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Torres Strait Finfish Fishery: Coral Trout and Spanish Mackerel Biological Sampling

AFMA Project Number 190851

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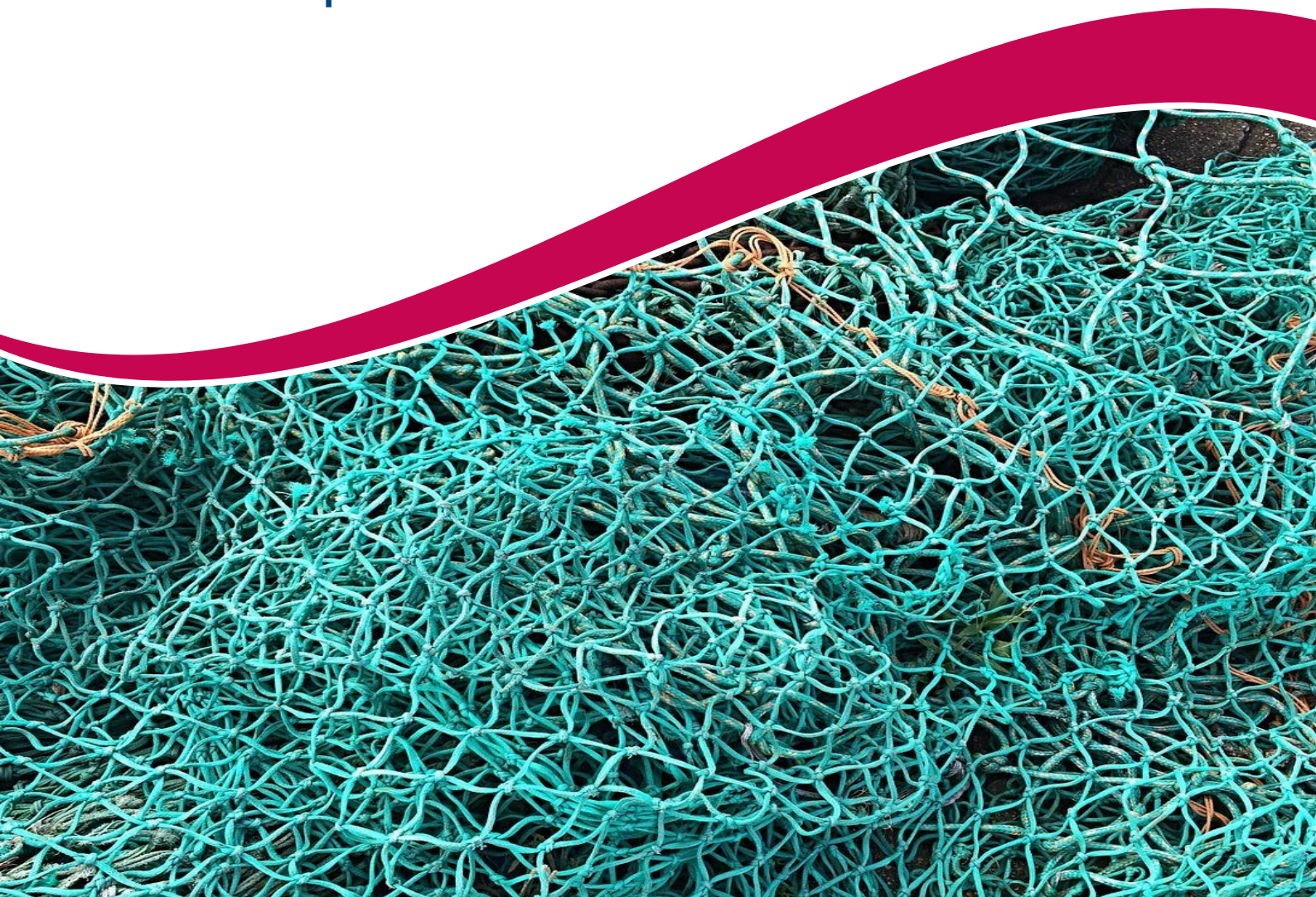

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1 Acknowledgements

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2 Acronyms and traditional names

AFMA	Australian Fisheries Management Authority
ALK	age length key
DAF	Department of Agriculture and Fisheries, Queensland
FL	fork length
FQ	Fisheries Queensland
JL	jaw length
n	number or count of samples
PBC	Prescribed Body Corporate (see RNTBC)
PZJA	Protected Zone Joint Authority
RNTBC	Registered Native Title Body Corporate (see PBC)
Sunset	Sunset licence holder/sector
TIB	Traditional Inhabitant Boat
TL	total length
TSRA	Torres Strait Regional Authority
TVH	Transferrable Vessel Holder

Traditional names

Erub	Darnley Island community
Maizab Kaur	Bramble Cay fishing grounds, north of Erub.
Masig	Yorke Island community
Mer	Murray Island community
Ugar	Stephen’s Island community

3 Summary

Spanish mackerel

Torres Strait Spanish mackerel are harvested by line fishing from ocean waters between Cape York Peninsula (north-east Australia) and the western province of Papua New Guinea. Spanish mackerel are an iconic fish for Torres Strait communities being an important food source and opportunity for economic development, with recent commercial harvests in the order of 82 t.

The commercial fishery is highly focused, with Spanish mackerel taken mostly between September and November. Commercial harvests are mostly from the eastern Torres Strait, and concentrated on north-eastern waters around Maizab Kaur (Bramble Cay) within the Kemer Kemer Meriam area of the Torres Strait.

Two commercial sectors, a traditional inhabitant boat (TIB) and non-traditional sector (sunset licence sector) target Spanish mackerel. Fish catch and catch rate data from the two sectors support the stock assessment for Torres Strait Spanish mackerel.

Recent declines in Spanish mackerel catch rates have driven a need to collect new biological fish age-length information. This is to support future stock assessments and help inform management decisions on sustainable levels of catch.

New biological sampling of Torres Strait Spanish mackerel was conducted in 2019-20 and again in 2020-21 to address a long-term critical need for updated fish age-length information. These data add to the historical fish age-length data collected 15–20 years ago during the 2000-01, 2001-02, 2002-03 and 2005-06 sampling programs.

A sampling program was employed to collect Spanish mackerel frames from both traditional inhabitant and non-traditional commercial fishing sectors. Many fishers and community members assisted to collect samples from fish frames and measure the lengths of fish from commercial and non-commercial traditional catches.

Overall, an estimated 74 % of the 2020-21 fishery harvest was measured. Most of the sampling occurred between October and December. Only two fishing areas outside of Maizab Kaur (Bramble Cay) were sampled, in the central (Kulkalgal) and eastern Torres Strait (Kemer Kemer Meriam).

The 2020-21 pattern of Spanish mackerel age-length data shows few fish older than six years of age. Most fish were aged between 2-4 years old. Results were similar to the recent 2019-20 sampling data and were also similar to the older 2000-01, 2001-02, 2002-03 and 2005-06 sampling data.

In 2020-21, the oldest Spanish mackerel found was 12 years of age (during 2019-20 the oldest was 13). This was equal to the oldest fish measured previously being 12 years of age. Spanish mackerel were measured between 70 and 144 cm fork length (FL), with a majority between 88 and 110 cm FL (75 %).

Future sampling needs to build on the spatial coverage of sampling, particularly outside of the main Bramble Cay fishing ground. This is to test for any spatial bias, as most of the stock assessment information was from Maizab Kaur (Bramble Cay). A finding of older fish from other fishing grounds might suggest a higher abundance of Spanish mackerel, than as indicated from recent catch rates.

Coral trout

The Torres Strait Reef Line Fishery is a multispecies line fishery predominantly targeting coral trout species (common coral trout, bar-cheek coral trout, passionfruit coral trout and blue-spotted coral trout).

The commercial fishery has two commercial sectors, a traditional inhabitant boat (TIB) and non-traditional sector (sunset licence sector) and is centred around many reefs of eastern Torres Strait. Since the 2008 buyback, catch and effort has been low in the fishery with both sectors generally harvesting around 20-35 t of coral trout per season combined. A 2019 preliminary stock assessment for the Torres Strait common coral trout stock suggested that there is a healthy level of biomass.

A data need for the fishery has been to expand the 2019-20 biological sampling program for Spanish mackerel to the collection of coral trout biological information for 2020-21. As per Spanish mackerel, a coral trout sampling program was employed to collect coral trout frames from both TIB and Sunset sectors to allow study of length, sex and age. An additional objective of the program is to collect and report on species composition of commercial catches noting that a key challenge for stock assessment is the ‘basket’ of four coral trout species harvested by Torres Strait fishers and generally reported as ‘coral trout’.

At the time of publication, the coral trout fishing season is still in progress with samples still currently being collected, processed, and aged. Samples from earlier in the season have been analysed and have enabled an initial examination and reporting on length frequency, sex ratios and catch compositions. These early data have included 176 coral trout of three species (common, passionfruit and bar cheek) which were measured, and otolith interpretation for age determination conducted on 27 common trout. Future sampling will allow for improved analysis and reporting on spatial temporal trends in these coral trout species.

General

Continued annual fish age-length sampling is essential to monitor trends and patterns in the recruitment, abundance, and cohort strengths of key commercial Torres Strait finfish stocks. This data is needed to improve stock assessments and management procedures.

Fishers and fish receivers from island communities within the eastern and central Torres Strait were key to the data gathering throughout the project. Participation of Traditional Owners and Inhabitants was fostered by community workshops which focused on opportunities for local involvement in sampling and data collection.

A key challenge for the project remains converting general support and interest in the project into fishers actively filling out length measures and providing fish frames for study. To address this in 2020-21 project staff have spent time in communities to focus on one-on-one engagement and coaching with fishers and fish receivers that have expressed an interest in sampling. This approach is required for businesses to understand the importance of data needs, the technical requirements of sample and data collection, and to find ways to include sampling in their routine business practices.

Continued partnerships with key stakeholders, regular community engagement and feedback of project results will continue to build and promote trust to support effective working relationships over time between communities and researchers.

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4 Objectives

The objectives of the project included:

- Design a cost effective and efficient sampling program to collect the required fishery dependent biological data from fishers (ageing data and length data for Spanish mackerel; ageing data, length data and catch composition for coral trout) for informing the assessment of stock status and catch limits for Spanish mackerel and coral trout species in the Torres Strait.
- Engage with indigenous and non-indigenous fishing sectors to collect fish length data. Collect and process fish specimens and conduct ageing of fishes sampled as per existing standardised Spanish mackerel ageing protocols and quality assured methodologies.
- Construct and report on age and length-frequency data for Spanish mackerel.
- Construct and report on age, length-frequency data and species composition for coral trout species.

5 Introduction

5.1 Spanish mackerel

Australia's Spanish mackerel, *Scomberomorus commerson*, are large pelagic fish that are harvested by line and net fishing from tropical and sub-tropical ocean waters. They can weigh in excess of 30 kg, mature between two and four years of age and live for up to 26 years (McPherson 1992; McPherson 1993; QDAF 2018). Growth is extremely rapid in the first 2 years slowing with the onset of maturity (Mackie et al. 2003). Growth of Spanish mackerel appears to be sex specific after the first 2 years, with females growing faster, larger and living longer than males (McPherson 1992; Tobin and Mapleston 2004; McIlwain et al. 2005).

Current research identifies Spanish mackerel in neighbouring waters of the Gulf of Carpentaria and along the east coast of Australia as separate biological stocks from those in the Torres Strait and recommendations from this research are such that Torres Strait Spanish mackerel be regarded as a discrete meta-population for management (Buckworth et al. 2007).

Spanish mackerel are an iconic fish for Torres Strait communities being both an important food source and an economic opportunity for commercial fishing (Begg et al. 2006; Busilacchi et al. 2014; Williams et al. 2019). Within the Torres Strait Spanish Mackerel Fishery there are two commercial sectors: Traditional Inhabitant Boat (TIB) and Sunset Licence holders (Sunset sector), both of which are line fisheries.

In 2008, the Australian Government funded a 100% buyback of Transferrable Vessel Holder (TVH) fishing licences, such that the catch entitlements in the fishery are 100% owned by the traditional inhabitant boat sector. As a condition of the buyout, the Protected Zone Joint Authority (PZJA) agreed that the Torres Strait Regional Authority (TSRA) would hold and lease out temporary licences until the TIB sector could increase its catch to the full allocation.

The TSRA manages the leasing out of fishing licences each fishing season on behalf of traditional inhabitants of the Torres Strait. The TIB sector has a large number of licenced operators (>200) harvesting a small amount of catch (2-11 t in 2017-18[1]). The sunset sector harvests most of the catch (77 t in 2017-18[1]) and consists of a small number of operators (<5), accessing the fishery through the temporary annual 'sunset' licence which is leased from the TSRA. These operators mainly target Spanish mackerel spawning aggregations around Maizab Kaur (Bramble Cay) during August to December and to a lesser extent target other fishing grounds around eastern Torres Strait. The sunset sector is regulated to no fishing within 10 nautical miles of the eastern Torres Strait communities of Masig, Ugar, Erub and Mer which drives some spatial differentiation in the use of the fishery by this sector.

Previous monitoring of Torres Strait Spanish mackerel was conducted by the Queensland Government (DAF) between 2000 and 2002 to obtain biological information (O'Neill and Tobin 2016. The monitoring was conducted on board commercial non-traditional fishing operations and focused on the main fishing grounds of Maizab Kaur (Bramble Cay) during October-November. An observer processed filleted fish frames to collect length, otoliths, gonads and genetic samples, with most fish sampled from morning catches.

A research project conducted by the Cooperative Research Centre (CRC) for the Torres Strait adopted similar protocols to sample Spanish mackerel in 2005 (Begg et al., 2006). There has been no length-age information collected from Torres Strait Spanish mackerel since this 2005 study.

The stock assessment for Torres Strait Spanish mackerel uses an integrated age-structured model and catch and effort data (O'Neill and Tobin 2016). The biological information used in the most recent assessment is based on early fishery-dependent surveys conducted in 2000 to 2002 (O'Neill and Tobin 2016) and in 2005 (Begg et al. 2006).

In 2019 the Torres Strait Scientific Advisory Committee, on behalf of the Protected Zone Joint Authority (PZJA) together with the Torres Strait Regional Authority (TSRA), funded the identified need to update the age-length information for the fishery based on recommendations from the recent stock assessment (O'Neill and Tobin 2016) and supported by both the PZJA Torres Strait Finfish Fishery Resource Assessment Group and Working Group. Recent concerns in declining standardised catch rates, used as a proxy for stock abundance, have also driven the collection of biological data as a high priority.

The results of project number 190851 "*Torres Strait Finfish Fishery: Coral trout and Spanish mackerel biological sampling*" are provided and will inform the next updated stock assessment of the Torres Strait Spanish mackerel stock.

[1] https://www.pzja.gov.au/sites/default/files/2018_torres_strait_spanish_mackerel_stock_assessment_update.pdf

5.2 Coral trout

Coral trout are key target species of the Torres Strait Finfish Fishery Reef Line sector. Four species of coral trout are known to occur in Torres Strait (Mapstone et al. 2003) and all are landed in the commercial fishery:

1. common coral trout (*Plectropomus leopardus*),
2. passionfruit coral trout *(P. areolatus*),
3. barcheek coral trout (*P. maculatus*),
4. bluespotted coral trout (*P. laevis*),

Coral trout are key fishes for Torres Strait communities and an important economic resource. As per Spanish mackerel, there are two commercial sectors targeting coral trout: Traditional Inhabitant Boat (TIB) and Sunset Licence holders (Sunset sector), both of which are line fisheries.

Studies suggest that common coral trout forms one stock on the Queensland east coast, including the Torres Strait region (van Herwerden et al. 2006; van Herwerden et al. 2009). The 2009 van Hewerden study sampled common coral trout from the Torres Strait and the Capricorn-Bunker region of the Great Barrier Reef and found that there was no significant difference in genetics between the two samples.

Research suggests that common coral trout stay on the same individual reefs after settlement as larvae, and that their larvae do not travel long distances (generally less than tens of kilometres) after spawning (Harrison et al. 2012). Common coral trout have a longevity of approximately 18 years and are mainly mature at 3 years of age (60 % mature by this age).

As for the Spanish Mackerel sector (pp. 9-10), the Torres Strait Finfish Fishery Reef Line sector was also subject to a buyback in 2008 with a small number of sunset licence holders leasing yearly access to the fishery since this time through the TSRA leasing process. The sunset sector is regulated to no fishing within 10 nautical miles of the eastern Torres Strait communities of Masig, Ugar, Erub and Mer which drives some spatial differentiation in the use of the fishery by this sector.

This sampling represents the first updated length-age information collected from the Torres Strait since the 2005 *Evaluation of the Effects of Line Fishing* study conducted by James Cook University (Williams et al 2005). The March 2019 preliminary Torres Strait Coral Trout Stock Assessment (as presented at PZJA FFRAG 4[2]) identified catch composition reporting (noting the species split issue) and biological sampling as key inputs to support testing the assumptions of the preliminary stock assessment as it is further developed.

The results of project number 190851 "*Torres Strait Finfish Fishery: Coral trout and Spanish mackerel biological sampling*" are provided below and will inform the next updated stock assessment of the Torres Strait coral trout stock.

[2] https://www.pzja.gov.au/sites/default/files/tsffrag_4_13-140319_record_0.pdf

6 Methods

6.1 Industry and Community Engagement

The sampling program relied on the cooperation of community leaders, commercial fishing sectors and community members to voluntarily allow access to their catches and to assist with data collection. The program worked by engaging community leaders (Elders, Torres Strait Island Regional Councils (TSIRC) councillors and Registered Native Title Body Corporate (RNTBC) Chairperson, commonly referred to in communities as PBC Chairs) explaining the project objectives and seeking permission to access community and work with community members.

A process of engagement was conducted to directly involve the traditional inhabitants of central (Kulkalgal) and eastern islands communities of Ugar, Erub, Masig and Mer (Kemer Kemer Meriam) where the highest commercial TIB catches of finfish are known to occur. The objectives of the engagement were to consult with the communities to inform about the research, seek input into the sampling strategies and design, seek involvement in the research, provide training and provide an opportunity for people to voice any concerns or objections relating to the research.

Project staff worked within the *Procedural Framework for Researchers in the Torres Strait* (Nakata 2018) and the *TSRA Cultural Protocols Guide* (TSRA 2011) when applying for project funding and when planning and conducting visits to the Torres Strait to work with Traditional Inhabitants. Project staff sought advice from TSRA and PZJA consultative committees that regularly work within these cultural guidelines and have established relationships with key Torres Strait island contacts.

Additional to the human ethics considerations provided by the Torres Strait Scientific Advisory Committee research funding process, internal oversight was conducted by project staff. As stated in the Nakata framework (Nakata 2018), Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) maintain the *Guidelines for Ethical Research in Australian Indigenous Studies* (2012)(GERIAS)[1] which is the primary Indigenous research ethics guide used in Australia alongside the *National Health and Medical Research Council (NHMRC) Values and Ethics: Guidelines for Ethical Conduct in Aboriginal and Torres Strait Islander Health Research*[2] and the *National Statement on Ethical Conduct in Human Research 2007 (updated 2018)*[3].

These national guidelines (GERAIS) aim to improve the standards of engagement and benefits that research can offer Aboriginal and Torres Strait Islander peoples[3]. These guidelines were considered and a process for ethical oversight of the project established. Proposed actions against each of the 14 GERAIS principles were developed and these actions considered and approved by the Torres Strait Scientific Advisory Committee.

[1] https://aiatsis.gov.au/sites/default/files/docs/research-and-guides/ethics/gerais.pdf

[2] https://www.nhmrc.gov.au/research-policy/ethics/ethical-guidelines-research-aboriginal-and-torres-strait-islander-peoples

[3] https://www.nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-human-research-2007-updated-2018

[3] https://aiatsis.gov.au/research/ethical-research

One of the key actions included ensuring that free prior informed consent is in place for the acknowledgement, attribution, and citation of local traditional knowledge and fisheries data. A copy of this project summary and informed consent form used to attain consent during initial engagement is provided in Appendix 1 and Appendix 2 respectively. Communities were advised of the community visits through notifications and discussions with Torres Strait Island Regional Councils. All community members were invited to workshops using methods such as notices on community notice boards and SMS messages sent to Traditional Inhabitant Fishery Boat Licence Holders.

During the 2019-20 project, a series of workshops were conducted within the communities of Erub, Masig, and Ugar between September and November 2019 (Langstreth et al. 2020; Appendix 3).

During 2020-21, the project used a similar workshop style format for the first of three community engagement visits to Erub, Ugar and Mer communities during sampling. These initial island workshops discussed the project objectives and sought involvement from traditional fishers and fish receiver businesses in the collection of fish samples and data. Project results from the 2019-20 project were also presented and discussed during this initial workshop.

Follow-up community visits, approximately six weeks later, were focused on one-on-one informal meetings conducted to continue discussions, progress sampling and to follow up with individual volunteer samplers/businesses to solve data and logistic issues around collecting and freighting samples. Project updates were presented at all community visits. Further details and dates of community visits are provided in Appendix 3).

All members of each community were invited to the initial workshops and participants were represented by commercial fishers and their families, fish buyers and processors, Torres Strait Island Regional councillors, traditional inhabitant members of the PZJA advisory committees, council staff, and community members. Training on how to collect samples and record fish lengths was provided during these workshops, as well as provision of sampling kits.

Project staff worked at the Erub Freezer, alongside trainees from the *Wapil* fisheries development program run by the TSRA. Some trainees were very interested in the biological sampling and opportunistically provided samples to support the project.

All non-traditional Sunset fishers with coral trout or Spanish mackerel catch allowance under a leased Sunset licence were consulted on the project. These fishers were invited to be involved in data and sample collection. Three of these fishers were provided with sampling kits and training, which represented the majority of fishing effort targeting mackerel or coral trout in this fishery.

6.2 Data collection

Sampling design

Early length-age data collection for Torres Strait Spanish mackerel (2000-2002, 2005) was primarily focused on the main fishing grounds around Bramble Cay during the main fishing season on the known spawning aggregation, which forms annually at this site (Oct-Nov) (Begg et al. 2006; O'Neill and Tobin 2016). These data were collected during on-board surveys of non-traditional fishing operations. This project aimed to continue the sampling that commenced in the 2019-20 project to

further update length and age information and to increase the spatial and temporal representativeness of the Torres Strait Spanish mackerel fishery. This project also aimed to capture information from catches of traditional fishing operations, from months outside of the main October to November fishing season, and from fishing grounds outside of Bramble Cay.

Spanish mackerel target sample sizes were determined prior to the commencement of sampling and were based on knowledge of DAF's routine annual sampling programs of Spanish mackerel stocks along the east coast and in the Gulf of Carpentaria, together with advice from Torres Strait Spanish mackerel stock assessment scientists and discussions with the project team. Targets were maintained from the 2019-20 sampling and included a total of 1,500 fish lengths from around 50 individual ungraded catches, and otoliths and sex information from around 500 fish.

Initial target sample sizes for coral trout sampling have been informed from feedback from the PZJA Torres Strait Finfish Resource Assessment Group (November 2019 meeting). These sample targets are 1,000 lengths and 300 otoliths.

While targets had been set based on suitable sample numbers, it was important to keep in mind current fleet sizes and that participation by commercial fishers and community members was voluntary. The success in the sampling design is underpinned by good levels of participation across both sectors and multiple participants within each sector. Furthermore, the majority of the harvest is taken by a small number of non-traditional operators. With this in mind, a significant focus of the fishery-dependent sampling program has been developing relationships with fishers and stakeholders to encourage participation.

Samples of fish tissue were collected opportunistically from fish frames/heads to start a collection of fine scale spatially representative genetic fish samples to further examine stock assumptions and boundaries (O'Neill and Tobin 2016) and close kin mark-recapture genetic assessments, which have been discussed by the PZJA Finfish RAG as a potential alternative index of abundance for the stock.

Financial year was used in the report as this period aligns with the fishing season dates as well as when spawning and recruitment to the fishery occurs.

Field collection

Length structure – Spanish mackerel and coral trout

Commercial fishers recorded the fork lengths of Spanish mackerel from whole unbiased (ungraded) catches onto waterproof measuring sheets with measurements to the nearest 1 cm. The measuring sheets were attached to a board with an aluminium end piece via two holes at one end. Where fishers could not measure an entire unbiased catch, they recorded the percentage of the catch. This representative length data was used to construct a length structure for the fishery.

Commercial fishers recorded the lengths of coral trout from whole unbiased (ungraded) catches, as per Spanish mackerel, using waterproof measuring sheets. Each sheet was used to record a single catch and fishers were asked to record a single species on each row of the data sheet (Figure 1). Fishers recorded the fork lengths of common, bar-cheek and blue spot trout species. Passionfruit trout was measured as total length due to their square-shaped tail. For all four species, fishers were

instructed to measure to the centre point of the tail on the relevant line of the sheet (Figure 2, Figure 3).

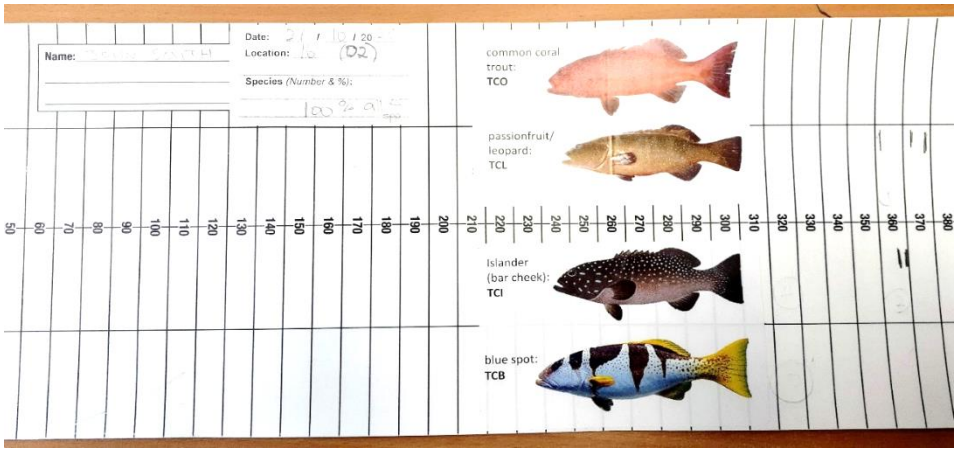

Figure 1. Example of the length frequency measuring sheet used by commercial fishers and fish receivers to collect measures of the four coral trout species noting one species is recorded per line.

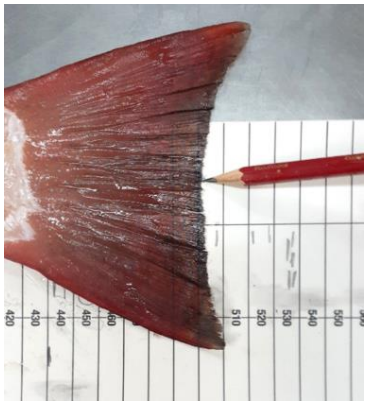

Figure 2. Position of fork length measurements collected for common, bar cheek and blue spot coral trout species being the centre point of the forked tail.

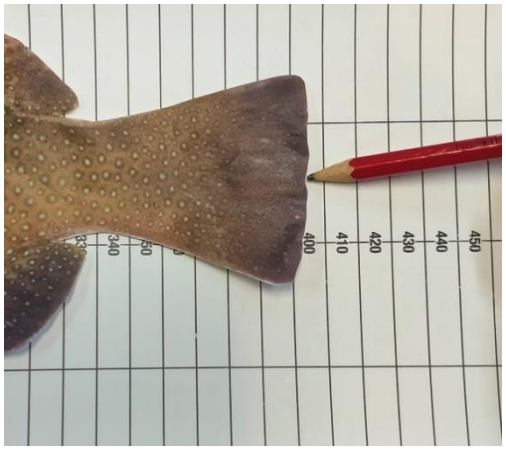

Figure 3. Position of total length measurements collected for passionfruit coral trout species only being the centre point of the square tail.

Coral trout species identification for recording length structure was performed using the AFMA publication "*Torres Strait Coral Trout Identification Guide*" (Appendix 4).

Catches were defined as the fish from one morning or afternoon session or from a pooled number of dories or days, as long as the total number of fish caught, the proportion sampled, and the date(s) were recorded.

Age and sex-at length

Commercial fishers collected samples of whole filleted fish frames (with gonads) and were provided with equipment necessary to do this. Fish were selected randomly by sex, and therefore the sex ratio was representative of the catch within each length class. The samples were freighted back to the laboratories at the DAF's Northern Fisheries Centre in Cairns where they were processed by DAF staff. Some fish were also processed in the field at Torres Strait Fish Receiver premises. Otoliths were removed and the sex of each fish determined.

Together with the biological material and length data, information on the catch including date caught, a general catch location and vessel name were provided by fishers with the fish samples and length data. Fishers were asked to provide position information as a general catch location that could include a reef or island name or a broader scale numbered region as per the Torres Strait Catch Disposal Record (TB02) (Appendix 5).

Laboratory and field processing

Processing - Spanish mackerel and coral trout

Most of the fish samples were processed in the laboratories at the DAF's Northern Fisheries Centre in Cairns. Some of the samples were processed at Torres Strait Fish Receiver premises during visits to conduct workshops in communities and to follow up with volunteer samplers and fish receivers.

To allow conversion between samples provided as a whole frame, or a fish head, all Spanish mackerel were measured by using callipers to measure the upper jaw length (Figure 4) of each fish to the nearest 1 mm. For Spanish mackerel fork length and total length (Figure 5) were also measured to the nearest 1 mm.

There was no need to collect measurements additional to fork or total length of each coral trout as the project was seeking to acquire whole coral trout frames. Fork length was measured to the nearest 1 mm for species with forked tails (common coral trout, bar cheek trout, blue spot trout (Figure 6) and total length, to the nearest 1 mm, was used for passionfruit trout, which have a square tail (Figure 7).

Location of the otoliths (ear bones) are in the cranial cavity and were accessed from the top of the head by making a dorsal transverse cranial incision with a saw or knife, cutting towards the back of the head (Figure 8). Otoliths were then removed using fine pointed forceps. Once removed, the sagittal otoliths were dried carefully with a tissue and stored in a 5 ml plastic vial labelled with a unique sample number. Otoliths were left in the vial for around 48 hours to allow further drying before capping with a lid.

Sex information was recorded whenever it was available. Sex was determined by macroscopically examining the gonads, or the residual pieces of the gonads connected to the frame. Sex was recorded as "unknown" if sex determination was not possible.

Genetic samples were opportunistically collected from Spanish mackerel samples only during processing. For this a small piece of tissue (approximately 2 mm in diameter) was removed from the fleshy portion at the dorso-posterior of the fish's head. Each sample was placed in a 2 ml vial filled with ethyl alcohol, labelled with a unique sample number, and stored in the laboratory freezer.

Ancillary data, including catch date and location, were recorded along with the biological data and all information was entered into a database and stored securely on the DAF server.

Figure 4. Upper jaw length measurement of a Spanish mackerel using Vernier callipers.

Figure 5. Position of fork and total length measurements collected from Spanish mackerel.

Figure 6. Position of fork length measures used for common coral trout, islander (bar cheek) trout and blue spot trout.

Figure 7. Position of total length measure used for passionfruit coral trout.

Figure 8. Stages of otolith extraction for a Spanish mackerel. Coral trout otolith extraction follows the same general procedure.

6.3 Fish ageing

Fish ageing - Spanish mackerel

DAF's Fisheries Queensland follows a standardised approach for routinely estimating the age of fish using otoliths (DPI&F 2007). For Spanish mackerel, this process involves examining whole sagittal otoliths under a microscope and identifying alternating opaque and translucent zones on the otoliths. Fisheries Queensland routinely interprets otoliths collected from both the Australian east coast stock and from Gulf of Carpentaria waters (part of the northern Australian stock). While the general otolith morphology is similar between the two stocks, there are subtle differences in the interpretation of the banding in the otolith and therefore separate protocols and quality assurance criteria are used for the two stocks (Fisheries Queensland 2013).

The standardised fish ageing methods for Gulf of Carpentaria Spanish mackerel (FQ. 2013) have previously been determined to be suitable for the interpretation of Torres Strait fish otoliths for this project (Langstreth and O'Neill 2020).

Training of staff was carried out using a reference set of otoliths with agreed interpretations. A competency test on 200 randomly selected otoliths from the reference set was then undertaken by the staff member. The otoliths were interpreted for:

- increment count – the number of opaque zones counted between the primordium (nucleus) and the distal (outside) edge of the otolith,
- edge type - the edge of the otolith is classified as new, intermediate or wide. Intermediate and wide classifications are based on the relative stage of completion of the marginal translucent zone (see Appendix 6), and
- readability – classifications included not-confident, confident, unreadable, or processing error.

Otolith increment counts were tested for bias and precision and edge classifications were tested for overall agreement. These quality control measures are used during reader competency before a sample of otoliths are interpreted (DPI&F 2007, FQ. 2013) to ensure precise and unbiased results. Following this competency process, the 302 otoliths collected during the project were then interpreted followed by a re-read of a 200 randomly selected subset. Standard bias, precision and agreement measures were assessed and fell within acceptable levels.

Fish ageing – coral trout

As per Spanish mackerel, DAF's Fisheries Queensland follow a standardised approach for ageing common coral trout. This process involves examining sectioned sagittal otoliths under a microscope and identifying alternating opaque and translucent zones on the otoliths. Unlike Spanish mackerel which are read as whole otoliths, common coral trout otoliths are set into clear resin blocks and sectioned into 0.27 mm slices, before being set on glass slides.

A staff member, experienced in reading common coral trout otoliths, trained on an existing reference set of common coral trout from the Queensland east coast stock with agreed interpretations. A competency test on 200 randomly selected otoliths from the reference set was then undertaken. The otoliths were interpreted for edge type as per Appendix 6.

Otolith increment counts were tested for bias and precision and edge classifications were tested for overall agreement. These quality control measures are used during reader competency before a sample of otoliths are interpreted (DPI&F 2007, FQ. 2013) to ensure precise and unbiased results. Following this competency process, the 27 common coral trout otoliths collected during the project were then interpreted and assigned an increment count and edge type. Given the small sample size, these 27 were only interpreted once (generally 200 fish are required for a re-read) and are considered a preliminary interpretation.

6.4 Data analysis

Length and weight conversions - Spanish mackerel

Multiple length measures from individual fish were collected where possible (total length, fork length, jaw length).

A conversion between fork to total length was used (where total length was not recorded) to provide the standard reporting form of total length, which is commonly used by fisheries management e.g. minimum size limits are generally in total length (Table 1).

Individual fish weight was calculated using sex-specific total length-weight conversions for Torres Strait Spanish mackerel developed by Begg et al 2006 (Table 1).

Table 1. Equations and source of length and weight conversions used in data analysis of Spanish mackerel. FL – fork length. TL – total length. F – female, M – male, P – pooled.

Conversion	Equation	Source
Fork to total length (mm)	Pooled: TL = 4.274 + 1.06 x FL	Mackie et al. (2003)
Total length (cm) to weight (kg)	Female: $W = 2.960e^{-6} * (TL^{3.148})$ Male: $W = 4.224e^{-6} * (TL^{3.068})$ Pooled: $W = 2.718e^{-6} * (TL^{3.165})$	Begg et al. (2006)

Length structures – Spanish mackerel

Individual fish counts were scaled to the percentage of the catch to account for any subsampling. Individual adjusted lengths were allocated into a 2 cm length class. Summed scaled counts were then used to calculate the proportion of fish within each length class.

Length structures were pooled by sex and calculated for each sector. Due to representative lengths measured from a low number of primary vessels for each sector, data was also pooled across sector for reporting purposes.

Age allocation – Spanish mackerel

The number and proportion of each otolith edge type were summarised to determine the distribution of each edge type across each month sampled between October 2020 and February 2021. This information was used to allocate each fish into an age group. Age group (or cohort), which is expressed in whole years, was the maximum age each fish would reach during 2020-21 (Error! R eference source not found.).

Spanish mackerel growth is extremely rapid in the first few years of life, with annual growth in the first year averaging 93 cm TL (Begg et al. 2006). To adjust for growth of individual fish over the sample period, fish length was adjusted to the length at a nominal birthdate. Spanish mackerel have a protracted spawning season in the Torres Strait, between August and March (McPherson 1986). The nominal birth date assigned was 1 November as the middle of the ‘expected’ peak in the estimated spawning season. Adjusted length was calculated using the von Bertalanffy growth equation defined as:

$$L_t = L_\infty (1 - \exp^{-K[t-t_0]}) + \varepsilon ,$$

where L_t was the length at age t, L_∞ is the asymptotic mean length, K is the growth coefficient, t is the age of fish when captured, t_0 is the theoretical age of fish at which mean length is zero, and ε indicates that residuals are assumed to be distributed normally about the fitted growth curve.

Growth coefficients as previously modelled for male, female and pooled sex (Langstreth and O'Neill 2020) were utilised in the adjustment of length and are provided in Table 2.

Table 2. Adjustment of otolith increment count to age group based on capture month of Torres Strait Spanish mackerel. Increment represents that the increment count was used as the value for age group. Increment + 1 represents that 1 year was added to increment count to calculate the value for age group.

Capture month	New	Intermediate	Wide
August	Increment	Increment + 1	Increment + 1
September	Increment	Increment + 1	Increment + 1
October	Increment	Increment	Increment
November	Increment	Increment	Increment
December	Increment	Increment	Increment
January	Increment	Increment	Increment
February	Increment	Increment	Increment

Table 3. Sex-specific von Bertalanffy growth parameters used to calculate adjusted length. The overall standard error of the observations for each sex are provided. Standard errors for each parameter estimate are provided in brackets.

Sex	Total n	L_∞	K	t_0	Standard Error
female	152	150.1555 (10.2366)	0.1461 (0.0405)	-5.0628 (1.29719)	6.86
male	74	109.8319 (11.26920)	0.5697 (0.1520)	-1.3037 (0.6215)	5.14715
pooled	252	142.7557 (13.65983)	0.1604 (0.05749)	-4.7961 (1.63011)	7.14786

Age length key – Spanish mackerel

One age-length key was generated for combined sexes for the 2020-21 samples using adjusted length allocated within a 2 cm length class and age group. The count of fish in each 2 cm length class was determined for each age group. From these, the proportion of fish in each length class was calculated for each age group to construct the age length key. All length classes in the length frequency sampled were matched with fish ages in the age-length key.

Age structures – Spanish mackerel

Age structures were constructed using the pooled-sex 2 cm adjusted fork length structure from both commercial sectors (TIB and Sunset combined) and the constructed age-length key described above.

To calculate the age structure of the fishery, the number of fish caught within each 2 cm length bin were divided between the appropriate ages according to the proportions of the age-length key. This was done by multiplying the proportion of ages within that length bin of the age-length key[4].

The proportion of fish in each age group were then calculated to develop the age structure for 2020-21.

7 Results and discussion

7.1 Data summary – Spanish mackerel

From October 2020 to February 2021, the length measurements of 2,304 Torres Strait Spanish mackerel were recorded from 52 individual commercial catches (Table 4). Fish measured represented 3,086 fish lengths when subsampling was accounted for. All catches were randomly sampled at greater than or equal to a 48 % subsample and were considered representative of the entire catch.

The majority of fish lengths collected were from the Sunset sector (97 %) with 71 fish (3 %) from four catches sampled from the traditional TIB sector (Table 5). The majority of the commercial harvest is taken by the Sunset sector (e.g. 55.6 t, 96.6 % in the most recent complete season 2019-20) with the remainder taken by TIB fishers (1.98 t, 3.4 % in the 2019-20 season) (AFMA 2020).

The proportion of sampling conducted in 2020-21 across each sector represents the contribution of each sector to the fishery. Based on estimates of total whole fish weight sampled in 2020-21 (11.8 t), the proportion of the commercial fishery reported through catch disposal records sampled was estimated at a total 74 %, with 15 % of the TIB and 80 % of the Sunset sectors (Table 4). Although sample sizes reflect the sector catch share for the fishery and total fishery sampling was estimated at 20.5 % in the previous 2019-20 season, the sample size of fish lengths caught by traditional

[4] For methodology see example 5. Pp-57 of http://www.fao.org/3/W5449E/w5449e.pdf

fishers may not capture the full variability in size of fish caught to enable length structure to be presented separately.

Length measurements were collected across two of the fishery areas. The majority (96.9 %) were from catches at the Bramble Cay fishing grounds (Table 5), in Area 4 of the fishery, where most of the commercial catch is known to be taken (e.g. 88 % of the fishery catches in the 2016-17 season (PZJA Finfish Resource Assessment Group Meeting 1, November 2017[5])). A smaller sample size of 71 lengths were collected outside of these grounds within Area 16 (Erub and Ugar reporting area).

A total of 302 Torres Strait Spanish mackerel otoliths were collected in 2020-21 with assistance from a number of individual commercial fishers and fish receiver businesses (Figure 9). Sampling occurred between the months of October and February. The greatest number of length and otolith samples were collected in October. Sex information was collected from 84 % of the fish sampled for otoliths.

Future sampling would benefit from enhanced sample sizes within the TIB sector as well as increased sample sizes from areas outside of the Bramble Cay grounds from both commercial fishery sectors. This would help to test for any spatial bias, as most of the historical information included in stock assessment was from Bramble Cay (O'Neill and Tobin, 2016, Presentation to PZJA Finfish RAG 8 November 2020[6]).

[5] https://www.pzja.gov.au/sites/default/files/tsffrag_1_091117_papers.pdf

[6] https://www.pzja.gov.au/sites/default/files/ffrag_8_record_4-5_nov_2020_final.pdf

Table 4. Sample sizes of Spanish mackerel length and age information collected during 2020-21. Total samples sizes are provided for each data type as well as the number of representative lengths and catches per fishing sub-sector, Sunset and TIB. Numbers of individual fishers or primary vessels indicate the number from which the information was collected for representative fish lengths.

Data type	Total number	TIB	Sunset
Lengths (subsampled)	2,304	71	2,233
Lengths (scaled)	3,086	71	3,015
Catches	52	4	48
Whole weight sampled*	23.04 t	0.49 t	22.55 t
Whole weight reported**	31.3 t	3.2 t	28.1 t
Proportion sampled***	74 %	15 %	80 %
Otoliths	301		
Sex data	248		
Genetic samples	292		

*** whole wet weight of sampled fish calculated from fork length.**

**** Commercial whole wet weight of Spanish mackerel reported via data request from AFMA 29 April 2021 based on catch disposal records in 2020-21 (AFMA 2021)**

***** represents proportion of the whole fish weight of fish sampled compared to the total catch estimate for 2020-21 fishing year.**

Table 5. Sample sizes of Spanish mackerel length and age information collected during 2020-21 across the Torres Strait docket book reporting areas (map of areas shown in Figure 2).

Data type	Area 4 (Bramble Cay)	Area 16 (Erub and Ugar)
Lengths (subsampled)	3,015 (2,233)	71 (71)
Catches	48	4
Otoliths	205	97
Sex data	188	60
Genetic samples	204	88

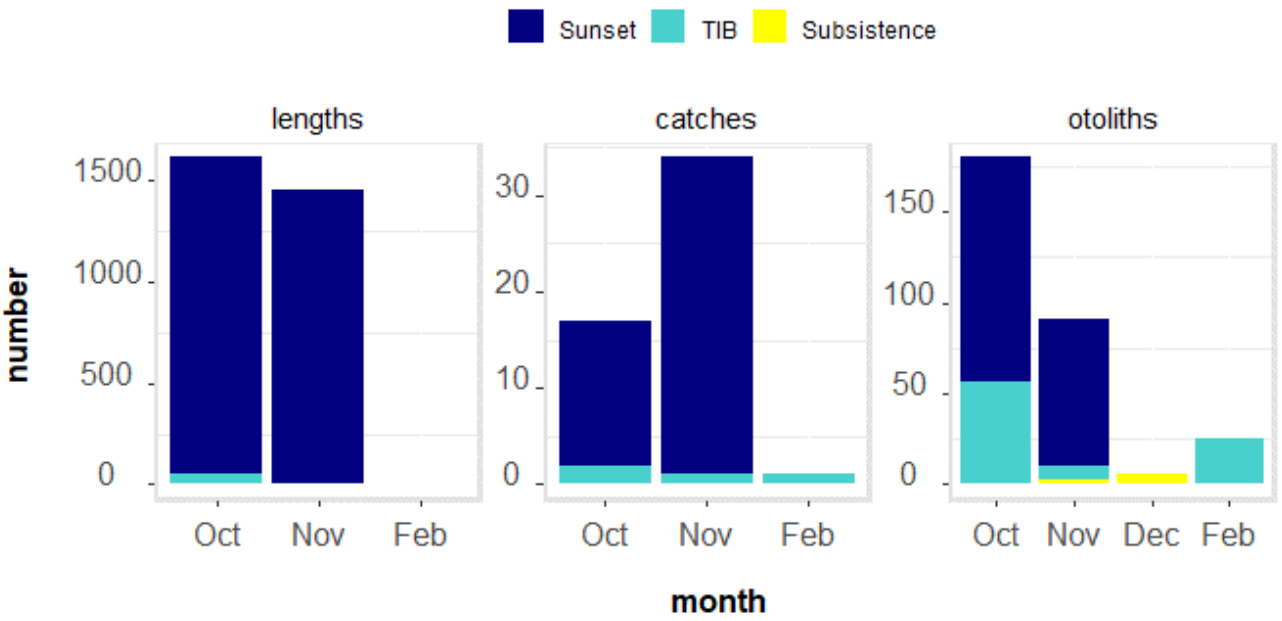

Figure 9. Seasonal spread of Spanish mackerel sample sizes of lengths, catches and otoliths by month and fishing sectors collected between October 2020 and February 2021.

Length structures – Spanish mackerel

Torres Strait Spanish mackerel sampled from commercial catches in 2020-21 ranged in length between 70 and 144 cm FL (~ 78 - 157 cm TL). The majority of fish (75%) were between 88 and 110 cm FL (Figure 5), with an average fish length of 97 cm FL (Figure 10).

Average fish lengths from the measured sub-samples of fish were similar between the commercial sectors at 93 cm FL for TIB (n=71) and 97 cm FL for Sunset sector (n=2233).

Increased sample sizes of fish lengths caught by traditional fishers would help to capture the full variability in length of fish caught. Due to privacy reasons, given the number of total primary vessels sampled within each sub-sector being less than five, the length structures were grouped for reporting.

Length structures sampled in 2019-20 and 2020-21 are similar to those reported from the older on-board surveys conducted in 2000-2002 and 2005 (Begg et al. 2006; O'Neill and Tobin, 2016; Langstreth and O'Neill 2020).

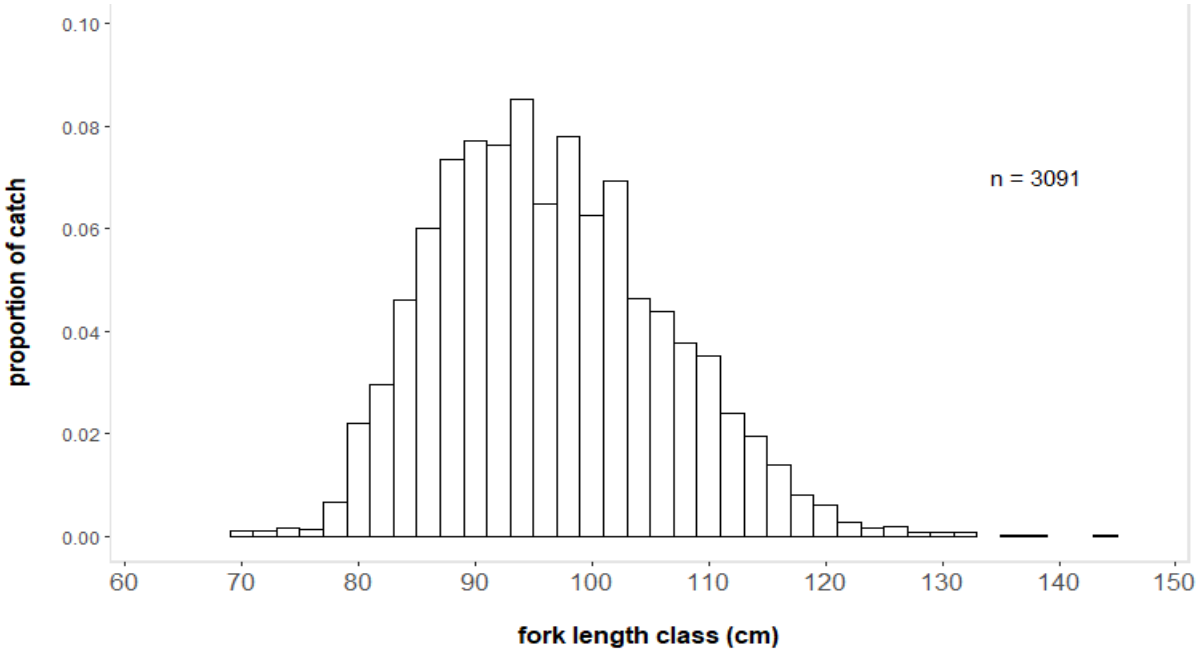

Figure 10. Length structure of the commercial Torres Strait Spanish mackerel catch in 2020-21. TIB and Sunset sectors combined. N-value (n=3091) is the number of fish scaled to account for subsampling.

Sampling in 2020-21 commenced in October 2020. Due to this late start the sampling did not capture the length structure of the start of the fishing season (August and September). During the August and September period, fishers typically report they catch smaller size class Spanish mackerel that are just over legal size (between 67 cm to 80 cm FL).

Sex ratio – Spanish mackerel

Sex ratios were biased towards females, particularly in the larger length classes (Figure 11). A breakdown of the sex ratios by length class demonstrates a change from a male to female bias as length increases.

This follows similar sex ratio by length class trends in the 2019-20 sampling and earlier Torres Strait sampling (Begg et al. 2006; Langstreth and O'Neill, 2020), although the smallest and largest length classes, with small sample sizes, are difficult to compare. This bias is likely to be influenced by sex-specific growth rates.

Sex ratio can vary with lunar cycle, with more males recorded over the first quarter and full moon periods and equal ratios over the new moon and last quarter periods (Mackie et al. 2003). Fish sampled for sex information were collected across the lunar cycle. However, this temporal variability could be investigated with additional years of sampling.

Figure 11. Sex ratio of Torres Strait Spanish mackerel in 2020-21 within each 5 cm length class 70-74 to 135-139 cm FL. Numbers on the bars represent sex-based sample sizes within length class.

Fish ageing – Spanish mackerel

Otoliths were collected from a total of 302 Torres Strait Spanish mackerel and interpreted, recording increment count, edge type and readability. A subset of 200 randomly selected otoliths were re-read.

Standard bias, precision and edge classifications were tested for overall agreement between the two interpretations. Increment counts were tested for bias and precision, and edge classification was

tested for overall agreement within each category. Quality control measures fell within acceptable levels as per existing measures for Gulf of Carpentaria Spanish mackerel[7] (FQ. 2013).

Three otoliths were classified as unreadable. The fish aged ranged in length between 69 cm and 144 cm FL and in age groups from 1 to 13 (Table 6**,** Table 7). Male fish were generally smaller and younger than the females sampled. The age group of each fish was determined using the methods described in 0.

Table 6. Observed length and age group data summary of Torres Strait Spanish mackerel during 2020-21. Total length is provided in brackets.

Data type	Female	Male	Unknown
Min FL (TL)	81 (91)	69 (78)	70 (78)
Max FL (TL)	144 (157)	120 (131)	115 (126)
Avg FL (TL)	100 (110)	92 (102)	93 (103)
Min age	2	1	1
Max age	13	9	9
Sample size (n)	118	125	53

[7] Calculated index of average percentage error (IAPE) was less than 6 (IAPE = 3.38) and edge type classification agreements were above the acceptable levels of correct otolith edge determination of 70% for new edge types, and 50% for intermediate and wide edge types. Edge type agreements were at 87%, 83% and 73 % for the new, intermediate and wide edge type categories respectively.

Table 7. Measured fork length (FL) in cm at age (age group) data summary of Torres Strait Spanish mackerel during 2020-21, showing mean length and sample size for both males and females. Numbers in brackets are the range of lengths for each sex within each age group.

Age group	Female FL (cm) Avg (range)	Number of females	Male FL (cm) Avg (range)	Number of males	Total number
1			75 (69-80)	8	8
2	92 (81-106)	55	88 (79-98)	50	105
3	101 (88-116)	23	93 (77-102)	27	50
4	105 (94-114)	20	97 (89-103)	18	38
5	113 (102-136)	7	103 (94-110)	12	19
6	116 (105-138)	11	104 (95-108)	6	17
7			112	1	1
8	115	1	108 (107-108)	2	3
9			120	1	1
10					
11					
12					
13	144	1			1

Age allocation – Spanish mackerel

Following the methodology established in the 2019-20 sampling, the edge type of Torres Strait Spanish mackerel otoliths (Figure 12) was determined as either new, intermediate, or wide in characteristics to be able to allocate each fish into an age group cohort. This process aims to group similar age fish into the same cohorts or age groups, using information on the month of capture and the number of annual increments and otolith edge type category determined during age interpretation.

The timing for the period of opaque zone otolith formation was similar to that observed for Spanish mackerel in neighbouring waters, which peaks in October for fish from east coast waters and September for fish from the Queensland zone of the Gulf of Carpentaria waters (DAF 2013; O'Neill and Tobin 2016; Langstreth and O'Neill 2020). The observed otolith increment counts were assigned to an age group (or cohort) based on the otolith edge types and month of capture. As there were no fish sampled prior to October, there was no adjustment of the increment count required, and, therefore, age group equalled increment count for all 2020-21 samples.

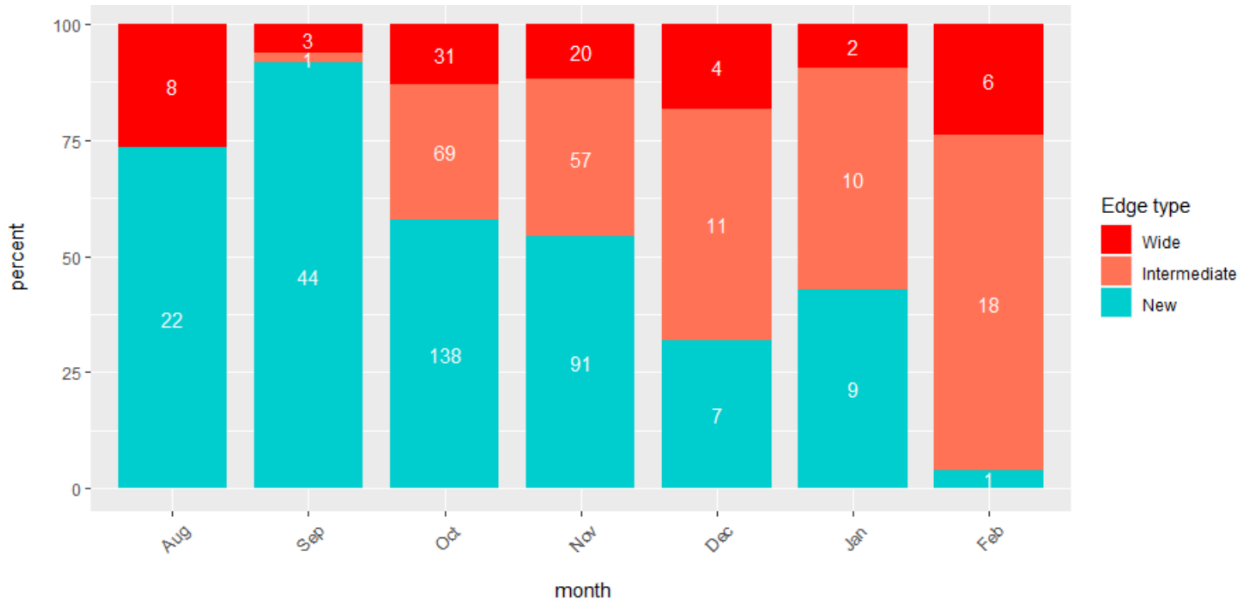

Figure 12. Torres Strait Spanish mackerel 2019-20 and 2020-21 otolith edge type by month n=552.

Age-length key – Spanish mackerel

The adjusted fork length and age group of 292 fish were used to construct an age-length key (ALK) to convert the length structures into an age structure for the fishery. Age information could not be collected from ten fish due to otolith breakages or very low readability.

All fish less than 76 cm were in the 1+ age group (Figure 13). The oldest fish was a female in the 13+ age group and measured at 144 cm FL (157 cm TL). Gaps in the ALK were identified as shown in Figure 13 below.

A comparison of the ALK to the sampled length frequency (adjusted fork length) determined there were no fish measured that would correspond to these gaps. Noting there are no length classes in the length frequency that were unmatched with fish classes in the ALK there was no treatment

conducted to fill these parts of the distribution. Although it was not required for 2020-21 sample data, if gaps in the ALK were required to be filled to match the length frequency, they would be modelled using a generalised linear model predicting age at length using the observed values.

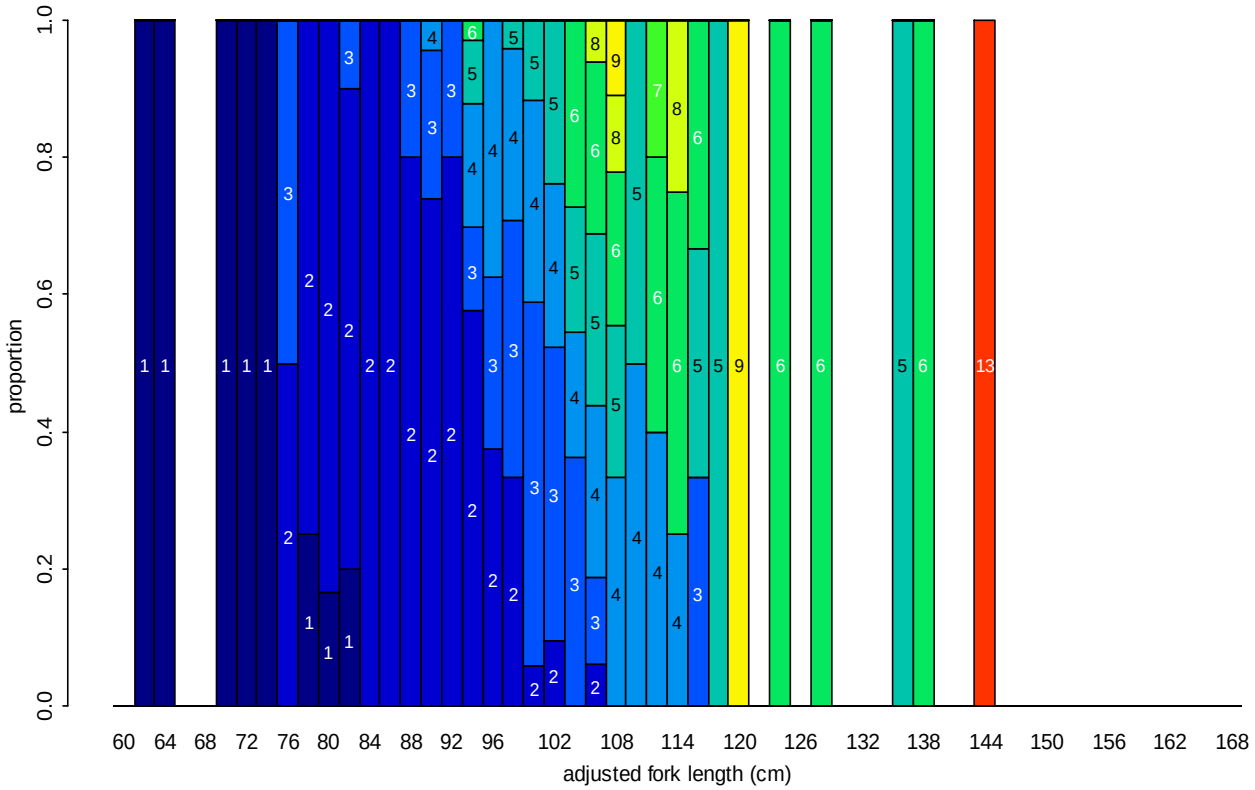

Figure 13. Plot of the observed age-length key of Torres Strait Spanish mackerel sampled in 2020-21 using age group and adjusted fork length (cm). Number of fish = 292. Numbers shown on bars represent age group.

Age structures – Spanish mackerel

The age structure of Torres Strait Spanish mackerel in 2020-21 from Sunset and TIB sectors was grouped and is presented in Figure 14. Fish ranged between 1+ and 13+ with the catch dominated by fish in age groups 2+ to 4+ which comprised 79.8% of the catch. Age structures for the fishery are heavily truncated with only 2.7% of fish in age groups greater than 6+.

The combined age structure in 2020-21 (Figure 14) is similar to those reported from 2000-01, 2001-02 (O'Neill and Tobin, 2016) and 2004-05 (Begg et al. 2006) showing few fish aged over 5 years. Spanish mackerel less than 2 years old (1+ age group) were considered not fully recruited into the fishery (O'Neill and Tobin 2016; QDAF 2018) and comprised 1.5% of the catch.

There again appears to be a large difference in 2020-21 in the low proportion of older fish (>6+ age group) and the maximum age of fish caught in the Torres Strait compared to fish caught in Queensland east coast and Gulf of Carpentaria fisheries (Langstreth et al. 2018; O'Neill et al. 2018; Bessell-Browne et al. 2020.). Langstreth and O'Neill (2020) provided analysis of these differences in age structures and discuss possible causes.

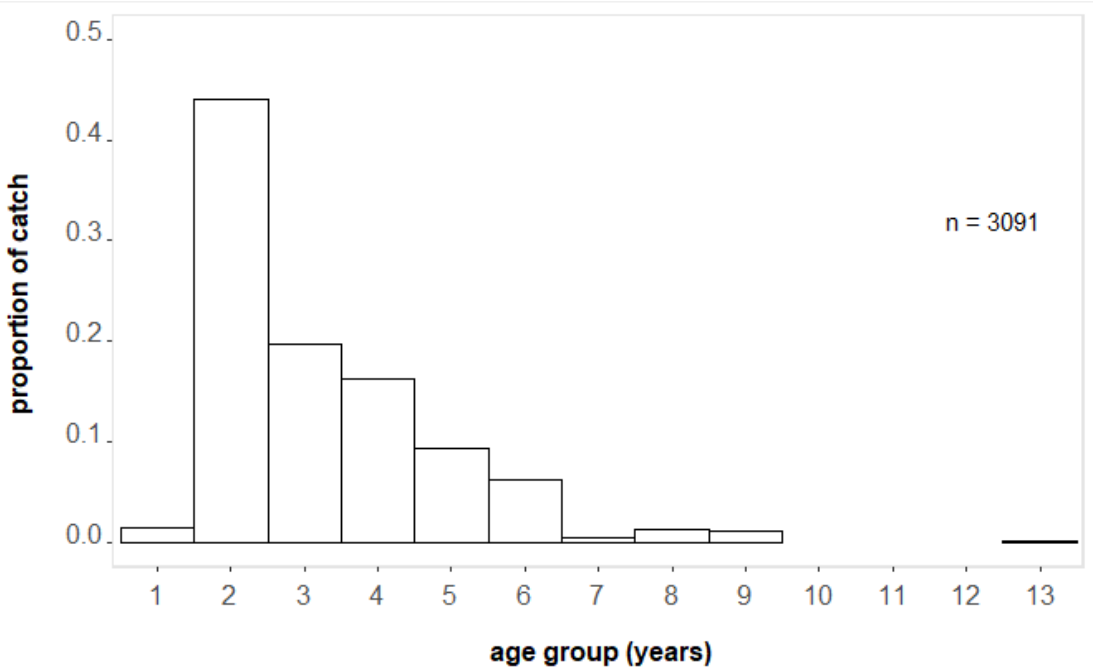

Figure 14. Age structure of the commercial Torres Strait catch in 2020-21. TIB and Sunset sectors combined. N-value (n=3091) is number of fish represented.

7.2 Data summary – coral trout

From October 2020 to February 2021, the length measurements of 75 common coral trout, 13 bar cheek coral trout and 84 passionfruit coral trout were recorded from 10 individual Torres Strait commercial catches.

At the time of publication, the coral trout fishing season is still in progress with samples still currently being collected, processed and aged.

A total of 58 coral trout otoliths were collected with assistance from individual commercial fishers (27 common coral trout, 22 passionfruit coral trout and 9 bar cheek coral trout).

Sex information was collected from 44 of the 58 fish sampled for otoliths.

Further sampling will enable enhanced sample sizes within the TIB and Sunset sectors and from a range of locations.

Catch composition – coral trout

Ten catches of coral trout were measured. These catches yielded three of the four known species of coral trout from Torres Strait. No blue-spot trout were sampled. Figure 15 (below) details the catch compositions for both the Sunset (n= 46) and Traditional Inhabitant Boat (n = 126) sectors for 2020-21 season sampling.

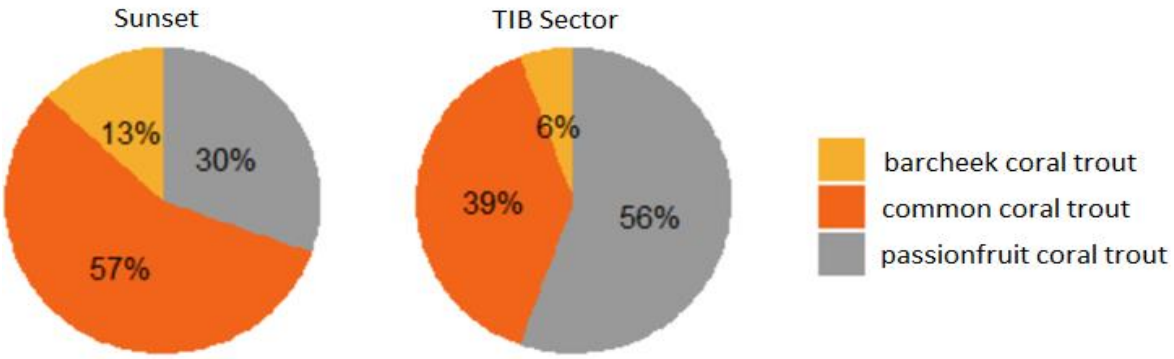

Figure 15. 2020-21 species composition of catches from coral trout catches.

Discussions with community members on species composition of coral trout revealed that certain reefs adjacent to eastern communities appear to have a high abundance of passionfruit trout compared to other coral trout species.

Length structures – coral trout

Torres Strait common coral trout measured from commercial catches in 2020-21 ranged in length between 36 cm and 60 cm FL. The majority of common coral trout (63%) were between 47cm and 57cm FL (Figure 16).

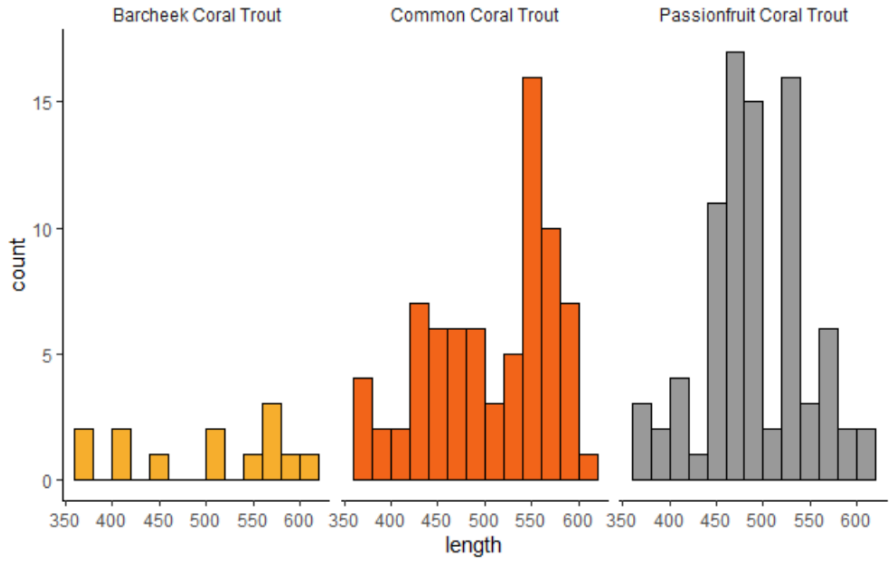

Figure 16. Length frequency analysis of Torres Strait coral trout species from 2020-21 sampling (common coral trout n=75, passionfruit coral trout n=84, barcheek coral trout n= 13).

Sex ratio – coral trout

Sex information was able to be determined from 43 out of 58 (80.4%) of the coral trout frames obtained for study in the lab. Analysis of sex ratios was not able to be performed due to the relatively small sample size.

Sex information was not able to be determined from most coral trout measured in the field as most coral trout length frequencies were measured at fish receiver premises and were being sold to market as whole fish or had been gutted prior to sampling.

Future catch sampling on coral trout could involve project teams working with volunteer samplers and fish receivers to increase the sample sizes and proportion of fish returned with gonads attached for study.

Fish ageing – coral trout

Otoliths were collected from a total of 27 Torres Strait common coral trout and interpreted by a qualified DAF staff member experienced in ageing common coral trout. An initial characterisation of the Torres Strait common coral trout by this experienced reader was able to conclude that the otoliths were generally similar in appearance to the east coast stock in terms of their structure and readability in line with the established east coast common coral trout ageing protocol (Fisheries Queensland 2020). In line with this protocol, being satisfactory for use on Torres Strait fish, the otoliths were interpreted recording increment count, edge type and readability.

These ageing data were considered as a preliminary data set due to the relatively low sample size for common coral trout. Not enough age data were available to support assigning ages based on edge type and month harvested, nor were there enough data to support forming an age-length key. Further sampling will be required to collect data to support these calculations.

The common coral trout sampled for ageing ranged in length between 48 cm and 59 cm FL and were assigned an age based on increment count from 4 to 12 years old.

In addition to the common coral trout aged, otoliths were collected from a further 22 passionfruit coral trout and 9 bar cheek coral trout. As per the project agreement these otoliths have been blocked into resin, sectioned and prepared on slides. They are securely stored at the DAF's Northern Fisheries Centre in Cairns for future study.

8 Conclusions

Conclusions – Spanish mackerel

The 2020-21 biological sampling of Torres Strait Spanish mackerel has continued to address a long-term critical fishery data need for updated length-age information to inform stock assessment for the fishery.

Total sample sizes of Torres Strait Spanish mackerel collected were suitable to represent the length-age structures of the commercial fishery as a whole sampling from both Sunset and TIB sectors as per each sector's annual catch share proportion. Increased sample sizes of measured catches from the TIB sector and increased participation (>5 vessels) in sampling from within each sector would allow construction and reporting of sector-based length-age structures for comparison.

The 2020-21 sampling has continued to improve on the spatial and seasonal spread of sampling compared to historic biological sampling that was primarily conducted at the main fishery Bramble Cay grounds during October and early November (Begg et al. 2006; O'Neill and Tobin 2016).

Enhanced sample sizes in fishery areas around the eastern and central islands would improve the representation of the sex, length and age data by better capturing the variability in catches across this area. This will help to test for any spatial bias, as most of the stock assessment information was from Bramble Cay in line with this being where the majority of fishing harvest occurs.

Length structures of commercial Torres Strait Spanish mackerel showed a majority (75%) of fish were between 88 and 106 cm FL. Age structures in 2020-21 were dominated by the 2+ to 4+ age groups (80%) and truncated from the 6+ age group, with limited numbers of older fish present. Age structures appeared highly similar to derived age structures from early sampling during 2000-2002 and 2005 (Begg et al. 2006; O'Neill and Tobin 2016) and 2019-20 (Langstreth and O'Neill 2020).

The absence of older Spanish mackerel in fisheries within Torres Strait and Queensland's zone of the Gulf of Carpentaria is of interest when comparing to age structures reported within east coast fisheries (Langstreth et al. 2014; O'Neill et al. 2018; Bessell-Browne et al. 2020), that record much higher proportions of older fish and a maximum age at 26+. Reasons for this large difference in the age structures are largely unknown however may be linked to major differences in available offshore reef habitats and food availability, total population size, fish movement patterns to other areas, fishing gears, marketing or high fishing and/or natural mortality. Documentation of the differences in fishing gears and techniques used by commercial fishers and product form across these fisheries would assist to understand size selectivity influences on fishery length-age structures.

Conclusions – coral trout

Biological sampling of Torres Strait coral trout species conducted in 2020-21 has helped to address a long-term data need for updated length at age information to help inform development of a stock assessment and harvest strategy for the fishery.

The project has engaged with volunteer samplers in communities actively fishing commercially for coral trout (Ugar, Erub, Mer) and the sunset vessels targeting coral trout and has begun to build a modest collection of samples from a range of catch locations across eastern Torres Strait.

Initial consideration of the species composition of catches from the representative sampling has been achieved. Of note was the relatively large amount of TIB sector passionfruit trout from catch location 16 (Erub and Ugar area). During sampling in communities, industry members advised the project team that certain home reefs near eastern communities do appear to have a high abundance of passionfruit trout compared to other coral trout species. With further sampling, the project team will monitor and address this proportionality.

The relatively low level of fishing effort and low number of operators actively targeting trout remains a challenge for coral trout sampling in Torres Strait. The 2020-21 initial sampling has produced good engagement from the Traditional Inhabitant Boat commercial sector especially fish receiver operations processing coral trout on Erub and Mer. It is expected that further sampling will expand on this representativity and will continue to build on these data increasing their utility in meeting the fishery data needs.

Collecting further samples of other coral trout species (bar cheek, passionfruit and blue spot) will enable consideration to be given for an appropriate approach for ageing relative to DAFs established common coral trout protocols.

Conclusions – general

Age-length data from this project will inform future Torres Strait Spanish mackerel and coral trout stock assessments and greatly inform management of these unique fisheries. Ongoing biological sampling will be critical in capturing inter-annual variability in age-length information and will benefit from further building sampling from the TIB sector and from collecting further Spanish mackerel samples from areas outside of the Maizab Kaur (Bramble Cay) fishing grounds where the majority of mackerel samples were collected.

While most data were collected from the Sunset sector, some valuable data was supplied from fish receivers taking product from TIB fishers in eastern communities. These businesses assisted the project to sample 15 % of the Spanish mackerel harvest from this sector. Most of these data were collected in collaboration with the project team while in community. Only a small portion of samples from the TIB sector were returned to the laboratory independently.

A key challenge for the project remains converting general support and interest in the project from stakeholders into active participation in completing length measures and providing fish frames at intervals for study. To address this in 2020-21, project staff have changed approach by spending time in communities to focus on one-on-one engagement and coaching with fishers and fish receivers that have expressed an interest in sampling. This approach is required over time for businesses to understand the importance of data needs, the technical requirements of sampling and data collection and to find ways to include sampling in their routine business practices.

Continued partnerships with key stakeholders, regular community engagement and feedback of project results are recommended to continue to build and promote trust to support effective working relationships between communities and researchers.

A further challenge for this project, and all research in Torres Strait, remains communication and logistics in this remote area. Organising on-ground community meetings, flights and accommodation for researchers takes time. The research may only be conducted through engaging and respecting the community elders and leaders while regarding the native title process in line with Prescribed Body Corporates. Future research and biological sampling in Torres Strait must continue to respectfully engage these community leaders.

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Appendix 1: Project information sheet

Department of Agriculture and Fisheries

Collecting biological data on coral trout and Spanish mackerel in the Torres Strait

About the research project

Torres Strait finfish are harvested from the ocean by line fishing. Fish such as coral trout and Spanish mackerel are an important traditional food source and income for communities.

The Protected Zone Joint Authority uses a stock assessment tool to set the amount of fish that are allowed to be caught each year by all fishers across the fishery. The most recent stock assessment for the Torres Strait Spanish Mackerel Fishery shows that catch rates in the fishery appear to be declining.

Length and age information is essential to future stock assessments for coral trout and Spanish mackerel. This information will help us understand more about the fish caught across different fishery areas.

Figure 1 A common coral trout

The Department of Agriculture and Fisheries, Australian Fisheries Management Authority and the Torres Strait Regional Authority staff will continue to work with commercial fishers and Torres Strait Islander communities to collect biological data from commercial catches of coral trout and Spanish mackerel.

The Australian Fisheries Management Authority and the Torres Strait Regional Authority is funding another year of this research.

Project objectives

The project will collect information on the age and length of coral trout and Spanish mackerel caught by commercial fishers in the Torres Strait during 2020 and 2021. It will also record the different species of coral trout caught by fishers. This information will be used in the stock assessments for these species.

Figure 2 A Spanish mackerel

Research locations

Sampling will focus on the eastern areas of the Torres Strait, where commercial fishing operations target these fish.

Project staff will aim to visit Erub (Darnley Island), Masig (Yorke Island), Ugar (Stephen Island), Mer (Murray Island) and Thursday Island to meet with fishers and representatives from fishing groups. They will discuss the project and ask fishers and staff at community freezer facilities to collect data and fish samples during the project period.

Data collection

The project will involve:

- collecting species, length, age and sex information of coral trout and Spanish mackerel from commercial catches
- working with Indigenous and non-Indigenous commercial fishers and staff at community freezer facilities to assist in the collection of length data and fish frame

Australian Government
Australian Fisheries Management Authority

Torres Strait Regional Authority

Queensland Government

samples. These samples will help determine the length, sex and age of each fish

- a stratified sampling design to make sure most of the fish length, sex and age information is collected at times and places where most of the fish are being caught
- freighting fish frames to Cairns to be processed in the Department of Agriculture and Fisheries Northern Fisheries Centre laboratories. The ear bones (otoliths) will be removed from the fish and used to determine the age of each fish (see Figure 2).

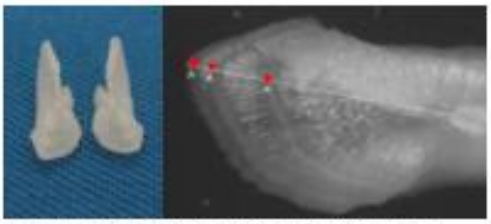

Figure 2 (left) A pair of whole otoliths (ear bones) from a Spanish mackerel. **(right)** An otolith under a microscope with three annual bands, each representative of a year of life, marked by red dots.

Working with fishers and communities

Project staff will talk to Torres Strait Islander communities and fishers about the project. There will be opportunities for fishers and community freezer facilities staff to be involved in collecting data and fish samples.

Figure 3 Scientific staff member removing otoliths from a Spanish mackerel at the Erub freezer

How will the information be used?

The species type, length, sex and age data will provide important insights into the structure of coral trout and Spanish mackerel stocks caught by the fishery. The data will be incorporated into future Torres Strait Finfish Fishery stock assessments.

This project may provide more certainty in the catch levels set by the Protected Zone Joint Authority. This will assist the long-term health and sustainability of these fisheries and will help to maximise the catch that can be taken.

Summarised results from 2019-20 for Spanish mackerel are available and further results will be also at the end of the project, and presentations will be conducted to communicate the major project findings.

For more information

Andrew Trappett, Department of Agriculture and Fisheries:
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Appendix 2: Free prior and informed consent form: information sheet and consent form.

INFORMED CONSENT FORM

Lead Researcher: Joanne Langstreth, Fisheries Queensland, Department of Agriculture and Fisheries
Research project: Enhancing biological data inputs to Torres Strait Spanish mackerel stock assessment

I understand the aim of this research project is to collect biological information on the length, sex, age and details of the catch (catch date, general location) of Spanish mackerel caught during commercial fishing in the Torres Strait. This information will provide important insights into the length and age structure of fish being caught across different areas of the fishery. This data is intended to be included in an update of the stock assessment for Torres Strait Spanish mackerel. Data from this project may provide more certainty in the catch levels that are set as a result of future stock assessments and will assist the long term health and sustainability of the fishery. If you decided to take part in the project and provide samples for the project, you will be provided a simple summary of our findings at the end of the project.

I acknowledge that:

- taking part in this workshop is voluntary and I am aware that I can stop taking part in it at any time without having to give a reason or feel like I am being judged.
- no names will be used to identify me in publications that results from this study without my approval;
- confidentiality cannot be assured in workshops.
- if I decide to assist with collecting fish samples or data for the project, I will receive $5 per fish frame and $40 per catch to cover the costs of my time. The number of samples that I can be paid for will be negotiated and agreed to with the project leader. All resources (such as bags and tags) and freight will be covered so I am not out of pocket.
- once my data and samples are submitted, even if I withdraw from providing further data, my previously submitted data will not be able to be withdrawn.

	(Please tick to indicate consent)			
I consent to participate in a workshop to discuss the research project		**Yes**		**No**
I consent to photographs being taken at the workshop		**Yes**		**No**
I consent that photographs of me may be used in project publications or promoting the project		**Yes**		**No**

Name: *(printed)*	
Signature:	**Date:**

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Workshops for Torres Strait Spanish mackerel biological data project

You are invited to take part in a research project to collect length data and fish frame samples of Spanish mackerel caught in the Torres Strait. This research is helping communities, fishers, managers and scientists to learn more about the length, sex and age of Spanish mackerel caught within the commercial fishery in the Torres Strait. This knowledge is being used to maintain the health of the fishery into the future.

This one-year project is the result of a need identified by the Protected Zone Joint Authority (PZJA) Finfish Working group for updated information on the ages and lengths of Spanish mackerel. There is uncertainty in the condition of the Torres Strait Spanish mackerel stock and concern about declining catch rates. This information will be supporting the stock assessment for your Torres Strait Spanish mackerel fishery. The stock assessment is the tool being used by the PZJA in assessing the health of the fishery and in setting the amount of fish that are allowed to be caught each year by all fishers across the fishery.

The project is being led by **Jo Langstreth** from **Fisheries Queensland, Department of Agriculture and Fisheries (DAF)**, in collaboration with **Australian Fisheries Management Authority (AFMA)** and **Torres Strait Regional Authority (TSRA)**. Our project team brings fishery research, monitoring and assessment experience, with leaders from local fisheries management and the regional authority. This team is looking forward to working with fishers of the Torres Strait to collect fish length data and fish frame samples.

A series of workshops will be held in Erub, Mer, Masig and Ugar communities to discuss the project, seek input and provide an opportunity to train fishers and staff at community freezer facilities on how to collect the fish length data and fish frame samples.

The length and age data of Spanish mackerel is needed from across the fishery during times when most of the fish are caught. It is important to collect data from both the Indigenous and non-Indigenous commercial fishers. To explain how the project will work, two to three hour workshops will: a) discuss the aims of the research project, b) seek participation in the research for people interested in collecting data and samples of Spanish mackerel, c) seek knowledge and ideas, and d) discuss issues.

Taking part in this research is voluntary and you can stop taking part in the study at any time without having to give a reason or feeling like you are being judged.

Any contact details you provide will be strictly confidential to the project team. The data from the study will be used in the fisheries stock assessment project, research publications, presentations, and a summary report back to you and your community. Individuals will not be identified in any way in these reports, publications or presentations. Please be informed that confidentiality cannot be assured among members of the workshop sessions, although we ask participants to maintain confidentiality outside of the group.

If you have any questions about the study, including the ethical conduct of the study, please contact our Project Manager:

Jo Langstreth
Fisheries Queensland,
Department of Agriculture and Fisheries
Phone: (07) 4241 1245, 0429 029 625
Email: Joanne.Langstreth@daf.qld.gov.au

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Appendix 3: Summary of project team community visits 2019-20 and 2020-21

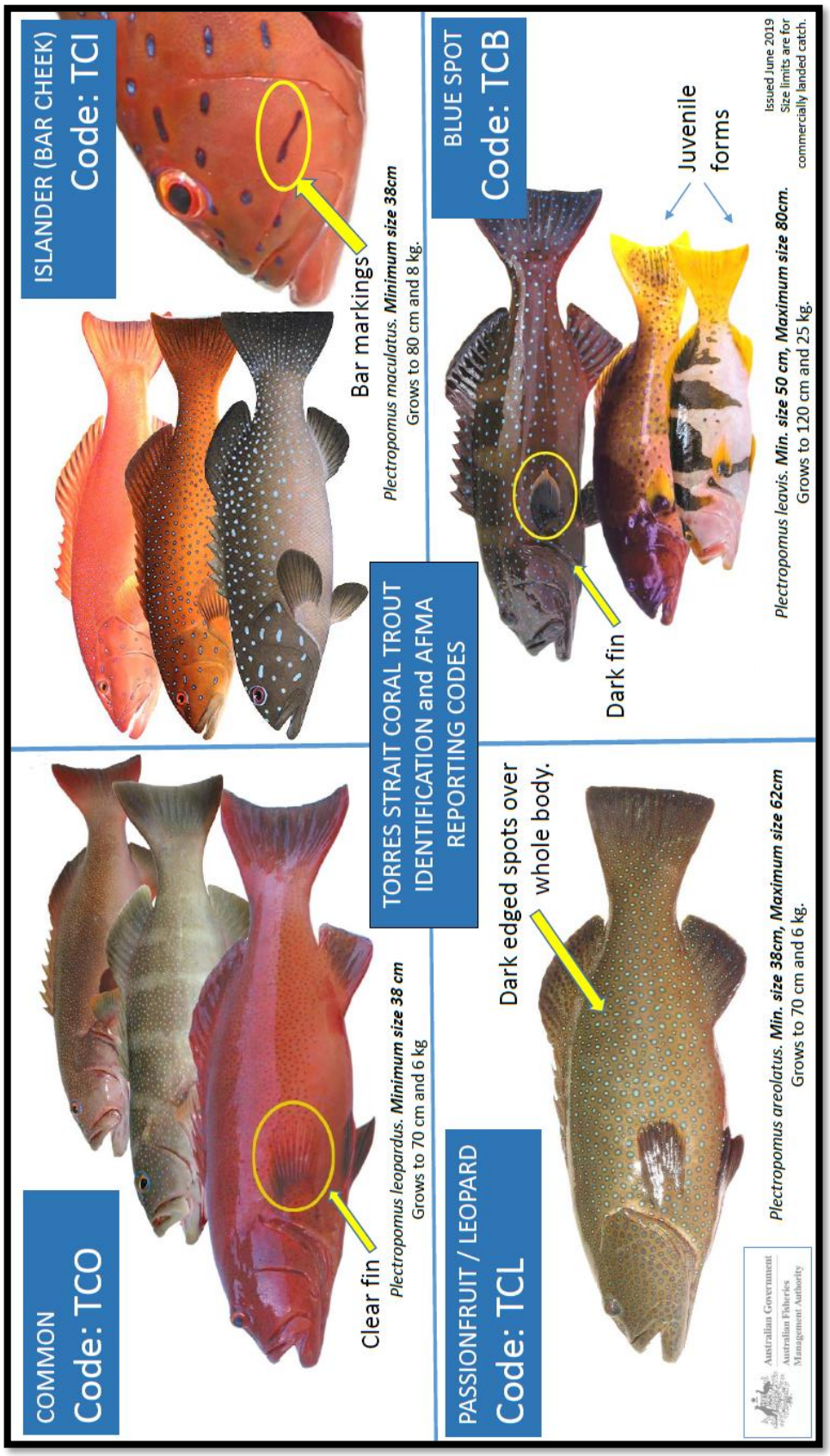
2019-20 sampling program community visits

Date	Activity	Project team agencies attending
17 September 2019	Workshop Erub along with PZJA Industry Members.	TSRA, AFMA, Fisheries Queensland.
19 September 2019	Workshop Masig along PZJA Industry Members.	TSRA. AFMA, Fisheries Queensland.
9 October 2019	Workshop Ugar along with PZJA Industry Members.	TSRA. AFMA, Fisheries Queensland.

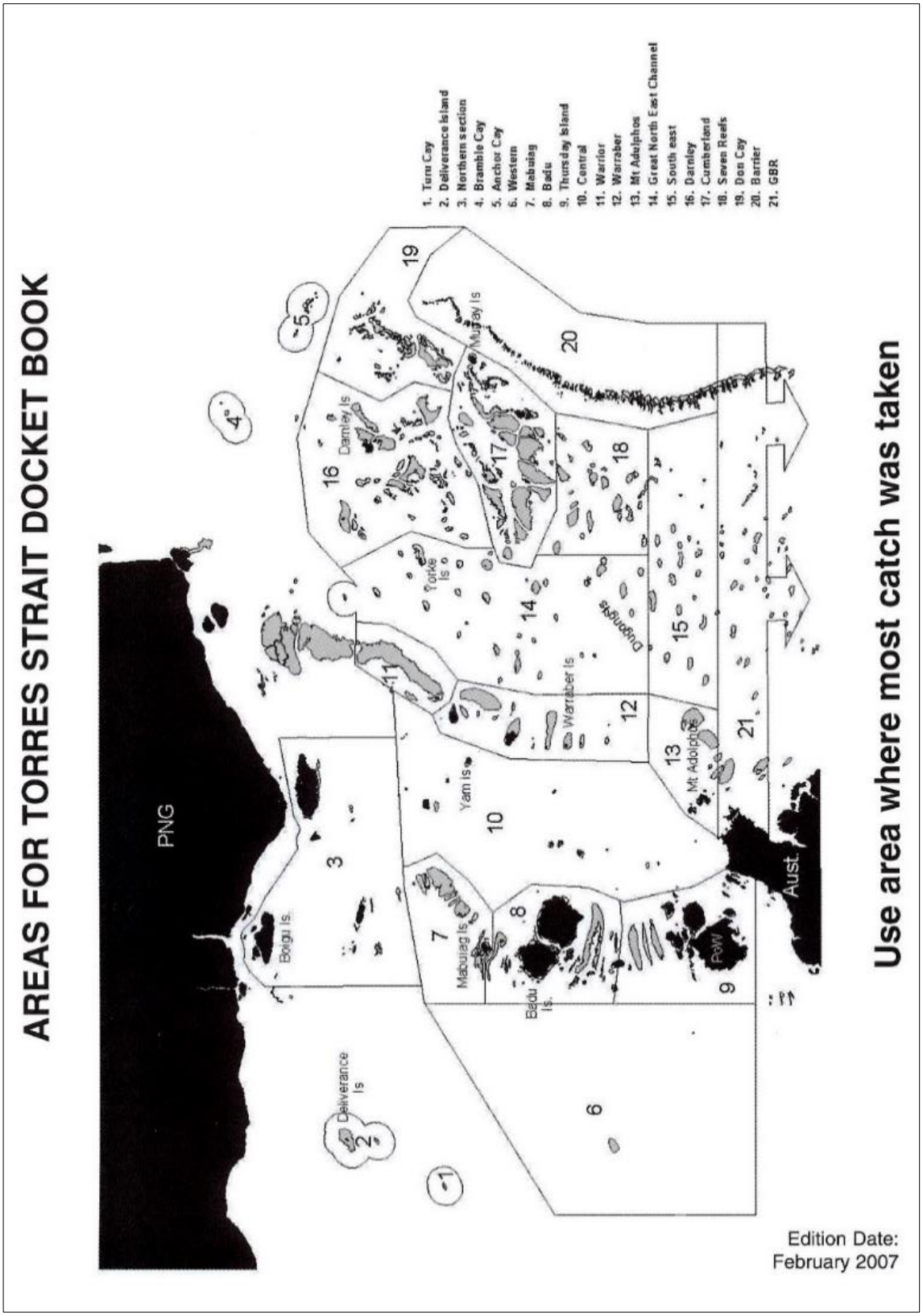
2020-21 sampling program community visits

Date	Visit	Agencies
27 Oct – 3 Nov 2020	General community meetings held on Erub, Ugar & Mer communities. Presentation of 2019-20 results, engaging with community and fishers/fish receivers.	AFMA, Fisheries Queensland.
7-11 Dec 2020	FQ, AFMA visit to Erub and Mer for targeted follow-up with fishers and fish receivers actively fishing and providing samples.	Fisheries Queensland, AFMA.
15-19 Feb 2021	FQ, AFMA & TSRA visit to Erub and Mer for targeted follow-up with fishers and fish receivers actively fishing and providing samples.	Fisheries Queensland, AFMA, TSRA.

Appendix 4: Coral Trout Identification Guide

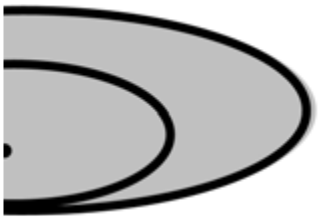


Appendix 5: Reporting areas used for areas fished – AFMA TDB02 Catch Disposal Record



Appendix 6: Otolith edge type categories used for ageing

Table 8. Otolith edge type categories and descriptions assigned to each fish during ageing with example diagrams for each category

Edge type	Description	Example diagram
1 - new	Opaque material is visible on the otolith edge. The opaque material need not be continuous around the entire edge. A narrow amount of translucent material may be visible in some areas on the otolith edge.	
2 - intermediate	A continuous band of translucent material is visible on the outermost edge of the opaque zone. This marginal translucent zone is less than 2/3 complete.	
3 - wide	Marginal translucent zone is more than 2/3 complete.