Survey of Tropical Snapper in Northern Territory Fisheries — 2021

NORTHERN TERRITORY GOVERNMENT

Document title	Survey of Tropical Snapper in Northern Territory Fisheries — 2021
Contact details	Department of Industry, Tourism and Trade
Approved by	Ian Curnow, Executive Director, Fisheries
Date approved	3 February 2023

Version	Date	Author	Changes made
1.0	May 2022	Ian Knuckey and Matt Koopman	First version
1.2	18 Nov 2022	Tim Porter	NTG Branding Template

Acronyms	Full form
CPUE	Catch per unit effort
CV	Coefficient of variation
NT	Northern Territory
SOCI's	Species of Conservation Interest
SRA	Stock reduction analysis

Disclaimer

The Northern Territory of Australia, acting through the Department of Industry, Tourism and Trade, has exercised due care and skill in preparing and compiling the information and data in this publication. While all care has been taken to ensure that the information contained in this publication is true and correct at the time of publication, it is not intended to be relied on as a comprehensive representation of technical or scientific advice or used for commercial purposes.

The Territory gives no warranty or assurances as to the accuracy of the information contained in the publication and accepts no direct or indirect liability for reliance on its content, including liability for negligence and for any loss, damage, injury, expense or cost incurred by any person directly or indirectly as a result of accessing, using or relying on any of the content of this publication to the maximum extent permitted by law.

Citation

This publication (and any information sourced from it) should be attributed to:

Knuckey, I., and Koopman, M. (2022). Survey of Tropical Snapper in Northern Territory Fisheries — 2021. Fishwell Consulting. 46pp.

ISBN 978-0-6453571-4-1

Report researcher

Name: Ian Knuckey
Email: ian@fishwell.com.au
Web: www.fishwell.com.au

Contents

Tables

Figures

Executive Summary

As part of a broader survey of tropical snapper across northern Australian waters, a fishery-independent trawl survey of snapper species important to the Northern Territory's Timor Reef Fishery and NT Demersal Fishery was conducted during July to October 2021. A total of 218 shots were undertaken within nine strata determined by a combination of NT fishery boundaries, Marine Protected Area boundaries, commercial fishing catch and effort, and biogeographic basins and sub-basins, and comprising an area of 373,708 km^2

Fishery-independent surveys are one of the most valuable tools for fish stock assessment and underpin the provision of management advice in numerous fisheries in Australia and overseas. Biomass estimates based on swept area trawl surveys are very dependent on assumed effective width of the trawl and vulnerability of fish to the gear. Thus, fishery independent trawl surveys are best used to obtain a time-series of consistent *relative* abundance indices as an input into stock assessments, although they are sometimes used to provide an estimate of absolute abundance. Nevertheless, as required for the first of what is expected to be a long-term time-series of random stratified fishery independent trawl surveys, we have provided biomass estimates based on three assumptions: 1) that all fish between the trawl doors are caught (the most precautionary assumption), 2) effective trawl path width based on fish herding models; and 3) that all fish between the wing tips of the trawl are captured (least conservative).

The most precautionary assumption of swept area (that all fish within the path of the net between the trawl doors were caught), resulted in biomass estimates of 98,921 t (CV 0.08) for Saddletail Snapper, 32,794 t (CV 0.15) for Crimson Snapper, 13,099 t (CV 0.92) for Mangrove Jack, 5,197 t (CV 0.13) for Goldband Snapper, 5,801 t (CV 0.14) for Painted Sweetlips, 5,144 t (CV 0.17) for Redspot Emperor, 2,728 t (CV 0.69) for Black Jewfish, 2,566 t (CV 0.37) for Golden Snapper and 1,612 t (CV 0.17) for Red Emperor.

Herding is known to occur for some tropical snapper species and effective trawl path width has been measured previously for Saddletail Snapper. Using a swept area based on effective trawl path width calculations, biomass estimates were 165,707 t for Saddletail Snapper, 54,828 t for Crimson Snapper, 25,290 t for Mangrove Jack, 9,346 t for Goldband Snapper, 9,589 t for Painted Sweetlips, 8,153 t for Redspot Emperor, 4,507 t for Black Jewfish, 4,337 t for Golden Snapper and 2,670 t for Red Emperor.

Length frequency data were collected for nine species: Crimson Snapper, Saddletail Snapper, Goldband Snapper, Painted Sweetlips, Redspot Emperor, Red Emperor, Mangrove Jack, Black Jewfish and Golden Snapper. Lengths of Crimson Snapper ranged 29 cm – 60 cm, with most between 35 cm –55 cm. Saddletail Snapper were caught over a much wider range of lengths from 18 cm – 78 cm with peaks at about 48 cm and 53 cm. Black Jewfish as small as 45 cm were measured, but most were 75 cm – 85 cm. Goldband Snapper ranged 23 cm – 62 cm and Mangrove Jack ranged 29 cm – 81 cm.

DNA samples or fish frames from a total 1,118 individuals of Crimson Snapper, Saddletail Snapper, Goldband Snapper, Red Emperor, Mangrove Jack, Black Jewfish and Golden Snapper were collected.

To improve consistency of data collected on fish captures, a turtle excluder device (TED) was not used during the survey. From the 218 shots undertaken, 132 elasmobranchs of conservation interest, five turtles and one Olive Seasnake were caught.

1. Introduction

Tropical snappers are an important target and byproduct species of several northern Australian fisheries including the Northern Territory (NT) Timor Reef Fishery, NT Demersal Fishery, and Queensland's Gulf of Carpentaria Developmental Fin Fish Trawl Fishery (GOCDFFTF). Key target species include Goldband Snapper (*Pristipomoides multidens),* Saddletail Snapper (*Lutjanus malabaricus*), Crimson Snapper (*Lutjanus erythropterus*) with other byproduct species including Red Emperor (*Lutjanus sebae*), Painted Sweetlip, (*Diagramma pictum*), Redspot Emperor (*Lethrinus lentjan*), Black Jewfish (*Protonibea diacanthus*), Mangrove Jack (*Lutjanus argentimaculatus*) as well as various rock cods (*Epinephelus spp.*).

The NT snapper fisheries are limited-entry, quota-managed, multi-gear and multi-species fisheries managed by the NT Government under a Joint Authority with the Commonwealth Government. The Timor Reef Fishery operates in a small offshore area of 8400 square nautical miles — the Timor Box (Figure 1). During the 2021-22 fishing year, there were nine licences with quota holdings in the Timor Reef Fishery and seven of the 14 licenses were actively fishing. Fishing historically used vertical lines, drop lines, and long lines. Trawling was undertaken in this fishery under a permit from 2014 - 2018. Because of the prevalence of reef in the area, midwater trawling was trialled but bottom trawls were also used. Fishers primarily target Goldband Snapper, Saddletail Snapper, Crimson Snapper, Red Emperor and cods. Currently, the Timor Reef Fishery operators predominantly use fish traps.

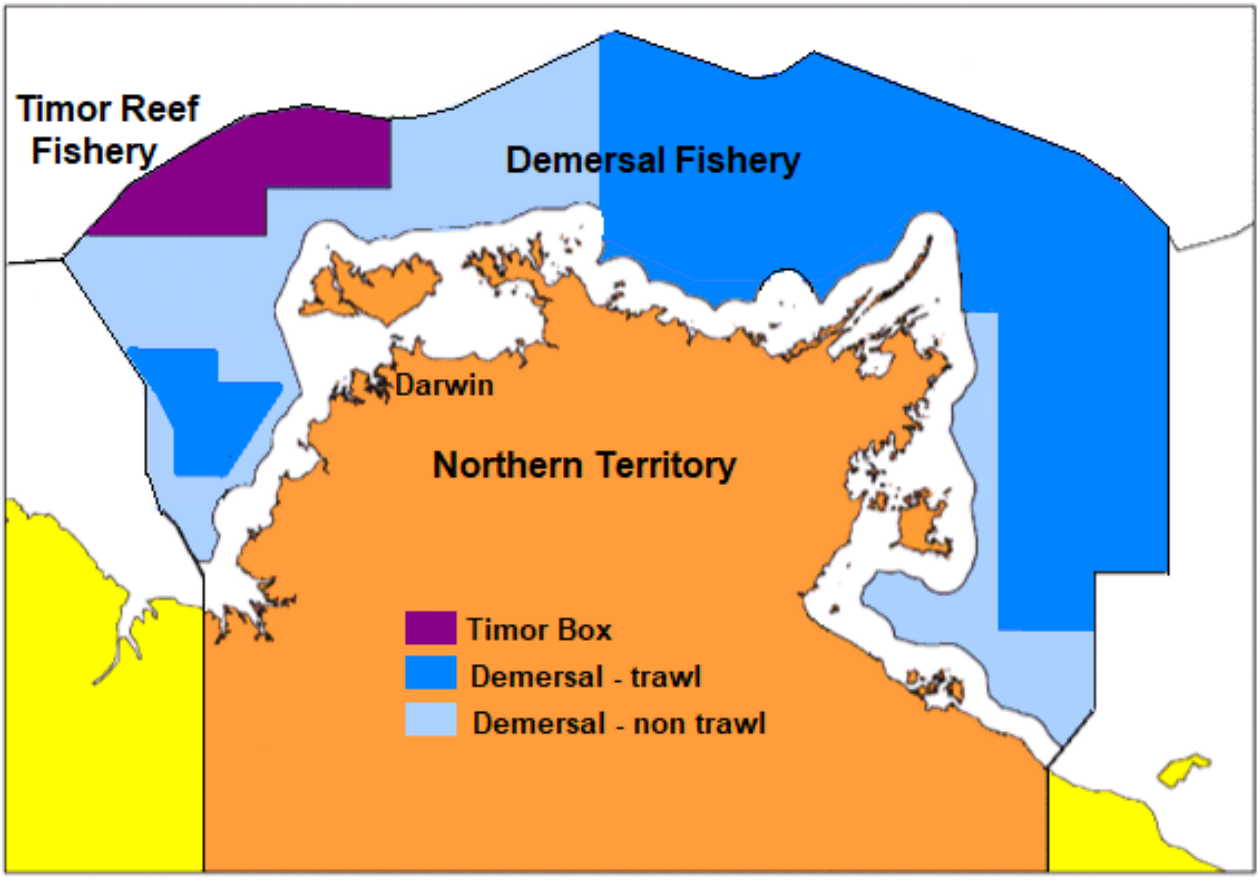

Figure 1. Survey area showing the Timor Reef Fishery and the Demersal Fishery.

The Demersal Fishery is also a multi-gear fishery that includes trawl, trap and line fishing. During the 2021-22 fishing year, there were ten licences with quota holdings in the Demersal Fishery and seven of the 14 licenses were actively fishing. The fishery operates from 15 nautical miles from the low water mark to the outer boundary of the Australian Fishing Zone. Trawling is restricted to two zones (Figure 1), while trap and line gear can be used throughout the fishery. Output management is the same as in the Timor Reef Fishery. Main target species are Saddletail Snapper, Crimson Snapper and Goldband Snapper with byproduct species including Red Emperor and cod. Vessels in the fishery range in size from 23 m – 30 m. Tow duration is generally 3 hours, but targeted tows on schooling fish can be as short as 20 minutes bottom time.

The stock assessments for tropical snapper in both fisheries rely on stochastic stock reduction analysis (SRA) models. Catch per unit effort (CPUE) from commercial catch and effort data forms the main index of abundance used in these models. The use of commercial CPUE as an indicator of relative abundance can be problematic for many reasons and can compromise the underlying assumption that commercial catch rates change linearly with abundance. Although some factors that are reported in logbooks can be used to standardise CPUE, there are other sources of variation including:

- modified fishing practices to target or avoid species to suit quota availability, meet market demands, or to comply with management arrangements;
- differences in selectivity of fishing gear and use of bycatch-reduction devices; and,
- the combined impacts of multiple management restrictions on a fishery.

Fishery-independent surveys are one of the most valuable tools for fish stock assessment, and underpin the provision of management advice in numerous fisheries in Australia (e.g. Peel *et al.* 2013; Deng *et al.* 2015, Day 2019, Nitschke *et al.* 2022) and overseas (e.g., New Zealand (MacGibbon 2019), Gulf of Alaska (von Szalay and Raring 2018) and many National Oceanic and Atmospheric Administration surveys (https://www.fisheries.noaa.gov/national/science-data/research-surveys). Rather than provide an estimate of absolute abundance, these surveys are usually conducted to obtain a time series of consistent relative abundance indices (Peel *et al.* 2013). The last fishery-independent survey of tropical snappers in the NT was conducted over 30 years ago by Ramm (1992, 1997) to provide biomass and preliminary yield estimates for the fishery and the relevance of the information from this survey has diminished over time.

Knuckey and Koopman (2019) designed a stratified random survey to provide a fishery-independent index of stock abundance for tropical snapper in Northern Territory and Queensland waters (Figure 2). Their stratification was based on analyses of commercial fishing effort, stock structure of the main target species, logbook catch records, and boundaries of bioregions. It proposed the use of commercial fishing vessels to undertake directed trawls with oversight by independent research scientists would provide a cost-effective and statistically-robust survey that could provide a fishery-independent estimate of relative biomass and coefficient of variation (CV) for the main tropical snapper species, removing many of the sources of variation associated with fishery-dependent CPUE data. Fishery-independent surveys also provide the opportunity for collection of other important data such as DNA samples for stock structure, otoliths for age estimation, size-frequency, and reproductive condition of important species.

This report focuses solely on the fishery-independent survey in the region of the NT Timor Reef Fishery and Demersal Fishery. In conjunction with this survey, a separate survey was conducted during April and May 2021 for the Queensland fishery (Knuckey *et al.* 2021).

2. Objectives

1. Undertake a demersal fish trawl survey across Northern Territories tropical snapper fisheries, to provide relative indices of abundance and CVs for:
    - Primary species (expected CVs <30%):
        i. Saddletail Snapper, (*Lutjanus malabaricus*);
        ii. Crimson Snapper, (*Lutjanus erythropterus*);
        iii. Goldband Snapper, (*Pristipomoides multidens*);
    - Secondary species (30<CVs<50%):
        i. Red Emperor, (*Lutjanus sebae*),
        ii. Painted Sweetlips, (*Diagramma pictum*);
        iii. Redspot Emperor (*Lethrinus lentjan*);
    - Additional species (poor CVs expected):
        i. Black Jewfish, (*Protonibea diacanthus*); and,
        ii. Mangrove Jack (*Lutjanus argentimaculatus*).
2. Collect length-frequency and other biological data on the main species caught;
3. Monitor any interactions with species of conservation concern.

3. Materials and Methods

3.1. Survey design

The detailed survey design and sampling methods are described in Knuckey and Koopman (2020), but is summarised below.

The nine strata (Figure 2) were defined from a combination of fishing catch and effort, divisions of geographic divisions basins and sub-basins and fishery boundaries. Combined, the strata have a total area of 373,708 km^2 and overlap with areas of non-trawl marine protected areas. A list of randomly allocated (using the QGIS Random Points in Polygons tool) shot locations across each stratum were provided to industry and a list of backup shot random shot locations was provided to be used in the event that the primary shot was deemed “untrawlable”.

Survey shots were undertaken at a speed ranging from 3.2 to 3.8 knots (average 3.6 knots), made with the tide abaft the beam (any direction more than 90 degrees from the current direction), and never trawling into the current. Tow duration was 1.5 hours from net on the bottom to the start of winch up. The start of a valid trawl shot (net on bottom) was restricted to between the hours of 06:00-18:00. Following completion of the shot, the net was hauled aboard and the catch sorted on deck. Commercial species were gathered in fish bins and catches of target species and important byproduct species were weighed using calibrated motion-compensated scales. Discarded by-catch was identified to species where possible and an approximate weight of each species estimated. Length measurements and DNA samples of main target species were collected randomly during the survey. A small number of otoliths was also collected from representative species.

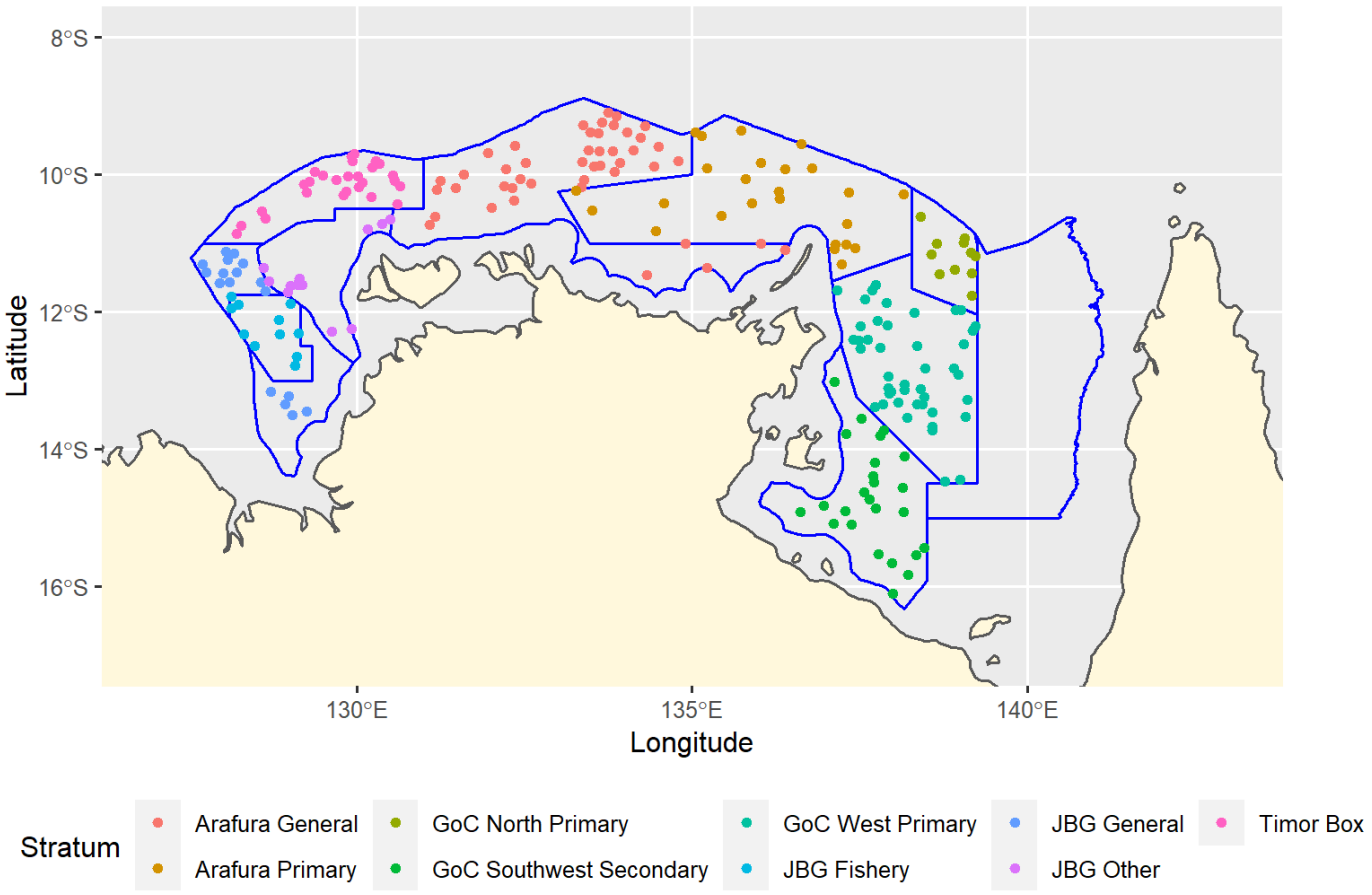

Figure 2. Area surveyed showing all strata including the Queensland GoC stratum used in Knuckey et al. (2021).

3.2. Calculation of relative biomass and coefficient of variation (CV)

Each survey shot provides a density estimate calculated by dividing the biomass of the catch of a particular species by the area swept by the net. Mean density is then estimated (with an associated coefficient of variation) from all shots within each stratum:

$$Mean\ density = \frac{biomass\ captured}{area\ swept\ by\ net}$$

Total biomass can then be estimated (for each species) as the product of mean density and total area following a stratified random survey design (Schnute and Haigh, 2003; Knuckey *et al.*, 2021).

3.2.1. Determining the density

For shots where main species are present in the catch (non-zero measurements), the mean density for each stratum (h) is

$$\mu_h = \frac{1}{n_h}\sum_{i=1}^{n_h}\mu_{hi}$$

The squared inverse of the coefficient of variation (CV) is

$$v_h = \mu_h^2 / s_h^2$$

The mean density of measurements for each stratum is

$$\delta_h = (1 - p_h)\mu_h$$

The variance of density of measurements each stratum is

$$\sigma_h = \sqrt{\left((1 - p_h)(1 + p_h v_h)\left(\mu_h^2 / v_h\right)\right)}$$

The estimated biomass for each stratum h is

$$b_h = A_h \delta_h$$

The CV of the biomass estimate for each stratum is

$$cv_h = \sqrt{\sigma_h} / b_h n_h$$

Where p_h is the proportion of hauls with zero catch for the species in stratum h, μ_h is the mean weight in kilograms per area swept (m^2) of species where catch >zero, s_h is the standard kilograms per area swept (m^2) of species where catch >zero, A_h is the total area of stratum (measured using the st_area function from the R package sf), n_h is the number of shots and b_h is the estimated relative biomass.

Total relative biomass (B) and CV for each species were calculated as follows:

$$B = \sum_h b_h$$

$$cv = \sum_h cv_h$$

The number of shots, n_h, in each stratum that produced the desired coefficient of variation, cv_h, was randomly allocated within each stratum.

Relative biomass was estimated using the swept area method upscaling density of individual species caught and applying an estimate of the swept area of the trawl.

The density measure (weight per area swept) was estimated as follows:

$$\mu_{hi} = C_{hi} / v_{hi} d_{hi} E_{hi}$$

Where each shot i in stratum h has a known catch of C_{hi}, effort (shot duration hour) E_{hi}, vessel speed (m/hour) v_{hi} and effective trawl width d_{hi}. Thus, the biomass estimate is sensitive to the value of effective trawl width applied.

3.2.2. Swept area of the trawl

At its simplest, the swept area of a trawl can be calculated by multiplying the distance trawled by the width of the trawl. One of the greatest unknowns in most trawl fishing however, is catchability of the gear, and the *effective* width of the trawl. These can be influenced by, among other factors, mesh size, the net configuration (including mesh size, headline height and length, footline length, ground gear configuration, floatation, sweeps, bridles, doors and warps) as well as the behaviour of fish (e.g. schooling, mobility, herding response) (Piasente et al., 2004). Two commonly used estimates for swept area are based on net

width (the distance between the wings of the net or wing spread) and door width (the distance between the trawl doors). Both of these estimates can result in biased biomass estimates (Ramm and Xiao, 1995). Using wing spread (a smaller swept area) will over-estimate biomass for species that are herded by the doors and sweeps, whereas using door width (a larger swept area) can under-estimate biomass. Both approaches are also potentially biased because they take no account of the fish that may swim over the headline, under the footline or escape through the meshes of the net.

Ramm (1992) considered catchability in his surveys as two different components, retention and effective trawl path. Based on information for lethrinids (family Lethrinidae) on the Northwest Shelf, the retention of large lutjanids may be high (90-100%), and herding may increase the effective path width of the trawl (30–60 m). He used these figures in estimations of biomass for Goldband Snapper and Saddletail Snapper, although he reported figures for effective trawl path-width ranging from 20–75 m and trawl retention from 10–100%.

In an experiment to measure effective trawl width, Ramm and Xiao (1995) reported that for Saddletail Snapper caught with a trawl net with a door spread of 64 m and a wing spread of 15 m (headline = 26 m, footline 30 m (Ramm, 1997), the effective herding distance was 73.9 m and that the effective path width was 35.6 m. This was the only species for which reliable estimates of herding parameters have been calculated.

In the absence of additional information on which to base the effective trawl path width, we report values of biomass using three different options for calculating swept area (Figure 3):

1. Door spread. A conservative calculation that assumes all fish in the path of the trawl between the doors are caught;
2. Effective trawl path. An effective trawl path width calculated from equation 12 in Ramm and Xiao (1995), using their estimate of effective herd distance (73.9 m) for Saddletail Snapper only, calculated wing spread and the calculated door spread from the current survey;
3. Wing spread. The least conservative calculation that assumes all fish in the path of the trawl between wings of the net are caught.

3.2.2.1. Door spread

This is often used in trawl surveys (e.g. MacGibbon, 2019), with the acknowledgement that the assumptions (that all fish in the water column are below the headline height and available to the net, that all fish in the area swept are caught and there is no escapement) are unlikely to be true, and therefore the biomass estimate is likely very conservative. In some studies where door spread is used to calculate absolute biomass (e.g. for Whiting (*Merlangius merlangus*) in Shephard *et al.*, (2015)) and a correction coefficient representing herding is applied. However, the correction coefficient needs to be measured experimentally.

During industry workshops two different figures for door spread were provided for two different depths: 70 m at a depth of 50 m and 96 m for a depth of 100 m.

The relationship between door spread and depth is often described by a simple logarithmic equation (e.g. see Arronte et al., 2021). A logarithmic equation was fitted to the two figures provided by industry resulting in the following:

$$DoorSpread = -76.74 + 37.51 \times \log(Depth)$$

Using the above relationship, door spread was calculated for each tow using the recorded depth. Depth was not recorded for one tow, for which the nearest tow depth was used.

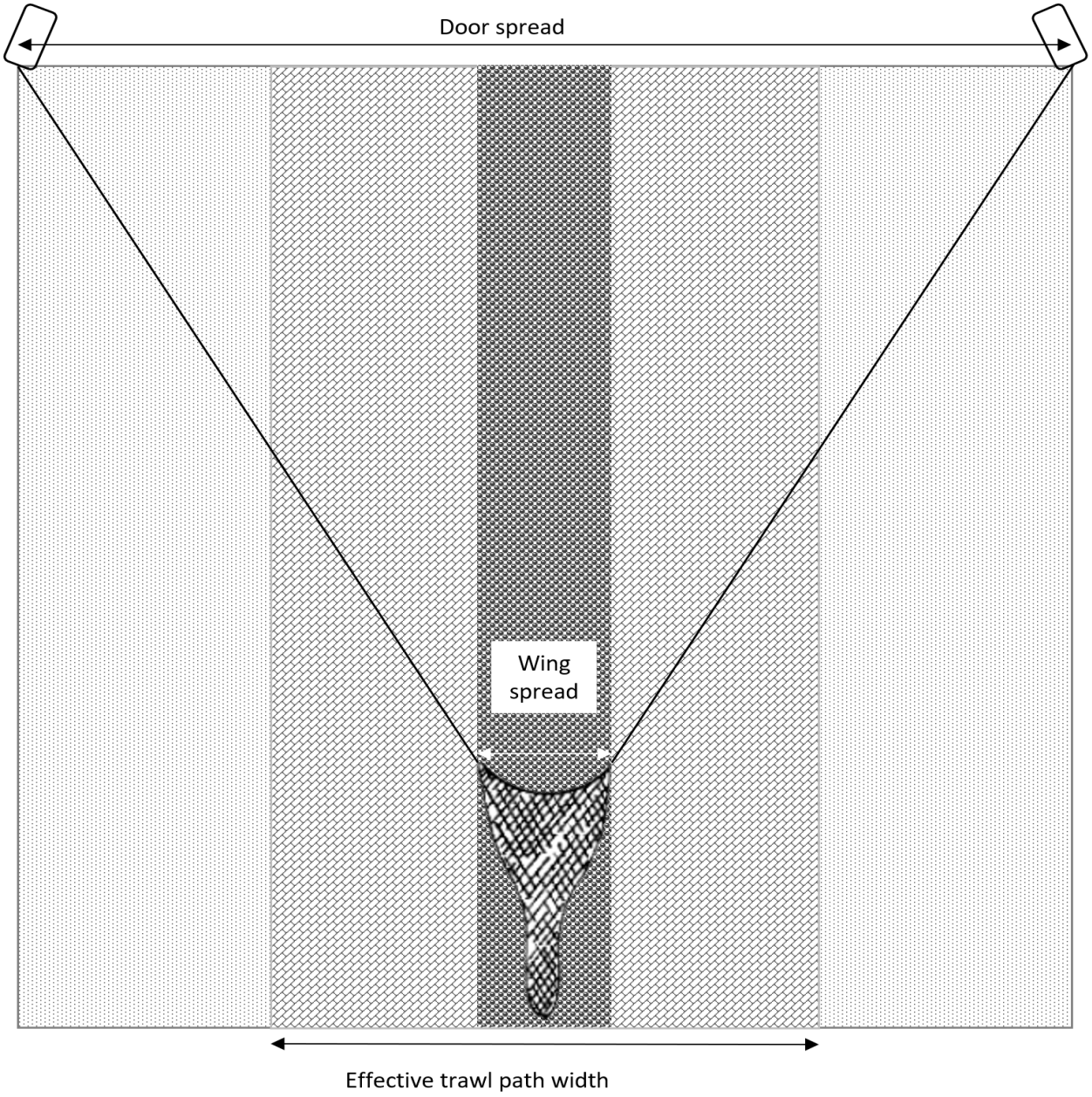

Figure 3. Schematic diagram of the three options used to calculate swept area (not to scale).

3.2.2.2. Wing spread

Biomass estimates based on wing spread (the distance between the tips of the net wings) result in the greatest biomass estimates. Wing spread is considered to be a realistic assumption of swept area for species which do not show herding behaviour (Walker et al., 2017).

The distance between wingtips was calculated using the following equation (Seafish, 2010):

$$WingEndSpread = \frac{GroundGearLength \times DoorSpread}{BridleLength + GroundGearLength}$$

Where bridle length was the combined bottom bridle (45 m) and sweep (90 m) lengths (135 m), door spread was as calculated above and ground gear length was 33.6 m.

3.2.2.3. Effective trawl path

Ramm and Xiao (1995) showed an effect of herding on many tropical demersal species including Saddletail Snapper. From experiments where door width was changed, they calculated the "effective herding distance" to be 73.9 m for Saddletail Snapper (the only species for which reliable estimates of herding parameters could be obtained) over their range of experimental door widths (42.3 m to 80.6 m). From this, they calculated that the effective trawl path width W_{eff} for their net (headline length = 26 m, footrope = 30 m) when operating with a door spread of 60 m and a net opening (wing spread) of 15 m was 35.6 m for that species.

Using door spread and wing spread calculated from the methods described above, effective herding distance was calculated for each shot. Calculations were done using the R code below (based on code provided by Michael O'Neill, QDAF).

```
weffCum<-data.frame(Set.Id=numeric(), Weff = numeric())
for(i in 1:nrow(WeffDF)) {       # for-loop over rows
  shot <- WeffDF[i, ]
W=shot$W
D=shot$D
H=shot$H
      #We know 3 values to construct the linear line on the x-axis; 0 and H/2 here was the Ramm model;
  x=c(W, median(c(W, H)), H)
  y=c(1, 0.5, 0) #We know 3 retention probabilities to construct the linear line on the x-axis
    # Step 3
  # Integrate over the linear model to calculate effective trawl width
  d <- data.frame(x, y) #Put the data into a Table format
  mdl<-lm(data=d,y ~ x)#linear model
     pred<-data.frame(x=seq.int(from=0,to=H,by=.001))# Setup x-values for prediction. This is a sequence of numbers from
zero to H.
  pred$y<-predict(mdl,newdata =pred)
  pred$y<-with(pred, ifelse(y>1,1,
                            ifelse( x>D,0,y))) ##Restrict maximum of y to 1 for net width and sets y to 0 for outside of door spread
  retention =sum(pred$y)/length(pred$y)
    weff = H * 2 * retention
  weffadd<-c(Set.Id=c(shot[,c(1)]), Weff=weff)
     weffCum<-rbind(weffCum,weffadd)
}
colnames(weffCum) <- c('Set.Id', 'Weff')
```

This effective trawl width is used as a less conservative but more realistic biomass estimate than door width for at least for Saddletail Snapper. Although Ramm and Xiao (1995) did not provide estimates of herding distances to enable calculation of W_{eff} for other species, they did find evidence of herding in many other species including, of relevance for this study, Painted Sweetlip. Catches of Crimson Snapper, Golden Snapper, Red Emperor and Redspot Emperor showed no significant correlation with door spread (herding). For those species with no evidence of herding, the use of W_{eff} may still be conservative.

3.3. Quality assurance

All data are recorded in an observer version of ORLAC Dynamic Data Logger (DDL), which includes quality assurance protocols including automatic data capture (time, date and position), field restrictions, range checks, mandatory fields and lookup tables. All data were manually error checked against data sheets before loading into the shore version of ORLAC DDL. The database is regularly backed up and used to extract data for analyses. All analyses were undertaken using R (R Core Team, 2022).

Results and their interpretations and conclusions were discussed amongst the research team and NT Fisheries. The draft report was made available to NT Fisheries researchers, managers and industry for comment. Where required, comments were addressed in preparation of the final report.

4. Results and discussion

4.1. Survey coverage

The NT tropical snapper fisheries survey was conducted over eight trips between 12th July 2021 and 28th October 2021, involving 88 survey days (111 sea days) during which 218 shots were completed (Table 1) across nine strata. The total survey strata area was about 373,708 km^2 (Figure 2), and the mean depth surveyed ranged 44.8 m in the GoC Southwest Secondary stratum to 147.4 m in the Timor Box stratum (

Table 2). Tow duration and speed were relatively consistent at 1.5 hours and 3.6 kts, however mean tow duration was slightly less at JBG General because of the rough ground reducing the distance that some shots could be undertaken. This resulted in a shorter tow length (9.6 km) compared to other strata (10.0–10.2 km).

The benthic habitat in two strata (JBG General and Arafura General) included significant areas of untrawlable ground which could not be excluded during the initial stratification and random shot allocation because the fine-scale GIS data on those untrawlable habitats was not available/known. As a result, some of the original random shot locations were allocated on or near untrawlable ground. This situation was only revealed once the vessel master was at the shot location. In these instances, the vessel either reduced the tow length to avoid losing or damaging the trawl gear or elected to use the nearest pre-allocated random backup shot.

Table 1. Ports of departure and return, start and end trip dates and number of shots undertaken during each trip.

Port of Departure	Start Trip Date	Port of Return	End Trip Date	Number of shots
Darwin	12/07/2021	Karumba	25/07/2021	26
Karumba	26/07/2021	Karumba	9/08/2021	33
Karumba	10/08/2021	Darwin	20/08/2021	21
Darwin	20/08/2021	Darwin	3/09/2021	33
Darwin	3/09/2021	Darwin	16/09/2021	28
Darwin	17/09/2021	Darwin	30/09/2021	30
Darwin	1/10/2021	Darwin	15/10/2021	27
Darwin	16/10/2021	Darwin	28/10/2021	20

Table 2. Mean and standard deviation (SD) depth fished (m), tow duration (hours), tow speed (knots), tow distance (km) and swept area (km^2) of shots during the 2021 survey. Area swept calculated using the three options described in methods.

Stratum	Stratum area (km^2)	Number of Shots	Depth (m)	Tow duration (hours)	Tow speed (kts)	Tow distance (km)	Area swept (km2) – Door spread	Area swept (km2) - Wing spread	Area swept (km2) - W_{eff}
Arafura General	79,620	45	91.1 (32.2)	1.5 (0)	3.6	10.1 (0.2)	0.908 (0.145)	0.181 (0.029)	0.462 (0.021)
Arafura Primary	79,618	25	59.4 (15)	1.5 (0)	3.6	10.1 (0.2)	0.767 (0.077)	0.153 (0.015)	0.451 (0.011)
GoC North Primary	15,710	11	51.8 |(3.9)	1.5 (0)	3.6	10.1 (0.2)	0.721 (0.031)	0.144 (0.006)	0.445 (0.011)
GoC Southwest Secondary	47,118	25	44.8 (9)	1.5 (0)	3.6	10.1 (0.3)	0.659 (0.094)	0.131 (0.019)	0.428 (0.036)
GoC West Primary	57,911	44	52.5 (2.8)	1.5 (0.1)	3.6	10 (0.4)	0.721 (0.032)	0.144 (0.006)	0.442 (0.016)
JBG Fishery	13,350	11	91.1 (15.8)	1.5 (0.1)	3.6	10 (0.4)	0.924 (0.084)	0.184 (0.017)	0.463 (0.022)
JBG General	27,341	17	89 (28.4)	1.4 (0.1)	3.6	9.6 (0.9)	0.864 (0.166)	0.172 (0.033)	0.441 (0.047)
JBG Other	24,917	13	62.2 (8.6)	1.5 (0)	3.6	10.2 (0.2)	0.79 (0.056)	0.157 (0.011)	0.453 (0.011)
Timor Box	28,123	27	147.4 (68.9)	1.5 (0.1)	3.6	10.2 (0.6)	1.094 (0.192)	0.218 (0.038)	0.485 (0.036)
TOTAL	373,708	218							

4.2. Catch composition

The total catch from the 218 shots undertaken during the 2021 survey was 142.7 t, and comprised 369 different species or species groups. Main target species caught were Saddletail Snapper 44.1 t (30.9%), Crimson Snapper 14.4 t (10.1%), Mangrove Jack 6.9 t (4.8%), Goldband Snapper 2.7 t (1.9%), Painted Sweetlips 2.3 t (1.6%), Redspot Emperor 1.8 t (1.2%), Black Jewfish 1.5 t (1%), Golden Snapper 1.3 t (0.9%) and Red Emperor 0.6 t (0.4%) (Table 3, Figure 4). Total catch of all species is shown in Appendix 1. A map of the percent composition of the main species / groups is shown in Figure 5 to Figure 8. Densities of each of the main species in each shot are shown in Figure 9 to Figure 17 and densities of each main species in each stratum is shown in Appendix 2.

Large single-shot catches (>1000 kg) were recorded for Mangrove Jack, Saddletail Snapper, Bigeye Trevally, Finny Scad and Malabar Trevally and catches of all main species were skewed right with numerous small catches (Figure 18). Of the main target species caught, those that were observed in the greatest number of shots were Saddletail Snapper (184 shots), Goldband Snapper (132) and Painted Sweetlips (112), whereas Black Jewfish were observed in only 18 shots (Table 4).

Saddletail Snapper were caught throughout the survey area except for areas in the north-east of the Timor Box and Arafura General where the depth was greater than 110 m (Figure 9). Crimson Snapper were infrequently caught in the Timor Box, Arafura General and the north of JBG General (Figure 10). Two large catches of Black Jewfish were recorded from the GoC West Primary stratum, while small catches were spread throughout the other strata except for JBG Primary where no Black Jewfish were caught (Figure 11). Goldband Snapper catches were highest in deep water sites (Figure 12). Some large catches of Golden Snapper were recorded from GoC North Primary, GoC West Primary and the JBG Fishery strata,

while zero catches were spread throughout the survey area (Figure 13). One very large catch of Mangrove Jack was recorded from the Arafura General stratum and small catches were frequently recorded from the GoC West Primary stratum (Figure 14). Catches of Painted Sweetlips were spread-out throughout the survey area except for the Timor Box and Arafura General where mostly zero catches were recorded (Figure 15). Red Emperor were also infrequently caught in the Timor Box and Arafura General strata (Figure 16). Redspot Emperor catches were highest in the GoC Southwest Secondary, JBG Fishery, GoC North Primary and Arafura Fishery strata, while they were infrequently caught in the Timor Box and Arafura General and northern part of the JBG General strata (Figure 17).

Table 3. Total catch (kg) of primary and secondary species caught during the 2021 survey.

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Saddletail Snapper	*Lutjanus malabaricus*	37346007	44128.40
Crimson Snapper	*Lutjanus erythropterus*	37346005	14351.67
Mangrove Jack	*Lutjanus argentimaculatus*	37346015	6892.69
Goldband Snapper	*Pristipomoides multidens*	37346002	2655.88
Painted Sweetlips	*Diagramma pictum*	37350003	2287.12
Redspot Emperor	*Lethrinus lentjan*	37351007	1768.88
Black jewfish	*Protonibea diacanthus*	37354003	1494.92
Golden Snapper	*Lutjanus johnii*	37346030	1263.00
Red Emperor	*Lutjanus sebae*	37346004	641.21

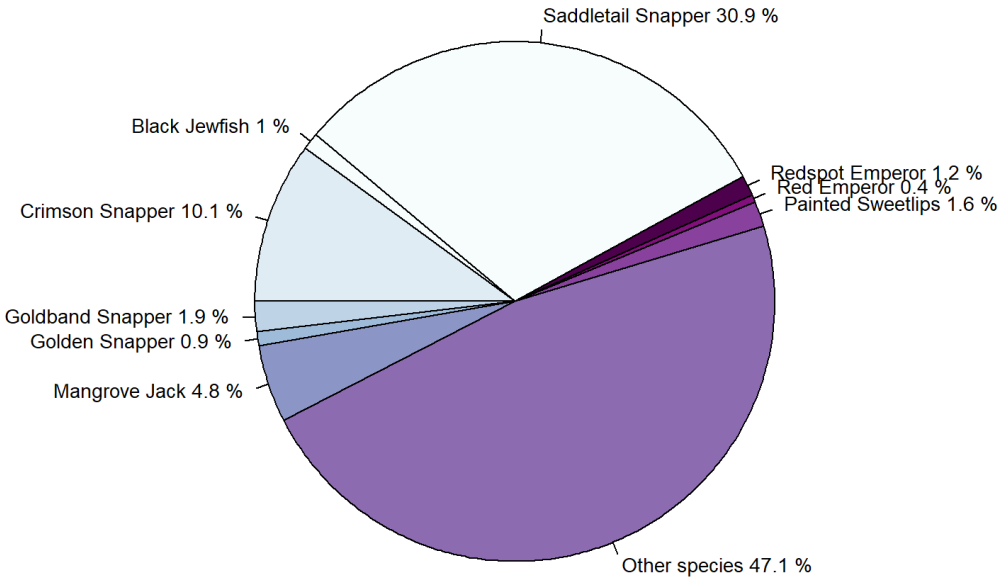

Figure 4. Percent weight (total catch 142.7 t) of species of interest and major species caught during the 2021 survey.

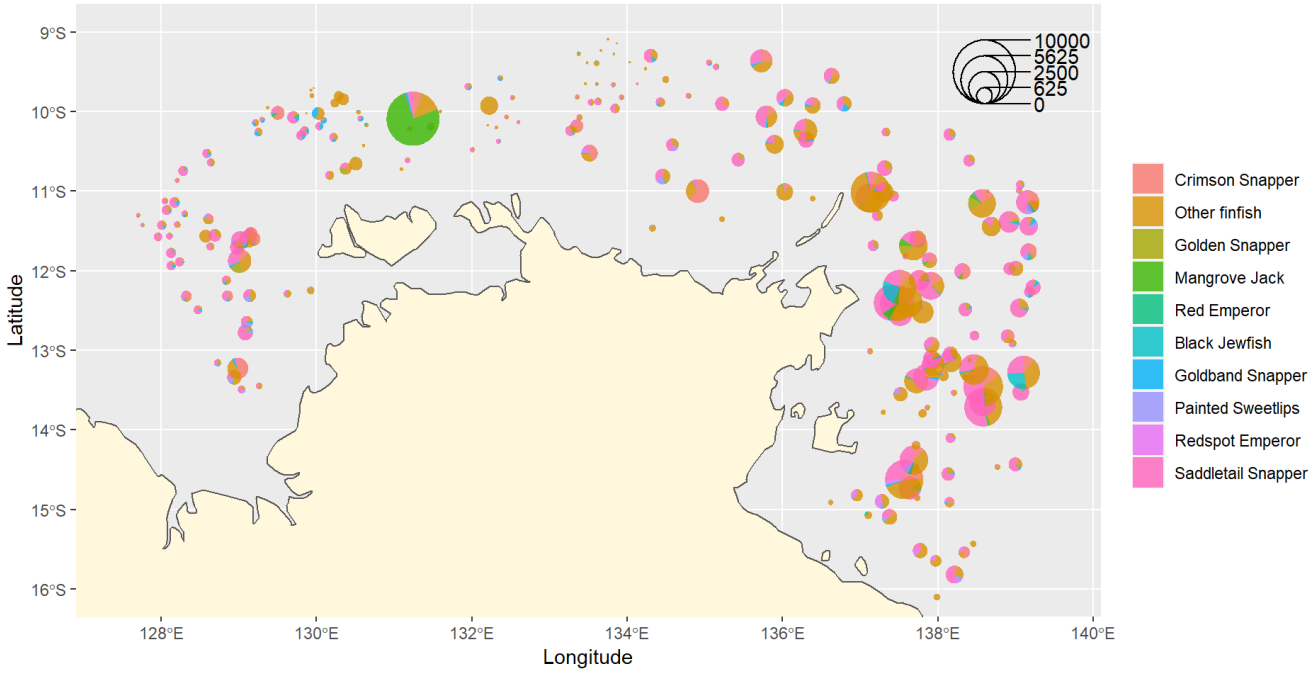

Figure 5. Relative percent composition of main species and “other teleosts” in each shot. The size of pie charts is scaled by the total catch (kg) of those species/groups.

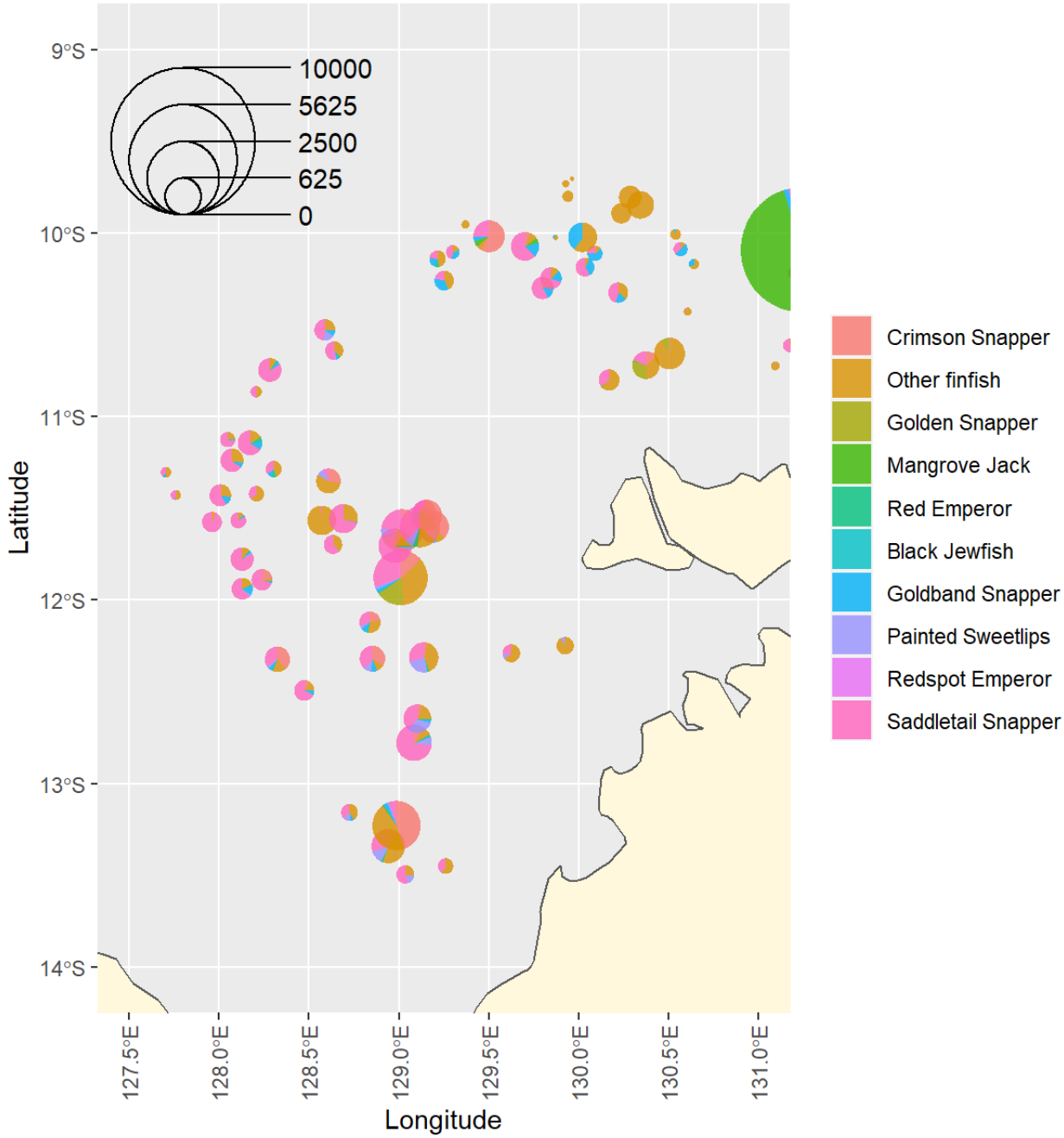

Figure 6. Relative percent composition of main species and "other teleosts" in each shot in the western strata. The size of pie charts is scaled by the total catch (kg) of those species/groups.

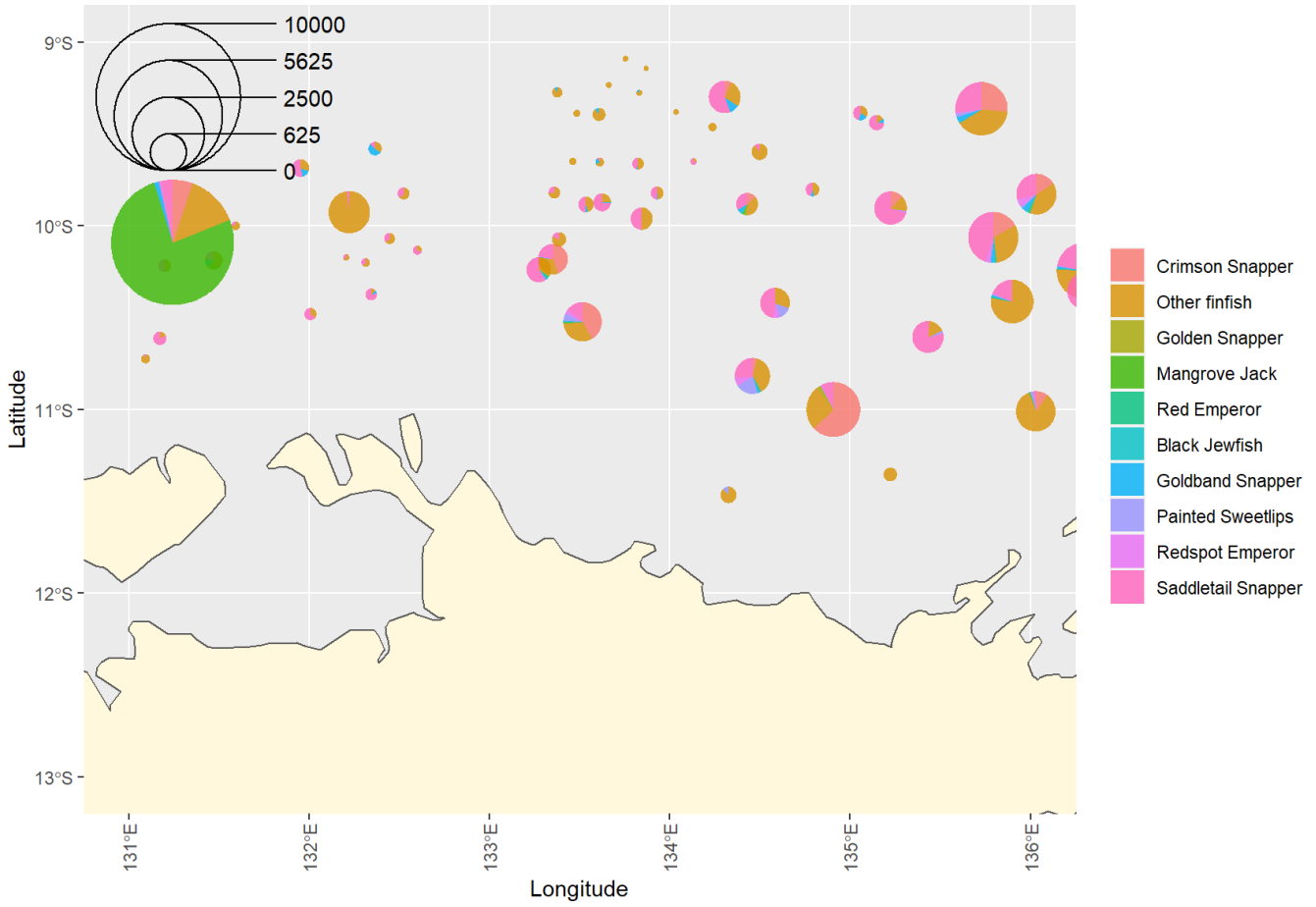

Figure 7. Relative percent composition of main species and “other teleosts” in each shot in the central strata. The size of pie charts is scaled by the total catch (kg) of those species/groups.

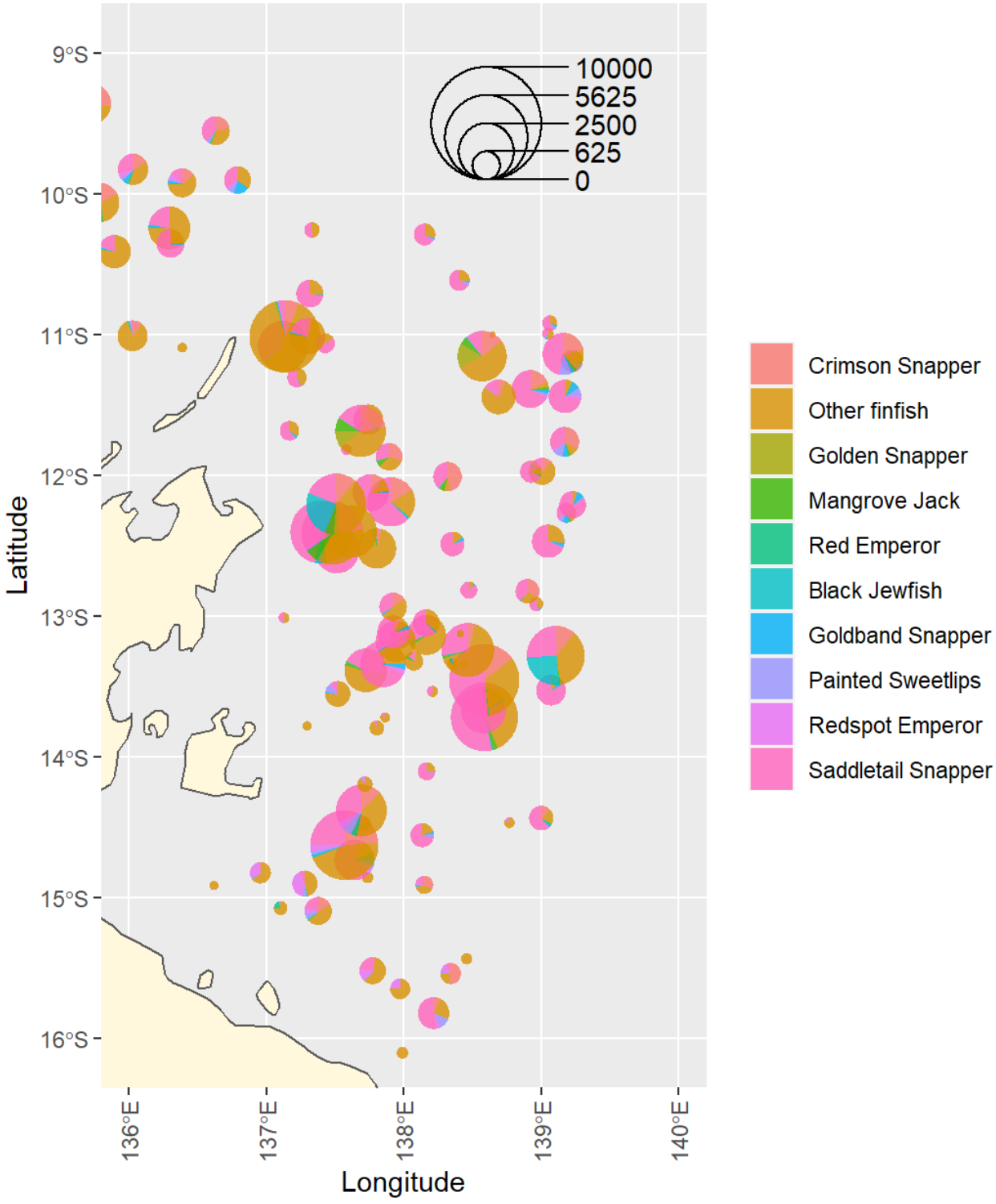

Figure 8. Relative percent composition of main species and "other teleosts" in each shot in the eastern strata. The size of pie charts is scaled by the total catch (kg) of those species/groups.

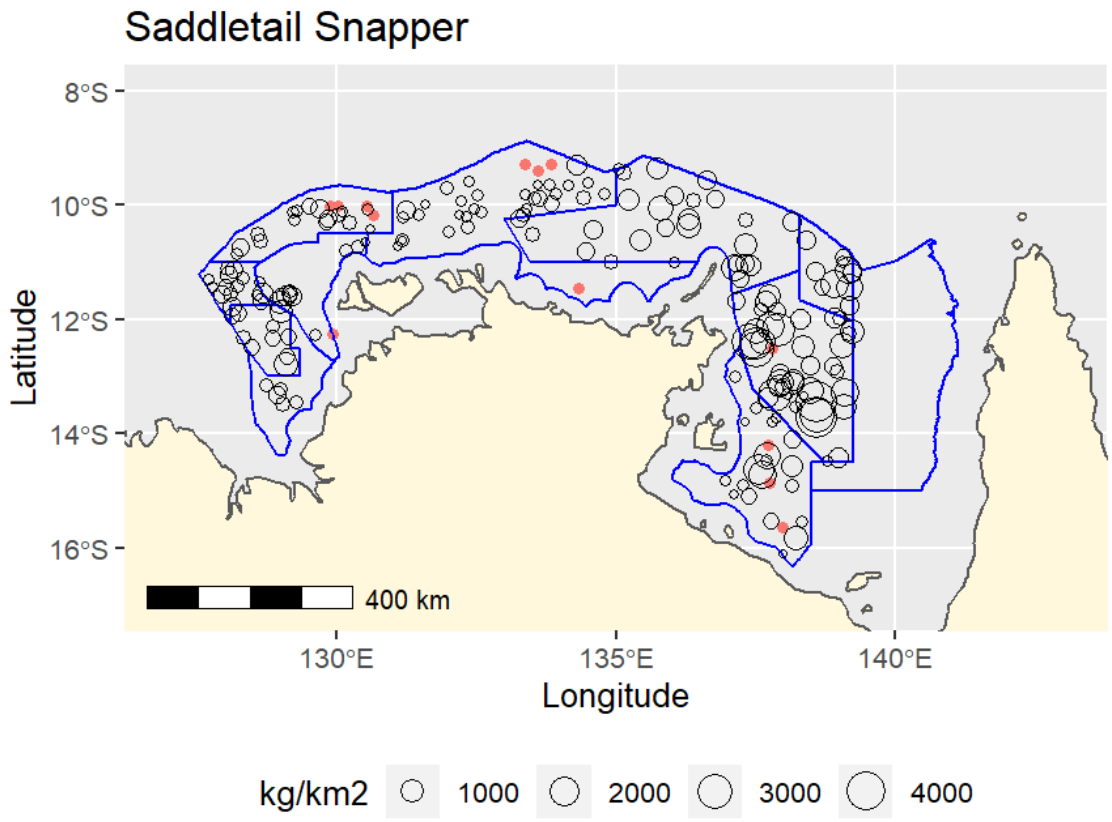

Figure 9. Density (kg/km2) of Saddletail Snapper caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

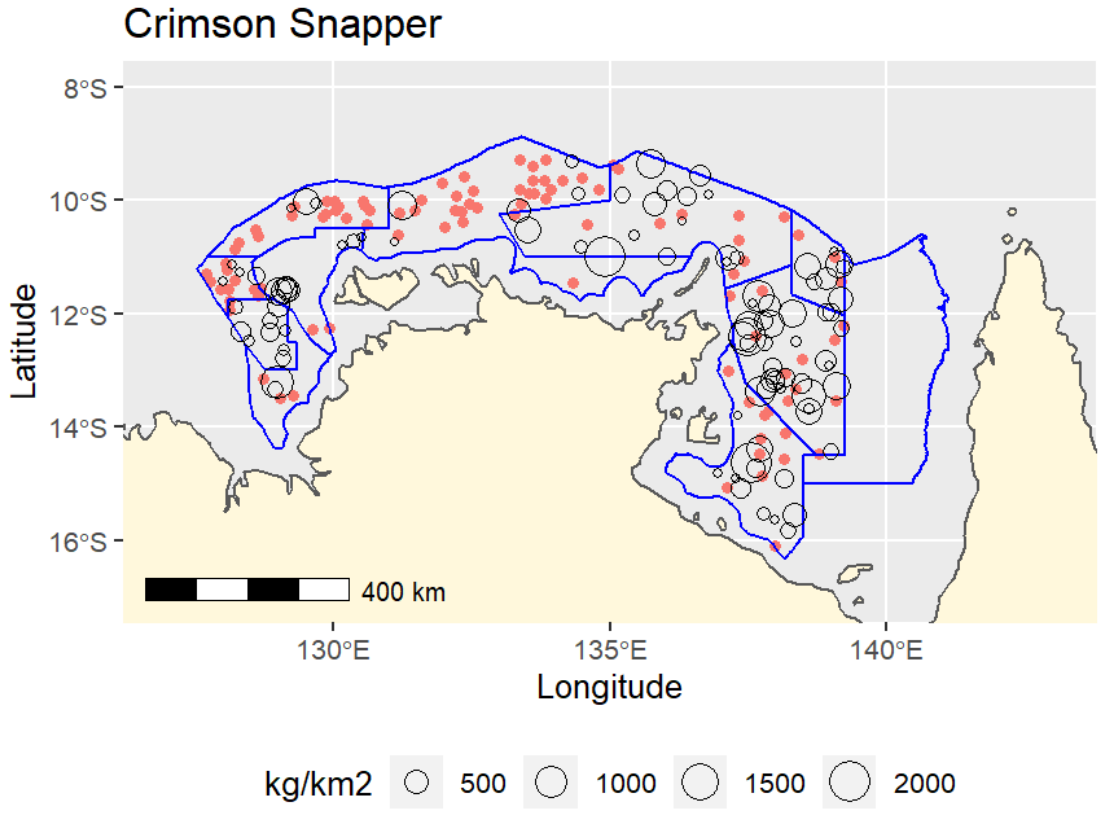

Figure 10. Density (kg/km^2) of Crimson Snapper caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

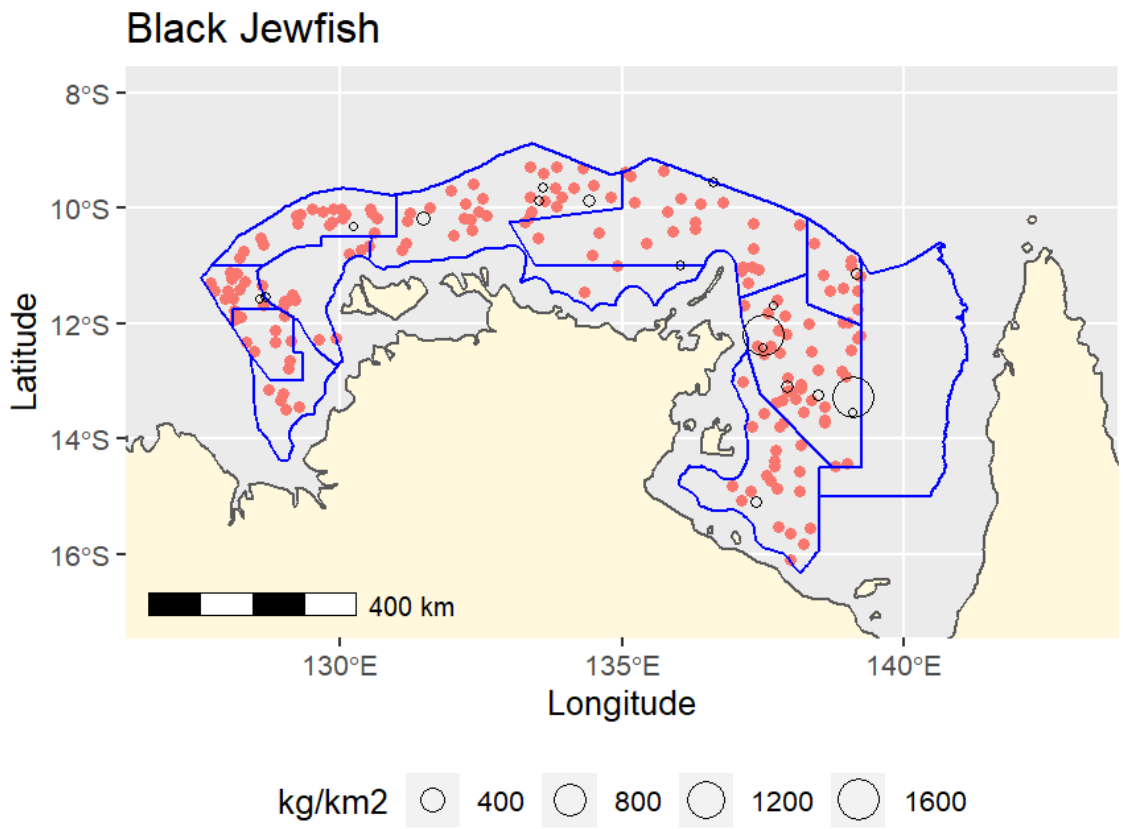

Figure 11. Density (kg/km^2) of Black Jewfish caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

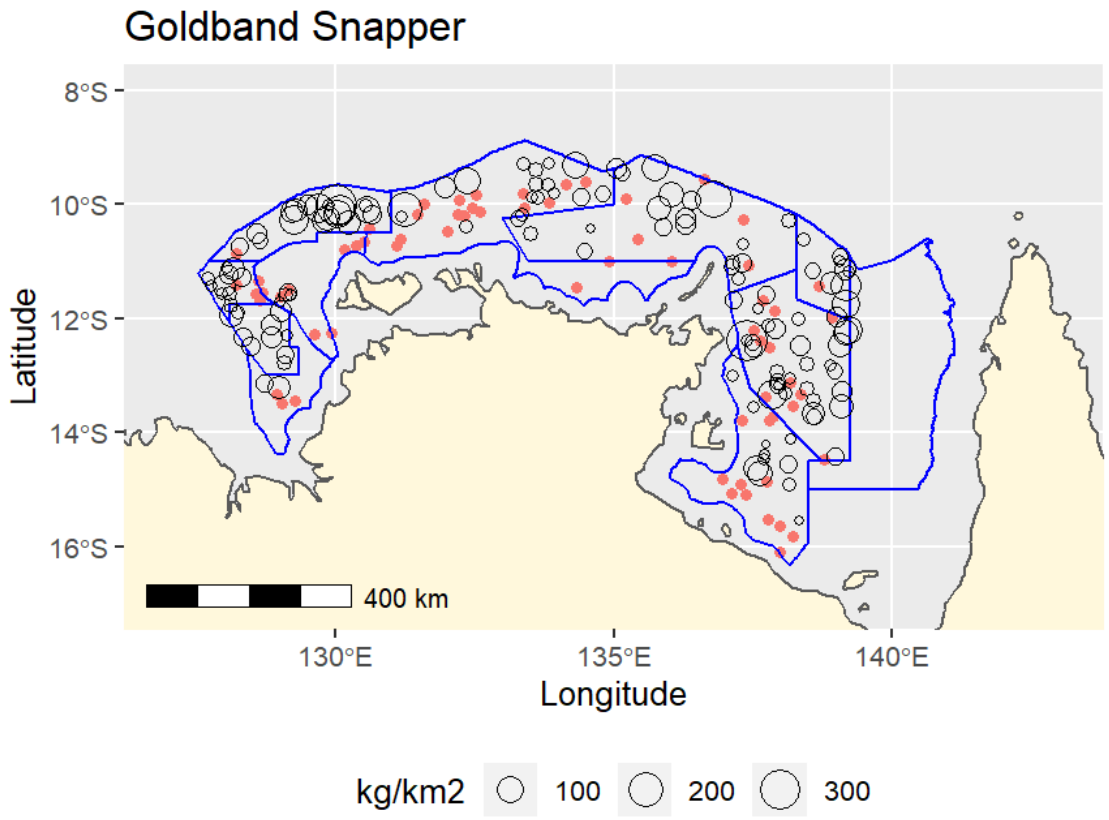

Figure 12. Density (kg/km^2) of Goldband Snapper caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

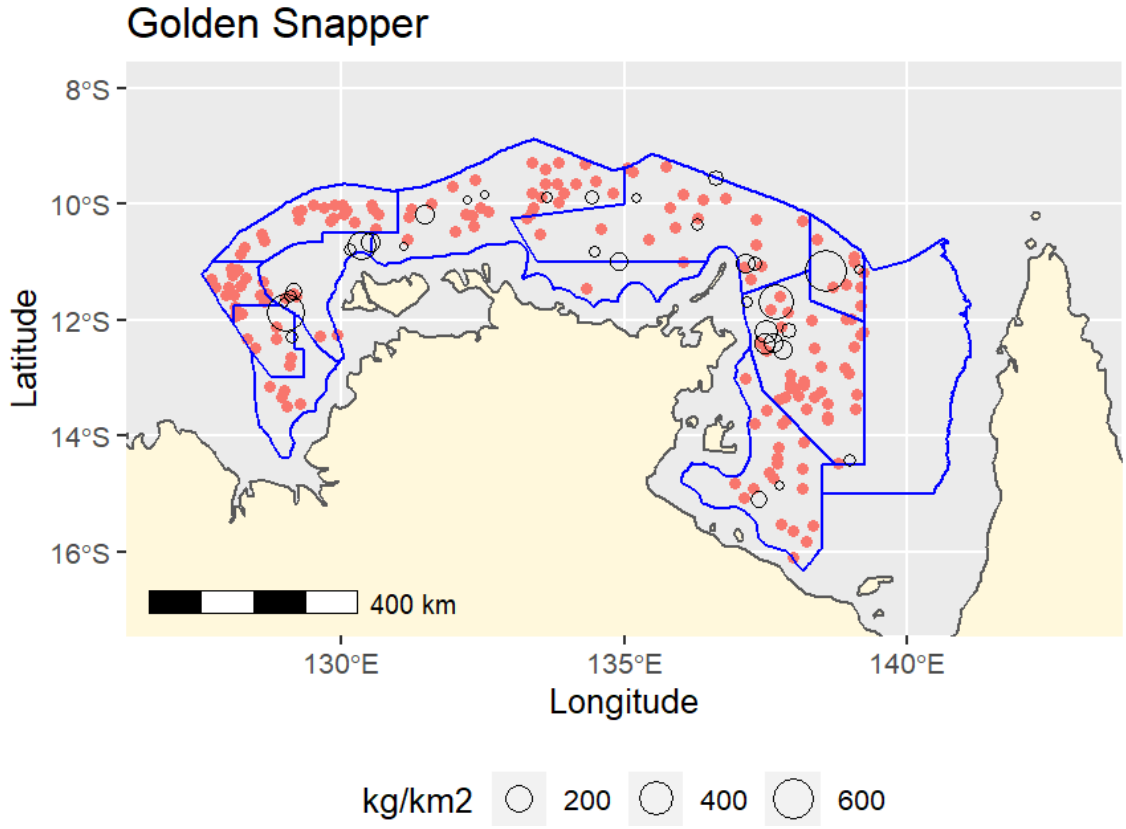

Figure 13. Density (kg/km^2) of Golden Snapper caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

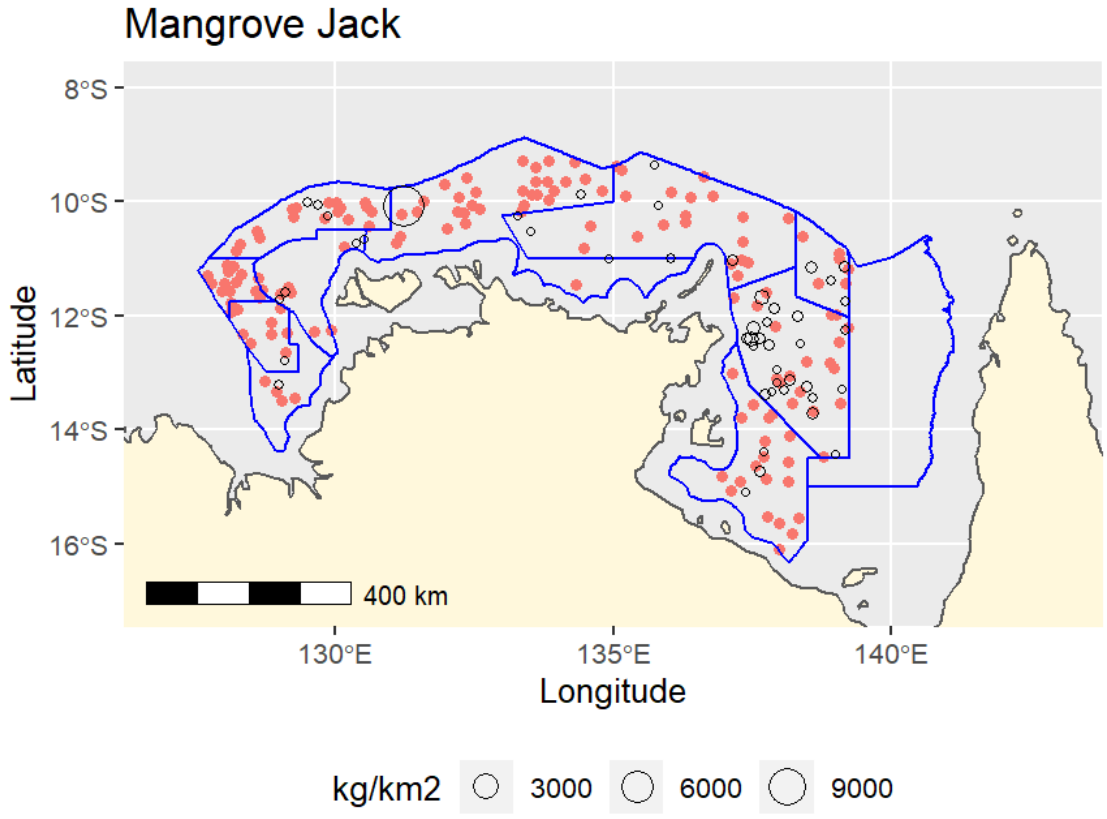

Figure 14. Density (kg/km^2) of Mangrove Jack caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

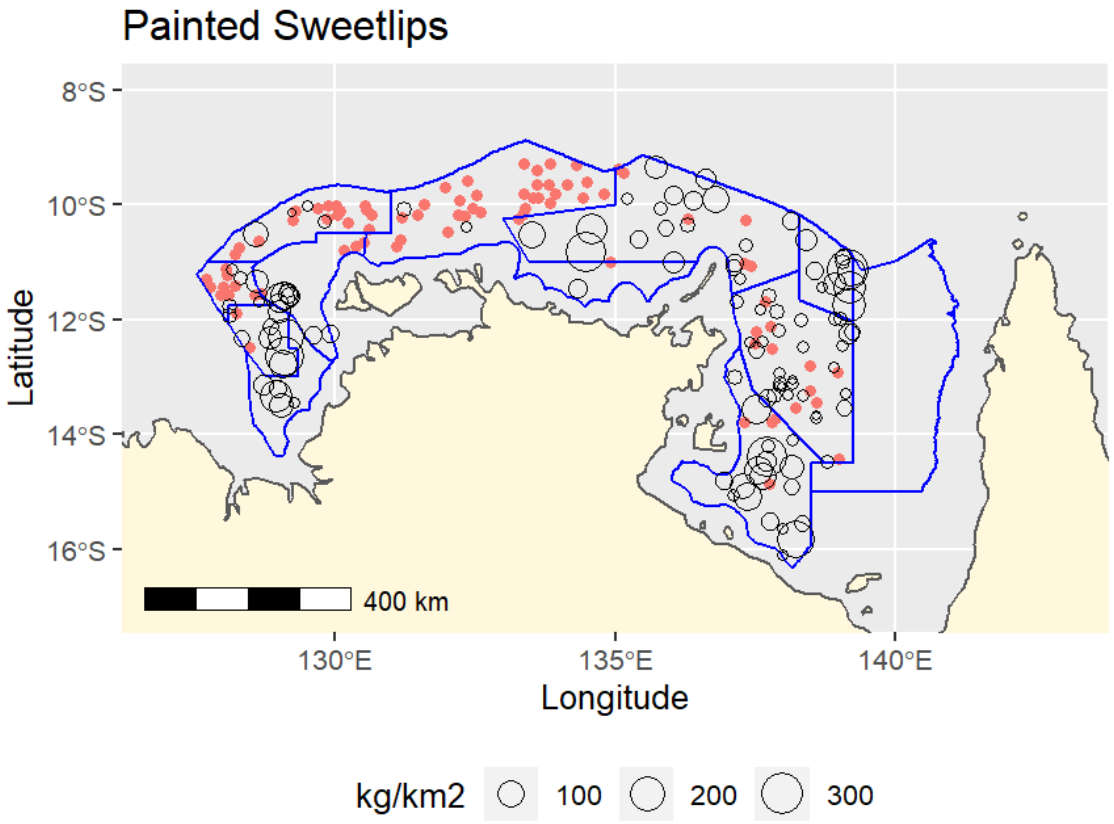

Figure 15. Density (kg/km^2) of Painted Sweetlips caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

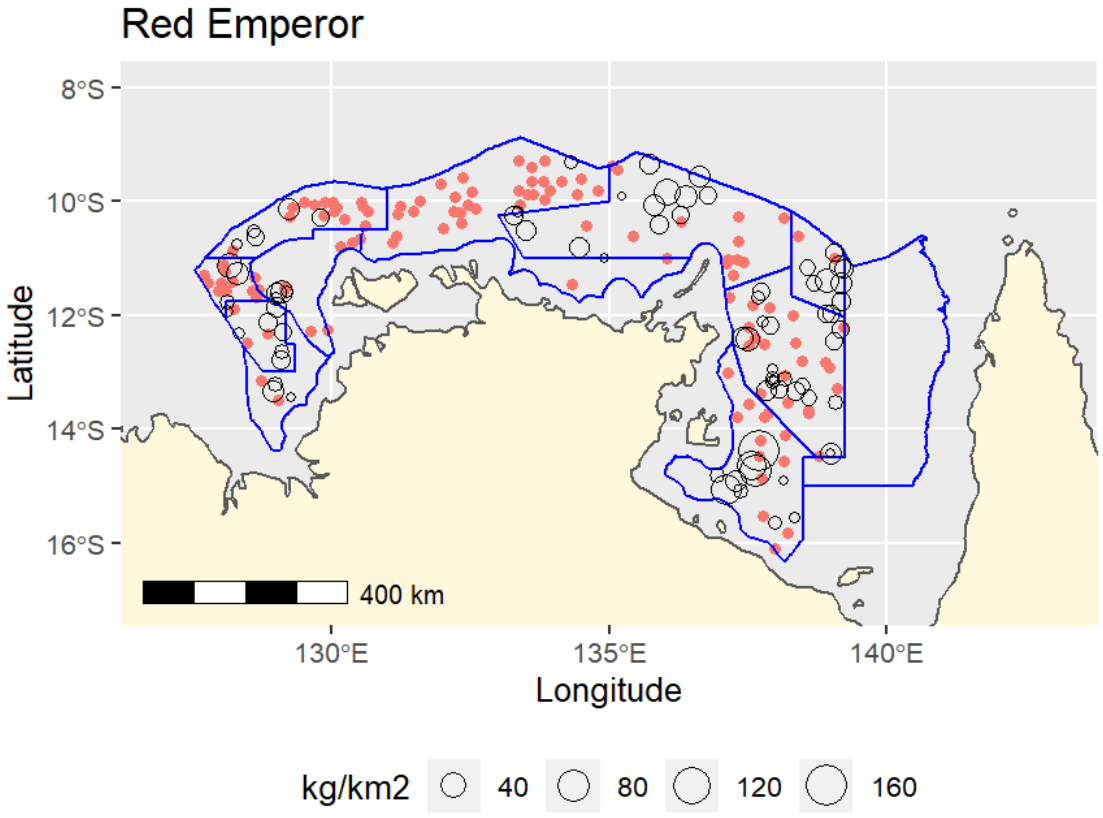

Figure 16. Density (kg/km^2) of Red Emperor caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

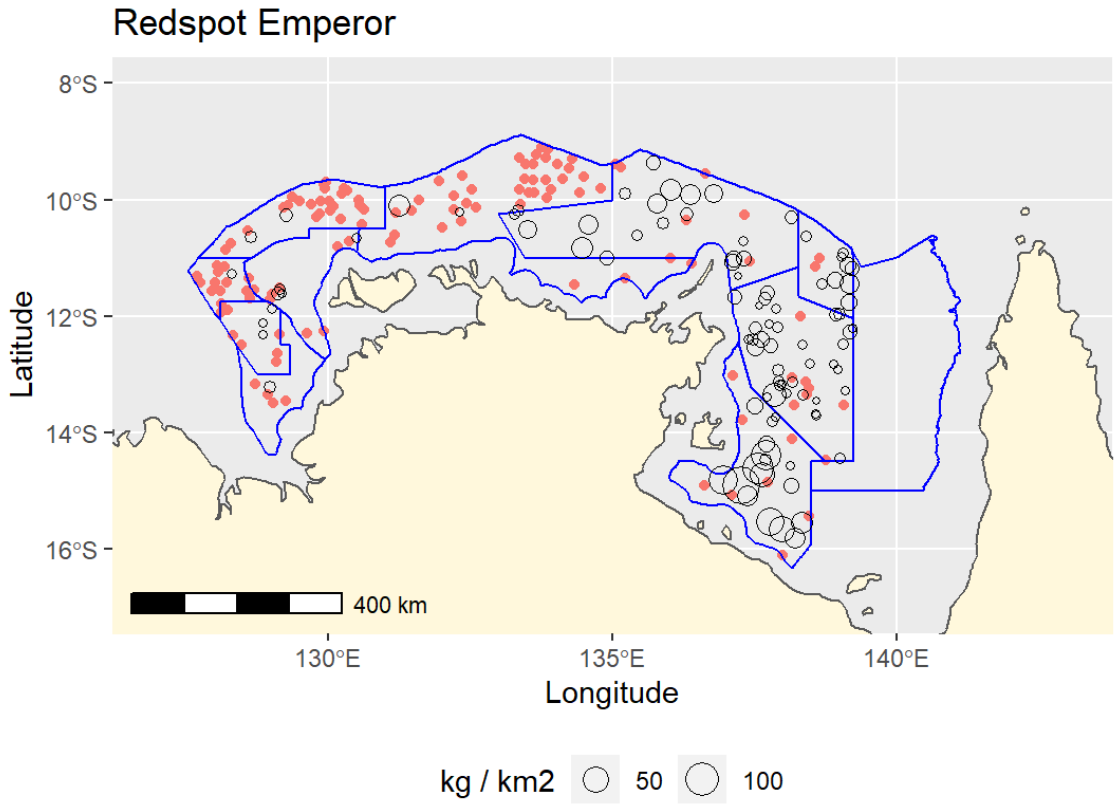

Figure 17. Density (kg/km^2) of Redspot Emperor caught during the survey. Red dots show shot locations where 0 kg catches were recorded. Densities were calculated using W_{eff}.

4.3. Relative biomass

Good CVs (<30% of mean values) were obtained for Crimson Snapper, Goldband Snapper, Painted Sweetlips, Red Emperor, Redspot Emperor and Saddletail Snapper, whereas a higher but satisfactory CV (0.38) was obtained for Golden Snapper (Table 4). Very high CVs were obtained for Black Jewfish (0.69) and Mangrove Jack (0.92).

Using a swept area based on calculated door spread, biomass estimates were 98,921 t for Saddletail Snapper, 32,794 t for Crimson Snapper, 13,099 t for Mangrove Jack, 5,197 t for Goldband Snapper, 5,801 t for Painted Sweetlips, 5,144 t for Redspot Emperor, 2,728 t for Black Jewfish, 2,566 t for Golden Snapper and 1,612 t for Red Emperor (Table 4).

Using a swept area based on the effective trawl path (W_{eff}), biomass estimates were 165,707 t for Saddletail Snapper, 54,828 t for Crimson Snapper, 25,290 t for Mangrove Jack, 9,346 t for Goldband Snapper, 9,589 t for Painted Sweetlips, 8,153 t for Redspot Emperor, 4,507 t for Black Jewfish, 4,337 t for Golden Snapper and 2,670 t for Red Emperor (Table 4). For species such as Crimson Snapper, Golden Snapper, Red Emperor and Redspot Emperor, which do not show evidence of herding behaviour, the biomass estimates provided with this option may be considered conservative. The biomass estimates based on door spread for each stratum is provided in Table 5. The density (kg/m^2) for the various species in each stratum is shown in Figure 19.

Using a swept area based on the wing spread (i.e. no herding behaviour), yields biomass estimates of 496,372 t for Saddletail Snapper, 164,558 t for Crimson Snapper, 65,730 t for Mangrove Jack, 26,078 t for Goldband Snapper, 29,111 t for Painted Sweetlips, 25,810 t for Redspot Emperor, 13,690 t for Black Jewfish, 12,875 t for Golden Snapper and 8,091 t for Red Emperor (Table 4).

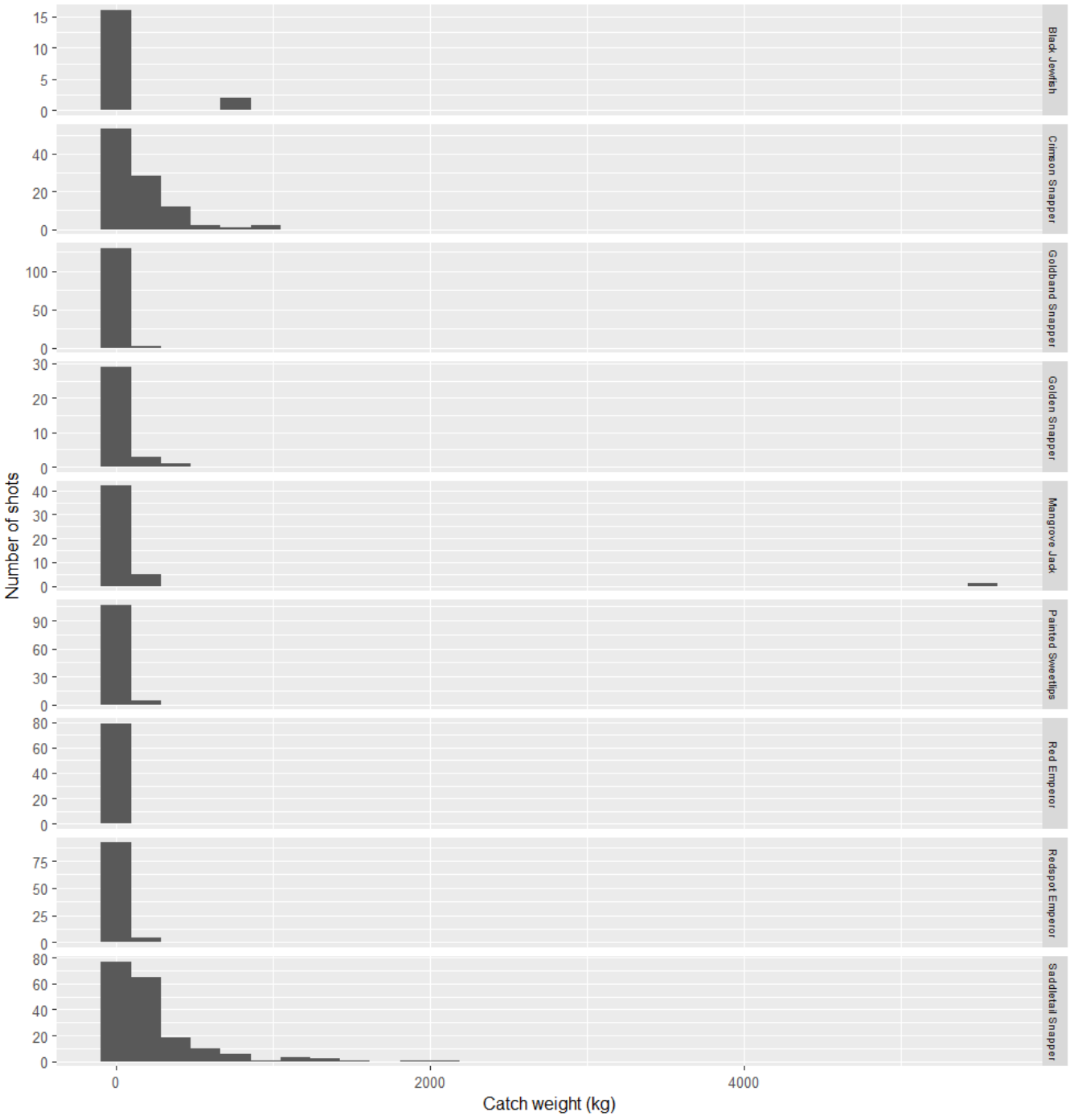

Figure 18. Frequency of catch weight of main species. Note that the large catch of Mangrove Jack is not an error.

Table 4. Estimated total relative biomass (t) with coefficient of variation (CV) of major commercial species within with the three different assumptions for trawl swept area.

Species	Number of shots caught	Relative biomass estimate (t) Door spread	Relative biomass estimate (t) Wing spread	Relative biomass estimate (t) W_{eff}	CV
Saddletail Snapper	184	98,921	496,372	165,707	0.08
Crimson Snapper	98	32,794	164,558	54,828	0.15
Painted Sweetlips	112	5,801	29,111	9,589	0.14
Goldband Snapper	132	5,197	26,078	9,346	0.13
Redspot Emperor	96	5,144	25,810	8,153	0.17
Red Emperor	77	1,612	8,091	2,670	0.17
Golden Snapper	33	2,566	12,875	4,337	0.37
Black Jewfish	18	2,728	13,690	4,507	0.69
Mangrove Jack	48	13,099	65,730	25,290	0.92

Table 5. Estimated total relative biomass (t) of major commercial species in each stratum based on the W_{eff} assumption of trawl swept area.

Species	Arafura General	Arafura Primary	GoC North Primary	GoC Southwest Secondary	GoC West Primary	JBG Fishery	JBG General	JBG Other	Timor Box	Grand Total
Saddletail Snapper	6,382	44,781	10,242	16,508	66,346	5,538	5,398	7,393	3,119	165,707
Crimson Snapper	6,282	11,297	3,563	7,391	16,799	1,610	2,039	5,184	662	54,828
Mangrove Jack	20,996	301	515	223	3,047	6	36	63	103	25,290
Goldband Snapper	1,051	2,736	649	428	1,805	439	530	94	1,615	9,346
Painted Sweetlips	172	2,938	1,287	2,367	387	944	507	881	107	9,589
Redspot Emperor	235	2,445	361	4,311	681	10	22	59	29	8,153
Black Jewfish	146	11	23	18	4,296		3	8	2	4,507
Golden Snapper	292	457	981	80	1,137	642		748		4,337
Red Emperor	12	804	221	816	366	99	174	117	61	2,670
Grand Total	**35,567**	**65,768**	**17,841**	**32,143**	**94,864**	**9,290**	**8,709**	**14,547**	**5,699**	**284,427**

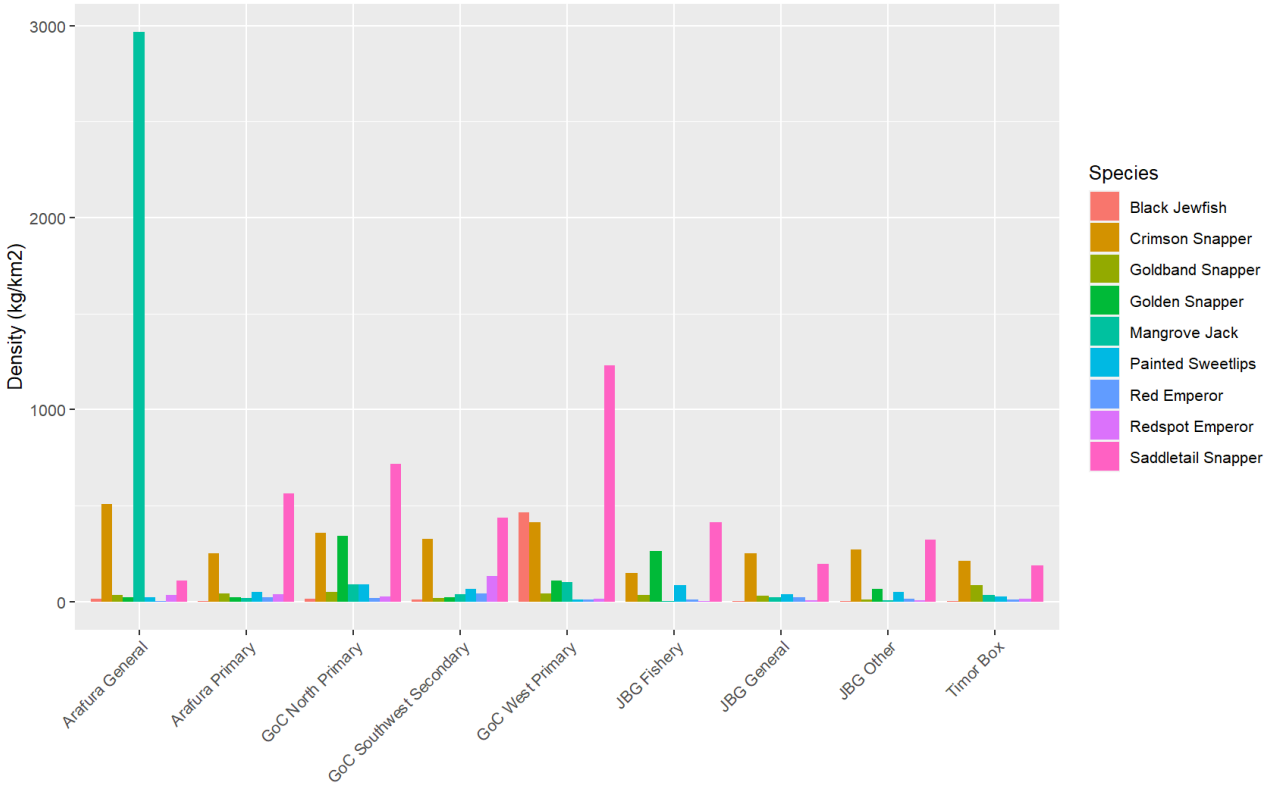

Figure 19. Density (kg/km^2 - in shots in which each species was caught) of species in each NT stratum based on the W_{eff} assumption of trawl swept area.

4.4. Length frequencies

The number of lengths of fish measured during the 2021 survey is shown in Table 6. Lengths of Crimson Snapper ranged 29 cm – 60 cm (Figure 20). Saddletail Snapper were caught over a much wider range of lengths from 18 cm – 78 cm. Mangrove Jack were also caught over a large size range, but most fish were between 40–55 cm.

A total of 1,118 DNA samples and fish frames were collected from six different species Table 6.

Table 6. Species and numbers of fish for which length was measured, and number of DNA samples collected and provided to QDAF during 2021 survey.

Species	Number of lengths measured	Number of DNA samples collected
Black Jewfish	146	15
Crimson Snapper	585	198
Goldband Snapper	189	136
Golden Snapper	67	28
Mangrove Jack	377	71 (271 frames)
Painted Sweetlips	41	
Red Emperor	48	9
Redspot Emperor	19	
Saddletail Snapper	676	390

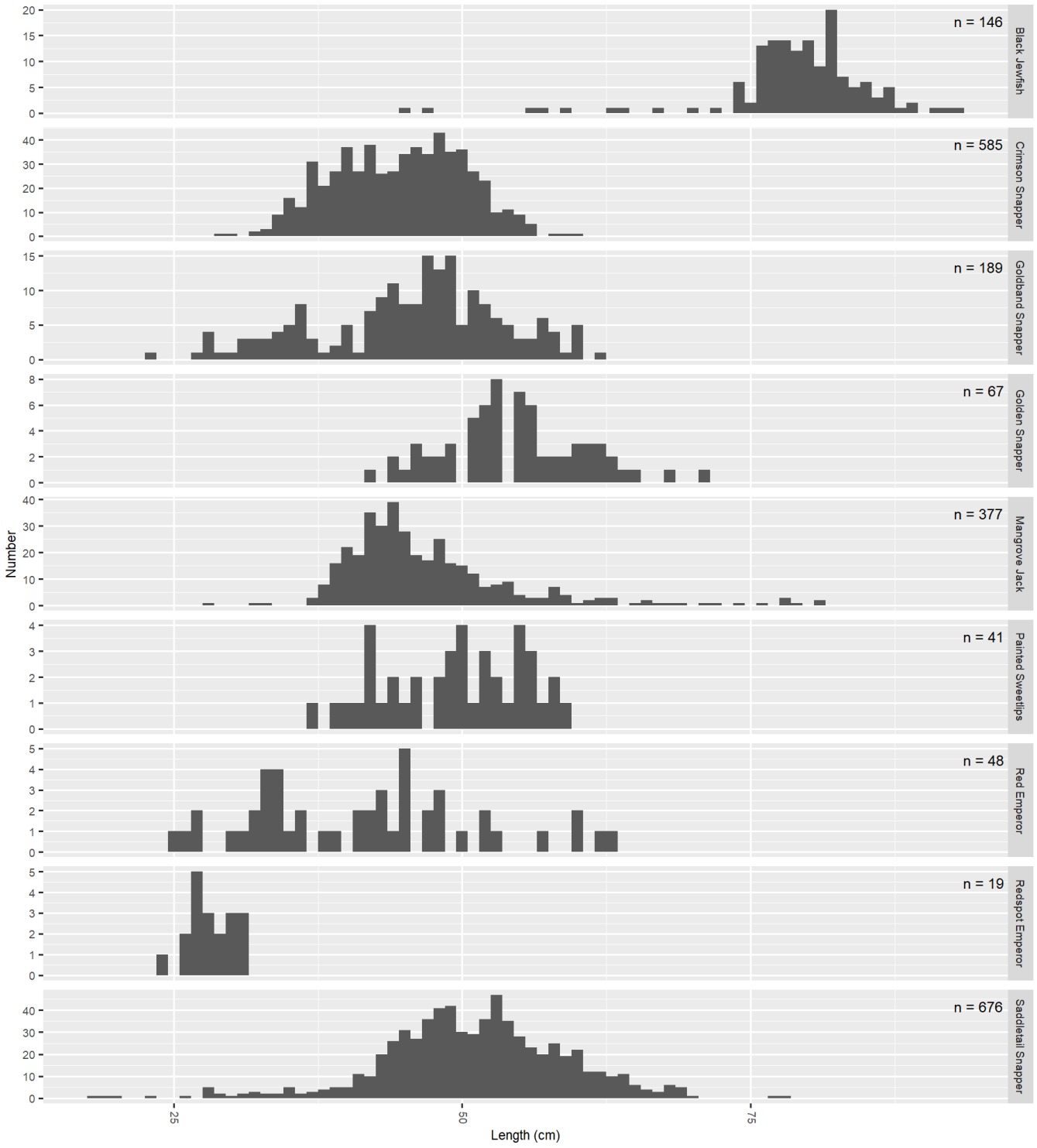

Figure 20. Length-frequencies (total length for all species except Goldband Snapper and Redspot Emperor were measured to fork length) of main species caught during the 2021 survey. Number of fish measured is annotated.

4.5. Species of Conservation Interest (SOCIs)

To improve accuracy of data collected during this survey, fishing was conducted without a turtle excluder device (TED). TEPS and other species of conservation interest (SOCIs) are shown in Table 7. Twelve different species of elasmobranchs, four species of turtles and 1 species of sea snake were caught. All turtles and the sea snake were released alive.

Table 7. TEPS and other species of conservation interest and their life state caught during 2021 biomass survey.

Common name	Species name	Alive	Dead	Unknown	Grand Total
Devilrays - undifferentiated	*Mobula spp.*	2	0	0	2
Kuhls Devilray	*Mobula kuhlii*	8	3	0	11
Eyebrow Wedgefish	*Rhynchobatus palpebratus*	19	12	0	31
Wedgefish - undifferentiated	*Rhynchobatus spp.*	2	0	2	4
Whitespotted Guitarfish	*Rhynchobatus australiae*	16	4	2	22
Shark Ray	*Rhina ancylostoma*	3	0	1	4
Giant Shovelnose Ray	*Glaucostegus typus*	3	0	0	3
Narrow Sawfish	*Anoxypristis cuspidata*	4	2	0	6
Winghead Shark	*Eusphyra blochii*	1	1	0	2
Scalloped Hammerhead	*Sphyrna lewini*	3	35	1	39
Great Hammerhead	*Sphyrna mokarran*	2	5	0	7
Pelagic Thresher	*Alopias pelagicus*	1	0	0	1
Flatback Turtle	*Natator depressus*	2	0	0	2
Green Turtle	*Chelonia mydas*	1	0	0	1
Hawksbill Turtle	*Eretmochelys imbricata*	1	0	0	1
Olive Ridley Turtle	*Lepidochelys olivacea*	1	0	0	1
Olive Sea Snake	*Aipysurus laevis*	1	0	0	1

5. Conclusions

The 2021 Northern Territory snapper biomass survey was successfully undertaken with 218 valid shots completed across nine strata in line with the survey design.

Biomass estimates are dependent on the assumptions of trawl swept area and the vulnerability of snapper to the trawl gear. Based on the most conservative assumption that all fish between the trawl doors were caught, resulted in biomass estimates of 98,921 t (CV 0.08) for Saddletail Snapper, 32,794 t (CV 0.15) for Crimson Snapper, 13,099 t (CV 0.92) for Mangrove Jack, 5,197 t (CV 0.13) for Goldband Snapper, 5,801 t (CV 0.14) for Painted Sweetlips, 5,144 t (CV 0.17) for Redspot Emperor, 2,728 t (CV 0.69) for Black Jewfish, 2,566 t (CV 0.37) for Golden Snapper and 1,612 t (CV 0.17) for Red Emperor.

Herding is known to occur for some tropical snapper species and effective trawl path width has been measured previously for Saddletail Snapper. Using effective trawl path for the trawl swept area calculation, biomass estimates for the main species were 165,707 t for Saddletail Snapper, 54,828 t for Crimson Snapper, 25,290 t for Mangrove Jack, 9,346 t for Goldband Snapper, 9,589 t for Painted Sweetlips, 8,153 t for Redspot Emperor, 4,507 t for Black Jewfish, 4,337 t for Golden Snapper and 2,670 t for Red Emperor.

In providing these biomass estimates, we emphasise that due to the uncertain assumptions of catchability, herding and escapement associated with each species, caution should be applied in the use of these figures as a once-off measure of *absolute* abundance. Surveys such as these are better used to obtain a time-series of consistent and robust *relative* abundance indices that can be incorporated as biomass trends in fully quantitative stock assessments.

6. Acknowledgments

We thank the owners of FV Australia Bay II and the skipper Leigh Claydon and the crew for their professional approach to conducting the 2021 survey. Particular thanks to Australia Bay General Manager, Mike O'Brien for helping coordinate the vessel, survey gear and operation of the survey trips.

We thank the NT Department of Industry, Tourism and Trade observers Grant Johnson and Matt Dorter for assistance with data collection and help with organising the trip and Steven Matthews and Thor Saunders for organising the administrative aspects of the survey.

7. References

Arronte, Juan & Baldó, Francisco & Börjesson, Patrik & Burns, Finlay & Chaves, Corina & Gillespie-Mules, Ruadhán & Kavanagh, Ailbhe & Kelly, Ruth & Kempf, Jed & Kvaavik, Cecilia & Ludwig, Kim & Melli, Valentina & Moriarty, Meadhbh & Rindorf, Anna & Salvany, Lara & Seixas, Sonia & Sell, Anne & Soni, Vaishav & Travers-Trolet, Morgane & Zhai, Hongru. (2021). Workshop on the production of swept-area estimates for all hauls in DATRAS for biodiversity assessments (WKSAE-DATRAS). 10.17895/ices.pub.8232.

Day, J. (2019) Tiger Flathead (*Neoplatycephalus richardsoni*) stock assessment using data to 2018 – development of a preliminary base case. pp 35 - 96 in Tuck, G.N. (ed.) 2020. Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery 2018 and 2019. Part 1, 2019. Australian Fisheries Management Authority and CSIRO Oceans and Atmosphere, Hobart. 353p.

Deng, R. A., Punt, A.E., Dichmont, C.M., Buckworth, R., Burridge, C.Y. (2015). Improving catch prediction for tiger prawns in the Australian northern prawn fishery. *ICES Journal of Marine Science*, Volume 72, Issue 1, January 2015, Pages 117–129, https://doi.org/10.1093/icesjms/fsu033

Knuckey, I. and Koopman, M. (2019). Preliminary resource survey of NT Snapper stocks. NT Project 17-1395. Fishwell Consulting. 181pp.

Knuckey, I., Koopman, M., and Hudson, R. (2021). Resource Survey of the Great Australian Bight Trawl Sector – 2021. AFMA Project 2019/0837. Fishwell Consulting 40pp.

MacGibbon, DJ. (2019). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 2019 (KAH1902). New Zealand Fisheries Assessment Report 2019/64. Ministry for Primary Industries, New Zealand.

Nitschke, J., Knuckey, I., Koopman, M., Hudson, R., Huveneers, C., Grammer, G., and Ward, T. (2022). Spatio-temporal variability in the demersal fish assemblage on the outer continental shelf of the Great Australian Bight. Estuarine, Coastal and Shelf Science, Volume 271, 107852. ISSN 0272-7714, https://doi.org/10.1016/j.ecss.2022.107852.

Peel, D., Bravington, M. V., Kelly, N., Wood, S. N., & Knuckey, I. (2013). A model-based approach to designing a fishery-independent survey. Journal of agricultural, biological, and environmental statistics, 18(1), 1-21.

Piasente, M., Knuckey, I.A. Eayrs, S., and McShane, P.E. (2004). In situ examination of the fish in response to demersal trawl nets in an Australian trawl fishery. Marine and Freshwater Research 55, 825-835.

R Core Team. (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Ramm, D. (1992). Biomass and preliminary yield estimates derived from data collected during the 1990 demersal trawl survey. Internal Report. Research and Development Branch, Fisheries Division. Darwin. Fisheries Research, 24: 243–259.

Ramm, D. (1997). Assessment of Groundfish Stocks in Northern Australian Waters between 127–137°E. RFDC Project 90/15. Fishery Report No. 38. Northern Territory Department of Primary Industries.

Ramm, D. and Xiao, Y. (1995). Herding in groundfish and effective pathwidth of trawls. Fish. Res. 24: 243–259.

Schnute, J.T. and Haigh, R. (2003). A simulation model for designing groundfish trawl surveys. Can. J. Fish. Aquat. Sci. 60:640-656.

Seafish. (2010). Research & Development, Catching sector Fact Sheet. Bridle angle and wing end spread calculations. January 2010. Seafish. https://www.seafish.org/document/?id=12e50496-cf27-4ecd-9833-c53d5ddb0c15

Shephard, S., Reid, D.G., Gerritsen, H.D. and Farnsworth, K.D. (2015). Estimating biomass, fishing mortality, and "total allowable discards" for surveyed non-target fish, ICES Journal of Marine Science, 72: 458–466. https://doi.org/10.1093/icesjms/fsu146

von Szalay, P. G., and N. W. Raring. 2018. Data Report: 2017 Gulf of Alaska bottom trawl survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-374, 260 p.

Walker, N.D., Maxwell, D.L., LeQuesne, W.J.F. and Jennings, S. (2017). Estimating efficiency of survey and commercial trawl gears from comparisons of catch-ratios. ICES Journal of Marine Science 74, 1448–1457. doi:10.1093/icesjms/fsw250

Appendix 1 Total catch (kg) of all species caught during the 2021 survey.

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Saddletail Snapper	*Lutjanus malabaricus*	37346007	44128.4
Crimson Snapper	*Lutjanus erythropterus*	37346005	14351.67
Mangrove Jack	*Lutjanus argentimaculatus*	37346015	6892.69
Goldband Snapper	*Pristipomoides multidens*	37346002	2655.88
Painted Sweetlips	*Diagramma pictum*	37350003	2287.12
Redspot Emperor	*Lethrinus lentjan*	37351007	1768.88
Black jewfish	*Protonibea diacanthus*	37354003	1494.92
Golden Snapper	*Lutjanus johnii*	37346030	1263
Red Emperor	*Lutjanus sebae*	37346004	641.21
Amberjack	*Seriola dumerili*	37337025	24.86
Anthozoa (u)	*Class Anthozoa - undifferentiated*	11168000	0.6
Australian Blackspot Shark	*Carcharhinus coatesi*	37018009	2354.03
Australian Blacktip Shark	*Carcharhinus tilstoni*	37018014	1793.97
Australian butterfly ray	*Gymnura australis*	37037001	808.57
Australian Halibut	*Psettodes erumei*	37457001	52.73
Australian Sharpnose Shark	*Rhizoprionodon taylori*	37018024	78.36
Aysmmetric Goatfish	*Upeneus asymmetricus*	37355010	0.34
Banded Eagle Ray	*Aetomylaeus caeruleofasciatus*	37039002	82.52
Banded Grouper	*Epinephelus amblycephalus*	37311015	17.05
Barracouta	*Thyrsites atun*	37439001	0.4
Barracuda - undifferentiated	*Sphyraena spp.*	37382901	10.48
Barracudinas (u)	*Stemonosudis spp.*	37126908	2.87
Barred javelin	*Pomadasys kaakan*	37350011	101.68
Barred Soapfish	*Diploprion bifasciatum*	37312002	0.88
Barred Yellowtail Scad	*Atule mate*	37337024	68.39
Benthos	*NA*		234.14
Bigeye - undifferentiated	*Priacanthus spp.*	37326901	3.51
Bigeye Scad	*Selar crumenophthalmus*	37337009	154.4
Bigeye Snapper	*Lutjanus lutjanus*	37346008	34.2
Bigeye Trevally	*Caranx sexfasciatus*	37337039	7527.1
Bigtooth Twinspot Flounder	*Pseudorhombus diplospilus*	37460015	0.95
Black Marlin	*Istiompax indica*	37444006	18.52
Black Pomfret	*Parastromateus niger*	37337072	458.83
Black stingray	*Bathytoshia lata*	37035002	9.86
Blackbanded Amberjack	*Seriolina nigrofasciata*	37337014	260.51
Blackdotted grouper	*Epinephelus stictus*	37311018	9.62
Blackfin Barracuda	*Sphyraena qenie*	37382009	554.03
Blackspot Barracuda (Blotched seapike)	*Sphyraena forsteri*	37382005	8.58
Blackspot Butterfish	*Psenopsis humerosa*	37445007	34.42
Blackspot Tuskfish	*Choerodon schoenleinii*	37384010	1.54
Blackspotted Rockcod	*Epinephelus malabaricus*	37311150	220
Blackspotted Whipray	*Maculabatis astra*	37035020	747.31
Blacktip Silverbiddy	*Gerres oyena*	37349004	14.36
Blacktip Tripodfish	*Trixiphichthys weberi*	37464001	215.12
Blind Lobster (U)	*Polychelidae - undifferentiated*	28815000	0.39
Blotched Javelinfish	*Pomadasys maculatus*	37350002	6.05

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Bluebarred Parrotfish	*Scarus ghobban*	37386001	15.11
Bluespotted Maskray	*Neotrygon australiae*	37035004	43.35
Brassy Trevally	*Caranx papuensis*	37337064	2574.92
Bristlemouth & Lightfish (U)	*Gonostomatidae, Phosichthyidae - undifferentiated*	37106000	0.56
Broadhead Goosefish	*Lophiomus setigerus*	37208001	0.64
Brown Stingaree	*Urolophus westraliensis*	37038009	7.18
Brownback Toadfish (Halfsmooth)	*Lagocephalus spadiceus*	37467017	1.83
Brownstripe Snapper	*Lutjanus vitta*	37346003	424.8
Bull Shark	*Carcharhinus leucas*	37018021	464
Bumpnose Trevally	*Carangoides hedlandensis*	37337042	1.37
Cardinalfish - Undifferentiated	*Apogon spp.*	37327901	0.23
Carid Prawn (U)	*Acanthephyridae - undifferentiated*	28735000	0.16
Catfish - Undifferentiated	*Arius spp.*	37188901	2251.03
Celebes Threadfin Bream	*Nemipterus celebicus*	37347004	1.73
Chinamanfish	*Symphorus nematophorus*	37346017	17.66
Cobia	*Rachycentron canadum*	37335001	289.47
Coffinfish (U)	*Chaunacidae - undifferentiated*	37211000	1.44
Common Coral Trout	*Plectropomus leopardus*	37311078	64.62
Common Ponyfish	*Leiognathus equula*	37341014	7.04
Common Saury	*Saurida tumbil*	37118028	0.96
Coral Crab	*Charybdis feriata*	28911001	8.8
Cowrie (U)	*Cypraeidae - undifferentiated*	24155000	0.28
Crab (U)	*Infraorder Brachyura - undifferentiated*	28850000	0.21
Crescent Grunter	*Terapon jarbua*	37321002	2.27
Crested Hairtail	*Tentoriceps cristatus*	37440006	0.31
Cuskeel (U)	*Bythitidae, Dinematichthyidae, Ophidiidae, Parabrotulidae - undifferentiated*	37228000	8
Cuttlefish (U)	*Sepiidae - undifferentiated*	23607000	27.7
Damselfishes - Undifferentiated	*Pomacentridae - undifferentiated*	37372000	0.12
Darkspot Tuskfish	*Choerodon monostigma*	37384008	2.91
Darktail Snapper	*Lutjanus lemniscatus*	37346010	229.1
Deep Pugnosed Ponyfish	*Leiognathus ruconius*	37341015	0.01
Deepwater Squirrelfish	*Ostichthys kaianus*	37261005	17.46
Devilrays - Undifferentiated	*Mobula spp.*	37041902	16
Diamond Trevally	*Alectis indica*	37337038	65.91
Ditchelee	*Pellona ditchela*	37085009	23.82
Dorab Wolf Herring	*Chirocentrus dorab*	37087001	7.75
Dotted Grouper	*Epinephelus epistictus*	37311046	4.3
Driftfish (U)	*Nomeidae - undifferentiated*	37446000	3.35
Duckbills (U)	*Bembrops spp.*	37393902	0.41
Dusky Whaler	*Carcharhinus obscurus*	37018003	97.15
Eagle Ray (U)	*Myliobatidae, Aetobatidae - undifferentiated*	37039000	49.37
Eastern Balmain Bug	*Ibacus peronii*	28821004	36.43
Echinoderm (U)	*Phylum Echinodermata - undifferentiated*	25000000	0.02
Emperors - Undifferentiated	*Lethrinus spp.*	37351902	10.87
Epaulette Trevally	*Carangoides humerosus*	37337031	144.9
Eyebrow Tuskfish	*Choerodon zamboangae*	37384011	0.16
Eyebrow Wedgefish	*Rhynchobatus palpebratus*	37026004	121.43
Eyebrowfishes (U)	*Ariomma spp.*	37447900	0.17
False Bailer Shell	*Livonia mammilla*	24207001	1.08
Ferocious Puffer	*Feroxodon multistriatus*	37467010	1.98

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Finny Scad	*Megalaspis cordyla*	37337028	3155.05
Fiveline Snapper	*Lutjanus quinquelineatus*	37346006	7.38
Flatheads - Undifferentiated	*Rogadius spp.*	37296915	0.01
Flounder (U)	*NA*	37485000	0.42
Flying Gurnards - Undifferentiated	*Dactylopteridae - undifferentiated*	37308000	1.37
Fossil Shark	*Hemipristis elongata*	37018011	87.4
Fourband Leatherjacket	*Pseudomonacanthus elongatus*	37465029	0.12
Fourline Striped Grunter	*Pelates quadrilineatus*	37321001	17.35
Freckled Porcupinefish	*Diodon holocanthus*	37469005	0.25
Frypan Bream	*Argyrops bleekeri*	37353006	223.27
Fusiliers, Tropical Snapper & Slopefish (U)	*Caesionidae, Lutjanidae, Symphysanodontidae - undifferentiated*	37346000	14.6
Gaper - Undiferentiated	*Champsodon spp.*	37401901	0.96
Gastropod (U)	*Class Gastropoda - undifferentiated*	24000000	0.1
Gemfish	*Rexea solandri*	37439002	3.95
Ghost Flathead (U)	*Hoplichthyidae - undifferentiated*	37297000	0.04
Giant Queenfish	*Scomberoides commersonnianus*	37337032	3.54
Giant Shovelnose Ray	*Glaucostegus typus*	37027010	140
Giant Trevally	*Caranx ignobilis*	37337027	103.11
Goatfishes (Parupeneus) - Undifferentiated	*Parupeneus spp.*	37355900	0.9
Goatfishes (Upeneus) - Undifferentiated	*Upeneus spp.*	37355903	0.33
Goldband Goatfish	*Upeneus moluccensis*	37355003	0.38
Golden Threadfin Bream	*Nemipterus virgatus*	37347009	4.19
Golden Trevally	*Gnathanodon speciosus*	37337012	1055.84
Goldeneye Shovelnose Ray	*Rhinobatos sainsburyi*	37027003	0.9
Goldspotted Rockcod	*Epinephelus coioides*	37311007	433.7
Goldstripe Sardinella	*Sardinella gibbosa*	37085013	0.51
Grass Emperor	*Lethrinus laticaudis*	37351006	11.7
Great Hammerhead	*Sphyrna mokarran*	37019002	215.24
Green Turtle	*Chelonia mydas*	39020002	15
Greeneyes - Undifferentiated	*Chlorophthalmus spp.*	37120903	8.7
Grey Carpetshark	*Chiloscyllium punctatum*	37013008	0.82
Grooved Razorfish	*Centriscus scutatus*	37280001	0.01
Gurnard - Undifferentiated	***non-current code** Triglidae sp.*	37288801	26.62
Hardnose Shark	*Carcharhinus macloti*	37018025	158.17
Highfin Veilfin	*Velifer hypselopterus*	37269002	6.02
Hound Shark (U)	*Triakidae - undifferentiated*	37017000	2.81
Humpback Turretfish	*Tetrosomus gibbosus*	37466006	1.49
Humphead Batfish	*Platax batavianus*	37362002	330.74
Hydroid (U)	*Class Hydrozoa - undifferentiated*	11000000	40.62
Indian Anchovy	*Stolephorus indicus*	37086006	0.56
Indian Driftfish	*Ariomma indicum*	37447007	63.38
Indonesian Snapper	*Lutjanus bitaeniatus*	37346025	8.66
Japanese Pineapplefish	*Monocentris japonica*	37259002	80.69
Japanese Seabass	*Acropoma japonicum*	37311167	1.26
Jellyfish (U)	*Class Scyphozoa - undifferentiated*	11120000	52.91
Jenkins' Whipray	*Pateobatis jenkinsii*	37035025	3074.06
Jewel Squid	*Histioteuthidae - undifferentiated*	23630000	0.21
John Dory	*Zeus faber*	37264004	41.31
Kuhls Devilray	*NA*	37041007	55
Lanternfish (U)	*Myctophidae - undifferentiated*	37122000	1.52

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Largescale Grunter	*Terapon theraps*	37321003	72.87
Largescale Saury	*Saurida undosquamis*	37118001	64.54
Largespot Flying Gurnard	*Dactyloptena papilio*	37308001	0.44
Leaping Bonito	*Cybiosarda elegans*	37441008	4.19
Leatherjackets - Undifferentiated	*Monacanthidae - undifferentiated*	37465903	0.98
Lemon Shark	*Negaprion acutidens*	37018029	70
Leopard Whipray	*Himantura leoparda*	37035026	1373.18
Lesser Spangled Emperor	*Lethrinus punctulatus*	37351001	125.79
Lined Javelinfish	*Hapalogenys dampieriensis*	37350027	49.57
Little Dory	*Cyttopsis cypho*	37264009	0.08
Lizardfishes - Undifferentiated	*Saurida spp.*	37118901	186.72
Longfin Escolar & Gemfish (U)	*Scombrolabracidae, Gempylidae - undifferentiated*	37439000	0.03
Longfin Silverbiddy	*Pentaprion longimanus*	37349002	6.34
Longnose Trevally	*Carangoides chrysophrys*	37337011	4651.28
Longraker Trevally	*Ulua mentalis*	37337048	267.82
Longray Monocle Bream	*Parascolopsis tanyactis*	37347010	0.17
Longspine Ponyfish	*Aurigequula longispinis*	37341004	8.45
Longspine Porcupinefish	*Tragulichthys jaculiferus*	37469004	22.85
Longtail Tuna	*Thunnus tonggol*	37441013	2.17
Lunartail Bigeye	*Priacanthus hamrur*	37326005	10.86
Mackerel Tuna	*Euthynnus affinis*	37441010	27.44
Malabar Trevally	*Carangoides malabaricus*	37337005	5951.59
Mantis Shrimps - Undifferentiated	*Squillidae - undifferentiated*	28051000	0.01
Manyspot Leatherjacket	*Thamnaconus tessellatus*	37465026	5.43
Margined Coralfish	*Chelmon marginalis*	37365007	0.18
Mauvelip Threadfin Bream	*Nemipterus mesoprion*	37347026	10.77
Milk Shark	*Rhizoprionodon acutus*	37018006	272.18
Mirror Dory	*Zenopsis nebulosa*	37264003	0.95
Mixed Fish	*NA*	37999999	9.18
Mollusc (U)	*Phylum Mollusca - undifferentiated*	23000000	0.88
Monocle Bream - Undifferentiated	*Scolopsis spp.*	37347902	0.92
Moreton Bay Bug (U)	*Thenus spp.*	28821903	71.93
Moses' Snapper	*Lutjanus russellii*	37346065	1234.71
Mouth Mackerel	*Rastrelliger kanagurta*	37441012	638.97
Muller's Coralfish	*Chelmon muelleri*	37365015	0.25
Narrow Sawfish	*Anoxypristis cuspidata*	37025002	271
Nautilus (U)	*Nautilidae - undifferentiated*	23600000	15.14
Needleskin Queenfish	*Scomberoides tol*	37337044	4.31
Northern Calamari Squid	*Sepioteuthis lessoniana*	23617006	1.15
Northern Pearl Perch	*Glaucosoma buergeri*	37320001	2
Notched Threadfin Bream	*Nemipterus peronii*	37347003	1.05
Ocean Sunfish (U)	*Molidae - undifferentiated*	37470000	54.6
Ocellate Butterflyfish	*Parachaetodon ocellatus*	37365003	10.58
Ochreband Goatfish	*Upeneus sundaicus*	37355013	0.15
Octopus - Undifferentiated	*Octopodidae - undifferentiated*	23659921	0.02
Octopus (U)	*Octopodidae, Eledonidae, Megaleledonidae, Bathypolypodidae, Enteroctopodidae - undifferentiated*	23659000	0.04
Opalescent Goatfish	*Parupeneus heptacanthus*	37355004	60.21
Orange Jewfish	*Atrobucca brevis*	37354012	109.07

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Orangebanded Coralfish	*Coradion chrysozonus*	37365004	0.64
Orangefin Ponyfish	*Photopectoralis bindus*	37341002	0.86
Oriental Bonito	*Sarda orientalis*	37441006	8.67
Ornate Eagle Ray	*Aetomylaeus vespertilio*	37039005	60
Ornate Rock Lobster	*Panulirus ornatus*	28820006	10.15
Ornate Threadfin Bream	*Nemipterus hexodon*	37347014	137.22
Oxeye Herring	*Megalops cyprinoides*	37054001	22.9
Oxeye Scad	*Selar boops*	37337008	169.73
Pacific Bonefish	*Albula argentea*	37055001	6.57
Painted Maskray	*Neotrygon leylandi*	37035013	27.29
Pandalid Prawn (U)	*Pandalidae - undifferentiated*	28770000	0.06
Penaeid Prawn (U)	*Penaeidae - undifferentiated*	28711000	1.46
Pennantfish	*Alectis ciliaris*	37337018	150.66
Philippine Spurdog	*Squalus montalbani*	37020047	2.14
Pickhandle Barracuda	*Sphyraena jello*	37382004	808.96
Pigeye Shark	*Carcharhinus amboinensis*	37018026	540
Pike Eels - Undifferentiated	*Muraenesocidae - undifferentiated*	37063000	7.77
Pinjalo	*Pinjalo pinjalo*	37346072	7.11
Plain Maskray	*Neotrygon annotata*	37035012	2.1
Plain Porcupinefish	*Cyclichthys hardenbergi*		54.22
Plaintail Lionfish	*Pterois russelii*	37287012	0.81
Polychaete Worm (U)	*Class Polychaeta - undifferentiated*	22000000	0.87
Pomfret (U)	*Bramidae - undifferentiated*	37342000	0.12
Ponyfishes - Undifferentiated	*Leiognathidae - undifferentiated*	37341000	7.56
Porcupinefish (U)	*Diodontidae - undifferentiated*	37469000	0.87
Potbelly Leatherjacket	*Pseudomonacanthus peroni*	37465020	0.71
Pugnosed Ponyfish	*Deveximentum insidiator*	37341006	0.07
Purple Tuskfish	*Choerodon cephalotes*	37384004	5.93
Purplespotted Bigeye	*Priacanthus tayenus*	37326003	196.14
Rainbow Monocle Bream	*Scolopsis monogramma*	37347006	6.82
Rainbow Runner	*Elagatis bipinnulata*	37337029	18.66
Razor Moonfish	*Mene maculata*	37340001	1010.98
Razorfish (U)	*Centriscidae - undifferentiated*	37280000	0.5
Red Champagne Lobster	*Linuparus trigonus*	28820004	25.6
Red Ocean Squid	*Ommastrephes bartramii*	23636007	37
Red Spot Gurnard	*Lepidotrigla cf japonica*	37288010	0.05
Red Squirrelfish	*Sargocentron rubrum*	37261001	342.89
Redspot Monocle Bream	*Scolopsis meridiana*	37347008	22.78
Redtail Scad	*Decapterus kurroides*	37337056	380.51
Remoras - Undifferentiated	*Echeneidae - undifferentiated*	37336000	19.71
Reticulate Whipray	*Himantura australis*	37035003	425
Ringtail Surgeonfish	*Acanthurus auranticavus*	37437005	3.36
Ringtail Surgeonfish (Copy)	*Acanthurus auranticavus*	37437005	0.51
River Jewfish	*Johnius borneensis*	37354007	0.55
Robinson's Seabream	*Gymnocranius grandoculis*	37351005	18.33
Robust Amour Gurnard	*Peristedion picturatum*	37288004	508.54
Rockcod - Undifferentiated	*Epinephelus spp.*	37311911	88
Rosy Goatfish	*Parupeneus chrysopleuron*	37355016	0.2
Rosy Sea Bass	*Doederleinia berycoides*	37311025	6.14
Rosy Sea Perch	*Parascolopsis eriomma*	37347015	31.78
Rosy Snapper	*Pristipomoides filamentosus*	37346032	0.19
Rosy Threadfin Bream	*Nemipterus furcosus*	37347005	76.27
Rough Flutemouth	*Fistularia petimba*	37278002	58.66

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Rough Golden Toadfish	*Lagocephalus lunaris*	37467012	107.69
Round Batfish	*Platax orbicularis*	37362007	74.41
Rusty-Spotted Toadfish	*Torquigener pallimaculatus*	37467009	3.82
Sandbar Shark	*Carcharhinus plumbeus*	37018007	190
Scads (Decapterus) - Undifferentiated	*Decapterus spp.*	37337901	7.75
Scalloped Hammerhead	*Sphyrna lewini*	37019001	210
Scallops - Undifferentiated	*Cypselurus poecilopterus*	37233010	0.06
Scampi	*Metanephrops spp.*	28786901	9.12
School Mackerel	*Scomberomorus queenslandicus*	37441014	1053.37
Schooling Bannerfish	*Heniochus diphreutes*	37365005	1.24
Scorpionfishes - Undifferentiated	*Scorpaena spp.*	37287904	0.03
Scribbled Angelfish	*Chaetodontoplus duboulayi*	37365009	12.63
Sea Apples - Undifferentiated	*Pseudocolochirus spp.*	25408922	35.05
Sea Urchin (U)	*Class Echinoidea - undifferentiated*	25200000	0.11
Seapen (U)	*Order Pennatulacea - undifferentiated*	11208000	0.04
Seastar (U)	*Class Asteroidea - undifferentiated*	25102000	4.79
Sentinel Crab	*Podophthalmus vigil*	28911014	0.39
Shark Ray	*Rhina ancylostoma*	37026002	236.5
Sharksucker	*Echeneis naucrates*	37336001	9.39
Sharptooth Snapper	*Pristipomoides typus*	37346019	272.82
Shortfin Batfish	*Zabidius novemaculeatus*	37362003	2699.81
Shortfin Saury	*Saurida argentea*	37118005	63.75
Shortnose Boxfish	*Ostracion nasus*	37466005	45.87
Shortnose Chimaera (U)	*Chimaeridae - undifferentiated*	37042000	40.19
Shortnose Tripodfish	*Triacanthus biaculeatus*	37464002	2.2
Shortspine Porcupinefish	*Cyclichthys orbicularis*	37469007	0.1
Short-Tail Hairtail	*Trichiurus nickolensis*	37440014	274.11
Sicklefish	*Drepane punctata*	37362005	6.95
Silver Toadfish	*Lagocephalus sceleratus*	37467007	6.38
Silverbiddies - Undifferentiated	*Gerreidae - undifferentiated*	37349000	1.45
Silvermouth Trevally	*Ulua aurochs*	37337041	27.75
Skate	*Raja spp.*	37031900	2.96
Slender Sardine	*Dussumieria elopsoides*	37085010	1.99
Sliteye Shark	*Loxodon macrorhinus*	37018005	36.07
Smalleye Stingray	*Megatrygon microps*	37035028	420
Smallmouth Scad	*Alepes apercna*	37337010	106.7
Smallspine Turretfish	*Tetrosomus reipublicae*	37466008	0.3
Smallspotted Herring	*Herklotsichthys lippa*	37085008	0.08
Smooth Golden Toadfish	*Lagocephalus inermis*	37467008	8.07
Smooth Toadfish	*Tetractenos glaber*	37467003	1.55
Soft Coral (U)	*Alcyoniidae - undifferentiated*	11176000	13.94
Southern Calamari	*Sepioteuthis australis*	23617005	0.19
Spangled Emperor	*Lethrinus nebulosus*	37351008	98.63
Spanish Mackerel	*Scomberomorus commerson*	37441007	651.89
Speckled Maskray	*Neotrygon picta*	37035029	7.55
Spider Crab (U)	*Majidae & related families - undifferentiated*	28880000	0.81
Sponge (U)	*Grantiidae - undifferentiated*	10216000	487.45
Sponges (Coral)	*Corallistidae - undifferentiated*	10038000	6.58
Spot-Tail Shark	*Carcharhinus sorrah*	37018013	212.81
Spotted Armour Gurnard	*Satyrichthys rieffeli*	37288019	285.5

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Spotted Bigeye	*Priacanthus macracanthus*	37326001	90.52
Spotted Mackerel	*Scomberomorus munroi*	37441015	1153.72
Spotted Sardine	*Amblygaster sirm*	37085006	0.11
Squat Lobster (U)	*Galatheidae, Munididae & Munidopsidae - undifferentiated*	28840000	0.26
Squid - Undifferentiated	*Loligo spp.*	23617907	126.41
Squid (Calamari, Inshore)	*Loliginidae - undifferentiated*	23617000	4.79
Stargazers - Undifferentiated	*Uranoscopus spp.*	37400904	2.77
Starry Puffer	*Arothron stellatus*	37467014	1.19
Starry Seabat	*Halieutaea sp. W4 [of P. Last]*	37212002	1.29
Starry Triggerfish	*Abalistes stellatus*	37465011	620
Stingray (U)	*Dasyatidae - undifferentiated*	37035000	19.27
Striped Barracuda	*Sphyraena pinguis*	37382001	4.59
Stripey Snapper	*Lutjanus carponotatus*	37346011	1.25
Sunrise Goatfish	*Upeneus sulphureus*	37355007	30
Swallowtail Seabream	*Gymnocranius elongatus*	37351010	6.46
Swimmer Crabs - Undifferentiated	*Portunidae - undifferentiated*	28911931	1.92
Tang's Snapper	*Lipocheilus carnolabrum*	37346031	15
Tawny Shark	*Nebrius ferrugineus*	37013010	120
Teardrop Threadfin Bream	*Nemipterus isacanthus*	37347019	7.34
Thorny Sea Cucumber	*Colochirus quadrangularis*	25408001	0.04
Threadfin Emperor	*Lethrinus genivittatus*		15.96
Threadfin Leatherjacket	*Paramonacanthus filicauda*	37465024	0.62
Threadfin Ponyfish	*Aurigequula fasciata*	37341009	281.74
Threadfin Silverbiddy	*Gerres filamentosus*	37349003	5.91
Threebar Boarfish	*Histiopterus typus*	37367008	27.88
Threeline Rockcod	*Epinephelus heniochus*	37311019	5.72
Three-Spotted Crab	*Portunus sanguinolentus*	28911006	2.89
Tille Trevally	*Caranx tille*	37337049	87.16
Toadfish (U)	*Tetraodontidae - undifferentiated*	37467000	0.01
Toadfishes (Lagocephalus) - Undifferentiated	*Lagocephalus spp.*	37467900	3.23
Toothed Ponyfish	*Gazza minuta*	37341007	4.7
Trevally (Carangoides) - Undifferentiated	*Carangoides spp.*	37337916	0.04
Trevally (Caranx) - Undifferentiated	*Caranx spp.*	37337917	57.81
Tripleband Butterflyfish	*Roa australis*	37365006	0.51
Tripodfish & Deepwater Tripodfish (U)	*Triacanthidae, Triacanthodidae - undifferentiated*	37464000	0.1
Tropical Rock Lobster - Undifferentiated	*Panulirus spp. except P. cygnus*	28820901	1.09
Turrum	*Carangoides fulvoguttatus*	37337037	104.42
Tuskfishes - Undifferentiated	*Choerodon spp.*	37384902	22.39
Unicorn Leatherjacket	*Aluterus monoceros*	37465022	226.09
Variegated Emperor	*Lethrinus variegatus*	37351014	0.4
Weasel Shark	*Hemigaleus australiensis*	37018020	115.91
Wedgefish - Undifferentiated	*Rhynchobatus spp.*	37026900	13.5
Western Angelshark	*Squatina pseudocellata*	37024005	29.31
Western Numbfish	*Narcinops lasti*	37028004	2.62
Western Spotted Gummy Shark	*Mustelus stevensi*	37017012	41.85

COMMON NAME	SCIENTIFIC NAME	CAAB Code	Catch (kg)
Whaler Sharks - Undifferentiated	*Carcharhinus spp.*	37018904	105.69
Whelks - Undifferentiated	*Buccinidae, Fasciolariidae, Nassariidae, Melongenidae, Colubrariidae, Belomitridae - undifferentiated*	24202000	2.5
Whipfin Ponyfish	*Equulites leuciscus*	37341005	1.41
Whiptail & Rat-Tail (U)	*Macrouridae & Bathygadidae - undifferentiated*	37232000	14.73
Whiteband Bigeye	*Pristigenys niphonia*	37326006	1.39
Whitefin Trevally	*Carangoides equula*	37337013	9.58
Whitemouth Trevally	*Uraspis uraspis*	37337020	85.6
Whitespotted Guitarfish	*Rhynchobatus australiae*	37026005	545.5
Whitespotted Rabbitfish	*Siganus canaliculatus*	37438004	62.37
Whitetongue Trevally	*Carangoides talamparoides*	37337043	219.63
Whiting - Undifferentiated	*Sillago spp.*	37330904	0.09
Winghead Shark	*Eusphyra blochii*	37019003	30
Wrasse (U)	*Labridae - undifferentiated*	37384000	0.02
Yellowback Bream	*Dentex spariformis*	37353002	5.3
Yellowband Fusilier	*Pterocaesio chrysozona*	37346009	1.38
Yellowbelly Threadfin Bream	*Nemipterus bathybius*	37347001	15.79
Yelloweye Toadfish	*Torquigener parcuspinus*	37467029	0.11
Yellowspotted Leatherjacket	*Thamnaconus hypargyreus*	37465012	0.76
Yellowspotted Rockcod	*Epinephelus areolatus*	37311009	19.44
Yellowstripe Scad	*Selaroides leptolepis*	37337015	246.8
Yellowtail Angelfish	*Chaetodontoplus personifer*	37365008	2.44
Yellowtail Fusilier	*Caesio cuning*	37346018	33.89
Yellowtail Stargazer	*Uranoscopus cognatus*	37400008	1.55
Yellowtip Threadfin Bream	*Nemipterus nematopus*	37347002	6.21
Zebra Shark	*Stegostoma tigrinum*	37013006	214
Total			142,701

Appendix 2 Density, biomass estimate and CV for each main species in each stratum.

Stratum	Species	Number of shots caught	Mean density (kg/km^2)	Standard error density (kg/km^2)	Relative biomass estimate (t)	CV	Mean density (kg/km^2) with zeros	S.E. density (kg/km^2) with zeros
Arafura General	Black Jewfish	5	16.5	7.8	146	0.63	1.8	1.1
Arafura General	Crimson Snapper	7	507.2	272.5	6282	0.64	78.9	48.4
Arafura General	Goldband Snapper	17	34.9	12.8	1051	0.41	13.2	5.4
Arafura General	Golden Snapper	7	23.6	11.3	292	0.59	3.7	2.1
Arafura General	Mangrove Jack	4	2966.6	2951.1	20996	1.10	263.7	262.6
Arafura General	Painted Sweetlips	4	24.3	9.4	172	0.62	2.2	1.3
Arafura General	Red Emperor	3	2.2	1.1	12	0.73	0.1	0.1
Arafura General	Redspot Emperor	4	33.1	22.3	235	0.82	2.9	2.2
Arafura General	Saddletail Snapper	33	109.3	22.4	6382	0.22	80.2	17.9
Arafura Primary	Black Jewfish	1	3.3	NA	11	NA	0.1	0.1
Arafura Primary	Crimson Snapper	14	253.4	71.0	11297	0.33	141.9	46.8
Arafura Primary	Goldband Snapper	20	43.0	12.6	2736	0.31	34.4	10.6
Arafura Primary	Golden Snapper	6	23.9	9.5	457	0.53	5.7	3.0
Arafura Primary	Mangrove Jack	5	18.9	13.5	301	0.82	3.8	2.9
Arafura Primary	Painted Sweetlips	18	51.2	15.4	2938	0.33	36.9	12.0
Arafura Primary	Red Emperor	12	21.0	3.3	804	0.26	10.1	2.7
Arafura Primary	Redspot Emperor	19	40.4	7.8	2445	0.22	30.7	6.9
Arafura Primary	Saddletail Snapper	25	562.4	70.3	44781	0.12	562.4	70.3
GoC North Primary	Black Jewfish	1	15.8	NA	23	NA	1.4	1.4
GoC North Primary	Crimson Snapper	7	356.3	104.3	3563	0.37	226.8	84.2
GoC North Primary	Goldband Snapper	9	50.5	18.2	649	0.39	41.3	16.0
GoC North Primary	Golden Snapper	2	343.4	337.8	981	1.17	62.4	61.9
GoC North Primary	Mangrove Jack	4	90.2	48.4	515	0.67	32.8	21.1
GoC North Primary	Painted Sweetlips	10	90.1	29.9	1287	0.35	81.9	28.3
GoC North Primary	Red Emperor	8	19.3	3.3	221	0.25	14.0	3.6
GoC North Primary	Redspot Emperor	9	28.1	8.5	361	0.33	23.0	7.7
GoC North Primary	Saddletail Snapper	10	717.1	175.5	10242	0.26	651.9	171.6

Stratum	Species	Number of shots caught	Mean density (kg/km^2)	Standard error density (kg/km^2)	Relative biomass estimate (t)	CV	Mean density (kg/km^2) with zeros	S.E. density (kg/km^2) with zeros
GoC Southwest Secondary	Black Jewfish	1	9.5	NA	18	NA	0.4	0.4
GoC Southwest Secondary	Crimson Snapper	12	326.8	163.9	7391	0.54	156.9	83.8
GoC Southwest Secondary	Goldband Snapper	11	20.6	9.5	428	0.51	9.1	4.6
GoC Southwest Secondary	Golden Snapper	2	21.2	16.7	80	1.04	1.7	1.5
GoC Southwest Secondary	Mangrove Jack	3	39.5	31.4	223	0.96	4.7	4.1
GoC Southwest Secondary	Painted Sweetlips	19	66.1	17.8	2367	0.29	50.2	14.7
GoC Southwest Secondary	Red Emperor	10	43.3	16.5	816	0.45	17.3	7.7
GoC Southwest Secondary	Redspot Emperor	17	134.6	32.5	4311	0.28	91.5	25.4
GoC Southwest Secondary	Saddletail Snapper	20	438.0	143.9	16508	0.34	350.4	120.0
GoC West Primary	Black Jewfish	7	466.2	295.1	4296	0.72	74.2	51.1
GoC West Primary	Crimson Snapper	31	411.7	74.7	16799	0.21	290.1	59.7
GoC West Primary	Goldband Snapper	32	42.9	10.6	1805	0.26	31.2	8.3
GoC West Primary	Golden Snapper	8	108.0	49.7	1137	0.56	19.6	10.7
GoC West Primary	Mangrove Jack	23	100.7	29.1	3047	0.32	52.6	16.9
GoC West Primary	Painted Sweetlips	31	9.5	1.4	387	0.18	6.7	1.2
GoC West Primary	Red Emperor	24	11.6	1.8	366	0.21	6.3	1.3
GoC West Primary	Redspot Emperor	36	14.4	4.2	681	0.30	11.8	3.5
GoC West Primary	Saddletail Snapper	41	1229.5	187.0	66346	0.16	1145.7	180.4
JBG Fishery	Crimson Snapper	9	147.4	42.7	1610	0.32	120.6	39.0
JBG Fishery	Goldband Snapper	11	32.9	6.8	439	0.21	32.9	6.8
JBG Fishery	Golden Snapper	2	264.6	251.3	642	1.14	48.1	46.8
JBG Fishery	Mangrove Jack	1	4.9	NA	6	NA	0.4	0.4
JBG Fishery	Painted Sweetlips	9	86.4	30.7	944	0.38	70.7	27.0
JBG Fishery	Red Emperor	8	10.2	2.4	99	0.30	7.4	2.2
JBG Fishery	Redspot Emperor	3	2.9	0.7	10	0.55	0.8	0.4
JBG Fishery	Saddletail Snapper	11	414.9	92.7	5538	0.22	414.9	92.7
JBG General	Black Jewfish	1	2.2	NA	3	NA	0.1	0.1
JBG General	Crimson Snapper	5	253.6	222.9	2039	0.96	74.6	67.0

Stratum	Species	Number of shots caught	Mean density (kg/km^2)	Standard error density (kg/km^2)	Relative biomass estimate (t)	CV	Mean density (kg/km^2) with zeros	S.E. density (kg/km^2) with zeros
JBG General	Goldband Snapper	11	29.9	7.7	530	0.31	19.4	6.1
JBG General	Mangrove Jack	1	22.4	NA	36	NA	1.3	1.3
JBG General	Painted Sweetlips	8	39.4	19.2	507	0.55	18.5	10.0
JBG General	Red Emperor	5	21.6	7.9	174	0.52	6.4	3.3
JBG General	Redspot Emperor	2	6.9	4.3	22	0.91	0.8	0.7
JBG General	Saddletail Snapper	17	197.4	31.5	5398	0.16	197.4	31.5
JBG Other	Black Jewfish	1	4.3	NA	8	NA	0.3	0.3
JBG Other	Crimson Snapper	10	270.5	79.3	5184	0.33	208.1	68.7
JBG Other	Goldband Snapper	4	12.2	5.4	94	0.60	3.8	2.2
JBG Other	Golden Snapper	6	65.1	35.5	748	0.62	30.0	18.2
JBG Other	Mangrove Jack	4	8.3	1.9	63	0.47	2.5	1.2
JBG Other	Painted Sweetlips	9	51.1	12.6	881	0.31	35.4	10.9
JBG Other	Red Emperor	4	15.3	7.0	117	0.62	4.7	2.8
JBG Other	Redspot Emperor	4	7.6	3.6	59	0.63	2.3	1.4
JBG Other	Saddletail Snapper	12	321.4	79.4	7393	0.26	296.7	77.1
Timor Box	Black Jewfish	1	2.3	NA	2	NA	0.1	0.1
Timor Box	Crimson Snapper	3	211.9	190.4	662	1.05	23.5	21.9
Timor Box	Goldband Snapper	18	86.1	17.8	1615	0.25	57.4	14.2
Timor Box	Mangrove Jack	3	33.0	14.9	103	0.71	3.7	2.5
Timor Box	Painted Sweetlips	4	25.6	20.7	107	0.93	3.8	3.2
Timor Box	Red Emperor	5	11.7	4.3	61	0.55	2.2	1.2
Timor Box	Redspot Emperor	2	13.9	3.3	29	0.72	1.0	0.7
Timor Box	Saddletail Snapper	16	187.2	36.4	3119	0.25	110.9	27.9

Note: Density is calculated based both on shots in which each species was caught, and also for all survey shots including zero catches. Calculation were made using the swept area calculated from W_{eff}.