain areas would be required to assist such employment opportunities.

The attendees at the community meeting on Mer Island did not support development of a bait fishery based on sardine or any other species. This outcome was primarily driven by concerns of the potential impacts of increased harvests of sardine on current food resources and adverse impacts on ecological/social interactions. It was noted that if a sardine-based bait fishery were to be developed, it would need to be located offshore (using seine net gears) and around adjacent reefs and islands so as to not interfere with the current harvesting of sardine for food close to Mer Island.

Levels of community support for the development of a bait fishery on Erub Island could not be determined in this project. It is acknowledged, however, that community members and the Erub Fishers Association have previously sought TSRA assistance in bait fishery development. The Erub Fishers Association has also previously investigated the potential of sourcing garfish (intended for bait sale) from the Warraber Island community. As noted above, at the start of 2017 the Erub Fishers Association purchased (from a north Queensland supplier) 1 tonne of garfish for bait sale.

5.1.11. Infrastructure Considerations

Successful commercial fisheries require appropriate infrastructure and management support systems. All four islands visited had a functional airfield and a wharf/port facility that provide regular air and sea transportation services for people and goods. Regular sea transportation of frozen product is available throughout the Torres Strait, and also with mainland ports (e.g. Cairns) although the reported cost of transporting frozen seafood product between the Torres Strait and Cairns is \$0.50/kg. It is noted that the IBIS retail chain has considerable logistical infrastructure concerning the transport of frozen goods around the Torres Strait.

Of the four islands visited, only Erub Island had an operational community freezer and processing facility suitable for bait fishery development. Community freezers on Mer, Masig and Warraber islands were not operational and, for a variety of reasons, mostly in a state of

disrepair. A private freezer and associated processing facility (with a 2 tonne snap freezer and two x 2 tonne holding freezers) owned by a reef-line TIB fisher on Mer Island was inspected, and provided a good model for other TIB fishers. No such private facilities were observed on the other islands, but Warraber and Masig islands have public and private facilities for holding live rock lobster. The economics, and levels of experience and capabilities among traditional inhabitants to manage and maintain a fishery processing and freezer facility were not determined in this project. Nevertheless, some such information is contained in the 'Review of Torres Strait Island Regional Council's Fishing and Freezing Operations' (AEC Group 2010), and the Finfish Action Plan (Cobalt MRM 2016). More current facts concerning fisheries-related infrastructure will be provided in the current TSRA project entitled 'Fisheries Infrastructure and Services Audit in the Torres Strait'.

Some attendees at community meetings expressed concerns regarding the lack of: (1) suitable boats (and motors) and appropriate fishing gears, and (2) experience and skills in fishing and processing, to engage in bait fishing. They viewed these as significant impediments to the immediate development of a bait industry in the region, noting also that significant financial and training packages would be required to facilitate the involvement of individuals and, therefore, the development of an on-going and potentially expanding industry. It was noted that the TSRA and other agencies have previously supplied boats and other ancillary equipment (e.g. freezers) and appropriate training to individuals to assist fishery development, but with limited success. Development of a bait fishery will require individuals or communities (e.g. via a fishing association, fishing cooperative) to invest in capital items (boats, nets) and training as part of a total bait industry business package.

The levels of experience in each community in catching and processing bait species, and managing and maintaining a business were not quantified during the site visits. However, discussions were held with several TIB, lobster and beche-de-mer fishers who did have successful businesses and therefore the relevant business acumen required for developing a bait industry. Such individuals could be used as role models and mentors to assist other community members to successfully engage in a bait fishery.

5.1.12. Best-Practice Procedures and Product Quality Control

Best-practice procedures need to be implemented across all fisheries regardless of the intended use of the product. Unfortunately, bait is often wrongly considered a secondary product that requires less stringent processing and quality standards than food-grade seafood. However, bait products usually need to be of the highest quality to satisfy end-users. The development of a bait industry in the Torres Strait should therefore incorporate best-practices and quality control measures throughout all facets of the operation to ensure a consistently high standard product. Such (food-safe) measures are already instilled in the current TIB commercial- and domestic-style freezer operations.

The Warraber Island community vision for a community-based fishery is commended and has many social merits. However, there are several drawbacks to this model that require consideration, particularly regarding product management and quality assurance, as well as financial accountability. Notably, garfish are relatively fragile and need to be handled and processed accordingly. With the potential of having many contributors to a community

catch, all with varying experience, the control of product quality may be compromised. Specific quality standards would need to be mandated so that cooperative management could accept or reject product. Also, there are several economic considerations to such a model, including the costs and proportioning of investments associated with such items as facility management, maintenance and transportation, and the equitable disbursement of sales revenue. All-in-all, whilst the suggested Warraber model is a good community-orientated concept, it does not present as a modern commercial fishery business case.

5.1.13. Species and Fishery Sustainability and Accountability

Modern-day commercial fisheries need to be publically accountable and demonstrate ecosystem sustainability, even if they are deemed small-scale and low-value as the case for an initial bait fishery supplying current local markets in the Torres Strait. This is particularly important in Torres Strait communities, which derive significant commercial, subsistence and cultural value from fisheries resources. At present, virtually nothing is published regarding the biology and ecology of species of garfish or sardine in the Torres Strait. These species and fisheries are therefore considered data-poor, which means that greater precautionary measures will need to be taken concerning fishery expansion.

Knowledge of some basic but vital biological and demographic attributes of each bait species would help guide decisions and assessments of potential fishery expansion. Some of this information (e.g. longevity, growth and size at maturity) could be collected from a snapshot sample of current catches. Obtaining some basic meristic measurements (e.g. length, girth) of a size range of individuals of each species could also assist the development of optimal fishing gears (e.g. appropriate mesh sizes in nets) and practices to minimise impacts on habitats and target and non-target species. This aligns with ecosystem-based management strategies.

A simple species and fisheries monitoring strategy should be implemented as part of any bait fishery development. Monitoring and assessment strategies need to be aligned with the scale, value and potential threat of each fishery as well as management and community expectations. Given the identified small-scale of any immediate bait fishery to supply local markets (<10 t garfish, <25 t sardine) here, the recording of fishing activities (catch, effort, method, location) and catch sampling (species and size composition) should be kept simple and low cost. A simple logbook could be used by fishers (or cooperative staff, fish receivers) to record fishing activity and associated catch and effort data. A regular low-level sampling of catches to collect species and size composition data should ideally be collected across appropriate spatial and temporal strata (e.g. islands, individual operators, seasons) – which can be identified once the fishery dynamics (operators, locations etc.) are determined. Again, fishers could collect such information themselves (which would facilitate greater responsibility in management and reduce costs), or alternatively, local community members (including rangers, cooperative staff) could be trained to collect such data.

5.2. Overview of Relevant Bait Species and Fisheries in Australia

A synthesis of relevant bait fisheries for garfish and sardine in Australia was done. These species were selected because it was previously identified by the TSRA that the initial focus species for a commercial bait industry in the Torres Strait would concern at least garfish and potentially sardine.

5.2.1. Garfish Biology and Fisheries

There are approximately 120 species of garfish (Family Hemiramphidae) throughout the world, with 17 species occurring in Australia and at least 10 of these species in the Torres Strait (Collette 1974). Most species are marine, occurring in tropical and temperate waters. Three species identified in catches in the Torres Strait were: black-barred garfish (*Hemiramphus far*), short-nose garfish (*Hyporhamphus quoyi*), and the three-by-two garfish (*Hemiramphus robustus*). All three occur across northern Australia, south-east Asia and, for *H. far*, the Mediterranean Sea (as a consequence of the opening of the Suez Canal).

Most species of garfish are considered 'data poor' (i.e. their biology and fisheries have not been well studied), and this includes the species in the Torres Strait. Notably, there are no accessible and published studies concerning the life histories of, or fisheries for, the three species identified in Torres Strait catches; *H. far*, *H. quoyi* and *H. robustus*.

Biological and fisheries-related studies about garfish are limited to a few exploited species, including the southern sea garfish (*Hyporhamphus melanochir*) in South Australia (Jones 1990, Ye et al. 2002, Fowler et al. 2008, Steer et al. 2011), the eastern sea garfish (*Hyporhamphus australis*), the snub-nose garfish (*Arrhamphus sclerolepis krefftii*) and the river garfish (*Hyporhamphus regularis ardelio*) in New South Wales (Stewart et al. 2004, 2005, 2008, Stewart and Hughes 2007, Hughes and Stewart 2006), and ballyhoo (*Hemiramphus brasiliensis*) and balao (*Hemiramphus balao*) in Florida (McBride et al. 1996, 2003, McBride and Styre 2002, McBride and Thurman 2003).

Garfish life-history characteristics

Most species of garfish are schooling, surface-orientated and inhabit sheltered shallow waters (Collette 1974). Garfish generally have short (2-4 years) to moderate (6-10 years) life spans, grow fast and reach maturity at young ages (1-2 years) (Ye et al. 2002, McBride et al. 2003, Stewart et al. 2005, Stewart and Hughes 2006, Fowler et al. 2008). Garfish have a reproductive strategy of producing several batches of eggs and spawning several times in a spawning season which can extend several months and sometimes be year-round (McBride et al. 2003, McBride and Thurman 2003, Hughes and Stewart 2006, Nuttall et al. 2013, Oliveria et al. 2015). Nevertheless, regional peaks in spawning activity are generally evident and, for those species studied, spawning mostly takes place between spring and autumn. Some species of garfish produce eggs that attach to submerged vegetation (e.g. seagrass and kelp), minimizing initial dispersal, whereas other species display no such strategy (Stewart et al. 2005). Early stage larval garfish are generally neustonic and stay that way until they metamorphose. Garfish are primarily omnivores, feeding on aquatic vegetation (algae, seagrass) and planktonic organisms (Stewart et al. 2005, Tibbetts and Carseldine 2005, Earl et al. 2011).

Australian Garfish Fisheries

Various species of garfish are harvested for food and bait by traditional, recreational and commercial fishers throughout the world (Collette 1974) and significant commercial fisheries, for both human consumption and bait, occur along the eastern and southern coasts of Australia. Reported commercial annual harvests of garfish have fluctuated between approximately 100-200 tonnes in Queensland, 50-100 tonnes in New South Wales, 30-80 tonnes in Victoria, and 200-300 tonnes in South Australia. Commercial catches in Queensland comprise at least four species, and in New South Wales three species.

Despite their life histories suggesting that they are somewhat resilient to reasonable levels of fishing, stocks of garfish can be overfished, as evidenced for harvested populations of eastern sea garfish in New South Wales and southern sea garfish in South Australia (Stewart et al. 2004, McGarvey et al. 2006, Fowler and Ling 2010) where overexploitation was primarily driven by catching too many young fish over extended periods of time. Commercial fishery catches of southern sea garfish in South Australia have displayed truncation of size and age compositions over time. These factors together with reduced total biomasses resulted in parts of the stock being classified as overfished. Likewise, in New South Wales, the excessive harvesting (> 100 tonnes per annum across 15 years: 1982-1998) of small (and young) individuals led to the eastern sea garfish stock being classified as overfished in 2002. The over harvesting of short-lived species such as garfish, is particularly problematic where populations have large inter-annual fluctuations in recruitment.

Adaptive management approaches including gear modifications, changes in legal lengths and spatial and temporal fishing closures resulting in effort/catch restrictions were implemented in both the South Australian and New South Wales commercial fisheries to protect and rebuild stocks of each species. Notably, in South Australia the minimum mesh size in the bunts of seine gears was increased from 30 to 35 mm (therefore improving selectivity for larger and older fish), the minimum legal length was increased from 230 to 250 mm TL so that it was greater than the 50% length at maturity (therefore allowing more fish to spawn prior to capture), and seasonal fishing closures that alternated between fishing areas were implemented (Steer et al. 2016). Similarly in New South Wales, the minimum mesh size in nets was increased (25 to 28 mm) and spatial and temporal fishing closures and catch restrictions were implemented as part of a species recovery plan (NSW DPI 2005). The NSW stock was classified as fully fished (as opposed to overfished) in 2015 following five consecutive years of improved age compositions in landings and substantial increases in catch rates since the mid-2000s.

Garfish are mostly commercially harvested in Australia using surface-orientated encircling type nets, including boat- and beach-based seines, lampara and mesh (bullring) nets. Garfish are relatively fragile, have deciduous scales, and thus can be susceptible to excessive handling and net damage (Butcher et al. 2011), and care is required when disentangling meshed individuals (Broadhurst et al. 2008). Following capture, the stomachs of some species need to be stripped to purge vegetative material in order to minimise product deterioration. Best-practice handling procedures include the immediate placement of catches in an ice-slurry or brine upon capture and prior to transportation to points of processing. Bait products should ideally be individually snap frozen (IQF), packaged and distributed for sale.

5.2.3. Sardine Biology and Fisheries

Sardine, herring, shad, sprat and menhaden are common names used to refer to various small clupeoid fishes. Around 200 species occur worldwide, with about 30 recorded from Australian waters. Such species are mostly short- to medium-lived (< 10 years), grow fast and spawn at a young age. They are forage fish that mostly eat planktonic organisms and are important components of coastal and oceanic ecosystems as they are the primary food source for many higher-order predatory fish such as tuna and trevallies, but also seabirds, dolphins, and seals.

Such species are often classified as small-pelagic fishes that form the basis of significant fisheries throughout the world. They are harvested for food, oil, fish meal and bait.

Torres Strait Sardine

The sardine 'Ari ari' observed in cast net catches on Mer and Erub islands was identified as the gold-spot herring, *Herklotsichthys quadrimaculatus* (Family Clupeidae). This species is widely distributed throughout tropical regions of the Indo-Pacific region (east Africa to Japan, Malaysia, Indonesia, northern Australia to Hawaii). It is an important traditional food source in several communities (Papua New Guinea, Torres Strait, Sri Lanka), and is harvested as part of the multispecies bait-fisheries for tuna throughout the south Pacific (Fiji, Hawaii, Kiribati, Papua New Guinea, Solomon and Marshall Islands).

The gold-spot herring is short-lived with a maximum age of 1 year, fast growing attaining a maximum total length of 110-140 mm (15-20 grams) at about 6 months with females reaching a slightly larger length than males. It reaches maturity at 5 to 6 months and spawns several times thereafter, releasing between 1000 and 7000 eggs (depending on the length of fish) each time it spawns. Spawning can take place year-round, but seasonal peaks are evident with most reported between spring and autumn. It is a schooling species that generally inhabits shallow waters close to shore during the day (refuge), but migrates offshore and to deeper waters at night to feed on vertically migrating zooplankton.

Australian Sardine Fisheries

The primary species of sardine harvested in Australian waters is the Australian sardine (*Sardinops sagax*), which is also known as Australian pilchard and blue pilchard. The species is primarily distributed in continental shelf waters around the southern half of Australia. Approximately 35,000 tonnes is harvested commercially each year, including 30,000 t in South Australia, 2,000 t in Western Australia, and 2,000 t in Victoria and New South Wales combined (Stewardson et al. 2016). Negligible (but unquantified) quantities of Australian sardine are taken by recreational and indigenous fishers.

The commercial fishery for sardine began in Australia in the 1800s, but was hampered by the lack of a substantial or consistent market. Since the 1970's, however, the harvesting of sardine has increased significantly as markets have grown. In particular, the fishery for sardine in South Australia has grown rapidly to now dominate the Australian catch.

Sardines are mostly processed and packaged and sold as bait for recreational anglers, commercial tuna fishing, rock lobster pots and fish traps, or for pet food, aquaculture feed

or canned for human consumption. There is also a very important growing market for fresh sardines for direct human consumption. Sardines attain up to \$9/kg as product for human consumption, but only around \$2/kg as bait.

Purse seine nets are the main gear used in commercial fisheries to target sardine, although there is also some very low level fishing (probably < 5 tonnes) using beach seine nets. Recreational fishers and indigenous people mostly use baited lines and small bait nets to catch sardine.

The average size of sardines caught varies among locations in Australia but, in general, fish are between 14 and 16 cm in length and 2 to 5 years old. They attain a maximum total length of about 25 cm and their longevity is 9 years. Age at maturity is 1–2 years (approximately 14.5 cm TL).

Stock Structure

The Australian sardine population is considered to be comprised of four separate biological stocks, all of which are determined to be sustainably fished (Stewardson et al. 2016). Bass Strait separates the biological stock that occurs off eastern Australia from three biological stocks to the west. The largest occurs off South Australia and western Victoria, and the other two off the south and west coasts of Western Australia. Some evidence is beginning to emerge to suggest that two stocks may occur off eastern Australia, but this requires further investigation.

In 1995 and 1998–99, two mass mortality events each killed more sardines, over a larger area, than any other monospecific fish kill ever recorded. These events were caused by a herpes virus to which the population had minimal or no immunity. Rates of recovery have been different between stocks, with spawning biomass increasing quickly in the Southern Australian stock and strong recovery was achieved in the two Western Australian stocks by the mid 2000s.

Monitoring and Assessment

Each of the four biological stocks is assessed annually and reported as part of the Status of Australian Fish Stocks Reports. The monitoring of catches includes logbook- and observer-based catch and effort data, length and age compositions of landed catches, and periodic spawning biomass estimates derived from egg surveys.

Ecosystem Impacts

Of particular interest to Torres Strait community groups as they consider developing a bait fishery for sardines may be Australia's experience with the rapid growth of the South Australian Sardine Fishery and concerns over its ecosystem impacts. The rise of this fishery led to significant community concerns that taking large catches could change the balance of associated ecosystems in South Australia's gulfs and the Great Australian Bight, and potentially affect the region's higher-level marine predators, including Southern Bluefin Tuna, seabirds and marine mammals. A large study was done to investigate the roles of Australian Sardine in the ecosystem and assess the potential ecological impacts of the fishery. This study reported that despite the rapid growth of the fishery, negligible impacts

were found on any species groups, even though several seabirds (e.g. Crested Terns—*Sterna bergii*) were potentially sensitive to changes in the biomass of sardines.

Interactions of Australia's sardine fisheries with Threatened, Endangered and Protected (TEP) species have had an impact on their management and operations. For example, the South Australian Sardine Fishery was closed for two months in 2005 because of high levels of encirclement and mortality of the Short-beaked Common Dolphin (*Delphinus delphis*). A TEP Species Code of Practice was developed during the closure period that outlined procedures for avoiding encirclements and releasing encircled animals. Interaction rates decreased significantly following the introduction of this code. A working group that includes industry, fisheries managers, scientists and representatives of conservation agencies meets every quarter to review logbook and observer data, and assess the effectiveness of the code of practice in reducing interaction rates. A report on interaction rates and the effectiveness of the code of practice is published annually.

A code of conduct was also established in 2006 to reduce Fleshy Footed Shearwater (*Ardenna carneipes*) interactions in the Western Australian South Coast Purse Seine Fishery. A Purse Seine Code of Practice was also established in 2008 by the Commonwealth-endorsed operators that outlined best practice methods for minimising harmful interactions with TEP species. Similarly, a NSW Purse Seine Industry Code of Practice was adopted in March 2008 establishing standard practice for minimising harmful interactions with TEP species in the east coast fishery.

5.3. Provide Recommendations on the Feasibility and Potential Business Models for the Development of a Bait Industry in the Torres Strait

We conclude from the work done in this project that there is some scope for the development of a bait industry as part of the Torres Strait Finfish Fishery, particularly for garfish. At least two island communities expressed interest in developing a bait (and potentially food-grade) fishery for garfish, but there was no interest among communities in developing a sardine-based bait fishery. By all reports, but without undertaking large-scale surveys, garfish appear to be readily available and abundant throughout the Torres Strait to initially support small-scale fishery development. The development of a bait fishery could render employment and economic benefits to traditional inhabitants and communities.

The identified (low) levels of local market demand and value for bait product would initially support only small-scale fishery development warranting only small levels of investment and limited employment. Initial business opportunities would probably be most suited to supplement existing businesses (or partnerships that involve an existing business) that have the necessary experience and access to fishing infrastructure (fishing vessels and gears, processing and freezer facilities). It is noted, however, that this is an important first stage in developing a larger bait industry in the Torres Strait.

Nonetheless, there are several immediate impediments that limit short- to medium-term implementation and development of a sustainable and economically viable broad-scale commercial bait industry throughout the Torres Strait.

5.3.1. Fishery Management Arrangements

The current management parameters that allow commercial fishing for bait by TIB fishers would probably not provide suitable regulation of a bait fishery beyond an initial exploratory phase. Consequently, appropriate regulatory arrangements will need to be developed for the longer-term and broader-scale management of a bait fishery in the Torres Strait. Permitted fishing gears, species and their sizes, times and locations of fishing and numbers of participants need to be considered in developing such arrangements. Moreover, such management initiatives need to be flexible and adaptive to the growth of a bait industry throughout the region. As noted above, the Western Closure Line restricts the potential development of a bait fishery to the eastern cluster of islands. Development of a broader bait industry throughout the Torres Strait will require a change to this fishery management arrangement.

5.3.2. Fishery Infrastructure

Suitable infrastructure for the transportation of bait product exists throughout the Torres Strait, but this is not the case for product processing and storage facilities.

The current lack of freezers and processing facilities constrain the development of the finfish fishery across the region (Cobalt MRM 2016), and this extends to any potential bait fishery. As detailed in the AEC Group (2010) report and the Finfish Action Plan, the viability of freezer and processing facilities is dependent on product throughput. A necessary step to grow a bait fishery will be the procurement of suitable processing and freezer facilities on identified islands. This could entail either community- or private-based facilities.

The current TSRA funded project 'Fisheries Infrastructure and Services Audit in the Torres Strait' will assess: (1) the extent of current fisheries-related community- and private-owned infrastructure and services, including port facilities (boat ramps, wharves), processing and storage facilities (freezers, cool rooms, live tanks), transport (roads, transshipping services, airstrips), supply (fishing/boating equipment, fuel, ice, bait) and repair services (mechanical, welding, boat repair), (2) current fishing activity and potential fisheries production, (3) individual community and fishery infrastructure and service needs, and (4) provide a prioritisation plan for the future investment, acquisition and maintenance of community facilities to support fisheries development throughout the region.

5.3.3. Small-Scale Bait Fishery Development to Support the TIB Fishery

There is limited local demand for bait among TIB fishers. In particular, among the communities visited, there is a distinct lack of identifiable within- and among-island markets for bait among traditional TIB fishers. At current TIB commercial fishing levels, there is a relatively low level of bait use and most TIB fishers simply catch their own bait (at a very low expense) for subsequent use. This situation probably extends to TIB fishers on other eastern islands that were not visited (e.g. Ugar and Poruma islands).

Nevertheless, as reported on Erub Island, some TIB fishers apparently purchase bait. However, it is unknown whether such fishers purchase all their bait, or only occasionally to supplement their own bait catches when necessary. Although the scale (number of TIB fishers, quantities purchased) could not be quantified, it is probably quite limited. For

example, over 6 months, the Erub Island freezer sold just 400 kg of the 1 tonne of available garfish bait to TIB fishers (and none to NTI fishers). A local annual demand of even 1 tonne of garfish is relatively low (a maximum value \$7.5K), that does not warrant large-scale bait fishery development. Such transaction levels could not sustain a full-time bait fishery business, but only supplement an existing fishery business.

Such a low-level supply of bait among local TIB fishers could easily be met by one or a small number of fishers and could be arranged and contracted at a local scale, either among individuals or at the community level. For example, fishers from Warraber or Masig Island could supply this level of garfish to the Erub Island community. Such an arrangement should deliver significantly cheaper product compared to sourcing and transporting the same quantity from a mainland (e.g. Cairns) wholesaler. However, to do so, both the supplying and receiving communities would require the appropriate fishery experience and infrastructure availability. Additionally, the purchase of, and maintenance of, fishing gears and processing facilities for individuals, and community freezer and processing facilities on an island, could not be justified by the needs of such a small-scale bait fishery alone.

Therefore, unless there is significant growth and expansion, both in overall participation and individual fishing levels, in the TIB fishery (especially for mackerel fishing using garfish as bait), there appears little opportunity for growing a regional bait fishery based solely on supplying TIB commercial fishers. Whilst one may consider that a greater availability and supply of bait will entice greater participation and overall fishing effort in the TIB fishery, there was no evidence that this would, in fact, transpire. That is, there was no acknowledgement among communities that bait supply limited participation in the TIB fishery, or overall fishing effort, and no persons stated that they would begin commercial fishing for mackerel or coral trout if bait was readily available to purchase. The uptake of TIB fishing for mackerel and reef-line species is therefore unlikely to increase concordantly with greater supplies of bait to purchase. Nevertheless, increases in TIB fishers participation in the TSFF could drive a need for improved bait supply.

There is, however, some additional potential that the small-scale supply of garfish to retail bait outlets on Thursday Island (for use by recreational anglers) and to the IBIS chain of stores could help supplement the development of a small-scale local-market bait fishery. Our discussions with store management identified some interest in such a proposal, but this would require further deliberations prior to any implementation.

Notably, there is greater demand for bait (garfish's 5 tonnes and sardines 15 tonnes per annum) among NTI fishers, demonstrating the potential scale of bait demand and use across the entire Torres Strait Finfish Fishery. Whilst the development of a bait fishery to supply NTI fishers may be more economically viable and support a broader-based fishery than solely supplying TIB fishers, the current long-term management vision for the fishery is one that only includes traditional inhabitants. That is, the NTI component of the fishery is theorised to reduce as the TIB sector grows. A future bait fishery therefore needs a vision just beyond supplying current NTI fishers.

Conclusions: The supply of bait to fulfil the current Torres Strait bait market (i.e. TIB and NTI fishery sectors, IBIS stores and ERUB freezer) would only support a small-scale, potentially part-time business(es) and most likely be best suited to supplement an existing fishery business(es). In the short-term, investments in bait fishery development would need to be minimal to ensure economic viability. Such development could prove an important first-step in growing a broader and larger-scale bait industry across the Torres Strait.

5.3.4. Strategic Development of External Markets to Support a Bait Industry

The longer-term development of an economically viable larger-scale Torres Strait bait industry is dependent on obtaining external markets. In particular, those bait and food markets for garfish that exist in mainland Australia, and potentially Asia. Nevertheless, there is considerable investment risk in developing a broader scale garfish-based bait fishery without testing or developing, and eventually obtaining suitable markets. Ideally, it would be most profitable to acquire a guaranteed market for Torres Strait bait product prior to full-scale fishery development.

A recommended way forward and a first step in building a business plan for a broader bait industry in the Torres Strait is to source and obtain a guaranteed market for Torres Strait garfish. It is suggested that an appropriately qualified and experienced regional seafood buyer/distributor/marketer(s) be engaged to scope and develop a specific market(s) for garfish bait (and potentially food) product. This model follows that for other export fisheries (e.g. coral trout and lobster) and could build on the current project focused on the branding and marketing of Torres Strait seafood (FRDC Project 2016-244).

In this way, subsequent business and fishing scenarios that cover fishery economics, viability and stock sustainability could then be modelled and assessed, and an appropriately scaled fishery and support industry developed to serve the identified market. Levels of subsequent growth in the industry and investment strategies for fishers and brokers could then be identified, individual business plans developed and associated support (financial, training, mentoring) schemes initiated.

Potential business models for a larger scale fishery could include either: (1) a cooperative-style business or businesses - where fishers individually catch and supply fish but the product is sold collectively, and expenses and profits shared accordingly, or (2) private businesses - where each individual fisher deals directly with agents and/or markets. The most optimal business models will depend on the particular market and fishery participants involved and should be developed once a market is identified.

Conclusions: In the longer-term, it is essential that external markets be secured for the growth of an economically viable and sustainable large-scale commercial bait industry in the Torres Strait. Only then can essential business decisions, including levels of investment and fishery viability and ecological sustainability, be determined and appropriate fishery management plans implemented.

5.4. Recommend a Precautionary Management Strategy to Ensure Harvest Levels are Sustainable

Significant concern was voiced among traditional inhabitants regarding the potential impacts of increased bait harvesting on target species, and in particular, on traditional food sources. Potential ecosystem/cultural impacts were also raised. Unfortunately, the actual ecological, economical and socially acceptable and sustainable target levels of bait harvests of any species (garfish or sardine) throughout the Torres Strait cannot be simply determined based on the information obtained here. Therefore, in accordance with strategies used for other low-value, small-scale, data-poor and developing fisheries (Astles et al. 2006, Scandol et al. 2009), it is recommended that, initially, a qualitative risk-based fishery management and harvest strategy be incorporated into the development of any bait industry that may occur in the Torres Strait.

By adopting such a procedure, it means that the potential impacts of anticipated growth (e.g. in species, quantities, locations, gear types, investments) in the fishery can be evaluated against specific ecological, economic and social criteria in a qualitative risk-based manner. Subsequent actions and decisions can then be made in regard to fishery expansion and consequences on the basis of those risks. Such systems can also be used to refine assessments and prioritize assessment needs for improving future decision-making. Moreover, qualitative risk-based procedures can often be readily interpreted and explained, are quite transparent and incorporate judgements from a variety of resource interest groups. Such fishery assessment frameworks are becoming quite commonplace in many Australian and international fisheries jurisdictions. Nevertheless, with expansion of the fishery and its value, and greater knowledge about ecological and species-ecosystem interactions knowledge, such an assessment system could eventually transition to, or at least incorporate, a more quantitative stock and ecosystem modeling framework (e.g. Smith et al. 2015).

Despite the lack of any formal assessment here, the immediate growth of a bait fishery at the levels indicated (e.g. garfish of < 10 tonnes per annum) to initially supply existing local markets (e.g. TIB sector, IBIS stores and Erub freezer) would present little risk to stock sustainability across the Torres Strait. Bait stocks at present are most likely not fully fished, given the estimated current traditional harvests and the vast number of uninhabited reefs and islands throughout the region where little or no fishing of bait species takes place. Nevertheless, there is some potential for local stock depletion and negative impacts on traditional food resources if increased harvests are spatially constricted and temporally concentrated in areas currently used for traditional food harvesting. Spatial management considerations that limit bait fishing away from traditional food harvest areas could help reduce potential conflicts and concerns regarding localised depletions.

The potential development of larger scale harvesting of bait throughout the Torres Strait to supply external markets will require greater precautionary measures due to the potential increased ecological and social risks. The development of such measures will require better assessments and therefore better data about species biology, ecology and the fisheries that exploit them. As mentioned, however, there is presently very little published information regarding the biology and ecology of species of garfish or sardine in the Torres Strait.

Prior to any fishery development, it would therefore be beneficial to introduce some small-scale snapshot sampling to assess the longevity, growth, size at maturity and other key demographic parameters for the key identified species. This could simply be done, for example, by sampling catches and collecting samples of garfish at Warraber island. Such basic information could help guide future harvesting and monitoring strategies. Further, obtaining basic meristic measurements (e.g. length-girth relationships) of each species would assist the determination of appropriate mesh sizes and optimal selectivity in nets to facilitate ecosystem-based fishery management approaches.

It is recommended that a simple species and fishery monitoring strategy be implemented concordant with fishery development. At the initial scales of bait harvests identified here, it is recommended that a simple strategy be implemented to collect basic fishing activity (catch, effort, method, location) and catch composition (species and sizes) information (as detailed above). This could be achieved by the introduction of a simple log book, and the regular low-level sampling of catches across appropriate spatial and temporal strata.

In the long-term, the scale of any such monitoring and assessment program will be dependent on the intrinsic and extrinsic value of the species and fishery, whilst also being attuned to community expectations. The optimal scale and periodicity of such sampling would be best identified under a risk-assessment framework along the lines mentioned above. Importantly, such a strategy should include obtaining information on catch levels, locations, lengths and age compositions of catches. It is noted that the introduction of a fish receiver system will go a long way to supplying some of this data. Biological information could be collected, for example, at community and private processing facilities upon the landing of catches. Appropriately trained local community members could sample catches and collect such basic, but vital information.

Conclusions: Development of an initial bait fishery to supply local markets would have limited impacts on stock sustainability of the targeted bait species across the Torres Strait. Nevertheless, because the bait species are data-poor, attainment of basic demographic information including size-at-age, growth and longevity, and size at maturity, reproductive mode and period, would help guide management strategies and deliberations concerning fishery expansion. It is recommended that appropriate fishing gears and practices be developed and initially, a simple monitoring strategy of catch quantities, species and size compositions be implemented across appropriate spatial and temporal strata concordant with fishery scale.

6. Concluding Statement

This project has gone a long way to identifying the varying potential, opportunities and challenges to establishing one or more commercial bait fisheries in the Torres Strait. By considering the biological characteristics of the species that could be involved in such enterprises, available background information and a large amount of information gleaned from site visits, community meetings, interviews and infrastructure inspections, we have been able to identify the numerous pros and cons associated with trying to establish commercial bait fisheries on these islands. We have also provided a series of suggested next steps to be taken in order to progress those opportunities that we identified as having the greatest potential for such an industry. The challenge now is for the numerous island communities of the region, with support as required from the TSRA and other appropriate agencies (such as fishers' associations), to begin the process of taking those steps that could, in the medium- to long-term, lead to quite a profitable (albeit small) commercial baitfish industry in the Torres Strait.

7. Recommendations

Business and Markets

Short-term:

- Prospective individuals and communities engage with management to initiate steps for a small-scale garfish fishery to supply local markets,
- Implement quality control standards for a bait fishery,
- Investigate the market potential to develop a food-grade fishery for garfish,

Long-term:

- Develop and secure external markets for Torres Strait bait product in Australia and Asia.

Methods and Training

Short-term:

- Source and test appropriate fishing gears and practices for sustainable harvesting of bait species,

Long-term:

- Identify and implement training and mentoring programmes for fishing, processing and business practices for bait fishers.

Data collection

Short-term:

- Implement a simple system to monitor bait fishing activities and catches,
- Undertake a snapshot study to determine key demographic parameters (length-at-age, growth, size/age at maturity, spawning period, spawning mode) of each bait species,

Long-term:

- Introduce an appropriate on-going monitoring and assessment strategy concordant with fishery expansion.

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Appendix 1. Summary of Site Visits

Project CA 2017-00046
Development of a Bait Fishing Industry in the Torres Strait
Field Trip Summary, September 2017

Team:

John Mathews - TSRA
Charles David - TSRA
Charles Gray - WFR

Schedule:

Mer (Murray) Island - Monday 28 August 2017
Warraber (Sue) Island - Tuesday 29 August 2017
Masig (Yorke) Island - Wednesday 30 August 2017
Erub (Darnley) Island - Thursday 31 August 2017

Overview:

TSRA staff arranged all aspects of the inspection visits including all meetings, travel and accommodation itineraries. Visits to each island involved a scheduled community meeting which was advertised prior. Each meeting included a brief overview of the project, including its origin, aims and the information being sought from community members to help achieve its outcomes. Informal discussions concerning the project and any other fisheries-related issues were also held with interested persons at other times. Either before or after each meeting, inspections of fisheries-associated infrastructure and facilities such as freezers, product processing and storage areas, boats and port facilities, were made. Where possible, local bait species were also obtained for identification.

Mer Island.

- A continuous dense band of sardine just-off the shoreline was observed. A sample was caught by cast net, and the species identified as the gold-spot (aka bluelined) herring, *Herklotsichthys quadrimaculatus*. This particular species, known as 'ari ari' is of great cultural significance to the Mer Island community. This species is widely distributed throughout the Indo-Pacific region and an important component of several bait fisheries.
- The community meeting was attended by 7 persons (all commercial fishers). From our discussions, we gleaned the following:
- Sardine along the shoreline are currently harvested for food and bait by community members, mostly by cast net.
- Commercial fishers harvest bait primarily for fishing for reef species such as coral trout.

- Current sardine food harvest was estimated at 5-20 tonnes per annum, based on 50-100 families harvesting 1-2 bucket (2kg) of sardines per-week each year. It was noted that a previous study (Busilacchi 2008) estimated the traditional take of sardines on Mer Island was 20 tonnes per annum.
- Current sardine bait harvest was estimated to be around 1.2 tonnes per annum. Based on 0.5-1 bucket (2kg) x 3 boats x 3 days/week per annum, and 5-6 buckets (2kg) per extended trip x 25 trips per annum.
- Meeting attendees acknowledged the potential of a developed bait industry, noting that it could supplement existing operations and incomes by offsetting costs such as fuel and fishing gears such as hooks and sinkers in the finfish fishery. But they did not think it would be a viable stand-alone business.
- No within-island bait market was identified as sardines are readily accessed and caught by all community members. But it was acknowledged that potential markets exist on other islands that do not have sardines, with existing trade of sardines (mostly for food) among island communities already occurring, but at an unspecified level.
- Passionate concerns were raised about the sustainability of sardine stocks and potential impacts of fishing on cultural-ecological interactions concerning sardines. Notably, the shoreline-schooling sardines: (a) provide a readily accessed and routine food supply for all community members, (b) attract other larger predatory fish species (such as trevally), which in turn are fished by community members along the shore for food, and (c) influence ecological interactions of immense cultural and aesthetic values (such as tern abundance and activity) that are of priceless value to the community.
- Fishers expressed concern regarding impacts of current harvest levels on sardine stocks, emphasising that they currently minimize current bait take, and noted that any fishery development could only occur if it did not adversely impact current sardine food supplies. Moreover, if a dedicated commercial bait fishery were to be developed it could not take place along the island shoreline. Fishers wanted to be assured that any increase in bait harvest would not impact stock levels, which at present are not quantified.
- Observations of sardine behaviour were presented by fishers, with schools occurring immediately adjacent to the shoreline during the day, but moving offshore at night. Although some sardines are present year-round, they are generally fewer in abundance in the months preceding the leading to the monsoon season. During these times, fishers travel to other nearby islands (e.g. Erub) to catch sardines for bait and food. Fishers also noted that at times, sardines school up during the day offshore (perhaps to spawn) where they would be susceptible to capture in large quantities using such gears as purse-seines.

- Fishers also noted that the shoreline sardines were not the natural food source of reef fish, but other forage species such as fusiliers– and if a method could be developed to catch such species, they could potentially form a bait fishery that did not interfere with the traditional food supply involving sardines.
- Attendees also mentioned the Mer Island sardine factory that closed in 1936 (which was of historical importance in the Mabo land case). It would be beneficial to explore the levels of catches involved for this factory to operate and reasons for its closure.
- Fishers also noted that, due to the limited number of available and suitable boats, development of the finfish (and any associated bait) fishery was currently limited.
- Inspections were made of the old community freezer facility which is now in disrepair. A successful reef fisher (Dennis) had a good independent facility consisting of 2 snap freezers and 3 bench freezers that could hold 3 tonnes of fish product. These facilities had a separate power board that was independent from the adjacent house power supply. Dennis's operation currently targets coral trout and other reef species and has 3 boats capable of undertaking day trips and a larger vessel able to stay at sea for extended (3-4 days) periods. The fish processing and storage facility visited is a good model for other independent businesses, and sufficient for adding any future bait fishery onto the existing business.

Outcome: Attendees were not currently interested in expanding a bait fishery for sardines on the island, primarily due to sustainability concerns that could adversely impact community food supplies.

Warraber Island.

- The community meeting was well attended (> 20 persons).
- Attendees stated that garfish are plentiful around the island and are easily taken from the shoreline by handlines and nets. Garfish are a very important food source for the entire community.
- Current garfish food harvest was estimated to be approximately 40 tonnes per annum. This consisted of: (a) net catch for cultural events and supply to other islands of 120-600 kg per annum (20-50 kg per catch x 6-12 times per year), (b) handline catch of 15-38 tonnes per annum (2-5 kg per catch x 3 catches per week x 50 weeks x 50 families). It was noted that during school holidays catch levels increase and this was not included in these calculations.
- No within-island bait or food market exists for garfish due to their ease of access, and the island commercial fishery is dominated by rock lobster and beche-de-mer that do not use bait. There is no commercial finfish fishery. Attendees noted that Erub Island was a potential bait market as it required garfish for its mackerel fishery.

[Apparently, there has been some previous discussions between persons regarding this possibility of Warraber supplying garfish to Erub for bait].

- Attendees requested background information on species biology (length-at-maturity, longevity, stock size) for adaptive and precautionary fishery development and what management plans and business models would accompany any implementation of a bait fishery.
- Concerns were expressed over the non-selective nature of current bait nets, and potential adverse impacts on small garfish and other non-target small species.
- Attendees supported development of a garfish bait fishery, but at a precautionary scale that was based on handline catches only, with nets only to be used for catching garfish for ceremonies and other special occasions. Garfish sustainability and habitat protection is paramount to bait industry development.
- A proposed bait fishery should involve all interested community members and the benefits shared accordingly. Attendees emphasised that it is a community-owned resource. Many people (families) could contribute small catches to the total community catch that would be processed and on-sold.
- It was noted that a garfish bait fishery could develop into a food fishery, but stringent processing standards need to be implemented. It was pointed out that even as bait, product needs to be in a consistent and good condition for sale and that best-practice handling procedures still need to be implemented and followed.
- A bait industry could support some part-time jobs but this would require TSRA business support and training for start-up.
- Garfish are not present along the shoreline year-round, as they move and school offshore between October and December presumably to spawn. Garfish are present on surrounding islands and reefs that could be accessed by boat and harvested.
- At least two species of garfish inhabit the region, the species identified from shore catches was the short-nose garfish, *Hyporhamphus quoyi*. This little studied species is widely distributed around northern Australia and the Indonesian archipelago.
- Necessary fishery infrastructure (snap freezers, storage freezers, processing areas etc.) required for bait industry development does not exist, and financial assistance to obtain such facilities is required. It was noted that there was potential to add-on to existing facilities that service the lobster fishery.
- Inspections were made of the rock lobster holding facility, the boat ramp and wharf areas. There is no current facility on the island for processing and storing finfish (there is no finfish commercial fishery), as required for a bait industry. Nevertheless, there are suitable sites for such a facility located close to the community wharf.

Outcome: Attendees supported development of a line-only, community-based bait fishery for garfish. Netting of garfish would only be permitted for ceremonies and other special occasions as per current practices.

Masig Island.

- Commercial fishing activities on Masig Island primarily revolve around the lobster and beche-de-mer fisheries, with prawn trawl vessels using the island as a base at specific times. There is limited commercial finfish fishing.
- The community meeting had a low attendance (5 persons, including 2 fishers), but there was robust discussion concerning a potential bait fishery and in particular, associated infrastructure needs.
- Discussion was dominated by issues surrounding the ownership of the current (non-functional) freezer facility and its potential refurbishment.
- Garfish (at least 2 species) reportedly are abundant around Masig Island and on several adjacent reefs/islands and have previously been fished using nets similar to purse-seines. No samples were collected to identify the garfish species, but the spotted gar (*Hemirhamphus far*) was reported to be common.
- Garfish and sardines are commonly harvested for food by community members using shore-based cast nets.
- No information was provided to allow an estimate of current catch levels of garfish or sardine.
- Other potential bait species such as mullet and octopus occur around the island and are also harvested.
- Fishers displayed interest in developing a bait industry for garfish, but stated it must be economically viable and appropriately supported by management to proceed, demonstrating a significant entrepreneurial and business understanding towards fishery development.
- A proposed bait fishery could initially be incorporated within existing business structures (primarily lobster and beche-de-mer), taking advantage of existing contacts and market opportunities.
- The diversity of fishing activities was encouraged to increase and enhance current businesses, but it was emphasised that any proposed bait fishery must be worth the effort. i.e. it must be cost-effective. It was further highlighted that a bait fishery could transform into a more profitable food fishery for external markets.

- Nets would be the most cost-effective and efficient means of catching adequate quantities of garfish per unit of effort.
- It was suggested that fishing effort could be rotated among reefs to reduce the potential of local depletions. Moreover, the monthly and seasonal closures of the lobster fishery could be ideal periods when fishers could target garfish, again partitioning fishing effort.
- It was noted that a bait industry could support the island economy and provide much-needed jobs within the community, particularly for young women.
- Noted that a financially viable bait industry required consistent markets and supply of product over a long period.
- Financial assistance and training to individuals would be required to start-up a bait industry.
- Masig Island is central to the prawn trawl industry with vessels visiting the island on a regular basis. There is some current utilisation of trawl bycatch for local bait use, but at unspecified levels. Attendees and other community members indicated there could be better utilisation of trawl bycatch bait species.
- The existing freezer/processing facility on the island is currently not in use and requires significant modifications and repairs/upgrading to be of value to a finfish and bait industry. It was acknowledged that financial support would be required to achieve this.

Outcome: Attendees supported the development of a bait fishery for garfish and recommended that any eventual expansion of a new bait fishery for garfish to also include greater utilisation of trawl bycatch species.

Erub Island.

- No community member attended the advertised scheduled meeting.
- Discussions were held with individuals at the freezer facility adjacent to the port and elsewhere. These discussions revealed that abundant populations of sardines and garfish occur around the island and other adjacent reefs/islands.
- Garfish and sardines (as well as other bait species) are caught in the traditional fish traps that surround the island and are utilised for food and bait but at unquantified levels.
- One sardine species was identified from shore catches, the same species as that observed at Mer Island – the gold-spot herring, *Herklotsichthys quadrimaculatus*. No samples of garfish were available for species identification.

- No information was provided to estimate current catch levels of sardines nor garfish.
- The commercial fisheries on Erub Island are dominated by the lobster fishery, with a limited finfish fishery but it was acknowledged that there is a large potential for expanding the mackerel fishery in particular.
- Mackerel lease holders visit the island throughout the season, a potential market for bait, notably garfish.
- A consistent bait supply is required for enhancing the mackerel fishery, thus the island is a potential market hub for bait supplies.
- Some local people purchase bait (garfish) from the island IBIS store to catch reef species and mackerel for their own food consumption.
- Interested persons expressed the need for financial support (to purchase nets), training (use of nets, product processing) and business support if they were to take up bait fishing at a greater level.
- The community freezer facility is a good design housing a processing area, snap freezer and freezer that has adequate capacity for bait fishery development. The freezer contained garfish previously imported (1 tonne) from a Cairns bait supplier for sale to local and transient mackerel fishers.

Outcome: No consensus could be made concerning the development of a bait fishery on the island although its potential is clear.

Concluding remarks.

- Community members displayed varying levels of interest and understanding regarding the development of a bait industry.
- All communities expressed concerns regarding the sustainability of bait species associated with any fishery development and impacts on traditional food supplies.
- Greatest interest in developing a bait industry occurred on the islands of Warraber and Masig.