

# A Survey of Recreational Fishing in the Greater Darwin Area 2014

Fishery Report No. 120



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## **Bibliography**

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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 2014'. 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. Additional information is provided on the size (length) of some socially important fish species as well as details on the size of vessels and level of technology used by recreational anglers.

The results from this report 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

On-site surveys were conducted at selected boat ramps between Dundee Beach and the mouth of the Adelaide River. A conventional access-point methodology was utilised with a combination of fisher interviews and estimates of effort based on trailer counts.

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 2014 to 30 November 2014, recreational fishers (both residents and visitors) spent an estimated total of 579 446 hours fishing in the Greater Darwin Area.

Line fishing was the most common method used, accounting for 67% of the total effort, followed by Mud Crab potting (26%). Cast netting and other methods were far less common. An estimated 70% of the recreational fishing effort occurred in estuarine waters.

The Darwin Harbour region supported 37% of the total fishing effort, followed by Bynoe Harbour (12%) and Shoal Bay (9%). The offshore regions adjacent to Bynoe Harbour and Dundee were the most popular sites for those fishers travelling seaward of estuaries.

Fishing effort was fairly consistent across the survey period, although activity during the run-off period (March-May) was slightly higher than in other seasons. An estimated 20.2% of all fishing effort was attributed to vessels launching from the Dinah Beach boat ramp. Significant levels of effort were also estimated for vessels departing from the Dundee Beach ramp (17.7%) and the Buffalo Creek ramp (11.4%).

The proportion of visiting angler effort (interstate or overseas) varied throughout the survey period and reached a peak during the dry season of 22% of the total fishing effort.

### 1.3.2. Catch

During the survey period from 1 March 2014 to 30 November 2014, recreational fishers (both residents and visitors) caught an estimated 638 440 organisms from the Greater Darwin Area. Most of the catch (77.6%) was comprised of fish species (bony fish and sharks/rays) with the bulk of the remaining catch consisting of crabs and prawns.

Collectively, over 116 000 tropical snappers from the genus *Lutjanus* (Golden Snapper, Stripey Snapper, Indonesian Snapper and other tropical snappers) were caught and they formed a major component (23%) of the total fish catch and were a major contributor to the reef fish catch. Excluding baitfish species, Golden Snapper was the most commonly caught fish accounting for 9.7% of the total fish catch.

An estimated 140 562 individual crustaceans were captured during the survey period, composed primarily of Mud Crabs (68%) and marine prawns (28%).

Almost 64% of all fish and 36% of crustaceans caught were released; however, actual release rates varied depending on the species. High release rates were reported for sharks/rays and catfish, whereas very low release rates were reported for mullet, Mangrove Jack and marine prawns.

Of the total catch taken by recreational anglers in the Greater Darwin Area, 68% was derived from estuarine waters and 32% from offshore waters. Mud Crab was the most frequently caught species in estuarine waters, accounting for 21.7% of the overall catch. Excluding baitfish species, the most common fish species caught in estuaries were catfish, Golden Snapper and cods/groupers. Stripey Snapper was the most common fish species caught offshore followed by sharks/rays, emperors and Golden Snapper.

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

The Bynoe Harbour/Dundee fishing zone represented an area of high importance for the capture of reef fish, with Stripey Snapper, emperor and Golden Snapper dominating the catch. Mud Crab only represented 2.9% 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 20% of the total catch from this zone. Excluding baitfish species, the most commonly captured fish species in the Darwin Harbour/Surrounds fishing zone were catfish and Golden Snapper.

An investigation of catch by fishing region revealed that Shoal Bay accounted for 20% of the total catch of all aquatic organisms, although this figure was dominated by crustaceans. The Bynoe/Dundee offshore region was the next most significant area producing 11% of the total catch of all aquatic organisms followed by Darwin Harbour with 10%.

Overall catch composition varied by season but Mud Crabs remained the most commonly caught species throughout the survey period. Excluding baitfish species, the most commonly caught fish species in both the run-off (March-May) and the build-up (September-November) period was Golden Snapper, whereas Stripey Snapper dominated the fish catch during the dry season (June-August) months.

### 1.3.3. 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 cm. The length of Black Jewfish harvested ranged from 35-130 cm with a mean length of 84 cm. The length of Barramundi harvested ranged from 55-110 cm with a mean length of 64 cm.

Mud Crab sex data indicated that 84% of male crabs caught were kept, whereas only 38% of female crabs caught were kept.

### 1.3.4. Vessel characteristics

More than 80% of recreational fishing vessels surveyed were 4.5 m or longer in length. Sounders were fitted to 93% of all vessels, while more than 85% of vessels had a form of Global Positioning System (GPS) on board.

### 1.3.5. Future research

This survey of the Greater Darwin Area was to be repeated in 2015. These successive surveys, using similar methodologies, will help determine estimates of inter-annual variation of fish populations and provide sound information on which to base future sustainable management of our fish stocks.

## 2. Introduction

### 2.1. Background

Recreational fishing is an important component of both the Northern Territory (NT) economy and lifestyle of many Territorians. The last national recreational fishing survey in 2000-01 revealed that the NT had the highest resident participation rate of any state/territory in Australia (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). When you consider that this figure does not include expenditure by visiting anglers, or money spent on charter fishing operations, the true 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.

An ecological risk assessment of key reef fish undertaken in 2010 also identified Black Jewfish (*Protonibea diacanthus*) and Golden Snapper (*Lutjanus johnii*) at high risk of depletion in the Greater Darwin Area due to increasing fishing pressure (Grubert et al. 2010). Although these species are some of the most heavily targeted reef fish in NT waters, it is expected that other similar reef fish (such as emperors and other snappers) may also be under considerable threat.

There is no doubt that reef fish are being 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 fish species suffer serious physical damage as a result of capture and are unlikely to survive release by recreational anglers. 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 likely growth of recreational fishing in the NT, the appropriate monitoring of this sector is essential for ensuring the effective management and future sustainability of these fisheries. The absence of up-to-date information for key recreational fishery assessments represents a high risk to sustainable management and impedes effective whole-of-fishery management in the NT. Indeed, in areas where commercial fishing closures exist, recreational fishing represents the only potential source of fishery dependent data for monitoring purposes.

To ensure the fish and aquatic life 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 discrete geographical areas of the NT where fish stocks are under significant pressure. Given recent concerns regarding the sustainability of reef fish in the Darwin region, the survey effort was planned to initially focus on increasing our knowledge of the recreational fishery around Darwin.

The 'Survey of Recreational Fishing in the Greater Darwin Area 2014' 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.

A similar access-point methodology developed for the boat ramp component of the 2009-10 survey was employed for this study in order to compare results between these studies.

## 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 the key fish and other species
- collect relevant biological information on some socially important fish species and Mud Crabs
- collect information on vessel size and technological aids such as sounders.

## 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. However, before making any quantitative comparison with the information obtained from previous NT surveys, changes in the survey scope and methodology should be noted. These are outlined below in Section 3. Of particular note is that in the 2009 survey, region 42 was part of the West Coast fishing zone; however, in this study it was included in the Bynoe Harbour/Dundee fishing zone.

Key terms and definitions used in the document are defined in Appendix 1.

- The total results presented 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 do 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 displayed for a particular region does not mean that no fishing occurred there; it simply means that the level of effort was very small when the figures were rounded to the nearest whole integer.

- Where data have been presented in a histogram, the accompanying data tables are 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.

## 3. Survey method and analysis

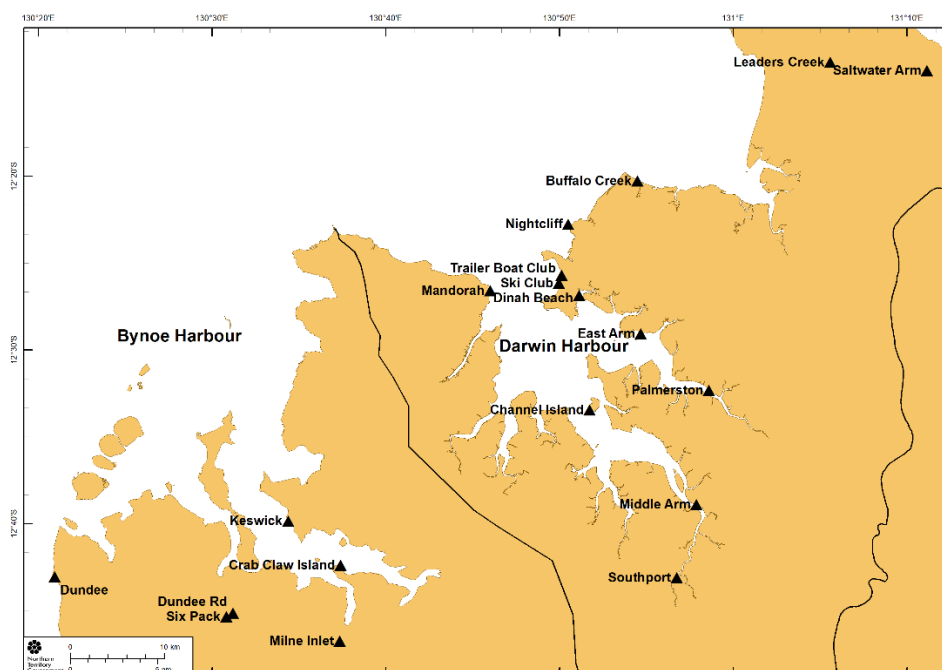
### 3.1. Survey scope

Recreational fishing was broadly defined as the capture or attempted capture of aquatic animals in NT waters other than for commercial activity. 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 of activity 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 was identified as receiving the highest recreational fishing effort within the NT (West et al. 2012) and is the area in which coastal reef fish stocks are considered to be most at risk of “overfishing” (Grubert et al. 2010).

### 3.2. Survey zones

The Greater Darwin Area was divided into two zones that were surveyed independently: (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 five 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 the boat ramps as either primary or secondary access sites (Table 1). Different survey sampling strategies were used at primary and secondary access sites. The primary ramps were included in the main survey that collected information about catch, fishing effort, catch rates, fish sizes, fishing regions visited, fishing activities undertaken and the residential status of fishers. Secondary boat ramps were only visited to obtain counts of trailers (Table 1).

**Table 1.** Primary and secondary boat ramps included in the Darwin Harbour/Surrounds (DHS) and Bynoe Harbour/Dundee (BD) fishing zones

Boat ramp number	Fishing zone	Interviews conducted	Trailer counts conducted
<i>Primary</i>			
1.	Buffalo Creek	DHS	✓
2.	Dinah Beach	DHS	✓
5.	East Arm	DHS	✓
6.	Nightcliff	DHS	✓
10.	Middle Arm	DHS	✓
12.	Leaders Creek	DHS	✓
15.	Six Pack	BD	✓
16.	Keswick	BD	✓
21.	Dundee	BD	✓
22.	Saltwater Arm	DHS	✓
<i>Secondary</i>			
3.	Ski Club	DHS	✓
4.	Channel Island	DHS	✓
7.	Palmerston	DHS	✓
8.	Trailer Boat Club	DHS	✓
9.	Mandorah	DHS	✓
11.	Southport	DHS	✓
13.	Crab Claw Island	BD	✓
14.	Milne Inlet	BD	✓
23.	Dundee Road	BD	✓

Three boat ramps and access points were excluded from survey coverage. These were Vestey's beach (a rarely used access point), Larrakeyah ramp (military base with access prohibited) 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 primary ramps

Access point surveys (Pollock et al. 1994) were conducted at the primary boat ramps in the two survey zones between 1 December 2013 and 30 November 2014 (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 these data were 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-hour shifts: early (09:00-14:00) and late (14:00-19:00).

Three survey days were randomly allocated to each day-type stratum within a season at each primary boat ramp. A survey shift was then randomly allocated to each survey day. However, logistic 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 primary ramps

Interviews with fishing parties were done at all primary ramps. A variety of data elements were collected during the interview process. Information often observed directly by the trained survey staff included the identification and number of fish retained (i.e. harvest), the size of fish retained and the number of returning vessels that had been involved in recreational fishing activities. Many other 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.

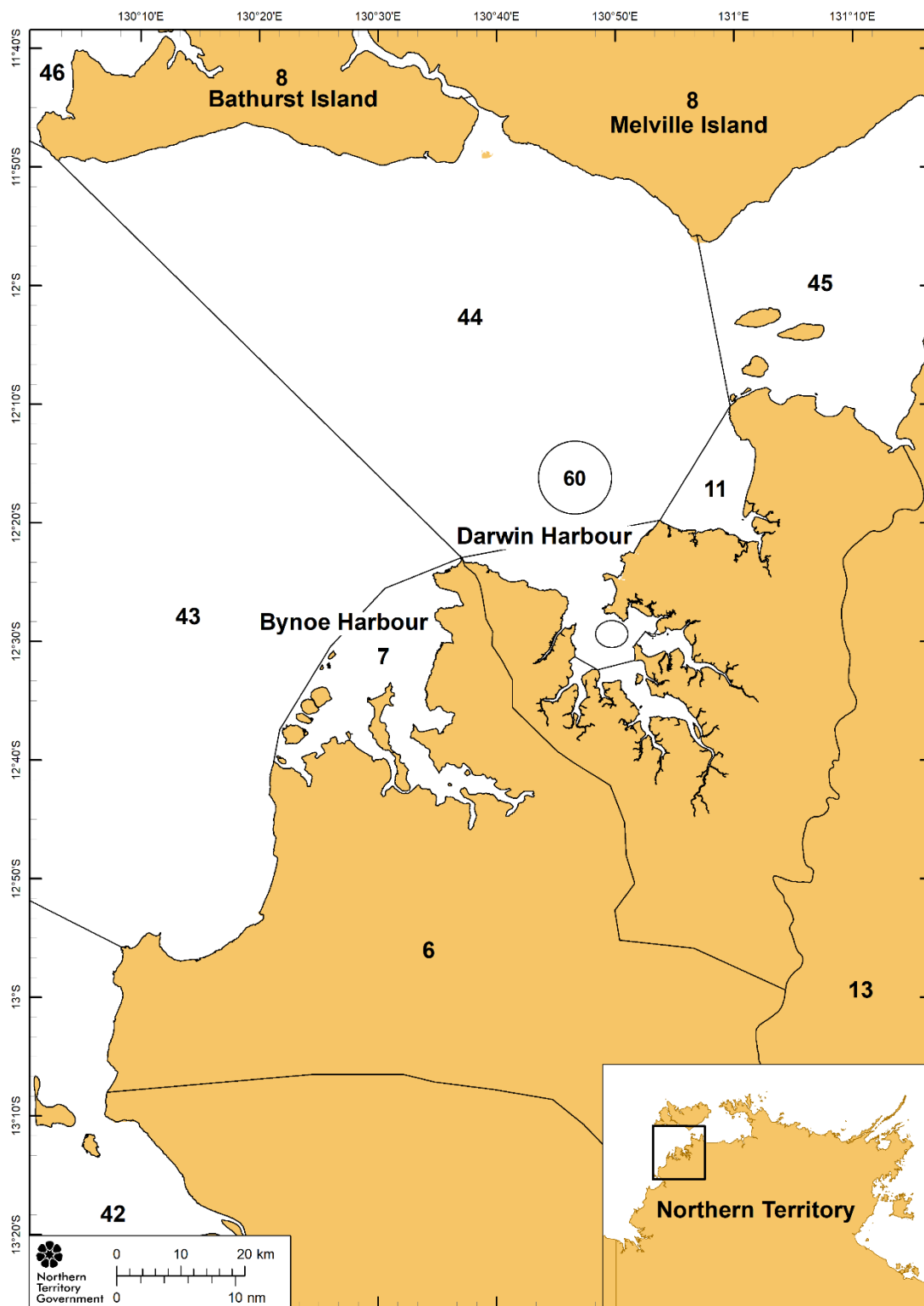
#### 3.4.2. Fishing regions

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).

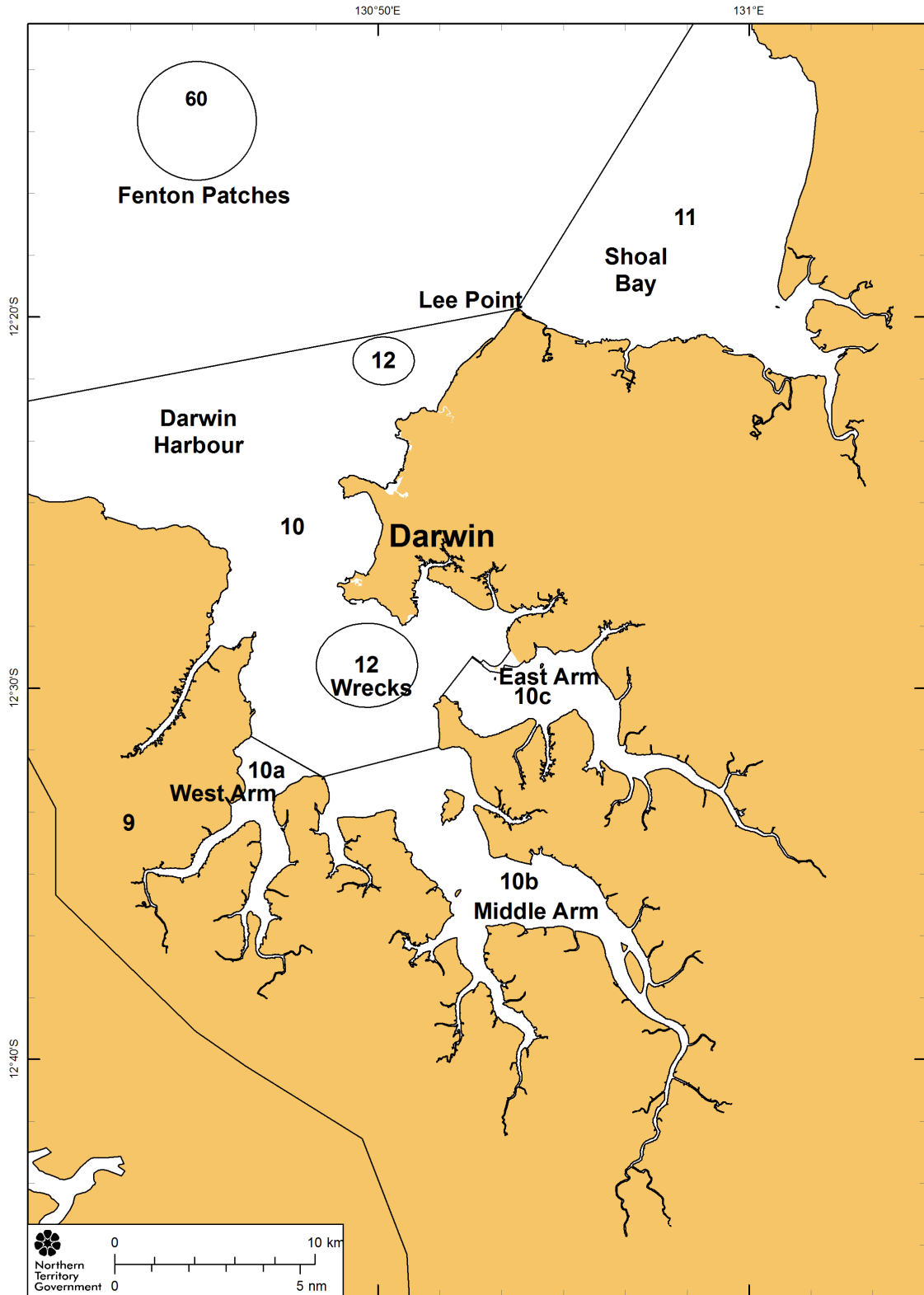
**Table 2.** Fishing zones and their fishing regions

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 on the basis of 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 Wahoo). 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. Non-directed fishing effort

Non-directed fishing effort is a measure of fishing activity that ignores any targeting behaviour and the use of different gear types and fishing regions. We report non-directed fishing effort in units of “days fished” to allow comparisons between the current survey and previous on-site surveys undertaken in 2009 (see Section 9.1 for comparisons). “Days fished” are equivalent to “fisher days”, a term commonly used in other reports to describe this same measure of non-directed fishing effort.

### 3.4.8. 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. This data was used to estimate the proportion of fishing activity by resident and non-resident fishers.

Where fishing parties comprised NT residents and visitors, the fishing information was recorded separately for each group (i.e. catch/effort for NT residents and catch/effort for visitors). In those cases where a fishing event was shared between members of a party (e.g. crab potting or cast netting) the catch was proportionally allocated to the respective residential groups.

### 3.4.9. Length and sex data

Throughout the survey period, length estimates (total length) for harvested specimens of key recreational fish species (Black Jewfish, Golden Snapper and Barramundi) were collected. Lengths of measured fish were recorded to the nearest centimetre. These data were used to calculate average harvest weights for these species.

Where possible, the sex of Mud Crabs (both kept and released) was recorded to determine the proportion of male and female Mud Crabs in the catch and to provide some insight into seasonal variation in catch of the different sexes.

### 3.4.10. Vessel characteristics and technology

Data was also collected regarding 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 have the ability to carry more anglers whereby increasing fishing effort per boat and consequently increasing fishing power. Larger vessels also allow anglers to travel greater distances in shorter periods. They also allow anglers 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 an image. 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.

### 3.4.11. Trailer counts

A trailer count was carried out at the completion of each late shift at all primary ramps to enable an assessment of daytime fishing activity (i.e. number of trips) that had been missed because the shift had finished before dark. We excluded known non-fishing boat trailers (e.g. jet-ski trailers).

## 3.5. Data collected at secondary ramps

A trailer count was carried out at every secondary boat ramp on three randomly allocated sampling days for day type stratum within each season (Appendix 5). Trailer counts were conducted between the hours of 11 am and 2 pm, which generally coincides with the maximum number of trailers present during the day. Known non-fishing boat trailers (e.g. jet-ski trailers) were excluded from the count. No interviews with fishing parties were done at secondary ramps.

## 3.6. Estimation methods for survey data

The survey estimates are derived from combining the results of three different data analyses:

- (1) A direct expansion of survey data that covers the early and late shift strata (i.e. 09:00 to 19:00) at primary boat ramps;
- (2) An estimation procedure that covers the period between the end of the late shift and sunset at the primary boat ramps; and
- (3) An estimation procedure that covers the daytime fishing activity at secondary boat ramps.

Each analysis has different assumptions that underpin the estimation procedures. These assumptions, outlined in the respective sections below, need to be considered when examining the survey results. The addition of estimates derived from these three analyses provide a total estimate of daytime fishing effort, harvest and released catch for primary and secondary boat ramps in each survey zone.

### 3.6.1. Direct expansion of survey data that covers the early and late shift strata (i.e. 09:00 to 19:00) 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).

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

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

Where:

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

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

The estimated variance of the mean daily values for the  $j^{\text{th}}$  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  $j^{\text{th}}$  stratum.

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

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

Where:

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

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

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

Where:

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

### 3.6.2. Estimation procedure that covers the period between the end of the late shift and sunset at the primary boat ramps

The trailer counts made at the end of late shifts were directly expanded to provide estimates of the number of fishing trips that had been missed by the survey coverage. This was done separately for each primary ramp using equations 1 to 4. We have assumed that all trailers counted were related to recreational fishing activity. This assumption is reasonable given that we excluded known non-fishing boat trailers (e.g. jet-ski trailers) from the counts and that it is known from previous work that the majority of other trailer boats are accessing the recreational fishery from these boat ramps.

We then converted these effort estimates (trips) into units of fisher hours. The first step was to obtain an estimate of the mean trip length (fisher hours) for each primary sample unit. This was done by calculating a daily mean trip length (fisher hours) for each survey shift.

Note that at any primary ramp each shift was scheduled on a different calendar day.

Secondly, the mean of the daily mean trip length values was calculated using the general form of equation 1. The variance of this mean of the daily mean trip length values was calculated using the general form of equation 2. Finally, the conversion of total effort from

trips into fisher hours was done by multiplying the mean of the daily mean trip length values with the number of days in a stratum. This was done using the general form of equation 3.

The variance of this additional fishing effort was estimated as follows:

$$\mathit{Var}(\hat{E}_j) = [Y_j^2 \times \mathit{Var}(\bar{X}_j)] + [\bar{X}_j^2 \times \mathit{Var}(Y_j)] - [\mathit{Var}(Y_j) \times \mathit{Var}(\bar{X}_j)] \quad \text{Eq. 8}$$

Where:

$\bar{X}_j$  is the mean of the daily mean trip length values for stratum j;

$\mathit{Var}(\bar{X}_j)$  is the variance of the mean of the daily mean trip length values for stratum j;

$\hat{Y}_j$  is the total fishing effort (trips) for stratum j;

$\mathit{Var}(Y_j)$  is the variance of total fishing effort (trips) for stratum j.

For each primary ramp this additional fishing effort was then partitioned and allocated proportionally to the fishing regions that had been visited by fishing parties using that ramp. Similarly, additional harvested fish and released fish were allocated to each fishing region in proportion to the amount of additional fishing effort. We assumed that the catches recorded during interviews for each fishing region were representative of catches associated with the additional fishing effort. The same estimation procedure was used to allocate additional variance for catches within each fishing region.

### 3.6.3. Estimation procedure that covers the daytime fishing activity at secondary boat ramps

The only data available for the secondary ramps were counts of trailers. The trailer counts were directly expanded to provide estimates of the number of fishing trips originating from secondary ramps. This was done separately for each secondary ramp using equations 1 to 4.

Data from nearby primary ramps (Table 3) were then used to convert these effort estimates (trips) into units of fisher hours. The mean trip length (fisher hours) for each primary sample unit at the nearby primary ramp was used as a proxy for the secondary ramp. The same estimation procedure described in section 3.6.2 was used. This additional fishing effort from the secondary ramp was then partitioned and allocated proportionally to the fishing regions that had been visited by fishing parties using the nearby primary ramp. The nearby primary ramp was also used as a proxy for catch rates at the secondary ramp (Table 3). Additional harvested fish and released fish were allocated to each fishing region in proportion to the amount of additional fishing effort. The same procedure was used to allocate additional variance for catches within each fishing region.

**Table 3.** Secondary ramps and their allocated primary ramp used to estimate catch and effort.

Boat ramp number	Fishing zone	Proxy ramp/region
3. Ski Club	DHS	Ramp 6, (Nightcliff), All Fishing Regions
4. Channel Island	DHS	Ramp 10, (Middle Arm), Fishing Region 10b only
7. Palmerston	DHS	Ramp 5, (East Arm), Fishing Region 10c only
8. Trailer Boat Club	DHS	Ramp 6, (Nightcliff), All Fishing Regions
9. Mandorah	DHS	Ramp 6, (Nightcliff), All Fishing Regions
11. Southport	DHS	Ramp 10, (Middle Arm), Fishing Region 10b only
13. Crab Claw Island	BD	Ramp 16, (Keswick), Fishing Region 7 only
14. Milne Inlet	BD	Ramp 16, (Keswick), Fishing Region 7 only
23. Dundee Road	BD	Ramp 15, (Six Pack), All Fishing Regions

The estimation procedures used have several assumptions: (a) that a trailer count provides an accurate measure of recreational fishing activity for a survey shift, (b) that fishing effort at a secondary ramp has the same spatial distribution among fishing regions as that measured at a nearby primary boat ramp that is used as a proxy and (c) that the composition and spatial distribution of catch (harvested and released fish) at a secondary ramp has the same spatial distribution among fishing regions as that measured at a nearby primary boat ramp that is used as a proxy.

### 3.7. Uncertainty in survey estimation

Survey estimates are subject to uncertainty for a variety of reasons. Non-optimal 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, more precise estimates 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.

### 3.8. 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 various fish 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.

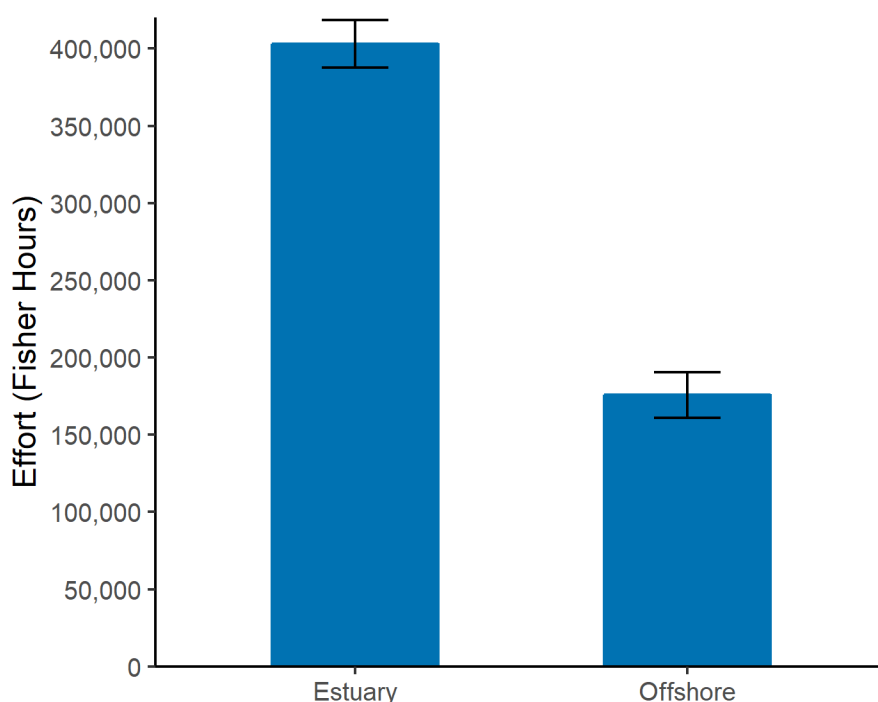
## 4. Fishing effort

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 2014 to 30 November 2014. 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 579 446 fisher hours were spent recreational fishing in the Greater Darwin Area during the survey period by both NT residents and visiting anglers. This figure of total effort was derived by the addition of the three analyses described in section 3.6. The direct expansion of primary ramps constituted 77% of the total effort; estimation of effort for primary ramps post late shift to sunset 14%; and estimation of effort for secondary ramps comprised 9% of the total effort. For a full breakdown of effort by analysis and ramp refer to Appendix 6.

### 4.1. Effort by water body

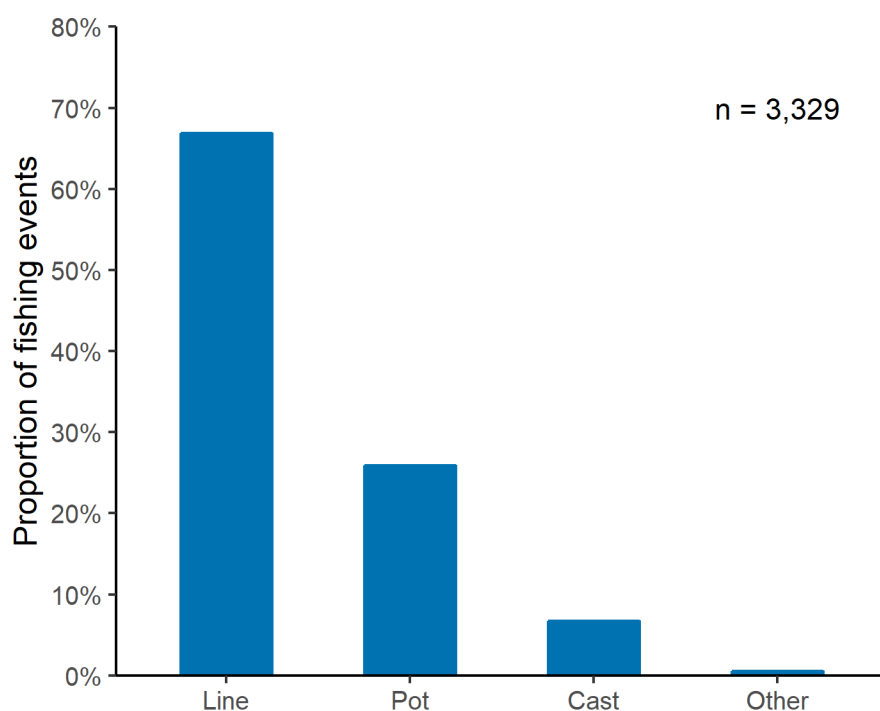
The majority of fishing effort (fisher hours) occurred in estuarine waters (70%) and the remainder in offshore waters (30%) (Figure 4).



**Figure 4.** Fishing effort (fisher hours) by water body type in the Greater Darwin Area for recreational fishers during the survey period from March 2014 to November 2014. 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 67% of the total fisher hours during the survey period (Figure 5). Pot fishing was the second most important method representing 26% of the total effort. Cast netting accounted for almost 7% of the effort hours and other methods, such as spearing, diving and hand collection combined only constituted 0.5% 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 2014 to November 2014.

## 4.3. Effort by fishing zone and region

### 4.3.1. 4.3.1 Effort by fishing zone

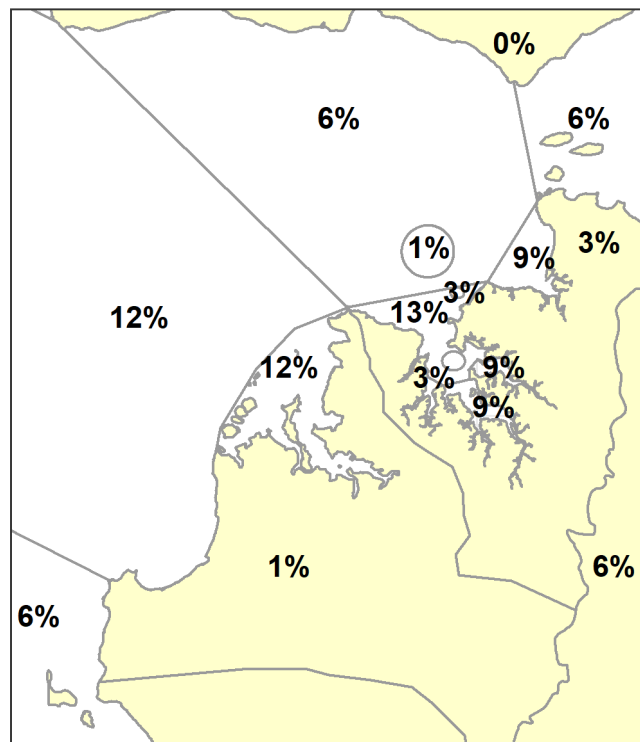
The Darwin Harbour/Surrounds fishing zone supported 69.5% of the total fishing effort (fisher hours) within the Greater Darwin Area, with the Bynoe Harbour/Dundee fishing zone supporting the remaining 30.5% of effort (Appendix 13).

### 4.3.2. Effort by fishing region

Darwin Harbour accounted for 13% of the total fishing effort (fisher hours) followed by Bynoe Harbour (12%) and Shoal Bay (9%) (Figure 6, Appendix 7). Collectively, Darwin Harbour and its tributaries supported 37% of the total effort.

The region offshore of Bynoe Harbour and Dundee was the most popular offshore water for recreational fishing accounting for 12% of the overall effort.

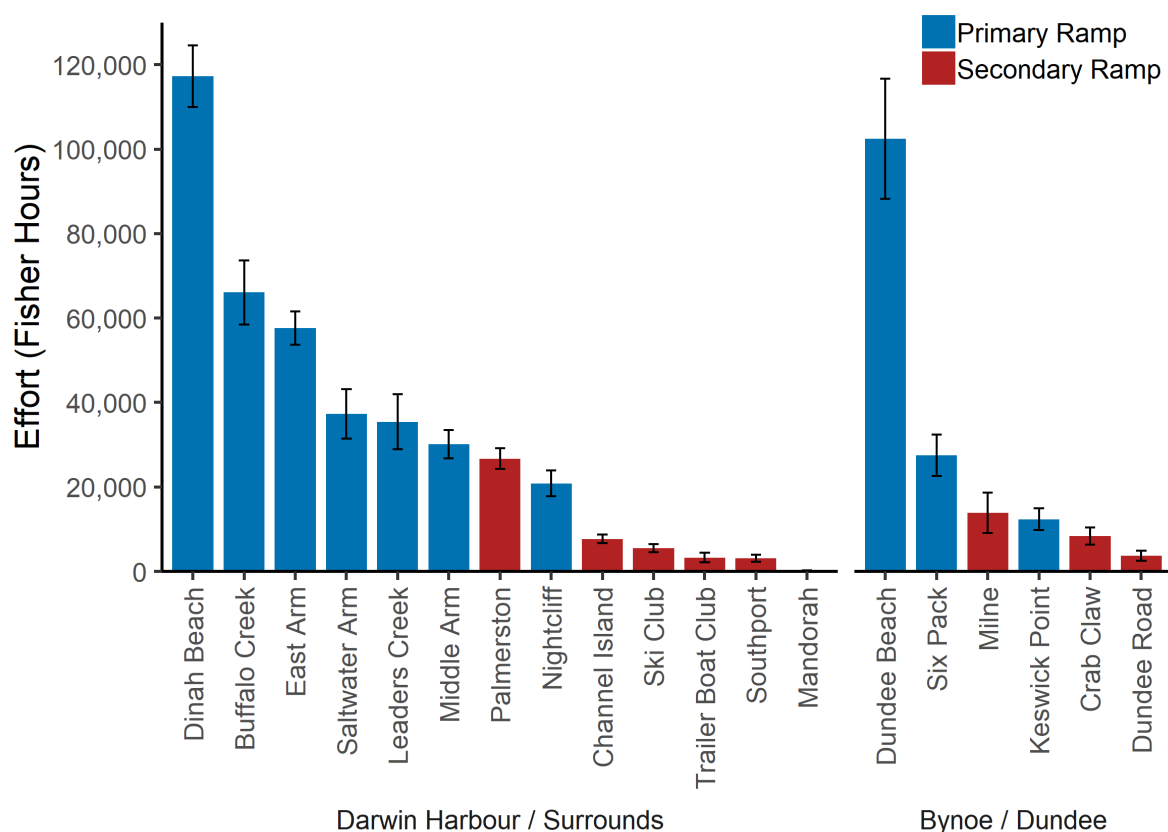
For full details of the relative fishing effort in each region please refer to Appendix 7.



**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 2014 to November 2014.

#### 4.4. Effort by boat ramp

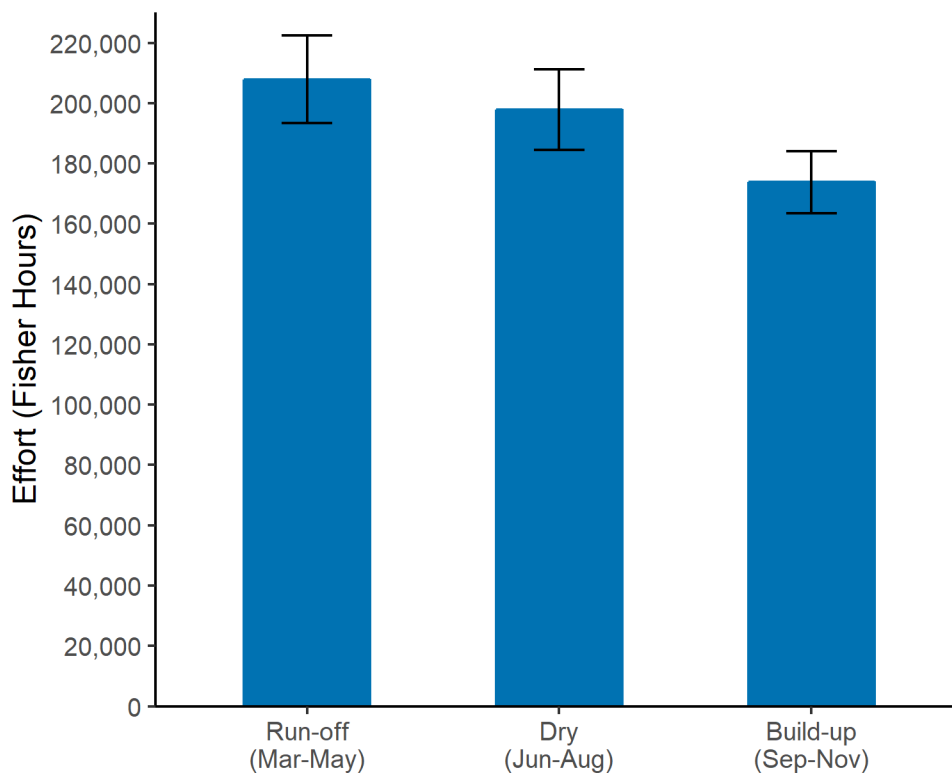
Recreational fishing vessels using the Dinah Beach boat ramp accounted for 20.2% of the total fisher hours in the Greater Darwin Area (Figure 7, Appendix 8). Vessels departing from Dundee Beach (17.7%), Buffalo Creek (11.4%) and East Arm ramp (9.9%) also made a major contribution to the total number 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 2014 to November 2014. Error bars represent one standard error.

## 4.5. Effort by season

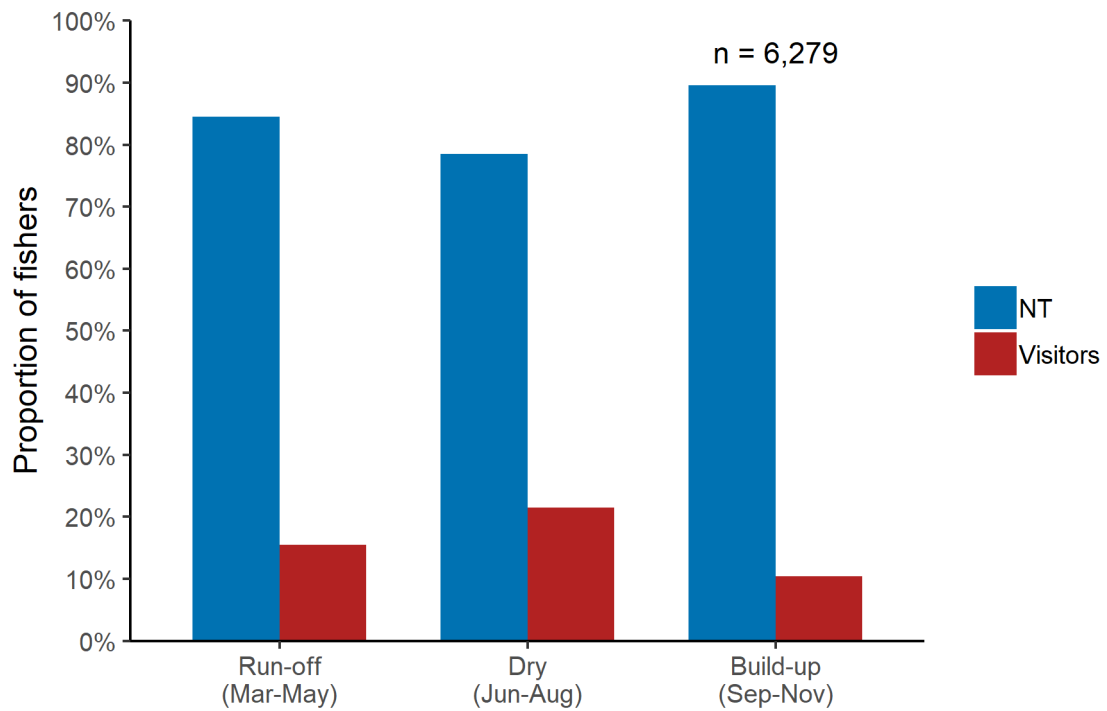
Seasonal fishing effort was relatively stable across the survey period, with the run-off season accounting for the most effort (36%) followed by the dry season (34%) and then the build-up period (30%) (Figure 8).



**Figure 8.** Fishing effort (fisher hours) by season in the Greater Darwin Area for recreational anglers during the survey period from March 2014 to November 2014. 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 throughout the survey period reaching a peak during the dry season of 22% of the total fishing effort (Figure 9). Visitor angler effort accounted for 15% of the run-off effort followed by 10% of the effort during the build-up season.



**Figure 9.** Unexpanded seasonal proportion of effort by residential origin of anglers in the Greater Darwin Area during the survey period from March 2014 to November 2014.

## 5. Catch

The following results represent the total catch of aquatic species from recreational vessels by fishers aged five years or more fishing within the Greater Darwin Area during the survey period from 1 March 2014 to 30 November 2014 (Table 4). A full listing of all taxa that comprise each of the reporting groups is provided in Appendix 9.

### 5.1. Total catch summary

An estimated 638 442 aquatic organisms were caught during the survey period. This figure of total catch was derived by the addition of the three analyses described in section 3.6. The direct expansion of primary ramps constituted 75% of the total catch; estimation of catch for primary ramps post late shift to sunset 13%; and estimation of catch for secondary ramps comprised 11%. For a full breakdown of catch by analysis and ramp refer to Appendix 10.

Of the total catch of aquatic organisms, 495 243 (77.6%) were fish (i.e. teleosts - bony fishes) and elasmobranchs (sharks/rays), with the bulk of the remaining catch (22%) comprised of crustaceans (primarily Mud Crabs and marine prawns). Some gastropods, cephalopods and other non-fish taxa (0.4%) were also recorded.

Excluding baitfish species, Golden Snapper was the most commonly caught fish species with an estimated 48 016 caught (9.7% of the total fish catch). Other fish species of importance included 41 090 Stripey Snapper (8.3%), 38 894 sharks/rays (7.8%) and 35 685 cods and groupers (7.2%).

Collectively, over 116 000 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 (23%) of the overall fish catch and a major contributor to the reef fish catch.

An estimated 140 562 crustaceans were caught, comprised largely of Mud Crabs (68%) and marine prawns (28%). For a full breakdown of catch by taxa refer to Appendix 9.

Almost 64% of all fish and only 36% of crustaceans caught were released; however, actual release rates varied depending on the species. High release rates were reported for sharks/rays and catfish, whereas very low release rates were reported for mullet, Mangrove Jack and marine prawns (crustaceans, other) (Table 4).

**Table 4.** 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 2014 to November 2014

Species/group	Total		Kept		Released		% released
	Number	SE	Number	SE	Number	SE	
Barramundi	18010	2187	5793	755	12217	1634	67.8
Bream, pikey	15642	3264	8613	2312	7029	1245	44.9
Catfish	32723	2888	1947	649	30776	2771	94.1
Cod/groupers	35685	2380	9334	770	26351	1859	73.8
Coral trout	2942	475	1868	325	1074	229	36.5
Emperor, other	28465	4265	10791	1583	17674	2920	62.1
Emperor, red	1993	847	998	390	995	479	49.9
Flathead	1116	133	320	64	796	117	71.3
Javelin fish	22389	2111	3993	535	18396	1820	82.2
Jewfish, black	7309	909	3429	415	3880	690	53.1
Jewfish, other	187	73	<b>25</b>	<b>22</b>	162	69	86.6
Mackerel, grey	2796	388	1170	180	1627	282	58.2
Mackerel, Spanish	6273	1068	3511	465	2762	657	44
Mackerel, spotted	2351	533	1035	240	1315	446	55.9
Moonfish/batfish	8878	820	1372	298	7506	761	84.5
Mullet	58028	4344	46495	4383	11533	2989	19.9
Queenfish	5324	663	1236	146	4088	639	76.8
Sharks & rays	38894	3471	1279	283	37615	3318	96.7
Small baitfish	25388	3881	10395	2607	14993	2799	59.1
Snapper, golden	48016	3463	24641	1778	23376	2134	48.7
Snapper, mangrove jack	1255	160	886	122	369	81	29.4
Snapper, Moses'	2385	356	268	73	2116	340	88.7
Snapper, other	<b>78</b>	<b>37</b>	<b>22</b>	<b>13</b>	<b>55</b>	<b>41</b>	70.5
Snapper, saddletail, crimson and indonesian	21487	2955	7690	1177	13798	2036	64.2
Snapper, stripey	41090	3760	10851	1013	30240	3065	73.6
Tarpon/ox-eye herring	1218	400	<b>779</b>	<b>352</b>	439	126	36
Threadfin, blue	9885	1295	6310	927	3575	566	36.2
Threadfin, king	1783	292	1200	167	582	205	32.6
Trevally, giant	5882	650	1038	142	4844	637	82.4
Trevally, golden	9521	936	1723	274	7797	868	81.9
Trevally, other	<b>480</b>	<b>294</b>	<b>9</b>	<b>9</b>	<b>471</b>	<b>293</b>	98.1
Tuna, longtail	1263	187	437	83	826	164	65.4
Tuna, mackerel	1087	221	469	113	618	194	56.9
Whiting	1830	453	1236	424	594	152	32.5
Wrasse, tuskfish	11205	954	4091	412	7114	708	63.5
Scalefish, other	22385	1808	5551	834	16834	1533	75.2
Mud crab	95528	9989	57436	5647	38093	4685	39.9
Crustaceans, other	<b>45034</b>	<b>22557</b>	<b>31629</b>	<b>22342</b>	13406	2295	29.8
Cephalopods	<b>21</b>	<b>13</b>	<b>21</b>	<b>13</b>	0	0	0.0
Gastropods	<b>2550</b>	<b>1273</b>	<b>2469</b>	<b>1272</b>	<b>81</b>	<b>67</b>	3.2
Other taxa	64	31	0	0	64	31	100.0

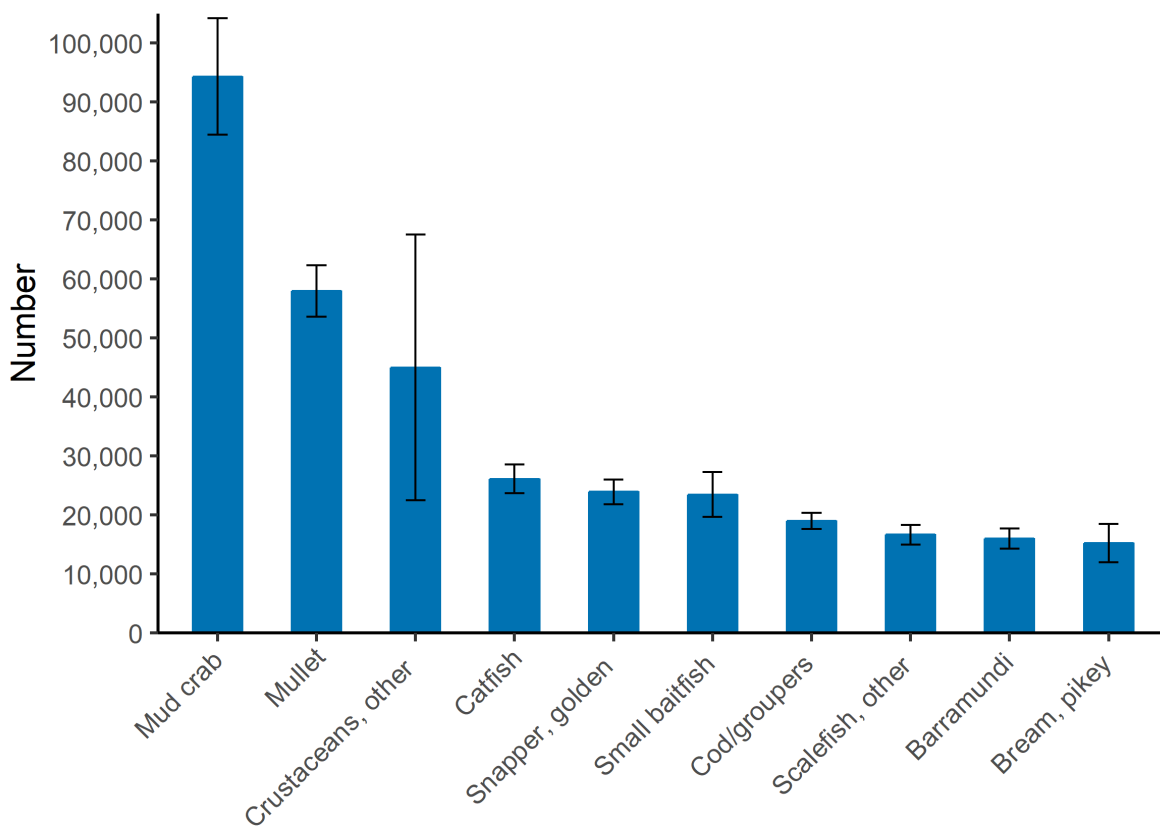
SE is standard error; values in italics have RSE between 25–50% and values in bold have RSE &gt;50%.

## 5.2. Catch by water body

Full catch details by water body type are provided in Appendix 11 but are summarised for key species in Figures 10 and 11 below. Of the total catch by recreational anglers in the Greater Darwin Area, 68% was derived from estuarine waters and 32% from offshore waters.

### Estuary

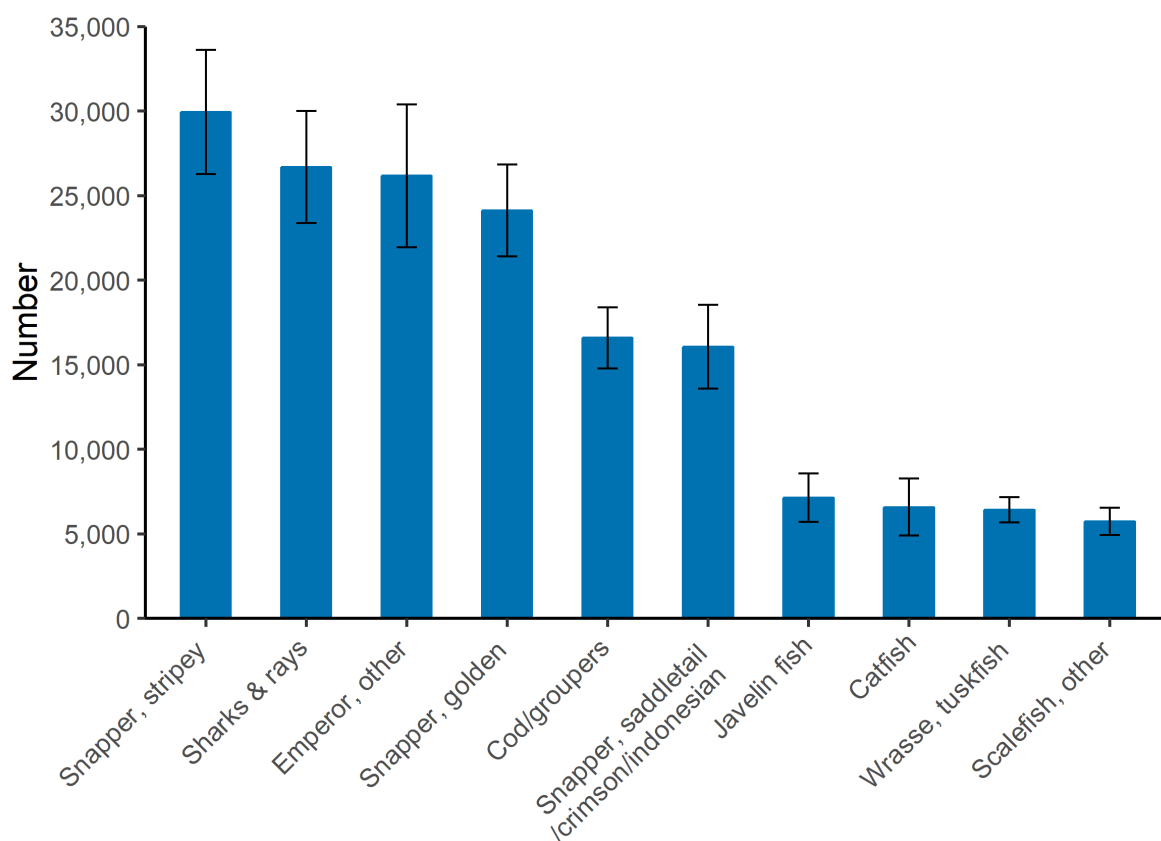
Mud Crab was by far the most frequently caught species in estuarine waters (21.7%) (Figure 10). Other frequently caught species, such as mullet, small baitfish and prawns comprised 29.1% of the estimated total catch and were mainly caught by cast net. Other than baitfish, the most frequent fish species caught in estuarine waters were catfish (6%), Golden Snapper (5.5%), cods/groupers (4.4%) and Barramundi (3.7%).



**Figure 10.** Catch estimates (numbers of fish) of the ten most frequent species/groups caught in estuarine waters of the Greater Darwin Area for recreational fishers during the survey period from March 2014 to November 2014. Error bars represent one standard error.

### Offshore

Stripey Snapper (14.6%) were the most common caught species from offshore waters, followed by sharks/rays (13%), emperor (e.g. Tricky, Blue lined) (12.8%) and Golden Snapper (11.8%) (Figure 11). Species of cods/groupers (8.1%) and red snappers (Saddletail, Crimson and Indonesian) (7.8%) were less frequently caught.



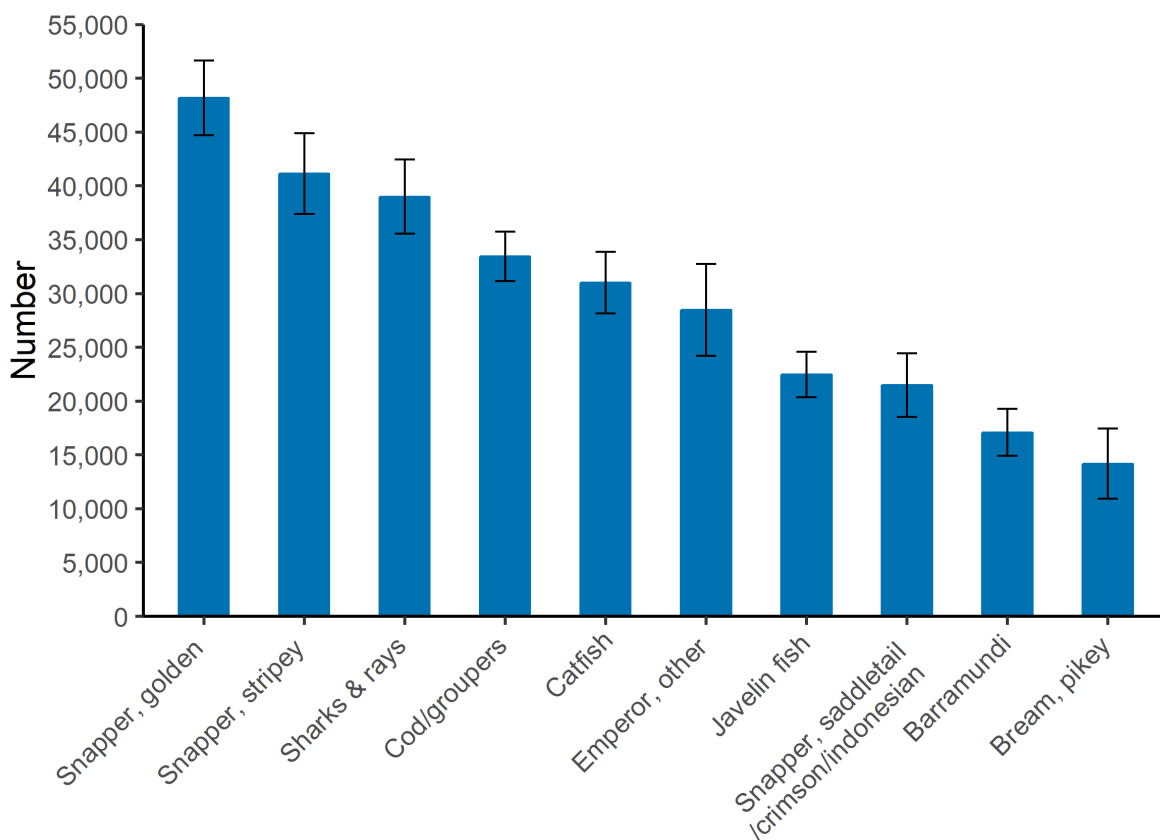
**Figure 11.** Catch estimates (numbers of fish) of the ten most frequent species/groups caught in offshore waters of the Greater Darwin Area for recreational fishers during the survey period from March 2014 to November 2014. Error bars represent one standard error.

### 5.3. Catch by fishing method

Full catch details by fishing method are provided in Appendix 12 but are summarised for key species in Figures 12, 13 and 14 below.

#### 5.3.1. Line

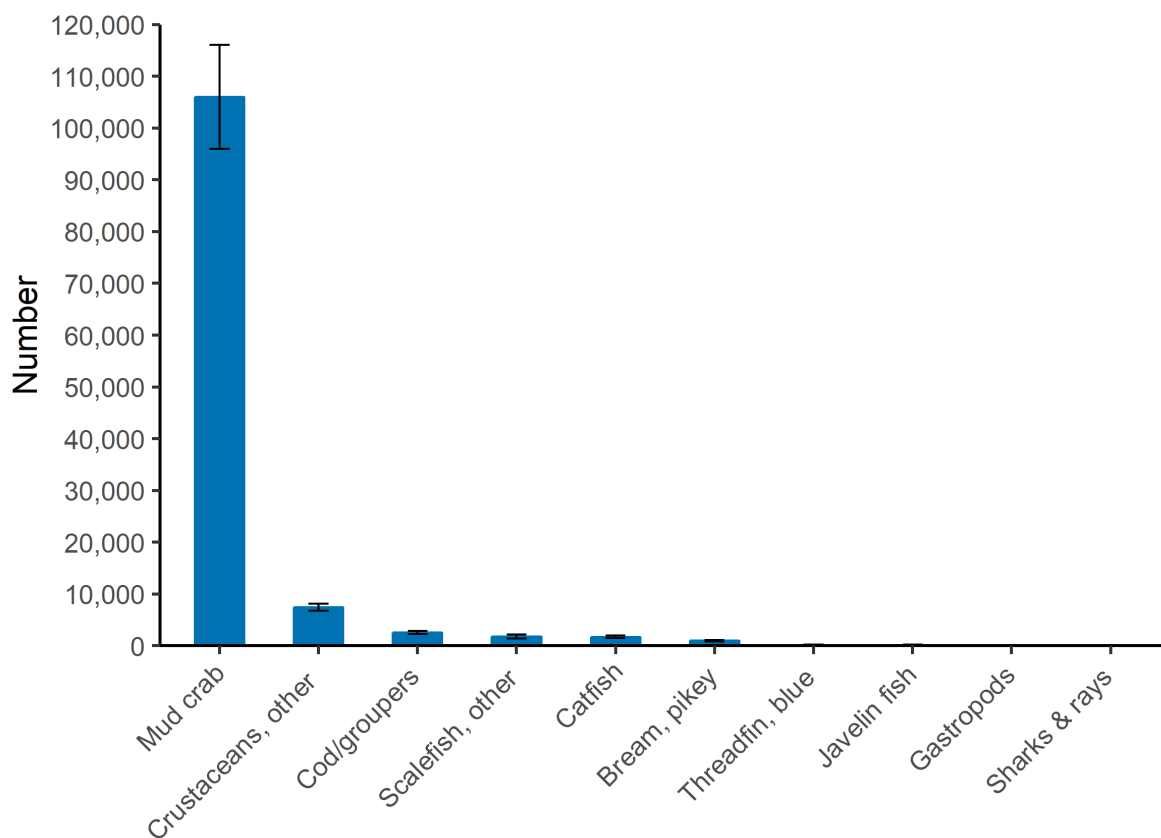
Fish accounted for almost all of the line catch, with Golden Snapper (12.1%) and Stripey Snapper (10.4%) being the most commonly encountered species. Sharks/rays (9.8%), cods/groupers (8.4%), emperors (7.2%) and catfish (7.8%) were less frequently caught with Javelin fish (5.7%) and Barramundi (4.3%) encountered in lower numbers (Figure 12, Appendix 12).



**Figure 12.** Catch estimates (numbers of fish) of the ten most frequent species/groups caught by line fishing methods for recreational fishers in the Greater Darwin Area during the survey period from March 2014 to November 2014. Error bars represent one standard error.

### 5.3.2. Pot

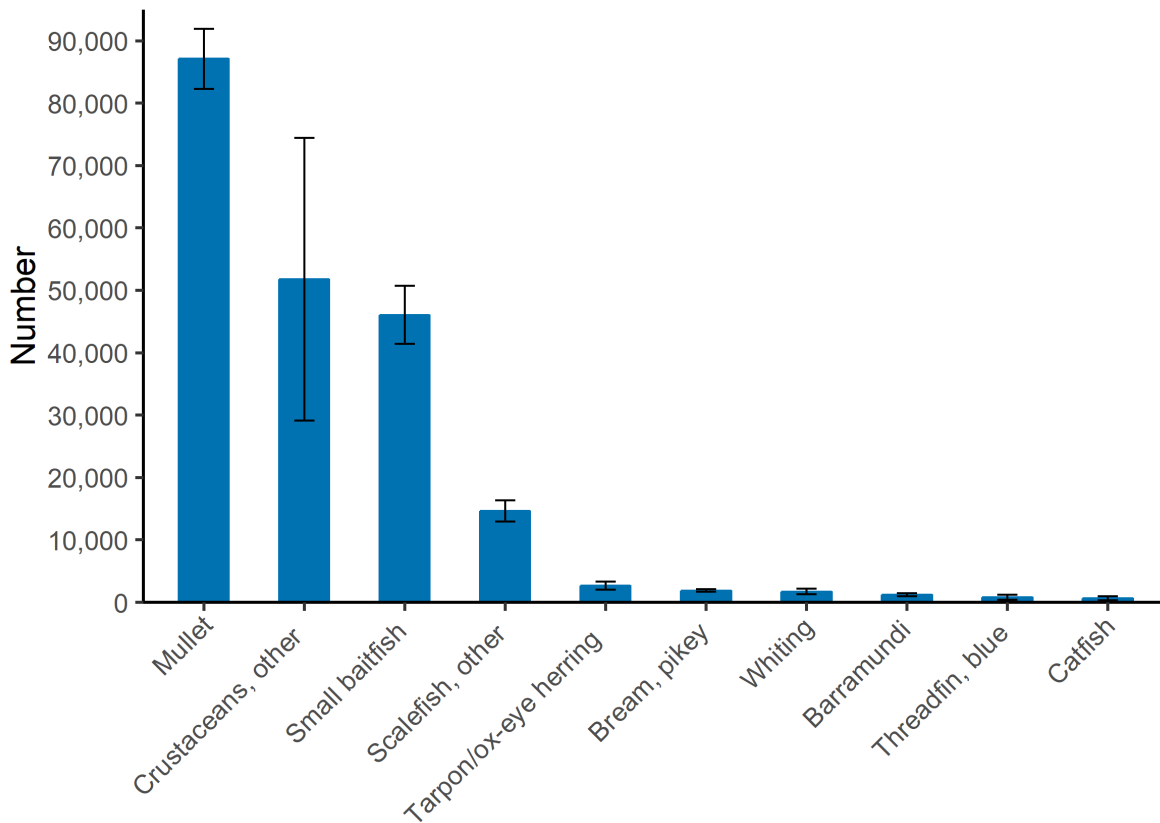
The majority of the pot catch comprised of crustaceans and largely dominated by Mud Crabs (87.5%). The remainder of the catch consisted of other crustaceans (6.1%), primarily Blue Swimmer Crabs, along with incidental fish (6.3%) bycatch (Figure 13, Appendix 12).



**Figure 13.** Catch estimates (numbers of fish) of the ten most frequent species/groups caught by pot fishing methods for recreational fishers in the Greater Darwin Area during the survey period from March 2014 to November 2014. Error bars represent one standard error.

### 5.3.3. Cast net

The cast net catch was dominated by mullet (41.6%). Crustaceans, such as prawns (24.7%) were also a major contributor to the catch from cast nets. The remainder of the catch comprised a mixture of scalefish species totalling 33.6% (Figure 14, Appendix 12).



**Figure 14.** Catch estimates (numbers of fish) of the ten most frequent species/groups caught by cast net fishing methods for recreational fishers in the Greater Darwin Area during the survey period from March 2014 to November 2014. Error bars represent one standard error.

## 5.4. Catch by fishing zone and region

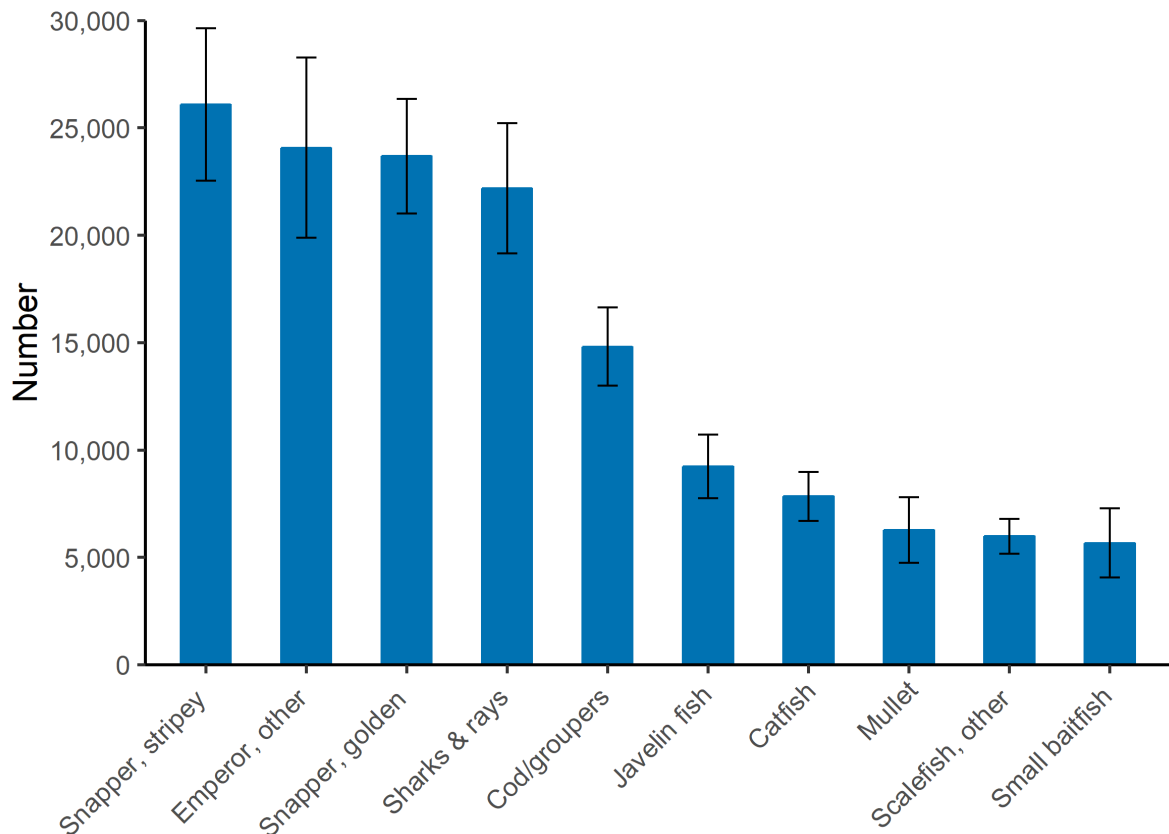
### 5.4.1. Catch by fishing zone

Detailed information on catch by fishing zone is provided in Appendix 13 and are summarised for some key species in Section 6.

The results presented in this sub-section are expanded estimates of the catch of different species in the two separate fishing zones.

#### 5.4.1.1. Bynoe Harbour/Dundee fishing zone

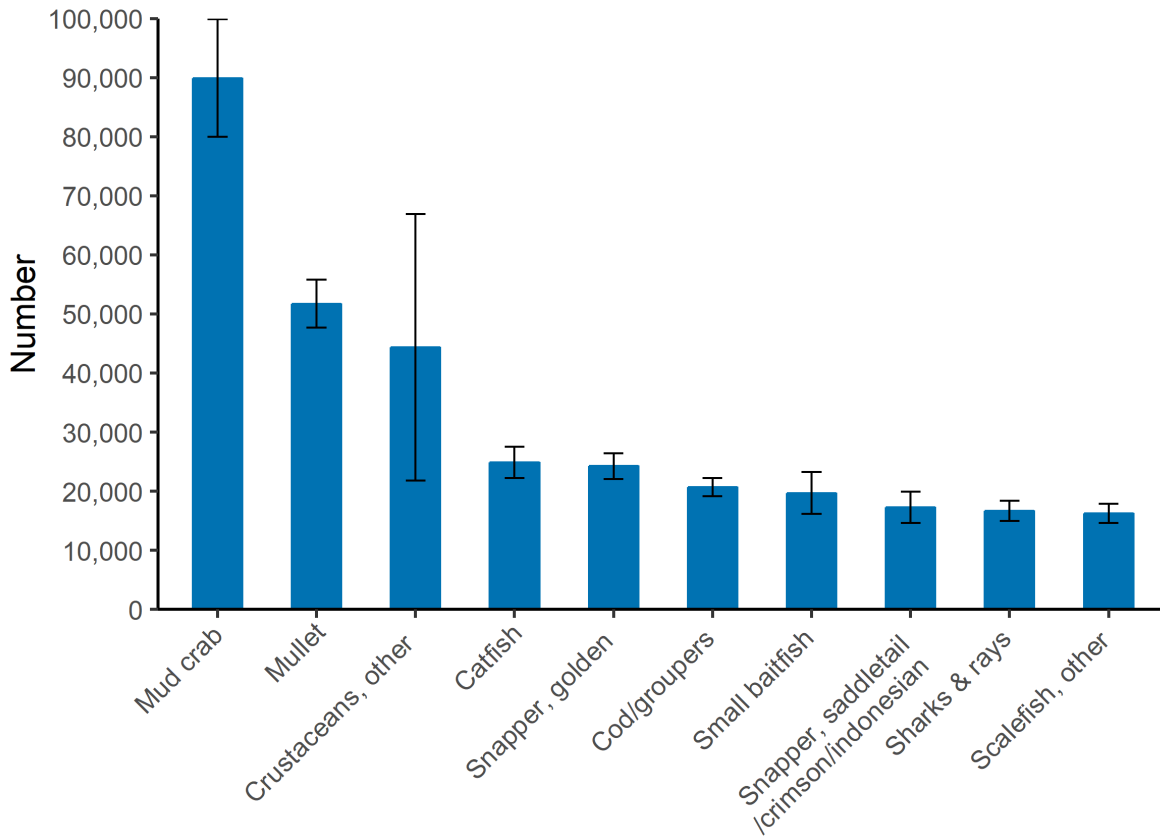
Stripey snapper (13.5%) was the most commonly caught species in the Bynoe Harbour/Dundee fishing zone followed by emperors (12.4%), Golden Snapper (12.2%) and sharks/rays (11.5%) (Figure 15). Only 2.9% of the total catch for the zone was comprised of Mud Crabs.



**Figure 15.** Catch estimates (numbers of fish) of the ten most frequent species/groups caught in the Bynoe Harbour/Dundee fishing zone by recreational anglers during the survey period from March 2014 to November 2014. Error bars represent one standard error.

### 5.4.1.2. Darwin Harbour/Surrounds fishing zone

Mud Crabs (20.3%) dominated the catch from the Darwin Harbour/Surrounds fishing zone, followed by mullet (11.7%) and other crustaceans such as marine prawns and Blue Swimmer Crabs (10%). Excluding baitfish, the most commonly caught fish species were catfish (5.6%), Golden Snapper (5.5%) and cods/groupers (4.7%) (Figure 16).



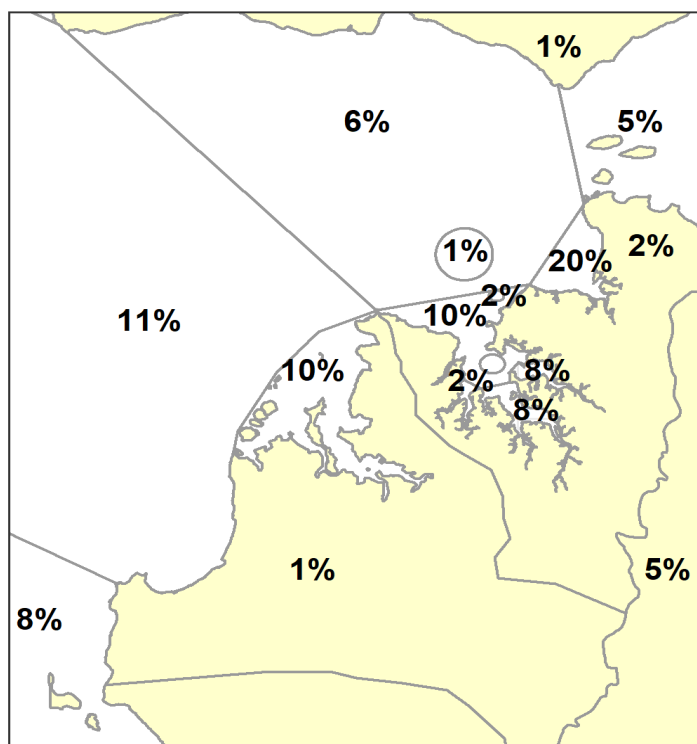
**Figure 16.** Catch estimates (numbers of fish) of the ten most frequent species/groups caught in the Darwin Harbour/Surrounds fishing zone by recreational anglers during the survey period from March 2014 to November 2014. Error bars represent one standard error.

### 5.4.2. Catch by fishing region

Shoal Bay accounted for 20% of the total catch of all aquatic organisms, although this figure was dominated by crustaceans. The Bynoe/Dundee offshore region was the next most significant area producing 11% of the total catch of all aquatic organisms followed by Darwin Harbour with 10% (Figure 17, Appendix 7). Collectively, Darwin Harbour and its tributaries produced 30% of the total catch.

The Bynoe/Dundee offshore region dominated the fish catch with 14.6% of the total fish numbers coming from this area. This catch was composed primarily of reef fish species. Shoal Bay had the next highest catch of fish with 11.9%, primarily due to high numbers of mullet and small baitfish.

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



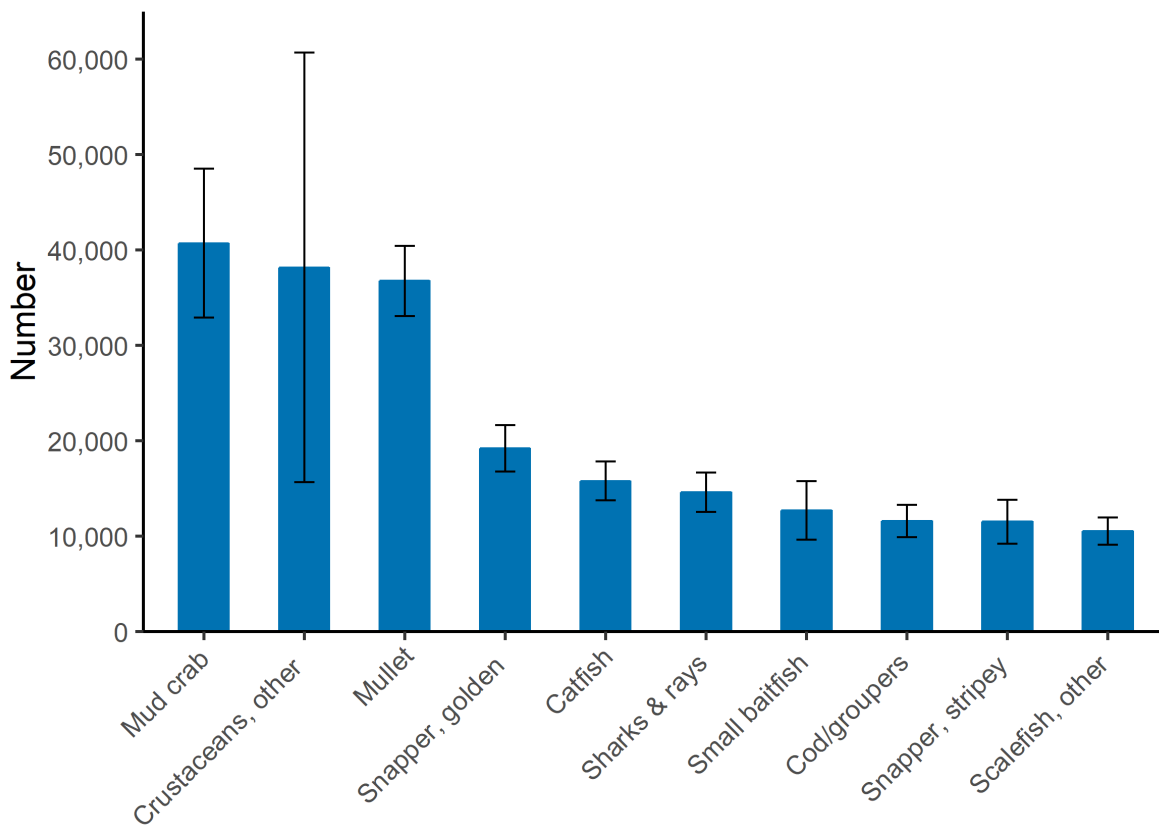
**Figure 17.** Map showing the spatial distribution (percentage) of catch by fishing region in the Greater Darwin Area for recreational fishers during the survey period from March 2014 to November 2014

## 5.5. Catch by season

Full details of the catch by season of the year are provided in Appendix 14. A summary of key species caught during each season is provided 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 40 000 individuals caught in the run-off, about 37 000 in the dry season and only about 17 000 individuals caught during the build-up. The estimated number of Golden Snappers caught was frequently high, irrespective of season.

### 5.5.1. Run-off (March-May)

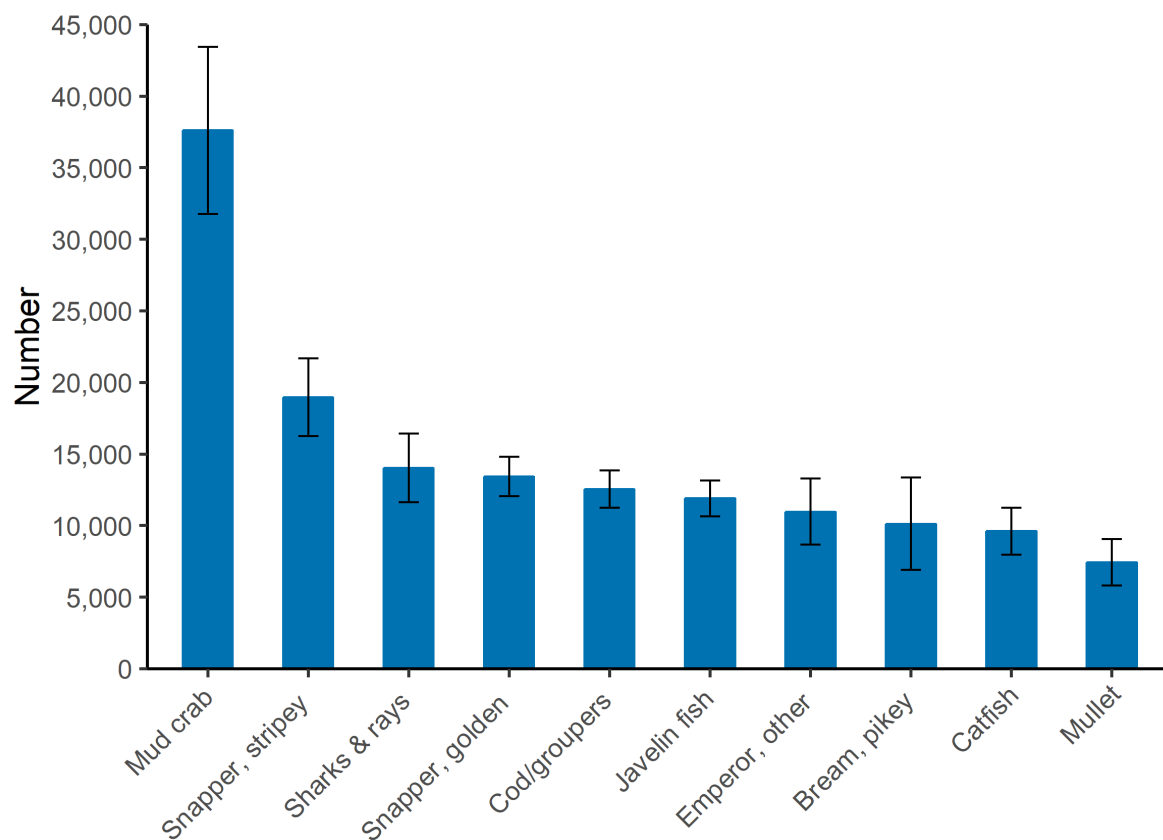
Mud Crabs (15.2%) and other crustaceans such as marine prawns and Blue Swimmer Crabs (14.3% combined) were the primary species caught in the Greater Darwin Area during the run-off period. Excluding mullet (13.7%), Golden Snapper (7.2%) was the most common fish species caught during this period (Figure 18).



**Figure 18.** Catch estimates (numbers of fish) of the ten 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)

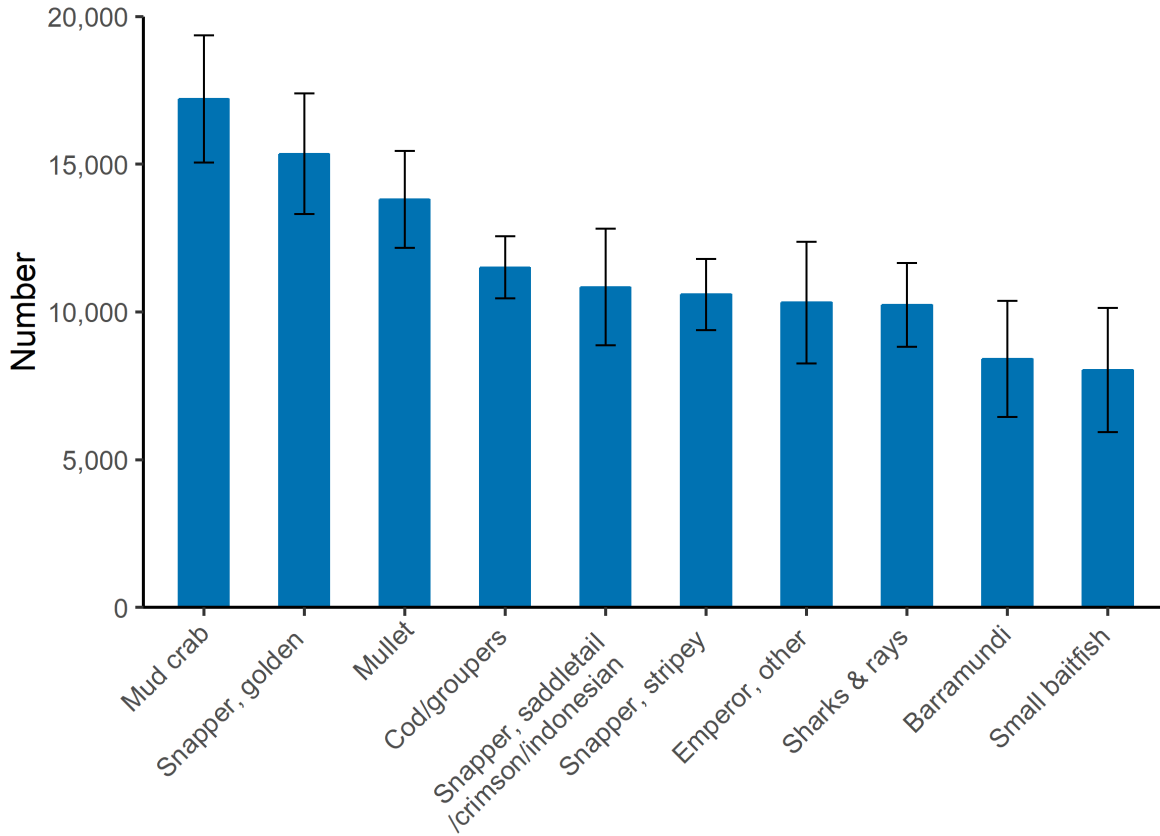
Mud Crabs (18.7%) dominated the catch during the dry season followed by Stripey Snappers (9.4%) and sharks/rays (7%). Golden Snappers (6.7%) also figured strongly in the catch during this period. (Figure 19).



**Figure 19.** Catch estimates (numbers of fish) of the ten 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)

Mud Crabs (10.1%) were again prominent in the catch however the catch of all species was lower in the build-up compared to other seasons (Figure 20).



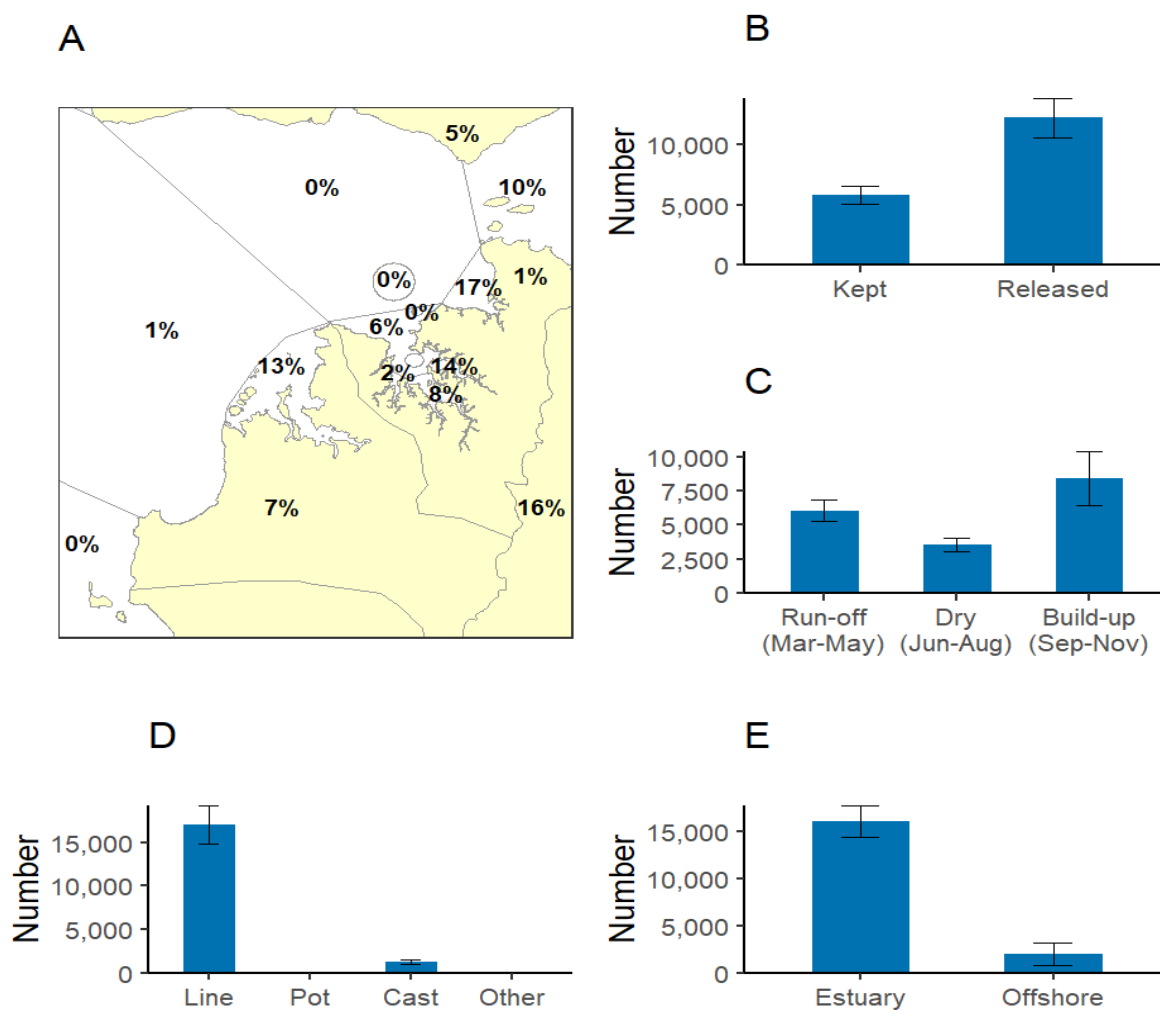
**Figure 20.** Catch estimates (numbers of fish) of the ten most frequent species/groups caught in the Greater Darwin Area by recreational anglers during the build-up (Sept-Nov) season. Error bars represent one standard error.

## 6. Key species profiles

### 6.1. Barramundi (*Lates calcarifer*)

Barramundi are an iconic fish that are a major target species in the recreational fishery. 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 (30%), Shoal Bay (17%) and the Adelaide River (16%). Bynoe Harbour (13%) and the coastal areas surrounding Leaders Creek, Cape Hotham and Melville Island (10%) were also major contributors (Figure 21A). Almost 68% of all Barramundi captured were released (Figure 21B). Barramundi were captured throughout the survey period with the highest catches recorded in the build-up (46.7%) followed by the run-off (33.7%) and the dry season (19.6%) (Figure 21C). The majority of Barramundi captures were by line fishing methods (93.4%) (Figure 21D) and predominantly from estuarine waters (88.8%) (Figure 21E).

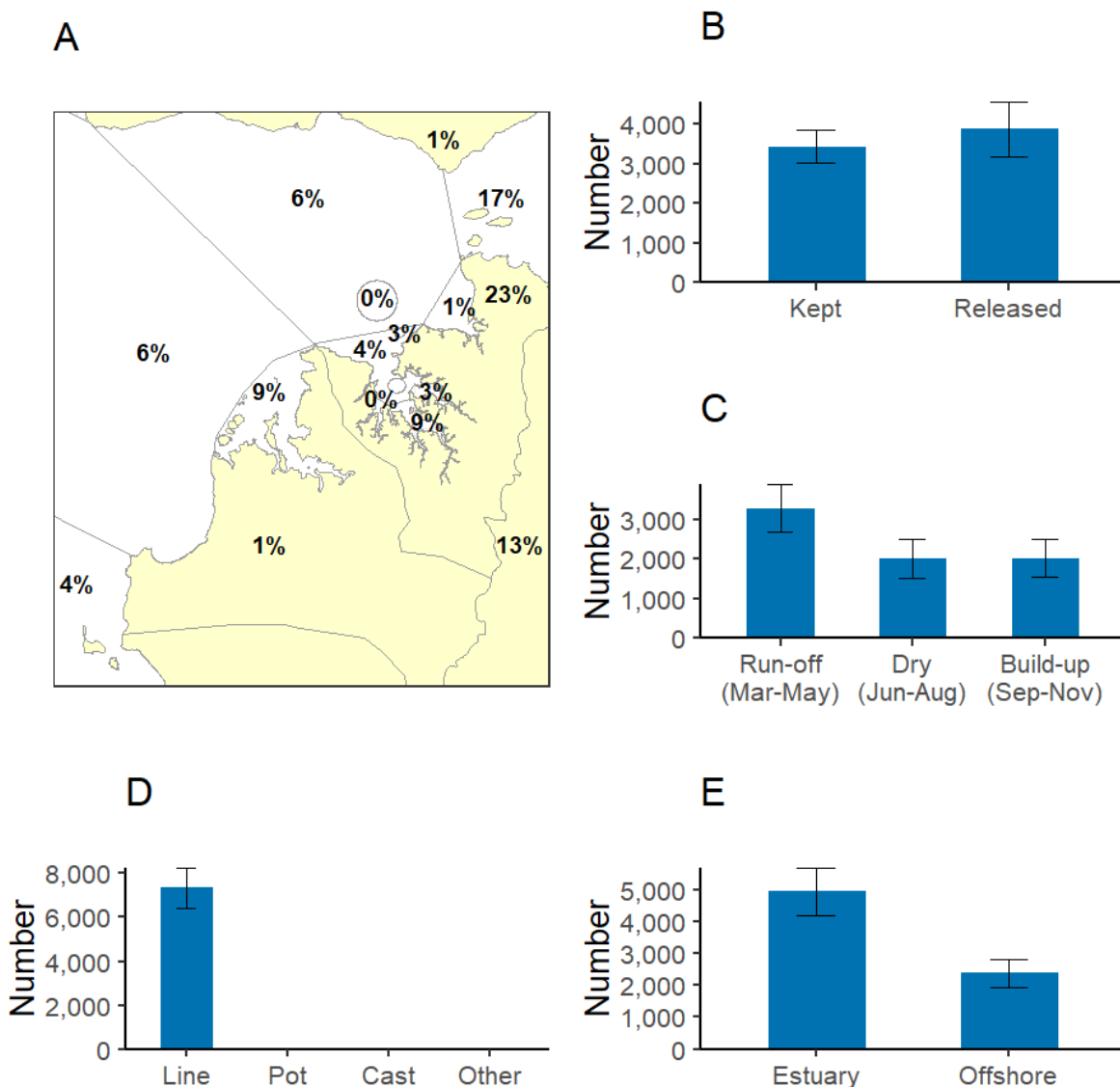


**Figure 21.** Summary results for Barramundi in the Greater Darwin Area from March 2014 to November 2014: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

## 6.2. Black Jewfish (*Protonibea diacanthus*)

Black jewfish has been identified as a species of concern in the Greater Darwin Area and is at high risk of overfishing (Grubert et al. 2010). Black jewfish is considered an indicator species of reef fish sustainability and close monitoring of the jewfish population and the size of recreational catch is necessary to gauge the recovery of these stocks in the Darwin area.

Recreational catches of Black Jewfish occurred within the Leaders Creek region (23%), Darwin Harbour (19%) and the Vernon Islands, Cape Hotham and Melville Island region (17%) (Figure 22A). More than 53% of all Black Jewfish captured were released (Figure 22B) with the highest catches reported in the run-off (45%) followed by the build-up and dry season each with around 27.5% of the total (Figure 22C). All Black Jewfish were caught using line fishing methods (Figure 22D) with 67.4% of individuals caught in estuarine waters (Figure 22E).

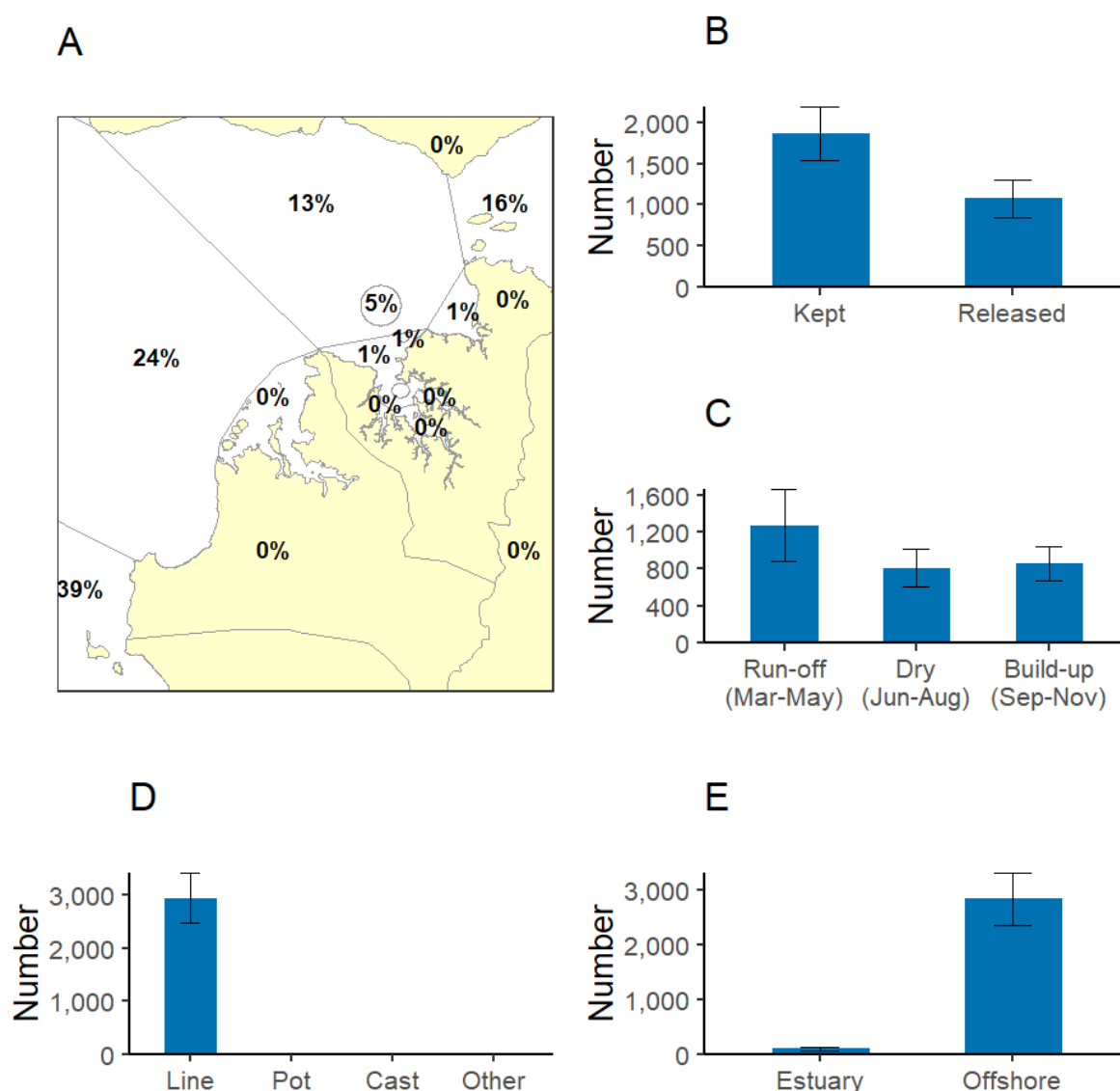


**Figure 22.** Summary results for Black Jewfish in the Greater Darwin Area from March 2014 to November 2014: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

### 6.3. Coral Trout (*Plectropomus maculatus*)

Coral Trout is a prized table fish in the Top End and details of the recreational harvest of this fish can provide additional information about the general health of reef fish stocks in the Greater Darwin Area.

The greatest proportion of the recreational catch of Coral Trout in the Greater Darwin Area occurred around the Peron Islands (39%). The offshore Dundee area (24%) and the Vernon Islands (16%) were also significant areas for the capture of Coral Trout (Figure 23A). More than 66% of all Coral Trout captured were kept (Figure 23B). The highest catch of Coral Trout occurred in the run-off (44.3%) followed by the build-up (29.1%) and the dry season (27.5%) (Figure 23C). All Coral Trout were caught using line fishing methods (Figure 23D) and they were captured almost exclusively in offshore waters (97%) (Figure 23E).

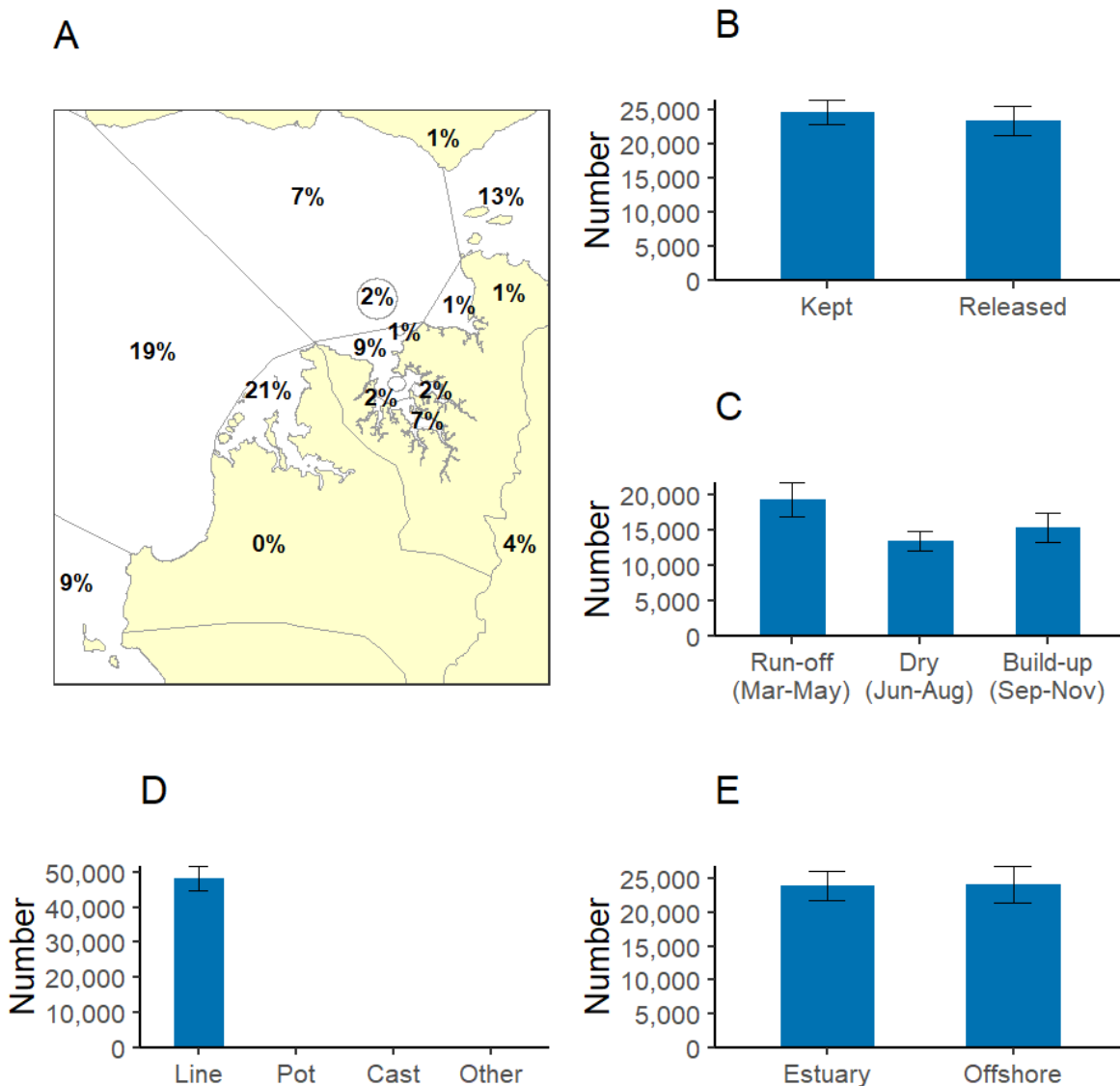


**Figure 23.** Summary results for Coral Trout in the Greater Darwin Area from March 2014 to November 2014: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

## 6.4. Golden Snapper (*Lutjanus johnii*)

Golden Snapper has been identified as a species of concern in the Greater Darwin Area and is at risk of overfishing (Grubert et al. 2010). Golden Snapper is considered an indicator species of reef fish sustainability and close monitoring of the population and the size of the recreational catch is necessary to gauge the recovery of these stocks in the Darwin area.

The majority of the recreational catches of Golden Snapper occurred within Darwin Harbour (21%), Bynoe Harbour (21%) and the area offshore from Dundee (19%) (Figure 24A). Just under half of all Golden Snapper captured were released (48.7%) (Figure 24B). Golden Snapper were captured throughout the survey period with the highest catches occurring in the run-off (40%) followed by the build-up (32%) and the dry season (28%) (Figure 24C). Almost all Golden Snappers were caught using line fishing methods (99.8%) (Figure 24D) with catches being shared evenly between offshore waters (50.2%) and estuarine waters (49.8%) (Figure 24E).

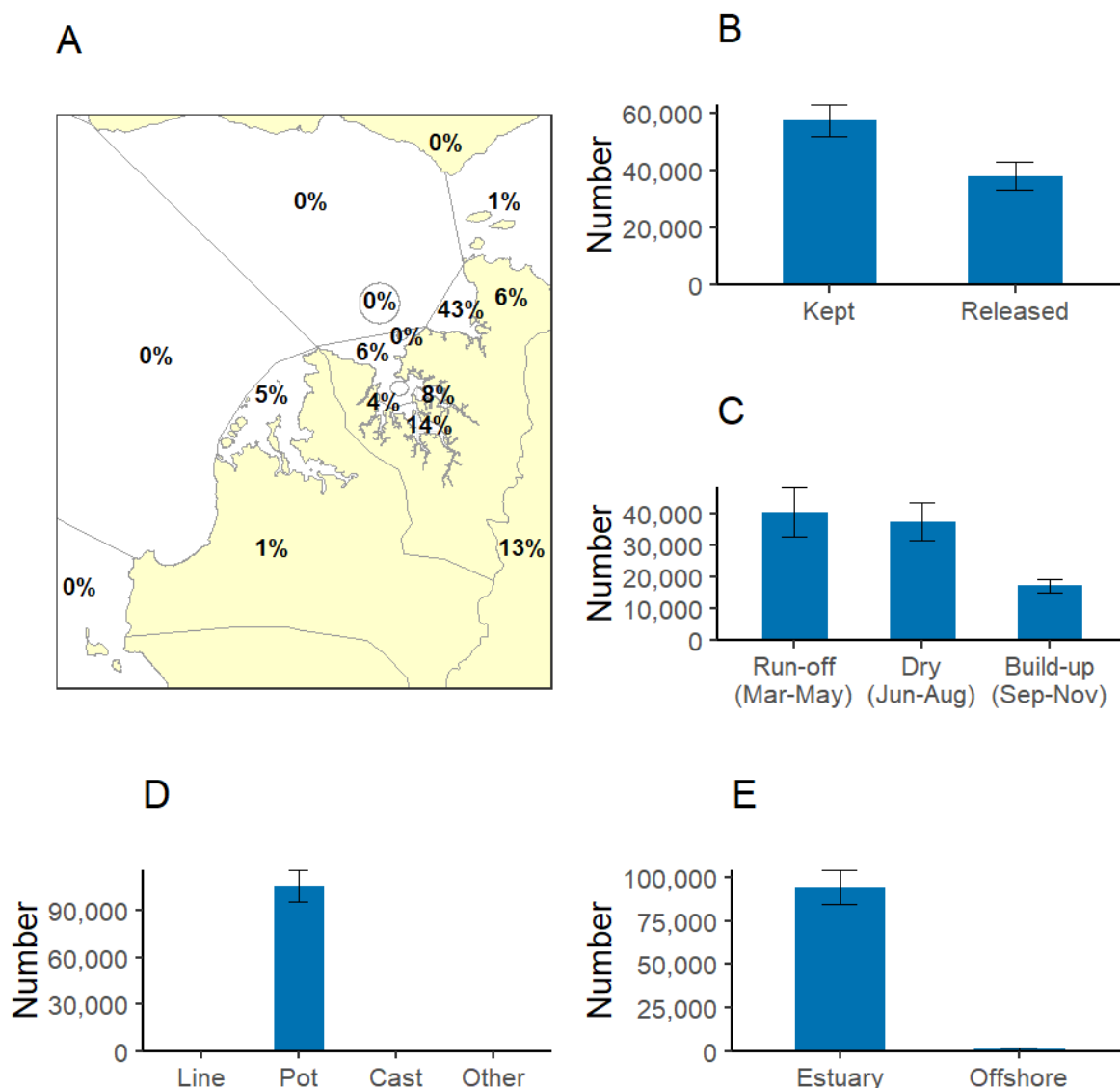


**Figure 24.** Summary results for Golden Snapper in the Greater Darwin Area from March 2014 to November 2014: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

## 6.5. Mud Crab (*Scylla* spp.)

Mud Crabs are an iconic Top End species and are the primary target of many fishermen due to their desirable eating qualities.

The majority of the recreational catch of Mud Crabs in the Greater Darwin Area came from Shoal Bay (43%) followed by Darwin Harbour (32%) and to a lesser extent the Adelaide River (13%) (Figure 25A). Just over 60% of all Mud Crabs captured were kept (Figure 25B) with the highest catches occurring during the run-off (30%) and the dry season (28%). The build-up months produced 13% of the Mud Crab catch for the survey period (Figure 25C). The vast majority of Mud Crabs were caught in pots (99.8%) with minor catches by line or spear (Figure 25D). Almost all Mud Crabs were caught in estuarine waters (98.8%) (Figure 25E).

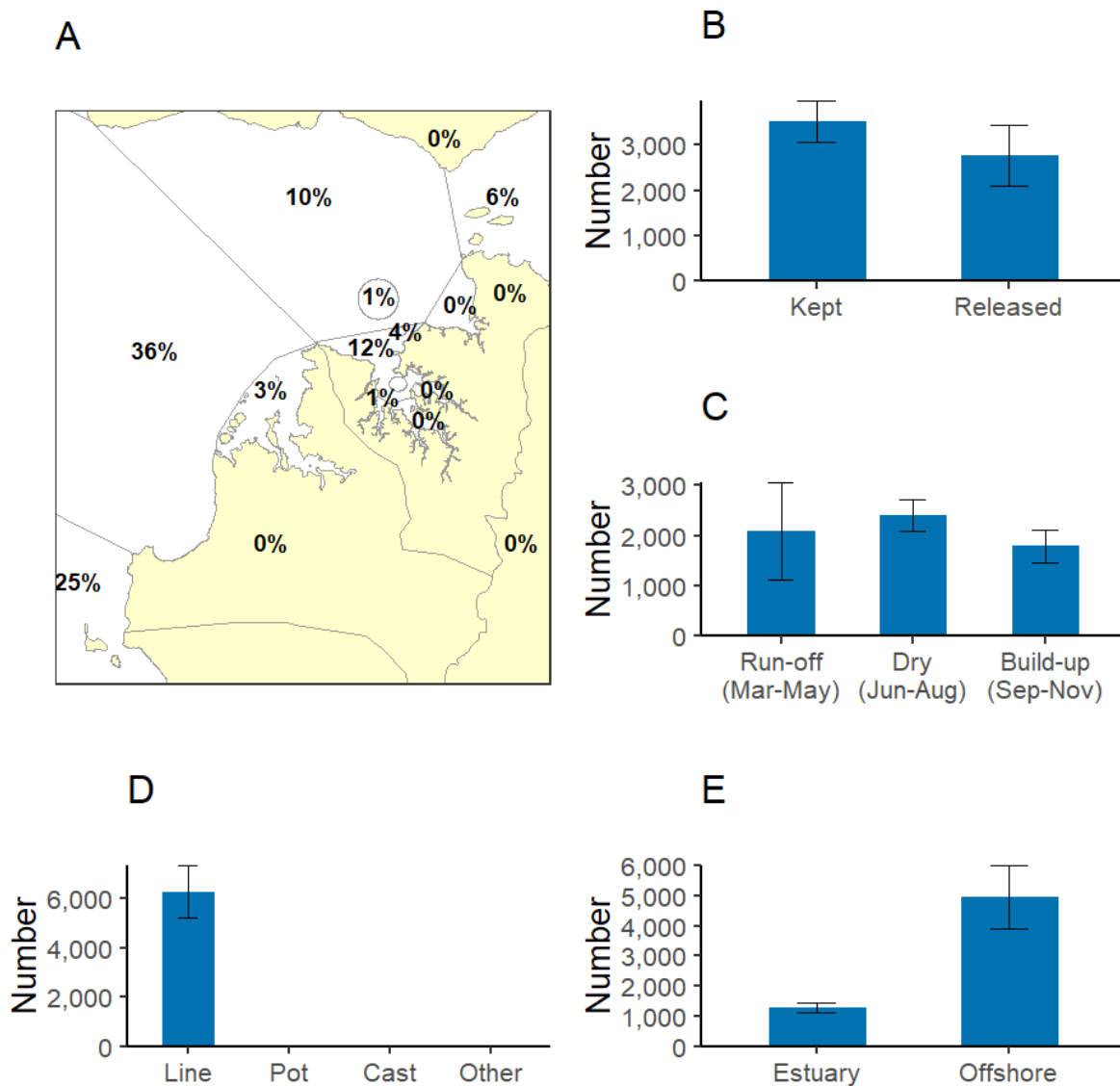


**Figure 25.** Summary results for Mud Crab in the Greater Darwin Area from March 2014 to November 2014: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

## 6.6. Spanish Mackerel (*Scomberomorus commerson*)

Spanish Mackerel is an important sportfish in the Top End, particularly during the dry season when large numbers of these apex predators come close to the coast, making them more accessible to recreational anglers.

The majority of the recreational catch of Spanish Mackerel in the Greater Darwin Area occurred offshore of Dundee and Bynoe Harbour (36%) and the Peron Islands (25%) (Figure 26A). Approximately 56% of all Spanish Mackerels captured were kept (Figure 26B) with the highest catches occurring during the dry season (38.3%) followed by the run-off (33.2%) and the build-up (28.5%) (Figure 26C). All Spanish Mackerels were caught using line fishing methods (Figure 26D), predominantly from offshore waters (79.3%) (Figure 26E).

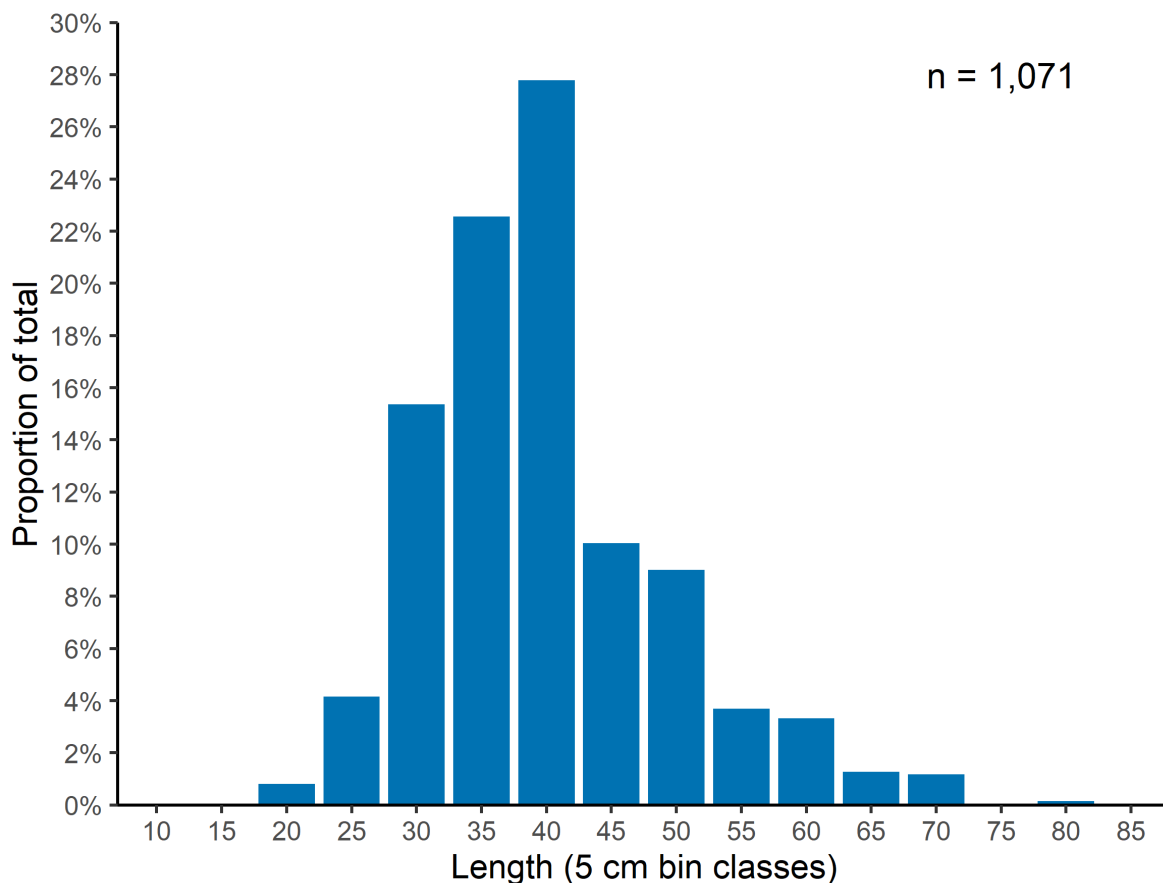


**Figure 26.** Summary results for Spanish Mackerel in the Greater Darwin Area from March 2014 to November 2014: A) proportion (%) of the total catch by region, B) total numbers kept and released, C) catch by season D) proportion (%) of catch by fishing method and E) total catch by water body. Error bars represent one standard error.

## 7. Length and sex data

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

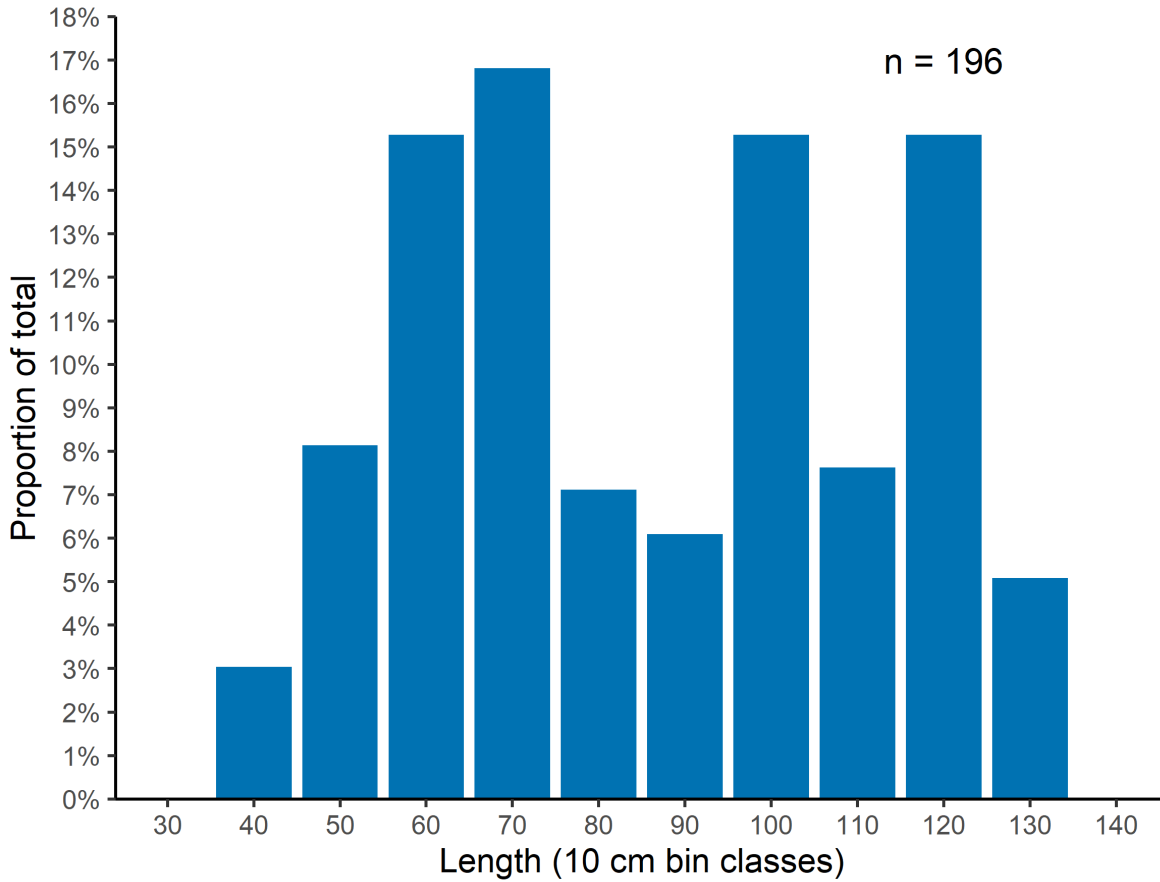
The length of harvested Golden Snappers ranged from 15 to 80 cm. The most frequent length was 40 cm and the mean length was 40 cm (Figure 27).



**Figure 27.** Length distribution of harvested Golden Snappers from the Greater Darwin Area taken by recreational fishers during the survey period from March 2014 to November 2014.

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

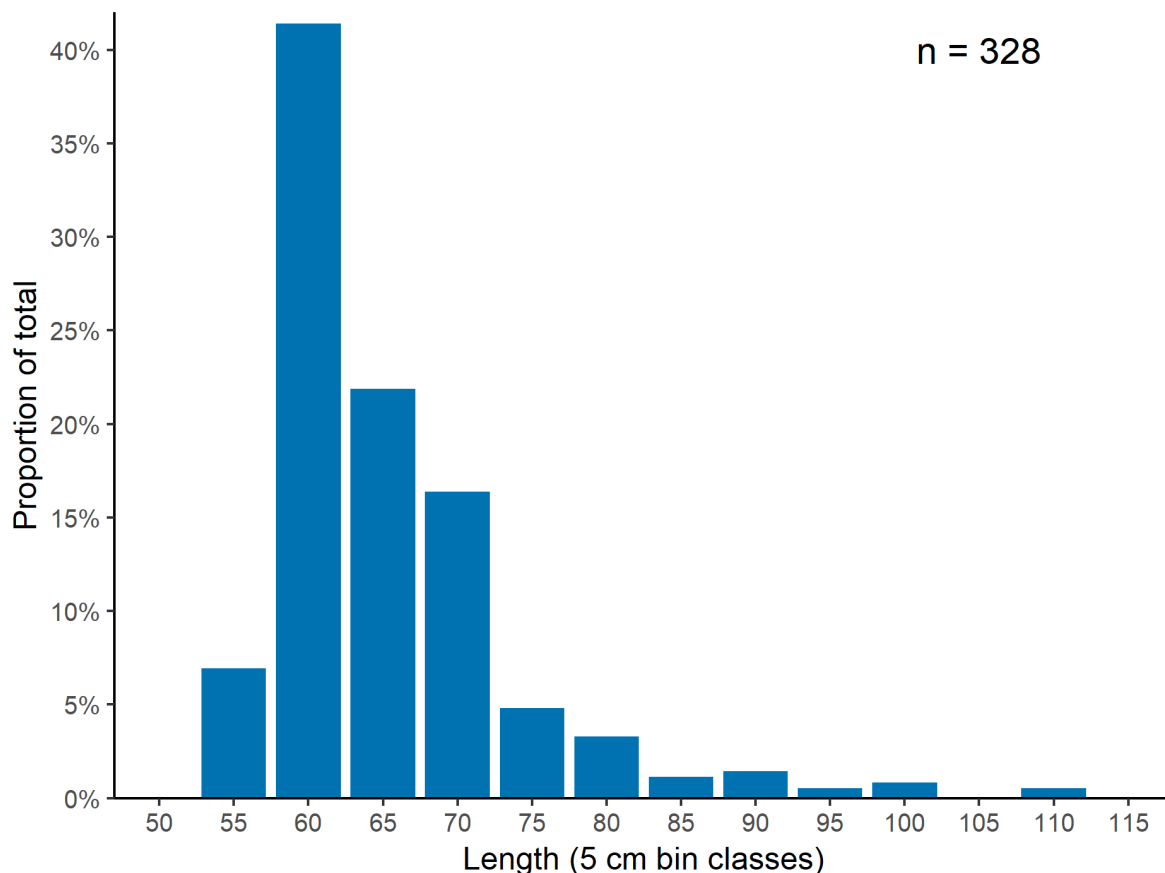
The length of harvested Black Jewfish ranged from 35 to 130 cm. The most frequent length was 70 cm and the mean length was 84 cm (Figure 28).



**Figure 28.** Length distribution of harvested Black Jewfish from the Greater Darwin Area taken by recreational fishers during the survey period from March 2014 to November 2014.

### 7.3. Barramundi (*Lates calcarifer*) harvest length data

The length of harvested Barramundi ranged from 55 to 110 cm. The most frequent length was 60 cm and the mean length was 64 cm (Figure 29).

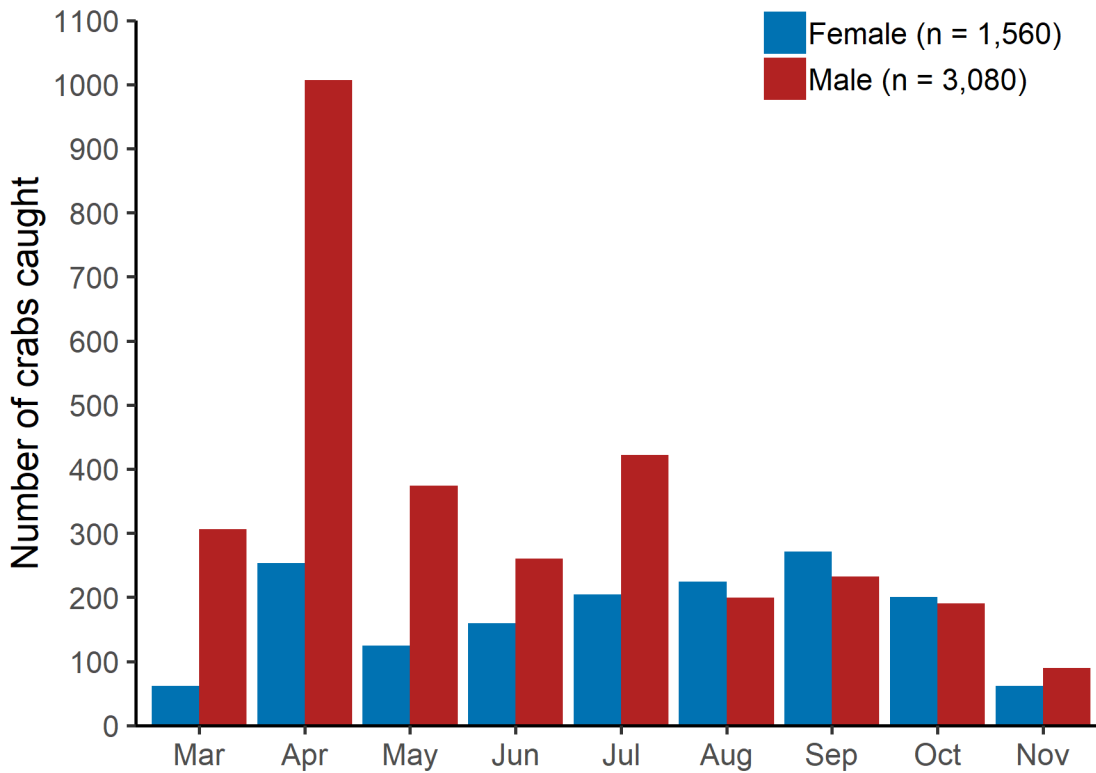


**Figure 29.** Length distribution of harvested Barramundi from the Greater Darwin Area taken by recreational fishers during the survey period from March 2014 to November 2014.

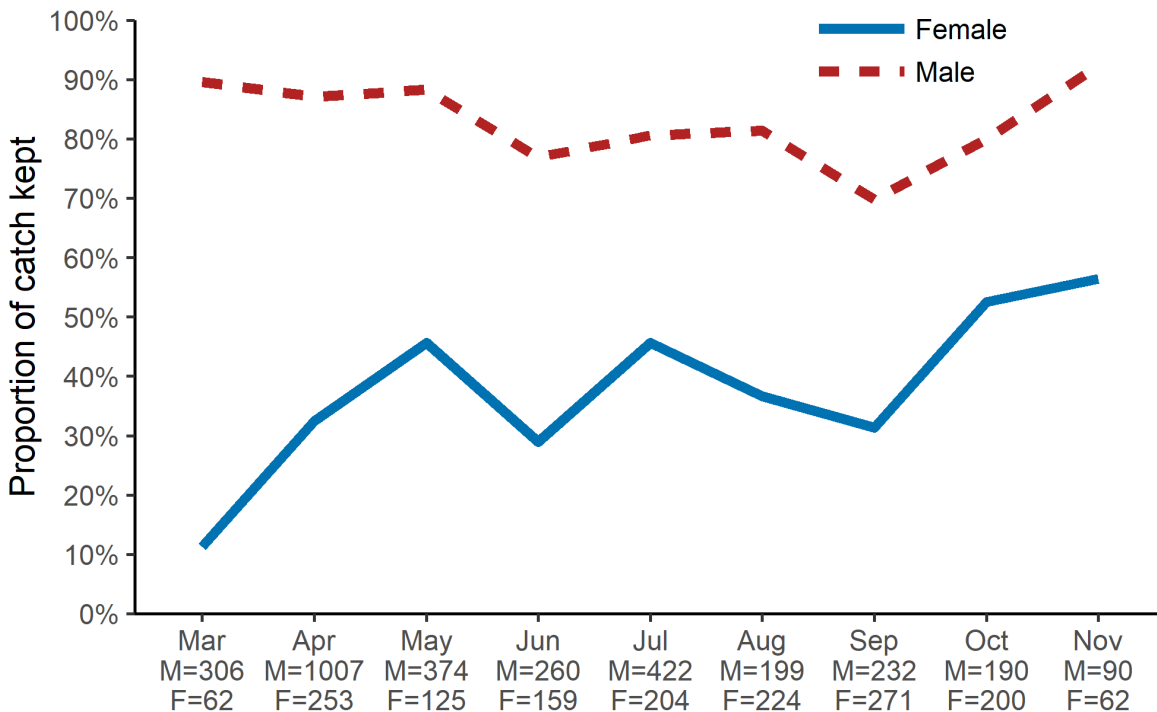
### 7.4. Mud Crab sex data

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. The overall catch was highest in April and decreased towards the end of the year (Figure 30), noting that care must be exercised when interpreting these results due to sampling artefacts (such as differences in people's ability to identify the gender of mud crabs).

Of the male crabs caught, 84% were kept, whereas only 38% of female crabs were retained. The proportion of males kept each month was always high (at least 70%), but the proportion of females kept increased from March to November (from 11% to 56%; Figure 31).



**Figure 30.** Monthly catch of male and female Mud Crabs by recreational fishers in the Greater Darwin Area during the survey period from March 2014 to November 2014.

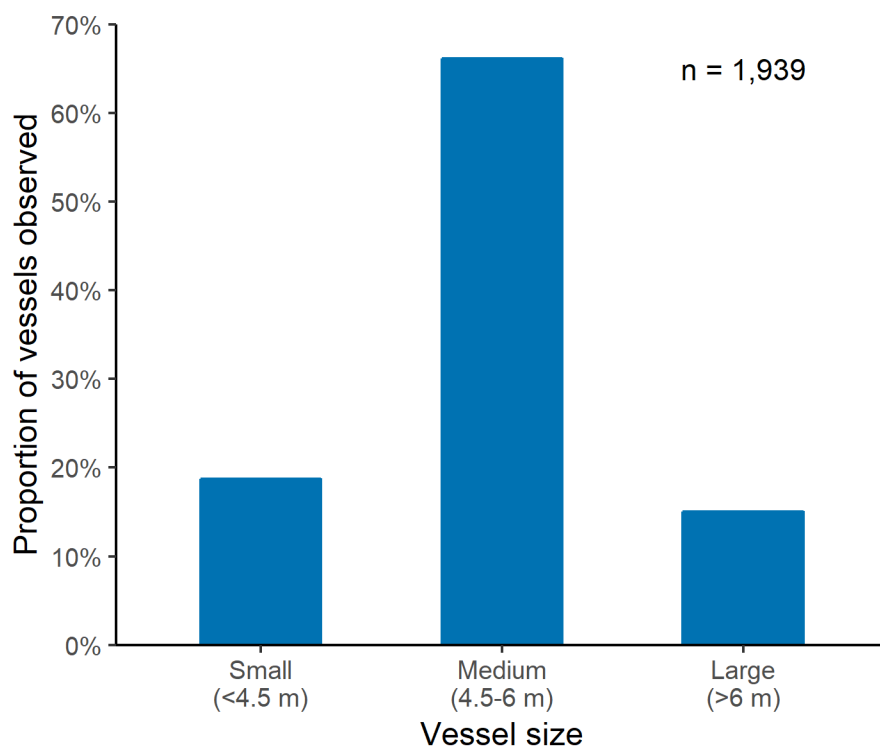


**Figure 31.** The proportion of Mud Crab catch (n=4640) kept by month for each sex by recreational fishers in the Greater Darwin Area during the survey period from March 2014 to November 2014.

## 8. Vessel characteristics and technology

### 8.1. Vessel size

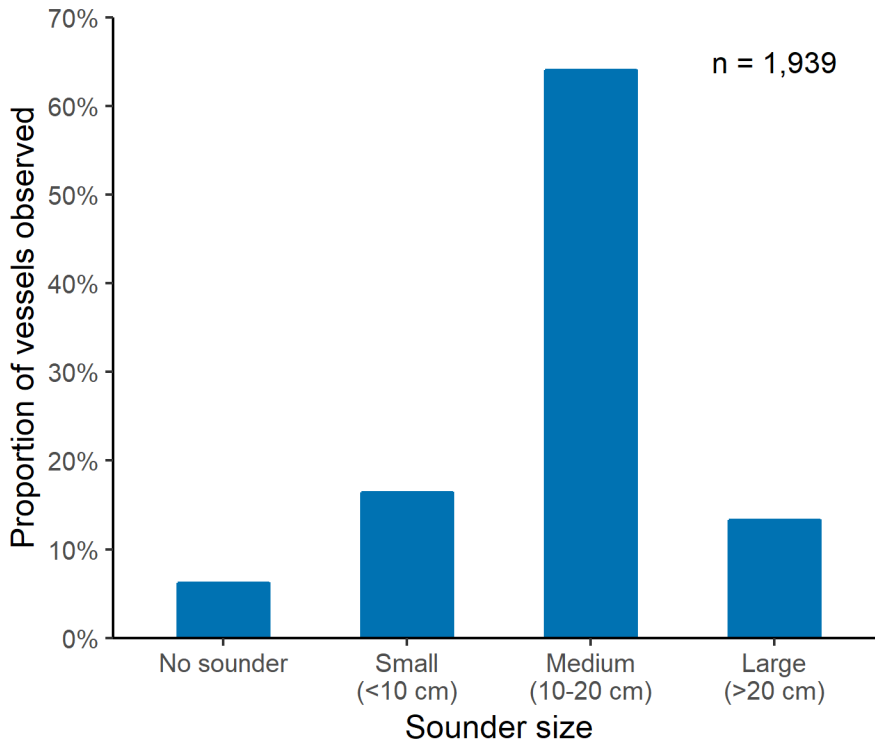
More than 80% of the recreational vessels observed were 4.5 m long or larger (Figure 32).



**Figure 32.** The proportion of recreational fishing vessels by size class in the Greater Darwin Area during the survey period from March 2014 to November 2014.

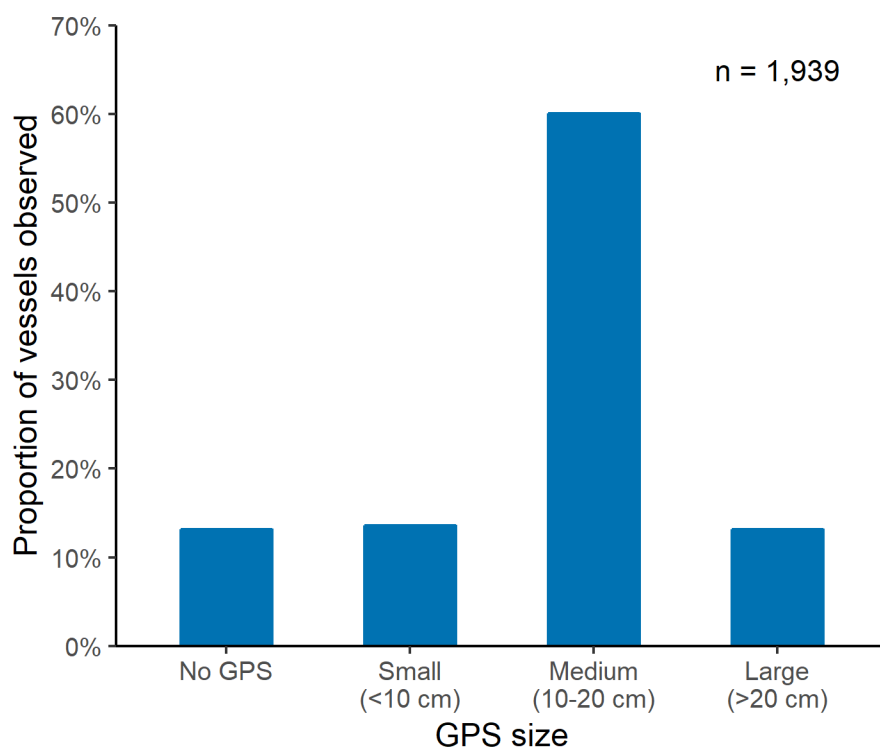
## 8.2. Vessel technology

More than 93% of the recreational fishing vessels observed were fitted with sounders (Figure 33). Most vessels (64%) had a sounder screen size ranging from 10 to 20 cm.



**Figure 33.** 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 2014 to November 2014.

More than 85% of recreational fishing vessels surveyed were fitted with a GPS (Figure 34). Most vessels (60%) had a GPS screen size of 10 to 20 cm and were often an integrated component of the sounder unit.



**Figure 34.** 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 2014 to November 2014.

The use of sounders and GPS varied with boat size; however, the general trend indicated advanced technology was more frequently associated with larger vessels compared with smaller vessels. Nonetheless, 94% of all vessels surveyed had a sounder and 87% 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 lacks the technology.

## 9. Summary and future research

This report summarises the key results from the 'Survey of Recreational Fishing in the Greater Darwin Area 2014' 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

The previous Survey of Recreational Fishing 2009-10 was predominantly an NT-wide survey using a telephone-diary methodology that collated data from NT residents only. An additional survey data set was collected from both resident and visiting anglers via on-site boat ramp surveys in 2009-10. If comparisons are to be made between the on-site surveys (2009-10 and 2014) the data set included in this report must be compared with the estimated totals in Tables 24 to 26 and Appendices 17 to 25 from West et al. 2012.

Comparisons between survey results from 2009-10 and 2014 are confounded by differences in fishing regions surveyed and the time period over which those surveys occurred. On-site data presented in the 2009-10 report did not include catch and effort from the Offshore Daly River area (Region 42) or the Saltwater Arm boat ramp (Ramp 22), whereas the 2014 survey did. It is also noted the catch and effort from the Dundee region presented in the 2009-10 report includes data for the period of June – November whereas the current survey included data for this region from March – November. Finally, the 2009-10 boat ramp surveys were conducted over a nine month period, whereas the 2014 survey included a ten-month period with the addition of data for the month of March. In effect, the current survey includes an increase in both spatial and temporal coverage over the boat ramp surveys conducted in 2009-10.

In order to compare between surveys, we have removed the raw data associated with the additional spatial and temporal coverage from the 2014 survey and have re-analysed the data to reveal the following:

- Fishing effort (days fished) has increased in both fishing zones in the period from 2009 to 2014 with effort in the Darwin Harbour/Surrounds and Bynoe Harbour/Dundee fishing zone increasing by an estimated 6% and 10%, respectively.
- Overall (both fishing zones combined) the number of days fished has increased by 6.5%.
- Despite a modest increase in effort between 2009 and 2014, the total catch (number) of all aquatic organisms has increased substantially over the same period. The total catch of aquatic organisms has increased in Darwin Harbour/Surrounds and Bynoe Harbour/Dundee fishing zone by 77% and 58% respectively. This increase in catch was predominantly due to an increase in reporting of crustaceans, including Mud Crabs, Blue Swimmer Crabs and marine prawns. Other species to contribute heavily to the reported catch increase were mullet, small baitfish, sharks/rays, Javelin fish, Stripey Snapper and catfish.

There are a number of additional factors that may have contributed to this estimated increase in catch. Firstly, these recreational surveys were conducted in different years and

the increased catch could simply be the result of a more productive fishing season being sampled in the current survey. It is also important to note that catches of crustaceans are inherently variable within any survey period and the precision of these catch estimates (i.e. standard errors) are generally large. Therefore, the reported increase in crustacean catches in 2014 needs to be viewed with some caution.

The recent advances in fishing technology will have also contributed to a proportion of the increases in catch. Sounder technology, such as side scan functions are now allowing fishers to locate fish more effectively than ever before and social media is accelerating the sharing of information regarding fish aggregations and periods of high catch. The ability to link the sounder to an electric motor is also permitting anglers to fish directly over fish aggregations, foregoing the need to anchor and thereby increasing the ability to consistently target schools. Additionally, better long-range weather forecasting allows anglers the confidence to travel further and to also target fish during short windows of good weather. Major improvements in gear technology (braided line, rods, reels, lures) have also increased fishing power. The combination of all these technological advances are undoubtedly contributing to catch increases and should be concerning considering the growing evidence suggesting the likelihood of over-exploitation of some local fish populations.

## 9.2. Future monitoring

Recent assessments have indicated that many of the reef fish commonly encountered around Darwin are at high risk of overfishing (Grubert et al. 2010) (NT Government 2014) and Golden Snapper and Black Jewfish have been overfished (Grubert et al. 2013). The findings from this survey will no doubt provide further valuable information on which to help monitor the health of these reef fish stocks. Furthermore, a real benefit of surveys is in documenting trends of fishing activity over time. For this reason, a survey of the Greater Darwin Area is to be repeated in subsequent years. These successive surveys, using similar methodologies, will for the first time allow for a longitudinal assessment of recreational fishing activity, improve our knowledge of fisher behaviour and provide managers with accurate and current data to incorporate into long-term management plans.

## 10. Acknowledgments

The contribution of the following is gratefully acknowledged:

- 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, Kane Dysart, Evan Needham, Chris Errity, Mark Grubert, Will Bowman, James Woodhams, Steve Sly, Hock Seng-Lee and Patti Kuhl.
- The on-site survey interviewing team of Clint Cameron, Ann Hyder, Peter Novak, Phil Parker, Keith Saunders and Barry Scott who worked tirelessly in all weather conditions to obtain quality data.
- Lastly, and most importantly, we would like 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.

## 11. References

- Grubert, M. A., Kuhl, P. J. and Penn, J. W. (2010). Ecological Risk Assessment. Northern Territory Coastal Line Fishery. Northern Territory Government, Australia. Fishery Report No. 103.
- Grubert, M. A., Saunders, T. M., Martin, J. M., Lee, H. S. and Walters, C. J. (2013). Stock Assessments of Selected Northern Territory Fishes. Fishery Report No. 110.
- Henry, G. W. and Lyle, J. M. (2003). The National Recreational and Indigenous Fishing Survey. Final Report to the Fisheries Research and Development Corporation, Project 99/158. NSW Fisheries Final Report Series No. 40, 188 pp.
- Northern Territory Government (2012). Economic Contribution of Fishing Tour Operators in the Northern Territory. Department of Resources.
- Northern Territory Government (2014). Fishery Status Reports 2012. Department of Primary Industry and Fisheries. Fishery Report No. 113.
- Northern Territory Government (2015). Media Release: NT Recreational Fishing Awards in sight. <http://newsroom.nt.gov.au/mediaRelease/14520>
- Pollock, K. H., Jones, C. M. and Brown, T. L. (1994). Angler survey methods and their application in fisheries management. *American Fisheries Society*, Special Publication 25, Bethesda, Maryland.
- R Development Core Team (2008). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0.
- SSA (2015). AS 5300 – 2015 Australian Fish Names Standard. Seafood Services Australia.
- West, L. D., Lyle, J. M., Matthews, S. R., Stark, K. E. and Steffe, A. S. (2012). Survey of Recreational Fishing in the Northern Territory, 2009 - 10. Northern Territory Government, Fishery Report No. 109.

## 12. Appendices

### Appendix 1: Glossary of terms

<b>Barotrauma</b>	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.
<b>Build-up</b>	The weather during September, October and November in the NT.
<b>Catch</b>	The total number of organisms caught, whether kept or released.
<b>Cephalopods</b>	A diverse group of molluscs that includes squid, cuttlefish and nautilus.
<b>Crustaceans</b>	A group of arthropods that includes crabs, lobster (crayfish) and prawns.
<b>Days fished</b>	Days spent recreational fishing by fishers.
<b>Dry season</b>	The weather during June, July and August in the NT.
<b>Estuary</b>	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.
<b>Fish</b>	Includes both teleost (bony fishes) and elasmobranchs (sharks/rays).
<b>Gastropods</b>	A group of molluscs that include snails (e.g. abalone, Telescopium [longbums]), periwinkles, conches and whelks.
<b>Harvest</b>	The total number of organisms retained or kept from the catch; the same as kept catch.
<b>Fisher hours</b>	Hours spent recreational fishing by fishers.
<b>Kept catch</b>	The total number of organisms harvested or retained from the catch; the same as harvest.
<b>Offshore</b>	All areas seaward of the coastline and estuaries.
<b>Primary sampling unit</b>	A calendar day that fell within the survey period.

<b>Recreational fisher</b>	Anyone more than five years old that went recreational fishing in the Greater Darwin Area during the survey period.
<b>Recreational fishing</b>	The capture or attempted capture of aquatic organisms for non-commercial purposes.
<b>Relative standard error</b>	The standard error of an estimate divided by the estimate and expressed as a percentage.
<b>Released catch</b>	The total number of organisms from the catch released back into the water.
<b>Residents</b>	People who normally reside in the Northern Territory.
<b>Run-off</b>	The period during March, April and May.
<b>Shift</b>	A five hour period of the day in which interviewers collected data from a boat ramp.
<b>Visitors</b>	People who normally reside outside the NT.

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

Season	Day type	Total
Wet # (December, January, February)	WD	61
	WE	29
Run-off (March, April, May)	WD	61
	WE	31
Dry (June, July, August)	WD	62
	WE	30
Build-up (September, October, November)	WD	65
	WE	26

# subsequently removed from expansion

WD - weekday, WE - weekend

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

Primary ramp	Fishing Zone	Season / day type								Total	
		Wet #		Run-Off		Dry		Build-Up			
		WD	WE	WD	WE	WD	WE	WD	WE		
1	Buffalo Creek	DHS	2	1	5	6	6	6	6	8	40
2	Dinah Beach	DHS	1	1	6	6	6	3	6	8	37
5	East Arm	DHS	1	1	6	6	6	6	6	6	38
6	Nightcliff	DHS	1	1	6	6	6	6	6	6	38
10	Middle Arm	DHS	1	1	6	6	6	5	6	7	38
12	Leaders Creek	DHS	1	1	6	6	6	6	6	6	38
22	Saltwater Arm	DHS	1	1	6	6	6	3	6	8	37
<b>Sub-Total</b>			<b>8</b>	<b>8</b>	<b>41</b>	<b>42</b>	<b>42</b>	<b>35</b>	<b>42</b>	<b>49</b>	<b>266</b>
15	Six Pack	BD	1	1	6	6	6	6	6	6	38
16	Keswick	BD	1	1	6	6	6	6	6	6	38
21	Dundee	BD	1	1	6	6	6	6	6	6	38
<b>Sub-Total</b>			<b>3</b>	<b>3</b>	<b>18</b>	<b>18</b>	<b>18</b>	<b>18</b>	<b>18</b>	<b>18</b>	<b>114</b>
<b>Total</b>			<b>11</b>	<b>10</b>	<b>59</b>	<b>60</b>	<b>60</b>	<b>53</b>	<b>60</b>	<b>67</b>	<b>380</b>

# subsequently removed from expansion

WD - weekday, WE - weekend, DHS - Darwin Harbour/Surrounds Zone, BD - Bynoe Harbour/Dundee

## Appendix 4: List of species caught by recreational anglers in the Greater Darwin Area during the survey period of March 2014 to November 2014

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
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, 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 &amp; bitaeniatus</i>
Snapper, stripey	Stripey snapper	<i>Lutjanus carpontatus</i>
Snapper, other	Chinaman fish	<i>Symphorus nematophorus</i>
	Snapper, other	Various families
Tarpon/Ox-eye herring	Oxeye herring	<i>Megalops cyprinoides</i>
Threadfin, blue	Blue threadfin	<i>Eleutheronema tetradaetylum</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>

Reporting group	Common name	Scientific name
Whiting	Whiting	Sillaginidae - undifferentiated
Wrasse, tuskfish	Parrotfish/tuskfish	Scaridae - undifferentiated
Scalefish, other	Archer fish	Toxotidae - undifferentiated
	Barracuda	Sphyraenidea
	Bream, other	Sparidae
	Cobia	<i>Rachycentron canadum</i>
	Eel	Various families
	Fish, other	Various families
	Flounder/sole	Various families
	Frogfish	Batrachoididae
	Fusiler	Caesionidae
	Garfish	Hemiramphidae - undifferentiated
	Jawfish/stargazer	Opistognathidae & Uranoscopidae
	Leatherjacket	Monacanthidae
	Lizardfish/grinner	Various families
	Long Tom	Belonidae
	Milkfish	<i>Chanos chanos</i>
	Remora	Echeneidae - undifferentiated
	Sailfish	<i>Istiophorus platypterus</i>
	Sand bass	<i>Psammoperca waigiensis</i>
	Scat/butterfish	Scatophagidae - undifferentiated
	Scorpionfish	Scorpaenidae - undifferentiated
	Sweetlip	Haemulidae - undifferentiated
	Toads/pufferfish	Various families
	Tripletail	<i>Lobotes surinamensis</i>
	Trumpeter, yellowtail	<i>Amniataba caudovittatus</i>
	Wahoo	<i>Acanthocybium solandri</i>
	Small mouth scad	<i>Alepes spp</i>
	Mud crab	Mud Crab
Crustaceans, other	Blue Swimmer Crab	<i>Portunus pelagicus</i>
	Hermit Crab	<i>Coenobita variabilis</i>
	Crab, other	Brachyura - undifferentiated
	Prawn, marine	Penaeoidea & Caridea - undiff.
Cephalopods	Squid	Loliginidae - undifferentiated
Gastropods	Telescopium snail (Longbum)	Potamididae
Other taxa	Non-fish, other	Various families

## Appendix 5: Summary of number of sampling days at secondary boat ramps

Secondary ramp	Fishing zone	Season / day type								Total	
		Wet #		Run-off		Dry		Build-Up			
		WD	WE	WD	WE	WD	WE	WD	WE		
3	Ski Club	DHS	3	3	3	3	3	3	3	3	24
4	Channel Island	DHS	3	3	3	3	3	3	3	3	24
7	Palmerston	DHS	3	3	3	3	3	3	3	3	24
8	Trailer Boat Club	DHS	3	3	3	3	3	3	3	3	24
9	Mandorah	DHS	3	3	3	3	3	3	3	3	24
11	Southport	DHS	3	3	3	3	3	3	3	3	24
13	Crab Claw Island	BD	3	3	3	3	3	3	3	3	24
14	Milne Inlet	BD	3	3	3	3	3	3	3	3	24
23	Dundee Road	BD	3	3	3	3	3	3	3	3	24
<b>Total</b>			<b>27</b>	<b>27</b>	<b>27</b>	<b>27</b>	<b>27</b>	<b>27</b>	<b>27</b>	<b>27</b>	<b>216</b>

# subsequently removed from expansion

WD - weekday, WE - weekend, DHS - Darwin Harbour/Surrounds Zone, BD - Bynoe Harbour/Dundee

## Appendix 6: Recreational effort (fisher hours) by analysis and ramp for the survey period of March 2014 to November 2014

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 daytime direct expansion	1. Buffalo Creek	54335	7382
	2. Dinah Beach	93200	6800
	5. East Arm	50269	3772
	6. Nightcliff	19127	3009
	10. Middle Arm	26229	3179
	12. Leaders Creek	30489	6019
	15. Six Pack	25134	4820
	16. Keswick	11384	2484
	21. Dundee	86039	13559
	22. Saltwater Arm	34166	5787
	Total	430372	
Primary ramp post late shift to sunset estimation	1. Buffalo Creek	11748	1890
	2. Dinah Beach	24096	2664
	5. East Arm	7368	1057
	6. Nightcliff	1693	524
	10. Middle Arm	3911	975
	12. Leaders Creek	4935	2432
	15. Six Pack	2352	680
	16. Keswick	<b>961</b>	<b>582</b>
	21. Dundee	16410	4310
	22. Saltwater Arm	3148	742
	Total	76622	
Secondary ramp estimation	3. Ski Club	5541	933
	4. Channel Island	7715	1068
	7. Palmerston	26706	2446
	8. Trailer Boat Club	3295	1095
	9. Mandorah	<b>118</b>	<b>118</b>
	11. Southport	3126	856
	13. Crab Claw	8342	2030
	14. Milne Inlet	13912	4788
	23. Dundee Rd	3697	1203
	Total	72452	
Grand Total		579446	

## 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 2014 to November 2014

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
<b>Effort</b>																
Effort hours	7153	2109	68239	7836	2109	641	16109	3825	77535	6296	19931	2606	54955	3902	54858	3467
<b>Catch</b>																
Barramundi	1207	431	2358	409	<b>886</b>	<b>505</b>	213	78	1044	234	448	156	1463	337	2456	390
Bream, pikey	<b>37</b>	<b>25</b>	1293	370	<b>28</b>	<b>24</b>	273	70	<b>6304</b>	<b>3187</b>	405	153	1348	323	3602	456
Catfish	1403	688	4242	696	<b>204</b>	<b>137</b>	2735	631	1480	283	833	386	3269	552	2169	266
Cod/groupers	<b>9</b>	<b>9</b>	3260	707	114	54	227	56	3788	532	1430	219	2512	246	1943	283
Coral trout	0	0	0	0	0	0	0	0	<b>36</b>	<b>23</b>	0	0	0	0	0	0
Emperor, other	0	0	361	95	0	0	<b>143</b>	<b>136</b>	909	190	<b>267</b>	<b>219</b>	<b>102</b>	<b>55</b>	<b>234</b>	<b>94</b>
Emperor, red	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Flathead	0	0	70	18	<b>11</b>	<b>10</b>	21	10	183	55	<b>95</b>	<b>51</b>	<b>125</b>	<b>60</b>	329	71
Javelin fish	<b>100</b>	<b>89</b>	5666	1160	0	0	200	94	2916	943	2266	267	2608	536	1143	237
Jewfish, black	<b>99</b>	<b>64</b>	642	161	<b>43</b>	<b>25</b>	1649	566	301	120	<b>34</b>	<b>24</b>	622	166	<b>255</b>	<b>239</b>
Jewfish, other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mackerel, grey	0	0	<b>34</b>	<b>21</b>	0	0	0	0	683	64	0	0	<b>57</b>	<b>30</b>	<b>22</b>	<b>11</b>
Mackerel, Spanish	0	0	192	61	0	0	0	0	764	122	<b>36</b>	<b>19</b>	<b>16</b>	<b>11</b>	0	0
Mackerel, spotted	0	0	0	0	0	0	0	0	570	231	0	0	0	0	0	0
Moonfish/Batfish	0	0	2076	400	0	0	0	0	974	189	0	0	211	64	523	97
Mullet	<b>925</b>	<b>693</b>	5308	1362	<b>1696</b>	<b>886</b>	<b>341</b>	<b>320</b>	2787	932	1747	602	5008	799	7722	975
Queenfish	<b>100</b>	<b>71</b>	596	125	<b>11</b>	<b>10</b>	0	0	1006	203	468	191	459	136	656	95
Sharks/rays	<b>185</b>	<b>104</b>	4677	730	<b>36</b>	<b>18</b>	659	295	3035	550	309	83	970	213	1220	135
Small baitfish	<b>1255</b>	<b>1129</b>	<b>2621</b>	<b>879</b>	0	0	<b>12</b>	<b>11</b>	<b>836</b>	<b>652</b>	<b>152</b>	<b>130</b>	<b>1376</b>	<b>554</b>	8384	2093
Snapper, golden	<b>9</b>	<b>9</b>	10295	1659	280	137	408	143	4139	700	975	305	3432	587	1116	143
Snapper, mangrove jack	0	0	388	117	110	49	<b>64</b>	<b>37</b>	153	47	181	57	180	49	<b>47</b>	<b>25</b>
Snapper, Moses'	0	0	<b>334</b>	<b>111</b>	0	0	<b>11</b>	<b>11</b>	535	79	42	19	<b>387</b>	<b>236</b>	685	188
Snapper, other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snapper, saddletail/Crimson/indo.	0	0	<b>1263</b>	<b>505</b>	0	0	<b>304</b>	<b>188</b>	2621	449	0	0	<b>497</b>	<b>254</b>	<b>22</b>	<b>11</b>
Snapper, stripey	0	0	2895	593	0	0	<b>12</b>	<b>11</b>	5640	629	<b>9</b>	<b>9</b>	632	267	539	193
Tarpon/Ox-eye herring	0	0	<b>591</b>	<b>212</b>	0	0	0	0	<b>17</b>	<b>15</b>	0	0	<b>212</b>	<b>131</b>	0	0
Threadfin, blue	<b>261</b>	<b>166</b>	691	256	<b>324</b>	<b>231</b>	787	354	<b>1211</b>	<b>617</b>	<b>119</b>	<b>62</b>	1221	367	245	49
Threadfin, king	<b>12</b>	<b>11</b>	325	104	<b>174</b>	<b>156</b>	<b>12</b>	<b>11</b>	112	23	<b>31</b>	<b>21</b>	238	79	<b>63</b>	<b>26</b>

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
Trevally, giant	0	0	527	127	11	10	11	11	886	78	144	76	198	74	221	64
Trevally, golden	0	0	2486	332	0	0	35	25	1784	286	78	33	388	111	298	52
Trevally, other	0	0	24	21	0	0	0	0	0	0	0	0	0	0	47	25
Tuna, longtail	0	0	0	0	0	0	0	0	757	125	0	0	0	0	0	0
Tuna, mackerel	0	0	0	0	0	0	0	0	92	86	0	0	0	0	0	0
Whiting	0	0	37	33	14	12	0	0	22	19	0	0	92	52	68	27
Wrasse, tuskfish	0	0	397	68	0	0	0	0	2839	497	12	11	199	83	465	82
Scalefish, other	34	24	2840	597	0	0	251	83	2707	822	304	116	1702	300	4742	774
Mud crab	960	386	4493	577	86	56	5627	1910	6169	1101	3412	969	12916	1252	7468	794
Crustaceans, other	12	11	646	155	0	0	18	17	3580	2187	1289	704	7677	2105	4914	1353
Cephalopods	0	0	0	0	0	0	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	2469	1272
Other taxa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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
<b>Effort</b>																
Effort hours	53512	6385	16372	2527	32923	5214	32801	6005	67266	10728	34235	2951	32740	4474	7707	1936
<b>Catch</b>																
Barramundi	3070	615	0	0	2928	1250	0	0	125	93	33	29	1845	1178	0	0
Bream, Pikey	1392	360	130	113	457	87	0	0	111	45	192	125	81	49	0	0
Catfish	2798	750	12	11	6988	1810	1461	640	737	249	931	400	3450	1462	0	0
Cod/groupers	3343	637	812	192	1529	499	3929	639	7612	1433	1732	311	2854	543	353	147
Coral trout	25	15	35	22	0	0	1138	330	693	142	368	120	477	182	147	50
Emperor, other	45	20	205	117	23	22	16196	3286	7524	1614	1751	504	556	227	79	0
Emperor, red	0	0	87	70	0	0	1261	615	579	260	14	12	55	49	0	0
Flathead	111	30	0	0	12	11	0	0	41	28	28	24	11	10	79	0
Javelin fish	33	32	93	58	223	75	568	269	2890	812	2913	887	312	136	433	375
Jewfish, black	80	65	229	216	974	224	264	98	451	124	410	195	1257	358	0	0
Jewfish, other	25	22	0	0	0	0	99	66	62	32	0	0	0	0	0	0
Mackerel, grey	11	10	267	74	0	0	24	22	538	214	648	117	442	243	0	0
Mackerel, Spanish	28	10	250	82	0	0	1590	647	2237	600	608	158	391	124	85	43
Mackerel, spotted	0	0	68	41	0	0	436	342	386	148	619	219	163	135	65	22
Moonfish/Batfish	228	144	1447	363	16	15	224	145	663	209	1030	313	188	124	1014	456

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
Mullet	31580	3273	0	0	842	292	0	0	46	45	0	0	24	22	0	0
Queenfish	150	44	0	0	131	54	157	152	836	367	32	18	717	304	0	0
Sharks/rays	708	226	395	132	183	60	5476	1369	11848	2203	4056	643	4110	1358	1096	342
Small baitfish	8490	2704	102	74	190	0	36	33	1756	745	128	85	0	0	0	0
Snapper, golden	703	200	595	172	1997	739	4152	1002	9213	1491	3507	564	6279	1639	777	231
Snapper, mangrove jack	34	25	27	24	16	15	0	0	9	9	7	6	54	35	0	0
Snapper, mosess'	49	31	95	91	0	0	0	0	62	34	77	35	54	29	28	27
Snapper, other	0	0	0	0	0	0	9	9	55	41	0	0	0	0	12	10
Snapper,saddletail/Crimson/indo.	0	0	793	398	0	0	1119	399	1832	589	5806	1199	5337	1373	1859	925
Snapper, stripey	28	15	1258	348	0	0	9022	1938	14167	2283	4777	908	1724	386	36	23
Tarpon/ox-eye herring	372	312	0	0	25	17	0	0	0	0	0	0	0	0	0	0
Threadfin, blue	772	136	248	216	808	418	335	153	1493	509	722	262	639	281	0	0
Threadfin, king	416	182	0	0	194	47	24	22	24	22	96	59	50	27	0	0
Trevally, giant	53	25	479	218	0	0	511	119	1000	453	742	275	784	221	299	117
Trevally, golden	69	49	901	292	23	22	633	352	1646	534	735	214	154	63	231	82
Trevally, other	0	0	0	0	0	0	45	35	0	0	20	17	343	289	0	0
Tuna, longtail	0	0	0	0	0	0	167	64	240	78	26	18	51	25	17	16
Tuna, mackerel	62	55	0	0	0	0	312	86	351	110	222	148	11	10	40	0
Whiting	1597	446	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wrasse, tuskfish	82	45	706	195	0	0	1682	380	1550	422	1812	385	1059	303	155	24
Scalefish, other	2812	863	442	248	711	318	1344	321	1762	401	2224	604	327	107	31	21
Mud crab	41188	9119	0	0	12063	2258	0	0	84	78	225	162	840	318	0	0
Crustaceans, other	26333	22290	0	0	559	496	0	0	0	0	0	0	0	0	0	0
Cephalopods	0	0	0	0	0	0	0	0	12	11	0	0	0	0	8	7
Gastropods	81	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other taxa	0	0	0	0	12	11	29	25	9	9	14	12	0	0	0	0

## Appendix 8: Estimated effort (fisher hours) by boat ramp during the survey period of March 2014 to November 2014

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
Buffalo	66083	7620	11.4
Dinah	117296	7303	20.2
Ski Club	5541	933	1
Channel Is	7715	1068	1.3
East Arm	57637	3918	9.9
Nightcliff	20820	3054	3.6
Palmerston	26706	2446	4.6
Trailer Boat Club	3295	1095	0.6
Mandorah	<b>118</b>	<b>118</b>	<b>0</b>
Middle Arm	30140	3325	5.2
Southport	3126	856	0.5
Leaders	35424	6492	6.1
Crab Claw	8342	2030	1.4
Milne	13912	4788	2.4
Six Pack	27486	4868	4.7
Keswick	12345	2551	2.1
Dundee	102450	14227	17.7
Saltwater Arm	37314	5834	6.4
Dundee Rd	3697	1203	0.6

## 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 2014 to November 2014

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>	18010	2187	5793	755	12217	1634
Bream, pikey	Pikey bream	<i>Acanthopagrus berda</i>	15642	3264	8613	2312	7029	1245
Catfish	Eeltail catfish	Plotosidae	106	41	<b>12</b>	<b>11</b>	94	39
	Forktail catfish	Ariidae	32617	2887	1935	649	30682	2770
Cod/groupers	Cod/groupers	Serranidae - undifferentiated	35685	2380	9334	770	26351	1859
Coral trout	Coral trout	<i>Plectropomus</i> spp	2942	475	1868	325	1074	229
Emperor, red	Red emperor	<i>Lutjanus sebae</i>	1993	847	998	390	995	479
Emperor, other	Emperor, other	Lethrinidae	28465	4265	10791	1583	17674	2920
Flathead	Flathead	Platycephalidae - undifferentiated	1116	133	320	64	796	117
Javelin fish	Barred javelin	<i>Pomadasys kaakan</i>	22389	2111	3993	535	18396	1820
Jewfish, black	Black jewfish	<i>Protonibea diacanthus</i>	7309	909	3429	415	3880	690
Jewfish, other	Croaker	Sciaenidae	187	73	<b>25</b>	<b>22</b>	162	69
Mackerel, grey	Grey mackerel	<i>Scomberomorus semifasciatus</i>	2796	388	1170	180	1627	282
Mackerel, Spanish	Spanish mackerel	<i>Scomberomorus commerson</i>	6273	1068	3511	465	2762	657
Mackerel, spotted	Spotted mackerel	<i>Scomberomorus munroi</i>	2351	533	1035	240	1315	446
Moonfish/Batfish	Batfish	Ephippidae	8878	820	1372	298	7506	761
Mullet	Mullet	Mugilidae - undifferentiated	58028	4344	46495	4383	11533	2989
Queenfish	Queenfish	<i>Scomberoides</i> spp	5324	663	1236	146	4088	639
Sharks/rays	Rays/skates	Dasyatidae	701	152	0	0	701	152
	Sawfish	Pristidae	<b>73</b>	<b>39</b>	0	0	<b>73</b>	<b>39</b>
	Shark	Various families	38120	3447	1279	283	36841	3293
Small baitfish	Baitfish, unspec.	Several families	4510	1558	2403	840	2107	927
	Herring, other	Clupeidae	20878	3444	7991	2425	<b>12886</b>	<b>2574</b>
Snapper, golden	Golden snapper	<i>Lutjanus johnii</i>	48016	3463	24641	1778	23376	2134
Snapper, mangrove jack	Mangrove jack	<i>Lutjanus argentimaculatus</i>	1255	160	886	122	369	81
Snapper, moses'	Moses' snapper	<i>Lutjanus russellii</i>	2385	356	268	73	2116	340
Snapper, saddletail/ crimson/indonesian	Saddletail, Crimson & Indonesian snapper	<i>Lutjanus malabaricus</i> , <i>erythropterus</i> & <i>bitaeniatus</i>	21487	2955	7690	1177	13798	2036

Reporting group	Common name	Scientific name	Total		Kept		Released	
			Number	SE	Number	SE	Number	SE
Snapper, stripey	Stripey snapper	<i>Lutjanus carponotatus</i>	41090	3760	10851	1013	30240	3065
Snapper, other	Chinaman fish	<i>Symphorus nematophorus</i>	46	45	0	0	46	45
	Snapper, other	Various families	32	13	22	13	9	9
Tarpon/ox-eye herring	Oxeye herring	<i>Megalops cyprinoides</i>	1218	400	779	352	439	126
Threadfin, blue	Blue threadfin	<i>Eleutheronema tetradactylum</i>	9885	1295	6310	927	3575	566
Threadfin, king	King threadfin	<i>Polydactylus macrochir</i>	1783	292	1200	167	582	205
Trevally, giant	Giant trevally	<i>Caranx ignobilis</i>	5882	650	1038	142	4844	637
Trevally, golden	Golden trevally	<i>Gnathanodon speciosus</i>	9521	936	1723	274	7797	868
Trevally, other	Trevally, other	Carangidae - undifferentiated	480	294	9	9	471	293
Tuna, longtail	Longtail tuna	<i>Thunnus tonggol</i>	1263	187	437	83	826	164
Tuna, mackerel	Mackerel tuna	<i>Euthynnus affinis</i>	1087	221	469	113	618	194
Whiting	Whiting	Sillaginidae - undifferentiated	1830	453	1236	424	594	152
Wrasse, tuskfish	Parrotfish/tuskfish	Scaridae - undifferentiated	11205	954	4091	412	7114	708
Scalefish, other	Archer fish	Toxotidae - undifferentiated	1598	441	24	10	1575	438
	Barracuda	Sphyraenidae	1192	182	109	38	1083	176
	Bream, other	Sparidae	8	7	0	0	8	7
	Cobia	<i>Rachycentron canadum</i>	508	106	284	72	224	61
	Eel	Various families	58	28	0	0	58	28
	Fish, other	Various families	544	194	55	49	489	188
	Flounder/sole	Various families	226	137	0	0	226	137
	Frogfish	Batrachoididae	455	89	0	0	455	89
	Fusiler	Caesionidae	69	46	50	45	19	9
	Garfish	Hemiramphidae - undifferentiated	3400	656	1707	553	1693	381
	Jawfish/stargazer	Opistognathidae & Uranoscopidae	1304	178	19	9	1285	178
	Leatherjacket	Monacanthidae	12	11	0	0	12	11
	Lizardfish/grinner	Various families	25	16	0	0	25	16
	Long tom	Belonidae	1344	520	1165	516	179	63
	Milkfish	<i>Chanos chanos</i>	21	12	8	7	13	9
	Remora	Echeneidae - undifferentiated	299	150	0	0	299	150
	Sailfish	<i>Istiophorus platypterus</i>	25	16	0	0	25	16
	Sand bass	<i>Psammoperca waigiensis</i>	1190	170	290	74	900	157
	Scat/butterfish	Scatophgidae - undifferentiated	746	454	0	0	746	454
	Scorpionfish	Scorpaenidae - undifferentiated	19	9	0	0	19	9

Reporting group	Common name	Scientific name	Total		Kept		Released	
			Number	SE	Number	SE	Number	SE
	Sweetlip	Haemulidae - undifferentiated	2360	548	953	161	1407	461
	Toads/pufferfish	Various families	4980	956	12	11	4968	956
	Tripletail	<i>Lobotes surinamensis</i>	55	35	55	35	0	0
	Trumpeter, yellowtail	<i>Amniataba caudovittatus</i>	79	0	0	0	79	0
	Wahoo	<i>Acanthocybium solandri</i>	65	54	9	9	55	54
	Small mouth scad	<i>Alepes spp</i>	1803	568	812	282	991	440
Mud Crab	Mud crab	<i>Scylla spp</i>	95528	9989	57436	5647	38093	4685
Crustaceans, other	Blue swimmer crab	<i>Portunus pelagicus</i>	5814	667	1620	350	4194	509
	Hermit crab	<i>Coenobita variabilis</i>	16	11	0	0	16	11
	Crab, other	Brachyura - undifferentiated	430	96	0	0	430	96
	Prawn, marine	Penaeoidea & Caridea - undiff.	38774	22601	30008	22403	8766	2215
Cephalopods	Squid	Loliginidae - undifferentiated	21	13	21	13	0	0
Gastropods	Telescopium snail (Longbum)	Potamididae	2550	1273	2469	1272	81	67
Other taxa	Non-fish, other	Various families	64	31	0	0	64	31

## Appendix 10: Recreational catch (total, kept and released numbers) by analysis and ramp for the survey period of March 2014 to November 2014

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 daytime direct expansion	1. Buffalo Creek	114611	15458	73406	14784	41206	5399
	2. Dinah Beach	82688	9013	33104	4245	49584	5070
	5. East Arm	42643	4768	19456	3448	23188	2383
	6. Nightcliff	14840	3021	4566	973	10274	2393
	10. Middle Arm	27159	4529	11983	2373	15176	2900
	12. Leaders Creek	29324	6278	10961	2581	18363	3983
	15. Six Pack	18381	3055	5866	1372	12515	2189
	16. Keswick	13771	3500	4591	1296	9180	2510
	21. Dundee	102069	16123	30755	4814	71313	11585
	22. Saltwater Arm	35944	7537	11458	2207	24485	5635
	Total	481430		206146		275284	
Primary ramp post late shift to sunset estimation	1. Buffalo Creek	21936	6064	13234	5349	8702	2439
	2. Dinah Beach	21577	4375	8454	2038	13122	2515
	5. East Arm	6624	1993	3203	1520	3422	919
	6. Nightcliff	<b>1335</b>	<b>924</b>	<b>417</b>	<b>299</b>	<b>917</b>	<b>762</b>
	10. Middle Arm	3620	1491	1506	749	2113	930
	12. Leaders Creek	<b>4783</b>	<b>2411</b>	<b>1674</b>	<b>925</b>	<b>3108</b>	<b>1606</b>
	15. Six Pack	<b>1644</b>	<b>861</b>	<b>525</b>	<b>367</b>	<b>1119</b>	<b>617</b>
	16. Keswick	<b>1220</b>	<b>1174</b>	<b>430</b>	<b>440</b>	<b>790</b>	<b>841</b>
	21. Dundee	19240	7174	5919	2198	13321	5123

Analysis	Ramp	Total		Kept		Released	
		Number	SE	Number	SE	Number	SE
Secondary ramp estimation	22. Saltwater Arm	3267	2443	1091	699	2176	1827
	Total	85246		36453		48790	
	3. Ski Club	4447	339	1406	140	3041	289
	4. Channel Island	8371	387	3688	184	4683	303
	7. Palmerston	26228	1345	13643	897	12585	776
	8. Trailer Boat Club	2821	211	875	90	1946	196
	9. Mandorah	111	41	33	16	79	42
	11. Southport	2855	219	1279	115	1577	165
	13. Crab Claw	8691	933	2878	413	5813	639
	14. Milne Inlet	15394	1290	5065	561	10329	895
	23. Dundee Rd	2848	689	895	258	1953	499
	Total	71766		29762		42006	
	Grand Total		638442		272361		366080

## 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 2014 to November 2014

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
<b>Effort</b>				
Effort hours	403211	15330	175716	14886
<b>Catch</b>				
Barramundi	16005	1686	<b>2003</b>	<b>1182</b>
Bream, pikey	15254	3263	384	141
Catfish	26137	2426	6582	1690
Cod/groupers	18989	1367	16592	1809
Coral trout	95	40	2837	475
Emperor, other	2304	432	26169	4231
Emperor, red	<b>81</b>	<b>66</b>	1909	844
Flathead	957	128	159	38
Javelin fish	15249	1617	7139	1444
Jewfish, black	4928	742	2381	435
Jewfish, other	<b>25</b>	<b>22</b>	162	69
Mackerel, grey	1095	106	1703	355
Mackerel, Spanish	1296	160	4970	1044
Mackerel, spotted	639	234	1712	471
Moonfish/Batfish	5601	602	3216	600
Mullet	57954	4344	<b>70</b>	<b>50</b>
Queenfish	3577	334	1746	572
Sharks/rays	12398	1027	26681	3313
Small baitfish	23463	3808	1953	751
Snapper, golden	23944	2091	24113	2720
Snapper, mangrove jack	1183	159	<b>70</b>	<b>36</b>
Snapper, moses'	2139	342	248	71
Snapper, other	0	0	78	37
Snappers,saddletail/crimson/indo	5502	891	16063	2490
Snapper, stripey	11106	1021	29939	3673
Tarpon/ox-eye Herring	1218	400	0	0
Threadfin, blue	6685	1041	3214	644
Threadfin, king	1578	277	208	72
Trevally, giant	2505	287	3366	587
Trevally, golden	6073	565	3421	703
Trevally, other	71	33	<b>408</b>	<b>292</b>
Tuna, longtail	759	125	501	111
Tuna, mackerel	<b>153</b>	<b>103</b>	939	196
Whiting	1830	453	0	0
Wrasse, tuskfish	4719	544	6415	751
Scalefish, other	16677	1641	5727	809
Mud crab	94329	9901	1149	365
Crustaceans, other	<b>45031</b>	<b>22557</b>	0	0
Cephalopods	0	0	<b>21</b>	<b>13</b>
Gastropods	2550	1273	0	0
Other taxa	<b>12</b>	<b>11</b>	<b>52</b>	<b>29</b>

## Appendix 12: Recreational catch of key species by fishing method in the Greater Darwin Area during the survey period of March 2014 to November 2014

Species/group	Method/Gear					
	Line		Pot		Cast	
	Number	SE	Number	SE	Number	SE
Barramundi	17094	2181	0	0	1200	251
Bream, pikey	14184	3261	964	107	1904	164
Catfish	31027	2857	1727	210	<b>628</b>	<b>337</b>
Cod/groupers	33444	2302	2578	309	<b>28</b>	<b>24</b>
Coral trout	2942	475	0	0	0	0
Emperor, other	28493	4265	0	0	0	0
Emperor, red	1993	847	0	0	0	0
Flathead	1086	131	<b>34</b>	<b>33</b>	<b>28</b>	<b>17</b>
Javelin fish	22459	2113	151	71	<b>60</b>	<b>31</b>
Jewfish, black	7339	910	0	0	0	0
Jewfish, other	187	73	0	0	0	0
Mackerel, grey	2800	388	0	0	0	0
Mackerel, Spanish	6277	1068	0	0	0	0
Mackerel, spotted	2351	533	0	0	0	0
Moonfish/batfish	8943	820	0	0	0	0
Mullet	<b>61</b>	<b>31</b>	0	0	87090	4808
Queenfish	5160	653	0	0	166	58
Sharks & rays	39011	3471	76	22	0	0
Small baitfish	2681	766	0	0	46058	4647
Snapper, golden	48194	3465	49	13	<b>55</b>	<b>48</b>
Snapper, mangrove jack	1253	160	0	0	0	0
Snapper, moses'	2420	356	<b>28</b>	<b>24</b>	0	0
Snapper, other	78	37	0	0	0	0
Snapper, saddletail/ crimson/indonesian	21492	2955	0	0	0	0
Snapper, stripey	41140	3760	0	0	<b>14</b>	<b>12</b>
Tarpon/ox-eye Herring	204	76	0	0	2643	656
Threadfin, blue	9226	1253	172	52	<b>789</b>	<b>402</b>
Threadfin, king	1565	244	<b>32</b>	<b>22</b>	<b>318</b>	<b>134</b>
Trevally, giant	5910	650	0	0	0	0
Trevally, golden	9564	936	0	0	0	0
Trevally, other	<b>433</b>	<b>292</b>	0	0	<b>70</b>	<b>32</b>
Tuna, longtail	1263	187	0	0	0	0
Tuna, mackerel	1087	221	0	0	0	0
Whiting	186	67	0	0	1729	452
Wrasse, tuskfish	11257	954	0	0	0	0
Scalefish, other	12871	1101	1783	426	14652	1682
Mud crab	247	75	106004	10032	0	0
Crustaceans, other	<b>100</b>	<b>45</b>	7428	715	<b>51792</b>	<b>22662</b>
Cephalopods	<b>21</b>	<b>13</b>	0	0	0	0
Gastropods	0	0	<b>81</b>	<b>67</b>	0	0
Other taxa	64	31	0	0	0	0
<b>Grand Total</b>	<b>396107</b>		<b>121107</b>		<b>209224</b>	

## 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 2014 to November 2014

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 Number	SE	Jarwin Harbour/surrounds Number	SE
<b>Effort</b>				
Effort hours	176765	16364	402850	15100
<b>Catch</b>				
Barramundi	3883	649	14388	2095
Bream, pikey	1442	373	14200	3243
Catfish	7845	1136	24878	2650
Cod/groupers	14814	1816	20690	1501
Coral trout	1830	424	1027	215
Emperor, other	24081	4202	4378	730
Emperor, red	1840	843	<b>152</b>	<b>83</b>
Flathead	111	33	1004	129
Javelin fish	9231	1486	13158	1392
Jewfish, black	1456	230	5853	856
Jewfish, other	162	69	<b>25</b>	<b>22</b>
Mackerel, grey	596	230	2121	312
Mackerel, Spanish	4019	1025	2169	294
Mackerel, spotted	821	386	1512	367
Moonfish/batfish	2964	478	5626	685
Mullet	6282	1529	51745	4066
Queenfish	1691	508	3633	425
Sharks/rays	22191	3025	16686	1691
Small baitfish	5668	1614	19686	3530
Snapper, golden	23685	2675	24269	2184
Snapper, mangrove jack	445	121	875	110
Snapper, moses'	398	116	1965	336
Snapper, other	<b>65</b>	<b>36</b>	<b>13</b>	<b>9</b>
Snapper,saddletail/crimson/indo	4209	915	17272	2669
Snapper, stripey	26085	3555	14813	1218
Tarpon/ox-eye herring	<b>592</b>	<b>212</b>	<b>627</b>	<b>339</b>
Threadfin, blue	2782	573	7103	1162
Threadfin, king	386	110	1397	270
Trevally, giant	2038	480	3737	437
Trevally, golden	4773	745	4714	554
Trevally, other	<b>70</b>	<b>40</b>	<b>411</b>	<b>291</b>
Tuna, longtail	407	107	855	131
Tuna, mackerel	663	128	424	180
Whiting	<b>37</b>	<b>33</b>	1793	452
Wrasse, tuskfish	3629	563	7418	759
Scalefish, other	5982	804	16278	1614
Mud crab	5541	689	89931	9965
Crustaceans, other	659	155	<b>44375</b>	<b>22557</b>
Cephalopods	<b>12</b>	<b>11</b>	<b>8</b>	<b>7</b>
Gastropods	<b>0</b>	<b>0</b>	2550	1273
Other taxa	<b>39</b>	<b>27</b>	<b>26</b>	<b>16</b>

## 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 2014 to November 2014

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
<b>Effort</b>						
Effort hours	207860	14486	197825	13305	173763	10368
<b>Catch</b>						
Barramundi	6065	812	3527	510	8418	1965
Bream, pikey	3067	453	10124	3221	2451	265
Catfish	15801	2027	9613	1631	7309	1253
Cod/groupers	11630	1686	12544	1304	11511	1058
Coral trout	1274	388	810	201	858	187
Emperor, other	7176	2940	10971	2307	10318	2055
Emperor, red	<b>1037</b>	<b>819</b>	553	171	403	130
Flathead	370	73	379	68	367	89
Javelin fish	5838	1403	11905	1246	4645	967
Jewfish, black	3286	595	2008	501	2015	471
Jewfish, other	0	0	150	63	<b>37</b>	<b>36</b>
Mackerel, grey	872	249	1328	154	597	255
Mackerel, Spanish	<b>2081</b>	<b>969</b>	2406	311	1786	323
Mackerel, spotted	<b>431</b>	<b>207</b>	<b>633</b>	<b>326</b>	1287	367
Moonfish/batfish	3564	513	2766	365	2547	525
Mullet	36784	3681	7438	1625	13806	1638
Queenfish	2114	377	1545	297	1666	457
Sharks/rays	14627	2065	14027	2405	10241	1415
Small baitfish	12712	3056	4640	1139	8036	2104
Snapper, golden	19235	2428	13430	1384	15352	2046
Snapper, mangrove jack	313	70	304	61	637	130
Snapper, moses'	286	84	816	94	1282	332
Snapper, other	0	0	0	0	<b>78</b>	<b>37</b>
Snapper,saddletail/ crimson/indo	<b>3844</b>	<b>1950</b>	6800	1018	10842	1974
Snapper, stripey	11539	2311	18963	2709	10589	1208
Tarpon/ox-eye Herring	<b>318</b>	<b>147</b>	<b>23</b>	<b>22</b>	<b>877</b>	<b>371</b>
Threadfin, blue	4596	1007	2904	725	2385	369
Threadfin, king	619	187	422	81	742	208
Trevally, giant	1995	272	1884	454	2003	378
Trevally, golden	2943	642	2981	441	3597	519
Trevally, other	<b>107</b>	<b>47</b>	<b>20</b>	<b>17</b>	<b>353</b>	<b>289</b>
Tuna, longtail	<b>96</b>	<b>53</b>	959	155	208	90
Tuna, mackerel	<b>115</b>	<b>89</b>	524	112	447	169
Whiting	704	164	<b>49</b>	<b>25</b>	1077	421
Wrasse, tuskfish	2842	486	4339	637	4025	518
Scalefish, other	10545	1416	5630	757	6210	832
Mud crab	40713	7808	37605	5848	17210	2149
Crustaceans, other	<b>38187</b>	<b>22515</b>	3529	565	3319	1256
Cephalopods	0	0	<b>12</b>	<b>11</b>	<b>8</b>	<b>7</b>
Gastropods	0	0	<b>2540</b>	<b>1273</b>	<b>11</b>	<b>10</b>
Other taxa	<b>26</b>	<b>16</b>	0	0	<b>39</b>	<b>27</b>