

A Survey of Recreational Fishing in the Greater Darwin Area 2016

Fishery Report No. 124



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1. Summary

1.1. Background

This report summarises the key results from the 'Survey of Recreational Fishing in the Greater Darwin area 2016'. The report includes detailed information relating to recreational fishing activities in the coastal area surrounding Darwin. Specifically, the report includes details on where people fish, how much time they spend fishing (effort), what fishing methods they use, and the type and number of fish harvested or released during the survey period. Additional information is provided on the size (length) of some socially important fish species as well as details on the size of recreational fishing vessels and level of technology used by recreational anglers.

The methodology applied during this survey closely follows that of the *Survey of Recreational Fishing in the Greater Darwin Area 2015* (Matthews et al. 2019).

The results of this report and previous similar reports will be incorporated into future stock assessments and harvest strategy development and will benefit the recreational fishing sector by ensuring that our Top End fisheries are managed in a sustainable way.

1.2. Survey methods

A conventional access-point methodology was utilised with fisher interviews conducted at selected boat ramps Between Dundee Beach and the mouth of the Adelaide River. Methodology followed Matthews et al (2019) except secondary ramps were allocated surveys to estimate catch and effort from the angler interviews rather than inferred from trailer count effort.

The total fishing effort (fisher hours), the number of fish harvested (kept) and the number of fish released were estimated for the recreational fishery in the Greater Darwin area.

1.3. Key results

1.3.1. Effort

During the survey period from 1 March 2016 to 30 November 2016, recreational fishers (both residents and visitors) spent an estimated total of 418 401 hours fishing in the Greater Darwin area.

Line fishing (using bait, lures or flies) was the most common fishing method used, accounting for 72% of the total effort, followed by pot fishing (20%). The use of other fishing methods was far less common. Approximately 70% of all recreational fishing effort occurred in estuarine waters.

The Darwin Harbour region and its associated arms and creeks supported 45% of the total fishing effort, followed by Bynoe Harbour (10%) and Shoal Bay (7%). The offshore regions seaward of Bynoe Harbour and Dundee were the most popular sites for those fishers venturing beyond estuarine waters.

Fishing effort was fairly consistent across the survey period, although activity during the run-off period (Mar-May) was slightly higher than in other seasons. An estimated 21% of all fishing effort was attributed to vessels using the Dinah Beach boat ramp. Significant levels of effort were also estimated for vessels using the Dundee Beach ramp (20%) and the East Arm ramp (15%).

The proportion of visiting angler effort (interstate or overseas) varied throughout the survey period and peaked during the dry season at 18% of the total fishing effort.

1.3.2. Catch

During the survey period from 1 March 2016 to 30 November 2016, recreational fishers (both residents and visitors) caught an estimated 509 179 aquatic organisms from the Greater Darwin area. Most of the catch (85%) was comprised of fish species (i.e. bony fish and sharks/rays) with the bulk of the remaining catch consisting of crabs and prawns.

Over 95 000 tropical snappers of the genus *Lutjanus* (e.g. Golden Snapper, Stripey Snapper, Indonesian Snapper and other tropical snappers) were caught and formed a major component (18.7%) of the total fish catch and were a major contributor to the reef fish catch. Golden Snapper was the most commonly caught reef fish accounting for 8.3% of the total fish catch.

Approximately 73 530 individual crustaceans were captured during the survey period, composed primarily of Mud Crabs (86%).

Almost 67% of all fish and 46% of crustaceans caught were released. However, actual release rates varied significantly depending on species. High release rates were reported for sharks/rays and catfish, whereas very low release rates were reported for mullet, whiting and Coral Trout.

Sixty seven per cent of all captures by recreational anglers in the Greater Darwin area occurred in estuarine waters and 33% in offshore waters. Mud Crab were the most frequently caught species in estuarine waters, accounting for 18% of the overall catch. Excluding baitfish species, the most common fish species caught in estuaries were Golden Snapper and cods. Stripey Snapper was the most common fish species caught offshore followed by emperors, sharks/rays and Golden Snapper.

Golden Snapper and Stripey Snapper were the most common species caught by line fishing methods. Mud Crabs dominated the catch by pots and mullet dominated the catch from cast nets followed by other baitfish species.

The Bynoe Harbour/Dundee fishing zone represented an area of high importance for the capture of reef fish, with Stripey Snapper, emperor, sharks/rays and Golden Snapper dominating the catch. Mud Crab only represented 3% of the total catch from this zone. By contrast, the Darwin Harbour/Surrounds fishing zone was very important for the capture of Mud Crabs as it accounted for over 16.7% of the total catch from this zone. Excluding baitfish species, the most commonly captured fish species in the Darwin Harbour/Surrounds fishing zone were Golden Snapper and sharks/rays.

The Bynoe/Dundee offshore region was the most significant single region producing 15% of the total catch of all aquatic organisms followed by the Darwin Harbour region with 14%

and Shoal Bay with 12% (Figure 17, Appendix 7). Collectively, Darwin Harbour and its associated arms and creeks produced 38% of the total catch.

The Darwin Harbour region dominated the fish catch with 48% of the total fish numbers coming from this area. This catch was composed primarily of Golden Snapper, mullet and Barramundi. The Bynoe/Dundee offshore region had the next highest catch of fish with 25%, primarily due to high numbers of reef fish species.

Overall catch composition varied by season, but Mud Crabs remained the most commonly caught species throughout the survey period. The most commonly caught fish species in both the run-off (March – May) and the build-up (September – November) period not including baitfish was Golden Snapper, whereas Stripey Snapper, cod/groupers and Golden Snapper dominated the fish catch during the dry season (June – August) months.

1.1.1 Length and sex data

Length data (total length) of harvested fish was recorded for the key species of Golden Snapper, Black Jewfish and Barramundi. The length of Golden Snapper harvested ranged from 15–80 cm with a mean length of 40.4 cm. The length of Black Jewfish harvested ranged from 30–135 cm with a mean length of 84.7 cm. The length of Barramundi harvested ranged from 55–96 cm with a mean length of 63.4 cm.

The vast majority (85%) of male Mud Crabs captured were kept, whereas less than half (47%) of the female Mud Crabs caught were kept.

1.1.2 Vessel characteristics

Almost 80% of recreational fishing vessels surveyed were 4.5 m or longer in length. Sounders were fitted to 96% of all vessels, while more than 90% of vessels had a form of Global Positioning System (GPS) on board.

1.2 Future research

Another survey of the Greater Darwin area will take place in 2017. This will be the fourth such survey of the Darwin area in the past four years. These successive surveys, using similar methodologies, will help determine estimates of inter-annual variation in fish populations and provide sound information on which to base future sustainable management of NT fish stocks.

2. Introduction

2.1 Background

Recreational fishing is a popular lifestyle activity in the Northern Territory (NT) and angling-related expenditure forms a significant component of the local economy. A national recreational fishing survey in 2000-01 revealed that the NT had the highest resident participation rate of any state/territory in Australia (at 32% or 44 000 resident fishers) and the highest proportion of interstate visiting anglers (over 35 000 fishers) (Henry and Lyle 2003). In addition, the most recent NT-wide survey in 2009-10 indicated that NT residents spend in excess of \$50 million annually in relation to recreational fishing (West et al. 2012). This figure did not include expenditure by visiting anglers, or money spent on charter fishing operations, and so the overall annual expenditure could be in the vicinity of \$80 million (NT Government 2012; NT Government 2015).

Recognising the importance of recreational fishing to the Top End, the NT Government has commissioned several major research projects over the years to monitor this activity (West et al. 2012). The most recent NT-wide survey took place in 2009-10 and highlighted the significance of the recreational catch of some of our most vulnerable reef fish species.

Recent stock assessments on Black Jewfish (*Protonibea diacanthus*) and Golden Snapper (*Lutjanus johnii*) indicate that Golden Snapper are at high risk of depletion and Black Jewfish are recovering in the Greater Darwin area. (Saunders et al., 2016a; 2016b). Although these species are some of the most heavily targeted reef fishes in NT waters, other reef-associated species (such as emperors and other snappers) may also be under threat.

Reef fish are targeted more efficiently than ever before due to advances in fishing technology, enhanced information sharing and improvements in access to popular areas. Biological traits, such as susceptibility to barotrauma, are also likely to exacerbate the problem as most deep-water reef fishes experience serious physical damage because of capture and are unlikely to survive release. Additionally, many of our popular reef fish species are long-lived and late maturing with a low reproductive success that makes them susceptible to over exploitation.

Given the significance and anticipated growth of recreational fishing in the NT, appropriate monitoring of this sector is essential to ensure the effective management and future sustainability of target species. The absence of up-to-date information for recreational fishery assessments represents a high risk to sustainable management and impedes effective whole-of-fishery management in the NT. These risks are heightened in areas where commercial fishing is prohibited, as recreational fishing represents the only potential source of fishery dependent data for assessment.

To ensure the fishery resources of the NT remain sustainable, the NT Government provided a level of ongoing funding to monitor fish stocks to benefit recreational fishing. The cost involved in conducting an 'NT-wide' recreational fishing survey is substantial. It was therefore considered appropriate to monitor a discrete geographical area where fish stocks are under significant pressure. Given recent concerns regarding the sustainability of reef fish in the Greater Darwin region, the survey effort was directed towards increasing our knowledge of the impact of recreational fishing in this area.

This resulted in the 'Survey of Recreational Fishing in the Greater Darwin area 2014' and subsequently the 'Survey of Recreational Fishing in the Greater Darwin area 2015'. These

studies involved a series of access-point surveys conducted at selected boat ramps between Dundee Beach and the Adelaide River mouth. This area was chosen for monitoring as it represents the region with the greatest recreational fishing pressure (West et al. 2012) and could provide a reasonable estimate of the impact on vulnerable reef fish species.

Following completion of the 2014 and 2015 survey, further funding was utilised to conduct a repeat of the survey in 2016. A similar access-point methodology was employed for this study in order to compare results across years.

2.2 Objectives

The primary focus of the survey was to collect data on recreational fishing catch and effort in the Greater Darwin area with a focus on coastal fishing activity and vulnerable reef fish species. The specific objectives were to:

- estimate the annual catch (harvest and release) by number and effort (fisher hours) for key fish and other species
- collect relevant biological information on some socially important fish and crustacean species
- collect information on vessel size and technological aids such as sounders and GPS

2.3 Notes to the reader

A large amount of information was collected on recreational fishing in the Greater Darwin area during the survey period. This report is a summary of the key findings.

While reading this report the following points should be considered:

- The report has been presented using the same format as previous recreational fishing surveys in the NT and uses similar methodology to the 2015 survey. However, before making any quantitative comparison with the information obtained from other previous NT surveys, changes in the survey scope and methodology should be noted. Key differences to the 2015 survey include:
 - Increased number of survey days in 2016.
 - Removed post-PM estimation and extended the AM and PM shift times to cover the whole daylight period of the day.
 - Removed trailer counts and surveyed every ramp and weighted the number of survey days proportional to the amount of fishing effort in previous years.
- Key terms and definitions used in the document are defined in Appendix 1.
- The results presented here are in the form of expanded estimates and relative percentages, often without commentary or interpretation.
- The grand totals and group totals in the tables have been estimated as separate variables from the survey data. Consequently, the estimated totals may not equal the sum of individual line items (i.e. other taxa in the group or entire table).

- Relative percentages have been rounded to the nearest integer. For example, a result showing 0% of effort for a particular region does not necessarily mean that no fishing occurred there; it simply means that the level of effort was very small (i.e. <0.5%).
- In those cases where expanded estimates are represented in histograms, they are also expressed numerically in tables included in the appendices.
- Standard errors (SE) are calculated and included in most figures and tables to account for statistical uncertainty associated with an estimate.
- The estimated values for total catch and effort are underestimates of the true values.
- Budgetary and logistic constraints necessitated the omission of night-time fishing, freshwater fishing, land-based fishing and ultimately, wet-season fishing. These omissions are consistent with the previous on-site surveys conducted in 2009, 2014 and 2015.
- Limitations in the survey design required the assumption of independence of data to be disregarded in order to estimate catch and effort totals for boat ramps and fishing regions.
- Dundee road boat ramp was omitted from the results as no fishing effort was recorded during the shifts allocated for the 2016 survey period.

3. Survey method and analysis

3.1 Survey scope

Recreational fishing was broadly defined as the capture or attempted capture of aquatic animals in NT waters other than for commercial purposes. All recreational fishing techniques and harvesting activities carried out in salt water were considered in-scope, including line-fishing, potting, nets, spears, hand and dive collection. The survey included saltwater boat-based fishing activity conducted during daylight hours, when the majority of all fishing activity occurs. Resident and non-resident fishers over five years of age were included within the scope. Shore-based fishing was not covered by the survey.

The geographical scope of the survey included the coastal zone extending from Dundee Beach (to the west of Darwin) to the mouth of the Adelaide River (specifically Saltwater Arm, to the east of Darwin). This area receives the highest recreational fishing effort within the NT (West et al. 2012) and is the area in which reef fish stocks are considered to be most at risk of “overfishing” (Saunders et al. 2016a; 2016b).

3.2 Survey zones

The Greater Darwin area was divided into two survey zones: (a) the Darwin Harbour/Surrounds zone and (b) the Bynoe Harbour/Dundee zone (Figure 1). The Darwin Harbour/Surrounds zone had 11 boat ramps within Darwin Harbour and two ramps to the east of Darwin at Adelaide River (Saltwater Arm) and Leaders Creek. The Bynoe Harbour/Dundee zone had six boat ramps within Bynoe Harbour and included the coastal ramp at Dundee Beach (Figure 1).

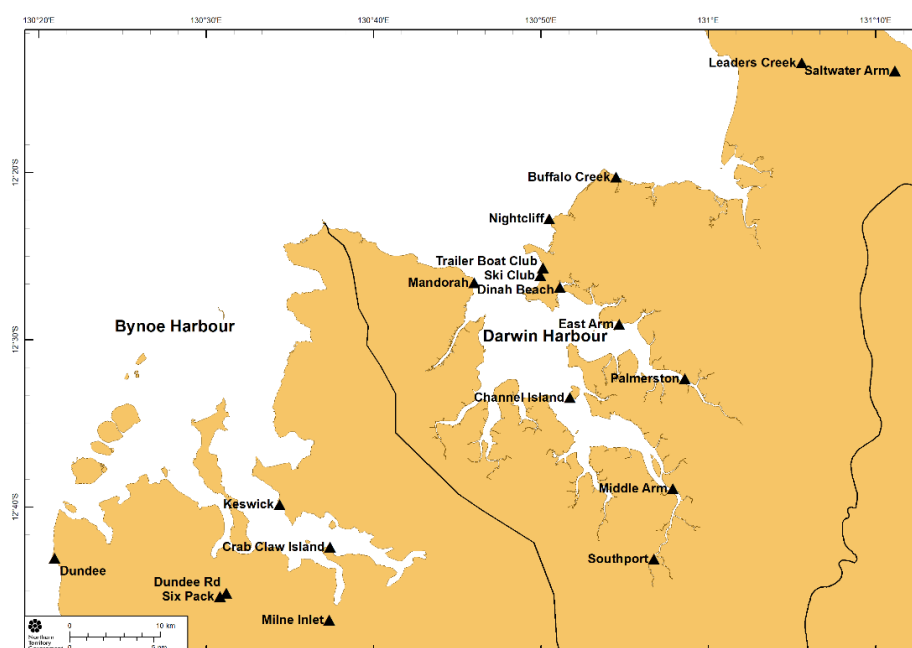


Figure 1 Map of the Greater Darwin area showing locations of public boat ramps

3.3 Primary and secondary boat ramps

Prior knowledge of fishing activity targeting coastal reef fish (Henry and Lyle 2003, West et al. 2012) was used to categorise boat ramps as either primary or secondary access sites (Table 1). The estimated effort at each ramp from the previous survey year (Matthews et al 2019) was used to determine the probabilities for random allocation of survey days. Primary ramps, where effort is greatest, were allocated proportionally more survey days than secondary ramps in order to increase the accuracy of estimated totals and minimise the variance. All surveys at all ramps collected information about catch, fishing effort, catch rates, fish sizes, fishing regions visited, fishing activities undertaken and the residential status of fishers.

Table 1 Primary and secondary boat ramps included in the Darwin Harbour and Surrounds and Bynoe Harbour and Dundee fishing zones.

Fishing Zone	Boat Ramp
Darwin Harbour & Surrounds	
<i>Primary</i>	1 Buffalo Creek 2 Dinah Beach 5 East Arm 6 Nightcliff 10 Middle Arm 12 Leaders Creek 22 Saltwater Arm
<i>Secondary</i>	3 Ski Club 4 Channel Island 7 Palmerston 8 Trailer Boat Club 9 Mandorah 11 Southport
Bynoe Harbour & Dundee	
<i>Primary</i>	15 Six Pack 16 Keswick 21 Dundee
<i>Secondary</i>	13 Crab Claw Island 14 Milne Inlet 23 Dundee Road

Three boat ramps and access points were excluded from survey coverage. These were Vestey's beach (a rarely used access point), Larrakeyah ramp (a military base with no public access) and Cullen Bay Marina (a private facility for residents and charter operators). The boat ramp in the upper Adelaide River was excluded as it is used to access freshwater fishing locations.

3.4 Survey design and sampling at all boat ramps

Access point surveys (Pollock et al. 1994) were conducted at all boat ramps in the two survey zones between 1 March 2016 and 28 February 2017 (Figure 1). The primary sampling unit was a calendar day. Stratified random sampling protocols were used. The survey year was divided into seasonal strata: run-off (March, April and May), dry (June, July and August), and build-up (September, October and November) (Appendix 2). Limited sampling was undertaken during the wet season (December, January and February) but this data was excluded from the final analysis. Day-type stratification was used within each season (i.e. weekday or weekend days and public holidays). Each calendar date was stratified into two five and a half-hour shifts: early (08:30 – 14:00) and late (14:00 – 19:30).

Survey days were randomly allocated to ramps within each day-type and season stratum using a ramp probability likelihood based on total effort in the previous survey year. A survey shift was then randomly allocated to each selected survey day using a probability likelihood based on total effort in the previous survey year. However, logistical issues resulted in some over-sampling and under-sampling at different access sites. A summary of sampling at primary boat ramps is given in Appendix 3.

3.4.1 Data collected at ramps

Interviews with fishing parties were conducted at all ramps. A variety of data elements were collected during the interview process. The information collected directly by the trained survey staff included identification and number of fish retained (i.e. harvest), the size of selected species of fish retained, and the vessel characteristics and technology used by returning vessels that had been involved in recreational fishing activities. Some data elements were self-reported by the fishers (e.g., identification and number of fish released, time spent fishing, activity undertaken and fishing region visited). These self-reported data elements may be less accurate than the data that is derived from direct observation. A description of the data elements collected during interviews is provided below.

3.4.2 Fishing regions

Fishing regions categorised by West et al. (2012) were used to quantify the spatial extent of fishing activity (Figures 2 and 3). Detailed catch and effort data were collected for all individual fishing regions and these were combined to obtain estimates for the fishing zones (Table 2).

Table 2 Fishing zones and their fishing regions

Fishing Zone	Regions included
Darwin Harbour & Surrounds	8, 9, 10, 10a, 10b, 10c, 11, 12, 13, 44, 45, 46* & 60
Bynoe Harbour & Dundee	6, 7, 42 & 43

* Note that no catch or effort was recorded from region 46 during the survey period.

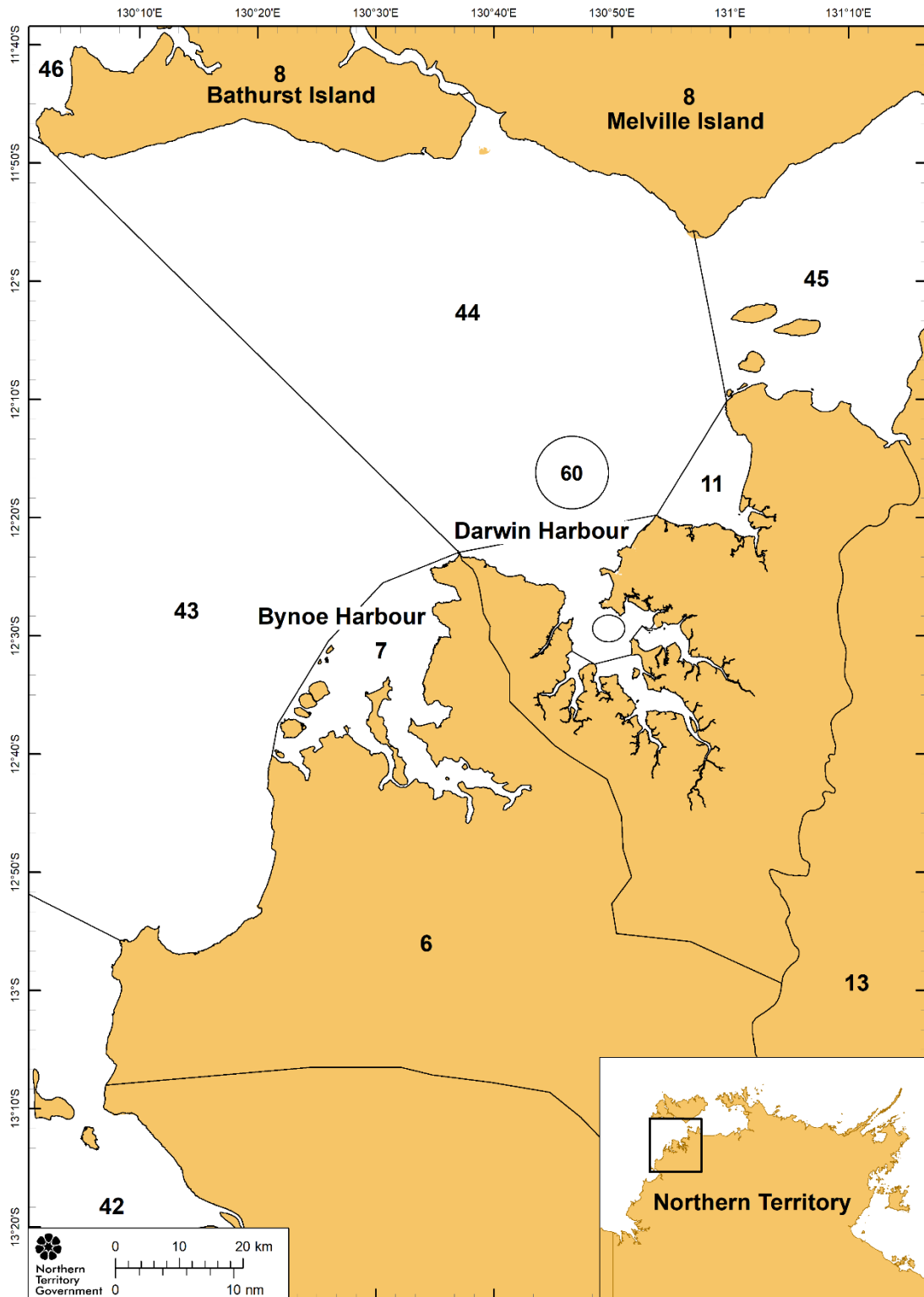


Figure 2 Map of the the fishing regions (numbered) used for reporting purposes

See Figure 3 for a detailed map of the Darwin Harbour area.

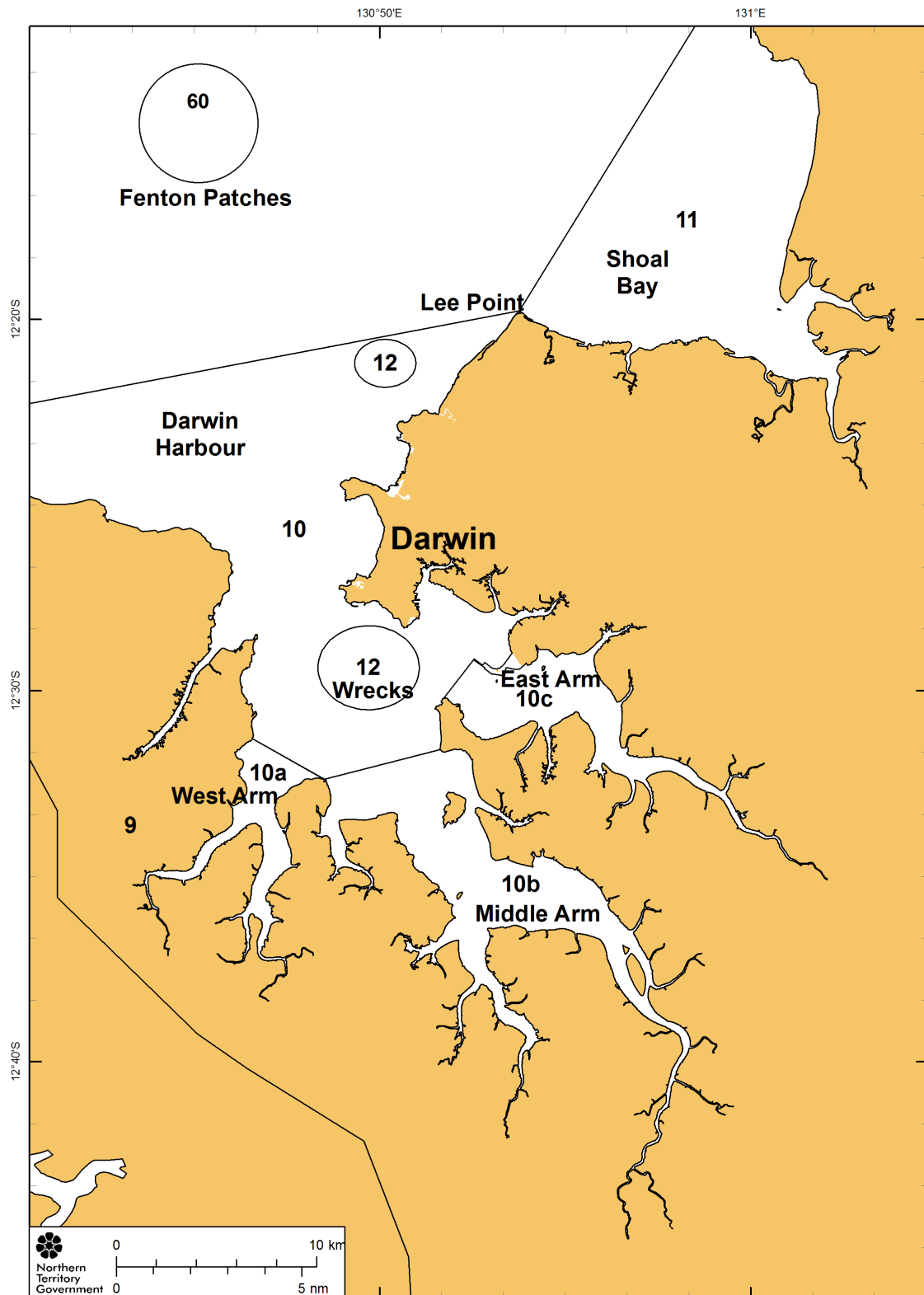


Figure 3 Map of the Darwin Harbour area showing fishing regions used for reporting purposes

3.4.3 Fishing events

Interviewers collected information on an 'event' basis, with an event being defined as a discrete fishing episode. Separate fishing events were recorded when there was a change in the fishing region or method used. Therefore, a day's fishing could consist of a number of fishing events. For example, line fishing in region 10 would be considered a separate event to line fishing in region 12, even if conducted by the same fishing party on the same day. Similarly, the cast netting of fish would be considered a separate event to using line methods to catch fish. The delineation of fishing activity in this way provided ability to partition catch and effort based on gear type and fishing region.

3.4.4 Fishing gear

The following gear categories were recorded for individual fishing events during interviews held at primary ramps:

- Line fishing (bait/lure or fly)
- Potting (pot/trap)
- Cast net
- Other gear/methods (e.g. diving, surface/hand spear, beach seining, surface hand collection, dip nets, hooking).

3.4.5 Catch (harvested and released fish)

The number of fish kept (harvest) and the number of fish released were recorded during interviews with fishing parties. Where possible, the catch was recorded to a species level (e.g. Barramundi or Golden Snapper). However, the identification of some taxa to species level was difficult, particularly when relying on the identification skills and recollection of fishers to document the released portion of the catch. Hence, it was necessary to broadly group some categories, such as 'red snappers'. Furthermore, some species were represented (in the data) by very few individuals making it necessary to pool these into a category of 'other scalefish' (e.g. Sailfish and Cobia). Taxa recorded during the survey are listed in Appendix 4.

3.4.6 Directed fishing effort

Directed fishing effort is a measure of effort targeted towards a particular species or group of species. Directed fishing effort can occur when fishing occurs at specific habitats (e.g. reef fishing or estuarine fishing) and when using different types of gear (e.g. line fishing or crab potting). Directed fishing effort for each event was calculated in fisher hours (i.e. for each event the number of fishers is multiplied by the time-spent fishing). Fishing effort (fisher hours) with different gear types in the same fishing region can be simultaneous (e.g. potting for crabs occurs at the same time as line fishing for finfish). The fishing effort for any one event in a region was assumed to be the maximum time spent fishing in that region irrespective of gear type used.

3.4.7 Fisher demographics

Information was collected on the number of fishers (aged five years or older) in each fishing party and the state/territory of residence of each fisher or if they were international visitors. This data was used to estimate the proportion of fishing activity by resident and non-resident fishers.

3.4.8 Length and sex data

Total length estimates (to the nearest centimetre) for harvested Black Jewfish, Golden Snapper and Barramundi were collected throughout the survey period and used to calculate average harvest lengths for these species.

Where possible, the sex of both kept and released Mud Crabs was recorded to determine the retention/release rate by sex and to provide some insight into spatial and seasonal variations in these variables.

3.4.9 Vessel characteristics and technology

Data was also collected on boat sizes and technology specifications to determine the proportion of different size vessels used in the fishery and the extent of electronic aids commonly used by coastal fishers in the Darwin area.

The significance of vessel size is that larger vessels are able to carry more anglers, thereby increasing both fishing effort (per boat) and fishing power. Larger vessels also allow anglers to travel greater distances in shorter periods and to fish through adverse weather conditions that may be unsafe in smaller craft.

Sounder dimensions can also influence fishing power. In general, the larger the dimension of a sounder, the greater is the picture quality and resolution of the display. This increased resolution provides greater detail and increases the ability of an angler to distinguish fish from general structure or scatter, thereby increasing the targeting ability and fishing power.

3.5 Estimation methods for survey data

The survey estimates were derived from a direct expansion of survey data that covers the early and late shift strata (i.e. 08:30 to 19:30) at all boat ramps. A number of assumptions underpin the estimation procedure and need to be considered when examining the survey results.

3.5.1 Direct expansion of survey data that covers the early and late shift strata (i.e. 08:30 to 19:30) at primary boat ramps

The estimation of fishing effort (fisher hours) within each fishing region and the number of fish kept and the number of fish released within each fishing region was calculated separately for each primary boat ramp. The base level of estimation was for each fishing region: shift (early or late) within each day-type (weekday days or weekend and public holiday days) within each season (run-off or dry or build-up). Stratum totals for shift types and day types were added together to obtain seasonal totals. The equations used follow Pollock et al. (1994).

The daily value was adjusted for shift type and furthermore for drive-offs and refusals to estimate a daily value total for the full day.

Mean daily values (\bar{x}_j) were calculated for fishing effort, harvest, and fish released for the j^{th} stratum:

$$\bar{x}_j = \frac{\sum x_{ij}}{n_j} \quad \text{Eq. 1}$$

Where:

x_{ij} is the daily value for the i^{th} day sampled within each fishing region within each day-type within each season stratum;

n_j is the number of sampling days for the j^{th} stratum.

The estimated variance of the mean daily values for the j^{th} stratum is:

$$\text{Var}(\bar{x}_j) = \frac{s_j^2}{n_j} \quad \text{Eq. 2}$$

Where:

n_j is from equation 1;

s_j^2 is the standard deviation for the j^{th} stratum.

The estimated stratum total (effort, kept fish, released fish) for the j^{th} stratum is:

$$\hat{X}_j = \bar{x}_j \cdot N_j \quad \text{Eq. 3}$$

Where:

\bar{x}_j is from equation 1;

N_j is the total number of primary sample units in the j^{th} stratum.

The estimated stratum variance of total effort, total kept fish, total released fish is:

$$\text{Var}(\hat{X}_j) = \text{Var}(\bar{x}_j) \cdot N_j^2 \quad \text{Eq. 4}$$

Where:

$\text{Var}(\bar{x}_j)$ is from equation 2; and

N_j is from equation 3.

The estimated total effort, total kept fish, total released fish for all strata combined (i.e. seasonal totals or survey year) is:

$$\hat{X}_{Total} = \sum_{j=1}^j X \quad \text{Eq. 5}$$

Where:

\hat{X}_j is from equation 3.

The estimated variance of total effort, total kept fish, total released fish is:

$$\text{Var}(\hat{X}_{Total}) = \sum_{j=1}^j \text{Var}(\hat{X}_j) \quad \text{Eq. 6}$$

Where:

$\text{Var}(\hat{X}_j)$ is from equation 4.

The estimated standard error of total effort, total kept fish, total released fish is:

$$SE(\hat{X}_{Total}) = \sqrt{\text{Var}(\hat{X}_{Total})} \quad \text{Eq. 7}$$

Where:

$\text{Var}(\hat{X}_{Total})$ is from equation 6.

3.6 Uncertainty in survey estimation

Survey estimates are subject to uncertainty for a variety of reasons. Suboptimal survey designs may cause coverage problems of the target survey population leading to biased results. Similarly, sampling errors such as measurement and non-response errors may occur during the data collection phase of a survey. Survey estimation is also uncertain because variable data are derived from a sample of the target population. Therefore, many strong assumptions are necessary when expanding these data to obtain survey totals.

In the absence of survey bias, it is possible to express the uncertainty in the survey estimates in terms of their precision. The standard error (SE) for each estimate is presented as a measure of the variability of these data. In general terms, estimates that are more precise have small SEs that indicate less uncertainty in the survey estimates. The relative SE (RSE) is the SE expressed as a percentage of the survey estimate. The RSE facilitates comparisons of the uncertainty associated with survey estimates that have different magnitudes. Within this report, results with an RSE of between 25% and 50% are represented by italic text, while results with an RSE of greater than 50% are represented by bold text. In general, terms, more precise survey estimates have small relative standard errors that indicate less uncertainty in the survey estimates.

3.7 Key species profiles

Data collected throughout the survey has been collated and presented individually for a number of key species targeted by recreational fishers in the greater Darwin area. The species highlighted below in Section 6 have been chosen for one or more of the following reasons: they are iconic species; have excellent eating qualities; are great sportfish; or are considered 'indicator' species on which to gauge and monitor the recovery of reef fish populations in the Greater Darwin area.

4 Fishing effort

The following results represent the total fishing effort expended by recreational fishers aged five years or more during daylight hours within the Greater Darwin area for the period from 1 March 2016 to 30 November 2016. Fishing effort is expressed as fisher hours. We present fishing effort partitioned by: the type of water body; the fishing method used; the zone and region fished; the boat ramps used by fishers; the season; and the residential origin of fishing activity (i.e. NT residents, visiting fishers).

An estimated 418 401 fisher hours were spent recreational fishing in the Greater Darwin area during the survey period by both NT residents and visiting anglers. The direct expansion of primary ramps constituted 81% of the total effort and estimation of effort for secondary ramps comprised 19% of the total effort. For a full breakdown of effort by analysis and ramp, refer to Appendix 6.

4.1 Effort by water body

The majority of fishing effort (fisher hours) occurred in estuarine waters (70%) and the remainder in offshore waters (30%) (Figure 4).

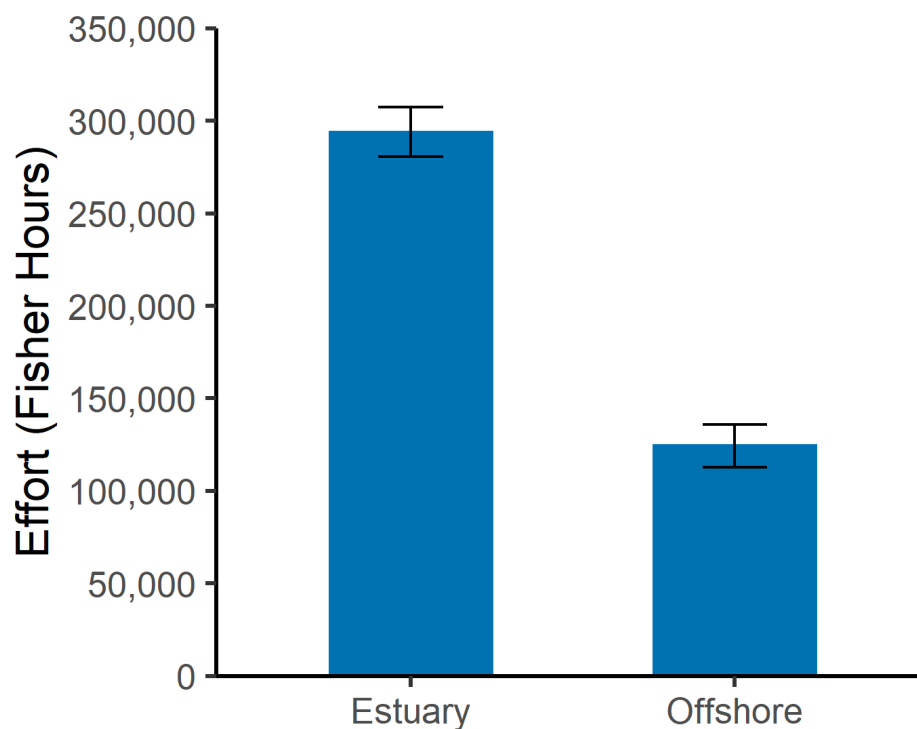


Figure 4 Fishing effort (fisher hours) by water body type in the Greater Darwin area for recreational fishers during the survey period from March 2016 to November 2016. Error bars represent one standard error.

4.2 Effort by fishing method

Line fishing (e.g. bait, lures, and jigs) was the most common fishing method used by recreational anglers, and accounted for almost 72% of the total fisher hours during the survey period (Figure 5). Pot fishing was the second most important method representing 20% of the total effort. Cast netting accounted for almost 6% of the effort hours and other methods, such as spearing, diving and hand collection combined constituted 2% of total effort.

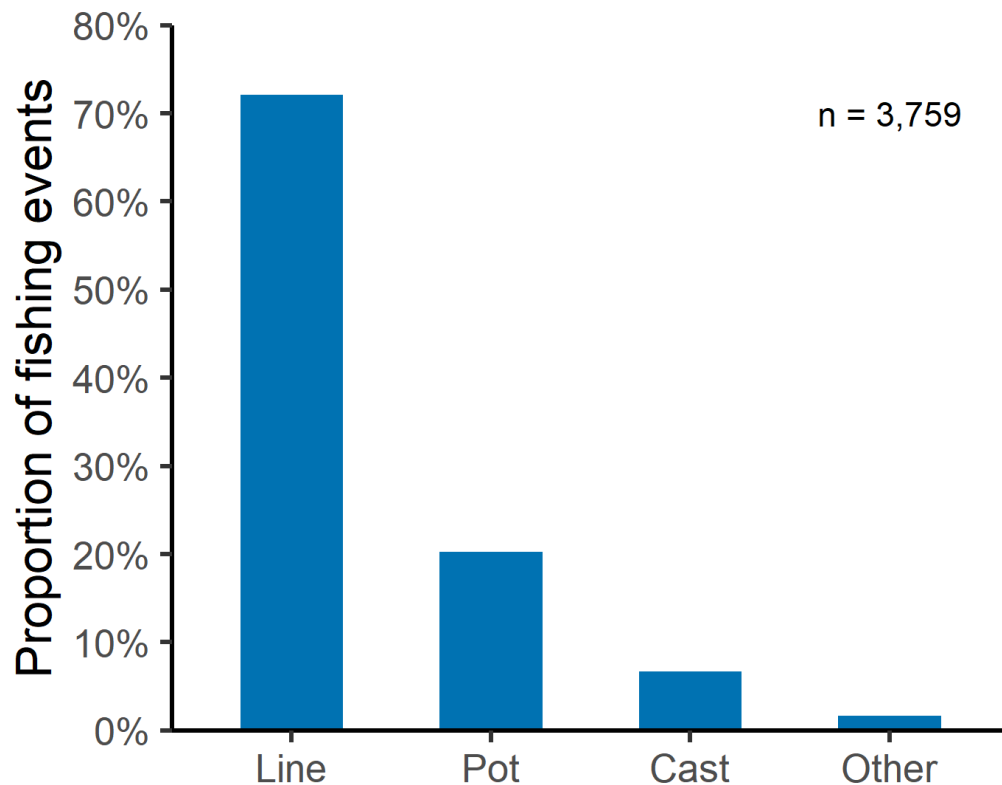


Figure 5 The proportion (%) of fishing effort by fishing method for recreational anglers in the Greater Darwin area during the survey period from March 2016 to November 2016.

4.3 Effort by fishing zone and region

4.3.1 Effort by fishing zone

The Darwin Harbour/Surrounds fishing zone supported 68% of the total fishing effort (fisher hours) within the Greater Darwin area, with the Bynoe Harbour/Dundee fishing zone supporting the remaining 32% of effort (Appendix 13).

4.3.2 Effort by fishing region

Darwin Harbour and its associated arms and creeks accounted for 45% of the total fishing effort (fisher hours) followed by Bynoe Harbour (10%) and Shoal Bay (7%) (Figure 6, Appendix 7). The region offshore of Bynoe Harbour and Dundee was the most popular offshore water for recreational fishing accounting for 13% of the overall effort.

For full details of the relative fishing effort in each region please refer to Appendix 7.

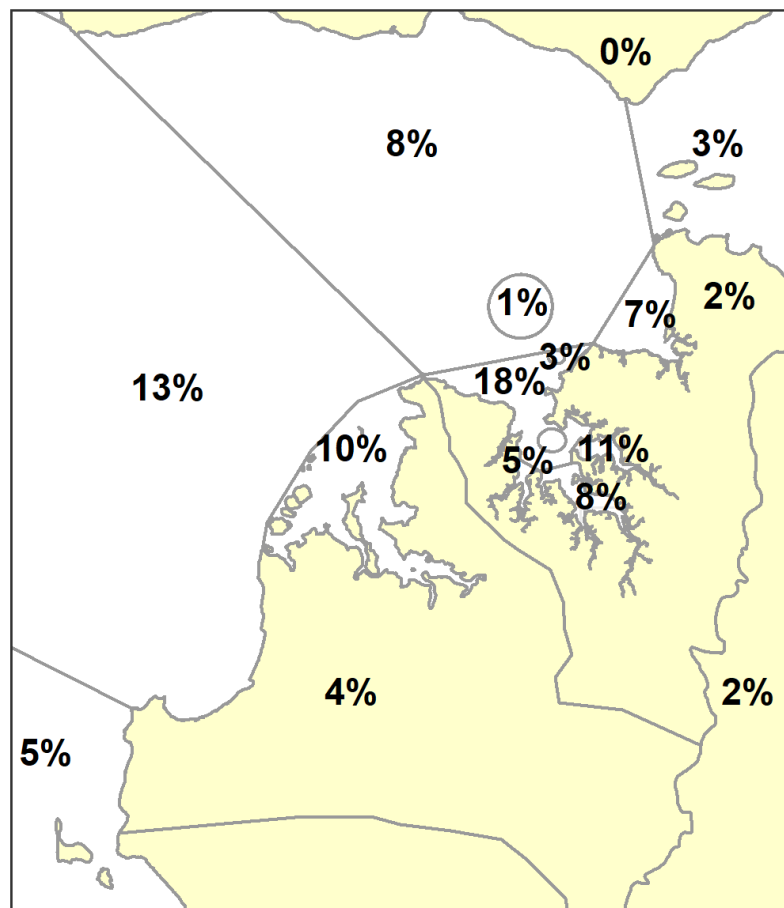


Figure 6 Map showing the spatial distribution (%) of fishing effort (fisher hours) by fishing region in the Greater Darwin area for recreational fishers during the survey period from March 2016 to November 2016.

4.4 Effort by boat ramp

Recreational fishing vessels using the Dinah Beach boat ramp accounted for 20.7% of the total fisher hours in the Greater Darwin area, closely followed by Dundee beach with 20.5% (Figure 7, Appendix 8). Vessels departing from East Arm (12.4%) and Buffalo Creek (8.4%) also made a major contribution to the total number of fisher hours.

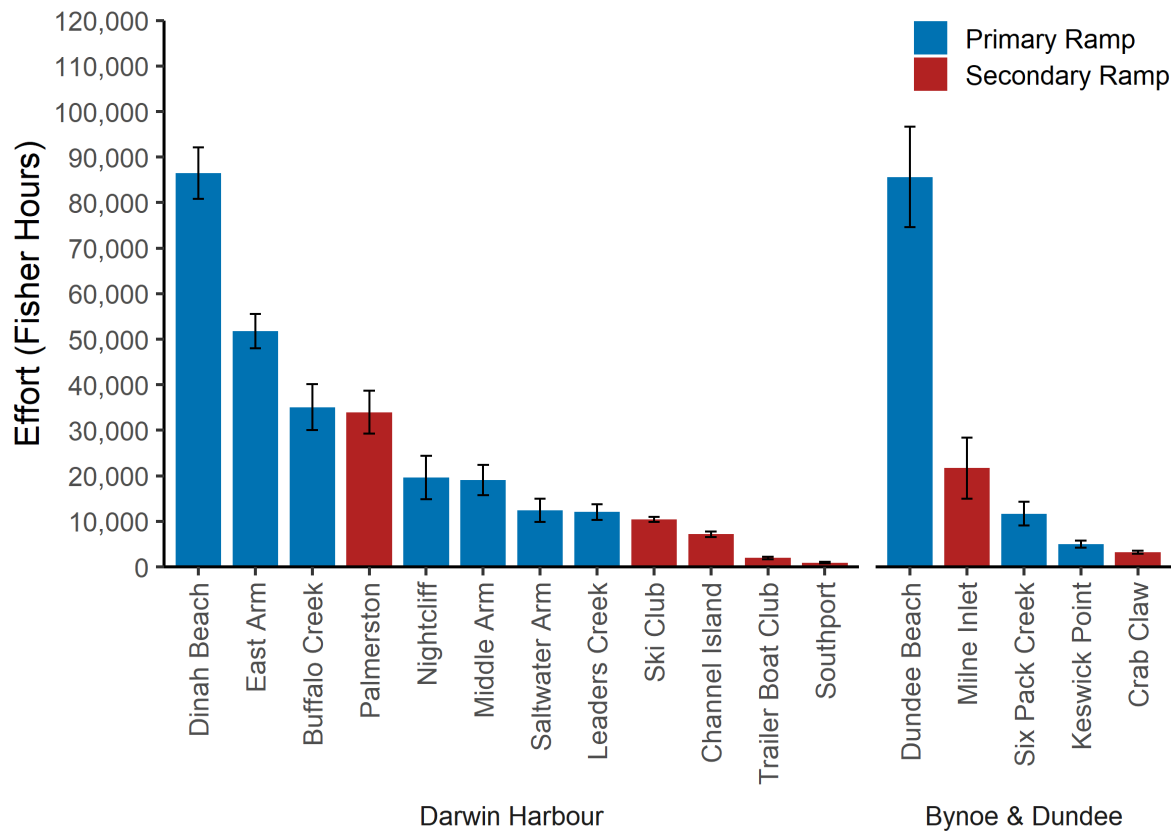


Figure 7 Fishing effort (fisher hours) by fishing zone and by boat ramp in the Greater Darwin area for recreational anglers during the survey period from March 2016 to November 2016. Error bars represent one standard error.

4.5 Effort by season

There was relatively no difference in fishing effort between seasons, with the run-off season accounting for the most effort (36%) followed by the dry season (35%) and then the build-up period (29%) (Figure 8).

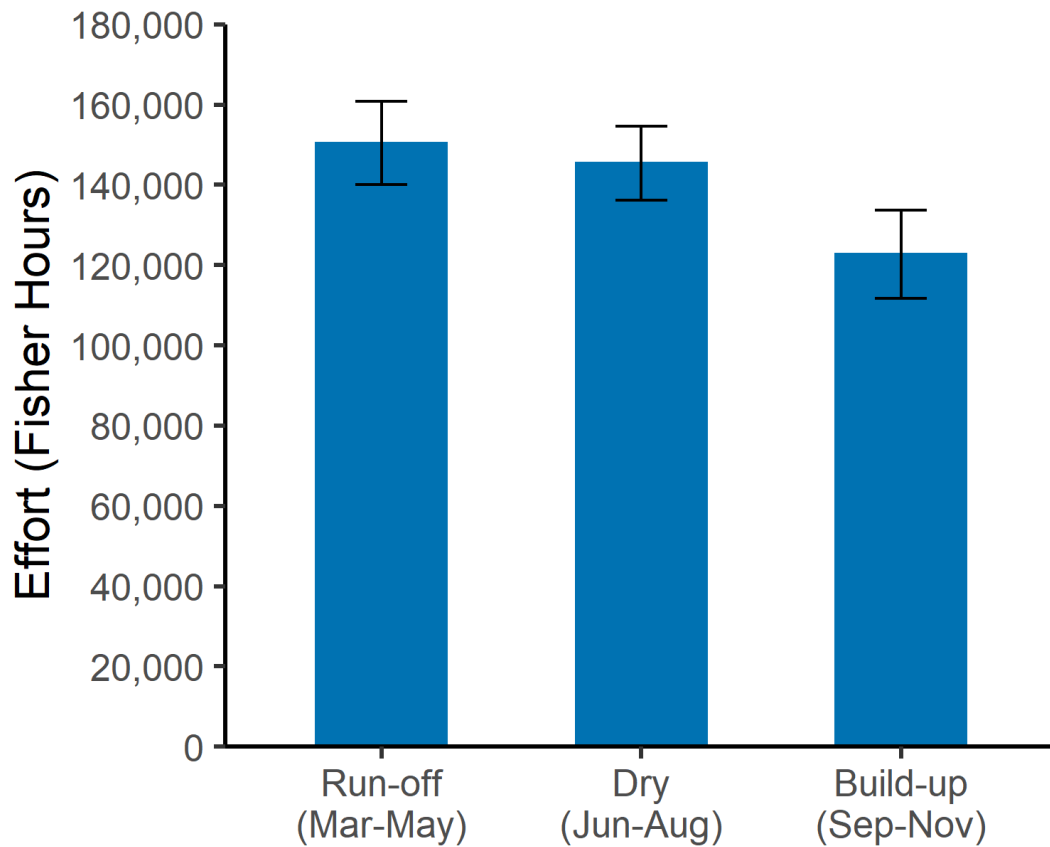


Figure 8 Fishing effort (fisher hours) by season in the Greater Darwin area for recreational anglers during the survey period from March 2016 to November 2016. Error bars represent one standard error.

4.6 Seasonal proportion of effort by residential origin of anglers

The proportion of visiting angler effort (interstate or overseas) varied during the survey period and peaked in the dry season at 18% of the total fishing effort (Figure 9). Visitor angler effort accounted for 15% of the effort in the run-off and 8.5% of effort in the build-up. Refer to Appendix 5 for a breakdown on the origin and number of fishers interviewed.

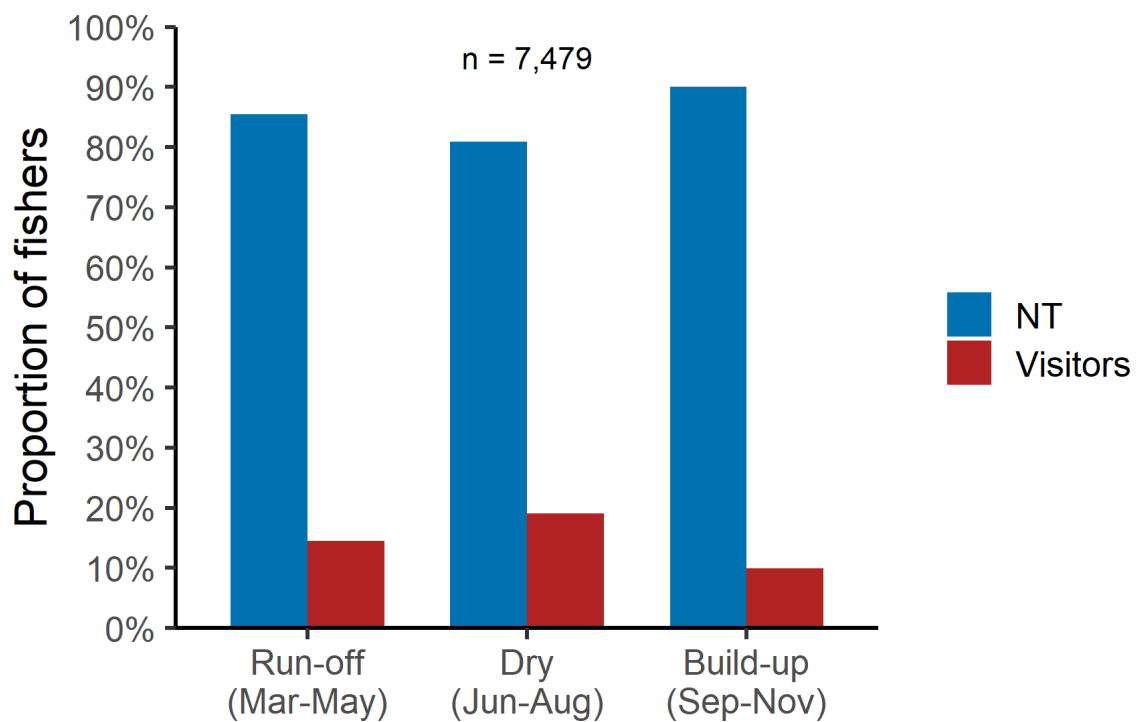


Figure 9 Unexpanded seasonal proportion of effort by residential origin of anglers in the Greater Darwin area during the survey period from March 2016 to November 2016.

5 Catch

The following results represent estimates of the total catch of aquatic organisms by vessel-based fishers (aged five years or older) within the Greater Darwin area during the survey period (1 March 2016 to 30 November 2016; Table 4). A full list of all taxa caught during the survey is provided in Appendix 9.

5.1 Total catch summary

An estimated 509 179 aquatic organisms were caught during the survey period. The direct expansion of primary ramps constituted 81% of the total catch and estimation of catch for secondary ramps comprised 19% of the total catch. For a full breakdown of catch by analysis and ramp, refer to Appendix 10.

Of the total estimated catch of aquatic organisms, 435 039 (85.4%) were fish (i.e. teleosts - bony fishes) and elasmobranchs (sharks/rays), with the bulk of the remaining catch (14.4%) comprised of crustaceans (primarily Mud Crabs and marine prawns). Some cephalopods and other non-fish taxa (0.1%) were also recorded.

Mullet was the most commonly caught fish species with an estimated 45 843 individuals caught (10.4% of the total fish catch). Other fish species of importance, included 42 533 Golden Snapper (8.4%), 37 831 Stripey Snapper (7.4%) and 29 456 cods and groupers (5.8%).

Collectively, over 95 000 tropical snappers from the genus *Lutjanus* (Golden Snapper, Stripey Snapper, Indonesian Snapper and other tropical snappers) were caught and this genus formed a major component (18.7%) of the overall fish catch and a major contributor to the reef fish catch.

An estimated 73 533 crustaceans were caught, comprised largely of Mud Crabs (86%). For a full breakdown of catch by taxa, refer to Appendix 9.

Almost 67% of all fish and only 46% of crustaceans caught were released; however, actual release rates varied markedly depending on species. High release rates were reported for sharks/rays and catfish, whereas very low release rates were reported for mullet, whiting and Coral Trout (Table 4).

Table 3 Estimated catch (total, kept and released numbers) and proportion released/discarded for key reporting groups in the Greater Darwin area by recreational fishers during the survey period from March 2016 to November 2016

Species/group	Total		Kept		Released		% released
	Number	SE	Number	SE	Number	SE	
Barramundi	9325	1191	3145	557	6179	780	66.1
Bream, pikey	10085	942	4054	537	6030	709	58.9
Catfish	18621	1844	857	390	17767	1650	96.4
Cod/groupers	29456	1856	7681	551	21771	1575	72.4
Coral trout	1612	304	1263	267	349	106	20.6
Emperor, other	22876	4417	7349	1076	15525	3817	66.6
Emperor, red	1274	428	863	309	410	157	33.1
Flathead	1008	197	285	57	720	186	69
Javelin fish	14029	1627	3210	610	10816	1488	77.3
Jewfish, black	5872	687	3911	470	1965	351	29.3
Jewfish, other	541	241	12	12	528	238	97.6
Mackerel, grey	1643	341	910	236	733	204	42.6
Mackerel, Spanish	4645	741	2640	435	2002	402	43.1
Mackerel, spotted	2661	764	1130	501	1532	310	57.6
Moonfish/Batfish	17117	2227	2024	402	15091	2087	88.9
Mullet	45843	10402	38016	8190	7824	4136	13
Queenfish	13352	1741	2273	300	11078	1652	84.4
Sharks & rays	33396	2396	1274	524	32123	2313	96.8
Small baitfish	33846	13956	9315	2804	24531	11515	77.7
Snapper, gold-band	70	70	28	28	42	42	60
Snapper, golden	42533	2731	20075	1440	22460	1670	53.7
Snapper, mangrove jack	1828	337	649	218	1179	181	58.7
Snapper, maori seapearch	127	127	0	0	127	127	100
Snapper, Moses'	1443	614	160	77	1282	600	88.8
Snapper, other	7	7	0	0	7	7	100
Snapper, saddletail/crimson/indonesian	11612	1585	5017	983	6595	906	59.5
Snapper, stripey	37831	3260	8292	1025	29538	2762	78.8
Tarpon/ox-eye herring	447	155	101	85	348	131	77.9
Threadfin, blue	7123	1072	4074	628	3046	662	39.6
Threadfin, king	1754	445	1063	316	691	278	45.1
Trevally, giant	4208	841	818	225	3389	699	83.2
Trevally, golden	3371	541	813	212	2564	468	71.1
Trevally, other	17571	2348	1394	315	16178	2140	92.4
Tuna, longtail	2673	727	1059	188	1616	645	60.5
Tuna, mackerel	1225	355	470	115	755	271	61.6
Whiting	1135	514	832	424	303	179	26.7
Wrasse, tuskfish	7416	851	2258	271	5158	754	69.7
Scalefish, other	25463	2923	5346	1904	20117	2163	78.3
Mud crab	63351	12356	36264	5299	27087	7432	43.4
Crustaceans, other	10182	1418	3349	710	6833	1224	53.5
Cephalopods	225	175	219	175	6	6	2.7
Gastropods	274	274	274	274	0	0	0
Other taxa	108	54	45	22	63	50	58.3

SE is standard error; values in italics have RSE between 25–50% and values in bold have RSE >50%.

5.2 Catch by water body

Of the total catch by recreational anglers in the Greater Darwin area, 67% was derived from estuarine waters and 33% from offshore waters. Numeric catch estimates for the ten most common species encountered by recreational fishers in estuarine and offshore waters are given in Figures 10 and 11, respectively. Details of all species caught in each water body type are provided in Appendix 11.

Estuary

Mud Crabs were the most frequently caught species in estuarine waters (18.5%) (Figure 10). The next most common species caught from estuarine waters were mullet (13.3%), small baitfish (9.9%) and Golden Snapper (7.3%).

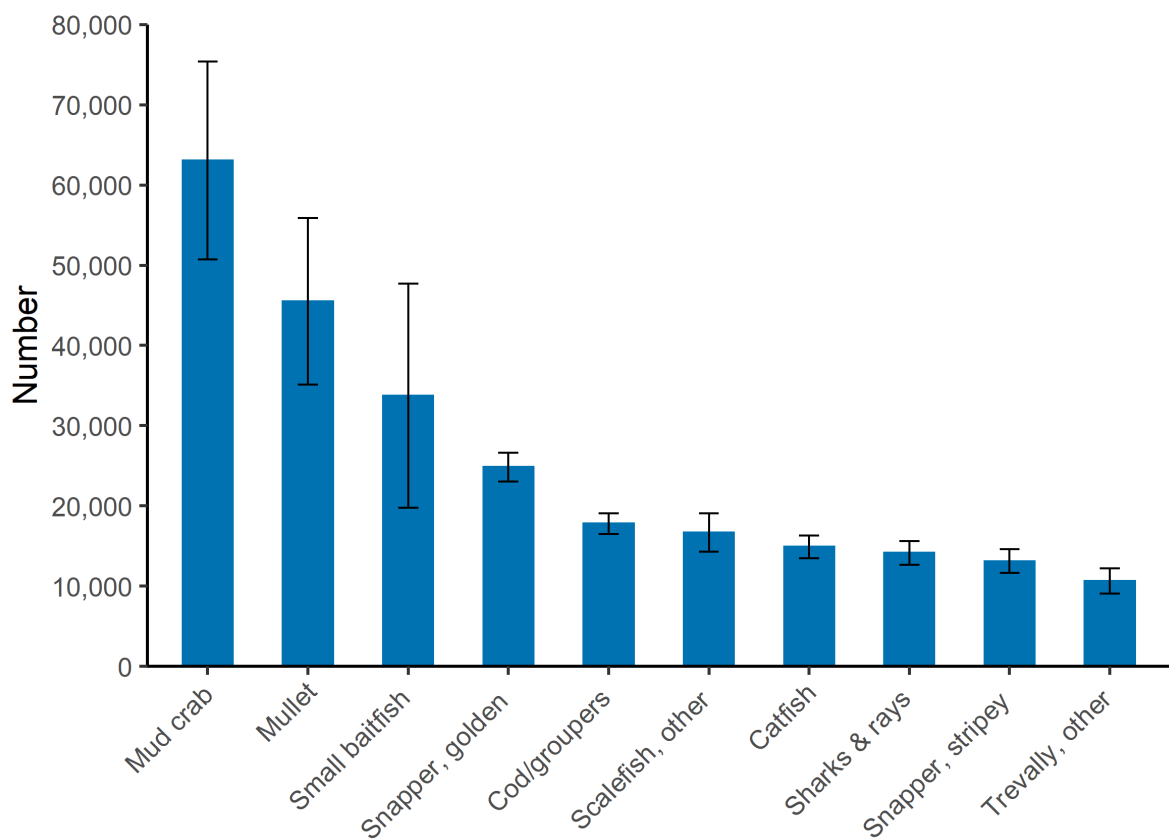


Figure 10 Catch estimates (numbers of fish) of the most frequent species/groups caught in estuarine waters of the Greater Darwin area for recreational fishers during the survey period from March 2016 to November 2016. Error bars represent one standard error.

Offshore

Stripey Snapper (14.7%) were the most common caught species in offshore waters, followed by emperor (e.g. Grass) (12.2%), sharks/rays (11.5%), Golden Snapper (10.5%) and cods/groupers (6.9%) (Figure 11). Batfish (5%) were less frequently caught along with queenfish, trevally and other scalefish species.

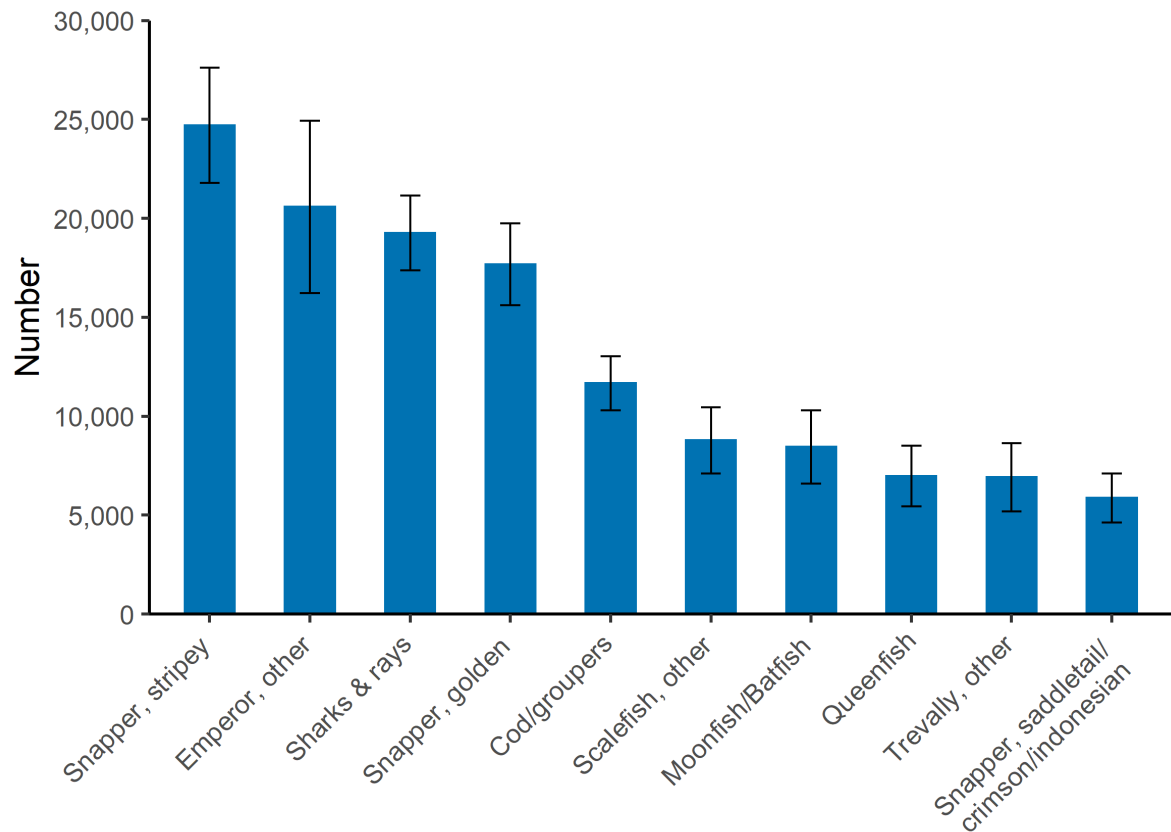


Figure 11 Estimated total catch (numbers of fish) of the most frequent species/groups caught in offshore waters of the Greater Darwin area for recreational fishers during the survey period from March 2016 to November 2016. Error bars represent one standard error.

5.3 Catch by fishing method

Line fishing methods accounted for 67% of all organisms caught, followed by cast nets (18.4%) and pots (14.5%). There were very few captures using other fishing methods (0.1%). Numeric catch estimates for the ten most common species encountered by recreational fishers using the three primary fishing methods are given in Figures 12, 13 and 14. Details of all species caught by each fishing method are provided in Appendix 12

5.3.1 Line

Fish accounted for almost all of the line catch, with Golden Snapper (12.5%) and Stripey Snapper (11.1%) being the most captured. sharks/rays (9.7%), cods/groupers (8%), emperors (6.7%) were less frequently caught with catfish (5.3%) encountered in lower numbers (Figure 12, Appendix 12).

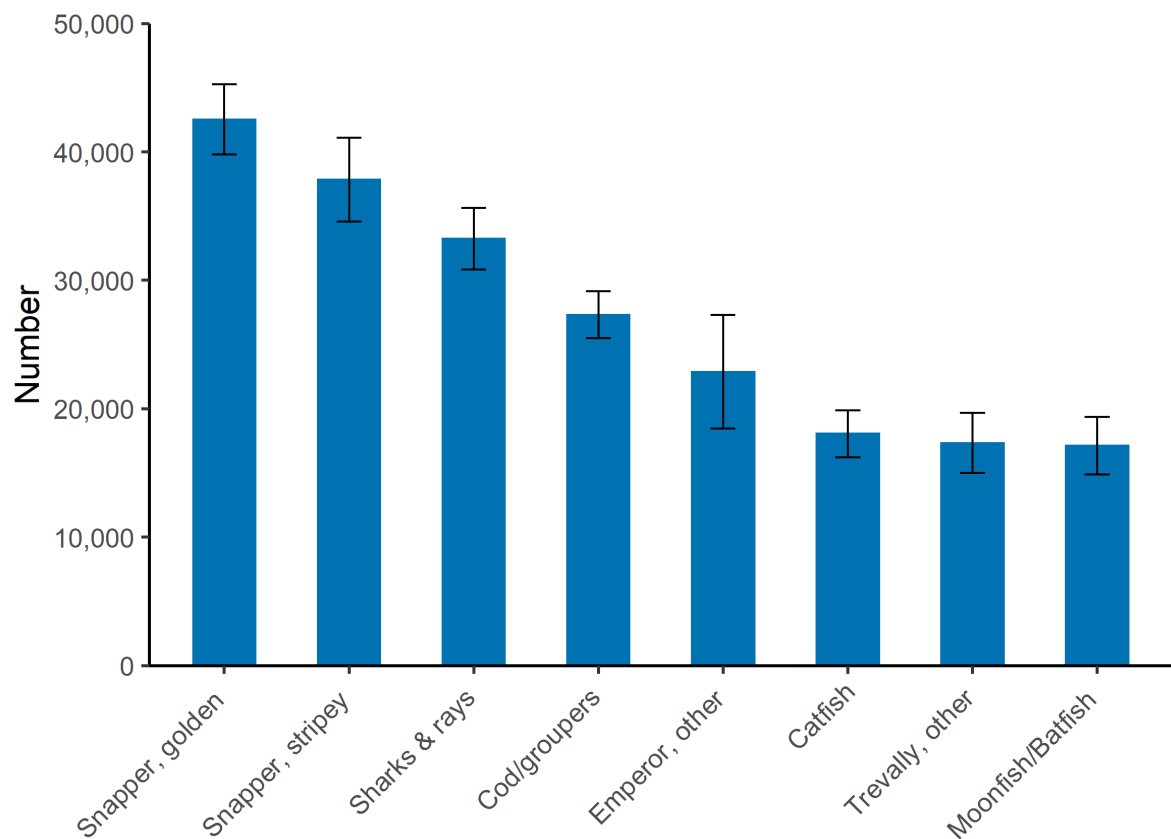


Figure 12 Estimated total catch (numbers of fish) of the most frequent species/groups caught by line fishing methods for recreational fishers in the Greater Darwin area during the survey period from March 2016 to November 2016. Error bars represent one standard error.

5.3.2 Pot

Mud Crabs dominated the catch in pots (85.2%) followed by other crustaceans (9.5%), most of which were Blue Swimmer Crabs. The remaining 5.3% consisted of incidental captures of various fish species (Figure 13, Appendix 12).

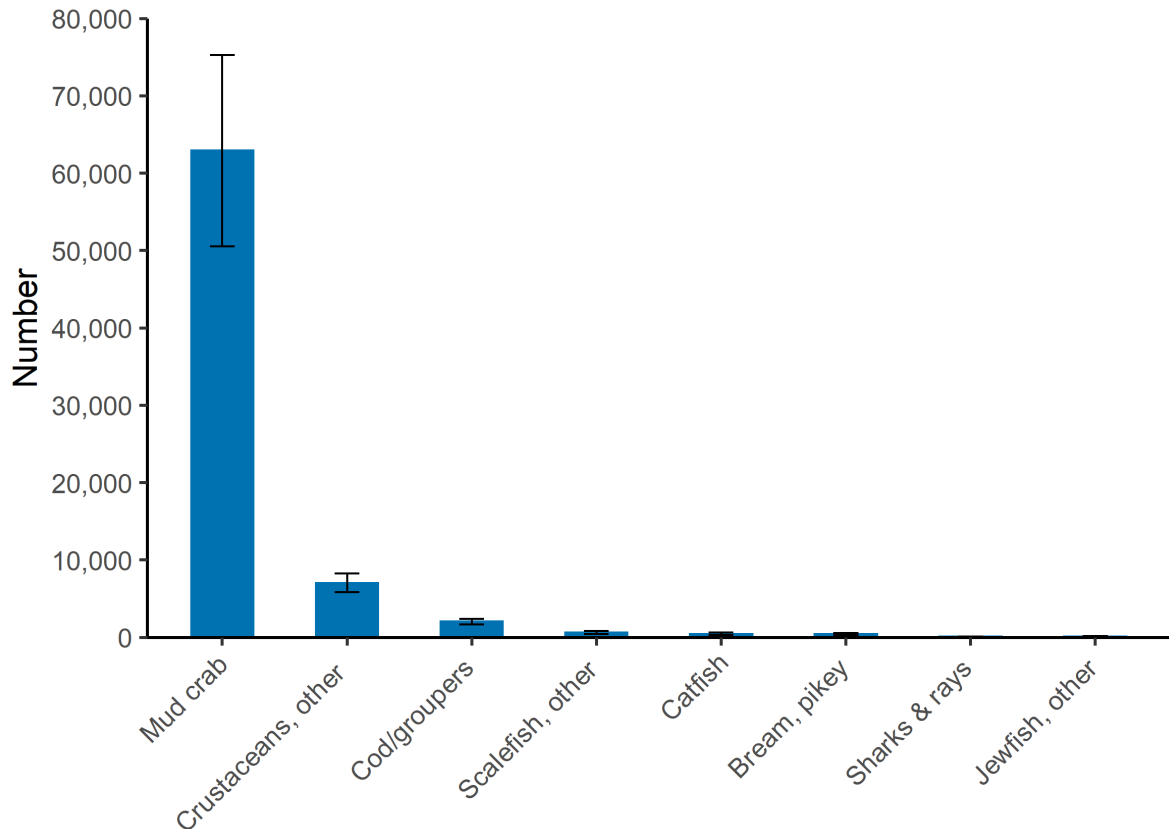


Figure 13 Estimated total catch (numbers of fish) of the most frequent species/groups caught by pot fishing methods for recreational fishers in the Greater Darwin area during the survey period from March 2016 to November 2016. Error bars represent one standard error.

5.3.3 Cast net

Mullet (48.6%) dominated the cast net catch. Small baitfish (35.5%) were also a major contributor to the catch from cast nets. The remainder of the catch comprised of other scalefish species (8.5%) and a mixture of crustaceans, such as prawns totalling 3.4% (Figure 14, Appendix 12).

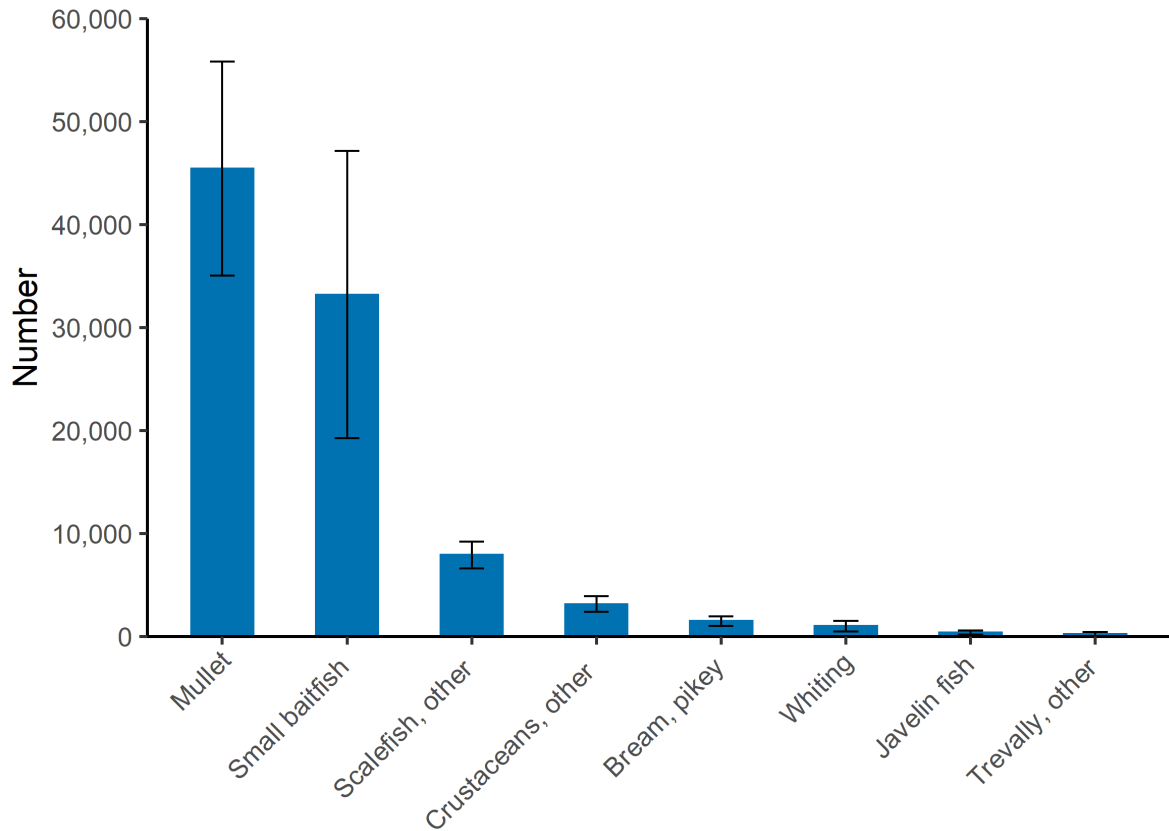


Figure 14 Estimated total catch (numbers of fish) of the most frequent species/groups caught by cast net fishing methods for recreational fishers in the Greater Darwin area during the survey period from March 2016 to November 2016. Error bars represent one standard error.

5.4 Catch by fishing zone and region

5.4.1 Catch by fishing zone

Numeric catch estimates for the ten most common species encountered by recreational fishers in the Bynoe Harbour/Dundee and Darwin Harbour/surrounds regions are given in Figures 15 and 16, respectively.

Detailed information on catch by fishing zone is provided in Appendix 13.

5.4.1.1 Bynoe Harbour/Dundee fishing zone

Stripy Snapper (12.4%) and emperors (10.9%) were the most commonly caught species in the Bynoe Harbour/Dundee fishing zone followed by small baitfish (10.3%), and Golden Snapper (8.6%) (Figure 15). Only 3.2% of the total catch for the zone was comprised of Mud Crabs.

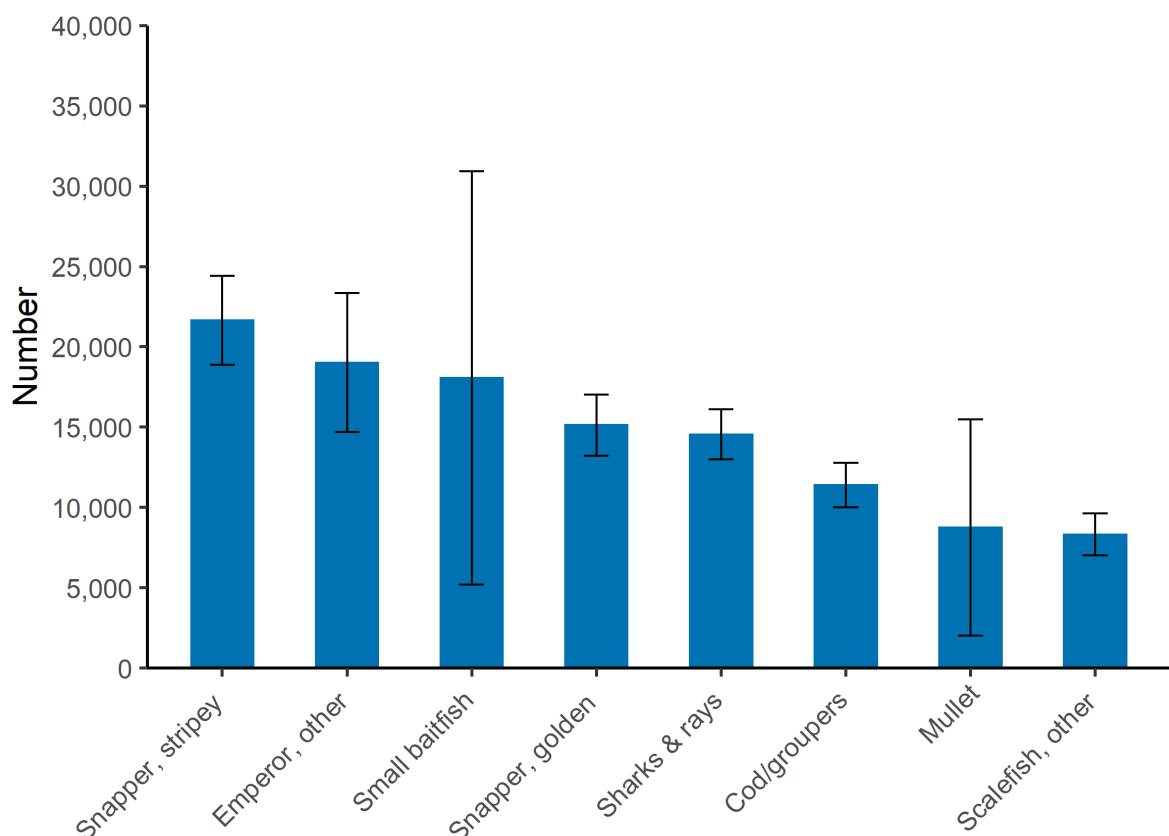


Figure 15 Catch estimates (numbers of fish) of the most frequent species/groups caught in the Bynoe Harbour/Dundee fishing zone by recreational anglers during the survey period from March 2016 to November 2016. Error bars represent one standard error.

5.4.1.2 Darwin Harbour/Surrounds fishing zone

Mud Crabs (17.3%) dominated the catch from the Darwin Harbour/Surrounds fishing zone, followed by mullet (11.1%), Golden Snapper (8.2%), sharks/rays (5.6%) and cod/groupers (5.4%) (Figure 16).

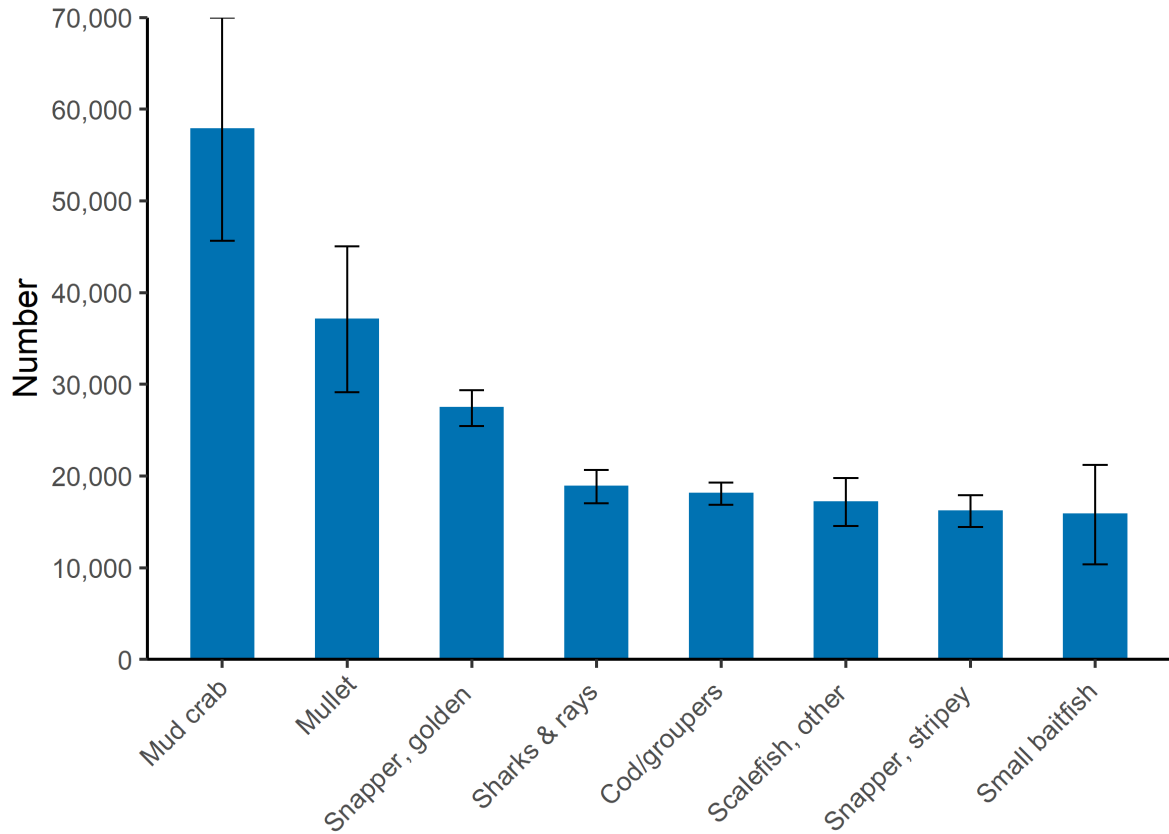


Figure 16 Catch estimates (numbers of fish) of the most frequent species/groups caught in the Darwin Harbour/Surrounds fishing zone by recreational anglers during the survey period from March 2016 to November 2016. Error bars represent one standard error.

5.4.2 Catch by fishing region

The Bynoe/Dundee offshore region was the most significant single region producing 15% of the total catch of all aquatic organisms followed by the Darwin Harbour region with 14% and Shoal Bay with 12% (Figure 17, Appendix 7). Collectively, Darwin Harbour and its associated arms and creeks produced 38% of the total catch.

The Darwin Harbour region dominated the fish catch with 48% of the total fish numbers coming from this area. This catch was composed primarily of Golden Snapper, mullet and Barramundi. The Bynoe/Dundee offshore region had the next highest catch of fish with 25%, primarily due to high numbers of reef fish species.

For full details of the relative catch in each region, please refer to Appendix 7

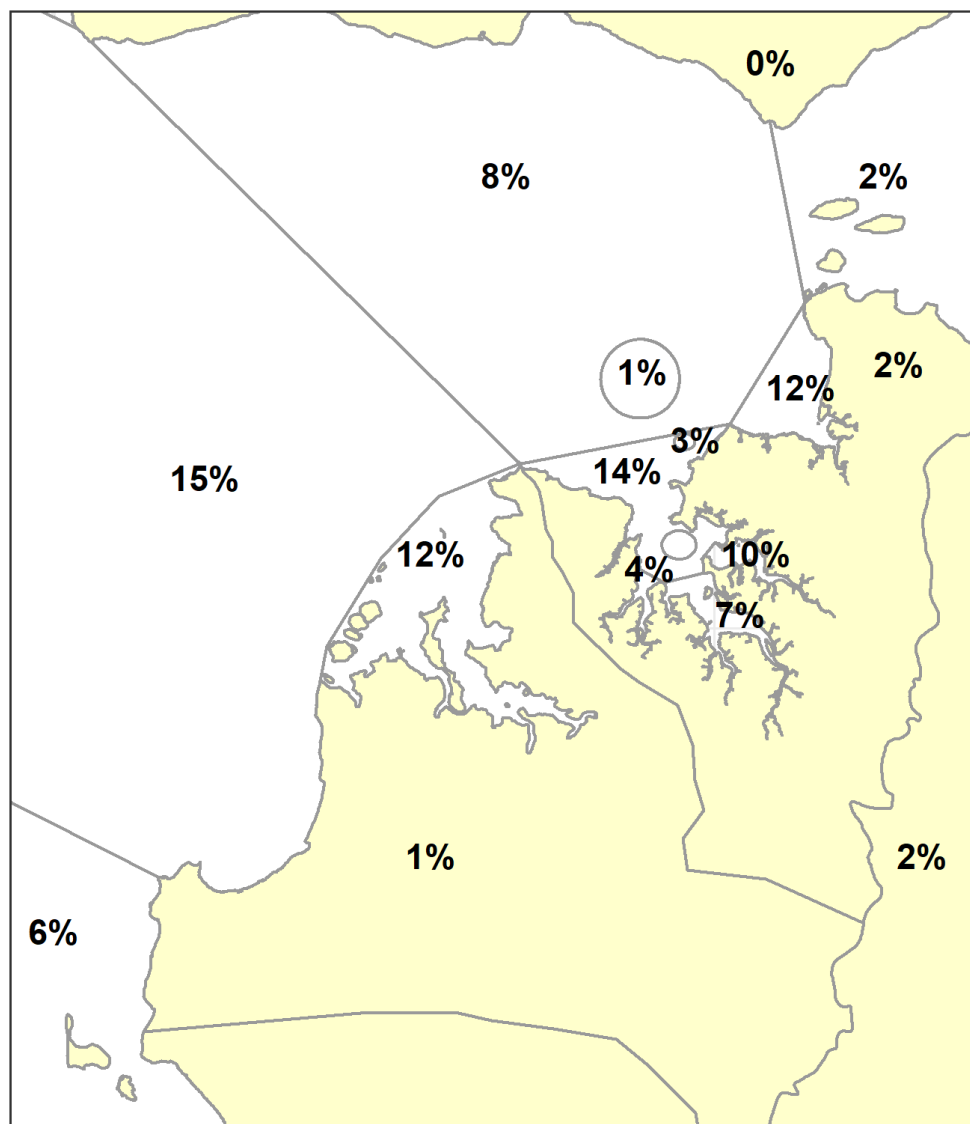


Figure 17 Map showing the spatial distribution (percentage) of catch by fishing region in the Greater Darwin area for recreational fishers during the survey period from March 2016 to November 2016.

5.5 Catch by season

Numeric catch estimates for the eight most commonly encountered species in each season are summarised in Figures 18, 19 and 20 below. Despite the overall catch composition varying by season, Mud Crab remained the most commonly caught species throughout the survey period. Nonetheless, the Mud Crab catch did fluctuate across the survey period with about 18 300 individuals caught in the run-off, about 36 400 in the dry and only about 8 500 individuals caught during the build-up.

Full details of the range of species caught in each season are provided in Appendix 14.

5.5.1 Run-off (March – May)

Golden Snapper (11.4%) and mullet (10%) were the primary species caught in the Greater Darwin area during the run-off period. Other species of importance were Mud Crab (9.5%) and Stripey Snapper (8.2%) (Figure 18).

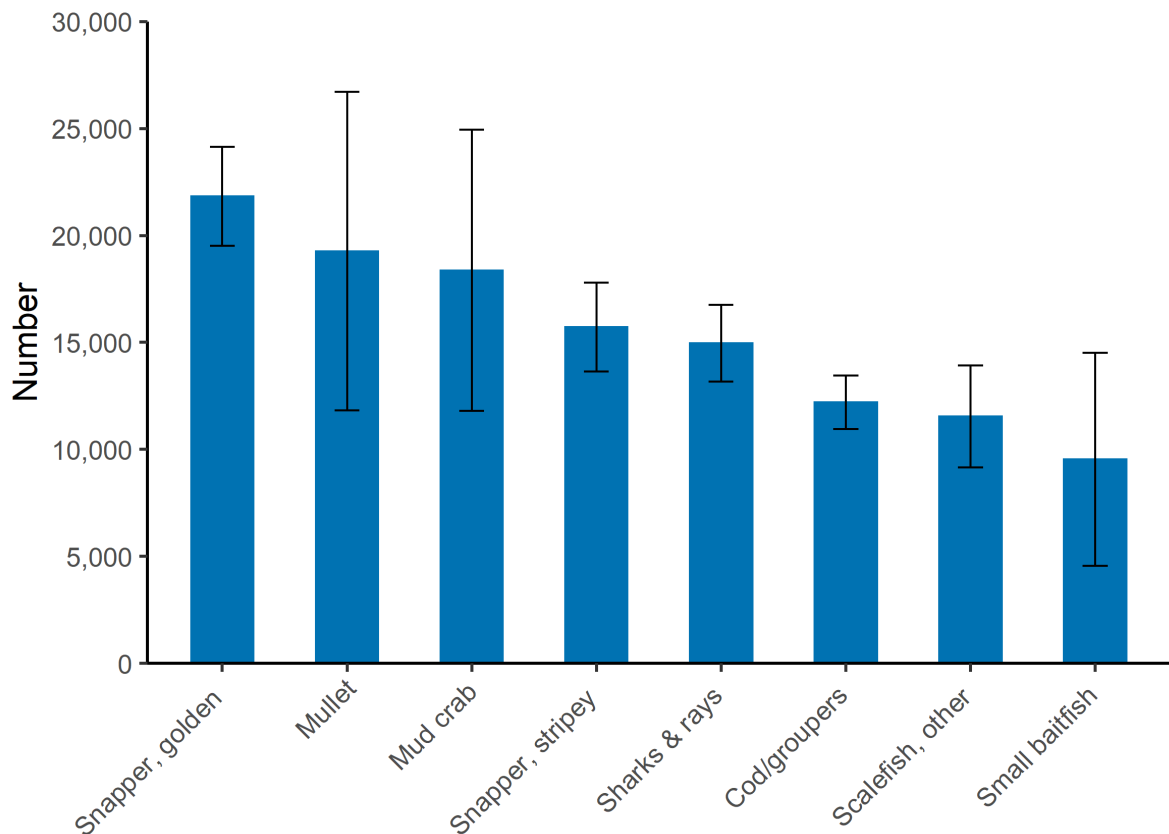


Figure 18 Catch estimates (numbers of fish) of the most frequent species/groups caught in the Greater Darwin area by recreational anglers during the run-off (March – May) season. Error bars represent one standard error.

5.5.2 Dry season (June – August)

Mud Crabs (22%) dominated the catch during the dry season followed by Stripey Snappers (7.3%), cod/groupers (6.1%) and Golden Snapper (5.6%) (Figure 19).

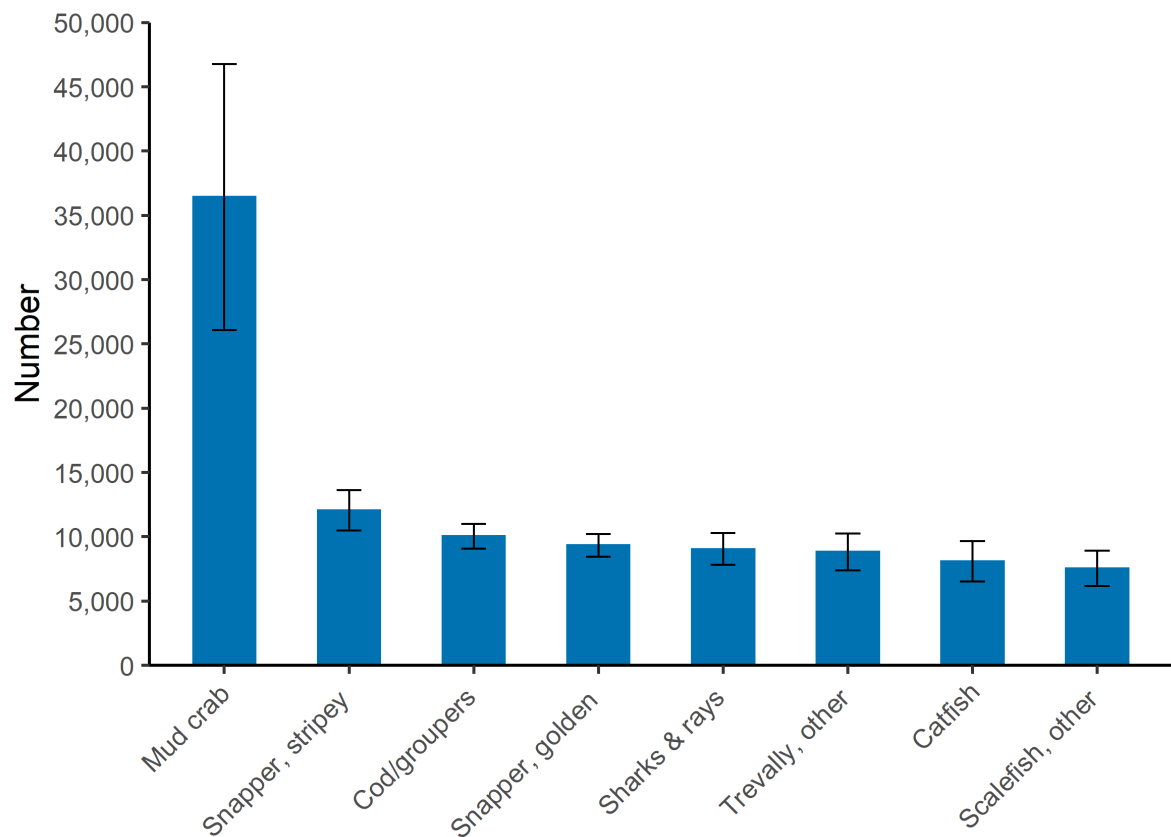


Figure 19 Catch estimates (numbers of fish) of the most frequent species/groups caught in the Greater Darwin area by recreational anglers during the dry season (June – August). Error bars represent one standard error.

5.5.3 Build-up (September – November)

Small baitfish (14.6%) were the predominant catch during the build-up months followed by mullet (12.9%), Golden Snapper (7.5%), Stripey Snapper (6.6%) and sharks/rays (6.2%) (Figure 20).

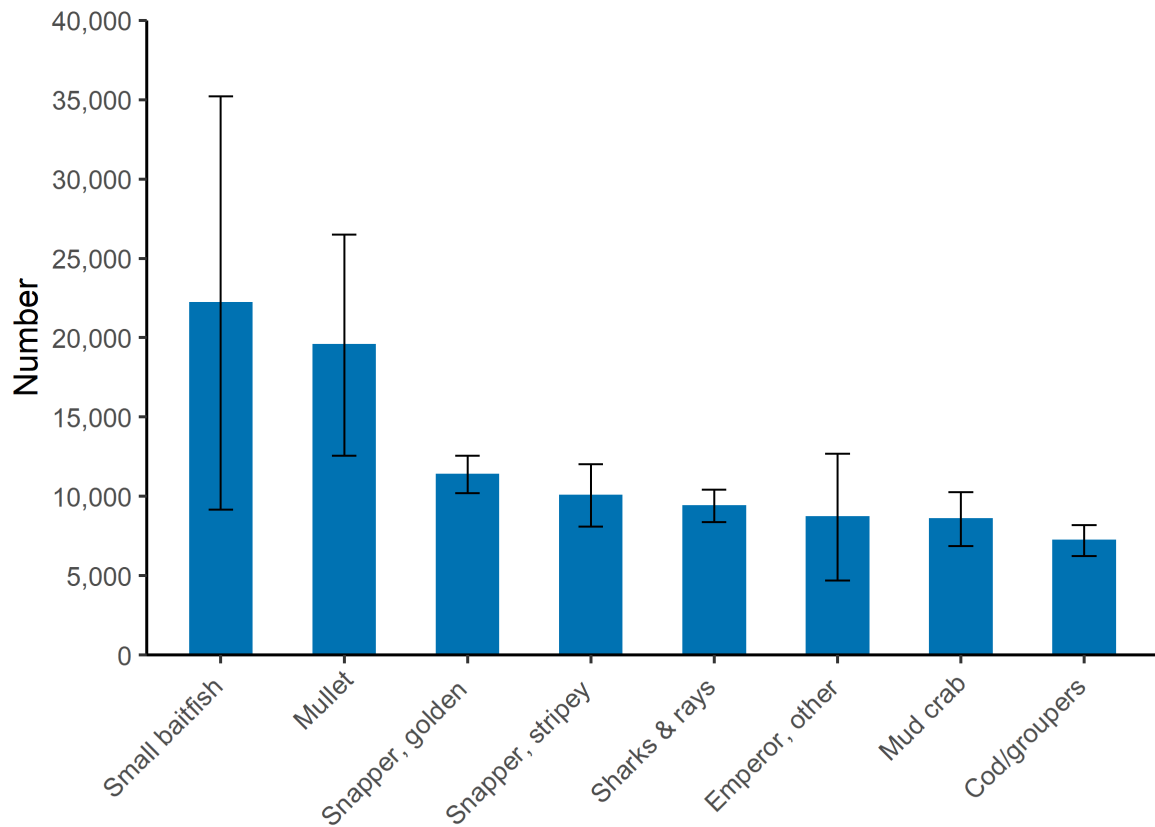


Figure 20 Catch estimates (numbers of fish) of the most frequent species/groups caught in the Greater Darwin area by recreational anglers during the build-up (Sept – Nov) season. Error bars represent one standard error.

6 Key species profiles

6.1 Barramundi (*Lates calcarifer*)

Barramundi are an iconic and key target species for recreational fishers in the NT. Monitoring of the barramundi population and the size of the recreational catch is important to ensure the ongoing sustainability of these fish stocks in the Greater Darwin area.

The majority of the recreational catch of Barramundi in the Greater Darwin area occurred within the confines of Darwin Harbour (35%), Shoal Bay (21%), Bynoe Harbour (18%) and the Finnis River region (18%) (Figure 21A). More than 66% of all Barramundi captured were released (Figure 21B). Barramundi were captured throughout the survey period with the highest catches recorded in the build-up (43.5%) and followed by the run-off (32.3%) (Figure 21C). The majority of Barramundi captures were by line fishing methods (97%) (Figure 21D) and predominantly from estuarine waters (96%) (Figure 21E).

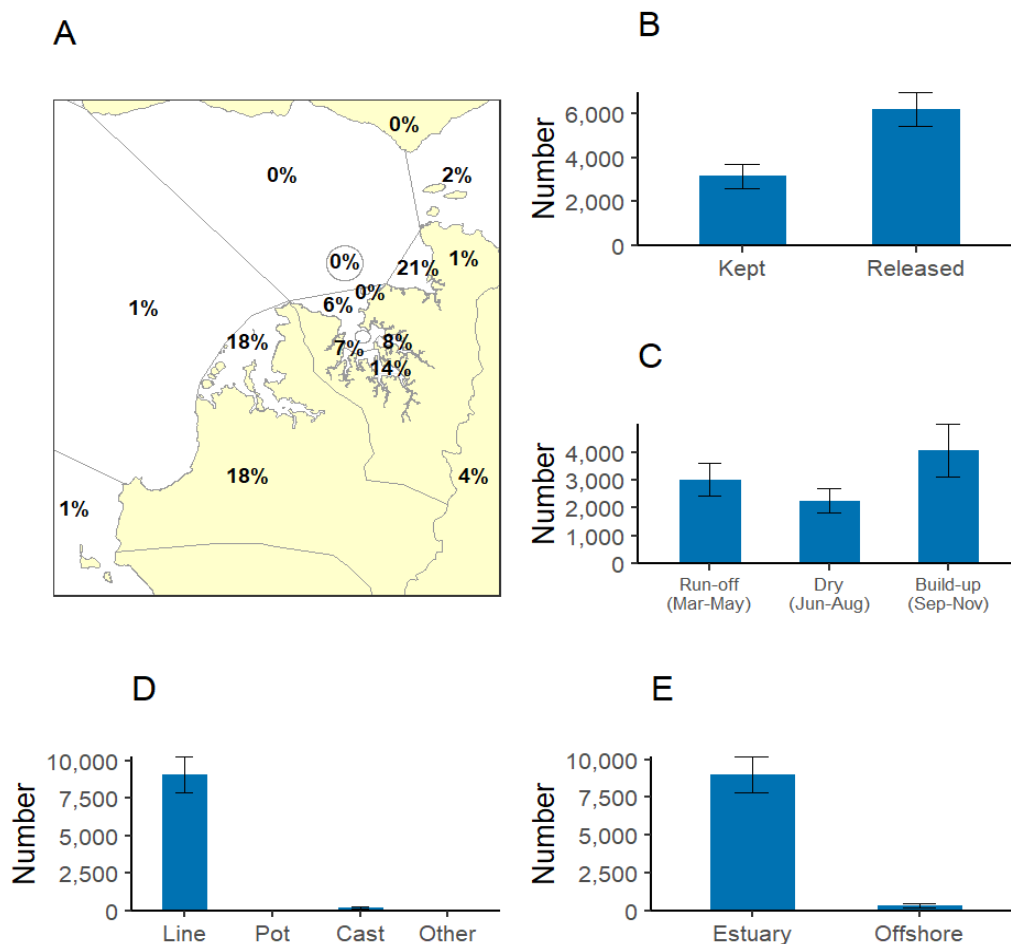


Figure 21 Summary results for Barramundi in the Greater Darwin area from March 2016 to November 2016: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

6.2 Black Jewfish (*Protonibea diacanthus*)

Black Jewfish has been assessed as recovering in the Greater Darwin area (Saunders et al. 2016a) after several management measures were implemented to promote the recovery of this species. Regular monitoring of the recreational catch of Black Jewfish is necessary to gauge the effectiveness of these recovery efforts.

Recreational catches of Black Jewfish occurred around the Darwin Harbour (26%), offshore Darwin area (19%) and offshore Dundee area (17%) (Figure 22A). More than 29% of all Black Jewfish captured were released (Figure 22B) with the highest catches reported in the run-off (50%) followed by the build-up (29%) and dry season with around 21% of the total (Figure 22C). All Black Jewfish were caught using line fishing methods (Figure 22D) and with 47% caught from estuarine waters (Figure 22E).

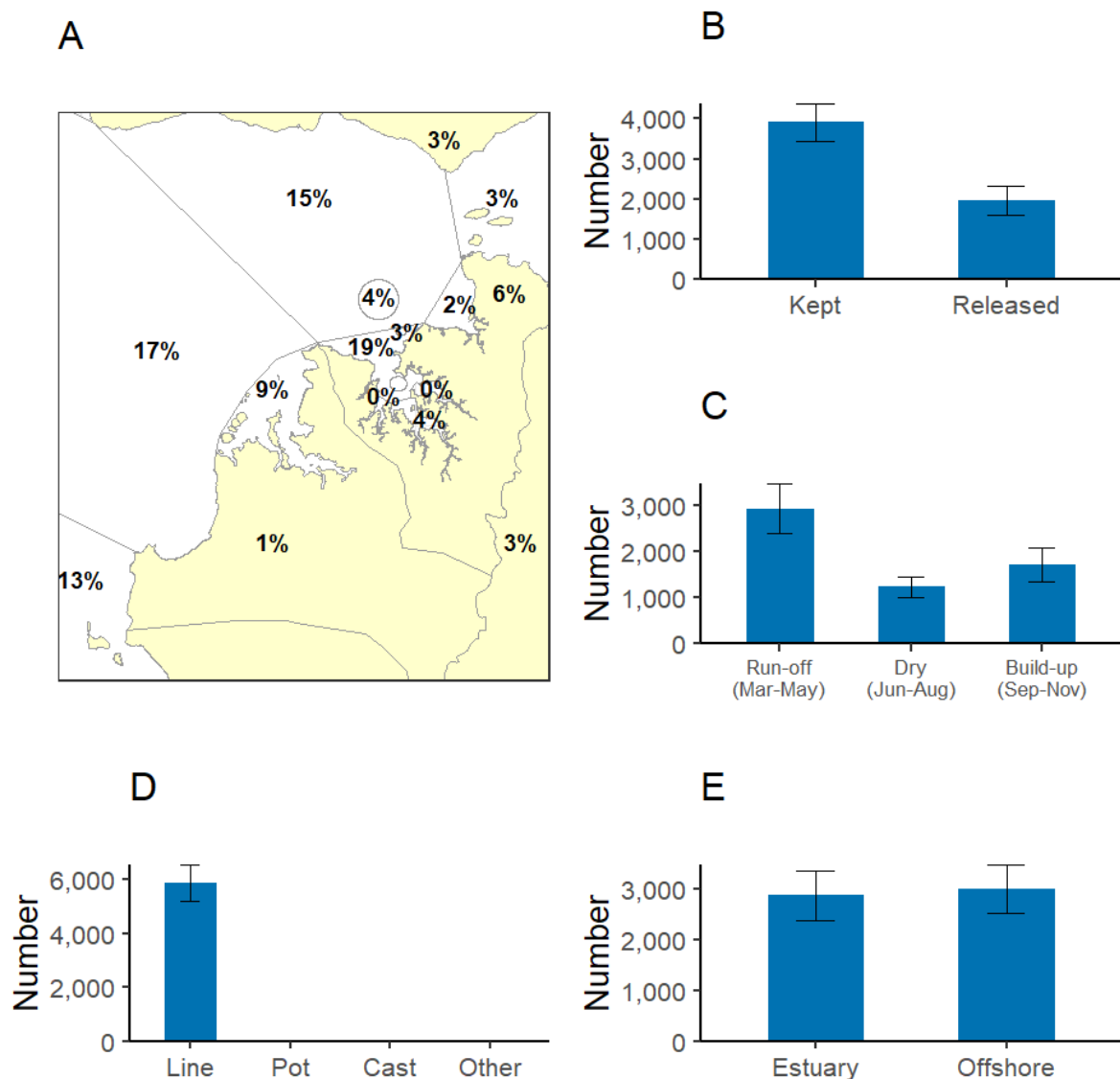


Figure 22 Summary results for Black Jewfish in the Greater Darwin area from March 2016 to November 2016: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

6.3 Coral Trout (*Plectropomus maculatus*)

Coral Trout is a highly prized table fish in the Top End and information on the recreational catch of this species can provide an indication of the status of other reef fish stocks in the Greater Darwin area.

The greatest proportion of the recreational catch of Coral Trout in the Greater Darwin area occurred in the offshore Peron Islands area (38%). The Dundee offshore area (34%) and Darwin Harbour (19%) were also significant areas for the capture of Coral Trout (Figure 23A). More than 78% of all Coral Trout captured were kept (Figure 23B). The highest catch of Coral Trout occurred in the dry season (36%) followed by the run-off (33%) and the build-up (31%) (Figure 23C). All Coral Trout were caught using line-fishing methods (Figure 23D) and they were captured primarily in offshore waters (81%) (Figure 23E).

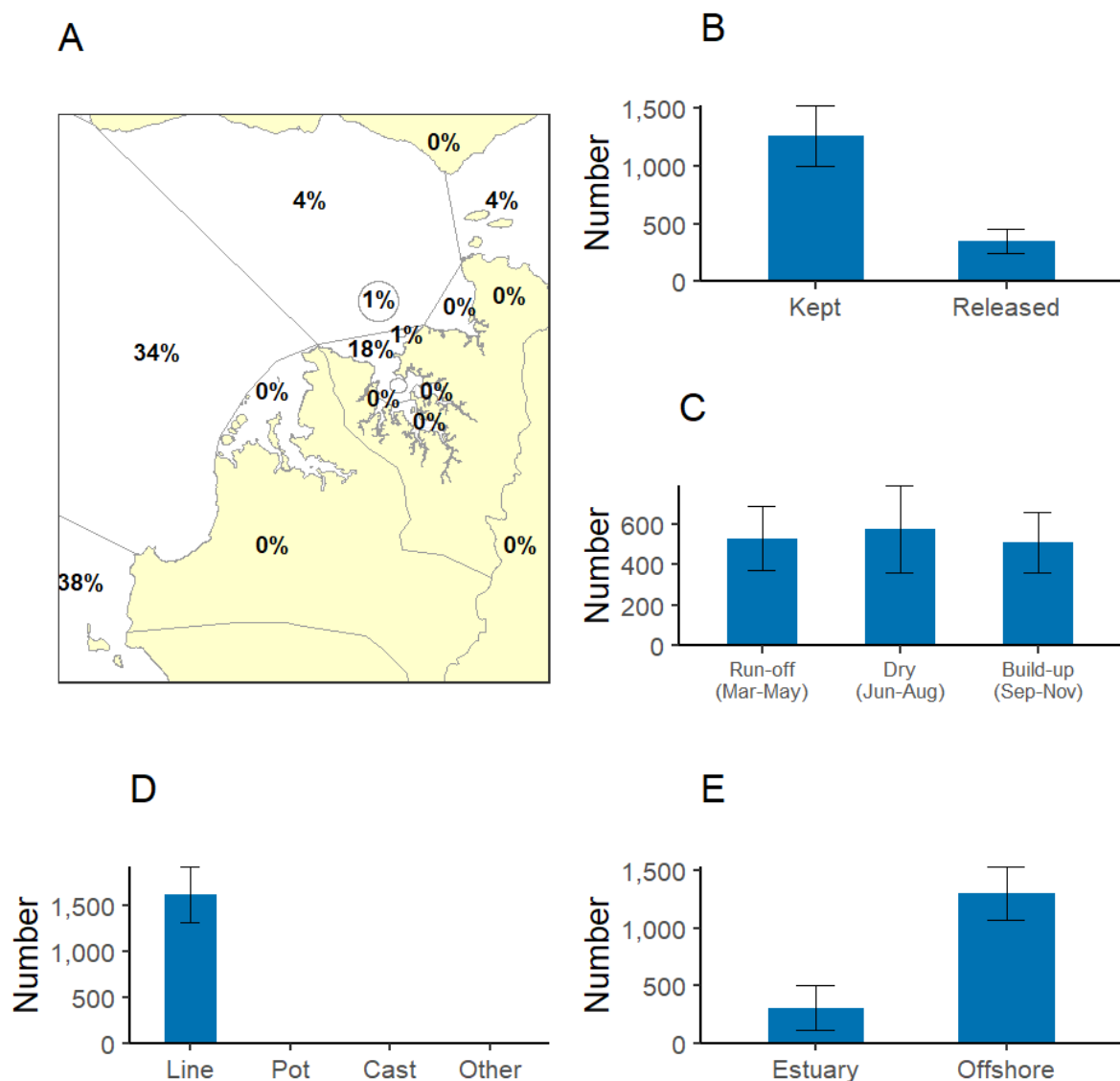


Figure 23 Summary results for Coral Trout in the Greater Darwin area from March 2016 to November 2016: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

6.4 Golden Snapper (*Lutjanus johnii*)

Golden Snapper has been assessed as overfished in the Greater Darwin area (Saunders et al. 2016b) and several management measures have been implemented to promote the recovery of this species. Regular monitoring of the recreational catch of Golden Snapper is necessary to gauge the effectiveness of recovery efforts.

The majority of the recreational catches of Golden Snapper occurred within Darwin Harbour (43%), the area offshore from Dundee (21%) and Darwin offshore (9%) (Figure 24A). More than half of all Golden Snapper captured were released (52%) (Figure 24B). Golden Snapper were captured throughout the survey period with the highest catches occurring in the run-off (51%) followed by the build-up (27%) and the dry season (22%) (Figure 24C). Almost all Golden Snappers were caught using line-fishing methods (99.3%) (Figure 24D) with catches being slightly higher in estuarine waters (58%) than in offshore waters (42%) (Figure 24E).

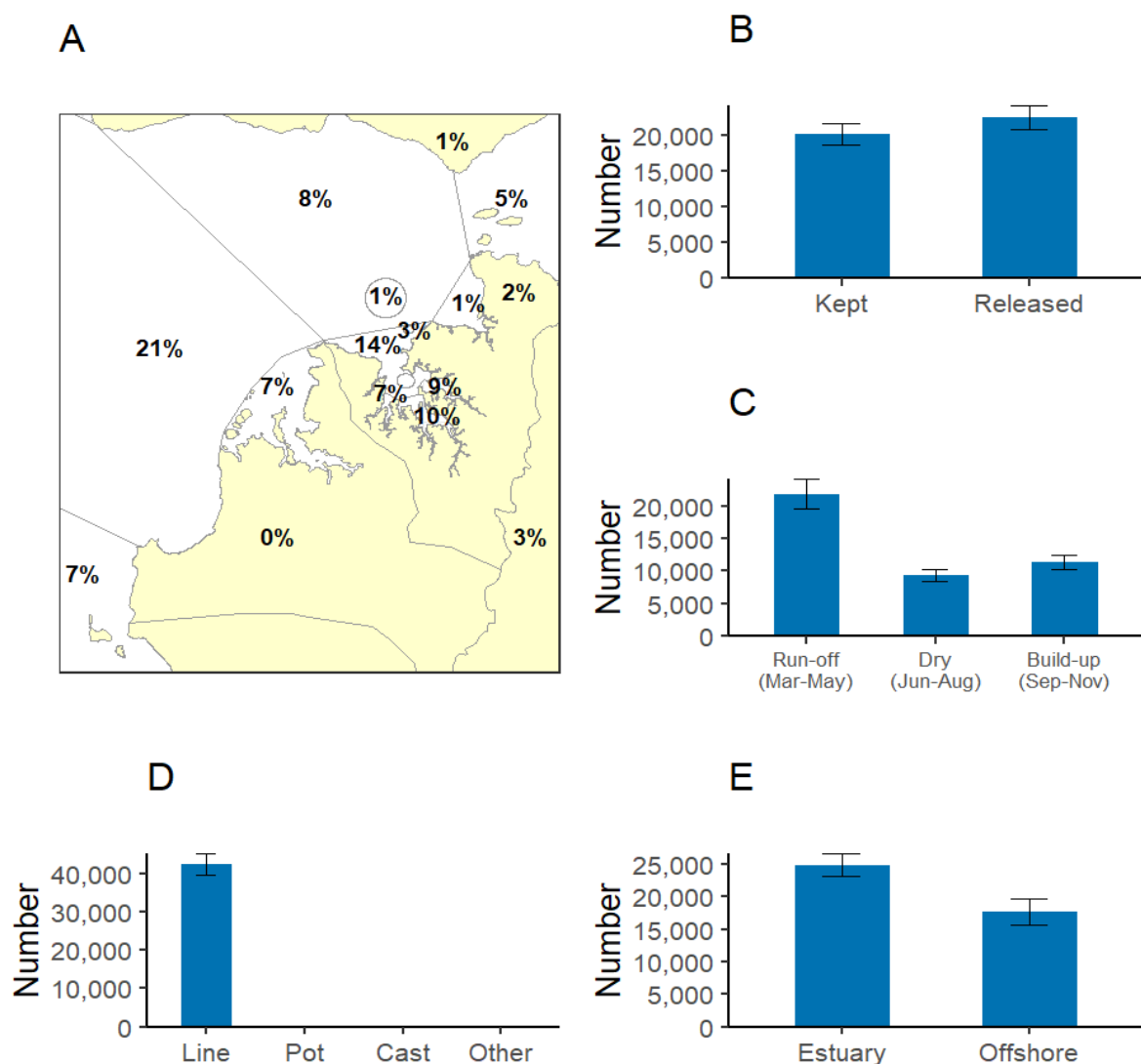


Figure 24 Summary results for Golden Snapper in the Greater Darwin area from March 2016 to November 2016: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

6.7 Emperors (Family Lethrinidae)

Emperors comprised mainly of Grass Emperor (*Lethrinus laticaudis*) are a highly prized table fish in the Top End and information on the recreational catch of this species can provide an indication of the status of other reef fish stocks in the Greater Darwin area.

The greatest proportion of the recreational catch of emperors in the Greater Darwin area occurred in the offshore Peron Islands area (40%) and the Dundee offshore area (40%). The Darwin offshore area (9%) was also a significant area for the capture of emperors (Figure 27A). More than 67% of all emperors captured were released (Figure 27B). The highest catch of emperors occurred in the build-up (38%) followed by the run-off (33%) and the dry season (29%) (Figure 27C). All emperors were caught using line-fishing methods (Figure 27D) and they were captured primarily in offshore waters (90%) (Figure 27E).

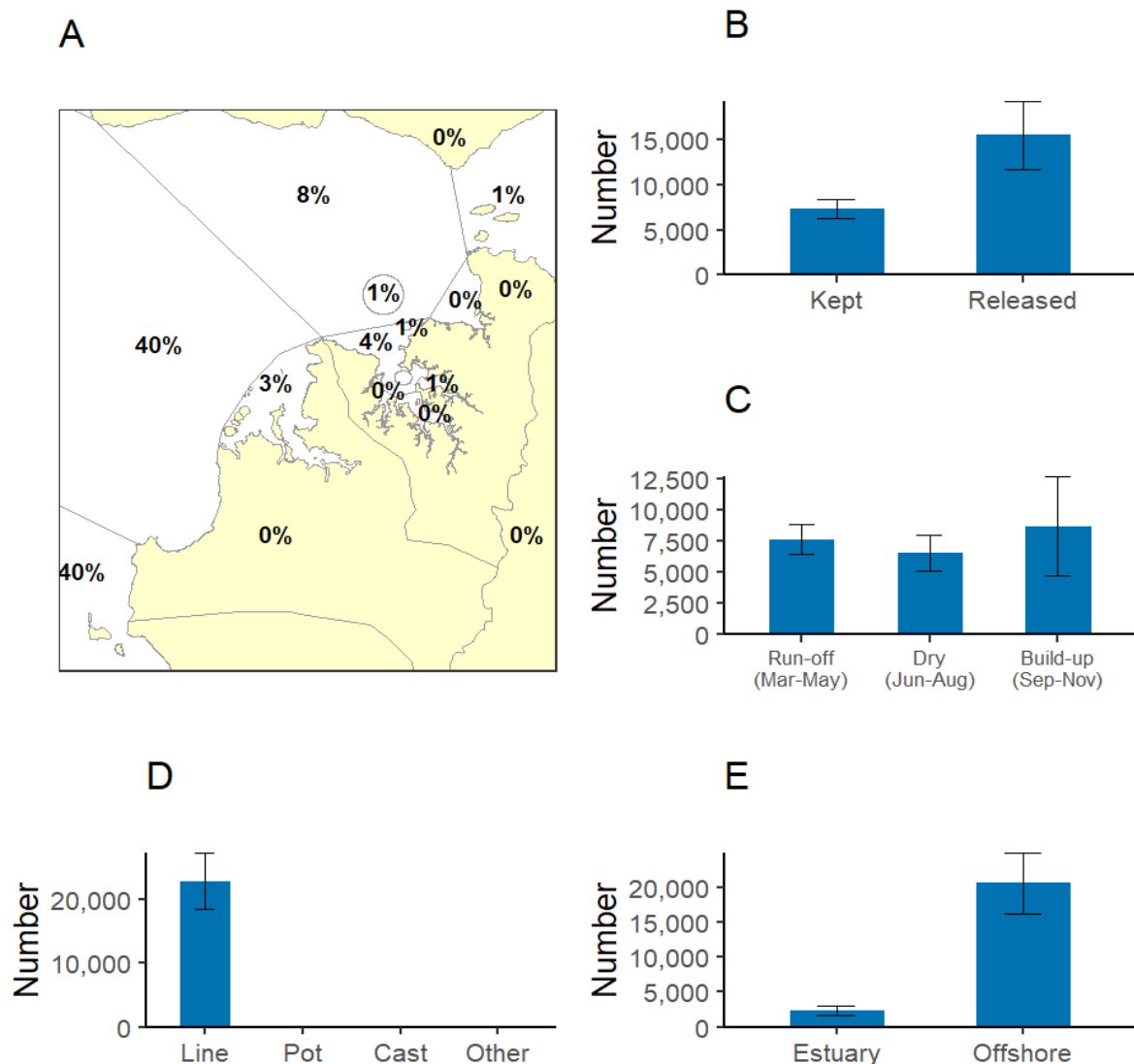


Figure 27 Summary results for emperors in the Greater Darwin area from March 2016 to November 2016: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

7 Length and sex data

7.1 Golden Snapper (*Lutjanus johnii*) harvest length data

The length of harvested Golden Snappers ranged from 15 to 80 cm. The most frequent length (mode) was 40 cm and the mean length was 40.4 cm (Figure 28).

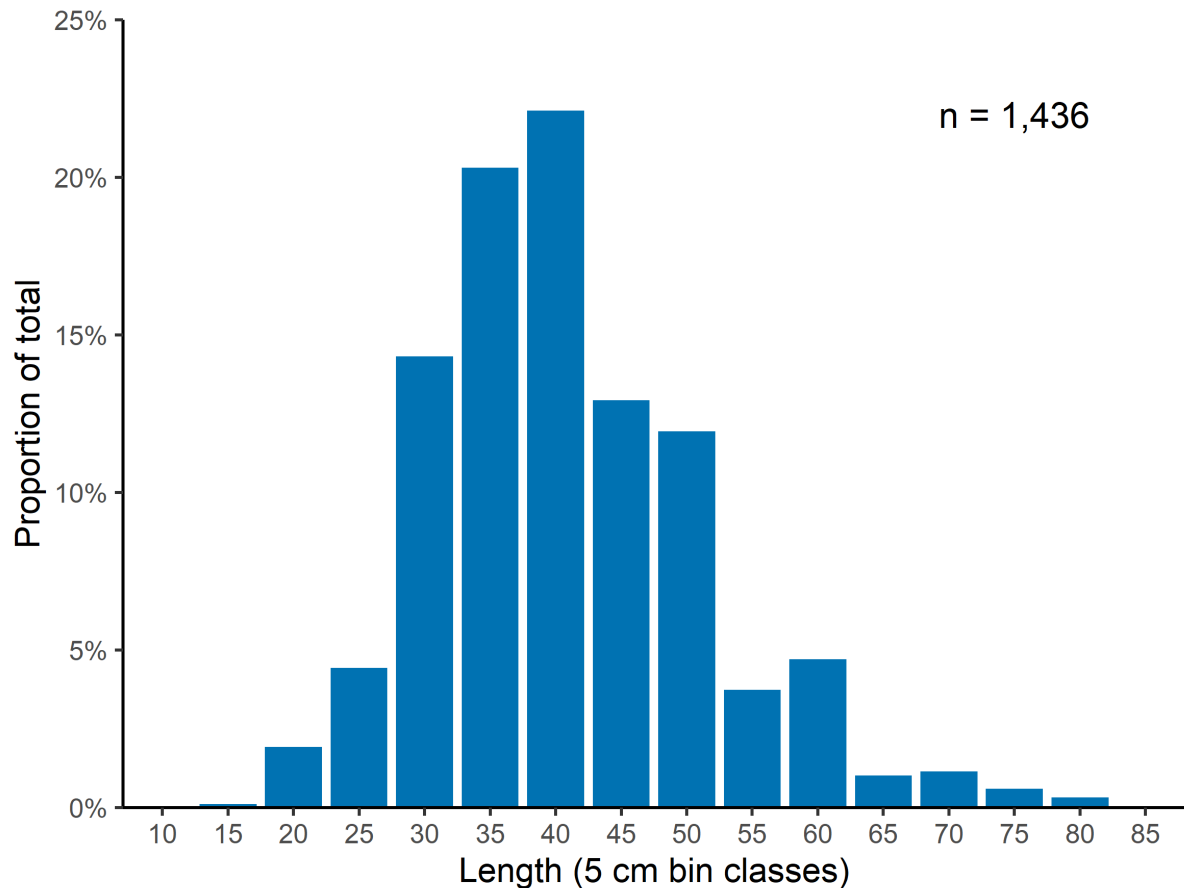


Figure 28 Length frequency distribution of harvested Golden Snappers from the Greater Darwin area taken by recreational fishers during the survey period from March 2016 to November 2016.

7.2 Black Jewfish (*Protonibea diacanthus*) harvest length data

The length of harvested Black Jewfish ranged from 30 to 135 cm. The most frequent length was 70 cm and the mean length was 84.7 cm (Figure 29). These figures increased from the 2015 survey where the mode was 60 cm and the mean was 81 cm.

Similar to previous surveys, Black Jewfish in the 90 cm size class were under-represented in the 2016 harvest sample.

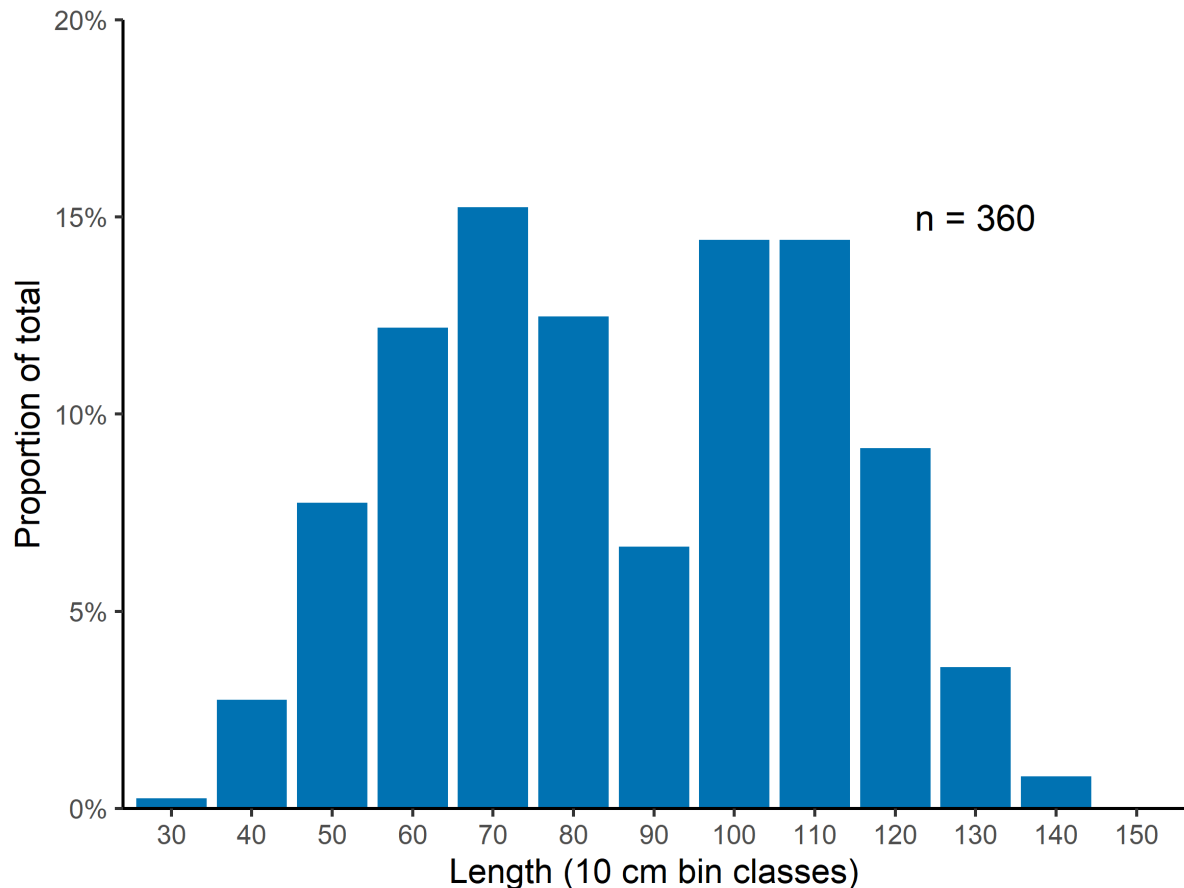


Figure 29 Length frequency distribution of harvested Black Jewfish from the Greater Darwin area taken by recreational fishers during the survey period from March 2016 to November 2016.

7.3 Barramundi (*Lates calcarifer*) harvest length data

The length of harvested Barramundi ranged from 55 to 96 cm. The most frequent length was 60 cm and the mean length was 63.4 cm (Figure 30).

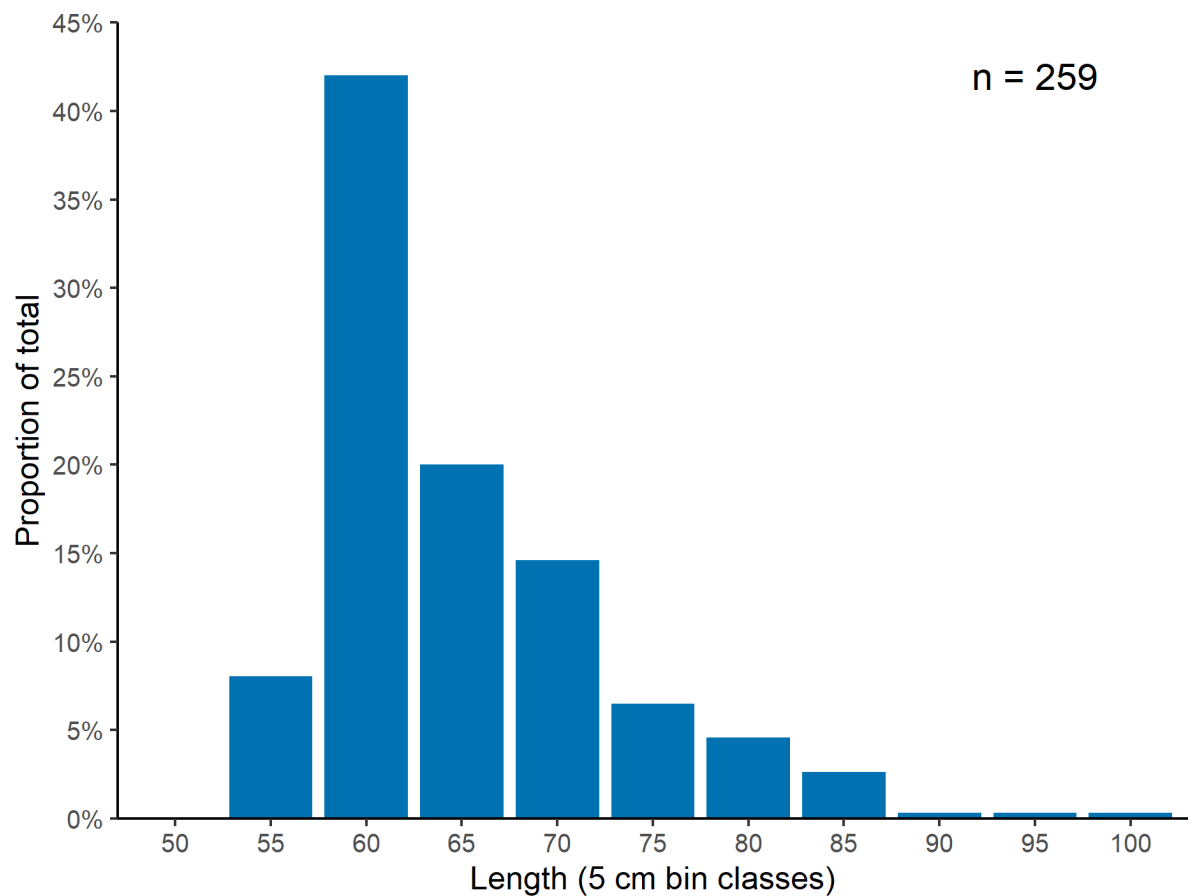


Figure 30 Length frequency distribution of harvested Barramundi from the Greater Darwin area taken by recreational fishers during the survey period from March 2016 to November 2016.

7.4 Mud Crab sex data

In those cases where fishers were confident in identifying the sex of Mud Crabs, interviewers recorded how many Mud Crabs of each sex were kept and/or released. Within this subset of data, the number of male crabs caught was roughly double the number of female crabs caught similarly to previous surveys. The overall catch was highest in July and decreased towards the end of the year. (Figure 31). However, care must be exercised when interpreting these results due to sampling artefacts (such as variability in the ability of fishers to identify the gender of Mud Crabs).

Of the male crabs caught, 85% were kept, whereas only 47% of female crabs were kept. The proportion of males kept each month was always high (at least 75%), but the proportion of females kept in a given month, rarely exceeded 60%, dropping as low as 37% in April (Figure 32).

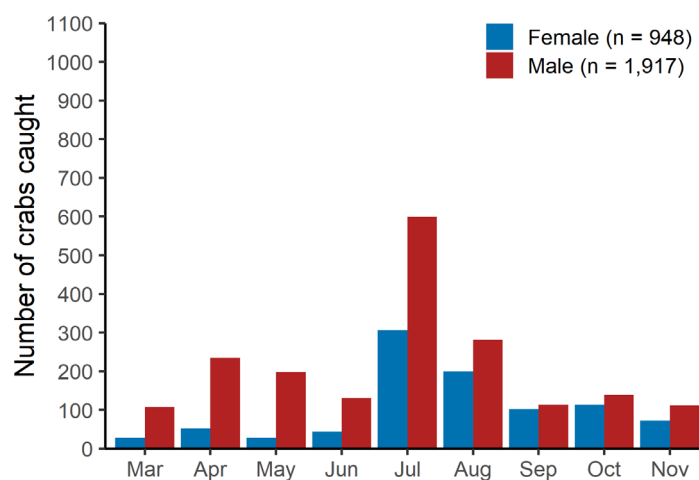


Figure 31 Monthly catch of male and female Mud Crabs by recreational fishers in the Greater Darwin area during the survey period from March 2016 to November 2016.

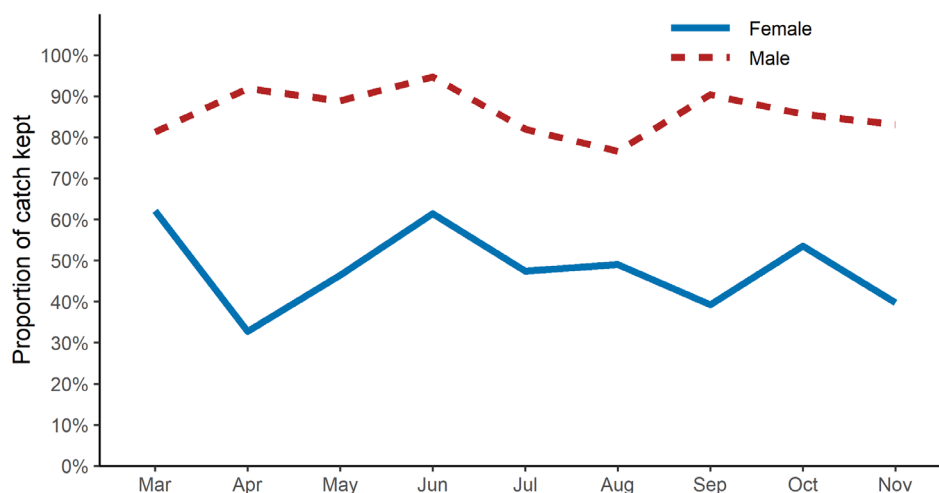


Figure 32 The proportion of Mud Crab catch (n=2865) kept by month for each sex by recreational fishers in the Greater Darwin area during the survey period from March 2016 to November 2016

8 Vessel characteristics and technology

8.1 Vessel size

Almost 80% of the recreational vessels observed were 4.5 m long or larger (Figure 33).

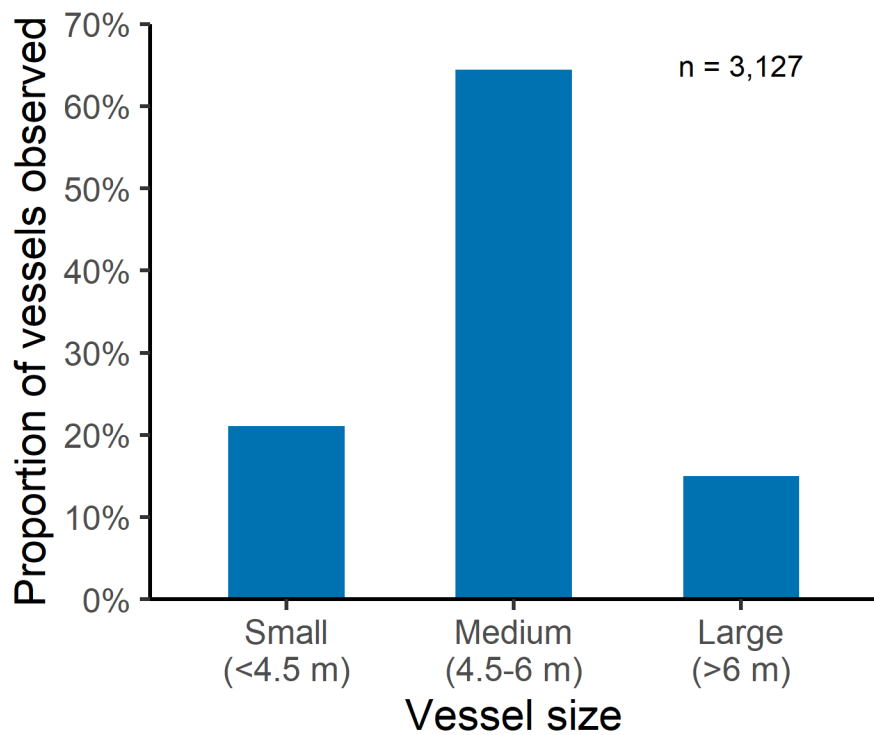


Figure 33 The proportion of recreational fishing vessels by size class in the Greater Darwin area during the survey period from March 2016 to November 2016.

8.2 Vessel technology

More than 96% of the recreational fishing vessels observed were fitted with sounders (Figure 34). Most vessels (64%) had a sounder screen that was 10 to 20 cm wide. Only 12% of vessels had a sounder with a screen exceeding 20 cm in width.

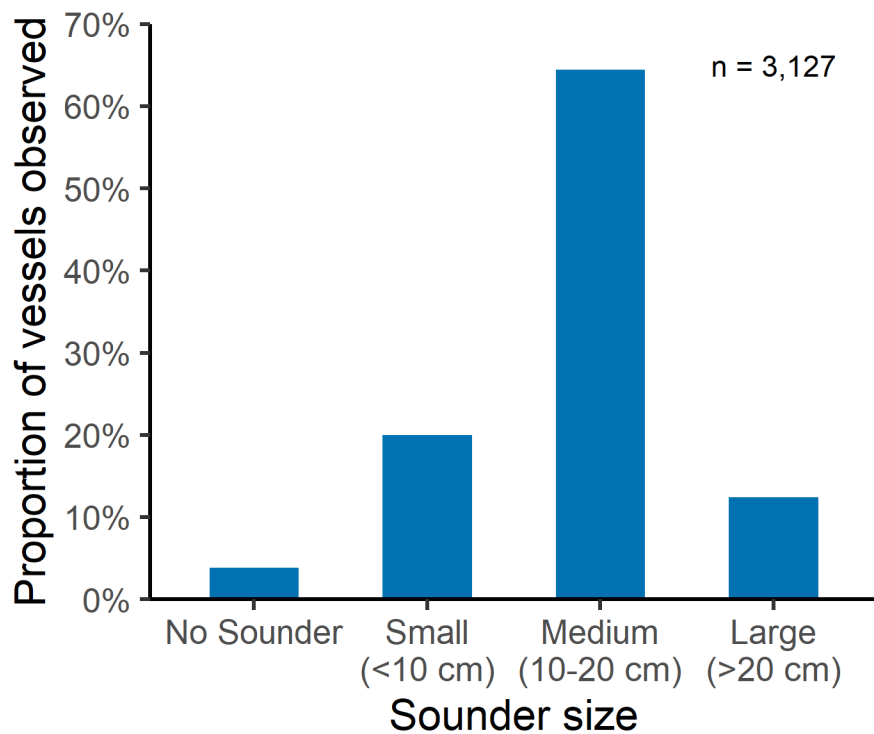


Figure 34 The proportion of recreational fishing vessels by sounder dimensions from a subset of recreational fishers who fished in the Greater Darwin area during the survey period from March 2016 to November 2016.

More than 90% of recreational fishing vessels surveyed were fitted with a GPS (Figure 35). Most vessels (62%) had a GPS screen size of 10 to 20 cm and were often an integrated component of the sounder unit.

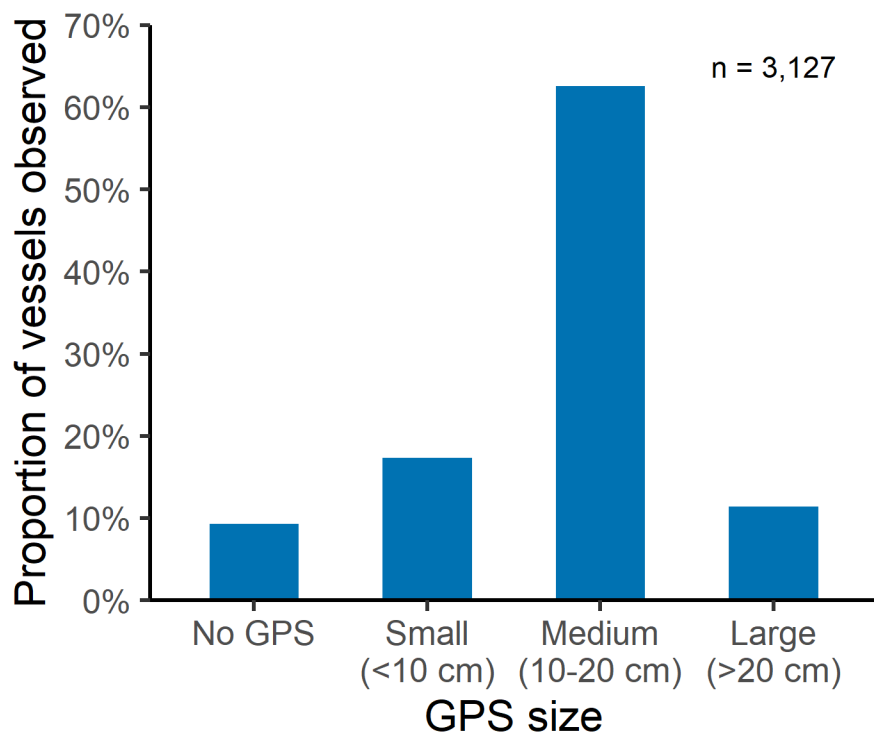


Figure 35 The proportion of vessels by GPS dimensions from a subset of recreational fishers who fished in the Greater Darwin area during the survey period from March 2016 to November 2016.

The use of sounders and GPS varied with boat size; however, the general trend indicated advanced technology was more frequently associated with larger vessels. Nonetheless, 96% of all vessels surveyed had a sounder and 90% of all vessels had a GPS. It is also worth noting that chart-plotting applications (apps) are now available for smart phones and tablets. Therefore, the absence of a GPS/plotter fitted to a boat does not necessarily mean a vessel lacked this technology.

9 Summary and future research

This report summarises the key results from the 'Survey of Recreational Fishing in the Greater Darwin area 2016' and includes detailed information relating to recreational fishing activities in the coastal area surrounding Darwin. Monitoring of the recreational fishery is particularly important in areas where commercial effort is reduced or excluded or where the recreational sector takes a significant proportion of the overall catch. This report provides expanded estimates of the recreational fishing catch and effort, which subsequently inform the assessments for determining the sustainability of harvesting fish stocks.

9.1 Comparisons with previous surveys

This survey used a modified methodology based on the "*Survey of Recreational Fishing in the Greater Darwin Area 2015*" and so comparisons of results should be made with caution. Additionally, the reader should be mindful of the standard errors around each expanded estimate; large standard errors represent a high degree of uncertainty in the survey estimates. Apparent differences between years may not be statistically significant if the standard errors for these estimates overlap.

A comparison of effort between the 2015 and 2016 survey years revealed that effort (fisher hours) across the Greater Darwin area declined from 513 055 to 418 401 hours (a decrease of about 18%). However, the effort in the Darwin Harbour/Surrounds Zone increased from 63% in 2015 to 68% of the total in 2016. In contrast, the total effort in the Bynoe Harbour/Dundee Zone declined from 37% in 2015 to 32% in 2016. Seasonal effort in 2016 was greatest for the run-off period. This is in contrast to 2015 in which the greatest effort occurred during the build-up period.

Despite a reduction in overall fishing effort there was an increase in total catch from 496 952 organisms in 2015 to 509 179 organisms in 2016, an increase of over 12,000 individuals (or about 3%). A 40% increase in mullet and small baitfish numbers in 2016 accounted for a large part of the difference in catch. Mud Crab total catch was relatively unchanged.

Of particular note, there was a significant decrease in the total catch of Barramundi from 19,200 in 2015 to 9,300 in 2016 (or about 52%). This could be due in part to having consecutive poor wet seasons with rainfall over the 2014/15 wet season being from 75 – 300 mm below the long-term average and the 2015/16 wet season 300 – 500 mm below the long-term average. Interestingly the 2015/16 wet season is the worst on record since 1991/92 (BoM 2018).

Other notable results include:

- Dinah Beach surpassed Dundee Beach as the ramp contributing the greatest number of fisher hours (effort).
- Visiting angler effort was similar for the total dry season effort in 2016 at 18% as compared to 16% in 2015.

9.2 Future monitoring

The Greater Darwin region supports about 80% of the overall fishing activity across the Northern Territory (West et al. 2012) and is therefore highly significant from a management perspective. With concerns remaining in regard to reef fish sustainability in this heavily fished region, it is prudent to continue these annual surveys. For this reason, it is expected that the Survey of Recreational Fishing in the Greater Darwin Area will be repeated in 2017. Information obtained from the three previous surveys may be used to improve the survey design going forward, however the methodology employed will essentially be the same.

These successive surveys, using similar methodologies, will provide a long-term assessment of recreational fishing activity, improve our knowledge of fisher behaviour and provide managers with contemporary information to guide the development and refinement of fishery management plans.

10 Acknowledgments

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The support and assistance of many NT Fisheries staff who contributed to the overall success of the project – in particular Ian Curnow, Bryan McDonald, Thor Saunders, Evan Needham, Steven Matthews, Graham Schultz, Blake Taylor, Mark Grubert, Will Bowman and Hock Seng-Lee.

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Lastly, and most importantly, we would like to thank the many recreational anglers who willingly participated in the survey and made a valuable contribution to the future management of the resources. On this note, it is worth mentioning that the survey staff located at boat ramps in the Greater Darwin area recorded exceptionally high response rates whilst conducting these surveys, indicating that the majority of recreational anglers support this data collection and are serious about assisting in the sustainable management of our fish stocks.

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12 Appendices

Appendix 1: Glossary of terms

Barotrauma	Physical damage to body tissue caused by a difference in pressure from a gas space inside the fish's body. The damage usually occurs when a reef fish is brought up from water deeper than 10 m.
Build-up	The season encompassing the months of September, October and November.
Catch	The total number of organisms caught, whether kept or released.
Cephalopods	A diverse group of molluscs that includes squid, cuttlefish and nautilus.
Crustaceans	A group of invertebrates that includes crabs, lobster (crayfish) and prawns.
Drive-offs	People who drive off before being interviewed.
Dry season	The season encompassing the months of June, July and August.
Estuary	A body of brackish water open to the sea with one or more rivers flowing into it. For the purposes of the survey, Darwin Harbour, Bynoe Harbour and Shoal Bay were all considered estuaries.
Fish	Includes both teleost (bony fishes) and elasmobranchs (sharks/rays).
Fisher hours	Hours spent recreational fishing by fishers.
Gastropods	A group of molluscs that include snails (e.g. abalone, longbums, periwinkles, conches and whelks).
Harvest	The total number of organisms that were caught and retained; the same as kept catch.
Kept catch	The total number of organisms that were caught and retained; the same as harvest.
Offshore	All areas seaward of the coastline and estuaries.

Primary sampling unit	A calendar day that fell within the survey period.
Recreational fisher	Any person, aged five years or more, that went recreational fishing in the Greater Darwin area during the survey period.
Recreational fishing	The capture or attempted capture of aquatic organisms for non-commercial purposes.
Refusals	People who decline to be interviewed.
Relative standard error	The standard error of an estimate divided by the estimate and expressed as a percentage.
Released catch	The total number of organisms that were caught and then returned to the water.
Residents	People who normally reside in the Northern Territory.
Run-off	The season encompassing the months of March, April and May.
Shift	A five and a half-hour period of the day (either 8:30-14:00 hr or 14:00-19:30 hr) in which interviewers collected data from recreational fishers.
Visitors	People who normally reside outside the NT.

Appendix 2: The total number of primary sampling units in each stratum

Season	Day Type	Total
Run-Off	WD	62
(March, April, May)	WE	30
Dry	WD	63
(June, July, August)	WE	29
Build-Up	WD	65
(September, October, November)	WE	26
WD - weekday, WE - weekend		

Appendix 3: Summary of number of sampling days at boat ramps

Boat Ramp		Season / Day Type								Total
		Wet #		Run-Off		Dry		Build-Up		
		WD	WE	WD	WE	WD	WE	WD	WE	
Darwin Harbour										
Primary										
1	Buffalo Creek	2	1	7	4	8	5	5	9	41
2	Dinah Beach	2	2	8	8	8	6	8	9	51
5	East Arm	2	1	6	6	5	6	6	7	39
6	Nightcliff	-	1	3	3	3	3	4	1	18
10	Middle Arm	1	1	3	5	1	6	4	4	25
12	Leaders Creek	1	-	3	4	7	5	6	3	29
22	Saltwater Arm	-	2	6	6	4	5	3	3	29
Secondary										
3	Ski Club	1	1	-	-	1	1	-	1	5
4	Channel Island	-	1	1	1	1	1	2	1	8
7	Palmerston	2	2	2	1	2	1	1	1	12
8	Trailer Boat Club	-	-	1	1	-	-	-	-	2
9	Mandorah	-	-	-	1	-	-	-	-	1
11	Southport	1	-	-	1	-	1	1	1	5
Sub-Total		12	12	40	41	40	40	40	40	265
Bynoe & Dundee										
Primary										
15	Six Pack Creek	2	1	5	5	6	4	5	3	31
16	Keswick Point	-	1	1	2	-	3	2	3	12
21	Dundee Beach	2	2	6	5	6	5	5	6	37
Secondary										
13	Crab Claw	-	1	-	1	-	-	-	-	2
14	Milne Inlet	1	1	1	-	2	2	2	2	11
23	Dundee Road	1	-	1	-	-	-	-	-	2
Sub-Total		6	6	14	13	14	14	14	14	95
Total		18	18	54	54	54	54	54	54	360

subsequently removed from expansion

WD - weekday, WE - weekend

Appendix 4: List of species caught by recreational anglers in the Greater Darwin area during the survey period of March 2016 to November 2016

Reporting group	Common name	Scientific name
Barramundi	Barramundi	<i>Lates calcarifer</i>
Bream, pikey	Pikey bream	<i>Acanthopagrus berda</i>
Catfish	Eeltail catfish	Plotosidae
	Forktail catfish	Ariidae
Cod/groupers	Cod/groupers	Serranidae - undifferentiated
Coral trout	Coral trout	<i>Plectropomus</i> spp
Coronation trout	Coronation trout	<i>Variola louti</i>
Emperor, red	Red emperor	<i>Lutjanus sebae</i>
Emperor, other	Emperor, other	Lethrinidae
Flathead	Flathead	Platycephalidae - undifferentiated
Javelin fish	Barred javelin	<i>Pomadasys kaakan</i>
Jewfish, black	Black jewfish	<i>Protonibea diacanthus</i>
Jewfish, other	Croaker	Sciaenidae
Mackerel, grey	Grey mackerel	<i>Scomberomorus semifasciatus</i>
Mackerel, Spanish	Spanish mackerel	<i>Scomberomorus commerson</i>
Mackerel, spotted	Spotted mackerel	<i>Scomberomorus munroi</i>
Moonfish/Batfish	Batfish	Ephippidae
Mullet	Mullet	Mugilidae - undifferentiated
Queenfish	Queenfish	<i>Scomberoides</i> spp
Sharks & rays	Rays/skates	Dasyatidae
	Sawfish	Pristidae
	Shark	Various families
Small baitfish	Baitfish, unspec.	Several families
	Herring, other	Clupeidae
Snapper, golden	Golden snapper	<i>Lutjanus johnii</i>
Snapper, gold band	Gold band snapper	<i>Pristipomoides multidens</i>
Snapper, mangrove jack	Mangrove jack	<i>Lutjanus argentimaculatus</i>
Snapper, Moses'	Moses' snapper	<i>Lutjanus russellii</i>
Snapper, saddletail/ crimson/indonesian	Saddletail, Crimson & Indonesian snapper	<i>Lutjanus malabaricus, erythropterus & bitaeniatus</i>
Snapper, stripey	Stripey snapper	<i>Lutjanus carpontatus</i>
Snapper, other	Chinaman fish	<i>Symphorus nematophorus</i>
	Maori sea perch	<i>Lutjanus rivulatus</i>
	Red bass	<i>Lutjanus bohar</i>
	Snapper, other	Various families
Tarpon/ox-eye herring	Oxeye herring	<i>Megalops cyprinoides</i>
Threadfin, blue	Blue threadfin	<i>Eleutheronema tetradactylum</i>
Threadfin, king	King threadfin	<i>Polydactylus macrochir</i>
Trevally, giant	Giant trevally	<i>Caranx ignobilis</i>
Trevally, golden	Golden trevally	<i>Gnathanodon speciosus</i>
Trevally, other	Trevally, other	Carangidae - undifferentiated

Tuna, longtail	Longtail tuna	<i>Thunnus tonggol</i>
Tuna, mackerel	Mackerel tuna	<i>Euthynnus affinis</i>
Whiting	Whiting	Sillaginidae - undifferentiated
Wrasse, tuskfish	Parrotfish/tuskfish	Scaridae - undifferentiated
Scalefish, other	Archer fish	Toxotidae - undifferentiated
	Barracuda	Sphyraenidea
	Bony bream (freshwater)	<i>Nematalosa erebi</i>
	Bream, other	Sparidae
	Cobia	<i>Rachycentron canadum</i>
	Eel	Various families
	Fish, other	Various families
	Flounder/sole	Various families
	Fusilier	Caesionidae
	Garfish	Hemiramphidae - undifferentiated
	Goatfish	Mullidae
	Hairtail	Trichiuridae
	Jawfish/stargazer	Opistognathidae & Uranoscopidae
	Leatherjacket	Monacanthidae
	Lizardfish/grinner	Various families
	Long tom	Belonidae
	Marlin - black	<i>Makaira indica</i>
	Monocle bream	Nemipteridae
	Rabbitfish/spinefoot	Siganidae
	Remora	Echeneidae - undifferentiated
	Sailfish	<i>Istiophorus platypterus</i>
	Sand bass	<i>Psammoperca waigiensis</i>
	Saratoga (freshwater)	<i>Scleropages leichardti</i>
	Scat/butterfish	Scatophgidae - undifferentiated
	Sooty grunter (freshwater)	<i>Hephaestus fuliginosus</i>
	Stonefish	Scorpaenidae
	Sweetlip	Haemulidae - undifferentiated
	Threadfin bream	<i>Nemipterus sp.</i>
	Toads/pufferfish	Various families
	Tripletail	<i>Lobotes surinamensis</i>
	Wolf herring	<i>Chirocentrus dorab</i>
	Yellowtail scad	<i>Atule mate</i>
Mud crab	Mud crab	<i>Scylla spp</i>
Crustaceans, other	Blue swimmer crab	<i>Portunus pelagicus</i>
	Crab, other	Brachyura - undifferentiated
	Prawn, marine	Penaeoidea & Caridea - undifferentiated
Cephalopods	Squid	Loliginidae - undifferentiated
	Octopus	Octipodidae
Gastropods	Periwinkle	Littorinidae
Other taxa	Non-fish, other	Various families

Appendix 5: Summary of Fisher origin and number of fishers during the survey period of March 2016 to November 2016

Fisher Origin	Number of Fishers	% of Total
Northern Territory	6376	85.25
Victoria	292	3.90
New South Wales	240	3.21
Queensland	219	2.93
Western Australia	132	1.76
South Australia	127	1.70
International	60	0.80
Tasmania	19	0.25
Australian Capital Territory	14	0.19
Total Fishers	7479	
 Total boats interviewed	 2894	
 Average fishers per boat	 2.6	

Appendix 6: Recreational effort (fisher hours) by analysis and ramp for the survey period of March 2016 to November 2016

SE is Standard Error; values in italics have an RSE between 25–50% and values in bold have an RSE >50%.

Analysis	Ramp	Effort	
		Fisher hours	SE
Primary ramp	1. Buffalo Creek	35090	5050
	2. Dinah Beach	86504	5652
	5. East Arm	51796	3731
	6. Nightcliff	19632	4788
	10. Middle Arm	19113	3335
	12. Leaders Creek	12042	1765
	15. Six Pack	11700	2573
	16. Keswick Point	5010	778
	21. Dundee Beach	85638	11034
	22. Saltwater Arm	12420	2543
	Total	338945	
Secondary ramp	3. Ski Club	10423	565
	4. Channel Island	7186	584
	7. Palmerston	33971	4746
	8. Trailer Boat Club	1961	243
	11. Southport	944	165
	13. Crab Claw	3253	312
	14. Milne Inlet	21718	6700
	Total	79456	
Grand Total		418401	

Appendix 7: Recreational effort (fisher hours) and total catch of key species by fishing region in the Greater Darwin Area during the survey period of March 2016 to November 2016

SE is Standard Error; values in *italics* have an RSE between 25–50% and values in **bold** have an RSE >50%.

Fishing Region ->	6		7		8		9		10		10a		10b		10c	
Species/group	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE
Effort																
Effort hours	17611	4900	41854	7212	1082	517	7662	1546	73443	5259	19560	1474	34591	3572	44179	5077
Catch																
Barramundi	1657	534	1651	812	29	21	51	22	582	134	626	123	1325	215	755	234
Bream, Pikey	0	0	1181	269	38	38	94	44	1922	516	519	208	1898	379	1816	261
Catfish	1202	447	1788	467	400	219	2038	589	1541	224	701	200	2545	278	1911	921
Cod/Groupers	458	344	1804	380	65	37	197	60	4450	649	1140	209	2628	404	3021	317
Coral Trout	0	0	0	0	0	0	0	0	293	197	0	0	0	0	0	0
Emperor, other	0	0	675	436	0	0	0	0	989	500	9	9	64	39	301	152
Emperor, Red	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Flathead	0	0	111	61	0	0	0	0	215	48	143	41	69	29	279	165
Javelin fish	16	16	2924	828	0	0	262	133	3499	1111	521	143	1496	475	1001	241
Jewfish, Black	54	41	503	184	147	118	334	133	1118	388	0	0	240	106	24	18
Jewfish, other	0	0	0	0	13	13	385	226	5	5	0	0	0	0	0	0
Mackerel, Grey	0	0	0	0	0	0	0	0	317	82	0	0	24	12	5	5
Mackerel, Spanish	0	0	6	6	0	0	0	0	362	156	0	0	0	0	52	28
Mackerel, Spotted	0	0	7	7	0	0	0	0	903	118	0	0	0	0	0	0
Moonfish/Batfish	0	0	465	219	0	0	0	0	2909	836	321	60	569	284	515	143
Mullet	866	437	7755	6705	0	0	242	165	6378	1461	2798	1042	4863	1351	5537	1712
Queenfish	74	32	413	226	0	0	38	29	2958	590	1601	433	227	46	508	122
Sharks/Rays	116	53	2780	414	468	468	381	140	3757	713	581	86	1419	315	1671	497
Small baitfish	99	99	17837	12868	0	0	0	0	2414	638	596	244	2214	644	9294	5228
Snapper, Gold-band	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snapper, Golden	148	133	3054	457	242	163	1001	333	6080	864	3178	833	4150	541	3686	706
Snapper, Mangrove jack	0	0	292	130	9	9	36	21	516	127	242	89	112	28	167	50
Snapper, Maori snapper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snapper, Moses'	0	0	77	44	0	0	0	0	442	392	41	33	105	100	5	5
Snapper, other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snapper, Saddletail/Crimson/Indo	0	0	1023	394	407	292	4	4	2757	822	29	17	212	104	358	146
Snapper, Stripey	0	0	2402	766	99	87	7	7	7901	1190	130	124	1090	167	450	103
Tarpon/Ox-eye herring	0	0	66	49	0	0	0	0	115	85	5	5	6	6	17	11
Threadfin, Blue	802	400	381	134	0	0	665	301	904	482	217	35	325	183	88	41

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Threadfin, King	139	56	397	238	0	0	36	25	101	19	29	16	118	68	13	9
Trevally, Giant	0	0	445	154	0	0	10	10	488	153	26	19	67	30	43	39
Trevally, Golden	0	0	0	0	0	0	0	0	509	162	50	36	335	138	432	234
Trevally, other	25	25	1990	1353	0	0	0	0	2463	645	473	97	138	58	4940	247
Tuna, Longtail	0	0	8	8	0	0	0	0	430	71	0	0	0	0	13	13
Tuna, Mackerel	0	0	0	0	0	0	0	0	36	22	0	0	0	0	0	0
Whiting	0	0	0	0	0	0	0	0	101	74	12	12	0	0	7	7
Wrasse, Tuskfish	0	0	147	56	0	0	45	29	2665	532	235	8	102	34	363	127
Scalefish, other	48	30	2540	814	0	0	352	215	5566	1993	857	248	1953	371	2965	792
Mud crab	361	170	5083	2175	0	0	1661	473	4954	2034	3107	435	5903	1442	8954	2020
Crustaceans, other	33	33	1343	593	0	0	43	43	2104	517	876	123	1388	451	3121	1010
Cephalopods	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0
Gastropods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other taxa	0	0	0	0	0	0	0	0	32	23	0	0	0	0	47	47

Fishing Region ->	11		12		13		42		43		44		45		60	
Species/group	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE
Effort																
Effort hours	29622	4796	14190	2282	10188	2362	19854	4173	55494	9076	31486	5187	11537	1915	6048	1025
Catch																
Barramundi	1920	518	0	0	408	225	50	50	47	34	0	0	224	126	0	0
Bream, Pikey	1462	491	37	37	282	89	0	0	55	27	515	37	90	84	176	176
Catfish	969	256	4	4	1801	402	272	109	703	180	879	235	1867	1115	0	0
Cod/Groupers	2017	540	1312	505	701	242	2563	694	6562	1092	1836	387	438	103	264	102
Coral Trout	0	0	14	14	0	0	611	173	544	142	67	28	61	53	22	12
Emperor, other	4	4	247	132	6	6	9213	2051	9124	3781	1889	720	154	89	201	25
Emperor, Red	0	0	0	0	0	0	614	210	660	374	0	0	0	0	0	0
Flathead	100	47	23	16	13	13	0	0	32	19	10	7	0	0	13	9
Javelin fish	402	232	236	172	261	95	94	56	1415	366	1659	408	177	82	66	37
Jewfish, Black	100	61	171	73	179	86	760	326	980	272	867	158	152	89	243	117
Jewfish, other	33	26	0	0	30	30	0	0	75	75	0	0	0	0	0	0
Mackerel, Grey	0	0	43	38	0	0	102	59	622	262	351	174	159	73	20	12
Mackerel, Spanish	47	29	398	174	0	0	963	316	1841	534	866	323	40	23	70	55
Mackerel, Spotted	47	47	682	682	0	0	151	81	276	165	547	262	0	0	48	25
Moonfish/Batfish	279	186	3608	812	6	6	757	331	2503	666	3473	1588	171	104	1541	571
Mullet	16362	7401	0	0	710	460	0	0	132	132	0	0	200	200	0	0
Queenfish	167	71	149	94	243	180	58	25	3806	1098	2310	1035	800	318	0	0
Sharks/Rays	1760	781	1141	531	69	28	4010	978	7639	1138	4682	940	1367	579	1555	320
Small baitfish	1020	936	248	248	0	0	0	0	124	124	0	0	0	0	0	0
Snapper, Gold-band	0	0	0	0	0	0	70	70	0	0	0	0	0	0	0	0
Snapper, Golden	539	223	1464	465	1305	538	2952	1030	8969	1528	3371	589	2180	746	214	79
Snapper, Mangrove Jack	37	21	0	0	93	46	41	31	272	255	0	0	11	11	0	0
Snapper, Maori snapper	0	0	0	0	0	0	0	0	127	127	0	0	0	0	0	0
Snapper, Moses'	0	0	120	120	40	40	35	35	60	23	430	430	0	0	88	88
Snapper, other	0	0	0	0	0	0	7	7	0	0	0	0	0	0	0	0
Snapper,Saddletail/Crimson/Indo.	30	30	925	197	0	0	1009	466	2886	994	1495	530	139	65	338	181
Snapper, Stripey	19	19	845	239	175	151	5252	1168	14009	2387	4168	1102	1210	450	74	42
Tarpon/Ox-eye herring	9	9	0	0	0	0	0	0	127	101	83	59	19	19	0	0
Threadfin, Blue	396	169	53	39	116	46	31	25	1389	511	1524	544	232	150	0	0
Threadfin, King	524	277	0	0	91	55	0	0	0	0	269	227	37	37	0	0
Trevally, Giant	26	26	45	38	0	0	365	155	676	204	307	126	888	588	822	477
Trevally, Golden	136	136	42	30	24	17	609	272	365	155	414	176	170	121	285	169

Fishing Region ->	11		12		13		42		43		44		45		60	
Species/group	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE	Number	SE
Trevally, other	458	454	167	67	0	0	134	62	2640	1084	2660	1278	244	120	1239	394
Tuna, Longtail	30	24	152	107	0	0	257	153	1143	605	627	348	0	0	13	13
Tuna, Mackerel	0	0	8	8	0	0	511	218	648	279	12	12	0	0	10	10
Whiting	1009	508	6	6	0	0	0	0	0	0	0	0	0	0	0	0
Wrasse, Tuskfish	246	163	388	130	0	0	536	202	1116	256	797	327	776	404	0	0
Scalefish, other	1456	425	700	220	248	117	660	154	5077	1006	2808	1323	113	59	120	51
Mud Crab	30294	11695	15	15	2723	660	0	0	98	77	0	0	198	80	0	0
Crustaceans, other	1222	388	0	0	52	33	0	0	0	0	0	0	0	0	0	0
Cephalopods	0	0	0	0	0	0	168	168	51	51	0	0	0	0	0	0
Gastropods	274	274	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other taxa	0	0	0	0	0	0	0	0	0	0	0	0	29	15	0	0

Appendix 8: Estimated effort (fisher hours) by boat ramp during the survey period of March 2016 to November 2016

SE is Standard Error; values in italics have an RSE between 25–50% and values in bold have an RSE >50%.

Boat ramp	Effort (fisher hours)	SE	Proportion of total effort
Dinah Beach	86504	5652	20.7
Dundee Beach	85638	11034	20.5
East Arm	51796	3731	12.4
Buffalo Creek	35090	5050	8.4
Palmerston	33971	4746	8.1
Milne Inlet	21718	6700	5.2
Nightcliff	19632	4788	4.7
Middle Arm	19113	3335	4.6
Saltwater Arm	12420	2543	3
Leaders Creek	12042	1765	2.9
Six Pack Creek	11700	2573	2.8
Ski Club	10423	565	2.5
Channel Island	7186	584	1.7
Keswick Point	5010	778	1.2
Crab Claw	3253	312	0.8
Trailer Boat Club	1961	243	0.5
Southport	944	165	0.2

Appendix 9: Recreational catch (total, kept and released numbers) by reporting group and species from the Greater Darwin Area during the survey period of March 2016 to November 2016

SE is Standard Error; values in *italics* have an RSE between 25–50% and values in **bold** have an RSE >50%.

Reporting group	Common name	Scientific name	Total		Kept		Released	
			Number	SE	Number	SE	Number	SE
Barramundi	Barramundi	<i>Lates calcarifer</i>	9325	1191	3145	557	6179	780
Bream, pikey	Bream, pikey	<i>Acanthopagrus pacificus</i>	10085	942	4054	537	6030	709
Catfish	Eeltail catfish	Plotosidae - undifferentiated	6	6	6	6	0	0
Catfish	Forktail catfish	Ariidae - undifferentiated	18615	1844	851	390	17767	1650
Cod/groupers	Cod/groupers	Serranidae - undifferentiated	29456	1856	7681	551	21771	1575
Coral trout	Coral trout	<i>Plectropomus spp</i>	1612	304	1263	267	349	106
Emperor, other	Emperor, other	Lethrinidae	22876	4417	7349	1076	15525	3817
Emperor, red	Emperor, red	<i>Lutjanus sebae</i>	1274	428	863	309	410	157
Flathead	Flathead	Platycephalidae	1008	197	285	57	720	186
Javelin fish	Javelin fish	<i>Pomadasys kaakan</i>	14029	1627	3210	610	10816	1488
Jewfish, black	Jewfish, black	<i>Protonibea diacanthus</i>	5872	687	3911	470	1965	351
Jewfish, other	Jewfish, other	Sciaenidae	541	241	12	12	528	238
Mackerel, grey	Mackerel, grey	<i>Scomberomorus semifasciatus</i>	1643	341	910	236	733	204
Mackerel, Spanish	Mackerel, Spanish	<i>Scomberomorus commerson</i>	4645	741	2640	435	2002	402
Mackerel, spotted	Mackerel, spotted	<i>Scomberomorus munroi</i>	2661	764	1130	501	1532	310
Moonfish/Batfish	Moonfish/Batfish	Ephippidae	17117	2227	2024	402	15091	2087
Mullet	Mullet	Mugilidae - undifferentiated	45843	10402	38016	8190	7824	4136
Queenfish	Queenfish	<i>Scomberoides spp</i>	13352	1741	2273	300	11078	1652
Sharks & rays	Rays/skates	Dasyatidae	911	375	48	30	863	372
	Sawfish	Pristidae	144	91	0	0	144	91
	Shark	Various families	32341	2365	1226	523	31116	2281
Small baitfish	Herring, other	Clupeidae	14649	11880	4327	2407	10320	9563

	Small baitfish	Several families	19197	7324	4988	1439	14211	6414
Snapper, gold-band	Snapper, gold-band	<i>Pristipomoides multidens</i>	70	70	28	28	42	42
Snapper, golden	Snapper, golden	<i>Lutjanus johnii</i>	42533	2731	20075	1440	22460	1670
Snapper, mangrove jack	Snapper, mangrove jack	<i>Lutjanus argentimaculatus</i>	1828	337	649	218	1179	181
Snapper, maori seapearch	Snapper, maori seapearch	<i>Lutjanus rivulatus</i>	127	127	0	0	127	127
Snapper, Moses'	Snapper, Moses'	<i>Lutjanus russellii</i>	1443	614	160	77	1282	600
Snapper, other	Chinamanfish	<i>Symphorus nematophorus</i>	7	7	0	0	7	7
Snapper, saddletail/crimson/indo	Snapper, saddletail/crimson/indo	<i>Lutjanus malabaricus, erythropterus & bitaeniatus</i>	11612	1585	5017	983	6595	906
Snapper, stripey	Snapper, stripey	<i>Lutjanus carponatus</i>	37831	3260	8292	1025	29538	2762
Tarpon/ox-eye herring	Tarpon/ox-eye herring	<i>Megalops cyprinoides</i>	447	155	101	85	348	131
Threadfin, blue	Threadfin, blue	<i>Eleutheronema tetradaetylum</i>	7123	1072	4074	628	3046	662
Threadfin, king	Threadfin, king	<i>Polydactylus macrochir</i>	1754	445	1063	316	691	278
Trevally, giant	Trevally, giant	<i>Caranx ignobilis</i>	4208	841	818	225	3389	699
Trevally, golden	Trevally, golden	<i>Gnathanodon speciosus</i>	3371	541	813	212	2564	468
Trevally, other	Trevally, other	Carangidae - undifferentiated	17571	2348	1394	315	16178	2140
Tuna, longtail	Tuna, longtail	<i>Thunnus tonggol</i>	2673	727	1059	188	1616	645
Tuna, mackerel	Tuna, mackerel	<i>Euthynnus affinis</i>	1225	355	470	115	755	271
Whiting	Whiting	Sillaginidae - undifferentiated	1135	514	832	424	303	179
Wrasse, tuskfish	Wrasse, tuskfish	Scaridae - undifferentiated	7416	851	2258	271	5158	754
Scalefish, other	Archerfish	Toxotidae - undifferentiated	3364	832	329	173	3035	806
	Barracuda	Sphyrnaeidea	1128	200	168	54	961	185
	Bream, bony	<i>Nematalosa erebi</i>	8	8	0	0	8	8
	Bream, monocle	Nemipteridae - undifferentiated	6	6	0	0	6	6
	Bream, threadfin	Nemipteridae - undifferentiated	16	16	16	16	0	0
	Cobia	<i>Rachycentron canadum</i>	747	151	481	98	268	87
	Eel	Various families	45	28	0	0	45	28
	Fish, other	Various families	310	153	0	0	310	153

Flounder	Pleuronectidae - undifferentiated	5	5	0	0	5	5
Fusiler	Caesionidae	192	22	6	5	186	22
Garfish	Hemiramphidae	5651	2012	3835	1884	1812	538
Goatfish	Mullidae	16	16	0	0	16	16
Grunter, sooty	<i>Hephaestus fuliginosus</i>	101	93	0	0	101	93
Hairtail	<i>Trichiurus lepturus</i>	77	72	0	0	77	72
Leatherjacket	Monacanthidae	246	233	0	0	246	233
Lizard fish/grinner	Various families	40	40	0	0	40	40
Longtom	Belonidae	534	143	17	17	517	142
Marlin	Istiophoridae	18	14	0	0	18	14
Rabbitfish	Siganidae - undifferentiated	510	510	0	0	510	510
Remora	Echeneidae - undifferentiated	674	185	0	0	674	185
Sailfish	<i>Istiophorus platypterus</i>	32	20	0	0	32	20
Sand bass	<i>Psammoperca waigiensis</i>	1547	620	19	11	1528	620
Saratoga	<i>Scleropages jardinii</i>	0	0	0	0	0	0
Scad, yellow-tail	<i>Trachurus novaezelandiae</i>	4572	1521	182	158	4391	1513
Scat	Scatophgidae - undifferentiated	364	159	0	0	364	159
Seahorse	Syngnathidae - undifferentiated	14	14	0	0	14	14
Sole	Solidae - undifferentiated	87	87	0	0	87	87
Stargazer	Uranoscopidae - undifferentiated	1387	265	0	0	1387	265
Stonefish	Synanceiidae - undifferentiated	67	38	0	0	67	38
Sweetlip, morwong	Haemulidae - undifferentiated	1072	211	261	76	811	181
Toads, pufferfish	Various families	2539	689	16	16	2523	689
Tripletail	<i>Lobotes surinamensis</i>	15	10	9	8	6	5
Wolf herring	<i>Chirocentrus dorab</i>	79	59	7	7	72	59
Mud crab	Mud crab	63351	12356	36264	5299	27087	7432
Crustaceans, other	Blue swimmer crab	6633	1155	1120	341	5512	1095
	Crab, other	441	317	0	0	441	317

	Prawn, marine	Penaeoidea & Caridea - undifferentiated	3108	760	2229	622	880	445
Cephalopods	Octopus	Octopodidae - undifferentiated	6	6	0	0	6	6
	Squid	Loliginidae - undifferentiated	219	175	219	175	0	0
Gastropods	Non-fish, other	Various families	274	274	274	274	0	0
Other taxa	Non-fish, other	Various families	108	54	45	22	63	50

Appendix 10: Recreational catch (total, kept and released numbers) by analysis and ramp for the survey period of March 2016 to November 2016

SE is Standard Error; values in italics have an RSE between 25–50% and values in bold have an RSE >50%

Analysis	Ramp	Total		Kept		Released	
		Number	SE	Number	SE	Number	SE
Primary ramp	1. Buffalo Creek	69099	13988	36721	8639	32380	7528
	2. Dinah Beach	99050	4949	38799	2891	60257	3421
	5. East Arm	59516	6085	20336	2156	39175	5467
	6. Nightcliff	21178	2934	7454	1379	13722	2309
	10. Middle Arm	19869	2024	9692	1374	10173	1035
	12. Leaders Creek	11268	1220	2366	350	8901	1096
	15. Six Pack	9323	1198	3260	721	6058	883
	16. Keswick	8659	1444	2099	457	6559	1364
	21. Dundee	101078	6232	27325	1813	73751	5274
	22. Saltwater Arm	13243	1728	4962	897	8284	1117
	Total	412283		153014		259260	
Secondary ramp	3. Ski Club	8516	0	821	0	7695	0
	4. Channel Island	8053	460	3770	292	4285	172
	7. Palmerston	35201	3040	11832	1823	23371	1985
	8. Trailer Boat Club	3384	0	654	0	2730	0
	11. Southport	1450	0	0	0	1450	0
	13. Crab Claw	1986	0	830	0	1155	0
	14. Milne Inlet	38306	14762	11891	4077	26412	11146
	Total	96896		29798		67098	
Grand Total		509179		182812		326358	

Appendix 11: Recreational effort (fisher hours) and total catch of key species by water body in the Greater Darwin Area during the survey period of March 2016 to November 2016

SE is Standard Error; values in italics have an RSE between 25–50% and values in bold have an RSE >50%.

Species/group	Estuary		Offshore	
	Number	SE	Number	SE
Effort				
Effort hours	293982	13448	124419	11463
Catch				
Barramundi	9004	1182	321	140
Bream, pikey	9249	921	836	200
Catfish	14900	1434	3721	1159
Cod/groupers	17793	1266	11663	1358
Coral trout	307	197	1305	232
Emperor, other	2295	695	20581	4362
Emperor, red	0	0	1274	428
Flathead	953	196	55	22
Javelin fish	10618	1528	3411	558
Jewfish, black	2870	496	3002	476
Jewfish, other	466	229	75	75
Mackerel, grey	389	91	1254	328
Mackerel, Spanish	865	237	3780	701
Mackerel, spotted	1639	694	1022	321
Moonfish/Batfish	8672	1243	8445	1847
Mullet	45511	10399	332	239
Queenfish	6378	808	6974	1543
Sharks & rays	14143	1472	19253	1890
Small baitfish	33722	13956	124	124
Snapper, gold-band	0	0	70	70
Snapper, golden	24847	1775	17686	2075
Snapper, mangrove jack	1504	218	324	257
Snapper, maori seaperch	0	0	127	127
Snapper, Moses'	830	428	613	440
Snapper, other	0	0	7	7
Snappers, saddletail/crimson/indo	5745	994	5867	1235
Snapper, stripey	13118	1465	24713	2912
Tarpon/ox-eye herring	218	99	229	119
Threadfin, blue	3947	754	3176	762
Threadfin, king	1448	381	306	230
Trevally, giant	1150	228	3058	810
Trevally, golden	1528	348	1843	415
Trevally, other	10654	1591	6917	1726
Tuna, longtail	633	131	2040	715
Tuna, mackerel	44	23	1181	355
Whiting	1135	514	0	0
Wrasse, tuskfish	4191	590	3225	614
Scalefish, other	16685	2398	8778	1671
Mud crab	63055	12356	296	111
Crustaceans, other	10182	1418	0	0
Cephalopods	6	6	219	175
Gastropods	274	274	0	0
Other taxa	79	52	29	15

Appendix 12: Recreational catch of key species by fishing method in the Greater Darwin Area during the survey period of March 2016 to November 2016

SE is Standard Error; values in italics have an RSE between 25–50% and values in bold have an RSE >50%.

Species/group	Method/Gear							
	Line		Pot		Cast		Other	
	Number	SE	Number	SE	Number	SE	Number	SE
Barramundi	9068	1189	54	0	169	62	34	20
Bream, pikey	8142	801	449	130	1494	479	0	0
Catfish	18049	1838	461	147	111	32	0	0
Cod/groupers	27316	1819	2051	358	89	89	0	0
Coral trout	1612	304	0	0	0	0	0	0
Emperor, other	22876	4417	0	0	0	0	0	0
Emperor, red	1274	428	0	0	0	0	0	0
Flathead	936	195	24	13	48	29	0	0
Javelin fish	13646	1615	0	0	383	195	0	0
Jewfish, black	5872	687	0	0	0	0	0	0
Jewfish, other	428	228	75	75	38	26	0	0
Mackerel, grey	1643	341	0	0	0	0	0	0
Mackerel, Spanish	4645	741	0	0	0	0	0	0
Mackerel, spotted	2661	764	0	0	0	0	0	0
Moonfish/Batfish	17117	2227	0	0	0	0	0	0
Mullet	426	244	0	0	45417	10399	0	0
Queenfish	13272	1741	0	0	44	25	36	19
Sharks & rays	33243	2395	89	32	35	22	29	19
Small baitfish	663	333	0	0	33183	13952	0	0
Snapper, gold-band	70	70	0	0	0	0	0	0
Snapper, golden	42524	2731	9	9	0	0	0	0
Snapper, mangrove jack	1803	336	25	17	0	0	0	0
Snapper, maori seapearch	127	127	0	0	0	0	0	0
Snapper, Moses'	1443	614	0	0	0	0	0	0
Snapper, other	7	7	0	0	0	0	0	0
Snapper, saddletail/crimson/indonesian	11612	1585	0	0	0	0	0	0
Snapper, stripey	37831	3260	0	0	0	0	0	0
Tarpon/ox-eye herring	447	155	0	0	0	0	0	0
Threadfin, blue	6871	1057	53	25	199	182	0	0
Threadfin, king	1748	445	0	0	0	0	6	6
Trevally, giant	4208	841	0	0	0	0	0	0
Trevally, golden	3371	541	0	0	0	0	0	0
Trevally, other	17324	2340	0	0	247	192	0	0
Tuna, longtail	2673	727	0	0	0	0	0	0
Tuna, mackerel	1225	355	0	0	0	0	0	0
Whiting	133	83	0	0	1002	507	0	0
Wrasse, tuskfish	7416	851	0	0	0	0	0	0
Scalefish, other	16914	2609	631	194	7918	1302	0	0
Mud crab	183	65	62931	12355	16	9	221	193
Crustaceans, other	0	0	7045	1197	3137	761	0	0
Cephalopods	225	175	0	0	0	0	0	0
Gastropods	0	0	0	0	0	0	274	274
Other taxa	63	50	0	0	0	0	45	22
Grand Total	341107		73897		93530		645	

Appendix 13: Recreational effort (fisher hours) and total catch of key species by fishing zone in the Greater Darwin Area during the survey period of March 2016 to November 2016

SE is Standard Error; values in *italics* have an RSE between 25–50% and values in **bold** have an RSE >50%.

Species/group	Bynoe Harbour/Dundee		Darwin Harbour/surrounds	
	Number	SE	Number	SE
Effort				
Effort hours	134813	13259	283588	11681
Catch				
Barramundi	3405	974	5920	685
Bream, pikey	1236	270	8849	903
Catfish	3965	680	14656	1714
Cod/groupers	11387	1392	18069	1228
Coral trout	1155	224	457	206
Emperor, other	19012	4323	3864	905
Emperor, red	1274	428	0	0
Flathead	143	64	865	186
Javelin fish	4449	907	9580	1351
Jewfish, black	2297	465	3575	507
Jewfish, other	75	75	466	229
Mackerel, grey	724	268	919	210
Mackerel, Spanish	2810	620	1835	405
Mackerel, spotted	434	184	2227	742
Moonfish/Batfish	3725	776	13392	2087
Mullet	8753	6720	37090	7940
Queenfish	4351	1122	9001	1332
Sharks & rays	14545	1557	18851	1821
Small baitfish	18060	12869	15786	5400
Snapper, gold-band	70	70	0	0
Snapper, golden	15123	1903	27410	1959
Snapper, mangrove jack	605	288	1223	174
Snapper, maori sea perch	127	127	0	0
Snapper, Moses'	172	61	1271	611
Snapper, other	7	7	0	0
Snapper,saddletail/crimson/ind	4918	1167	6694	1073
Snapper, stripey	21663	2766	16168	1725
Tarpon/ox-eye herring	193	112	254	107
Threadfin, blue	2603	663	4520	843
Threadfin, king	536	244	1218	372
Trevally, giant	1486	299	2722	787
Trevally, golden	974	313	2397	442
Trevally, other	4789	1735	12782	1582
Tuna, longtail	1408	624	1265	372
Tuna, mackerel	1159	354	66	28
Whiting	0	0	1135	514
Wrasse, tuskfish	1799	331	5617	784
Scalefish, other	8325	1304	17138	2616
Mud crab	5542	2183	57809	12162
Crustaceans, other	1376	594	8806	1288
Cephalopods	219	175	6	6
Gastropods	0	0	274	274
Other taxa	0	0	108	54

Appendix 14: Recreational effort (fisher hours) and total catch of key species by season in the Greater Darwin Area during the survey period of March 2016 to November 2016

SE is Standard Error; values in *italics* have an RSE between 25–50% and values in **bold** have an RSE >50%.

Species/group	Run-off (March - May)		Dry season (June - Aug)		Build-up (Sept - Nov)	
	Number	SE	Number	SE	Number	SE
Effort						
Effort hours	150375	10357	145402	9173	122624	10992
Catch						
Barramundi	3012	590	2255	428	4058	941
Bream, Pikey	2694	408	4485	707	2906	471
Catfish	5890	703	8092	1578	4639	645
Cod/groupers	12204	1254	10041	956	7211	979
Coral Trout	528	158	574	213	510	149
Emperor, other	7622	1206	6560	1428	8694	4002
Emperor, Red	591	207	187	97	496	362
Flathead	270	88	416	156	322	81
Javelin fish	5371	1175	5498	863	3160	723
Jewfish, Black	2928	535	1227	230	1717	365
Jewfish, other	362	211	54	38	125	112
Mackerel, Grey	594	217	746	236	303	116
Mackerel, Spanish	2270	552	1450	374	925	322
Mackerel, Spotted	1054	696	733	295	874	116
Moonfish/Batfish	8399	1612	5462	1344	3256	744
Mullet	19259	7444	7051	2036	19533	6974
Queenfish	4663	899	5025	1148	3664	952
Sharks/rays	14956	1793	9053	1218	9387	1020
Small baitfish	9536	4978	2125	631	22185	13023
Snapper, gold-band	0	0	70	70	0	0
Snapper, Golden	21830	2303	9336	876	11367	1178
Snapper, Mangrove Jack	466	92	796	194	566	260
Snapper, maori snapper	0	0	0	0	127	127
Snapper, Moses'	479	430	897	437	67	18
Snapper, other	0	0	0	0	7	7
Snapper,Saddletail/Crimson/Indo	3750	812	3725	908	4137	1015
Snapper, Stripey	15724	2072	12062	1572	10045	1965
Tarpon/Ox-eye herring	95	53	153	92	199	113
Threadfin, Blue	3951	776	1788	500	1384	546
Threadfin, King	794	355	633	254	327	87
Trevally, Giant	2080	759	860	236	1268	277
Trevally, Golden	1113	328	1520	383	738	196
Trevally, other	2824	688	8826	1432	5921	1728
Tuna, Longtail	1033	361	1123	536	517	333
Tuna, Mackerel	697	315	142	60	386	154
Whiting	43	38	650	386	442	337
Wrasse, tuskfish	2770	400	3144	560	1502	502
Scalefish, other	11540	2385	7535	1374	6388	981
Mud crab	18369	6566	36425	10330	8557	1692
Crustaceans, other	2242	636	4357	1005	3583	773
Cephalopods	6	6	168	168	51	51
Gastropods	0	0	0	0	274	274
Other taxa	62	48	30	19	16	16

