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Torres Strait Finfish Fishery: Coral Trout and Spanish Mackerel Biological Sampling 2024-25

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Acronyms and traditional names

Acronyms and Terms

AFMA	Australian Fisheries Management Authority
CDR	Catch Disposal Record issued by AFMA for mandatory recording of harvests by licenced fish receivers (TDB02)
DPI	Department of Primary Industries, Queensland
FL	fork length
IAPE	index of average per cent error
IQR	inter quartile range
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 leasing annual access to commercially fish
TIB	Traditional Inhabitant Boat sector (commercial fishers)
TL	total length
TSFF	Torres Strait Finfish Fishery
TSFFRAG	PZJA Torres Strait Finfish Fishery Resource Assessment Group
TSIRC	Torres Strait Island Regional Council
TSRA	Torres Strait Regional Authority
TVH	Transferrable Vessel Holder

Traditional names

Erub	Darnley Island community
Maizab Kaur	Bramble Cay fishing grounds, approximately 50km NNE of Erub.
Masig	Yorke Island community
Mer	Murray Island community
Ugar	Stephen’s Island community
Waiben	Thursday Island community

Summary

Annual fish age-length sampling is essential to monitoring trends and patterns in the recruitment, abundance, and cohort strengths of key commercial Torres Strait finfish stocks. These data are needed to support stock assessments and sustainable management of these culturally and economically significant fisheries.

Annual age-length sampling of fish is vital for tracking recruitment, abundance, and cohort strength in key commercial finfish stocks of the Torres Strait. These biological data are key information used to inform stock assessments and guide sustainable fisheries management.

This report presents the outcomes of the 2024–2025 Torres Strait Finfish Fishery Coral Trout and Spanish Mackerel Biological Sampling Program, a priority research need identified by the Torres Strait Protected Zone Joint Authority (PZJA). The program builds on previous work funded in 2019–2020 to 2023-2024 (Langstreth and O’Neill 2020); Trappett et al. 2021; Trappett et al. 2024) and applies refined sampling methods developed in those studies.

The program collected biological samples from Traditional Inhabitant Boat (TIB) and non-traditional commercial (Sunset) sectors. Strong participation from fishers, fish receiver businesses, and community members enabled the collection of fish lengths and otoliths (fish ear bones used for ageing). Community workshops, individual training sessions, and targeted communication promoted local engagement and capacity-building.

Spanish Mackerel

Due to declining catch rates and biomass estimates in recent stock assessments, updated biological sampling for Spanish Mackerel was re-commenced in 2019–2020 following a long gap since 2005–2006. These data support age-at-length modelling and population assessments used to set sustainable harvest levels.

Since 2019–2020:

- 12,424 Spanish Mackerel were measured from 352 commercial catches.
- Sampling occurred across six key areas, including Maizab Kaur (Bramble Cay), the primary fishing ground.
- Length sampling covered an average of 41% of annual fishing effort.
- 5,141 otoliths were collected, with 2,211 aged.
- Ages ranged from 0 to 13 years, with 2-year-olds being the most common.
- A strong cohort was traceable across years (2-year-olds in 2020–2021, 3-year-olds in 2021–2022, 4-year-olds in 2022–2023).
- 4,898 genetic samples were collected to support broader genetic research.

Coral Trout

To address a data gap identified by the PZJA for coral trout, the program expanded in 2020–2021 to collect biological data across the four key coral trout species, typically grouped together in catch records (Common, Barcheek, Passionfruit and Bluespotted Coral Trout).

Since 2020–2021:

- 1,515 coral trout were measured from 93 catches.
- 575 otoliths were collected, with 526 aged.
- Sampling covered six fishery areas, including key harvest zones in eastern Torres Strait.
- Common Coral Trout and Passionfruit Coral Trout reached up to 13 years of age; Barcheek Coral Trout were generally younger (1–10 years).
- Most coral trout aged were between 4 to 7 years old.
- The Sunset sector predominantly caught Common Coral Trout; TIB catches were more evenly split between Common Coral Trout and Passionfruit Coral Trout species.

Project Outputs and Outcomes

This program delivered valuable, representative biological data from remote locations, enabling robust stock assessment inputs. Strong working relationships with fishers and stakeholders were key to the project success.

Key achievements:

- Biological data directly supported annual Spanish Mackerel stock assessments and the 2023 coral trout stock assessment update.
- For the first time, a recruitment pulse (strong cohort) of Spanish Mackerel was tracked across multiple years in the age structure of the fishery.
- Provided updated age data for coral trout species not available since 2005.
- Supported CSIRO's Close Kin Mark Recapture (CKMR) pilot study through provision of genetic tissue samples to inform stock connectivity assumptions.
- Collected 1,000+ genetic samples per year since 2021–2022 to support future research.

Communications and extension activities exceeded project expectations, including:

- In-community meetings during sampling trips,
- Presentations at PZJA advisory groups, and
- Outreach via a dedicated webpage, video explainers, community flyers, digital notice boards and SMS updates.
- These activities contributed to building trust and encouraged continued community collaborative engagement in fisheries science and management.

Challenges and Recommendations

Sustained biological monitoring is essential to understand changes in fish stocks, especially under increasing climate pressures. However, securing consistent fisher participation in sample collection remains a key challenge.

Recommendations include:

- Enhancing temporal and spatial sampling coverage, especially outside Maizab Kaur and from the TIB sector.
- Embedding project staff in communities during peak fishing periods or hiring local research assistants to collect samples.
- Increasing sampling effort for coral trout, including onboard surveys, particularly to increase number of samples and to address the complexity of multiple species being reported under one species basket.

Continued community engagement, transparent feedback, and capacity-building will be critical to the longer-term success of the monitoring program and to ensuring the resilience of Torres Strait fisheries.

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Objectives

The objectives of the project included:

- Continuation of the 2019-20 to 2023-24 biological sampling program established through the AFMA funded projects: Torres Strait Finfish Fishery: Coral Trout and Spanish Mackerel Biological Sampling (AFMA project numbers 2019/0832, 190851, 2020/0814) to collect representative biological data from fishers.
- Sampling program established through engagement with Traditional and non-Traditional fishing sectors collecting length frequency measures of representative catches.
- Collection and processing of fish specimens and conduct ageing of fishes sampled (Spanish Mackerel and coral trout species) as per existing standardised ageing protocols and quality assured methodologies.
- Collection of age, sex, length-frequency data for Spanish Mackerel.
- Collection of genetic samples for genetic analysis to support future research on Spanish Mackerel genetics.
- Collection of age, sex, and length-frequency data, and species composition for coral trout species.

Introduction

The Torres Strait Finfish Fishery (TSFF) is made up of two sub-fisheries; the Torres Strait Finfish (Reef Line) Fishery, mainly targeting coral trout species (*Plectropomus* spp.), and the Torres Strait Spanish Mackerel Fishery targeting Spanish Mackerel (*Scomberomorus commerson*). Under the Protected Zone Joint Authority (PZJA), the Australian Fisheries Management Authority (AFMA) is the lead agency for management of Torres Strait stock of Spanish Mackerel and coral trout species with Queensland's Department of Primary Industries - Fisheries Queensland providing scientific support. These species are iconic fishes with cultural significance for Torres Strait communities and represent an important economic opportunity and food source, with recent commercial harvests in the order of 20-40 t for coral trout species and 50-100 t for Spanish Mackerel.

Two commercial sectors, the Traditional Inhabitant Boat (TIB) and non-traditional sector (Sunset licence sector), target Spanish Mackerel and coral trout species. Fish catch and catch rate data from these two sectors provide data for the stock assessments for these species. While this study focuses on commercial fishing sectors, other sectors of the fishery in Torres Strait waters include recreational, charter and traditional subsistence fishers.

The Torres Strait Reef Line Fishery is a multispecies line fishery predominantly targeting a basket of coral trout species (*Plectropomus spp.*). The target species are:

- Common Coral Trout (*Plectropomus leopardus*)
- Barcheek Coral Trout (*Plectropomus maculatus*)
- Passionfruit Coral Trout (*Plectropomus areolatus*)
- Bluespotted Coral Trout (*Plectropomus laevis*)

The TSFF Spanish Mackerel Fishery is a line fishery targeting Spanish Mackerel. Spanish Mackerel are a large pelagic, predatory fish which are commonly targeted by fishers during breeding aggregations (Thurstan et al. 2016). The Torres Strait commercial fishery for Spanish Mackerel has periods of focused harvest, e.g. Spanish Mackerel is taken mostly between

September and November at a known breeding aggregation at Maizab Kaur (Bramble Cay). Peak coral trout species harvests are reported following the monsoon in the first half of the calendar year. Commercial harvests are mostly taken from eastern Torres Strait. Spanish Mackerel harvests are concentrated on north-eastern waters around Maizab Kaur.

In 2008, the Australian Government funded a 100 per cent buyback of Transferrable Vessel Holder (TVH) fishing licences, such that the catch entitlements in the fishery since are 100 per cent owned by the TIB sector. As a condition of the buyout, the 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 many licenced operators (>200) harvesting a small amount of catch. The non-traditional Sunset sector harvests most of the catch and consists of a small number of operators accessing the fishery through a temporary annual ‘sunset’ licence which is leased from the TSRA. These operators generally target Spanish Mackerel spawning aggregations around Maizab Kaur during August to December and, to a lesser extent, target other fishing grounds for Spanish Mackerel and coral trout species around eastern Torres Strait waters. The sunset sector is regulated to prohibit fishing within ten nautical miles of each of the eastern Torres Strait communities of Masig, Ugar, Erub, and Mer which drives some spatial differentiation in the use of the fishery by sector.

Concerns around declines in Spanish Mackerel catch rates from 2010 to 2018 (see O’Neill et al. 2024) have driven a need to collect age-length information for this species. This data is to support future stock assessment investigations, with these assessments informing management decisions on sustainable levels of catch. Biological sampling of Torres Strait Spanish Mackerel has been conducted annually since 2019-2020 financial year (Langstreth et al. 2020; Trappett et al. 2021) to address this need for updated fish age-length information. Data from these surveys adds to the historical fish age-length data collected during 2000-2001 to 2002-2003 (DPI data, O’Neil et al. 2024) and in 2005-2006 (Begg et al. 2006).

Coral trout biological sampling was added to the current research program in 2020-2021 and augments historical research performed by the Cooperative Research Centre through James Cook University from 2004 to 2006, sampling the spatial and temporal nature of commercial catches in the Reef Line Fishery in eastern Torres Strait (Williams et al. 2007).

We report here on an additional year of results from the study (2024-2025) which builds on the previous five years of data collection (2019-2020 to 2023-2024), creating a six-year continuous time series for Spanish Mackerel and five-year continuous time series for coral trout species. Where appropriate, reporting on the data has been included from the previous reports to help examination of trends through time.

Methods

Industry and Community Engagement

The sampling program used in this study 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 operated by engaging community leaders (Elders, Torres Strait Island Regional Councils (TSIRC) Councillors, and Registered Native Title Body Corporate (RNTBC) Chairperson and members), explaining the project objectives and seeking permission to access community and work with community members. An example letter communicating extension of the project to 2024-2025 and community objectives is at Appendix 1.

Trappett et al. (2021, pp. 13-14) provides an overview of the ethical oversight provided by the PZJA and the cultural protocols followed by the project team in delivering this research (TSRA 2011; Nakata 2018). This included ensuring free prior informed consent was obtained for the acknowledgement, attribution, and citation of local traditional knowledge and fisheries data.

A summary of Catch Disposal Records (CDRs) provided by AFMA enabled the program to see where finfish were being harvested in notable quantities and to plan community engagement and sampling activities accordingly. The program has focused on sampling in the communities reporting the most catches (Erub and Mer) while also aiming to include as many communities as possible in the study (Table 1). This was achieved by liaison with community leaders and industry members on PZJA advisory groups and in collaborating with AFMA and TSRA on joint travel to communities to take opportunities to present the research.

In 2019-2020, 2020-2021 and 2021-2022 financial years, the program held initial community engagement workshops generally timed to coincide with the start of the Spanish Mackerel fishing season. To be respectful to the people and country, both land and sea, on which this research was conducted, the project made sure to focus on sharing with communities what the research was aiming to achieve, what data would be collected, how it would be used and securely stored and how individual data would not be reported, i.e. fishers' commercial business would remain anonymous. During the workshops, the project team also sought advice from community members about when would be the most appropriate time to be invited back to work with fishers on sampling.

The workshops were followed up around six weeks later by sampling trips collaborating with community fishers and fish receivers who retained frames to support the program. Sometimes an additional sampling trip was possible, before the monsoon set in, late in the calendar year. Community notices were posted for each of these visits to advise community members of who was attending and their business in community (example shown in Appendix 2). Prior to visiting the program sought permission to visit from the community elders including the PBC Chairpersons and TSIRC Councillors. Appendix 3 details the community visits and sampling trips by project staff/ the project team conducted in communities since the 2019-2020 financial year. The table also includes meetings attended by project staff where updates on the project were given to our stakeholders. These meetings also allowed the project team face-to-face opportunities to liaise with fishers and community leaders about the project, provide additional sampling equipment, and provide training on length-measurement procedures.

Table 1. Overview of project days spent in Torres Strait communities to discuss the project or conduct catch sampling by fishing season (*note fixed service flights to Mer & Erub airstrips were suspended for many months in late 2022 meaning the project could not visit to sample as planned).

Financial year	Mer	Erub	Ugar	Masig	Waiben
2019-2020	0	1	1	1	0
2020-2021	3	3	1	0	1
2021-2022	5	5	0	0	1
2022-2023*	2	2	0	0	1
2023-2024	4	4	1	0	2
2024-2025	4	2	0	0	4
Total	**18**	**17**	**3**	**1**	**9**

Several fishers and community members took the opportunity to visit the DPI Northern Fisheries Facility in Cairns and were provided a laboratory tour and demonstration of processing techniques applied to fish samples being provided from their fishery. The tours included practical demonstrations of measuring fish frames and removal of otoliths, preparation of otoliths for ageing, and ageing fish under a microscope. A similar experience was provided by DPI for PZJA Torres Strait Finfish Fishery Resource Assessment Group (TSFFRAG) and PZJA Torres Strait Scientific Advisory Committee members.

All non-traditional sunset sector fishers holding any coral trout or Spanish Mackerel catch allowance were briefed by the project team on the objectives of the research program and asked to assist. Some vessels were able to provide significant assistance to the program and provided large numbers of frozen fish frames or heads, as well as measuring their catches at the end of a fishing session. Samples were shipped to the laboratory for processing via the local barge service. All freight costs, and sampling and packaging supplies were covered by the projects budget.

Data Collection

Sampling design

The program's objective is to gather comprehensive data about the length, sex and age of fish retained in the commercial fishery. An additional objective for the coral trout species is to gather data on the species composition of sampled catches. Appendix 4 details the field and laboratory sampling protocol for Spanish Mackerel and coral trout species data collection methods. An overview is provided here.

The number of catches sampled, and the quantity of biological data collected varies by year. Sampling is heavily influenced by the amount of fishing occurring, participation from fishers and processors, logistical considerations regarding access to the fish, community access (remote locations, travel restrictions during COVID etc.). The form in which fish are sold to mainland buyers e.g., whole, gilled, and gutted, filleted, significantly influences what data can be collected. The crewing/staffing available to vessels and/or fish processors is another factor which can influence the amount of data collected. All these factors vary between fishing seasons and seem to be pronounced in Torres Strait, which is characterised by long distances from markets, smaller businesses (relative to mainland Australia), remote fishing locations, and seasonal effects of monsoon weather.

For commercially caught fish (TIB and Sunset sectors), data are gathered through voluntary cooperation from commercial fishers and fish processors. These businesses facilitate data collection by providing program staff access to fish within the supply chain or by measuring or supplying samples from their own catches.

While the main objective of the program was to gather information on commercially retained fish, data from community catches (subsistence and recreational) was also collected to provide further information on the age at length of fish to increase sample sizes. Collecting data from community catches also involves voluntary cooperation to allow program staff to measure fish at boat ramps, access fish processors, or working with fishers in providing samples of their own catches.

The primary sampling unit is the "catch", which comprises fish from an individual fishing session on a single day or spanning several days, by one fisher or multiple fishers working together. Ideally these catches are 'representative' meaning that the length frequency of the samples that were measured matched that of the fish that were harvested during that catch i.e. the samples were not graded by size prior to being measured. The program is designed to collect data from the fishery by setting targets for the number of commercial catches to be sampled. For commercially caught Spanish Mackerel, the desired target is 50 different catches with around 1,500 fish to be measured. Around 400 to 500 otoliths per fishing season are required to form the age at length relationship. A similar target was applied for coral trout species initially. Following advice from the PZJA TSFFRAG (November 2019[1]) based on the level of harvest, this target for coral trout species was scaled down to 1,000 fish to be measured from representative catches (no minimum level of catches was advised) and 300 otoliths collected for age interpretation to attempt to build age at length relationships.

Samples acquired from non-representative catches supplied during community sampling (e.g. Traditional non-commercial (subsistence) or recreationally caught fish) were used by the program to support determining the age at length relationship and for collecting tissue samples from Spanish Mackerel in support of CSIRO's genetic analysis on close-kin mark-recapture (Williams et al. 2022). This provided all community members with an opportunity to participate in the research program.

Catch details including fishing sector (commercial, Traditional etc.), catch date, fishing method and location was recorded for each catch. Location was reported to one of 21 unique bioregions as used in the AFMA Catch Disposal Record[2]. This level of spatial recording preserves the confidentiality of the exact fishing location while enabling the data collected to be aggregated to a suitable and comparable spatial scale.

Appendix 5 shows an alternative map with these bioregions/reporting regions labelled with traditional names for communities and sampling sites referred to in this report.

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[1] https://www.pzja.gov.au/sites/default/files/2023-01/pzja_ffrag_5_outcomes_oct_31-1_nov_2019.pdf

[2] https://www.afma.gov.au/sites/default/files/2023-02/torres_strait_catch_disposal_record-tdb02_updated_080819.pdf

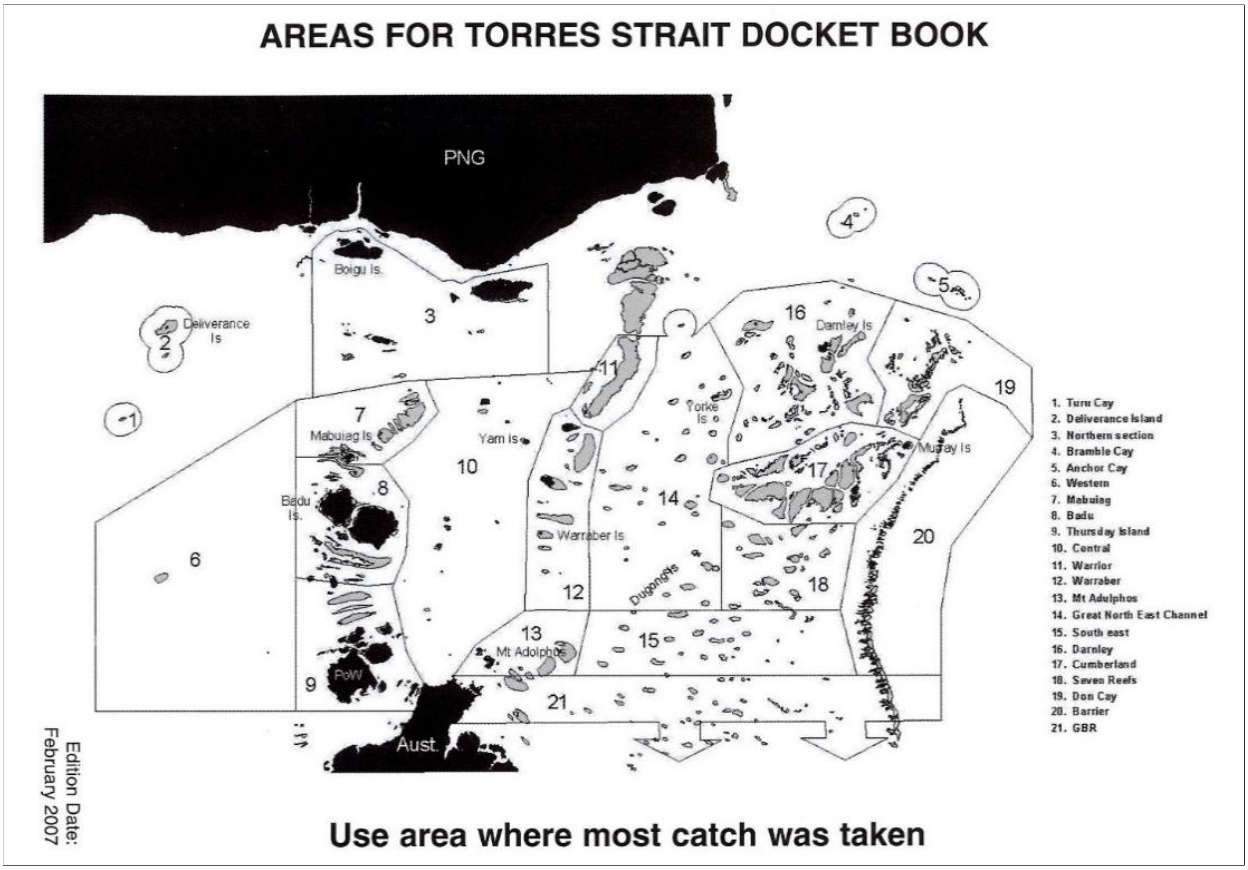

Figure 1. Reporting areas for the Torres Strait docket book used by fishers to record the location of their sampled catch. Map sourced from the 2019 Torres Strait Catch Disposal Record book (TDB02).

Fish size was recorded as Fork Length (FL) (nose to caudal fork) and where possible also total length (TL) (nose to end of tail) and jaw length (JL) (tip of the upper jaw to the end of the maxilla). Note that Passionfruit Coral Trout was an exception and were only measured as Total Length (TL) due to their square shaped tail. Alternative measurements were converted to FL (or TL for Passionfruit Coral Trout) using stock-specific equations.

Where a catch was identified as size biased (for example, the catch may have been graded or some large or small fish removed), it was flagged for exclusion from analysis that requires representative length frequency data. The project was careful to examine catch data from the Reef-Line fishery as some operations advised that certain coral trout species were marketed whole and not supplied to the study as frames for data collection. Additionally, some species were retained whole, when landed, under a certain size and filleted over a certain size due to market demand, for example Common Coral Trout and Passionfruit Coral Trout under 2.2 kg were retained whole by one business for ‘plate’ size fish and frames from this portion of the catch were not supplied to the study.

When a catch was very large, only a subsample of the catch was measured by project staff, or fishers were sometimes only able to supply a proportion of a catch’s frames to be sampled for otoliths. The proportion of the whole catch measured was recorded and scaling was used to convert the data to account for subsampling.

Where possible, gonads were examined macroscopically (without the aid of a microscope), relying on colour, structure, and texture of the gonad, along with reference photographs to determine sex. The sex of fishes was classified as male, female, transitional (in the process of changing from female to male in the case of coral trout species) or unknown.

Most data for the study were collected onboard by fishers measuring commercial catches of Spanish Mackerel and sex was not recorded. Some fishers collected and provided whole fish frames, with attached gonads, allowing project staff to determine the sex of the fish. Some fishers removed heads from fish frames at sea after identifying the sex of the fish. These were supplied in bags that had been labelled by the fishers with sex information.

Samples of muscle tissue from each individual Spanish Mackerel sample were collected using a gene tagging tool specially designed by CSIRO to minimise contamination between samples and to facilitate high-throughput DNA sequencing (next-generation sequencing). Tissue samples were taken from the fleshy portion at the dorso-posterior of the fish's head, placed in a two-millilitre vial filled with 98% ethanol, labelled with a unique sample number, and stored in the laboratory freezer. Samples were later sent to CSIRO laboratories in Hobart for archiving and future processing and analysis (see Williams et al. 2022 for further detail).

Fish Ageing

Otoliths (fish ear bones) were used to estimate the age of a fish by taking counts of annual growth rings (Fisheries Queensland 2024). Each year, the program aimed to collect otoliths from retained fish. Spanish Mackerel were aged using images of whole otoliths (Fisheries Queensland in prep) and coral trout were aged using images of thin sections of the otolith (Fisheries Queensland 2020). A trained reader examined the image of the whole otolith (Spanish Mackerel), or section (coral trout species) using a microscope and assigned an increment count, an edge type (new, intermediate, or wide) and a readability score.

Age was calculated based on capture date, increment count, edge type, the expected timing of new increments being formed and the assumed common birthday of all fish in the stock based on knowledge of peak spawning times (Fisheries Queensland 2020). Each year, readers underwent refresher training and testing on a reference collection of otoliths, before undertaking the current year's otolith reading.

Data analysis

Length and weight conversions - Spanish Mackerel

The primary measure used to record length was Fork Length (FL). However, if a whole fish or a whole fish frame was collected, multiple length measures were taken to allow conversion factors to be calculated and used when the primary measurement could not be taken. Individual fish weight was calculated using sex-specific total length-weight conversions for Torres Strait Spanish Mackerel developed by Begg et al. (2006) (see Table 7, page 24). FL to Total Length (TL) and Jaw Length (JL) to FL conversions were calculated from all five years of available multi-measure data combined.

Jaw length to fork length conversion – Spanish Mackerel

As most of the samples supplied to the project in 2021-2022 to 2023-2024 were fish heads rather than whole frames it was important to review and update the JL to FL conversion. A quadratic model (Table) was used to convert between JL and FL.

The model is described as $FL = \beta 0 + \beta 1 \times JL + \beta 2 \times (JL^2)$ where:

- β0 = intercept
- β1 = Coefficient for Jaw Length
- β2 = Coefficient (base) for JL^2

Appendix 6 shows the model fit to data and model standardised residuals. The model was based on data from fish with available multi-measure data pooled across years and analysed by sex (males: n = 275, females: n = 346, pooled: n = 665).

Total length to fork length conversion – Spanish Mackerel

A linear relationship was used to covert between FL and TL for pooled data across years (2019-2020 to 2023-2024) and sex (Table).

Total length to weight relationship - Spanish Mackerel

Non-linear least squares regression models from Begg et al. (2006) were used as a length-weight relationship in this study (Table 7, given that no fish weights were measured (all samples were provided for study as heads or frames following filleting). Note this formula uses TL.

Length structures – Spanish Mackerel and coral trout

Individual fish counts were scaled to the percentage of the catch to account for any subsampling. Individual adjusted lengths were allocated into a two-centimetre length class. The sum of scaled counts was 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 data being collected from a low number of primary vessels for each sector (less than five vessels), data was also pooled across sector within each fishing season for reporting purposes to ensure confidentiality of potentially commercially sensitive information from individual vessels was protected.

For coral trout species, sufficient samples enabled length structures to be produced for Common Coral Trout, Passionfruit Coral Trout and Barcheek Coral Trout species only.

Age allocation and growth parameters – Spanish Mackerel

The number and proportion of each otolith edge type for Spanish Mackerel was reviewed across five years of data and summarised to determine the distribution of each edge type across each month sampled and across the fishing season. This identified the seasonal trend in the formation of annual bands and confirmed that one band was formed annually. This information was used to allocate each fish into an age group (or cohort), which is expressed in whole years, was the maximum age a fish would reach during the sampling season.

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. *Fish with an age of zero and edge type of intermediate sampled in October were given an 'Increment +1' modification to calculate age group.

Capture month	New	Intermediate	Wide
July	Increment	Increment + 1	Increment + 1
August	Increment	Increment + 1	Increment + 1
September	Increment	Increment	Increment + 1
October	Increment	Increment*	Increment
November	Increment	Increment	Increment
December	Increment	Increment	Increment
January	Increment	Increment	Increment
February	Increment	Increment	Increment
March	Increment	Increment	Increment
April	Increment - 1	Increment	Increment
May	Increment - 1	Increment	Increment
June	Increment - 1	Increment	Increment

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 may have a protracted spawning season in the Torres Strait, between August and March (McPherson 1993). The nominal birth date assigned was 1st 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:

$\mathbf{L_t = L_\infty (1 - exp^{-K[t-t_0]}) + \varepsilon}$ 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 from the individual age at length data from 2019-2020 to 2023-2024 were modelled using R program software packages 'FSA' and 'fishmethods' utilising the 'vbStarts' and 'growth' functions to fit non-linear least square regression models to male, female, and pooled sex data. Growth coefficient outputs from the models were then used to adjust fish length and are provided in Table 8 with further results outputs provided in Appendix 6. Note that values of t_0 are negative due to the nature of the fishery dependent sampling conducted that does not sample undersized fish and is biased away from 0+ and 1+ age groups. These growth model parameters are used for the adjustment of length within the sampling season and are not used as inputs into the stock assessment model.

Age-length keys – Spanish Mackerel and coral trout

For Spanish Mackerel, age-length keys were generated for combined sexes for each year sampled using adjusted length allocated within a 2 cm length class and age group. The count of fish in each two-centimetre 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.

For coral trout, age-length keys were generated for combined sexes for all years sampled combined (2020-2021 to 2024-2025) using length allocated within a 2 cm length class and age being increment count. The count of fish in each two-centimetre 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.

Age structures – Spanish Mackerel and coral trout

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 keys described above. Individual fish can then be assigned to an age group using this age-length key. 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[3]. The proportion of fish in each age group were then calculated to develop the age structure for each year.

For Spanish Mackerel, annual age structures with pooled sex were produced (2019-2020 to 2024-2025). For coral trout species, an age structure was produced for each species from data pooled across all years sampled (2020-2021 to 2024-2025).

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

Results

Data summary – Spanish Mackerel

From 2019-2020 to 2024-2025, the length measurements of 12,424 Torres Strait Spanish Mackerel were recorded from 352 individual commercial catches (Table 3). Fish measured represented 14,511 fish when subsampling was accounted for. All catches were sampled at greater than or equal to a 20% subsample and were considered representative of the entire catch.

Table 3. Sample sizes of Spanish Mackerel length and age information collected during 2019-2020 to 2024-2025. Total samples sizes are provided for each data type as well as the number of representative lengths and catches per fishing sector (TIB and Sunset).

Data type	Total number	TIB	Sunset
Lengths (sub-sampled)	12,424	194	12,230
Lengths (scaled)	14,511	205	14,306
Catches (representative commercial) *	352	17	335
Whole weight sampled (kg) (scaled)**	121,064	1,638	119,426
Whole weight reported (kg)***	294,442	19,067	275,375
Per cent of harvest sampled****	41%	9%	43%
Otoliths collected*****	5,141	227	4,806
Otoliths aged	2,211		
Sex data from representative catches	1,862		
Genetic samples	4,898		

** Representative commercial catches are those with greater than 20 per cent sub-sampling from Sunset and TIB sectors only.*
*** Whole weight of sampled fish calculated from fork length scaled to account for sub-sampling*
**** Commercial landings source: AFMA Catch Disposal Records*
***** Represents per cent of the whole fish weight sampled compared to the total harvest estimate for the 2019-20 to 2023-24 fishing years combined.*
******* Note that some otoliths were collected and aged from non-commercial catches (both traditional non-commercial and recreation sectors) to aid in forming the age at length relationship.*

Most fish lengths measured from commercial catches were from the Sunset sector (12,230 measured or provided for study, 98%) with 194 fish (2%) provided for study or measured from the TIB commercial sector. Most of the commercial harvest is taken by the Sunset sector (ranging from 89% to 99% between 2019-2020 to 2024-2025, with the remainder taken by the TIB sector (ranging from 1% to 11% of the fishery commercial harvest by year).

The proportion of the commercial fishery sampled was estimated to range from 24% to 75% by year based on annual estimates of total whole fish weight sampled (ranging from 13 t to 33 t). Figure 2 (page 20) details the number of lengths, catches and otoliths collected for analysis. The figure also shows the seasonal distribution of sampling achieved through the months of each year. Note most harvest in the fishery occurs late in the calendar year prior to the wet season.

Figure 2. Monthly distribution of samples of Torres Strait Spanish Mackerel showing the measured frequency of lengths, catches and otoliths sampled from commercial representative catches by fishing sector, month and by year.

Table 4. Annual whole fish weight sampled (scaled to account for subsampling), commercial harvest, and proportion of the fishery sampled during 2019-2020 to 2023-2024. This is calculated from the weight of fish measured (weight estimated from a length-weight conversion) as a proportion of the commercial fishery harvest per year. *Note 2024-2025 fishing season CDRs incomplete at time of publication.

Financial Year	Total whole fish weight sampled (kg)	Harvest (from CDRs) (kg)	Proportion of fishery sampled (%)
2019-2020	13,647	56,550	24
2020-2021	24,062	31,942	75
2021-2022	15,070	47,320	32
2022-2023	20,896	50,833	41
2023-2024	33,445	57,349	58
2024-2025	13,335	44,604*	30

A total of 4,898 fish had genetic samples taken (Table 5). These have been sent to CSIRO Hobart for sequencing and inclusion in any future genetic studies such as Close Kin Mark Recapture population analysis, which is an identified research priority for the fishery.

Table 5. Torres Strait Spanish Mackerel genetic samples collected during 2019-2020 to 2024-2025.

Financial Year	Number of genetic samples
2019-2020	128
2020-2021	292
2021-2022	970
2022-2023	1,031
2023-2024	1,408
2024-2025	1,069
Total	**4,898**

Across all years of the study, most of the sampling (89%) was from Maizab Kaur, which is a known breeding aggregation for Torres Strait Spanish Mackerel. This location represents the main concentration of fishing catch and effort in the fishery. The minority of the sampling of commercial catches (11%) was conducted within four other sampling regions as defined in the AFMA Catch Disposal Record and detailed in Table 6.

Spanish Mackerel samples were sampled from other fishery users in addition to the two commercial sectors (TIB and Sunset). Additional Spanish Mackerel samples (n = 25) were obtained from the Traditional sector being fish taken for subsistence by members of Erub and Mer and Masig communities. Recreational Spanish Mackerel samples (n = 83) were also donated to the project from Erub (n = 48) and Waiben (n = 35) communities.

Table 6. Spatial spread of sample sizes of representative Commercial Spanish Mackerel length information collected during all years combined across the Torres Strait docket book reporting areas (map of areas shown in Figure 1).

Reporting Area	Area, Reefs, Communities	Lengths (sub-sampled)	Lengths (scaled)	Catches	Sex data
CDR Zone 4	Maizab Kaur (Bramble Cay)	11,005	13,076	294	560
CDR Zone 14	Masig, Poruma, Great North-East Channel	654	654	23	3
CDR Zone 15	South-east Torres Strait, Atub (Dugong Islet)	371	371	9	8
CDR Zone 16	Erub, Ugar, Au Meri Reef, Kebi Meri Reef	244	260	17	129
CDR Zone 17	Mer, Hibernia Passage, Cumberland Passage	89	89	7	1
CDR Zone 18	Seven Reefs – South of Cumberland Passage	61	61	2	0

Table 7 details the results of updated length conversion equations calculated using data from 2019-2020 to 2023-2024 data.

Table 7. Equations and source of Torres Strait Spanish Mackerel length and weight conversions used in data analysis. FL: fork length. TL: total length, JL: jaw length, W: weight.

Conversion	Equation	Source
Jaw Length (mm) to Fork Length (cm)	Male: $FL = -388.7065 + 16.9734 \times JL + 0.9565219 \times (JL^2)$ Female: $FL = 13.740 + 9.913 \times JL + 0.9860846 \times (JL^2)$ Unknown: $FL = -174.504 + 12.64393 \times JL + 0.9753584 \times (JL^2)$ Pooled: $FL = -51.95306 + 10.87157 \times JL + 0.9827502 \times (JL^2)$	Calculated from 2019-2020 to 2023-2024 Torres Strait data
Total Length (cm) to Fork Length (cm)	Pooled: $FL = (TL – 36.6) / 0.938$	
Fork Length (cm) to Total Length (cm)	Pooled: $TL = 0.938 \times FL + 36.6$	
Total Length (cm) to weight (kg)	Male: $W = 4.224e - 6 * (TL^{3.068})$ Female: $W = 2.960e - 6 * (TL^{3.148})$ Pooled: $W = 2.718e - 6 * (TL^{3.165})$	Begg et al. (2006)

Table 8 (page 23) details the results of the review of the growth parameters used to calculate adjusted length within the sampling season. This review used data from 2019-2020 to 2023-24.

Table 8. Torres Strait Spanish Mackerel 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	661	177.12006975 (17.31379960)	0.08449171 (0.02148493)	-6.85907654 (1.01565563)	7.196134
Male	611	109.6325002 (1.51219266)	0.3614444 (0.03834002)	-2.5151018 (0.33328460)	5.315446
Pooled	2,025	134.976942 (3.6561495)	0.164044 (0.0178035)	-4.655811 (0.4153098)	7.369837

Length structures – Spanish Mackerel

Torres Strait Spanish Mackerel sampled from commercial catches during the study ranged in length between 61 cm and 163 cm FL (calculated from a jaw length to fork length conversion). Most fish (75%) were between 90 cm and 104cm FL (Figure 3, page 24), with an average fish length of 97 cm FL for all years combined.

Average fish lengths from the measured sub-samples of fish were similar between the commercial sectors at 95 cm FL for TIB sector (n = 218) and 98cm FL for Sunset sector (n = 9,471).

Length structures sampled from 2019-2020 to 2023-2024 (Figure 3, page 24) were generally similar in structure to those reported from the on-board surveys conducted by Queensland DPI from 2000-2001 to 2002-2003 (O'Neill et al. 2024) and by James Cook University in 2005-2006 (Begg et al. 2006). These earlier studies share similar shaped length distributions with most fish lengths (75%) measured between 86 to 107cm FL (2000-2001, n = 900; 2001-2002, n = 909; 2002-2003, n = 612; 2005-2006, n = 744) with an average fish length of 96 cm FL for all years combined.

The length structure of the commercial fishery in 2024-2025 showed a smaller average size than previous sampling years. This could be attributed to a larger number of measures coming from fishery areas outside of the Maizab Kaur breeding aggregation (890 out of 1771 lengths). In previous years generally less than 10 per cent of samples have come from outside of Maizab Kaur. This is further considered in the report's discussion section (page 40).

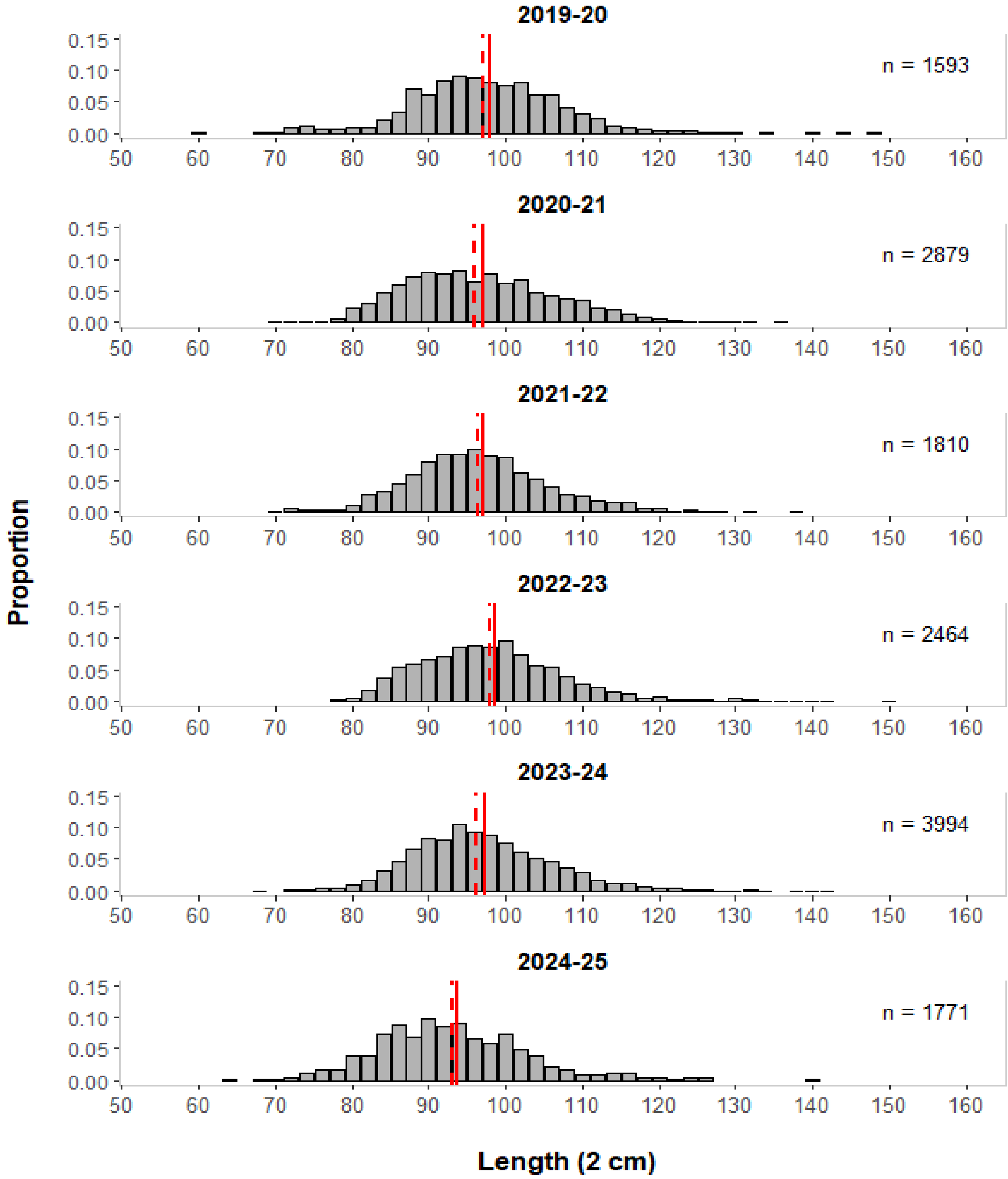

Figure 3. Length structure of the commercial Torres Strait Spanish Mackerel harvest by year. TIB and Sunset sectors combined. N-value is the number of fish scaled to account for subsampling. Fork length class is adjusted length and displayed here in 2 cm bins. Solid line represents mean length per year, dashed line represents the median length per year.

Sex ratio – Spanish Mackerel

Across all years of the study, sex data (male / female) was able to be determined from 60% of the Spanish Mackerel frames sampled. This determination ability varied annually from 10% to 90%. Sex ratios were biased towards females, particularly in the larger length classes. A breakdown of the sex ratios by length class demonstrates a change from a male to female bias as length increases (Figure 4). This follows similar sex ratio by length class trends in earlier Torres Strait sampling (Begg et al. 2006; O'Neill et al. 2024), although the smallest and largest length classes with small sample sizes were difficult to compare. This bias is likely to be influenced by sex-specific growth rates (McPherson 1992).

Sex ratio in the harvest is reported to 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.

Spanish Mackerel display sexual dimorphism with males growing slower and achieving smaller maximum size and weights compared to females (McPherson 1993). This is likely due to factors such as females investing more into growth to increase their size which increases chances of reproductive success; a larger body means larger gonads and, therefore, more egg production. Understanding these population dynamics is an important consideration in stock assessments which must consider how factors such as maturity, fecundity and recruitment distribution influence the population model (O'Neill et al. 2024).

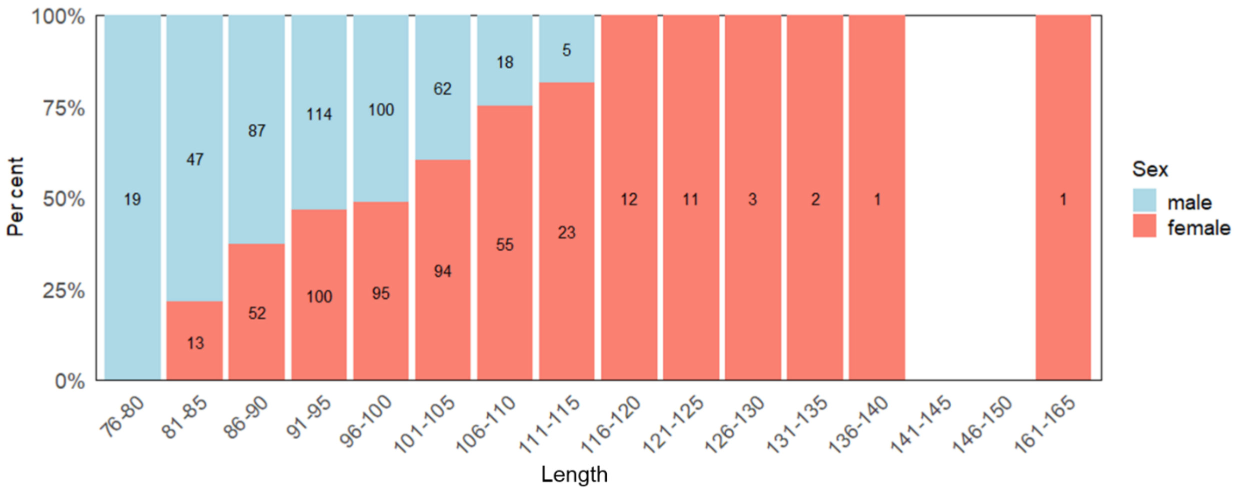

Figure 4. Sex ratio of Torres Strait Spanish Mackerel 2019-2020 to 2023-2024 within 5 cm length classes (adjusted fork length). Numbers on the bars represent sex-based sample sizes within each 5 cm length class.

Fish ageing – Spanish Mackerel

Otoliths were collected from a total of 2,241 Torres Strait Spanish Mackerel and interpreted for increment count, edge type, and readability. For each year's process of assigning ages to the otoliths, 200 fish were re-aged for increment count. 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 for all interpretations fell within acceptable levels documented in the DPI ageing protocol (Fisheries Queensland 2024). IAPE was the index of average percent error in ageing across fish re-aged for increment count. Acceptable levels for Torres Strait Spanish Mackerel ageing, for a pass criteria were: IAPE ≤ 6 and edge% correct ≥ for new 70%, intermediate 50% and wide 50%.

Across the study, age information could not be collected from 27 fish due to otolith breakages or very low readability (Table 9). Ages could be attributed to 2,211 fish in total.

Table 9. Ageing results for each read of Torres Strait Spanish Mackerel by year. Pass criteria were: IAPE ≤ 6 and edge% correct ≥ for new 70%, intermediate 50% and wide 50%.

Ageing	2019-20	2020-21	2021-22		2022-23	2023-24	2024-25
Number of otoliths examined for ageing	256	306	400	56	504	530	189
Number of otoliths aged	254	299	394	55	500	523	186
Number of otoliths re-aged	200	200	200	55	200	200	186
% increment agreement	92	89	83	100	88	87	91
IAPE increment count	1.2	3.4	3.8	0.4	2.3	3.1	1.96
% agreement news	91	87	93	98	94	94	92
% agreement intermediates	74	83	59	NA*	73	NA*	74
% agreement wides	91	73	50	NA*	62	74	81
Number of news	170	142	246	43	325	420	134
Number of intermediates	58	108	78	5	106	48	31
Number of wides	26	49	70	7	69	55	21
Number unreadable	1	6	2	0	4	6	0
Number of processing errors	1	1	4	1	0	1	3

**NA scores mean 20 or less of some edge types were re-interpreted in the second read so, as per the ageing protocol, a pass mark was not calculated for these edge types (second 2021-2022 read and the 2023-24 read).*

Fish interpreted for age ranged in length between 59 cm and 163 cm FL and in age from 0 to 13 (Appendix 7). Male fish were generally smaller and younger than the females sampled (Figure 6).

The results indicate that the male Torres Strait Spanish Mackerel sampled have a smaller average size than females (94.2 cm FL compared to 101.1 cm FL) and attain a smaller maximum size and age compared to females (121 cm FL and 10 years old for males compared to 163 cm FL and up to 13 years of age for females).

Table 10. Summary statistics of length and age for male and female Torres Strait Spanish Mackerel from 2019-2020 to 2024-2025 combined, all observations, including non-representative catches from all sectors.

Data type	Female	Male	Unknown
Minimum FL	62	59	58
Maximum FL	163	121	150
Average FL	101.1	94.2	96.6
Median FL	99.8	94.4	95.8
Minimum age	1	1	0
Maximum age	13	10	10
Sample size (n)	1,329	1,284	8,550

Length and age data allow comparison of the range of sizes that male and female fish were at each age group across seasons (Appendix 7**)**. More female fish of larger size classes were available for sampling for age compared to males, which did not exceed 10 years of age or 121 cm in length. The highest proportion of age group sampled for both male and female fish was the 2+ age group (215 and 243 samples for males and females respectively).

Ageing results for all years of the study combined (2019-2020 to 2024-2025) are illustrated in Figure 5. showing the variation in length (adjusted fork length) at age of all fish aged (n = 2,211). Generally, the distribution of lengths of fish in ages 1+ to 7+ have an Inter Quartile Range (IQR) clustered around the mean of the observations. Above this age (>8+ age group) there is greater variation in the age at length but also fewer samples to produce a clear trend in variability.

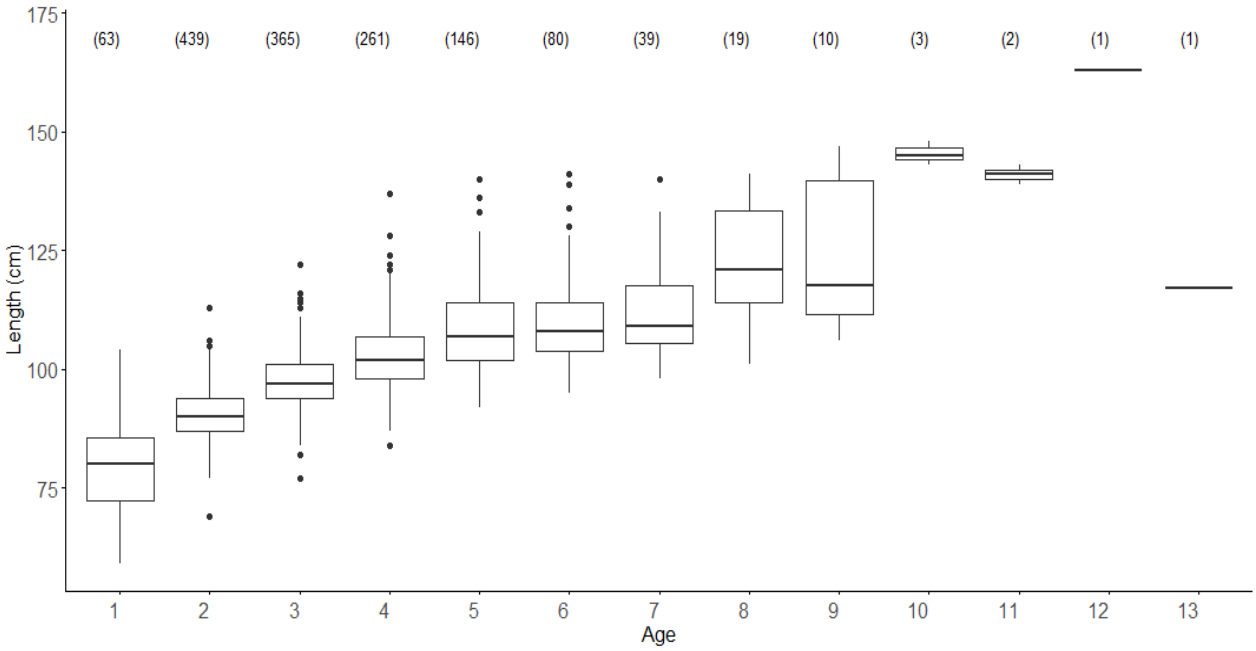

Figure 5. Ageing results box plot from all years combined, showing the fork length (adjusted length) range by age group. Total sample size (n) is 2,211. Boxes are the Inter Quartile Range (IQR) which represent the middle 50% of the range of the IQR, dots are 'outliers' and lie outside of 1.5 times the IQR range.

Ageing results for all years of the study by sex are combined (2019-2020 to 2024-2025) are illustrated in Figure 6 (n = 1,429). The plot shows the variation between sexes including how male fish (blue) aged reached a maximum of 121 cm and 10 years old, whereas females (pink) reached a larger size (163 cm) and an older maximum age of 13.

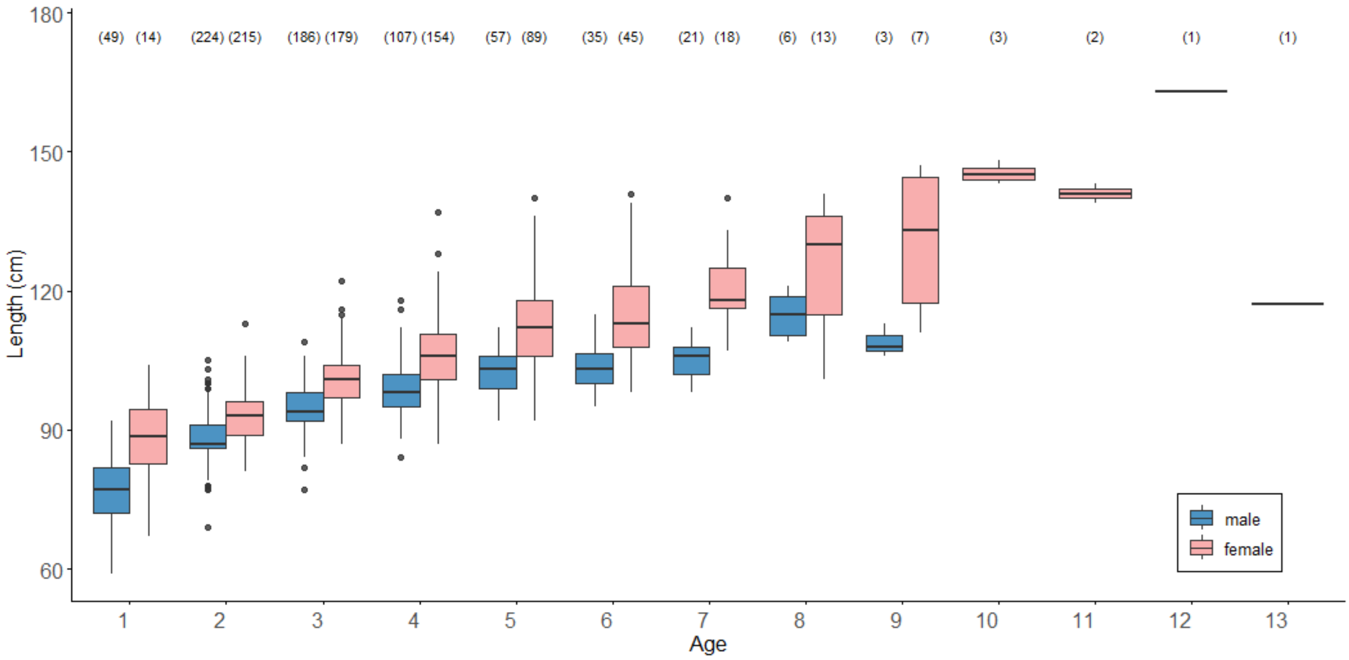

Figure 6. Ageing results by sex from all years combined, showing the fork length (adjusted length, cm) range by age group. Boxes are the Inter Quartile Range (IQR) which represent the middle 50% of the range of the IQR, dots are 'outliers' and lie outside of 1.5 times the IQR range (n = 1,429).

Age allocation – Spanish Mackerel

Following the methodology established in 2019-2020, the otolith edge type of Torres Strait Spanish Mackerel otoliths was determined as either "new", "intermediate", or "wide" to be able to allocate each fish into an age group or cohort. This process aims to group fish from the same spawning season (cohort) into the same age group, 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 (Figure 7) shows a peak period of new edge type (opaque zone formation) in September and October, a period of peak intermediate edge type in December through to March and a peak period of wide edge type in April. This trend is like that observed for Spanish Mackerel in neighbouring waters where new edge type observations peak in October for fish from east coast waters and September for fish from Queensland Gulf of Carpentaria waters (Bessell-Browne et al. 2020; Trappett et al. 2021).

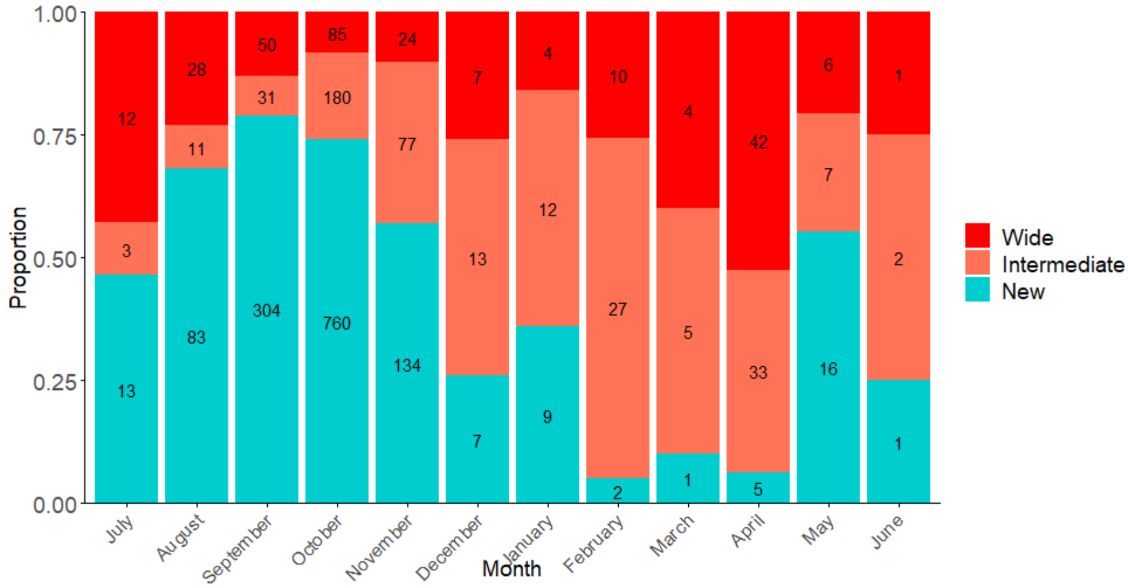

Figure 7. Proportion of edge types (wide, intermediate, new) of Torres Strait Spanish Mackerel 2019-2020 to 2023-2024 by month. Numbers provided are the sample sizes for each edge type by month.

Age-length key – Spanish Mackerel

The adjusted fork length and age group of all aged fish from 2019-2020 to 2023-2024 (n = 2,211 fish) were used to construct an age-length key to convert the length structures into an age structure for the fishery (Figure 8).

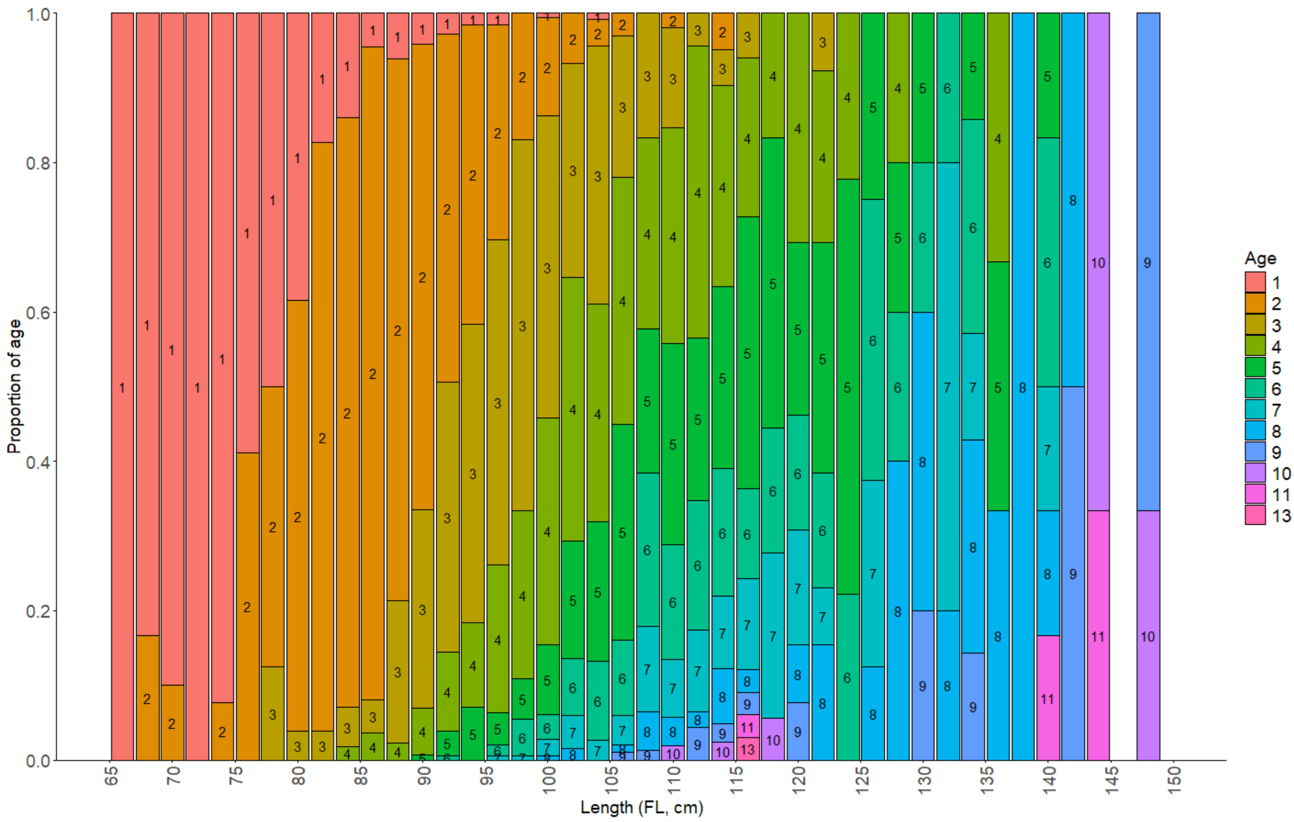

Figure 8. Plot of the observed proportional age-length key of Torres Strait Spanish Mackerel sampled from 2019-2020 to 2024-2025 combined years, using age group and adjusted fork length (cm). (n = 2,211 fish aged). Numbers shown on bars represent age group.

Fish smaller than 75 cm were generally assigned an age in the 1+ age group while fish from 80 to 90 cm FL were generally in the 2+ age group. Fish at 100 cm FL were generally in the 3+ or 4+ age group but in some cases a small number were found to range up to 6+ or 7+ years. In this context, the "+" symbol refers to fish that are at least that age, for example, 2+ includes fish that are two years old but may be approaching three.

Age structures – Spanish Mackerel

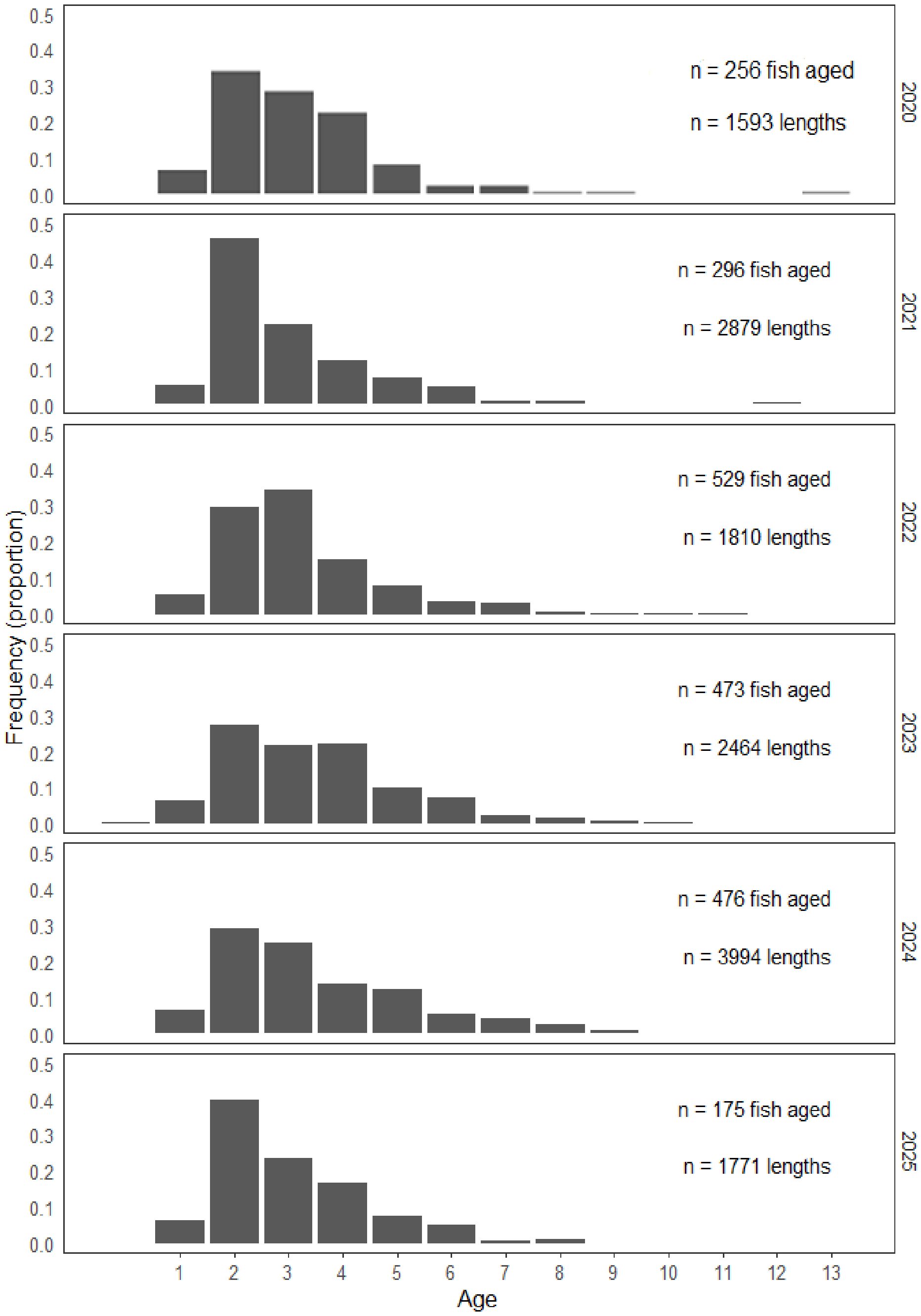

Figure 9. Annual age structure of commercial Torres Strait Spanish Mackerel harvest between 2019-2020 and 2024-2025. The horizontal axis represents age which is adjusted age in years and the vertical axis represents proportion of the commercial fishery at each age increment. TIB and Sunset sectors are combined. The n-values are the number of fish represented as fish aged and fish lengths (scaled to account for sub-sampling) measured per year.

The age structure of Torres Strait Spanish Mackerel fishery from 2019-2020 to 2024-2025 from Sunset and TIB sectors combined (Figure 9) shows a strong indication of increased recruitment evident in 2020-2021 with more than 40% of the year's fishery being made up of 2-year-old fish.

This age cohort can be tracked through the 2021-2022 fishing season (3-year-old fish making up 33% of the harvest) and was still present as a high proportion of 4-year-old fish in the 2022-2023 fishery (25%) see Appendix 8: Cohort analysis of Torres Strait Spanish Mackerel spawned in 2018 . In a manner like 2019-2020, the most recent 2024-2025 fishery also has a large proportion of 2-year-old fish apparent in the age structure.

Through the study, fish ranged between 1+ and 13+ with the catch dominated by fish in age groups 2+ to 4+, which between years comprised between 72% to 82% of the catch.

Data summary – coral trout

From 2020-2021 to 2024-2025, length measurements of 1,515 coral trout (Common Coral Trout n = 825, Barcheek Coral Trout n = 214, Passionfruit Coral Trout n = 468 and Bluespotted Coral Trout n = 8) were sampled from 93 catches. These catches were from all users of the fishery (TIB and Sunset commercial sector, the Recreational sector and the Traditional non-commercial sector. Some of these catches recorded more than one species of coral trout, so in total these 93 catches allowed the program to measure 163 samples of individual coral trout species within these multi-species catches.

Otoliths were collected from 171 Common Coral Trout, 222 Passionfruit Coral Trout, 176 Barcheek Coral Trout and 6 Bluespotted Coral Trout (575 in total across all species). To augment frames collected from the commercial sector, 236 of these 579 coral trout frames were able to be sourced from recreational (non-traditional) fishers from Erub and Waiben communities. These fish were not used as representative catches as part of the commercial fishery in the analysis; instead, these samples were able to provide age at length data.

Out of 93 catches sampled,41 catches were from commercial sectors (TIB or Sunset) with 1,121 coral trout of all species measured from a complete fishing day or as sub-sampled catches (e.g. 80% of the days catch). Once sub-sampling was accounted, a total of 1,444 coral trout of all species were measured from commercial representative catches. Total numbers of samples collected are described in Table , page 32.Table 11. Sample sizes of coral trout (pooled species and years) length and age information collected during 2020-2021 to 2024-2025. Total samples sizes are provided for each data type as well as the number of representative lengths and catches per sector.

Sampled weight from commercial representative catches equals an estimated weight of 1,738 kg of all coral trout species combined (2,272 kg when scaled to account for subsampling). This represents sampling 2.3% of the commercial coral trout harvest for combined years 2020-2021 to 2023-2024 (97,281 kg harvest of all coral trout species for TIB and Sunset sectors combined over these four fishing seasons).

Most coral trout samples in this study were acquired from either at sea length-frequency measures completed by commercial fishers in the months of March to May or were acquired late in the calendar year (September to December) during community visits to conduct sampling ahead of the monsoon period (Figure 10). Some samples were also freighted to the laboratory directly from commercial fishing vessels or community-based fishers.

Table 11. Sample sizes of coral trout (pooled species and years) length and age information collected during 2020-2021 to 2024-2025. Total samples sizes are provided for each data type as well as the number of representative lengths and catches per sector.

Data Type	Total	TIB	Sunset	Rec	Traditional non-commercial
Lengths: number of all coral trout measured all sectors for length	1,515	285	986	236	8
Representative lengths from commercial sectors measured (sub-sampled)	1,121	249	872	NA	NA
Lengths commercial, representative, scaled up to account for sub-sampling	1,444	250	1,194	NA	NA
Catches (all sampled)	93	24	17	51	1
Catches (representative commercial)	28	15	13	NA	NA
Otoliths collected	575	80	251	236	8
Otoliths aged	526				
Sex data (male or female)	343				

Coral trout samples were acquired from six areas in total of Torres Strait as described by the AFMA issued Catch Disposal Record system and presented in Table 12, page 33.

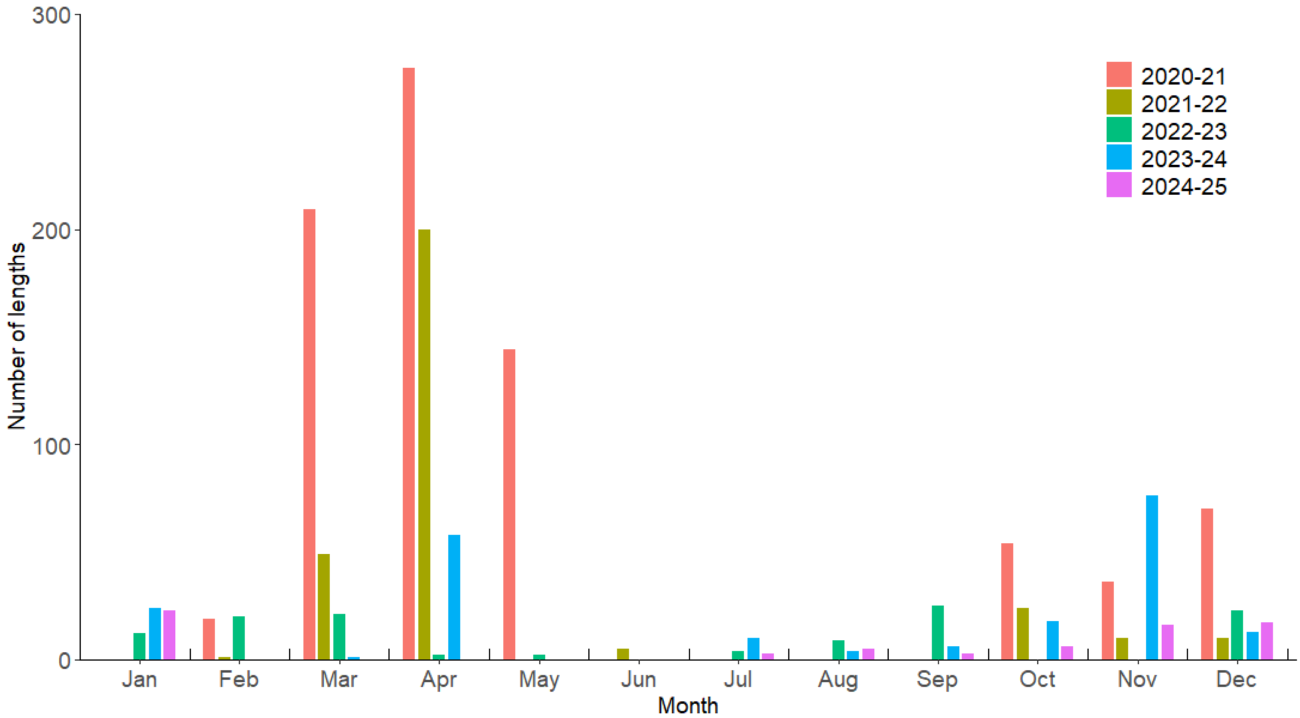

Figure 10. Seasonal spread of sampling effort of Torres Strait coral trout species showing samples from all fishery sectors combined, all coral trout species combined, number of lengths measured by month.

Table 12. Number of lengths sampled of Torres Strait coral trout by AFMA Catch Disposal Record Zone. All sectors pooled including recreational sector samples (n = 1,515).

Reporting Area	Area, Reefs, Communities	Lengths
CDR Zone 16	Erub, Ugar, Au Meri Reef, Kebi Meri Reef	709
CDR Zone 17	Mer, Hibernia Passage, Cumberland Passage	408
CDR Zone 14	Masig, Poruma, Great North-East Channel	204
CDR Zone 18	Seven Reefs	99
CDR Zone 9	Inner west area (Waiben, Muralag, Ngurapai)	82
CDR Zone 10	Central Torres Area – includes Iama community	5

Length structures – coral trout species

The observed length structure of Torres Strait coral trout species measured in the study (all sectors combined) is presented in Figure 11.

Most Common Coral Trout sampled in this study were between 41 cm to 56 cm fork length (75% of samples), with few fish under 40 cm, a pattern likely reflecting the influence of the minimum legal-size restriction of 38 cm fork length. Barcheek Coral Trout had 75% of the commercial samples measured with lengths ranging between 40 to 58 cm (fork length). Passionfruit Coral Trout had 75% of the commercial samples measured with lengths ranging between 43 to 57 cm (total length).

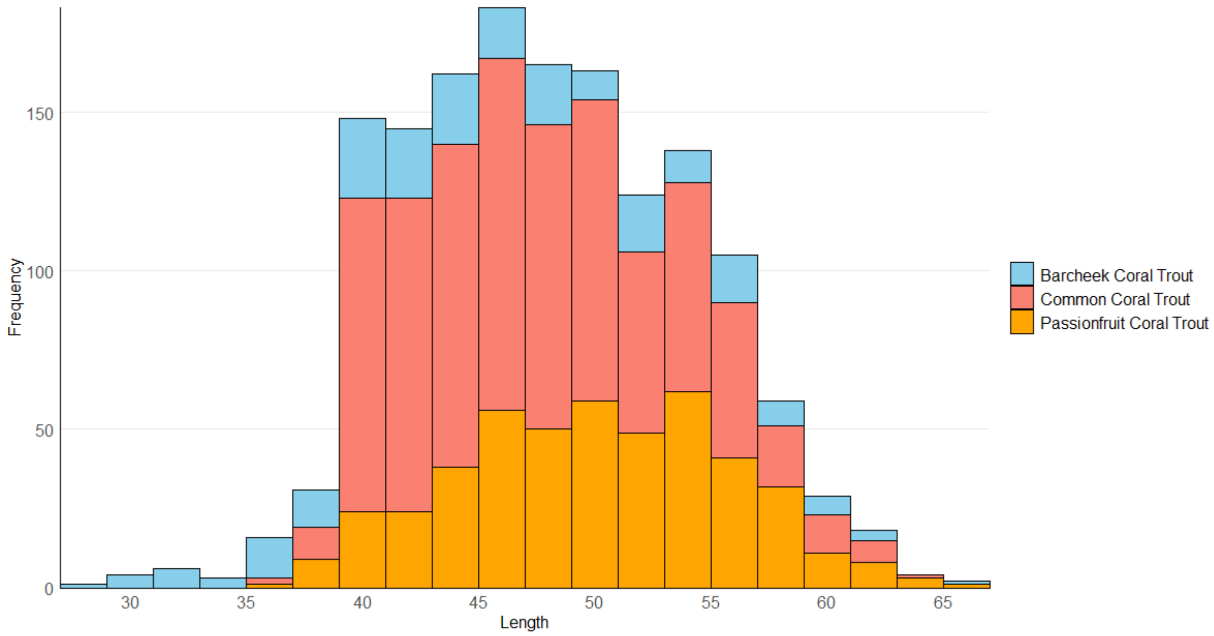

Figure 11. Observed measurements of all Torres Strait coral trout species lengths 2020-2021 to 2024-2025 (n = 1,507) across all sectors of the fishery (TIB, Sunset, Recreational, Traditional Non-Commercial) binned into in 2 cm length increments. All species are FL except Passionfruit Coral Trout which is TL. Common Coral Trout n = 825, Passionfruit Coral Trout n = 468, Barcheek Coral Trout n = 214.

Both Passionfruit Coral Trout and Common Coral displayed a more normally distributed frequency of the lengths sampled (Figure 12, page 34). Due to their reported rarity in commercial catches only eight Bluespotted Coral Trout were measured in this study therefore no length frequency was able to be produced for this species. Insufficient commercial samples of Barcheek Coral Trout (n = 60) were measured to allow a robust length frequency distribution to be developed. However, the data have been graphed and included for completeness (Figure 12).

Fishers from the TIB sector can legally retain undersized coral trout (below 38 cm total/fork except for Bluespotted Coral Trout which has a minimum legal size 50 cm for subsistence purposes and these frames donated were included in the study. Of note were the lower size classes of Barcheek Coral Trout, ranging as small as 28 cm FL. Most Common Coral Trout lengths from commercial, representative catches were between 41 and 56 cm FL (75%). For Barcheek Coral Trout 75% of lengths were between 40 to 57 cm FL and for Passionfruit Coral Trout 75% of lengths were between 42 to 57 cm TL (Figure 12).

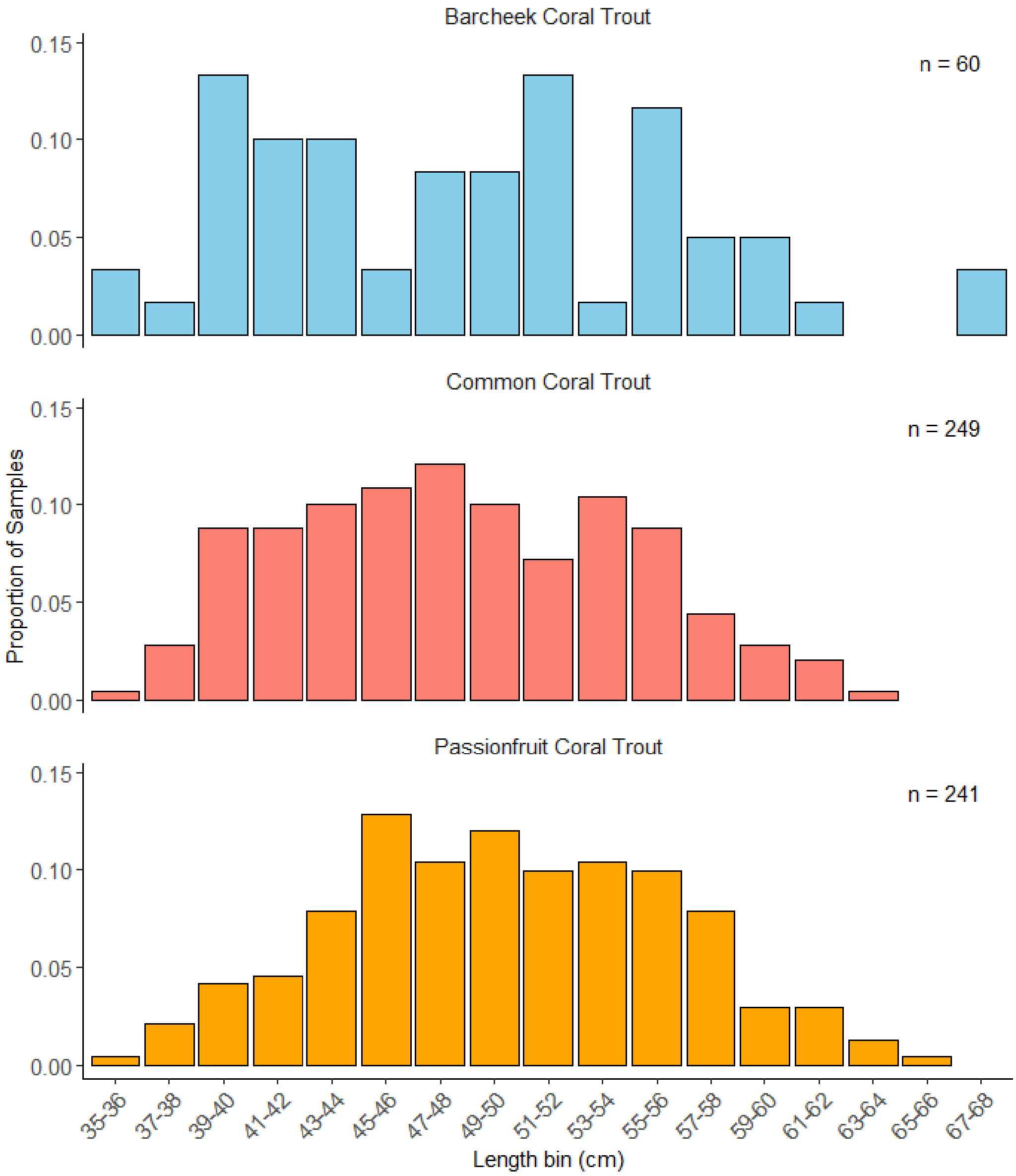

Figure 12. Proportion of length samples measured from representative, commercial catches of coral trout species all years combined (2020-2021 to 2024-2025). Length measures for Common Coral Trout and Barcheek Coral Trout are fork length, Passionfruit Coral Trout are total length.

Ageing Results – coral trout

Otoliths were collected from a total of 575 coral trout from four species. Of these, 529 were interpreted for age and a random subset of otoliths (up to 200) per read 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. Results for ageing reads are shown in Table (page 36).

Quality control measures for all interpretations fell within acceptable levels defined/documented in the DPI ageing protocol (Fisheries Queensland 2024).

Across the study, age information could not be collected from 15 fishes due to otolith breakages or readability issues. Ages could be attributed to 377 fishes in total.

Table 13. Results for ageing reads of Torres Strait Coral Trout by year. Pass criteria were: IAPE ≤ 6 and edge% correct ≥ for new 50%, intermediate 50% and wide 50%.

Ageing Result	2020-2021	2021-2022, 2022-2023 2023-2024	2024-2025
No. otoliths examined for age	90	304	152
No. otoliths aged	90	287	149
No. otoliths re-aged	90	200	149
% increment agreement	69	67	71
IAPE increment count	2.62	4.91	3.33
% agreement news	91	86	75
% agreement intermediates	NA*	54	NA*
% agreement wides	90	60	78
Count news	34	141	65
Count intermediates	14	62	20
Count wides	42	84	64
Count unreadable	0	14	1
Count processing error	0	1	2

**NA scores mean an insufficiently low number of some edge types were re-interpreted in the second read so, as per the ageing protocol, a pass mark was not calculated for these edge types.*

Age was estimated using otolith increment counts across coral trout species. While this provides a useful measure of relative age, a more precise method involves combining increment counts with analysis of otolith edge type to determine the timing of annulus formation. This allows for more accurate assignment of fish to cohorts (age classes). However, to apply this method reliably, samples must be collected across all months of the year to observe seasonal changes in edge type. At present, this study lacks sufficient monthly coverage to assess edge progression. Future research with more consistent temporal sampling would enable this refinement. Larger sample sizes across species, months, and sexes would also support the development of growth curves that account for seasonal variation in age at length and would also help validate assumed size-at-maturity schedules—an important input to stock assessments.

The maximum age of Common Coral Trout and Passionfruit Coral Trout in the study was 13. Barcheek Coral Trout sampled were overall younger in age, with a lower minimum of age of 1 and a maximum age of 10 (Table 14).

Table 14. Summary statistics of observed fish lengths by species with maximum and minimum age group data of Torres Strait Coral Trout from 2020-2021 to 2023-2024 combined.

Data type	Common Coral Trout	Barcheek Coral Trout	Passionfruit Coral Trout
Minimum Length	36	27	36
Maximum Length	63	68	65
Average Length	48	45	50
Median Length	48	45	50
Number aged	176	157	215
Minimum age	2	1	2
Maximum age	13	10	13
Sample size (no. lengths)	825	214	468
Minimum Weight (g) (calc)	644	260	665
Maximum Weight (g) (calc)	4,081	5,083	4,593
Mean Weight (g) (calc)	1,815	1,545	2,034
Median Weight (g) (calc)	1,692	1,345	1,948

Coral trout show large variation in age at length. Most fish aged being 3-6 years of age for Barcheek Coat Trout and 4-5 years of age for Common Coral Trout (Figure 13). Results of the age at length of the aged coral trout are presented in Appendix 7 which also shows the range of sizes (maximum and minimum length) observed for fish aged.

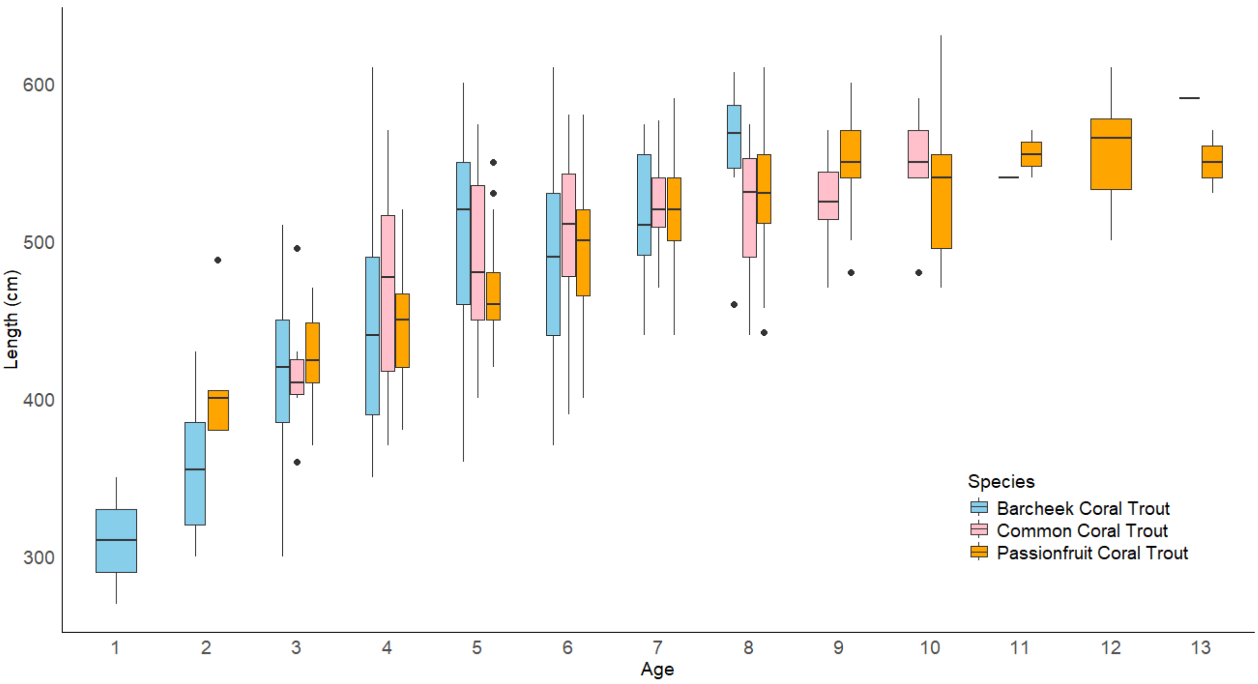

Figure 13. Ageing results box plot from all years (2020-2021 to 2024-2025) combined, showing the range of lengths at age for aged fish (Barcheek Coral Trout FL, Common Coral Trout FL, Passionfruit Coral Trout TL) Boxes are the Inter Quartile Range which represent the middle 50% of the range of the IQR, dots are 'outliers' and lie outside of 1.5 times the IQR range. Sample sizes are Barcheek Coral Trout n = 146, Common Coral Trout n = 165 and Passionfruit Coral Trout n = 215.

Age structure – coral trout

Most Common Coral Trout measured in the study ranged between 4-7 years of age with the highest proportion of samples being 4 years old. Most Barcheek Coral Trout were 3-6 years of age with the highest proportion of samples being 4 years old. Passionfruit Coral Trout had a broad range of ages with most fish aged between 4-10 years of age. (Figure 14) shows the proportion of the observed ages for each species of coral trout (except for Bluespotted Coral Trout for which six otoliths were collected but not aged).

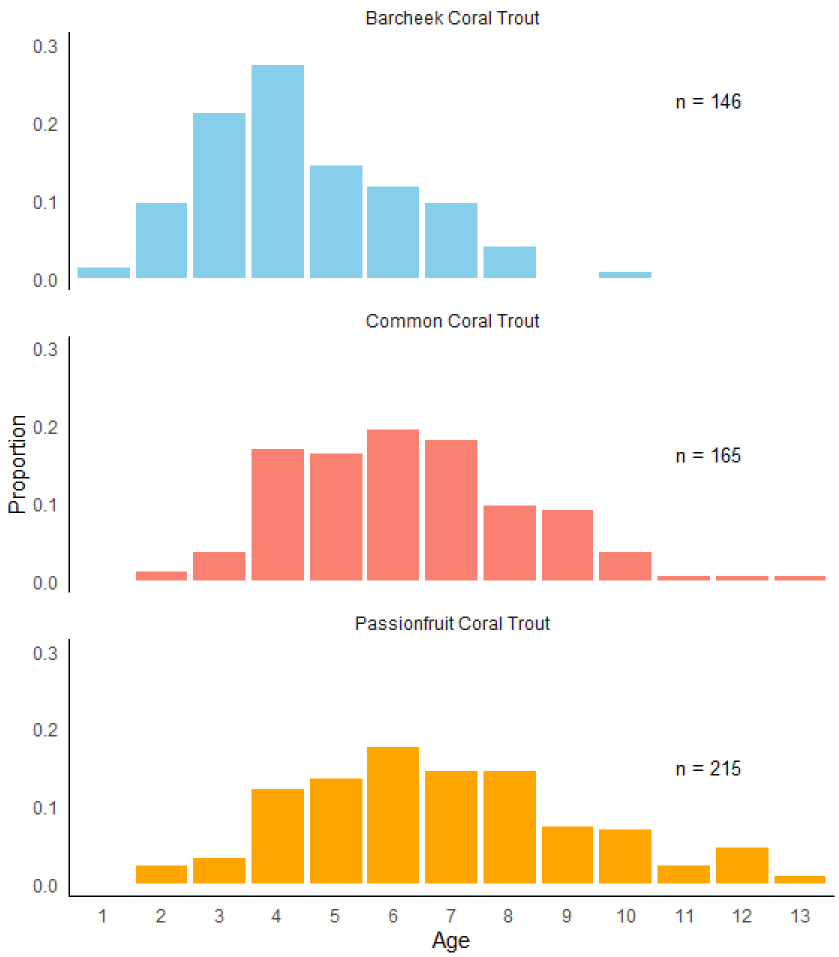

Figure 14. Proportion of coral trout sampled for age in length-age data for Torres Strait Coral Trout all years combined 2020-2021 to 2024-2025.

For Common Coral Trout, fewer frame samples were acquired from the Sunset sector for study of age at length from fish under approximately 2.2 kg (approximately 52 cm FL (n = 31)) meaning that fewer smaller size class Common Coral Trout might have been aged then could normally be expected. This was attributed to some parts of this sector keeping some fish under this size in whole product form for supply to market meaning their frames could not be studied.

As such, further representative sampling to understand age at length from a range of size classes, and a larger sample size (n = 165 Common Coral Trout aged to date) will enable reliable age at length keys to be formed which will permit a more accurate age structure of the commercial fishery to be produced using length frequency data from representative catches.

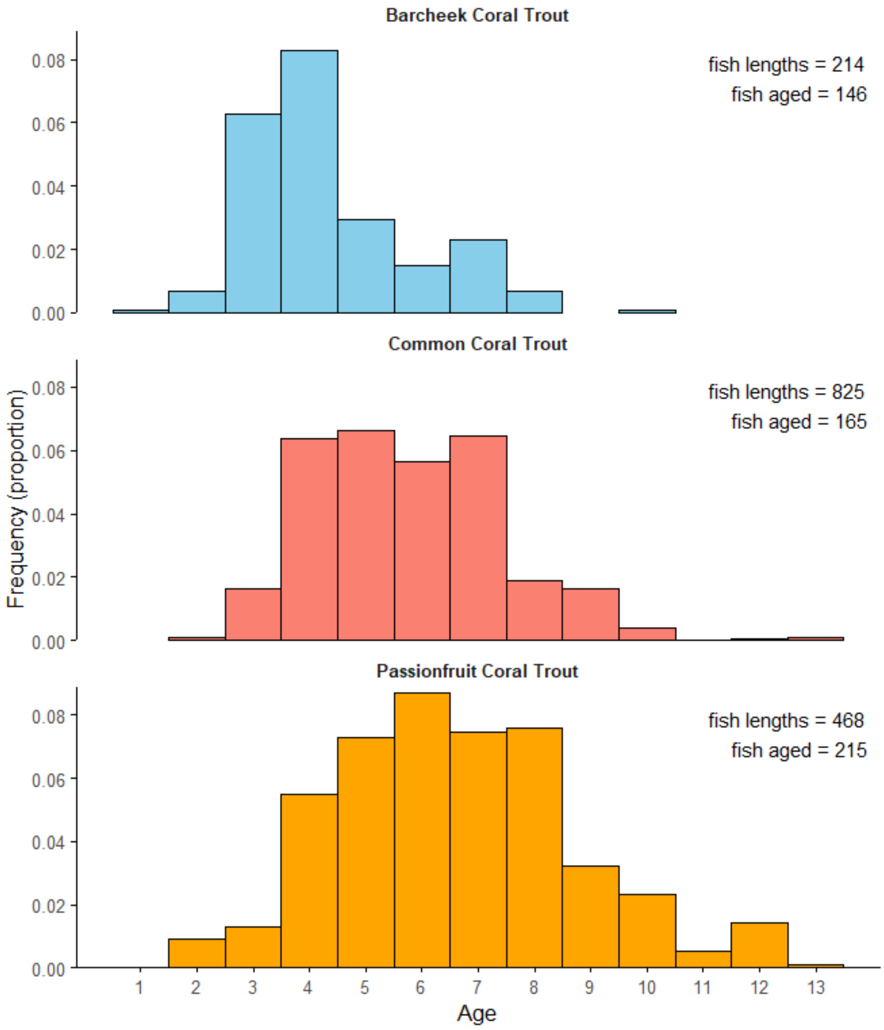

Figure 15. Indicative age structure of commercial Torres Strait Coral Trout harvest by species between 2020-2021 and 2024-2025 combined. The horizontal axis represents age, and the vertical axis represents proportion of the commercial fishery at each age increment. TIB and Sunset sectors are combined. The n-values are the number of fish represented as fish aged and lengths of fish measured per year.

Sex ratio – coral trout

Sex information was determined for 60% of the 575 coral trout sampled for otoliths (frames examined) (male n = 164, female n = 179, unknown = 232).

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

Coral trout are protogynous hermaphrodites, beginning life as females and changing sex to males later in life (Ferreira, 1995). Through the study, although there was overlap between sizes of males and females (Figure 16) at age increments, most fish in smaller size classes were found to be female with a general pattern trending towards more males in larger size classes.

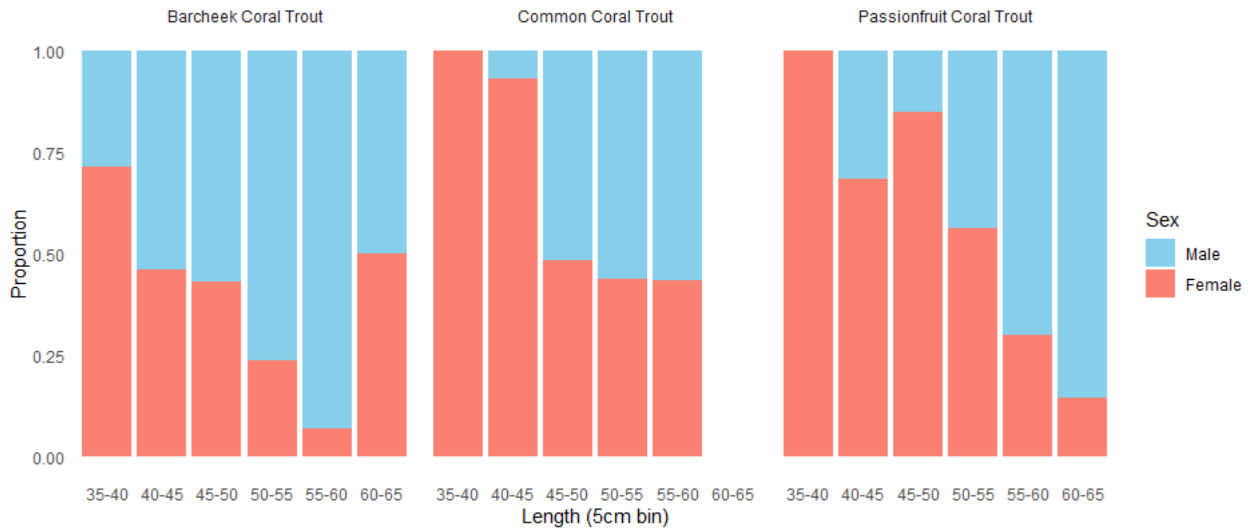

Figure 16. Sex ratio by 5cm length bin (cm) by species and all sectors combined. Sample sizes were: Sample sizes were: Barcheek Coral Trout male = 59, female = 35; Common Coral Trout male n = 51, female n = 56; Passionfruit Coral Trout male = 54, female = 88.

Catch composition – coral trout

The two commercial sectors using the fishery were found to have different catch compositions. The TIB sector catches a larger proportion of Passionfruit Coral Trout relative to the Sunset sector which primarily harvested Common Coral Trout in the sampled catches (Figure 17).

Results from analysing catch composition data by catch varied through the study (Figure 18). Some catches had nearly 100% harvest of Common Coral Trout while others displayed a large proportion of Passionfruit Coral Trout or a mix of two or three species.

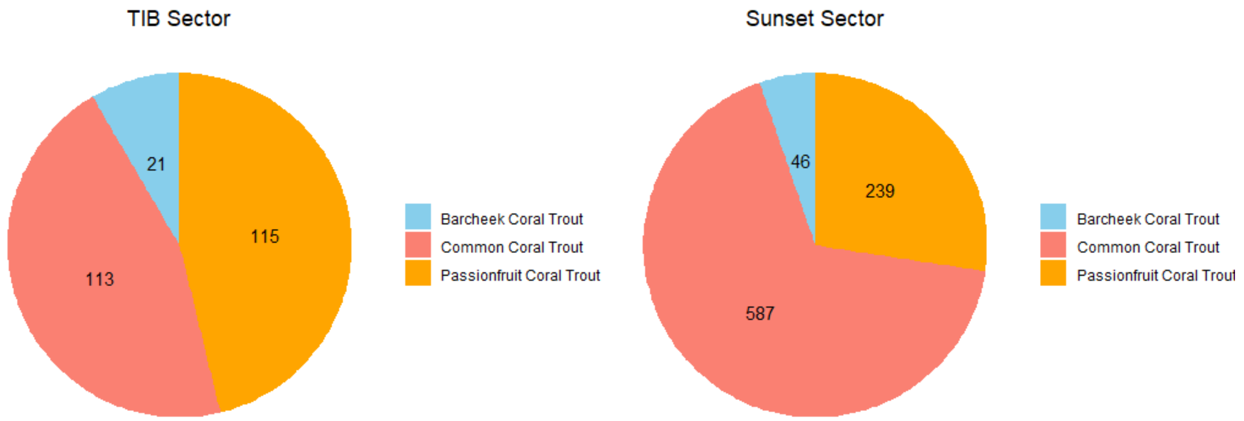

Figure 17. Overall catch composition from representative commercial catches (TIB and Sunset sectors) 2020-2021 to 2024-2025 combined. N values represent number of measurements per species and by sector.

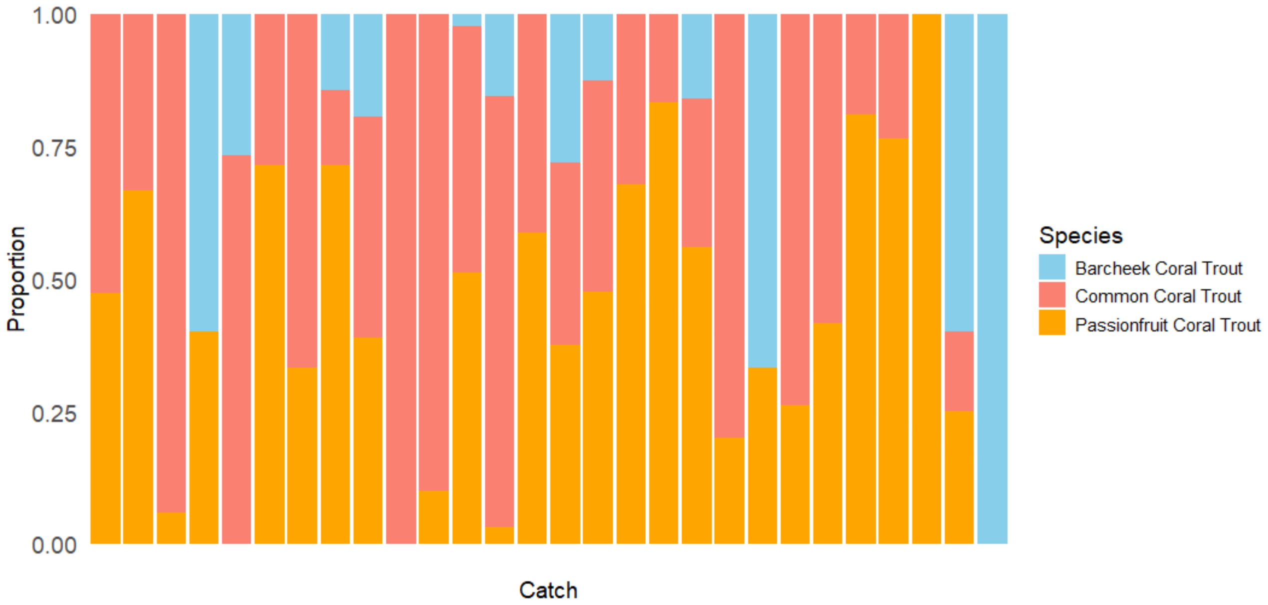

Figure 18. Proportion of Torres Strait coral trout species caught on 28 different commercial representative catches sampled for lengths. Each bar represents a single catch, and the proportional breakdown of species caught within the catch.

Discussion

General discussion

The 2024–2025 biological sampling of coral trout and Spanish Mackerel in Torres Strait builds upon monitoring conducted in previous years (2019–2020 to 2023–2024). This project has met its objectives, providing further years of age and length-frequency data for these key fisheries. These data provide insight into how many young fish are entering the fishery (recruitment), how well different year classes are performing (cohort strength), and how these contribute to the overall population (stock abundance). These data are key inputs to stock assessments, where they help estimate trends in biomass, recruitment, and mortality. These assessments, in turn, inform fisheries management decisions by tracking biomass against reference points and guiding the setting of sustainable harvest levels.

This ongoing research has expanded stakeholder knowledge of the biology of key Torres Strait fish stocks, including:

- Age structure tracking in Spanish Mackerel, notably a strong recruitment event in 2020–2021, where more than 40% of sampled fish were two-year-olds. This cohort was also dominant in subsequent years as three-year-olds (2021–2022) and four-year-olds (2022–2023).
- Improved geographic and temporal sample spread, expanding beyond the historical focus on Maizab Kaur. Samples were collected from communities on Erub, Mer, Ugar, Masig, and Waiben. Six Catch Disposal Record (CDR) bioregions were sampled for Spanish Mackerel and six for coral trout.
- Improved understanding of catch composition in coral trout species and how it differs among fishery sectors.

Using both established and new sampling strategies, the project engaged with all user groups — TIB, Sunset, subsistence traditional, and recreational fishers — to collect representative length data (TIB and Sunset sectors), fish frames (all sectors), and otoliths for age determination.

Despite lower-than-expected sample returns from some communities, there were positive community outcomes. The program has spent over 48 days have been spent engaging with Torres Strait communities since 2019–2020. This included facility tours at DPI Northern Fisheries Centre and presentations to Native Title bodies and PZJA advisory committees, which strengthened local engagement with fisheries science and management.

Challenges Encountered

- Logistics in remote communities: limited freezer space and barge schedules led to some sample losses. A trial initiative—placing a communal freezer at a fisher's home in Mer—received positive feedback from community members but yielded few samples.
- Stakeholder communication: SMS alerts, community notices and videos helped improve engagement.
- Fish handling by receivers: some whole coral trout were frozen prior to staff visits, preventing otolith extraction and accurate length recording.
- Participation issues: willingness to help did not always result in good sample numbers, e.g., vessels without extra deckhands couldn't prioritize data collection.
- Business closure impacts: the closure of a key TIB-sector fish processing business resulted in reduced sampling opportunities and fishing effort in that community.
- Food security considerations: fish frames are an important food source (for meals and other uses such as pet food) and stored samples were sometimes understandably used before researchers could collect them.

Discussion – Spanish Mackerel

The 2024–2025 Spanish Mackerel sampling produced good sample sizes across fishing sectors and months, with data representative of the fishery's harvest. Age data enabled revision of the age at length relationship.

Over the six-year period, 75% of Spanish Mackerel measured were between 86 and 110 cm fork length (FL)—a distribution consistent with previous research. Sampling in 2024–2025 occurred primarily from October onwards, missing the early season (August–September). Nevertheless, this year's data shows a higher proportion of fish under 90 cm FL, possibly indicating a strong recruitment year.

Due to operational issues (e.g. crew illness and freezer breakdowns) regular project contributors were unable to provide the usual 1,000 biological samples and 1,500 length measures prior to Christmas and the end-of-year monsoon. As a result, the project adapted by implementing an alternative plan to work with fishers to collect as many samples as possible later in the season, with the majority ultimately gathered in March. However, due to project time constraints ageing was only conducted on fish sampled during the standard pre-monsoon period. The March collected fish, while numerous, were measured for length-frequency but were not aged, limiting our ability to assess the age structure and confirm the recruitment signal in this later-season cohort.

Age structures from 2021–2022 to 2024–2025 were dominated by two to four-year-old fish (70–80%), with few fish older than six years of age. This aligns with earlier sampling from 2000–2006, which also reported limited presence of fish older than five years. Fish under two years of age were rare in commercial samples (2–6%), likely reflecting that while these fish are likely present in the population, they are not yet fully recruited to the fishery and may not be effectively captured due to gear selectivity such as hook size. The strong 2020–2021 cohort—comprising over 40% of the commercial harvest—was again visible in 2021–2022 (33%) and in 2022–2023 (25%). Tracking such cohorts provides valuable insights into recruitment dynamics and potential environmental drivers.

Maximum observed ages were 13 years for females and 10 years for males—unchanged from previous studies. This contrasts with east coast Queensland fisheries, where fish have been recorded up to 26 years. Possible reasons for this disparity include habitat availability, population size, gear selectivity, movement patterns, and mortality rates.

Fishers from the Sunset and TIB sectors indicated the presence of larger, potentially older fish that are either avoided due to depredation risks, handling difficulties, or cultural significance—meaning they are less likely to be sampled.

Spatial sampling coverage has improved since 2020–2021, with samples now drawn from four areas in addition to Maizab Kaur. However, around 90% of samples still originate from Maizab Kaur. Increasing sampling outside this main aggregation area—especially in eastern and central Torres Strait—is a priority. Doing so would help detect spatial variability in length, age, and sex structure.

More samples from the TIB sector and increased participation (targeting samples from more than five vessels per sector in line with AFMA's Information Disclosure Policy) would enable construction and communication of sector-specific age and length structures for comparison.

Discussion – coral trout

Updated sampling for coral trout species between 2021–2022 and 2024–2025 has continued to build the biological knowledge base for these important commercial and subsistence species. Length-frequency and ageing data were collected for Common, Barcheek, and Passionfruit coral trout. Additionally, the project provided considerations of catch composition.

Average lengths from length frequency sampling were 47 cm, 45 cm and 49 cm respectively for commercial catches of Common Coral Trout (FL), Barcheek Coral Trout (FL) and Passionfruit Coral Trout (TL) respectively.

Ageing data show that the highest proportion of aged Common Coral Trout and Barcheek Coral Trout were 4 years old. Passionfruit Coral Trout displayed a broader age distribution, ranging mostly from 4 to 8 years old. Additional sampling is expected to improve our understanding of age–length relationships for each species. Further samples will improve understanding of size and age at sex change, which is critical for managing protogynous species like coral trout where individuals change from female to male during their lifespan.

The project also evaluated sampling strategies for coral trout to obtain adequate data. However, as outlined in the general discussion above, several challenges affected the number of samples collected. Sampling yields were lower than anticipated, and the total number of fish aged (526) was divided across the three commonly encountered species. For example, only 176 Common

Coral Trout were aged. Due to this limited sample size, it was not possible to construct robust species-specific age-length keys. However, increasing the number of aged samples in future years (see future research recommendations below) will support the development of more reliable age structures for the commercial fishery.

Notably, few biological samples were collected for Bluespotted Coral Trout during this study. Only two individuals of this species were measured on length sheets and six frames donated for study. Given its rarity in catches, it is unlikely that sufficient samples will be collected in future research to develop length or age frequency profiles for this species.

Future research recommendations

Based on findings from this study, the following recommendations are proposed for future biological sampling of coral trout and Spanish Mackerel in the Torres Strait:

Onboard Survey Work

- Future survey work onboard commercial fishing vessels is recommended to collect length-frequency data, otoliths, and catch weights. Having an onboard staff member collect these samples would significantly reduce the burden currently placed on a small number of fishers who have made considerable efforts to bag and measure catches to support the project.
- Onboard sampling, particularly in the Reef Line Fishery, is likely to yield a higher volume of length and otolith samples than what was collected over the five years of this study.
- Measuring catch weights at sea would also allow validation of assumptions used in calculating length–weight relationships for Spanish Mackerel and coral trout.

Processor-Based Sampling

- Sampling conducted by project staff at fish processing facilities proved effective. For instance, 89 samples were collected in 2020–2021, and 20 samples in 2021–2022, during periods when major processors were operational.
- Future monitoring programs should continue to align community staff visits and sampling schedules with periods of active processing and fish landings to maximize sampling efficiency and value for effort.

Community-Based Sampling Support

- Employing a casual community-based staff member during peak finfish seasons (e.g. "dark of the moon" periods in September–November for Spanish Mackerel) could significantly improve sampling rates. This person could assist fishers with length-frequency measurements and the collection of research samples for lab analysis.
- The project has discussed this potential role with the Torres Strait Regional Authority (TSRA), particularly in relation to the TSRA Ranger Program and economic development initiatives like the ‘Wapil Program’ (a fisheries skills and infrastructure development package). These programs could provide capacity or logistical support.
- Further integration of this biological monitoring program into broader Torres Strait initiatives is recommended to enhance sampling outcomes.

Partnerships for Capacity Building

- Collaboration with Torres Strait agencies such as TSRA, *Gur A Baradharaw Kod* Land and Sea Council or *Meriba Ged Ngalpun Mab* (Community Development Program) could support the funding and creation of longer-term community-based sampling roles. These positions would provide multiple benefits, including improved sample collection, increased local capacity, and enhanced community understanding of fisheries data, science, and research careers.

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Appendices: Supplemental Information

Appendix 1: Letter sent to fishery stakeholders to advise of program extension 2024-25

02 September 2024

Dear Stakeholder,

I am writing to advise of the successful funding for the *Torres Strait Finfish Biological Sampling Program*. This will allow the program to continue through to June 2025.

This project - *Torres Strait Finfish Fishery: Coral Trout and Spanish Mackerel Biological Sampling 2024-25* - is funded by PZJA management agencies (AFMA, TSRA and Fisheries Queensland) and is being led by Fisheries Queensland.

This continues the research conducted in the 2019-20 to 2023-24 financial years. The need for the research has been identified as a high priority by the PZJA Advisory Groups (Finfish Resource Assessment Group and Finfish Working Group). There is a strong need to collect biological information to support the Torres Strait Spanish mackerel and coral trout stock assessments.

With your support we will continue working with Torres Strait communities to achieve the objectives of the research which are to:

- Collect information from commercial catches on the sex, lengths and ages of Spanish mackerel and coral trout.
- Collect information on the catch composition of coral trout (percentage split between the four main commercial species).
- Collect genetic samples from all available Spanish mackerel to support future research on Spanish mackerel genetics (e.g. close-kin mark recapture).
- Analyse this information and securely provide the results to AFMA to support Spanish mackerel and coral trout stock assessments.
- Report the findings back to the PZJA and communities.

To achieve the objectives the project team will continue to:

- Work with volunteer fishers and fish receiver businesses in your community to collect biological information from the TIB sector for study. Across eastern communities we are seeking:
- 100-200 Spanish mackerel frames per season.
- 100-200 coral trout frames per season
- Measure every fish from 20-30 Spanish mackerel catches per season.
- Measure every fish from 20-30 coral trout catches per season.
- Visit Mer & Erub communities twice during the season to take any samples fishers and community members can keep frozen to support the project.
- Work with fish receiver businesses to keep frozen fish frames and send these using pre-paid shipping to the Cairns lab (Northern Fisheries Centre) at intervals.
- Analyse the samples provided at the Cairns lab and report these summaries back to communities electronically and when visiting.

The Sunset sector have also been engaged with the research program and have volunteered to provide several hundred Spanish mackerel and coral trout frames per season along with measuring 20-30 catches.

The information collected will be used to:

- assist communities, scientists and managers to better understand the status of the Torres Strait Spanish mackerel and trout stocks,
- inform the scientific stock assessments for the Torres Strait Finfish Fishery that set appropriate catch levels for the fishery,
- maintain the profitability and long-term sustainability of the Spanish mackerel and coral trout fisheries in the Torres Strait which support local businesses, and
- empower communities with information to support making their own local management arrangements for their sea country and resources.

The next step will be for myself (Andrew Trappett) contacting TSIRC Councillor's and Island Native Title PBCs. This will allow me to arrange suitable dates to visit, conduct sampling and share results with communities from the first five years of the research project. These results have recently been published and are available here: (https://www.pzja.gov.au/sites/default/files/2024-08/Torres-Biological-Sampling-June-2024.pdf).

I will be contacting fishers and fish receivers, asking them to continue retaining samples and filling out length sheets for collection by the project team during the first visit.

Further information on the project is available on the PZJA webpage here:

https://www.pzja.gov.au/torres-strait-biological-sampling-program. Please contact me (or one of the other project partners below) if you would like any additional information or if you would like to discuss any concerns or provide feedback.

I hope to see you soon and look forward to continuing to work with you.

Andrew Trappett
Fisheries Biologist, Fishery Monitoring
Fisheries Queensland
0488 021 694 andrew.trappett@daf.qld.gov.au

Additional contacts:

Project principal investigator: Olivia Whybird (QDAF) Olivia.Whybird@daf.qld.gov.au;
Project partner: Chris Boon (AFMA) 07 4069 1990 or Chris.Boon@afma.gov.au
Project partner: Quinten Hirakawa (TSRA) 07 4069 0700 or Quinten.Hirakawa@tsra.gov.au

Appendix 2: Example Community Notice

Mer Community Science: Dabor and Coral Trout Biology

Project: Torres Strait Finfish Fishery: Coral trout and Spanish mackerel biological sampling 2021-2024

- Interested in participating in community science and learning about the age of dabor and coral trout fish?
- Curious about tracking changes in the populations of these species?
- If so, you are invited to talk with Fisheries Queensland while they are visiting Mer community.

When	**Tuesday 14th November 2023**
Where	**TSIRC Meeting Room 1-4 PM Tues 14th November (afternoon tea provided)** Andrew will be in community from late afternoon 13 Nov and the morning of 14 Nov before the meeting and is available to meet.
Why	Fisheries Queensland will share information and will be helping Meriam fishers take biological samples (length, sex, age). You can help by bringing any dabor and coral trout fish frames you may have in your freezer to Andrew at this time. $5 is paid for each fish frame you contribute to the project.
Who should come	All fishers, fish receivers and interested community members.
Who is visiting	Andrew Trappett, Fisheries Queensland 0488 021 694 or Andrew.Trappett@daf.qld.gov.au

Scan QR code for more info:

daf.qld.gov.au

Queensland Government

Appendix 3: Table of Community Visits and Stakeholder Meetings

2019-2020 sampling program community visits and meetings

Date	Activity
17 September 2019	Workshop held on Erub along with PZJA Industry Members. TSRA, AFMA, Fisheries QLD. Practical demonstration of sampling techniques.
19 September 2019	Workshop held on Masig along PZJA Industry Members. TSRA, AFMA, Fisheries QLD. Practical demonstration of sampling techniques.
9 October 2019	Workshop held on Ugar along with PZJA Industry Members. TSRA, AFMA, Fisheries QLD. Practical demonstration of sampling techniques.
1 November 2019	Project update provided to TSFFRAG 5 meeting held in Cairns.

From Trappett et al. (2021)

2020-2021 sampling program community visits and meetings

Date	Activity
27 October - 3 November 2020	Community meetings held on Erub, Ugar & Mer. Presentation of 2019-20 results, engaging with community and fishers/fish receivers and determine best time for follow up sampling in community (AFMA led visits with Fisheries Queensland invited)
5 November 2020	Presentation to TSFFRAG 8 meeting held in Cairns. Summary of the first 12 months of the project and the initial findings.
7-11 December 2020	Community visit to Erub and Mer for targeted follow-up with fishers and fish receivers actively fishing and providing samples (Fisheries Queensland led with AFMA sending an officer to assist)
15-19 February 2021	Community visit to Erub and Mer for targeted follow-up with fishers and fish receivers actively fishing and providing samples. (Fisheries Queensland led with AFMA & TSRA sending officers to accompany and assist)

From Trappett et al. (2021)

2021-2022 sampling program community visits and meetings

Date	Activity
18-19 October 2021	Community visit to Mer community, presentation of 2020-2021 results to fishers at TSIRC Hall. Sampling.
20-21 October 2021	Community visit to Erub community, presentation of 2020-2021 results to community at TSIRC Hall. Sampling.
14-16 June 2022	Attend AFMA led community meetings in Erub (15 June 2022) and Mer (16 June 2022) and conduct sampling.

2022-2023 sampling program community visits and meetings

Date	Activity
12 October 2022	TSFFRAG 11 Data meeting
3-4 November 2022	Presentation to TSFFRAG meeting in Cairns.
12-15 September 2022	Sampling in Mer community 12-13 September 2022 Sampling in Erub community 14-15 September 2022
26-27 October 2022	Planned to spend the week sampling in Mer/Erub communities but flights grounded. Spent time on Waiben and Ngurupai instead.

2023-2024 sampling program community visits and meetings

Date	Activity
8 June 2023	Attended TSFFRAG 13 and gave an update on the project to RAG members and observers.
28-30 August 2023	Community meeting, practical demonstration on Ugar, 28 August 2023 Waiben, sampling recreational catches 29-30 August 2023
30 Aug 2023	Attended TSFFRAG data meeting on Waiben and give a short update on sampling to RAG members and other stakeholders present.
16-20 October 2023	Sampling Mer 16-17 October 2023 Sampling Erub 18-19 October 2023 Sampling Waiben 20 October 2023
13-17 November 2023	Sampling Mer 13-14 November 2023 Sampling Erub 15-16 November 2023 Sampling Waiben 17 November 2023
29-30 Nov 2023	TSFFRAG 13 Presentation, Cairns

2024-2025 sampling program community visits and meetings

Date	Activity
30 September – 4 October 2024	Sampling Mer 30 September – 2 October 2024 *(Note sampling in Erub community planned for 2-3 October 2024 was deferred due to sorry business in community)* Sampling Waiben 3-4 October 2024
28 October – 1 November 2024	Sampling Mer 28-29 October 2024 Sampling Erub 30-31 October 2024 Sampling Waiben 1 November 2024
15 October 2024	Attended TSFFRAG 17 meeting in Cairns and give a short update on sampling to RAG members and other stakeholders present. Supply sampling gear to fishers present.
28 November 2024	Presentation to board of directors of Gur A Baradharaw Kod Land and Sea Council Torres Strait at Palm Cove. Discuss progress and potential collaboration on research program. Provide sampling gear to some fishers present.

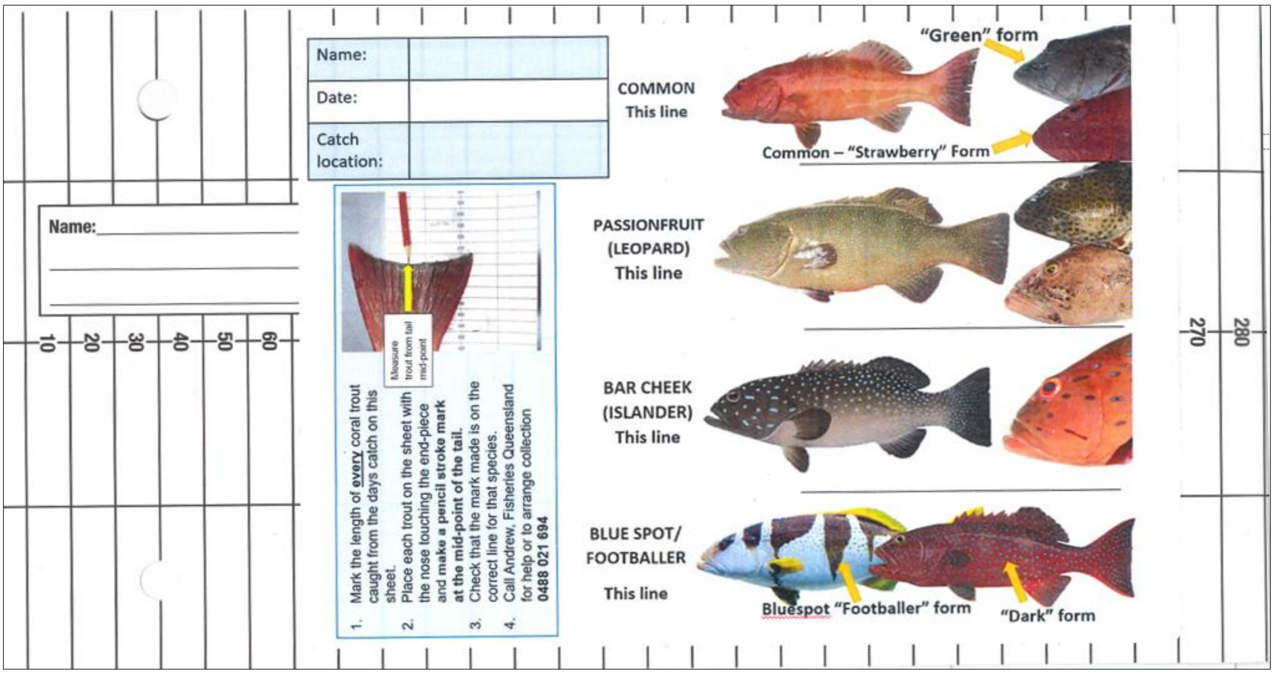
Appendix 4: Sampling Procedures

Field sampling – Spanish Mackerel and coral trout species

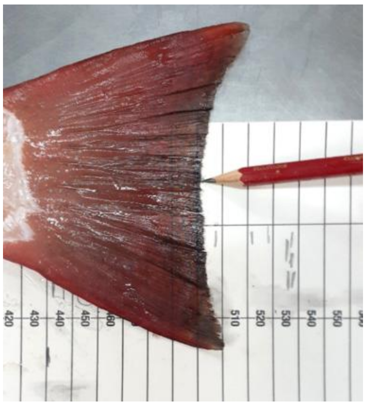
Length sampling procedures

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 precision built for purpose board with an aluminium end piece via two holes at one end. A percentage of the catch was recorded where fishers could not measure an entire unbiased catch. This representative length data was used to construct a length structure for the fishery.

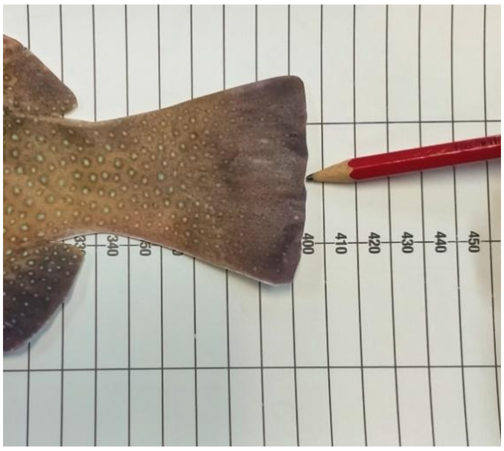
Commercial fishers recorded the lengths of coral trout from whole unbiased (ungraded) catches, as per Spanish Mackerel, using waterproof measuring sheets. Each sheet was used to record a single catch, fishers were asked to record a single species on each row of the data sheet (Figure 1). Fishers recorded the fork lengths of Common, Barcheek and Bluespotted 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).



Appendix 4. 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.



Appendix 4, Figure 2. Position of fork length measurements collected for Common, Barcheek and Bluespotted Coral Trout species being the centre point of the forked tail.



Appendix 4, 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 initially using the AFMA publication "*Torres Strait Coral Trout Identification Guide*". However, based on feedback from TIB sector fishers', amendments were made to the length-sheets to include stickers of coral trout species with useful identification features to help fishers place the correct species on the correct line of the measuring sheet for that days catch. A single page summary ID guide based on these features was also produced to aid identification (Figure 13).

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

Sampling procedure – Age at length 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 DPI Northern Fisheries Facility in Cairns where they were processed by DPI 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).

Lab Processing procedures - Spanish Mackerel and coral trout species

Most of the fish samples were processed in the laboratories at the DPI Northern Fisheries Facility 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 (Appendix 4 Figure of each fish to the nearest 1 mm. For Spanish Mackerel fork length and total length (TL) were also measured to the nearest 1 cm.

For coral trout species fork length was measured to the nearest 1 cm for species with forked tails (Common Coral Trout, Barcheek Trout, Bluespotted Trout) and total length, to the nearest 1 cm, was used for Passionfruit Trout, which have a square tail (Figures 8 and 9). An upper jaw length (Figure 6) was taken with vernier callipers to the nearest 1 mm.

For both Spanish Mackerel and coral trout species the 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 10). 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 (Figure 4), or the residual pieces of the gonads connected to the frame. Sex was recorded as “unknown” if sex determination was not possible (Table 1).

Appendix 4, Table 1. Sex codes for Spanish Mackerel

Sex code	Features
1 – Male	gonads are creamy white, solid, small amount of milt can be extruded
2 – Female	tubular, orange and grainy texture
5 – Unknown	sex cannot be confidently determined (e.g. whole, gutted, degraded)

Appendix 4, Table 2. Sex codes for coral trout species

Sex Code	Features
1 – Male	gonads are often white, solid, small amount of milt can be extruded
2 – Female	gonads are tubular, orange and grainy
5 – Unknown	sex cannot be confidently determined (e.g., whole, gutted, degraded)
6 – Transitional	gonad has areas with characteristics of a female while other areas have male characteristics. Senior staff should be consulted when a transitional gonad is I identified as transitional gonad specimens can be difficult to determine

Appendix 4, Figure 4. Mackerel frames showing female ovaries (above) and male testes (below)

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 2ml 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 DPI Queensland server.

Appendix 4 Figure 5. Upper jaw length measurement of a Spanish Mackerel using Vernier callipers.

Appendix 4, Figure 6. Upper jaw length measurement of a coral trout using Vernier callipers.

Appendix 4, Figure 7. Position of fork and total length measurements collected from Spanish Mackerel.

Appendix 4, Figure 8. Position of fork length measures used for Common Coral Trout, Barcheek Coral Trout and Bluespotted Coral Trout.

Appendix 4, Figure 9. Position of total length measure used for Passionfruit Coral Trout.

Appendix 4, Figure 10. Stages of otolith extraction for a Spanish Mackerel. Coral trout otolith extraction follows the same general procedure.

Representative sampling: percentage of catch sampled

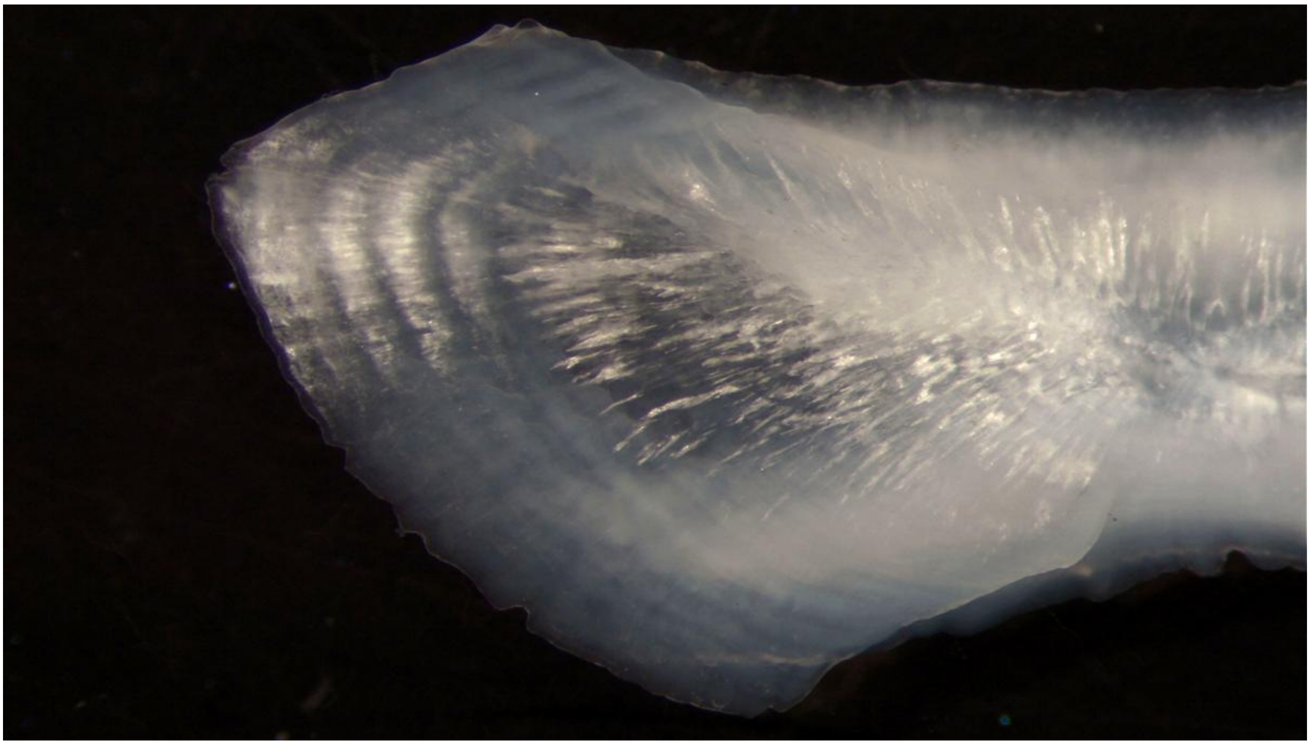
Recording 'percentage of catch' sampled identified length biased samples (0%) and/or allowed sub-sampled catches (>0 to <100%) to be scaled up to be representative of the whole catch (Table 3). In general, commercial catches that were subsampled at less than a quarter of the total catch were deemed unlikely to be representative. However, each catch was considered separately based on the total number of fish in the catch, the relative proportion of the catch to be subsampled, and the lengths of fish in the catch.

Appendix 4, Table 3. Percentage of catch sampled

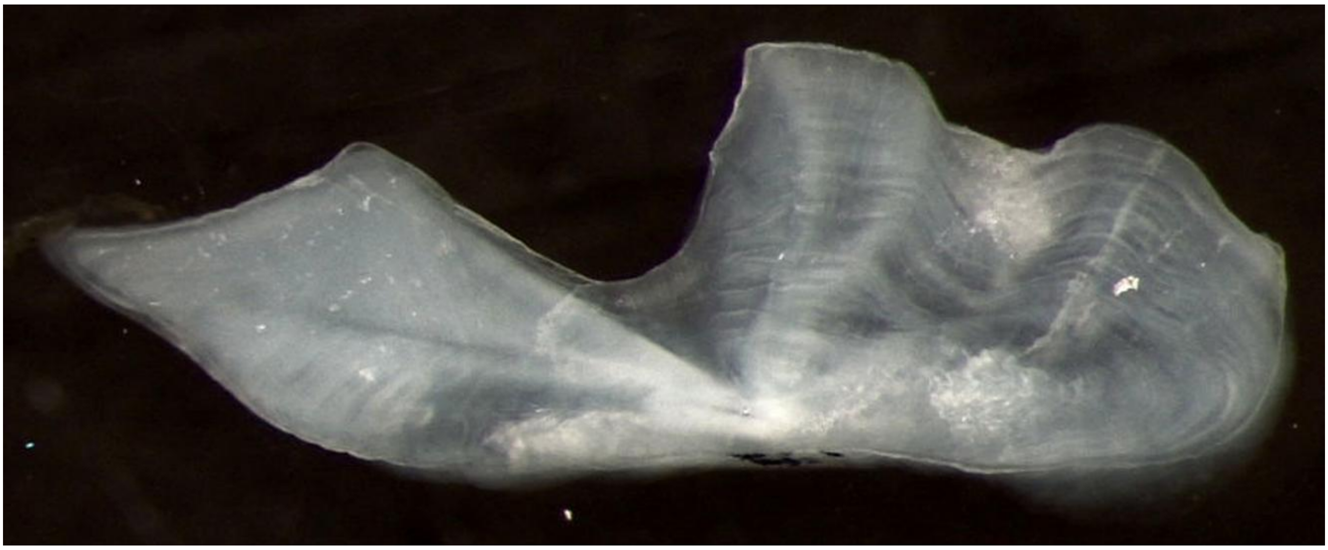
% catch sampled	Situation
100%	Representative sample - the entire catch has been sampled
~25-99%	Representative sample – the whole catch has been sub-sampled in a manner which has a representative proportion of the catch measured (a minimum of approximately 25%) and which has not been biased by fish length. The percentage of the fish that were measured (either by weight, number of fish or number of bins) is recorded together with the total catch (in same units i.e. weight or numbers).
0%	Length biased (non-representative) sample - • suspected or known bias – if the accessible fish no longer represent the lengths of the whole catch, this may be due to size grading for sale; removal of some sizes e.g. for filleting or selling whole. • duplicate - fish may have been recorded twice – once as a length and a second time as a biological sample i.e. length and age and/or sex. The length data of these catches can be used along with the age and sex information to construct age at length or sex at length relationships but not as representative lengths.

Age estimation

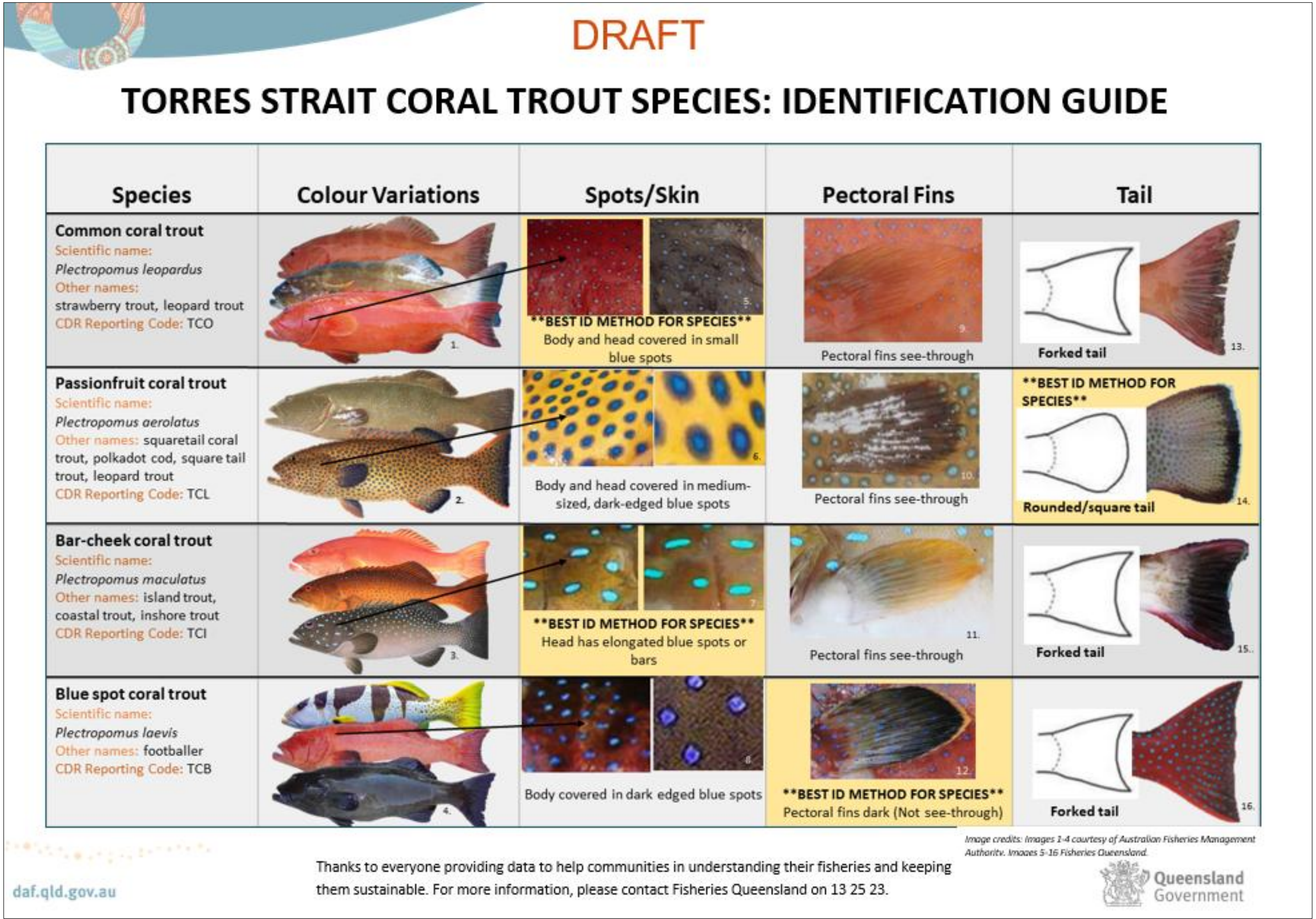
Age is estimated for each fish where an otolith is collected following the General Fisheries Ageing Protocol and the specific Torres Strait Spanish Mackerel Ageing Protocol (Fisheries Queensland, in prep) and the Torres Strait Coral Trout Ageing Protocol (Fisheries Queensland, in prep). Examples of Torres Strait Spanish Mackerel and coral trout otoliths are shown in Appendix 4, Figure 11 and 12.



Appendix 4, Figure 11. Distal view of the left whole otolith of Spanish Mackerel from Torres Strait at 12.5 times magnification.

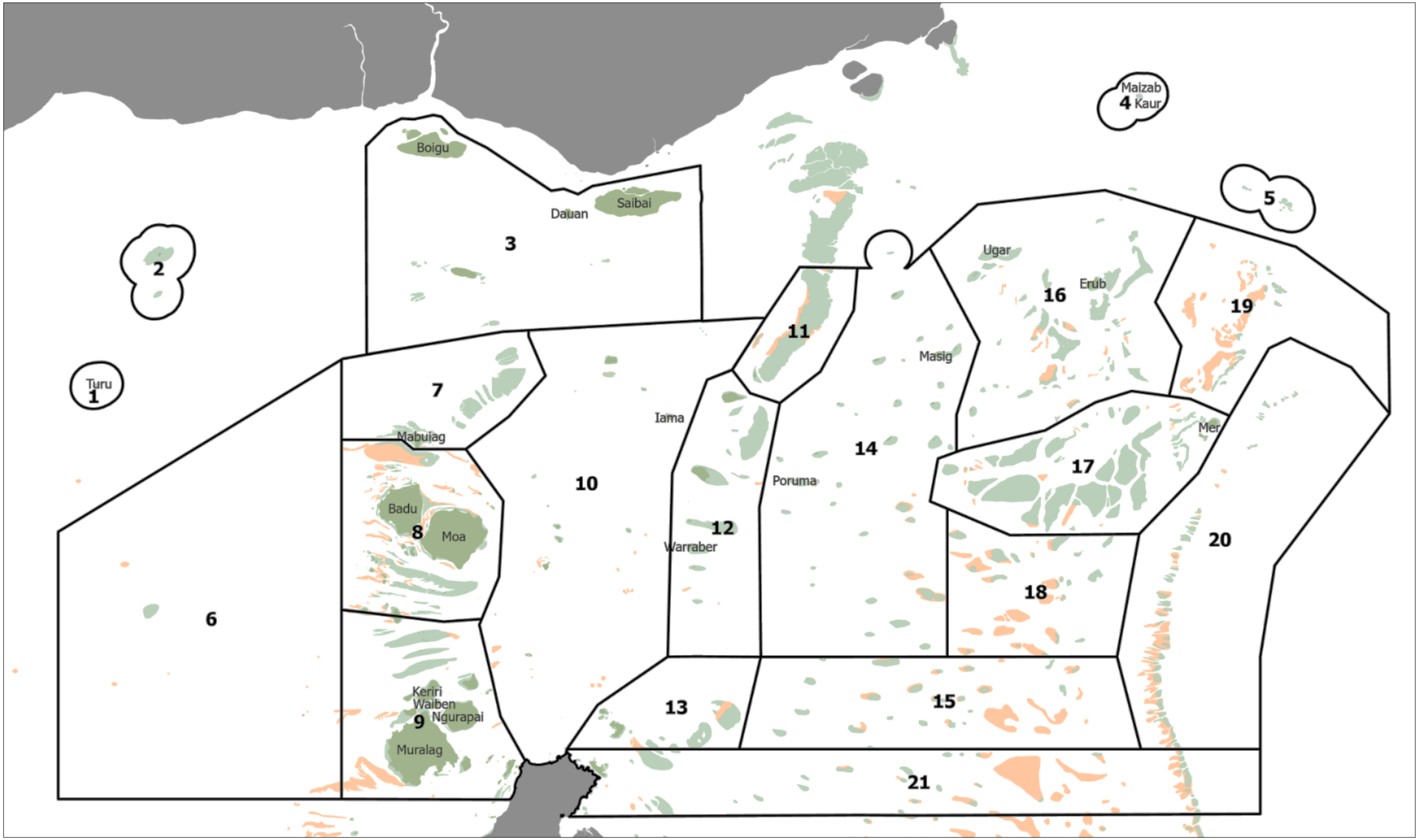


Appendix 4, Figure 12. Distal view of the left whole otolith of Common Coral Trout from Torres Strait at 25 times magnification.



Appendix 4. Figure 13. Species identification guide, Torres Strait coral trout species showing key diagnostic features.

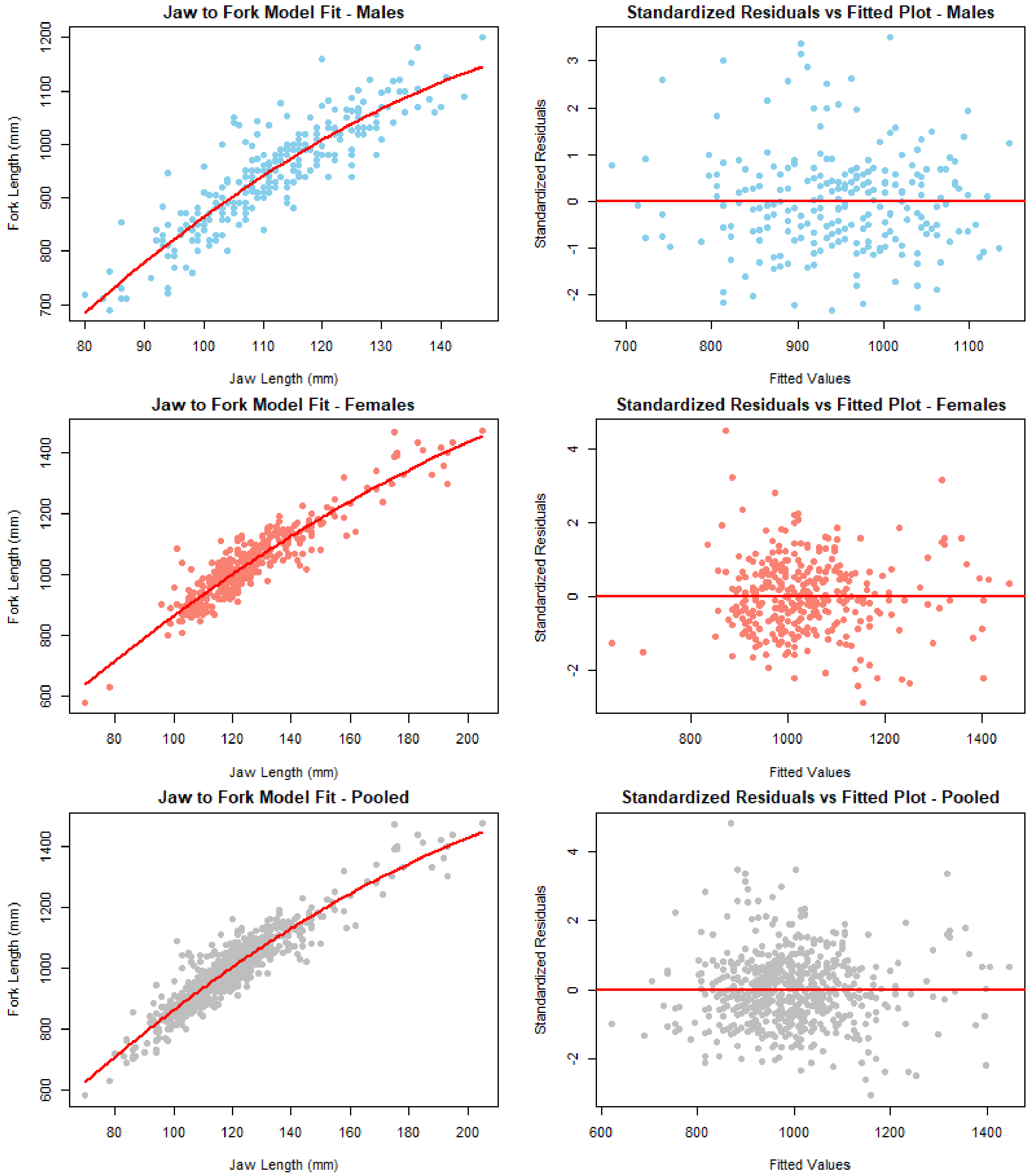
Appendix 5: Torres Strait bio-regions / reporting regions



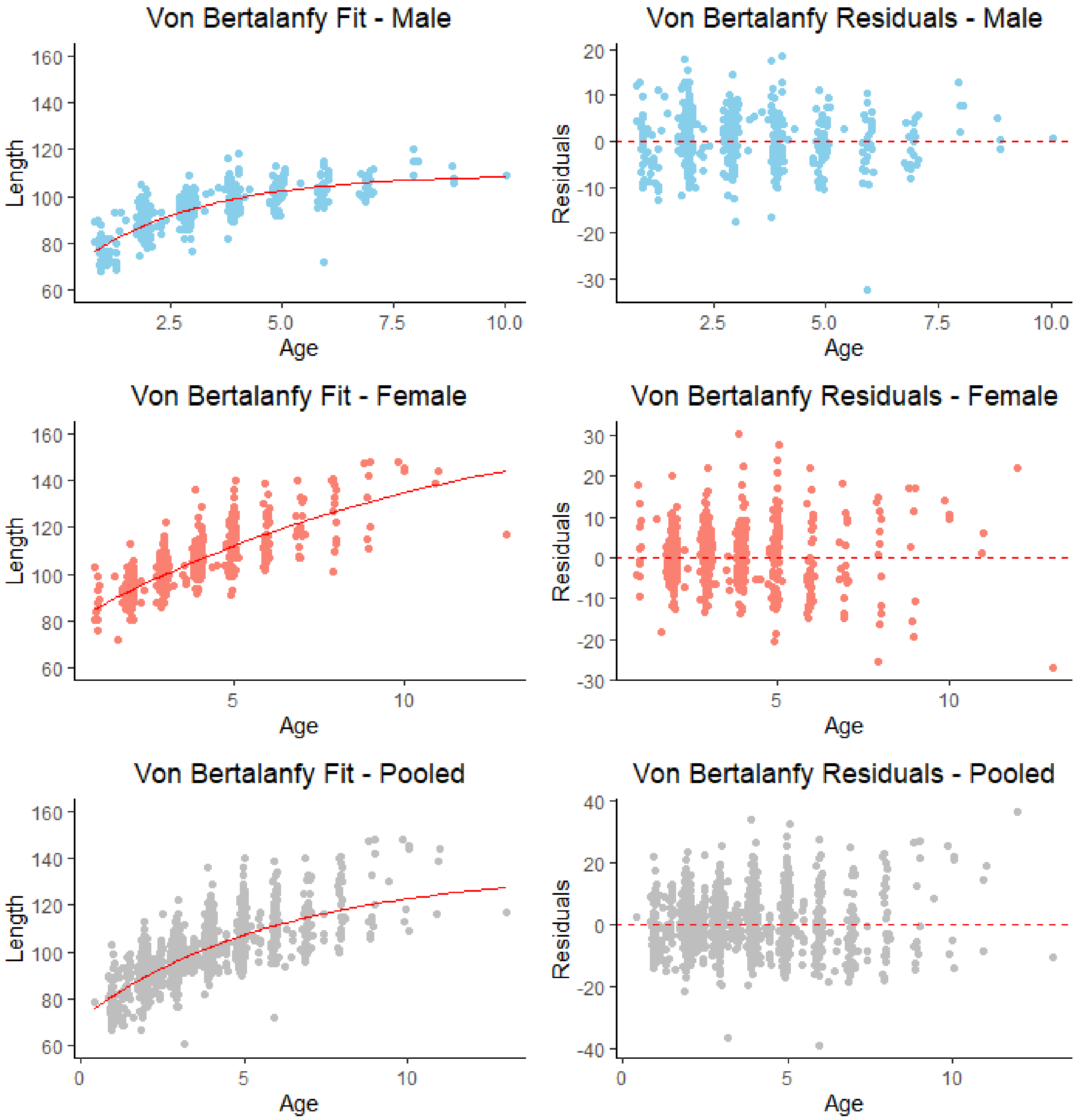
Appendix 5, Figure 1. Annotated map of Torres Strait showing the 21 bioregions used for reporting catch and effort. Source: AFMA TBD02 Catch Disposal Record.

Appendix 6: Torres Strait Spanish Mackerel growth function

Appendix 6. Figure 1. Jaw Length to Fork Length quadratic regression conversion model, lm(fl ~ jl + I(jl^2), data = df). Pearson's R (correlation coefficient) R^2 for Males: 0.90 (n = 275), R^2 for Females: 0.93 (n = 346), R^2 for Pooled: 0.93 (n = 665).



Appendix 6. Figure 2. Von Bertalanfy growth curve model fit to data and residuals used for adjustment of length (FL) within sampling season. Pearson's R (correlation coefficient) R^2 for Males: 0.80 (n = 611), R^2 for Females: 0.81 (n = 661), R^2 for Pooled: 0.77 (n = 2025).



Appendix 7: Data summary of age at length of Torres Strait Spanish Mackerel and coral trout species

Appendix 7. Table 1. data summary of all aged Torres Strait Spanish Mackerel showing measured fork length (FL) in cm at age (age group) (n = 2,025). Showing average length and sample size for males, females and unknown sex fish aged. Numbers in brackets are the range of lengths for each sex within each age group.

Spanish Mackerel													
Age	Females				Males				Unknown				Total
	Av.	Min.	Max.	No.	Av.	Min.	Max.	No.	Av.	Min.	Max.	No.	
0	-	-	-	0	-	-	-	0	79	79	79	1	1
1	88	72	103	14	78	60	93	49	79	58	98	63	126
2	92	81	113	215	88	74	105	224	89	67	116	243	682
3	100	86	122	179	94	77	109	187	96	61	112	212	578
4	106	88	136	155	99	82	118	108	100	86	124	124	387
5	112	91	140	89	102	92	113	57	104	90	127	66	212
6	115	98	141	45	103	72	115	36	108	94	133	32	113
7	120	107	140	18	105	98	112	21	111	96	131	20	59
8	126	101	141	13	115	109	121	6	115	100	131	11	30
9	131	111	148	7	109	106	113	3	122	113	130	2	12
10	146	144	148	3	109	109	109	1	116	113	118	2	6
11	141	139	144	2	-	-	-	0	116	116	116	1	3
12	163	163	163	1	-	-	-	0	-	-	-	0	1
13	117	117	117	1	-	-	-	0	-	-	-	0	1

Appendix 7. Table 2. Summary of age at length data for Torres Strait Comon Coral Trout using measured fork of those fish aged during 2020-2021 to 2024-2025, showing average, minimum-maximum range of lengths per age increment and by sex. No. is number of samples per age increments.

Common Coral Trout													
Age	Females				Males				Unknown				Total
	Av.	Min.	Max.	No.	Av.	Min.	Max.	No.	Av.	Min.	Max.	No.	
1	-	-	-	0	-	-	-	0	-	-	-	0	0
2	-	-	-	0	-	-	-	0	50	47	52	2	2
3	41	40	41	2	50	50	50	1	40	36	43	3	6
4	49	37	57	10	49	41	56	8	44	39	50	10	28
5	47	40	57	9	52	45	57	7	47	38	55	11	27
6	51	39	57	12	51	46	55	11	49	41	58	9	32
7	52	47	55	10	53	47	58	9	49	39	54	11	30
8	52	49	57	3	55	53	56	5	50	44	57	8	16
9	49	42	52	4	53	49	55	5	53	46	62	6	15
10	42	42	42	1	57	55	59	2	53	48	57	3	6
11	-	-	-	0	54	54	54	1	-	-	-	0	1
12	-	-	-	0	48	48	48	1	-	-	-	0	1
13	-	-	-	0	59	59	59	1	-	-	-	0	1

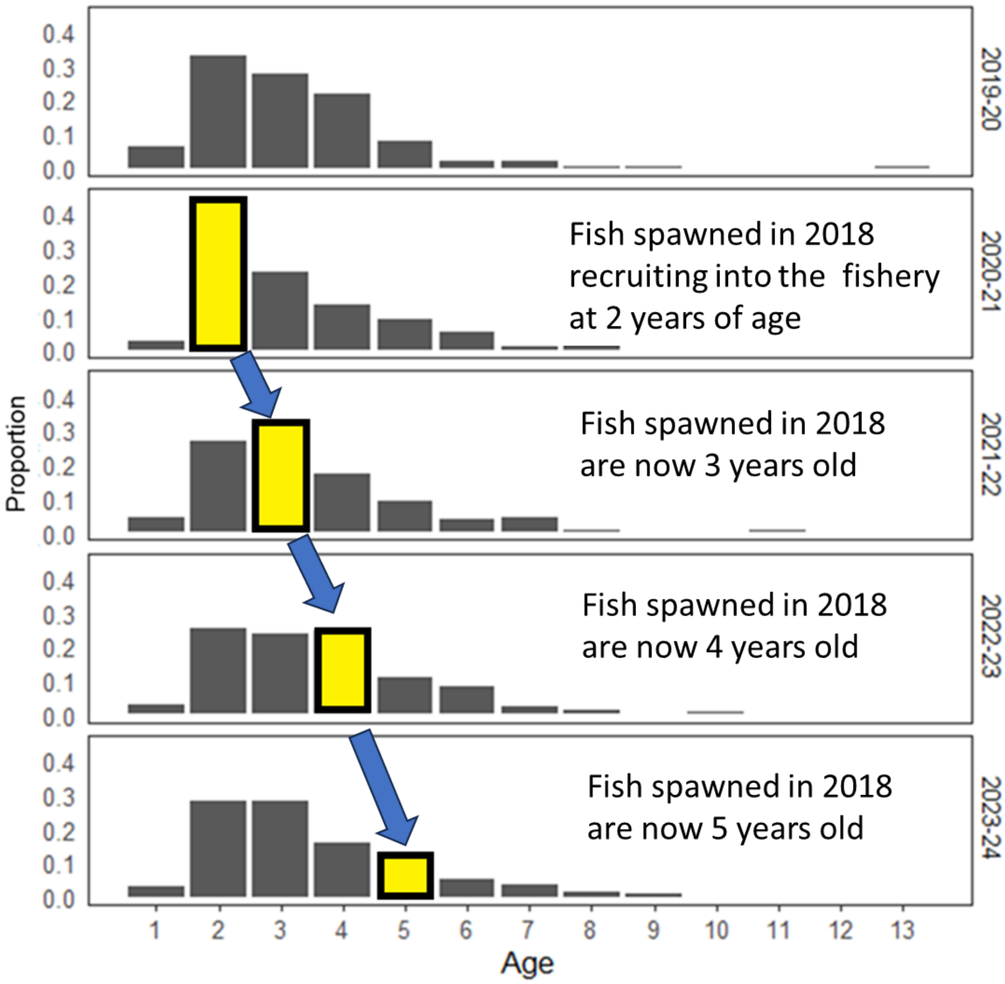
Appendix 7. Table 3. Summary of age at length data for Torres Strait Passionfruit Coral Trout using measured total length of those fish aged during 2020-2021 to 2024-2025, showing average, minimum-maximum range of lengths per age increment and by sex. No. is number of samples per age increments.

Passionfruit Coral Trout													
Age	Females				Males				Unknown				Total
	Av.	Min.	Max.	No.	Av.	Min.	Max.	No.	Av.	Min.	Max.	No.	
1	-	-	-	0	-	-	-	0	-	-	-	-	0
2	42	38	49	3	-	-	-	0	39	38	41	2	5
3	44	42	47	3	43	40	46	2	40	37	42	2	7
4	46	39	51	13	43	40	45	4	45	38	52	9	26
5	47	43	55	22	49	48	49	2	46	42	53	5	29
6	49	44	54	15	50	40	58	8	48	43	54	15	38
7	51	44	56	14	53	50	58	7	52	45	59	10	31
8	52	44	60	14	56	51	61	8	52	46	56	9	31
9	54	53	54	2	55	48	58	4	55	50	60	10	16
10	49	49	49	1	55	47	63	7	53	48	56	7	15
11	-	-	-	0	57	54	61	4	55	55	55	1	5
12	54	54	54	1	56	50	61	5	56	51	60	4	10
13	-	-	-	0	53	53	53	1	57	57	57	1	2

Appendix 7. Table 4. Summary of age at length data for Torres Strait Barcheek Coral Trout using measured fork of those fish aged during 2020-2021 to 2024-2025, showing average, minimum-maximum range of lengths per age increment and by sex. No. is number of samples per age increments.

Barcheek Coral Trout													
Age	Females				Males				Unknown				Total
	Av.	Min.	Max.	No.	Av.	Min.	Max.	No.	Av.	Min.	Max.	No.	
1	35	35	35	1	-	-	-	0	27	27	27	1	2
2	34	31	37	2	35	32	41	3	36	30	43	9	14
3	44	32	51	9	43	39	49	8	39	30	51	14	31
4	44	37	61	10	48	36	55	10	43	35	59	20	40
5	50	48	52	2	52	42	60	12	47	36	55	7	21
6	54	47	61	3	55	52	59	5	44	37	53	9	17
7	50	43	57	2	53	47	61	8	49	44	52	4	14
8	53	46	61	2	55	54	56	2	58	57	59	2	6
9	-	-	-	0	-	-	-	0	-	-	-	0	0
10	40	40	40	1	-	-	-	0	-	-	-	0	1
11	-	-	-	0	-	-	-	0	-	-	-	0	0
12	-	-	-	0	-	-	-	0	-	-	-	0	0
13	-	-	-	0	-	-	-	0	-	-	-	0	0

Appendix 8: Cohort analysis of Torres Strait Spanish Mackerel spawned in 2018



Appendix 8, Figure 1. Annotated plot showing how a cohort of Torres Strait Spanish Mackerel, likely spawned in late 2018, can be seen to move through the fishery, first appearing in 2019-2020 as 1-year olds (likely not fully selected to the fishery at this stage i.e. only the larger fish of this cohort are captured by the fishing gear at this stage). In 2020-2021 these fish (highlighted in yellow) are seen to be most of the commercial fishery with over 40 per cent of the year's harvest being these fish. They again appear in 2021-2022 as 3-year-olds, 2022-2023 as 4-year-olds and in 2023-2024 as a minor proportion of the fishery harvest as 5-year-olds.