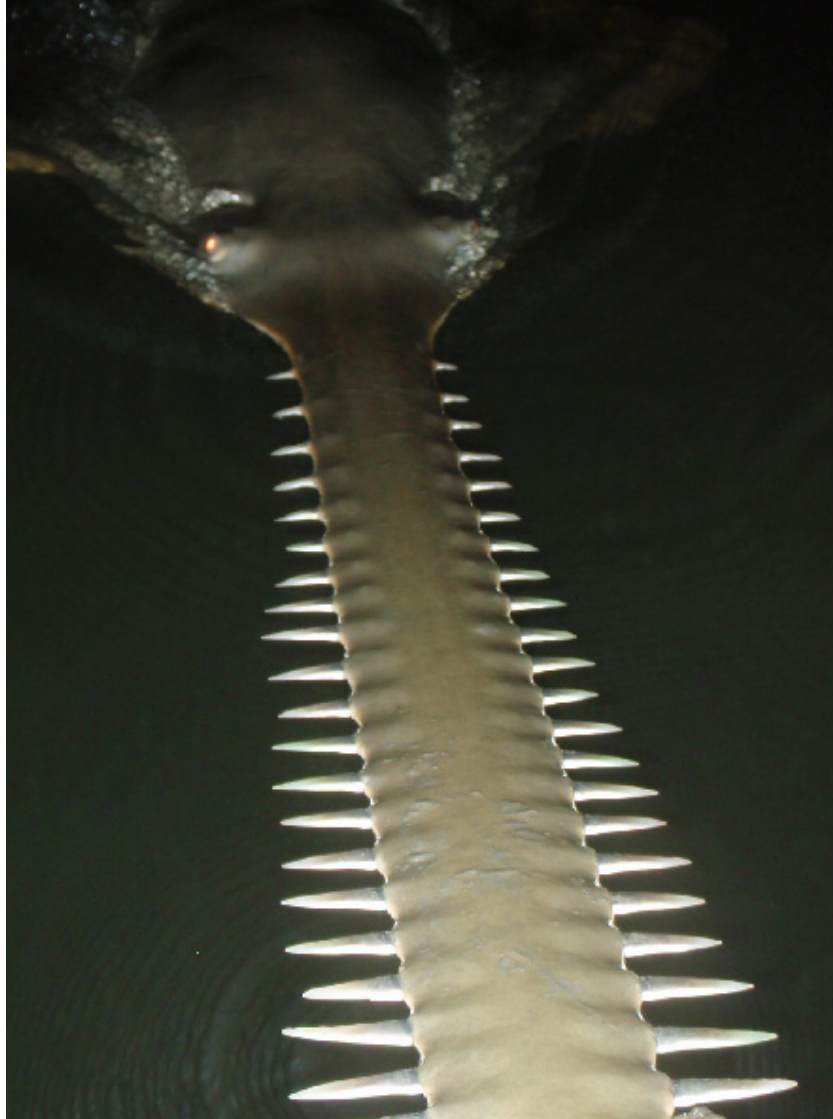


# Fisheries and Aquatic Values of Port Musgrave, North Queensland

S. C. Peverell, M. J. Vickers, N. A. Gribble and J. E. Seymour



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On 26 March 2009, the Department of Primary Industries and Fisheries was amalgamated with other government departments to form the Department of Employment, Economic Development and Innovation.

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## Contents

1.0	Summary.....	1
1.0	Introduction .....	5
1.1	Background.....	5
1.2	Gulf of Carpentaria and Port Musgrave Fisheries.....	5
1.2.1	Port Musgrave and previous studies.....	5
1.2.2	Commercial Harvest Fisheries .....	8
1.3	Species of Conservation Interest (SOCI) .....	13
1.3.1	Spertooth Shark ( <i>Glyphis glyphis</i> ).....	14
1.3.2	Sawfish (Pristidae spp.).....	18
1.3.3	Queensland Groper ( <i>Epinephelus lanceolatus</i> ).....	25
1.3.4	Saltwater Crocodile ( <i>Crocodylus porosus</i> ).....	26
1.4	Purpose and Scope of this Report.....	28
2.0	Methods .....	29
2.1	Fishery Independent Surveys of Port Musgrave .....	29
2.1.1	Overview .....	29
2.1.2	Surveys .....	30
2.1.3	Incidental Observations .....	38
2.1.4	Data Analysis.....	40
2.2	Fishery Dependent Data from Port Musgrave.....	41
2.2.1	Commercial Fishery .....	41
2.2.2	Recreational Fishery .....	42
2.2.3	Indigenous Fishery .....	42
2.3	Species of Conservation Interest (SOCI) .....	42
3.0	Results .....	43
3.1	Fishery Independent Surveys of Port Musgrave .....	43
3.1.1	Fisheries Resources .....	43
3.2	Fishery Dependent Data from Port Musgrave.....	60
3.2.1	Commercial Gillnet Fishery .....	60
3.2.2	Shark (Carcharhinidae spp.).....	64
3.2.3	Crab fishery .....	65
3.2.4	Charter Boat and Recreational Fisheries .....	66
3.3	Species of Conservation Interest (SOCI) .....	68
3.3.1	Desktop Assessment.....	68
3.3.2	Fisheries Independent Survey.....	76
3.3.3	Population Estimates .....	88
4.0	Discussion.....	90
5.0	Conclusions .....	97
6.0	References .....	98
	Appendix A Community Fisheries Resource Assessment Project.....	108
	Appendix B Species List .....	109
	Appendix C EPBC Protected Matters Online Search Tool.....	115

## List of Tables

Table 1: Shannon-Weiner diversity indices and Evenness for each site and each survey period.....	43
Table 2: Species list and CPUE (fish/set) for fish, sharks and rays captured with set lines at each survey site and survey period.....	53
Table 3: Number of medusa caught for the three surveys.....	60
Table 4 : Species categories of combined commercial landings in the Port Musgrave area for the years 2002 to 2008 (Source: CFISH database October 2009). ....	62
Table 5: Total weight and percent of fish kept and fish released alive by commercial tour operators in Port Musgrave for the years 2000 to 2008 (Source CFISH database as at 12 September 2009).....	67
Table 6: Summary of fauna desktop assessment and survey observations for National Environmental Significance and Marine Migratory Species.....	70
Table 7: Running total of tagged and recaptured specimens (MR–March recapture, JR–June recapture and NR–November recapture).....	80
Table 8: Sawfish species recaptured.....	81
Table 9: SOCI interactions in 2008 from the Gulf of Carpentaria commercial logbooks. ....	89

## List of Figures

Figure 1: Gulf of Carpentaria Inshore Finfish Fishery and Port Musgrave study area. ...	7
Figure 2: Location of gill netting in the March 2009 survey. ....	32
Figure 3: Location of gill netting in the June 2009 survey.....	33
Figure 4: Location of gill netting in the November 2009 survey. ....	34
Figure 5: Location of set lines for each of the three surveys; March, June and November 2009.....	35
Figure 6: Cast net locations at each of the three survey sites.....	37
Figure 7: Crab pot locations at each of the three survey sites. ....	39
Figure 8: Gill net catch (+95%CI) at each survey site for each survey period.....	44
Figure 9: Gill net catch (+95%CI) for each net size at each survey site. ....	44
Figure 10: Size frequency of Barramundi ( <i>Lates calcarifer</i> ) caught from the three survey sites and three survey periods combined. ....	45
Figure 11: Catch (+95%CI) of Barramundi caught at each survey site for each survey period.....	45
Figure 12: Size frequency of Giant Queenfish caught from the three survey sites and three survey periods combined. ....	46
Figure 13: Catch (+95%CI) of Giant Queenfish caught at the three survey sites for the three survey periods combined. ....	46
Figure 14: Size frequency of sharks ( <i>Carcharhinus</i> spp.) caught from the three survey sites and three survey periods combined (n = 178). ....	47
Figure 15: Species composition of sharks ( <i>Carcharhinus</i> spp.) caught from the three survey sites and three survey periods combined (n = 202). ....	47
Figure 16: Catch (+95%CI) of sharks ( <i>Carcharhinus</i> spp.) caught at each survey site for each survey period.....	48
Figure 17: Catch (+95%CI) of sharks ( <i>Carcharhinus</i> spp.) caught at each survey site for the three survey periods combined. ....	48
Figure 18: Catch (+95%CI) of sharks ( <i>Carcharhinus</i> spp.) caught in each survey period for all survey sites combined. ....	49

Figure 19: Catch (+95%CI) of Speartooth Shark caught at each survey site for the three survey periods combined. ....	49
Figure 20: Catch (+95%CI) of Green Sawfish caught in each survey period for all survey sites combined.....	50
Figure 21 Catch (+95%CI) of Freshwater Sawfish caught in each survey period for all survey sites combined.....	51
Figure 22: Catch (+95%CI) of Freshwater Sawfish caught at each survey site for the three survey periods combined. ....	51
Figure 23: Species caught with set lines in the Ducie River (A), Namaleta Creek (B) and Wenlock River (C) for the three survey periods combined.....	54
Figure 24: Set line catch (+95%CI) at each survey site for each survey period. ....	55
Figure 25: Numbers of species caught in set lines at each survey site for each survey period.....	55
Figure 26: Top 12 species captured in cast nets from the three survey sites and three survey periods combined.....	56
Figure 27: Catch (+95%CI) of Giant Mud Crabs at each survey site for all three survey periods combined.....	57
Figure 28: Catch (+95%CI) of Giant Mud Crabs in each survey period for all surveys sites combined. ....	57
Figure 29: Total number and catch (+95%CI) of Giant Mud Crabs at the survey sites for March (white), June (light grey) and November (dark grey) surveys. ....	58
Figure 30: Size frequency of male (black), female (grey) and parasitised (white) Giant Mud Crabs caught at the survey sites for (A) March (n = 96), (B) June (n = 159) and (C) November (n = 102). ....	59
Figure 31: Giant Mud Crab ( <i>Scylla serrata</i> ) infected with the parasite <i>Loxothylacus ihlei</i> . ....	60
Figure 32: Total number of boats and fishing effort (boat days) in the Port Musgrave commercial net fishery for the years 2002 to 2008 (Source: CFISH database October 2009).....	61
Figure 33: Annual commercial gill net catch in tonnes (columns) and catch per unit of effort (kg/per day) for AB6 & AB7 logbook grid references for the years 2002 to 2008 (Source: CFISH database October 2009). ....	61
Figure 34: Average catch (tonnes) (+95%CI) of target species caught in the AB6 & AB7 logbook grids for the years 2002 to 2008 (Source: CFISH database October 2009). ....	61
Figure 35: Average monthly Barramundi catch (+95%CI) for the commercial logbook grid references AB6 & AB7 for the years 2002 to 2008 (Source: CFISH database October 2009).....	63
Figure 36: Average monthly Grey Mackerel catch (+95%CI) for the commercial logbook grid references AB6 & AB7 for the years 2002 to 2008 (Source: CFISH database October 2009). ....	64
Figure 37: Average monthly ‘Shark’ ( <i>Carcharhinidae</i> spp.) catch (+95%CI) for the commercial logbook grid references AB6 & AB7 for the years 2002 to 2008 (Source: CFISH database October 2009).....	64
Figure 38: Total number of boats and fishing effort (boat days) in the Port Musgrave commercial crab fishery for the years 2002 to 2008 (Source: CFISH database October 2009).....	65
Figure 39: Annual Giant Mud Crab catch (columns) and catch per unit of effort (CPUE kg/day) for the commercial logbook grid reference AB6 & AB7 for the years 2002 to 2008 (Source: CFISH database October 2009). ....	65

Figure 40: Average monthly Giant Mud Crab catch (tonnes) (+95%CI) for the commercial logbook grid reference AB6 & 7 for the years 2002 to 2008 (Source: CFISH database October 2009).....	66
Figure 41: Average monthly commercial charter operator catch (kg) ( $\pm$ SE) and average monthly catch per unit of effort (kg/boat day) for the years 2000 to 2008 (Source CFISH database as at 12 September 2009).....	67
Figure 42: Total weight of species recorded in the CFISH database for commercial log book grids AB6 & AB7 for the years 2000 to 2008 (as at 12 September 2009).....	67
Figure 43: The main species tagged by recreational anglers as a percent of the total recreational catch pooled for the years 1986 to 2009 (Source INFO-FISH Services)...	68
Figure 44: Total length of all specimens of sawfish species and Speartooth Shark captured from the Ducie River, Namaleta Creek and Wenlock River in the March, June and November surveys. ....	76
Figure 45: Speartooth Shark capture locations.....	77
Figure 46: Sawfish capture locations.....	78
Figure 47: Movement patterns of tagged sawfish. ....	82
Figure 48: Dwarf Sawfish attacked by a crocodile and shark while in the net (A), recaptured four months later (B), with wounds almost fully healed (C).....	83
Figure 49: Length-frequency data of Queensland Groper (n = 50) for animals captured in the March, June and November surveys across all survey sites.....	83
Figure 50: Queensland Groper capture locations. ....	84
Figure 51: Saltwater Crocodile observation and capture locations. ....	86
Figure 52: Sea snake and turtle observation locations. ....	87

## 1.0 Summary

This report establishes the baseline information (historic and current) on the fisheries and invertebrate resources of Port Musgrave and the lower reaches of Namaleta Creek, Ducie and Wenlock Rivers. Key species were identified as being important because of their conservation status and their importance to the Traditional Owners (five clan groups are present in the Port Musgrave area and are outlined below). The key species were assessed in terms of their population size and potential utilisation of habitat.

Addressing the objectives of this study:

*Characterise the fish and invertebrate resources of the proposed development site.*

- In general, the fisheries resources appear to be in good health and comparable to other commercially and recreationally fished areas in the Gulf of Carpentaria (GoC). The major commercially important species found in this survey were: Barramundi (*Lates calcarifer*), Blue Threadfin Salmon (*Eleutheronema tetradactylum*), King Threadfin Salmon (*Polydactylus macrochir*), Blacktip Shark complex (*Carcharhinus tilstoni* and *Carcharhinus limbatus*) and juvenile Grey Mackerel (*Scomberomorus semifasciatus*). Species of recreational importance such as Giant Queenfish (*Scomberoides commersonianus*) and Barramundi were identified and stocks currently support commercial charter operations.
- Commercial quantities of Giant Mud Crab (*Scylla serrata*) were observed and we also identified the presence of Banana Prawns (*Fenneropenaeus merguensis*) and Black Tiger Prawns (*Penaeus monodon*). Giant Mud Crab catch data indicate that the fishery is relatively healthy when compared to other more heavily fished areas such as Albatross Bay (Weipa) and Trinity Inlet (Cairns). Juvenile Giant Mud Crabs were identified as being infected with low levels of a parasitic barnacle (*Loxothylacus ihlei*).
- A major finding of our review of commercial logbook catch and effort data demonstrated that relative fishing effort has been variable with a slight decline in recent years in the gill net and crab fishery of Port Musgrave. Both effort and catch has decreased but the catch per unit of effort (CPUE) has remained relatively stable; given CPUE is a reliable indicator of the underlying abundance then stocks of fished resources appear healthy.
- Over the three research surveys completed in this study, a total of 6407 individual animals from 126 species were recorded. Of these 126 species there were: 72 fish species, 29 shark and ray species, six reptile species, two dolphin species, five jellyfish species and 12 crustaceans (crab and prawn species). The species diversity of the Port Musgrave area was found to be similar to that reported for the nearby Weipa/ Albatross Bay by Blaber et al. (1989, 1995).

*Determining changes in these resources over time.*

- The main seasonal drivers for the fisheries resources and fishing industry of the Port Musgrave area are the monsoonal wet-dry climate/environmental cycle and the management imposed seasonal closure of the Barramundi fishery

between October and January; although this has varied in duration between years.

- Long-term temporal changes can only be inferred from the commercial catch-effort logbook time series. For the major commercial categories recorded, although there has been considerable variation in effort and catch, there has not been a consistent decline in the overall standardised CPUE (weight of fish caught per day per fisher).
- The Giant Mud Crab fishery logbook data show a drop in effort and catch over the last two years, but an apparent increase in the CPUE; due to a change in the management policy removing the Giant Mud Crab licence endorsement from the inshore gill net N3 fishery. This rise in CPUE is not due to an increase in the underlying crab population but is an artefact of management policy.
- Within the nine month time-frame of the field surveys for this study there appears to be no temporal trend in the catch of Barramundi, although the CPUE was higher for Blue Threadfin Salmon in winter; consistent with this species being a winter spawner. Barramundi is known to be a wet season spawner and is therefore protected by the current seasonal closure of the inshore gill net fishery. The closure also coincidentally protects other wet season breeders (such as Mangrove Jack (*Lutjanus argentimaculatus*) and Freshwater Sawfish).

*Description of the likely impacts on the resources attributable to the proposed development with respect to a nearby undeveloped/control site.*

The current study has established the baseline data on the species composition and relative abundance of fisheries resources in the area of the proposed development, before any site-works are begun. These baseline data will allow a statistically robust “before and after” comparison of the proposed development area, subsequent to completion of the site-works, referenced against the adjacent undeveloped areas.

Prior to such a comparison the following general inferences of the likely impact(s) can be described:

- The commercial and recreational take of Barramundi and other targeted species may be effected in two ways;
  1. Displacement of fishing effort; a 200 metres (m) exclusion zone is required around port facilities plus further displacement due to the presence of additional/ wider navigational channels. The impact of these spatial exclusions on fished stocks would be the concentration of fishing effort in alternative/ adjacent areas, increasing the risk of depleting local populations.
  2. An increase in recreational fishing pressure from improved road access, new boat launching facilities and additional mine personal (similar to Weipa/ COMALCO development).
- Queensland Groper (*Epinephelus lanceolatus*) is commonly found around port facilities and proposed additional structures may provide added habitat for this species.
- The spatial distribution of the commercial fishery is currently mainly outside areas directly impacted by the proposed development. Furthermore, the commercial fishing effort in the inshore net and crab fisheries of the area is small relative to the rest of the GoC and has been declining over the last

decade; therefore despite the displacement, a major impact due to the development would not be anticipated.

*Assessment of the impacts on population and habitat utilisation of key species and species of conservation interest in the area in relation to fluctuating environmental change.*

This study recorded, either by direct capture or by field observation, the occurrence of at least 13 species of high conservation status in the Port Musgrave region. These include:

- Speartooth Shark (*Glyphis glyphis* – referred to as *Glyphis* sp. A until 2008) that are Critically Endangered under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act);
- Four sawfish species: Freshwater Sawfish (*Pristis microdon*), Green Sawfish (*Pristis zijsron*) and Dwarf Sawfish (*Pristis clavata*) that are all Vulnerable under the EPBC Act and Narrow Sawfish (*Anoxypristis cuspidata*) that are listed as Endangered on the IUCN Red List (IUCN 2009);
- Protected iconic Queensland species, Queensland Gopher (*E. lanceolatus*) and Australian Snubfin Dolphin (*Orcaella heinsohni*); and
- Other species of conservation concern, which are known to utilise the habitat in the Port Musgrave region included: Green Turtle (*Chelonia mydas*) and Flatback Turtle (*Natator depressus*) (both Vulnerable under the EPBC Act); Pacific Ridley Turtle (*Lepidochelys olivacea*) (Endangered under the EPBC Act); Dugong (*Dugong dugon*) and Saltwater Crocodile (*Crocodylus porosus*) both Vulnerable under the Queensland Nature Conservation Act 1992; and sea snakes (Hydrophiidae spp.) that are protected in Queensland waters.

The Speartooth Shark (*G. glyphis*) has the most restricted distribution of all the Species of Conservation Interest observed in the Port Musgrave area. Although this species has only recently been fully described (therefore previously difficult to identify), the only recorded observation of a *G. glyphis* population in the Gulf of Carpentaria has been in the Port Musgrave area. For this critically endangered species in particular, due care in the planning of marine works would be required as would the ongoing monitoring of its status while work was in progress.

In terms of the impact of fluctuating environmental change; there was a very high level natural variability observed in all measures of abundance across all species in the current study. This was observed within survey sites, across surveys and across sampling gear type.

- The implication of such levels of variation is that statistical comparison of data between “sites” or “times” can be obscured by the inherent variability within the “site” or “time” data. It effectively reduces the statistical power of such comparisons.
- The source of this variation in the data can be “observer error” or “process error”; in tropical habitats the latter is usually larger and includes the environmental effects of variable weather/climate and sea conditions, as well as habitat change due to tropical storms.

- A further implication is that very careful statistical design will be required to determine any future environmental impact. Such an impact will have to be large and unambiguous to be statistically significant.

*Identify the consequences of the proposed impact on associated fisheries and Traditional Owners in the area.*

- The Traditional Owners in the Port Musgrave area include a number of clan groups: In Mapoon township there are the Tjungdji clan group; on the northern banks of Port Musgrave there are the Warrangku clan group and the Angkamuthi clan group (Native Title claimants); and at the mouth of the Ducie River there are the Taepathiggi clan group that are also at the mouth of the Wenlock River along with the Mpakwithi clan group.
- The data compiled in the Community Fisheries Resource Assessment report (Appendix A) is the most comprehensive data set available for subsistence/recreational fisheries of Indigenous communities in the Port Musgrave/Weipa region. One hundred and forty one creel surveys were conducted between 16/06/09 and 30/11/09 representing 504 people. Community residents were represented evenly in the survey statistics (52% of participants) with only 39 people identified as residing outside of Queensland. Line fishing was the dominant gear type used by anglers followed by crab pot gear.
- Of those local residents interviewed, a large percentage was male (55%), although women and children actively participated in fishing activities. Fishing was not only seen as a means to obtain food but a way to spend quality time with family and friends. The Pikey Bream (*Acanthopagrus berda*) was the most abundant species recorded from a total of 76 species from 30 Families. Giant Mud Crab (*S. serrata*) and Barramundi (*L. calcarifer*) were also species of importance to both community and non-community fishers. Often numerous small fish were caught by line or cast nets (e.g. mullet) as bait for line fishing for larger predatory fish.
- One hundred and twenty one observations of Species of Conservation Interest were reported, mainly crocodiles and dolphins. Speartooth Sharks (*G. glyphis*) were not recorded in the catch, although a number of unidentified whaler shark species were.
- A discussion of the likely impacts of the proposed development is included in the Community Fisheries Resources Assessment Project (Appendix A). Detailed assessment of the potential impact of the proposed development to the Traditional Owners is also provided in a Social Impact Assessment study; another element of the Environmental Impact Assessment presented in a separate report.

# 1.0 Introduction

## 1.1 Background

Cape Alumina Ltd is investigating options for establishing a port facility in Port Musgrave to service a proposed bauxite mining operation north of Weipa. An Environment Impact Assessment (EIA) for the proposed mine and port facility will be prepared that will comprise multiple elements, including the potential impacts on marine ecological values.

The Marine Fisheries Group (MFG), Sustainable Fisheries, Department of Employment, Economic Development and Innovation have been surveying and monitoring the fisheries resources in the Port Musgrave region since the early 1980's as part of a broad scale monitoring program in the inshore finfish and crab fisheries of the Gulf of Carpentaria (GoC). The MFG were contracted by Cape Alumina Ltd to assess the fisheries resources of Port Musgrave.

The following document comprises the identification, description and assessment of the fisheries and aquatic values of the Port Musgrave area that are to be incorporated into the Environmental Impact Assessment.

## 1.2 Gulf of Carpentaria and Port Musgrave Fisheries

### 1.2.1 Port Musgrave and previous studies

Port Musgrave is located on the north-west coast of Cape York Peninsula, North Queensland, in the Gulf of Carpentaria and is approximately 80 kilometres (km) north of Weipa (S 12°01.205, E 141°56.393) (Figure 1). The Port Musgrave area comprises both ocean beach habitat and muddy, mangrove lined shores fed by a number of tidal creeks. This remote area has a semi diurnal tidal variation which can exceed 3.5 m, submerging the shoreline mangroves at high tide and exposing large areas of mud and sand banks at low tide.

Port Musgrave has three waterways draining into it, Namaleta Creek, Ducie River and the Wenlock River. Namaleta Creek is close to the Port entrance and with a mainstream length of 13.5 km is substantially smaller than both the Ducie River (47.7 km) and Wenlock River (42 km) (Messel et al. 1981). The three waterways are seasonally influenced by freshwater flooding during the monsoonal wet season. The input of freshwater declines more rapidly with the onset of the dry season in Namaleta Creek than the two much larger river systems. Throughout the year the freshwater inflow in the Ducie River and Wenlock River remains sufficient to prevent the salinity upstream from rising above the seawater values measured at the mouth of the system. This characteristic is not observed for Namaleta Creek which displays hypersaline characteristics typical of small waterways with direct access to coastal marine waters (Messel et al. 1981).

Port Musgrave opens into the Gulf of Carpentaria (GoC) which is a large, relatively shallow tropical gulf system in northern Australia with a maximum depth of approximately 65-70 m and water movement dominated by tidal and wind driven currents. The GoC (the Gulf) supports a diverse arrangement of habitat types and is

characterised by a generally muddy sea floor. Algae and coral encrusted rock and rubble beds are present in inshore and offshore waters and are more predominant in the northern sector of the Gulf. Between the months of December and March monsoonal flood waters drain into the Gulf from 27 major rivers with freshwater plumes extending in excess of 12 nautical miles (nm) offshore. The region has significant seagrass, mudflat, mangrove, saltpan and freshwater swamps. These habitats combined produce an area of very high fisheries productivity (Roelofs 2003).

The fish communities of the GoC have been described quite extensively (Ramm et al. 1990; Harris and Poiner 1991; Blaber et al. 1994; Stobutzki et al. 2001). There have been no previous studies of fish communities specifically focussed on Port Musgrave. The major studies of the fishes in inshore waters of the north-western Cape York were undertaken in the Weipa area, in Albatross Bay and the Embley Estuary, from the mid 1980's to early 1990's (Blaber et al. 1989, 1990a and b, 1995; Cyrus and Blaber 1992). Using gill nets and beach seine Blaber et al. (1995) identified 118 fish species in the shallow inshore waters south of the Embley Estuary, with the communities dominated by Giant Queenfish (*S. commersonianus*), Milkfish (*Chanos chanos*) and Blue Threadfin Salmon (*E. tetradactylum*). The number of species in these inshore waters was less than inside the Embley Estuary where 197 species were recorded, with the greater numbers of species most likely due to the presence of more diverse habitats (Blaber et al. 1989, 1995).

A variety of gear in five different habitats was used by Blaber et al. (1989) in the Embley Estuary and it was found that the highest biomass of fish were in the intertidal mudflats adjacent to mangroves, followed by open water channels, small mangrove creeks and inlets, sandy mud beaches and seagrass areas. Gill nets were only used in the open water channels and 127 species were recorded from 1204 hours of gill netting. The lower reaches of the estuary had the highest numbers of species, probably due to the presence of more diverse habitats than in the middle and upper reaches (Blaber et al. 1989). The dominant species varied among habitats: in the intertidal mudflats adjacent to mangroves they were Sickleafish (*Drepane punctata*) and Cowtail Stingray (*Dasyatis sephen*, now *Pastinachus atrus*); in open water channels they were Giant Queenfish (*S. commersonianus*), Arafura Catfish (*Arius proximus*) and Barramundi (*L. calcarifer*); in small mangrove creeks and inlets they were Redstripe Toadfish (*Tetraodon erythrotaenia*) and Greenback Mullet (*Liza subviridis*); in sandy mud beaches they were Pikey Bream (*A. berda*) and Barramundi (*L. calcarifer*); and in seagrass areas many small fishes (<10 cm Total Length) were dominant.

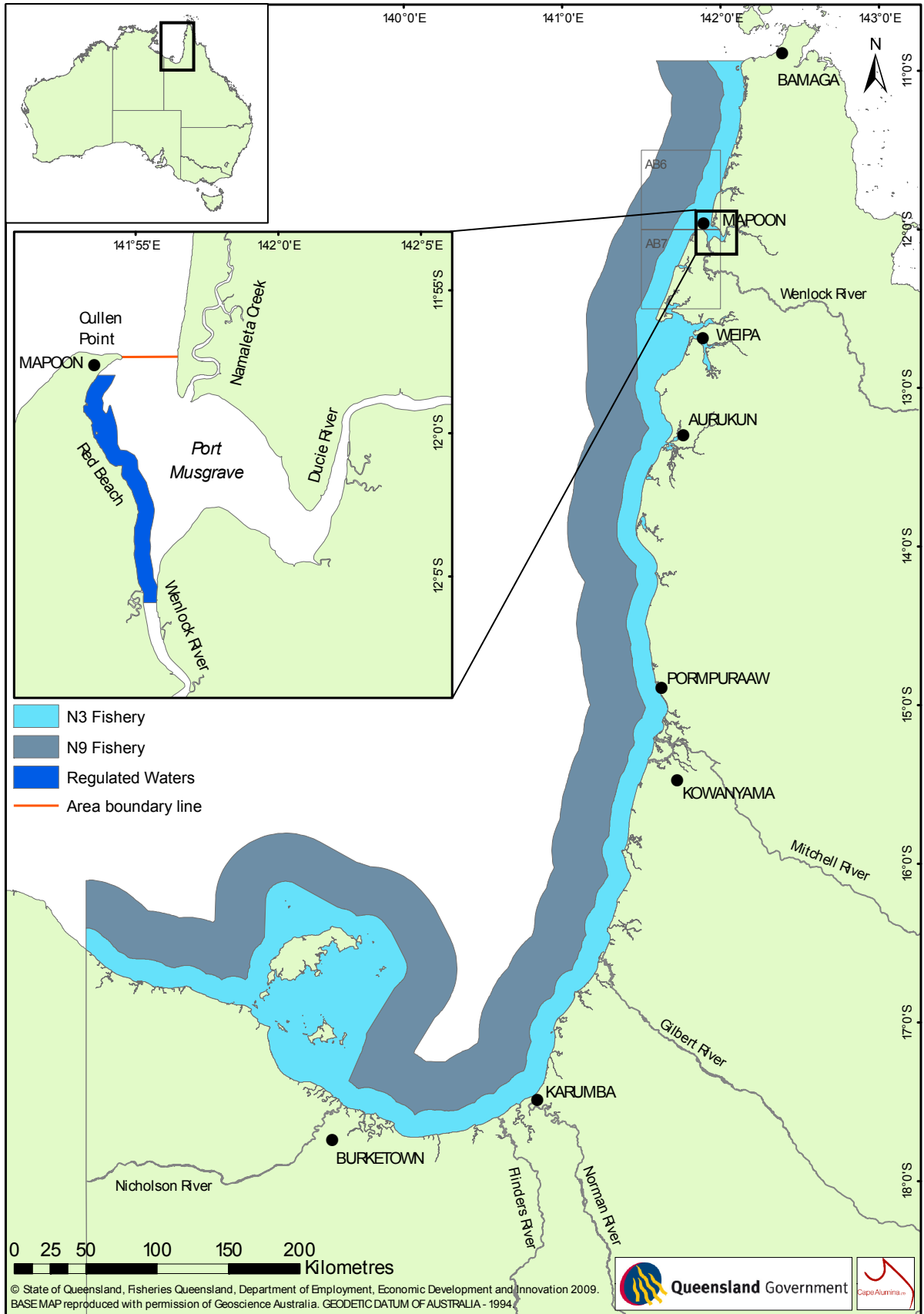


Figure 1: Gulf of Carpentaria Inshore Finfish Fishery and Port Musgrave study area.

The Embley Estuary, typical of a tropical northern Australian estuary exhibited strong seasonal patterns in turbidity and salinity largely determined by rainfall patterns in the catchment with three distinct seasons evident: wet (December to April), early dry (May to August) and late dry (September to December) (Cyrus and Blaber 1992). In the wet season turbidity increased and salinity decreased from the lower to upper reaches, while in the early dry season there was a reverse turbidity gradient with the highest turbidity values in the lower reaches and lowest values in the upper reaches. Decreased fresh water flows at this time led to an increase in salinity due to tidal exchanges, and the entire estuary system was close to seawater. In the late dry season there was negligible river flows and the turbidity values were lowest with waters uniformly clear throughout the estuary. The salinities in the middle and upper reaches rose due to decreased freshwater inflows and increased evaporation, and upper reaches exceeded seawater values.

These surveys in the Weipa area did record sawfish in the Embley Estuary and in Albatross Bay. Gill nets recorded Smalltooth Sawfish (*Pristis pecinata*) in the middle reaches of the open water channels in the Embley estuary and Common Sawfish (*Pristis pristis*) in the middle and lower reaches of the estuary. *Pristis pristis* were also recorded from the more open waters of Albatross Bay with trawl gear, as were Green Sawfish (*P. zijnsron*) and Narrow Sawfish (*A. cuspidata*). Since the late 1980's there has been a taxonomic revision of Pristidae with the Australian species reported in Last and Stevens (2009) and neither *P. pecinata* or *P. pristis* are now considered as present in Australian waters. It is possible that the identifications were erroneous and that *P. pristis* was *P. clavata* and *P. pectinata* was *P. microdon*. No Speartooth Sharks were recorded on any of these surveys.

## **1.2.2 Commercial Harvest Fisheries**

### **Net, Line and Crab Fisheries**

Commercial net, line and crab fisheries are permitted in Port Musgrave, Ducie River and Wenlock River. Commercial net fisheries in Port Musgrave are part of the Gulf of Carpentaria Inshore Finfish Fishery (GOCIFF). The GOCIFF extends from Slade Point on the north-west coast of Cape York Peninsula (intersection of longitude 142°09' E with the shore) to the Queensland/Northern Territory border and extends from the high water mark to 25 nm offshore. The GOCIFF includes waters of all rivers and creeks influenced by the tide and flowing into the Queensland side of the GoC. It is a multi-species fishery with fishers targeting different species at different times of the year throughout the geographical extent of the fishery (Figure 1) (Roelofs 2003).

Gill netting is the dominant commercial fishing activity in the GOCIFF and is managed as two separate management units; the inshore N3 and offshore N9 fishing symbols (Figure 1). The GOCIFF also includes recreational fishing, charter boat fishing and Indigenous fishing. Fishers operating an N3 fishing symbol are permitted to fish from the coast, including tidal waters of rivers, out to 7 nm. Fishers target primarily Barramundi (*L. calcarifer*) and Threadfin Salmon (*P. macrochir* and *E. tetradactylum*) and use surface set mesh nets ranging in mesh size from 162.5 millimetre (mm) to 245 mm with maximum net lengths either 360 m in rivers or 600 m on foreshores. The combined Gross Value of Production (GVP) for the GoC N3 fishery for 2007/08 was \$10.5 million (Williams, Fisheries Queensland, unpublished data). Currently there are 79 N3 fishing symbols in the GOCIFF.

Any commercial net fishing in the Port Musgrave area is under the N3 Symbol and is mainly gill netting for Barramundi (*L. calcarifer*). There are some waters in Port Musgrave that are permanently closed to gill netting that include foreshores and waters within one km of the western shore of Port Musgrave and the Wenlock River at low water mark between latitude 12°05.92' South and latitude 11°57.96' East (Figure 1).

The offshore N9 fishery extends from 7 nm to 25 nm and principally targets Grey Mackerel (*S. semifasciatus*) and tropical shark; predominantly Blacktip Shark complex (*C. tilstoni* and *C. limbatus*, two closely related species that cannot generally be separated on external characteristics; certain size animals can be identified to species on the basis of the size at sexual maturity as this differs between the two species). Fishers operating under an N9 fishing symbol are restricted to 1200 m of surface set net of mesh size 162.5 to 245 mm. The fishery is restricted to six licences and has a conservatively estimated GVP of \$2 million (Williams, Fisheries Queensland, unpublished data). Although the area of N9 fishery is offshore from Port Musgrave the inshore estuarine habitat of Port Musgrave, mangrove fringes, seagrass meadows, rocky reefs and sand/mud flats, support the juvenile life history stages of target species in the N9 fishery.

Seasonal and permanent spatial closures in the GOCIFF are in place that protect target, by-product (non target species retained for sale) and by-catch species (species of no commercial value) for a greater part of their lifecycle. There are also restrictions on fishing gear, maximum/minimum size limits on key species and bag limits and there has been a substantial reduction of commercial fishing effort in the GOCIFF (Roelofs 2003).

One hundred and forty finfish species are recorded as either target or bycatch in the inshore and offshore net fisheries of the GOCIFF (Magro et al. 1997; Halliday et al. 2001; Stapley and Rose 2009). The finfish diversity in these net fisheries is comparable to that in the Queensland tropical east coast net fishery where 141 finfish species have been reported from independent gill net sampling (Halliday et al. 2001).

The other dominant viable commercial fishing activity in the Port Musgrave area is potting for Giant Mud Crab (*S. serrata*). This is conducted under the Queensland Commercial Crab Fisheries C1 fishing symbol that operates throughout the State's coastal waters. A maximum of 50 bottom set wire-mesh crab pots, trawl-mesh (nylon) crab pots or collapsible traps made from nylon trawl mesh are the main gear used by commercial fishers to catch Giant Mud Crabs with the take restricted to males of minimum size of 15 centimetre (cm) carapace width. Commercial crab fishers can use small mesh nets to take bait for use in their own operations.

Commercial Line fishers can also access Port Musgrave, under an L4 Gulf of Carpentaria Finfish Fishery symbol, however commercial line fishing activity in the area is minimal. This Fishery covers tidal waters from the border with the Northern Territory to the border with New South Wales. The main gear is bottom handlines and trolling gear, with a restriction on the number of hooks that can be used and regulations that include seasonal, spawning and spatial closures, restrictions on boat size and species

size limits. Within the GoC the main target species are Spanish Mackerel (*Scomberomorus commerson*) and to a lesser extent Grey Mackerel (*S. semifasciatus*).

Fisheries Queensland (FQ), a service of the Department of Employment, Economic Development and Innovation (DEEDI), is responsible for developing and implementing fisheries management in Queensland. The *Queensland Fisheries Act 1995 & Regulations 2008* and the Gulf of Carpentaria Inshore Finfish Management Plan 1999 form the legislative framework governing the fisheries management measures of the Gulf of Carpentaria Inshore Finfish Fishery. The N9 fishery is jointly managed by the State and Commonwealth Governments through the Queensland Fisheries Joint Authority (QFJA). This legislative framework drives the sustainable harvest levels in a broad ecosystem context; it is not species specific because it is considered a multi-species fishery.

The commercial catch of the GOCIFF and GoC line and crab fisheries is monitored by Fisheries Queensland through the compulsory reporting of data by fishers in logbooks. This logbook data is expressed as species catch landings per 30 nm x 30 nm spatial grid reference and dates back to the early 1980's. This long term data set forms the platform on which past and present management decisions are based. Fisheries management regulations in Queensland are subject to change in response to resource needs and the social requirements of the resource users. An ecological risk assessment conducted by Fisheries Queensland on the GOCIFF, which utilised outcomes from a multi-stakeholder workshop and stock assessment data on key species, indicated the fishery was being sustainably managed (Zeller and Snape 2006).

### **Recreational Fishery**

Recreational fishing is permitted in Port Musgrave and the estuarine and freshwater reaches of the Ducie River and Wenlock River. Recreational fishers primarily use line fishing apparatus to catch target fish species, as well as 7 m cast nets and 16 m seine nets to catch baitfish species. Up to three fishing lines with a total of six hooks or lures may be used at any one time. Management of the recreational fishery imposes species bag and size limits and seasonal and spatial closures. The seasonal closure applies to Barramundi from October to January with specific dates determined by lunar phases and there is one permanent spatial closure in place in the South Mitchell River.

Anglers target a range of species using baited hook (live and dead) and lures. Species targeted in inshore waters of the GoC include Barramundi, Pikey Bream (*A. berda*), Barred Javelin/Grunter (*Pomadasys kaakan*), Threadfin Salmon (*P. macrochir* and *E. tetradactylum*), Golden Snapper (*Lutjanus johnii*) and Mangrove Jack (*L. argentimaculatus*).

The number of recreational anglers that fish the Port Musgrave area is difficult to estimate. There are no recreational fishing clubs that conduct fishing competitions and outings in the catchment, although INFO-FISH records indicate some anglers tag and release fish in the area. In 2009 the Federal Government provided funding to invest in roads and a new sealed boat ramp and this may increase the numbers of recreational anglers due to improved vehicle access to the area.

### **Charter Boat Fishery**

All commercial charter tour operators in Queensland must possess a fisheries permit issued by Fisheries Queensland to conduct fishing tours. The permit restricts charter operators and anglers aboard the vessels to the same regulations as those imposed on recreational anglers. These restrictions include bag limits, size limits and seasonal and spatial closures. Commercial charter operators are also required to complete fishing logbooks on their catch and fishing activities. The GoC charter fishery in 2007/08 had an estimated GVP of \$2 million (Williams, Fisheries Queensland, unpublished data).

### **Indigenous Fishery**

Fishery resources of the GoC are used by at least 15 Aboriginal clan groups, each of which has specific fisheries resource interests. The Indigenous communities in the GoC catch finfish and crabs using a combination of traditional subsistence fishing methods, recreational fishing methods and a limited use of commercial fishing apparatus. Traditional fishing methods include nets, stone fish traps and spear and provide product solely for community use (Roelofs 2003).

The level of national Indigenous bycatch is thought to be considerably less than that of commercial harvest and recreational fisheries, totalling less than five percent nationally (Henry and Lyle 2003). Although the fisheries resources of the GoC are a primary source of diet for coastal Indigenous communities (Roelofs 2003), catch data are limited for the Indigenous fishing sector. The paucity of information and data on Indigenous fishery harvest is largely attributed to funding inconsistency and over the years this has resulted in monitoring projects operating in an *ad hoc* manner (Henry and Lyle 2003).

The fisheries resources of Port Musgrave, Ducie River and Wenlock River are important to the Traditional Owners for customary and dietary purposes (Woodley, Mapoon Aboriginal Shire Council Trustee pers. comm. 2009). The Traditional Owners in the Port Musgrave area include a number of clan groups: The Mapoon township are the Tjungdji clan group; on the northern side of Port Musgrave there are the Warrangku clan group and the Angkamuthi clan group (Native Title claimants); and at the mouth of the Ducie River there are the Taepathiggi clan group that are also at the mouth of the Wenlock River along with the Mpakwithi clan group. The considerations of these clan groups and the potential impact of the proposed development to these groups are assessed in detail in a Social Impact Assessment study that forms a separate report with the information to be included in the main Environmental Impact Assessment

Giant Mud Crabs are of particular importance to the Mapoon Aboriginal Community as a stable food source and potential income earner. Unlike recreational and commercial fishing, possession and size limits do not apply to traditional and customary fishing. However, amendments to the *Fisheries Act 1994* in October 2008 included the restriction of traditional and customary fishing to:

- personal, domestic and non-commercial communal use only
- recreational fishing or prescribed traditional apparatus (such as fish traps).

The *Fisheries Act 1994* still provides Indigenous people the right to apply for a general fisheries permit to use large fishing nets for cultural and ceremonial events. Historically

the Mapoon Aboriginal Shire Council held a permit fishing licence (permit number 55096) that expired on 24/5/2000. Mapoon Aboriginal Shire Council currently possesses a Community commercial fishing licence, number 4525, boat symbol FXGU. The fishing symbols issued under this licence include net (N3), crab (C1) and line (L3 and L4), however this fishing licence is currently not being used.

In addition to acquiring permit fishing licences, Aboriginal communities can apply for assistance under the Queensland Government's initiative 'Cape York Partnership Program' to become active participants of the GOCIFF. This is achieved through the acquisition of available fishing licences offered for sale. This initiative is designed to promote economic growth and prosperity within Indigenous communities.

### ***Northern Prawn Fishery***

The Northern Prawn Fishery (NPF) targets Banana Prawn (*Fenneropenaeus merguensis*) and Tiger Prawns (*Penaeus esculentus* and *Penaeus semisulcatus*) and extends off Australia's northern coast, from the low water mark to the outer edge of the Australian fishing zone (AFZ) in the area between Cape York in Queensland and Cape Londonderry in Western Australia. It is a Commonwealth Government managed fishery and is considered one of the most valuable fisheries in Australia, with a GVP of \$72 million in 2007/08 (AFMA 2009).

Port Musgrave seagrass habitat is a known nursery area of prawn species commercially harvested in the NPF (Coles et al. 2003). Prawns have estuarine/marine life history phases to their life cycle with recruitment of post larvae into inshore nursery habitat largely influenced by tidal currents (Kenyon et al. 2004). It has been suggested that larvae spawned in regions adjacent to inshore nursery habitat have a greater survival rate compared to larvae spawned outside these regions where they are lost offshore (Kenyon et al. 2004). Hence Port Musgrave and the adjacent waters offshore to the area are likely to be important to the sustainability of Queensland's NPF area of operation.

The NPF has undergone considerable changes in the management regime over the past 30 years with the most notable change being the steady reduction in fishing effort (65% reduction in fishing effort since 1981) to a level that is considered sustainable (Kenyon et al. 2004). Historically and currently very few anthropogenic impacts threaten the fishery due to northern Australia's remoteness and the present infrastructure and activities have had no reported discernable impact on prawn stocks. However as fishery stocks of prawn species rely on stable nursery habitats for the juvenile phase and threats to seagrass and mangrove habitats, banks and bare substrates may impact the prawn stocks and the NPF, future development and their associated impacts should be considered and assessed as part of any planning process (Kenyon et al. 2004).

### ***Gulf of Carpentaria Developmental Finfish Trawl Fishery***

This Fishery is currently considered a Developmental Fishery and operates outside 25 nm generally from the Queensland Gulf of Carpentaria coastline north of 15 degrees South latitude. It is a limited entry, quota-managed, semi-demersal trawl fishery with five Developmental Fishing Permits issued since 1998; however only two were active in 2006. The main species captured are tropical red snappers including the Crimson

Snapper (*Lutjanus erythropterus*) and the Saddletail Snapper (*Lutjanus malabaricus*) that are found on coastal and inshore reefs. However a variety of other valuable species are also retained as saleable product, including Mangrove Jack (*L. argentimaculatus*), Golden Snapper (*Lutjanus johnni*), Painted Sweetlips (*Diagramma labiosum*) and Goldband Snapper (*Pristipomoides multidens*). The Fishery has a maximum commercial Total Allowable Catch (TAC) of 1500 tonnes with a commercial TAC set annually (Kaus et al. 2008). Some of the species that are captured in this Finfish Trawl Fishery may occur in the Port Musgrave Region in different phases of their life history.

### 1.3 Species of Conservation Interest (SOCI)

The Marine Fisheries Group broad scale monitoring program in the inshore finfish and crab fisheries of the Gulf of Carpentaria (GoC) has been conducted since the early 1980's. It collects fisheries information from independent research and fisheries observer surveys with commercial fishers. This program has recorded the occurrence of a number of species of high conservation status in the Port Musgrave region. These include:

- Speartooth Shark (*Glyphis glyphis*) (referred to as *Glyphis* sp. A until 2008 (Compagno et al. 2008)) that are Critically Endangered under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) and listed as Endangered by the IUCN Red List of Threatened Species (IUCN 2009).
- Four sawfish species: Freshwater Sawfish (*P. microdon*), Green Sawfish (*P. zijnsron*) and Dwarf Sawfish (*P. clavata*) that are all Vulnerable under the EPBC Act and Narrow Sawfish (*A. cuspidata*) that are not listed under the EPBC Act. All these sawfish species are listed as Critically Endangered by the IUCN (2009).
- Iconic Queensland species, Queensland Groper (*E. lanceolatus*) and the Australian Snubfin Dolphin (*Orcaella heinsohni*) that is listed as Rare under the NCA and Near Threatened by the IUCN (2009).

Other species of conservation concern, which are known to utilise the habitat in the Port Musgrave region include: Green Turtle (*Chelonia mydas*) and Flatback Turtle (*Natator depressus*) (both Vulnerable under the EPBC Act with the Green Turtle listed as Endangered by the IUCN (2009) and Flatback Turtles as Data Deficient); Pacific Ridley Turtle (*Lepidochelys olivacea*) (Endangered under the EPBC Act, Vulnerable by IUCN (2009)); Dugong (*Dugong dugon*) and Saltwater Crocodile (*Crocodylus porosus*) both Vulnerable under the NCA with Dugong also listed as Vulnerable by the IUCN (2009); and sea snakes (Hydrophiidae spp.) that are protected under the *Queensland Fisheries Act 1994*.

All the species above are also protected under Queensland State legislation. The Speartooth Shark, all sawfish and Queensland Groper are regulated species under the *Queensland Fisheries Act 1994 (Regulations 2008)* that prohibits the unlawful take of these species. Additionally all native wildlife in Queensland is protected under the *Nature Conservation Act 1992* (NCA) i.e. the Speartooth Shark, sawfish, Queensland Groper, Saltwater Crocodiles, turtles, dolphins, dugongs and sea snakes.

Ecological and biological information for the Speartooth Shark, sawfishes, Queensland Groper and Saltwater Crocodile are provided below with their conservation status and habitat use summarised in Section 3.3, Table 6. The conservation status for the other Species of Conservation Interest recorded from Port Musgrave or known to use the habitat in the region are also described in Section 3.3 with more detailed information on their ecology provided in the main Environmental Impact Assessment.

### 1.3.1 Speartooth Shark (*Glyphis glyphis*)

Critically Endangered under the EPBC Act, the Speartooth Shark (*G. glyphis*) was previously referred to as *Glyphis* sp. A and thought to be endemic to northern Australia (Stevens et al. 2005; Peverell et al. 2006; Compagno et al. 2008). *Glyphis glyphis* is thought to have a range that extends from tropical northern Australia (Northern Territory and Western Cape York Peninsula in Queensland) to the Fly River in New Guinea (Compagno et al. 2008; Last and Stevens 2009). *Glyphis glyphis* was historically recorded in 1983 from Princess Charlotte Bay (Normanby River and Bizant River), a region on the tropical east coast of Queensland (Peverell et al. 2006). There are also historic records of *Glyphis* species (taxonomy uncertain) captured in the Weipa Region; Hey River in 1981 (two specimens) and in the Embley River in 1985 (one specimen); and in Port Musgrave in the Ducie River in 1980 (one specimen) (Peverell et al. 2006). Since these initial records, *Glyphis* species have not been recorded in any of these locations, except the Ducie River, despite commercial and recreational fishing effort and research sampling in these areas over the last 26 years (DEWHA 2008a).

The taxonomic status of *Glyphis* species has only recently been resolved (Compagno et al. 2008). In 1994 two species of *Glyphis* were identified from Australian waters (Last and Stevens 1994) with the distributional range of *G. glyphis* and *Glyphis garricki* (formerly *Glyphis* sp. C) confirmed through genetic samples collected during a collaborative study across Northern Australia (Wynen et al. 2009). The *Glyphis* species complex was formally taxonomically revised in 2008 (Compagno et al. 2008). Consequently, prior to 1994, records of Speartooth Shark distribution and abundance were hindered by the ability of researchers and fishers to positively identify different shark species (Peverell et al. 2006). The information available indicates that juvenile Speartooth Shark populations are fragmented and that they are restricted to only a few drainage systems throughout tropical northern Australia. From published records, Stevens et al. (2005) reported that Australian Speartooth Shark populations only occur across an estimated area of 502 km<sup>2</sup>. This estimate was obtained by summing the area of river and estuary habitats of: Van Diemen Gulf in the Northern Territory (South, East, West Alligator Rivers; Adelaide River; Murganella Creek and Marrakai Creek); Port Musgrave in the Queensland GoC (Ducie and Wenlock Rivers); and the Bizant River in Princess Charlotte Bay, Queensland north-east coast. However this estimate of available habitat should not be taken as being the total available habitat utilised by Speartooth Shark because there is strong evidence to indicate that mature animals are known to occupy offshore marine habitat (Stevens et al. 2005). In addition other known areas of Speartooth Shark habitat, namely the Wenlock River, Hey River, Embley River and the Normanby River were not included in the estimated area.

The Speartooth shark was once considered obligate freshwater sharks; i.e. they were thought to only occur in freshwater (Last 2002). This knowledge led to research efforts

to locate this species to be concentrated in freshwater habitats of Northern Australia, such as in the study conducted by Thorburn et al. (2003). In that study *Glyphis* sp. C (now known as *G. garricki*) (Compagno et al. 2008) was not found in freshwater although it was found in estuarine waters fortuitously by a collaborative research team (Morgan et al. 2004). Following on from the Thorburn et al. (2003) report, additional survey efforts were conducted in estuarine waters of previously sampled rivers in Queensland (Wenlock River) and in King Sound, Western Australia (Thorburn and Morgan 2004). In Queensland, nine juvenile Speartooth Sharks in the Wenlock River, Port Musgrave were recorded (Peverell et al. 2006). Eight specimens were captured in gill nets in the mid reaches of the Wenlock River where the salinity ranged from 0-9 parts per thousands (ppt). The nets were set at the mouths of tributaries or runoff areas leading into the main channel of the river and all eight animals were captured at night on an outgoing tide when the water was at its most turbid. The ninth specimen was captured at the mouth of the Wenlock River at the bottom of the tide in a salinity of 28 ppt (Peverell et al. 2006). Another survey in the Wenlock River recorded 29 neonate and juvenile *G. glyphis* all from further upstream than the specimens captured by Peverell et al. (2006) and all in salinities below 13 ppt (Pillans et al. 2008). In Western Australia six specimens of another *Glyphis* species, *Glyphis* sp. C (now known as *G. garricki*) were recorded from King Sound in the Kimberley region with gill nets and baited lines. They were all captured during the outgoing tide in water of low clarity with salinities between 32.0 and 36.6 ppt in areas dominated by mangroves and with large tidal movements (up to 10 m twice daily) (Thorburn and Morgan 2004). A number have recently been found in the same area (Whitty et al. 2008, 2009b)

These studies undertaken in the past five years on juvenile Speartooth Shark and surveys in the Adelaide River, Northern Territory (Pillans et al. 2005) suggest this species, and *G. garricki*, are euryhaline, tolerating a wide range of salinity levels from 0.8 to 36 ppt. This euryhaline classification is further supported by the fact that three captive kept animals in the Melbourne Aquarium (establishment of the first captive breeding program) were acclimatised in salinity levels ranging between 0 and 35 ppt (L. Jnr. Squire, Director Cairns Marine pers. comm. 2009).

In addition to surveys, a set of shark jaws of *G. glyphis* was provided to Fisheries Queensland by a GOCIFF inshore net (N3) commercial fisherman in 2005. The specimen was caught early in the fishing season (February) in inshore coastal waters 50 nm south of Weipa. In the Northern Territory two large *G. glyphis* specimens greater than 220 cm in Total Length (TL) were recorded in the Commonwealth long line fishery operating in marine waters off the Northern Territory. These two records were validated from examination of jaws and subsequent teeth count (G. Johnson, Shark Biologist Northern Territory Department of Resources pers. comm. 2009) and because of their size may have been mature animals; currently there are no published records of mature *G. glyphis*. These records further indicate *G. glyphis* has a marine component to its life cycle and occupies additional habitat to that of estuaries and rivers. The paucity of distribution records of *G. glyphis* may be associated with the lack of taxonomic clarity until recently but may also be due partly to the concentration of surveys in freshwater with only a few surveys specifically targeting Speartooth Shark in estuarine waters and no targeted surveys in offshore marine waters that may also form part of their habitat.

The Speartooth Shark has been confused with other shark species of similar appearance such as the Bull Shark (*Carcharhinus leucas*), Pigeye Shark (*Carcharhinus amboinensis*), Creek Whaler (*Carcharhinus fitzroyensis*) and Lemon Shark (*Negaprion acutidens*) and as a result has probably led to misreporting by researchers and fishers alike (Peverell et al. 2006). A unique identification feature used to distinguish *Glyphis* species from other shark species is the presence of broad, flat, triangular teeth in the upper jaw and narrow spear-shaped teeth in the first few teeth in the lower jaw (Compagno et al. 2008; Last and Stevens 2009). Similar to the Lemon Shark, Speartooth Shark has very broad triangular pectoral fins; however it has a more streamlined appearance (Peverell et al. 2006; Ward and Larson 2006). Apart from the teeth, the small eye and large second dorsal fin separates this species from Bull Shark, Pigeye Shark and Creek Whaler. Accurate species identification by researchers and fishers still remains a problem and hampers ongoing monitoring and data gathering processes required to sustainably manage the species (Peverell et al. 2006; DEWHA 2008a).

Other than those records of Speartooth Shark from marine waters, this species is typically caught in tropical tidal estuarine and riverine habitats with fast flowing turbid water and a muddy substrate with undulating deep holes (Stevens et al. 2005; Peverell et al. 2006; Ward and Larson 2006; Pillans et al. 2008). The species' small eyes and abundant sensory ampullae on their snout; ability to osmoregulate between changing salinity levels; and large broad pectoral and dorsal fins are indicative of adaptations to survive in such environments (Taniuchi et al. 1991; Thorburn and Morgan 2004; Peverell et al. 2006). These features suggest that *G. glyphis* may be less reliant on visual sighting of prey and more reliant on sensing the vibration and electrical activity of buried, borrowing or bottom associated prey items in turbid waters; hence the species can occupy a habitat niche not commonly shared with other carcharhind shark species in similar habitats (Peverell et al. 2006).

The captive Speartooth Sharks in the Melbourne Aquarium were reported to be predated on other species in the exhibit namely Forktail Catfish (Ariidae spp.), Bony Bream (*Nematalosa erebi*), Barramundi and Saratoga (*Scleropages jardinii*). The examination of stomach contents of wild caught Speartooth Shark indicate the species predate on Freshwater Prawns (*Macrobrachium* spp.); burrowing Gobies (*Taenioides* spp. or *Trypauchenichthys* spp.); Gudgeons (*Prionobutis microps*); and benthic feeding Jewfish (*Nibea squamosa*) and Bony Bream (*Nematalosa erebi*) (Peverell et al. 2006). Speartooth shark have also been line caught on dead fish baits by the first author.

The current state of knowledge on Speartooth Shark biology is poor, partly due to the lack of specimens in research collections (Fowler 1997). Speartooth Shark specimen collections are not likely to increase markedly due to legalities associated with their current conservation status that limits access and retention of animals for scientific studies. This in turn limits the ability to improve the knowledge of the biology and ecology of these animals. Data deficient areas include age and growth, reproductive biology, population structure, distribution and abundance. From available information it is inferred that the species has a maximum size of 300 cm TL with a birth size of 50 to 65 cm TL (Last and Stevens 2009). Stevens et al. (2005) and Compagno et al. (2008) inferred from studies of similar whaler species (e.g. Bull Shark) that Speartooth Shark have a placental viviparity reproductive cycle giving birth to live young. The periodicity

of this reproductive cycle is unknown. Information on juvenile Speartooth Shark growth rates is limited to coarse estimates from length-frequency data on a handful of animals (19 to 30 cm/year) (DEWHA 2008a).

Information on habitat utilisation by juvenile Speartooth Shark is limited to two acoustic tracking studies, one in the Adelaide River and one in the Wenlock River (Pillans et al. 2005). These studies, although only conducted on a total of six animals during the winter dry season, inferred that neonates and juvenile Speartooth Shark in these river systems use habitat repeatedly, and utilise a very small area of habitat. Anecdotal catch records by commercial net fishermen indicate that neonate Speartooth Shark inhabit the large tidal mud banks of Port Musgrave in the months of February to April (T. Dudgeon, GoC Inshore Net Fisherman pers. comm. 2009). It is also anecdotally reported by commercial fishers that larger sub-adult Speartooth Shark greater than 110 cm TL are caught in this same Port Musgrave habitat throughout the fishing season (February to October) (T. Dudgeon, GoC Inshore Net Fisherman pers. comm. 2009). The home range of juvenile Speartooth Shark populations may be seasonally influenced and possibly greater than previously thought; this is another data deficient area that requires further investigation.

The small home range of juvenile Speartooth Sharks inferred by Pillans (et al. 2008) is a type of behaviour not uncommonly observed in other shark species of similar age cohort, such as neonate Bull Sharks and Freshwater Sawfish (Simpfendorfer et al. 2005; Whitty et al. 2009a). It has been suggested that restricted movement within a small home range in neonate Bull Sharks (*C. leucas*) and Freshwater Sawfish may be a predator avoidance mechanism (Simpfendorfer et al. 2005; Whitty et al. 2009b). Juvenile Speartooth Shark may employ similar survival mechanisms given their alleged strong preference for highly turbid estuarine water where predation by larger sharks and crocodiles may occur.

In Queensland the absence of catch records of Speartooth Shark in the Princess Charlotte Bay (Normanby River and Bizant River) and Weipa (Embley River and Hey River) regions since the mid 1980's has led to the conclusion that the species has undergone a decline in population. The full extent of this decline is unknown, given the absence of accurate baseline data on the species distribution and abundance. The species population decline is thought to be attributed primarily to commercial net fishing in inshore waters (Stevens et al. 2005; DERM 2008; Pillans et al. 2008). The level of risk this activity may present to Speartooth Shark was highlighted recently with the fisheries management decision to close the Normanby River and Bizant River to net fishing under the East Coast Queensland Finfish Management Plan 2009 (Anon 2009).

The commercial longline fishery in the Northern Territory is anecdotally reported to capture Speartooth Shark although apparently only in very small numbers (G. Johnson, Shark Biologist Northern Territory Department of Resources pers. comm. 2009). This activity is considered to be of minor threat to the species sustainability (DEWHA 2008a, 2008b). Across northern Australia Speartooth Shark is at risk of being caught by recreational fishermen using net and line apparatus (Pogonoski et al. 2002; Larson et al. 2004; Stevens et al. 2005; Ward and Larson 2006). The level of risk to Speartooth Shark by recreational fishing has been considered low in Queensland (DERM 2008)

although there is insufficient data to quantify this impact. Similarly the Indigenous harvest of Speartooth Shark is unknown although sharks are an important food source for Indigenous people and in some communities possess significant cultural value (McDavitt 2005).

The size of Australian Speartooth Shark populations is unknown, however there is considerable concern for the species long term survival because of the fragmentation of habitat known to support juvenile animals and the vulnerability this creates for local populations. The physical constraints of inhabiting an estuarine or riverine environment limit a species ability to evade human-induced problems such as pollutants, habitat modification and destruction, or most importantly, directed and incidental capture in fisheries (Compagno and Cook 1995).

Habitat modification and destruction from pollution and infrastructure development such as shipping ports have been identified as threats to Speartooth Shark sustainability (DEWHA 2008a). Water extraction for agricultural and mining purposes may influence the natural flow of rivers supporting Speartooth Shark habitat (DEWHA 2008b). Mining activities however have been permitted to operate in areas of high conservation value such as the Ranger Uranium mine operating in Kakadu National Park, Northern Territory. The South, East and West Alligator Rivers are within Kakadu National Park and are known to support the highest concentration of Speartooth Shark in the Northern Territory (DEWHA 2008a).

### **1.3.2 Sawfish (Pristidae spp.)**

Sawfish belong to the Super Order Rajomorphii within the Subgroup Elasmobranchii (Hamlett 1999). They form the Family Pristidae and are unique in that their body form and features are more like that of a shark than those of a ray. The Pristidae comprises the two genera *Pristis* and *Anoxypristis*, and currently between four and seven species are known to science (Compagno and Last 1999). Of these species, four occur in Australian waters, Freshwater Sawfish (*P. microdon*), Dwarf Sawfish (*P. clavata*), Green Sawfish (*P. zijsron*) and Narrow Sawfish (*A. cuspidata*) (Last and Stevens 2009).

The Pristidae have a global distribution, favouring shallow coastal waters and river systems in tropical and subtropical latitudes of the Indo-West Pacific (Compagno and Cook 1995; Compagno and Last 1999; Last and Stevens 2009; Wueringer et al. 2009). Specific pristid habitats include muddy enclosed bays; estuaries; inshore coastal waters; adjacent to large continental islands; and freshwater in rivers and lakes in water depths up to 40 m (Compagno and Last 1999; Last and Stevens 1994; Stobutzki et al. 2002). These habitats are all present in the GoC and it is not unforeseen that all four species of Australian pristids inhabit the GoC waters.

The distributional range of Australian pristids has been poorly reported with few records held in Australian museums or documented in scientific literature. However, based on Australian museum records and more recent studies, Freshwater Sawfish, Dwarf Sawfish, Green Sawfish, and Narrow Sawfish are classified as euryhaline (inhabiting marine inshore waters, estuaries, lagoons and freshwater) and as being brackish marginal (inhabiting brackish to freshwater) (Pogonoski et al. 2002).

Although not endemic to Australian waters, contemporary populations of sawfishes are largely restricted to inshore and offshore waters in northern Australia. Freshwater Sawfish are known from a single record south of Cape Naturaliste, Western Australia (Chidlow 2007) and in Princess Charlotte Bay on the east coast of Queensland (Salini et al. 2007). Green Sawfish and Narrow sawfish have been recorded in recent times (2009) as far south as Rockhampton on the Queensland East coast (J. Stapley, DEEDI Fishery Observer Program pers. comm. 2009). Although once reasonably abundant, all sawfish are now considered rare globally with anecdotal and limited catch records indicating substantial reductions in their known range over the past 15-20 years, especially throughout the Indo-west Pacific (Giles et al. 2007). The population status of Australian sawfish is unknown, although the GoC and north coast of Western Australia may represent the last two areas of Australian viable populations (Peverell 2005; DEWHA 2008a).

The four species of Australian sawfish are considered critically endangered globally by the IUCN (2009) and all species with the exception of *P. microdon* are listed on Appendix One under CITES (Convention on International Trade in Endangered Species) (CITES 2009). A CITES Appendix I listing places sawfish in the same category as tigers and elephants; trade in these animals is prohibited. Freshwater Sawfish have been listed under CITES Appendix II with a special annotation that effectively provides for a very limited opportunity to live trade in the species. The annotation states: “for the exclusive purpose of allowing international trade in live animals to appropriate and acceptable aquaria for primarily conservation purposes” (CITES 2009). Hence the trade in this species for any other purpose other than that stated in the annotation is prohibited in countries that are Party to CITES.

Australian Freshwater Sawfish (*P. microdon*), Dwarf Sawfish (*P. clavata*), and Green Sawfish (*P. zijnsron*) are listed as Vulnerable under the Commonwealth EPBC Act (Section 3.3.1). The EPBC Act regulates the export trade in protected species and assigns offence provisions with respect to these species in Commonwealth waters. *Pristis* species and Narrow Sawfish (*A. cuspidata*) are afforded further protection in the form of 'no take species' in the recreational and commercial fishing sectors in Queensland under the *Queensland Fisheries ACT 1994* and *Regulation 2008* and in Western Australia under the *Fisheries Management Act*. *Pristis zijnsron* is also protected in Western Australia under the *Wildlife Protection Act 1950* (Department of Fisheries Government of Western Australia 2008; Queensland Parliamentary Council 2009).

In the Northern Territory (NT), sawfish are protected under the *Northern Territory Parks and Wildlife Act (2007)* and *Northern Territory Fisheries Act (2005)*. Sawfish species are listed as 'no take' in the recreational fishing sector, however Narrow Sawfish (*A. cuspidata*) are allowed to be taken by commercial fishers as incidental catch in the NT (Northern Territory Government Department of Resources – Fisheries 2008).

Sawfish reach extraordinary lengths, exceeding seven m (Compagno and Last 1999; Last and Steven 2009). The shark-like similarities include pectoral fins distinctly separate from the head, two enlarged dorsal fins and a prominent caudal fin (Last and Stevens 2009). The most distinctive feature characterising sawfish as a ray or batoid is the positioning of the gill slits. In sawfish the gill slits are situated ventrally on the head rather than laterally as in sharks (Peverell 2008). Pristids also possesses an extended

rostrum with lateral teeth (Bigelow and Schroeder 1953), used primarily for feeding and warding of predators (Wueringer et al. 2009). The body form of pristids indicates that they are slow but strong bottom dwellers, resting on soft mud or sandy bottoms but also swimming just above the bottom and at times near the surface in search of prey.

Narrow Sawfish have been referred to as being benthopelagic. Stobutzki et al. (2002) first classified the species as being a mid-water feeder after stomach content analyses of trawled animals revealed both flathead (*Platycephalus* spp.) (benthic species) and squid (*Photololigo chinensis*) (mid-water species). These findings are supported by DEEDI Fisheries Observer reports in the GOCIFF offshore N9 component, where Narrow Sawfish are commonly caught in surface set nets and stomach content analyses found Bluespotted Trevally (*Caranx bucculentus*) (Peeverell 2008; J. Stapley, DEEDI Fishery Observer pers. comm. 2009). Preliminary studies on stomach content analysis of GoC pristid species by Peeverell (2008) support the benthopelagic classification of Narrow Sawfish by Stobutzki et al. (2002) and the finding that *Pristis* spp., although benthic in classification, are active predators and will opportunistically feed on bony fishes and crustaceans on the benthos and in mid-water (Thorburn et al. 2007, 2008).

Sawfish are one of four cartilaginous families that occur in freshwater, the other families include Dasyatidae and Potamotrygonidae (Freshwater Stingrays) and Carcharhinidae (Whaler Sharks) (Compagno and Cook 1995). Sawfish are not classified as obligate (not known from any other environment) freshwater animals. Last (2002) stated that *P. microdon* were obligate freshwater sharks; this information has since been disproved with specimens being recorded from marine waters (Chidlow 2007, Thorburn et al. 2007; White and Dharmadi 2007).

The habitat preferences of Australian sawfish overlap among species although it appears from the limited amount of data that they are likely to utilise different habitat types at different stages of their life cycle (Peeverell 2008). This is especially evident for Freshwater Sawfish and Narrow Sawfish in the GoC (Peeverell 2005).

Narrow Sawfish is the most widely distributed and abundant sawfish species recorded in the GoC gill net fisheries (Peeverell 2005, 2008). These findings are further supported by catch statistics from the Northern Prawn Fishery (Stobutzki et al. 2002). Analysis of fishery observer data recorded in the inshore and offshore set net fishery of the GOCIFF revealed that there was a significant difference in the habitat preference between juvenile and mature Narrow Sawfish; mature animals of this species were found predominantly in offshore waters (Peeverell 2005).

The distribution of mature and immature Freshwater Sawfish (*P. microdon*) in the commercial inshore set net fishery (GOCIFF) was found to be seasonal, with animals mainly concentrated in the river mouths during periods of freshwater flow over the monsoon wet season (Peeverell et al. 2004; Peeverell 2008). Similar findings of seasonal and size class distribution for *P. microdon* have been reported in the Fitzroy River, Western Australia (Thorburn et al. 2007; Whitty et al. 2009a, 2009b). These findings are possibly the result of the species preference for freshwater habitats during this time of the year may be to exploit the increase in abundance of spawning prey items such as the freshwater prawns (*Macrobrachium australiense*, *M. rosenbergii* and *M. handschii*).

In the study by Peverell (2005, 2008), pupping in a *P. microdon* of 303 cm TL was observed on one occasion; a female (582 cm TL) carrying full term embryos was examined on another occasion; and a number of neonate *P. microdon* were captured in the inshore set net fishery during the wet season. Thus in the GoC, breeding *P. microdon* populations and possibly those of other GoC sawfish species have been at least partially protected by the seasonal four month closure (over the monsoon wet season) of the inshore and offshore set net fisheries since its introduction in 1980 (Peverell 2008).

From dart tagging studies on 175 Freshwater Sawfish in the GoC, Peverell (2008) demonstrated that specimens up to 2200 cm TL and approximately 4 years of age utilise the riverine brackish and freshwater environments of the GoC. Peverell (2008) tagged a neonate in the Mitchell River estuary during the wet season and recaptured it 183 days later 83 km upstream in a freshwater pool. Furthermore, a 2+ year class Freshwater Sawfish was tagged in a freshwater pool approximately 100 km upstream of the river mouth during the dry season and was recaptured 224 days later at the river mouth during the wet season. The occurrences of Freshwater Sawfish upstream of tidal waters are also reported by freshwater recreational anglers, such as the anecdotal record of an animal inhabiting the Wenlock River upstream of the Moreton Telegraph Station (Steptoe 2010).

This life history strategy of juvenile Freshwater Sawfish utilising brackish and freshwater habitat has also been observed in animals of the same age cohort in the Fitzroy River, Western Australia (Thorburn et al. 2003; Morgan et al. 2004; Thorburn 2006; Thorburn et al. 2007; Whitty et al. 2009a, 2009b). All of these authors have inferred that juvenile Freshwater Sawfish are capable of extensive movement within a river system and can remain for extended periods in the tidal brackish waters of the downstream river section or in the upstream sections in freshwater pools. Thus any modification to environmental river flow such as the construction of weirs may impede the natural behaviour of movement patterns of juvenile Freshwater Sawfish. These potential impacts are well documented in the Kimberley region of Western Australia (Morgan et al. 2004; Thorburn et al. 2007; Whitty et al. 2009b).

Whitty et al. (2009a, 2009b) successfully investigated the micro-movement patterns of juvenile Freshwater Sawfish in the Fitzroy River using acoustic telemetric methods over the monsoon wet and dry season periods. In that study, Whitty et al. (2009a, 2009b) demonstrated that habitat partitioning between 0+ and 1+ year old animals was occurring, with 0+ year class animals preferring water depths less than 0.6 m. Furthermore, investigations into the nocturnal behaviour of 1+ year class Freshwater Sawfish revealed that lunar phase significantly influenced depth partitioning in animals. Over the full moon period, 1+ year class animals were found to utilise a shallower and narrower depth range compared to new moon periods (Whitty et al. 2009b). The small scale movements and habitat use of Freshwater Sawfish of 0+ and 1+ year class was likely to be related to predator avoidance, foraging behaviours, temperature and/or light regimes.

Freshwater Sawfish of the subadult size class (150 to 300 cm TL) (Peverell 2004) may be less reliant on freshwater habitat than juvenile size class animals, with tag and recapture information in the GoC indicating inter-river movement during the monsoon

dry season of up to 220 km (Peverell 2008). However, subadult Freshwater Sawfish are also thought to exhibit restricted movement with tagged animals in Normanby River (Queensland) and Fitzroy River (Western Australia) recaptured within a short distance of their initial release site even after days at liberty exceeding twelve months (Thorburn 2006; Thorburn et al. 2007; Peverell 2008; Whitty et al. 2009a). Understanding the habitat preferences and movement patterns of subadult Freshwater Sawfish is only one of many data deficient areas requiring attention for this species.

There still remains a paucity of information on the movement patterns and habitat preferences of mature Freshwater Sawfish. From limited data, mature *P. microdon* are known to occupy estuarine and coastal marine waters at certain times of the year. Data records of two pupping females in the GoC indicate that the species pup during the monsoon wet season in inshore coastal foreshore and river mouth habitats (Peverell 2008). This conclusion is supported by Morgan et al. (2004), Thorburn et al. (2007) and Whitty et al. (2009a) that recorded neonate specimens, exhibiting open umbilical scars, in the mouth of the Fitzroy River soon after the monsoon wet season.

Both immature and mature Freshwater Sawfish are known from within Port Musgrave; there is one commercial catch record of a female specimen that was captured two miles upstream of the Ducie River mouth in May (vertebrae supplied to first author) and a mature male specimen was acoustically tagged by the first author 10 km upstream of the Wenlock River mouth in July. These records and the information on pupping females highlight the critical importance of the monsoon season and inshore coastal habitats to birthing females and the use of estuarine habitat by mature animals during the dry season months. The very small number of records also demonstrates the urgent need for more information on the species distribution.

From a small number of records, Freshwater Sawfish of size classes known to be mature (>300 cm TL) (Peverell 2005) have been recorded in inshore and offshore marine waters to a depth of 40 m (Stobutzki et al. 2002; Chidlow 2007; Thorburn et al. 2007; White and Dharmadi 2007). In consideration of this and the juvenile habitat requirements, the life history of Freshwater Sawfish most probably extends from freshwater to marine; freshwater as a juvenile, estuarine coastal marine as a subadult and coastal marine as a mature adult. Analysis of the micro-element concentrations Strontium and Calcium in the vertebrae of Freshwater Sawfish substantiates this conclusion (Peverell 2008).

Similar to the Freshwater Sawfish, the habitat requirements and movement patterns of Dwarf Sawfish (*P. clavata*) are poorly understood. Dwarf Sawfish are known from salinity concentrations ranging between 1 and 41.1 ppt with estuarine river mouths such as the Fitzroy River (Western Australia) providing refuge for young of the year (Thorburn et al. 2008). In the GoC Peverell (2005a) described the species abundance as being low and highly variable with the species occupying sand and mud foreshore habitats similar to that described by Thorburn et al. (2008) and Stevens et al. (2008).

Acoustic and satellite tracking studies on subadult Dwarf Sawfish in the Kimberly region of Western Australia by Stevens et al. (2008) and catch records of juvenile and subadult specimens in the GoC commercial inshore net fishery (GOCIFF N3 fishing symbol) (Peverell 2005, 2008) further support the findings of Thorburn et al. (2008). In

all these studies juvenile and subadult Dwarf Sawfish were reported to inhabit inshore mangrove lined coastal foreshores and embayments.

From the studies of Stevens et al. (2008) it appears subadult Dwarf Sawfish exhibit limited, tidally influenced movements and occupy a restricted range of only a few square kilometres. Of the animals studied by Stevens et al. (2008) the only successfully satellite tracked animal exhibited movement of 9 km from the original tagging site over 50 days. A neonate Dwarf Sawfish in the GoC was dart tagged and released in shallow mangrove lined foreshore habitat and recaptured after 121 days in the same habitat 23 km from the original tagging site (Peeverell 2008). This animal may have exhibited similar site fidelity as those animals studied by Stevens et al. (2008). There is an absence of information regarding the habitat use of Dwarf Sawfish.

Green Sawfish (*P. zijssron*) in their juvenile and mature life stages inhabit all regions of the Queensland GoC with a pattern of relative abundance similar to that of Dwarf Sawfish; that is, in low numbers and with a highly variable frequency of occurrence (Peeverell 2005). In the GoC Green Sawfish have been caught in: offshore marine water to a depth of 25 m (Stobutzki et al. 2002); inshore coastal waters; estuarine embayments; and in the mouth of major rivers (Peeverell et al. 2004, Peeverell and Pillans 2004; Peeverell 2005). Green Sawfish have also been recorded in similar habitat in other areas of Northern Australia including the east coast of Queensland (Giles et al. 2007; Bunce 2009; Stevens et al. 2008; Last and Stevens 2009). Globally the species is also known from freshwater environments and is classified as being euryhaline (Compagno and Cook 1995; Last 2002).

Studies on habitat utilisation by Green Sawfish are limited to two studies and only two animals, one mature and one immature specimen (Peeverell and Pillans 2004; Stevens et al. 2008). In both studies, the conclusions drawn were that the species appears to exhibit tidally influenced movement and occupy a restricted range of only a few kilometres square. Both specimens were studied in an inshore coastal foreshore environment fringed with mangroves, rocks and sand/mud flats. The species also appears to have no inhibitions in moving into shallow water (< 1 m depth) despite their large size of greater than 500 cm TL (Peeverell and Pillans 2004).

The inshore coastal habitat is also thought to be important to pupping in Green Sawfish; Peeverell (2008) reported the capture of neonate specimens in the inshore coastal fringes of the western GoC during the wet season months of January to March. Furthermore, commercial set net fishermen in the western GoC have reported the capture of pregnant females in inshore coastal habitat in October (Peeverell, unpublished data). In Western Australia instances of pupping have occurred in January (R. McAuley, Fisheries Biologist Western Australian Fisheries pers. comm. 2003). This very scant dataset suggests pupping for this species may occur during the wet season and in inshore coastal habitat, as has been suggested for Freshwater Sawfish and Dwarf Sawfish. This limited data also demonstrates the lack of information on this species and possibly a reflection of its true rarity.

Sawfish populations globally have been markedly reduced by extensive fishing in coastal, estuaries and freshwater areas throughout their ranges (Simpfendorfer 2000). The current knowledge on Australian pristids is limited and it is thought, that like most

elasmobranchs, Narrow Sawfish, Freshwater Sawfish, Dwarf Sawfish and Green Sawfish are long lived, produce few offspring and mature late in life (Tanaka 1990, Compagno and Last 1999; Stevens et al. 2000; Pogonoski et al. 2002; Stobutzki et al. 2002; Cavanagh et al. 2003). This is a life history strategy that makes them especially vulnerable to overexploitation (Stobutzki et al. 2002). Detailed biological studies of these sawfish species by Peverell (2008) concur with this life history strategy, with the exception of Narrow Sawfish. As described below, this species may not be as long lived as the others and may grow faster and/or mature earlier (younger).

All GoC sawfish exhibit extremely fast growth especially in their juvenile (70 cm to 150 cm TL) and subadult life (150 cm to 300 cm TL) stages. Growth rates in *Pristis* species of approximately 40 per cent of their initial birth size (between 75 to 90 cm TL) are expected in the first year of life and maturity is thought to be at around eight to nine years of age (300 cm TL). That is, maturity occurs at approximately 25 per cent of their longevity which is estimated to be around 35 to 40 years (Peverell 2008). The longevity estimates of *Pristis* spp. are similar to other large elasmobranch species such as Tiger Shark (*Galeocerdo cuvier*) (Simpfendorfer 2005). In contrast to the *Pristis* species, the longevity of Narrow Sawfish is substantially less at 27 years (Peverell 2008).

In Narrow Sawfish it is estimated that 146% of the birth length (56 cm TL) is attained in the first year, and maturity reached at approximately three years (203 cm TL for males and 225 cm TL for females) (Peverell 2008). This growth rate is substantially faster than that of *Pristis* species and is possibly a life history strategy adapted to limit juvenile mortality. This life history strategy is commonly observed in smaller shark species such as the Australian Sharpnose Shark (*Rhizoprionodon taylori*) (Simpfendorfer 1993).

A combination of *Pristis* species longevity and their relatively late maturation implies there is a long period where these inshore animals are vulnerable to netting prior to them reproducing and that they remain vulnerable to capture throughout their life. Data on the periodicity of the species reproductive cycle is limited, although Freshwater Sawfish and Narrow Sawfish are thought to have an annual cycle (Peverell 2008). Further studies are urgently required to validate this information. Narrow Sawfish appear to have faster growth rates and smaller size at maturity than other *Pristis* species and this life history strategy may account for their more common occurrence throughout the GoC in comparison to *Pristis* species.

The lack of species-specific information can cause difficulties for resource managers that are required to develop management policies in the face of uncertainty and at times, after the animals have been fully exploited. Compounding the challenge of conservation management is the lack of knowledge on the levels of genetic diversity, demographic history (past and present population sizes) and population structure (e.g. number of management units) of Australian sawfish.

The preliminary findings from a collaborative genetics study across Northern Australia indicated that female Freshwater Sawfish populations are genetically differentiated between the GoC and the west coast of Australia, with females being philopatric (Phillips et al. 2009). Hence the two regions are likely to be genetically linked by male dispersal only given that some of the genetic diversity observed is present in rare

alleles. Similarly, genetic studies undertaken on Dwarf Sawfish and Green Sawfish populations indicate that both species are genetically differentiated between the GoC and west coast of Australia. Of concern to scientists and conservation groups is the low level of genetic diversity found within Dwarf Sawfish and Green Sawfish populations. This level of genetic diversity is of a similar level to that observed in population studies undertaken on the critically endangered Greynurse Shark (*Carcharias taurus*) (N. Phillips, Murdoch University, Western Australia pers. comm. 2010). In order to protect the remaining genetic diversity within existing Dwarf Sawfish and Green Sawfish populations, additional conservation management within the GoC may be required.

As with the majority of threatened species, it is the effect of cumulative pressures that can threaten the survival of Australian sawfish. The remote nature of Australia's northern waters has prevented development of the scale seen in sawfish habitats in other parts of the world. Similarly, the fishing pressures in these remote areas are far less than other parts of the world where sawfish occur. Ongoing fisheries management is ensuring that Australian sawfish populations and their supporting habitat remain sustainable.

In Queensland, the GoC pristid populations have been conserved due to a number of factors including: relatively minor coastal development; low levels of habitat degradation; and a multitude of spatial and temporal fishing closures, which help reduce interaction with commercial fisheries (Peverell 2008). Whether these combined factors provide a level of protection that is sufficient to sustain GoC sawfish populations is not known and additional fishery management measures may be required.

Recreational and Indigenous fishing pressure in the GoC have also impacted on Freshwater Sawfish populations (Peverell 2008), similar to those populations in the Fitzroy River (Thorburn et al. 2007). Seitz and Poulakis (2006) tried to quantify the impact of human induced pollution and injuries caused by fishers on the Smalltooth Sawfish (*P. pectinata*) in the United States. These impacts mainly consisted of fishing line and rostra removal, although shooting with power heads and arrows was recorded. The potential of these impacts on Australian sawfish populations is of concern, particularly in populated areas of known sawfish habitat.

There is strong evidence to indicate recreational fishing of sawfish does occur, especially in restricted riverine habitats such as the Fitzroy River (Thorburn et al. 2003, Morgan et al. 2004; Thorburn et al. 2007; Whitty et al. 2009a). However, the impact of this fishing on Australian sawfish populations is unquantified. The riverine habitats are physically constrained and juvenile Freshwater Sawfish populations, in particular are limited in their ability to evade incidental capture by recreational and Indigenous fishers and other pressures such as pollutants and habitat modification or destruction (e.g. weirs and water extraction) (Compagno and Cook 1995).

### **1.3.3 Queensland Groper (*Epinephelus lanceolatus*)**

Queensland Groper is not listed as a species of National Environmental Significance under the Commonwealth Governments EPBC Act nor are they listed as a Migratory species under the EPBC Act. In Queensland the species is protected under the *Queensland Fisheries Act 1994* and *Regulations 2008* which prevents recreational and commercial fishers from targeting them as a species or having them in their

possession. They are also protected under the NCA that protects all native wildlife in Queensland. The decision to include this species as no take under the *Fisheries Act 1994* was not based on scientific evidence but on the precautionary principal, to ensure the survival of one of Queensland's iconic fish species. Although there are no immediate concerns over the population status of Queensland Groper their population status is unknown and information on their biology and ecology is data deficient. The species is commonly caught in estuaries across Cape York Peninsula by recreational line fishers using live bait for Barramundi and in crab potting gear.

The species is found throughout the Pacific and is known to inhabit estuaries and sheltered bays and inshore rocky reefs. Size at maturity is unclear although fish of 90 to 100 cm TL (approximately 15 kg whole weight) caught from the wild are known to spawn in a captive environment after hormone induction treatment (A. Reynolds, DEEDI Fisheries Biologist pers. comm. 2009). There are no published papers on the growth rates of wild Queensland Groper although captive growth rate data indicated that they can grow more than 500 grams per month; this species can experience a fast rate of growth under optimal environmental conditions (Vatanakul et al. 1999). The species is known to be a top order apex predator within the ecosystem and as such their presence is a good indicator of ecosystem health.

From anecdotal catch records of recreational fishers in Weipa and from bycatch records of Giant Mud Crab studies in Weipa, it is inferred that juvenile Queensland Groper aggregate in sites with high structural complexity. These habitats include mangrove lined estuaries and eroded mud and rock shorelines. Mature animals as large as 180 cm TL and weighing over 100 kg are known to inhabit wharf structures in ports and harbours. From the limited information available, Queensland Groper appears to occupy a similar habitat niche as other large *Epinephelus* species from around the world, such as Goliath Groper (*Epinephelus itajara*) (Frias-Torres 2006). Juvenile Goliath Groper is known to have a limited home range and adults form spawning aggregations. These life history traits make Goliath Groper extremely vulnerable to fishing pressure and localised population declines in the United States led to the introduction of fishing bans (Sadovy and Eklund 1999).

Queensland Groper is not considered under immediate threat of population decline and is not listed as a species requiring conservation action in Queensland (D. Murphy, Department of Environment and Resource Management Protected Species Section pers. comm. 2009). The threats most likely to impact on localised populations of Queensland Groper are line fishing, crab potting and poor water quality.

#### **1.3.4 Saltwater Crocodile (*Crocodylus porosus*)**

Saltwater Crocodiles are not listed as a species of National Environmental Significance under the Commonwealth Government's EPBC Act however they are listed as a Migratory Species (low conservation status) (Section 3.3). In Queensland the species is listed as Vulnerable under the *Nature Conservation Act 1992*, which is administered by the Department of Environment Resource Management (DERM - previously Environmental Protection Agency, EPA). From scientific studies and published information, DERM has determined that Saltwater Crocodiles are a species of low priority for conservation management action because of the species increasing abundance, wide ranging distribution and current protection measures (DERM 2008).

The Saltwater Crocodile is distributed from the Solomon Islands to Papua New Guinea and across northern Australia to Indonesia, south-east Asia and the eastern coast of India (Read et al. 2007). It is the largest and most dangerous species in the Family Crocodylidae with specific habitat requirements that include tropical and sub-tropical reefal, coastal and inland waterways (Read et al. 2004a; Wilson 2005; Read et al. 2007). The species is semi-aquatic and has an oviparous reproductive cycle (Wilson 2005). In Australia, Saltwater Crocodiles are known to occur from Gladstone on the Queensland East Coast, throughout Cape York Peninsula and west across Northern Territory to Broome in Western Australia, although small numbers are found as far south as the Exmouth Gulf (Mark Read Great Barrier Reef Marine Park Authority pers. comm. 2009). Saltwater Crocodiles prefer low-lying coastal waterways and floodplains not excluding non-tidal sections of major rivers that extend hundreds of kilometres inland (Wilson 2005).

Saltwater Crocodiles were the subject of large scale wild harvest by post Second World War servicemen (Taplin 1987). The species was afforded complete protection in Queensland in 1974 as concern over their long term survival arose as harvest numbers noticeably declined. This protection triggered studies to be undertaken into the species distribution and abundance with this information being thoroughly documented firstly by Messel et al. (1981) for Northern Australia and more recently by Read et al. (2004a) for Queensland. The north-western region of Cape York Peninsula is one of eight biogeographical regions in Queensland known to support Saltwater Crocodile populations, with the Wenlock River recorded as supporting the highest concentration of post hatchling crocodiles, 2.2, and non-hatchlings, 2.0, per km respectively (Read et al. 2004a).

The north-western region of Cape York Peninsula was also recognised by Messel et al. (1981) and Read et al. (2004a) as being of critical significance to supporting the post-harvest recovery of Saltwater Crocodiles, in particular the Wenlock River and one of its tributaries known as Tentpole Creek (Read et al. 2004a). This conclusion was determined primarily from the results of repeated standardised surveys and the linkages drawn between hatchling numbers and habitat types where crocodile nesting was known to occur. Successful nesting of Saltwater Crocodiles in the lower Wenlock River and its tributaries is thought to occur because the topographic relief of the habitat ensures that it is less prone to monsoonal flooding in comparison with known nesting sites identified in other bio-geographical regions in Queensland (Magnusson et al. 1980; Read et al. 2004a). Saltwater Crocodile recruitment can be influenced by the length and size of the monsoonal wet season and associated flood periods (Messel et al. 1981). Nesting sites in the Wenlock River system are found typically amongst Mangrove Palm (*Nypa fruticans*) vegetation in swampy areas behind stands of Grey Mangrove (*Avicennia marina*), Cannoball Mangrove (*Xylocarpus granatum*) and other salt tolerant vegetation that line the river bank (Magnusson et al. 1980; Messel et al. 1981).

Read et al. (2004a) also reported that the population structure of Saltwater Crocodiles in Queensland waterways was biased towards immature crocodiles, a phenomenon known to occur in populations that have been heavily impacted. Typically, the size structure of a healthy population of Saltwater Crocodiles would be dominated by large mature specimens because of high rates of natural mortality of younger animals (Cott

1961; Graham 1968). This characteristic has been documented in the population structure of estuarine crocodiles in the Northern Territory, where the availability of suitable nesting habitat is substantially greater than in Queensland (Webb et al. 1994; Webb et al. 2000). The bias towards smaller immature crocodiles observed in Queensland survey data by Read et al. (2004a) was interpreted as the species population either still recovering from over harvesting or that larger animals are still being removed from the population.

The greatest threats impacting on Queensland's Saltwater Crocodile population is directed or incidental removal of animals through the management of 'problem crocodiles', entanglement in commercial net fishing apparatus and habitat modification or destruction (Read et al. 2004a, 2004b). These anthropogenic influences are more pronounced in highly populated areas; any coastal development will increase the risk of survival to local Saltwater Crocodile populations. Feral pig depredation of nesting sites is also considered a major threat to the sustainability of Saltwater Crocodiles throughout their range.

#### **1.4 Purpose and Scope of this Report**

This study will establish baseline information (historic and current) on the fisheries and aquatic values of Port Musgrave and the lower reaches of the Ducie and Wenlock Rivers. Key species identified as being important to the Traditional Owners (Wik language group) and because of their conservation status will be assessed in terms of their population size and structure and utilisation of habitat.

Specifically this study will:

- Characterise the fish and invertebrate resources of the proposed development site (thereby providing a benchmark for assessing changes over time).
- Determine changes in these resources that occur over time.
- Describe the impacts on the resources attributable to the proposed development with respect to a nearby undeveloped/control site.
- Assess the impacts on population and habitat utilisation of key species and Species of Conservation Interest in the area in relation to fluctuating environmental change.
- Identify the consequences of the proposed impact on associated fisheries and Traditional Owners in the area.
- Department of Primary Industries & Fisheries (now Fisheries Queensland) agrees to report on the presence or absence of the protected, endangered or threatened species sighted during the surveys.

Information collected will input directly into the formulation of impact assessment on fisheries resources (including protected species) and can be used in the formulation of appropriate mitigation strategies. The development of a monitoring program for fisheries resources and species of conservation and community importance will be formulated as part of the reporting risk assessment outputs from the first year fisheries resource assessment surveys. This fisheries resource assessment and discussion of any potential impacts on the fisheries resources of Port Musgrave associated with the proposed development refers to the proposed development as described in the Cape Alumina Pre-Feasibility Study Supplementary Report 2009.

## 2.0 Methods

### 2.1 Fishery Independent Surveys of Port Musgrave

#### 2.1.1 Overview

The methods employed for this study were designed to capture fish and invertebrate (crab and prawn) species of commercial, recreational, Indigenous and conservation importance. Targeted species of commercial, recreational and Indigenous importance included: Barramundi (*L. calcarifer*), King Threadfin Salmon (*P. macrochir*), Blue Threadfin Salmon (*E. tetradactylum*), Giant Mud Crab (*S. serrata*) and Penaeid Prawns. In addition to these, jellyfish species representative of ecosystem health were monitored.

Species of conservation importance recognised under State or Federal legislative protection that inhabit the Port Musgrave Region were captured using conventional fishing gear or recorded opportunistically as incidental observations. Species targeted using fishing gear included: Speartooth Shark (*G. glyphis*), Freshwater Sawfish (*P. microdon*), Green Sawfish (*P. zijsron*), Dwarf Sawfish (*P. clavata*), Narrow Sawfish (*A. cuspidata*) and Queensland Groper (*E. lanceolatus*.) Species recorded by incidental observation included sea snakes, Saltwater Crocodiles, Dugong, dolphins and turtles.

Surveys were conducted across the Port Musgrave study area in the area potentially impacted by the proposed Port developments; Ducie River (Impact site) and in areas not likely to be affected; Wenlock River and Namaleta Creek (Control sites). Intensive sampling also occurred within and adjacent to areas of the Port Musgrave where there are current or proposed impacts such as dredged areas and channels.

Three independent fisheries surveys were conducted in 2009 across the wet and dry seasons: March 20 to 28 - wet season; June 18 to 28 - dry season; and November 10 to 19 - pre-wet season. The three survey periods coincided with the dark moon and making tides, a more favourable period for net fishing because of reduced tidal flow and lower light levels. Fishing was undertaken with four main gear types: gill nets, set lines, cast nets and crab pots. In addition, surveys for sea snakes and jellyfish were conducted from a boat during the day and night using dip nets to collect observed animals. Any observations of other marine fauna during their surveys were recorded as incidental observations. The position, date, time, and depth of the gear type was recorded using a Garmin® GPS. This information was graphically presented using Arc GIS® software. Salinity, water temperature and turbidity were not recorded on these surveys as these water quality parameters were recorded as part of the hydrological surveys of Port Musgrave and are documented in the main Environmental Impact Assessment.

All fish and crabs caught were identified *in situ* to species and measured to the nearest 0.1 cm (total length (TL), fork length (FL) or carapace length (CL)) using a flexible tape before live release. Species that were difficult to identify in the field were frozen and taken back to the laboratory or sent to the Queensland Museum for taxonomic verification. Additional morphological measurements were obtained for sawfishes (Pristidae spp.) and stingrays and these included lower jaw total length (LJT<sub>L</sub>), and

lower jaw to fork length (LJF<sub>L</sub>) and rostral teeth counts for sawfishes and disk width (DW) for stingrays.

Where possible, specimens of Speartooth Shark (*G. glyphis*), sawfish (Pristidae spp.) and Queensland Groper (*E. lanceolatus*) were DNA sampled and tagged intramuscularly with Hallprint® stainless steel dart tags (SSD) and injected with Oxy-tetracycline at a dose rate of 1 ml/10 kg body weight. Tissue samples of either muscle or fin were taken on an opportunistic basis and preserved in dimethyl sulfoxide (DMS) for future genetic analysis. In addition to the above species, Freshwater Whipray (*Himantura dalyensis*) and other shark and ray species of interest were tagged and DNA sampled using the same techniques described above. Deceased animals' vertebrae were extracted from below the first dorsal fin for use in future age and growth studies. Gender and maturity staging of male and female shark and ray specimens were recorded using the technique described in Stevens and McLoughlin (1991).

A Community Fisheries Resource Assessment Project was run in parallel with this study. An inventory of the fisheries resources utilised by the local Indigenous community was collated with species of significance to the community identified and their harvest quantified.

### **2.1.2 Surveys**

The three estuarine sites that were surveyed within Port Musgrave; Namaleta Creek, Ducie River and Wenlock River were selected with input from Mapoon Aboriginal Community residents and commercial net fishermen. Knowledge on the spatial and temporal distribution of target species was shared to ensure the surveys were designed to capture the species of interest. Information on the habitat preference and distribution of Species of Conservation Interest was also obtained from published studies (Thorburn et al. 2003; Peverell et al. 2006; Pillans et al. 2008) and unpublished fisheries data (J. Stapley, DEEDI Fisheries Observer Program pers. comm. 2009). Local traditional owners and ex-commercial fishermen were employed on each of the three surveys to include local expertise and knowledge that complimented that of the experienced survey team.

For each survey the team consisted of eight persons with operations undertaken out of small craft working from a mother vessel. All animals captured or observed were identified to species where possible. Common names used were Standard Names from Codes for Australian Aquatic Biota whereby the standard uses capitals for all parts of the name, for example Narrow Sawfish (<<http://www.cmar.csiro.au/caab>>).

The gear types used and locations in which they were deployed are described below.

#### **Gill nets**

A number of different types of gill nets were used to maximise the likelihood of capturing fish from various species and age/size classes. Monofilament gill nets of 4.25, 6.5, 8, and 10 inch<sup>1</sup> stretch mesh (10.8, 16.5, 20.3 and 25.4 cm respectively) and 33 mesh drop were used to capture most fish while white cord net of 400 pound ply, 19

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<sup>1</sup> Industry standards apply inches and pounds to describe commercial gill net mesh sizes and in this report reference to gill nets follows industry standard, i.e. expressed in inches.

inch (48.3 cm) stretch mesh and 15 mesh drop was used to target large elasmobranch species, in particular Sawfish. The length of both the monofilament gill nets and the white cord net was 50 m and soak times varied depending on access to the net (tidal stage and pressure on the net). The selection of the location for each net was dependent on habitat with respect to water depth, potential current and accessibility.

For the three surveys combined, the total amount of fishing effort or total hours fished was 1852 hours. Gill net fishing effort was relatively evenly spread between sites with 37%, 29% and 34% of time spent at the Ducie River, Namaleta Creek and Wenlock River respectively (Figure 2, Figure 3, Figure 4).

The total combined length of the different nets used over the three surveys was 3050 m for the Ducie River, 2850 m for the Wenlock River and 2496 m for the Namaleta Creek. The gill net catch data is expressed as Catch Per Unit Effort (CPUE), that is, number of fish (all species combined) caught per hour per 50 m net (CPUE (fish/hour/50m net)) among survey sites and across the three survey periods; and also as CPUE for each of the net sizes at each survey site. The CPUE was also calculated separately for some of the target species as detailed in Section 2.1.4 and for each species was expressed as number of fish, for example, Barramundi caught per hour per 50 m net (CPUE (Barramundi/hour/50m net)).

### **Set Lines**

The purpose of set lining was to target large predatory species not commonly caught in gill netting apparatus, such as stingrays. Set line fishing was conducted using size 20/O tuna circle hooks that were attached to 5 m of 1200 pound multi-strand stainless steel wire trace. The wire trace was attached to a stainless steel turn buckle swivel and 15 m of 8 mm lead rope. The lead rope was attached to a 1.5 m, 10 mm silver rope snood that was shackled to a 38 cm hard plastic screw top float. A Sealite Strobe light was connected to the bouy with a screw stick. The snood and lead rope were secured to the seafloor using 15 m of 10 mm silver rope and a 24 pound Danforth anchor. Set lines were baited with Blue Threadfin Salmon (*E. tetradactylum*), Giant Queenfish (*S. commersonnianus*) or Freshwater Whipray (*H. dalyensis*). Whipray was used because stingrays are a known prey item of Speartooth Shark (*G. glyphis*) as stingray barbs have been found embedded in the jaws of captured Speartooth Shark by the first author.

For the three surveys combined a total of 488 set lines were deployed with 38%, 22% and 40% of fishing effort spread across the Ducie River, Namaleta Creek and Wenlock River respectively (Figure 5). The soak time for each set line varied depending on tide, weather and small craft availability. The data recorded were set line position, set and check times, bait used and species caught. Set line catch data is presented as CPUE, that is, number of fish per set (CPUE fish/set) among survey sites and across the three survey periods.

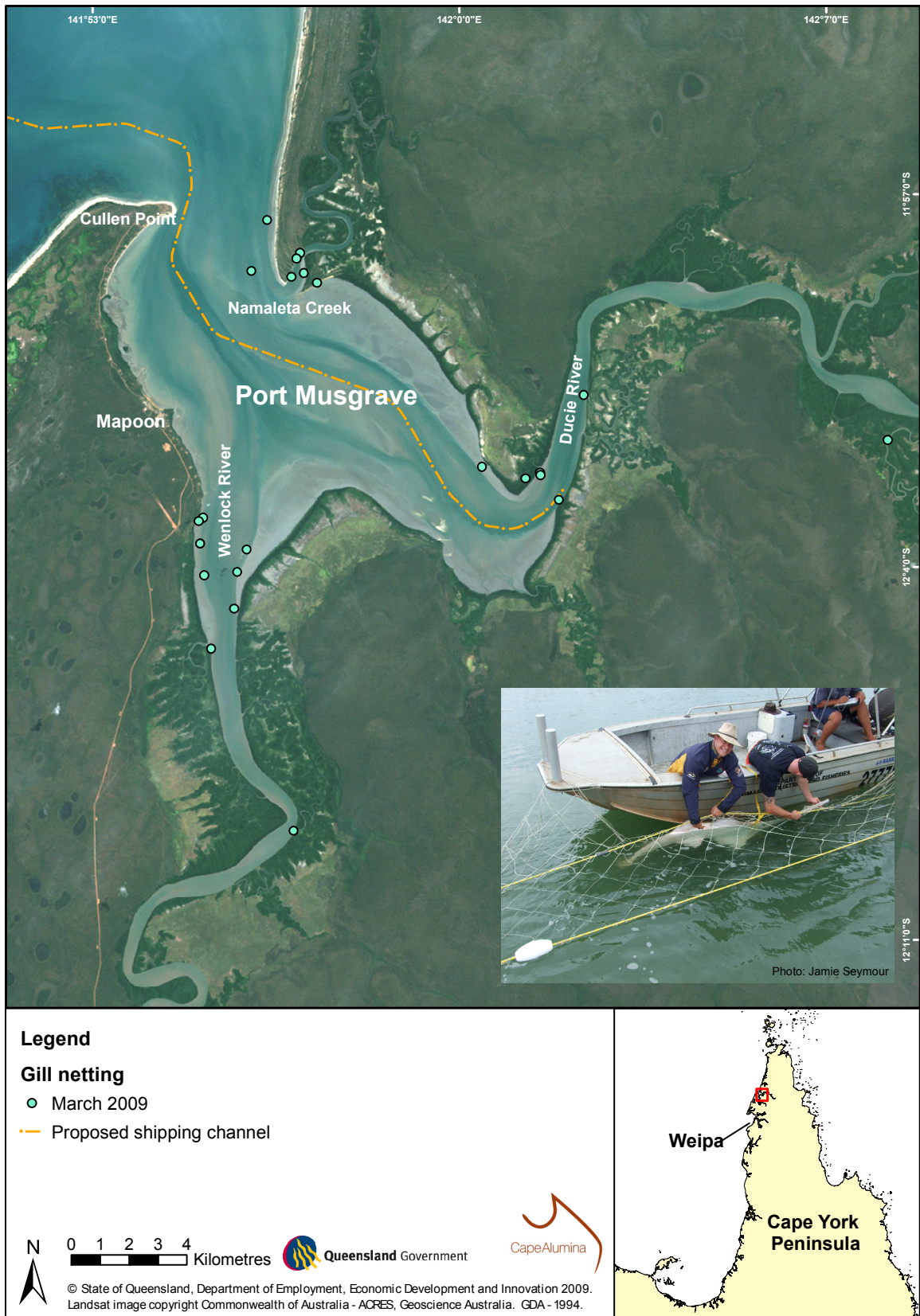


Figure 2: Location of gill netting in the March 2009 survey.

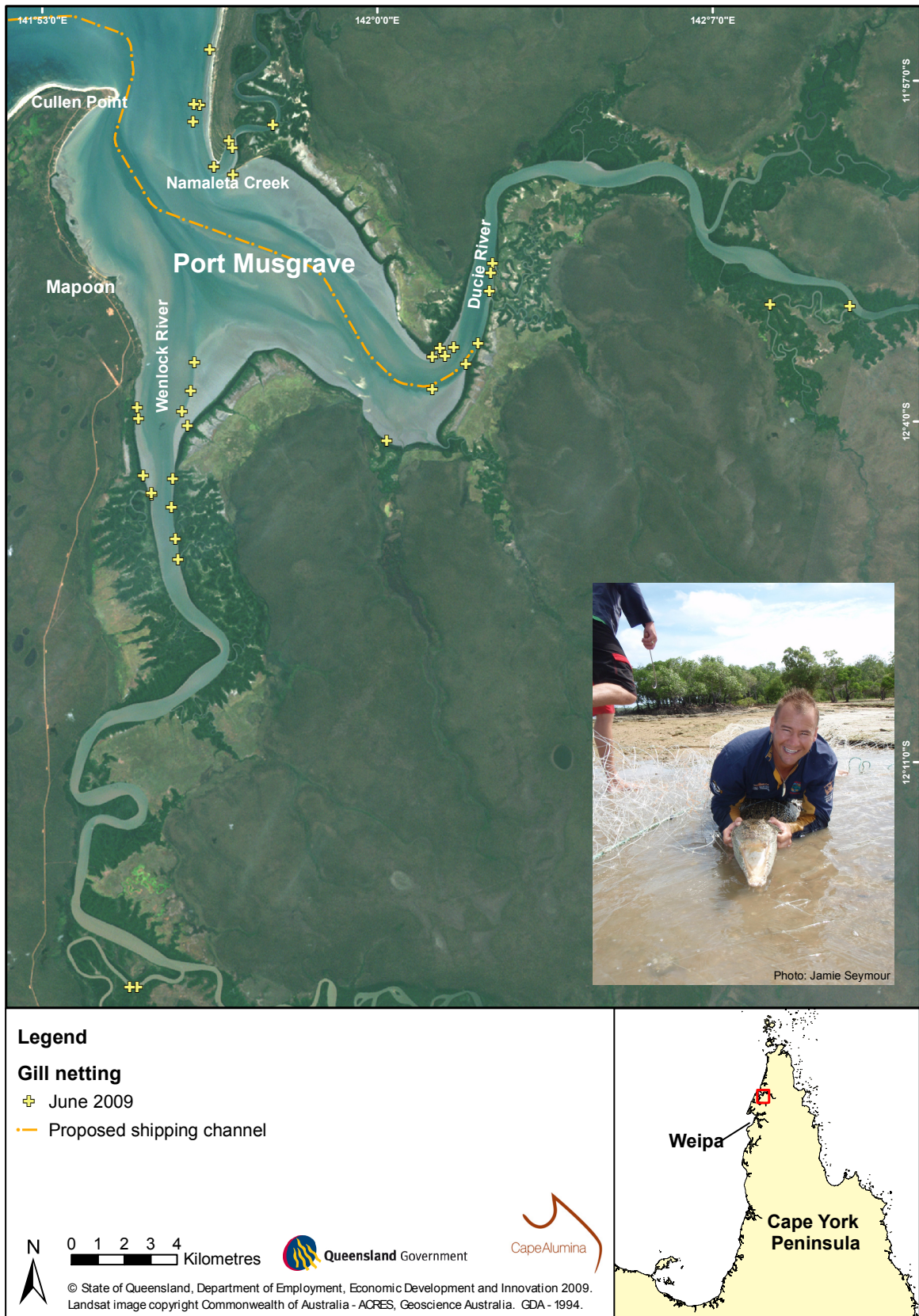


Figure 3: Location of gill netting in the June 2009 survey.

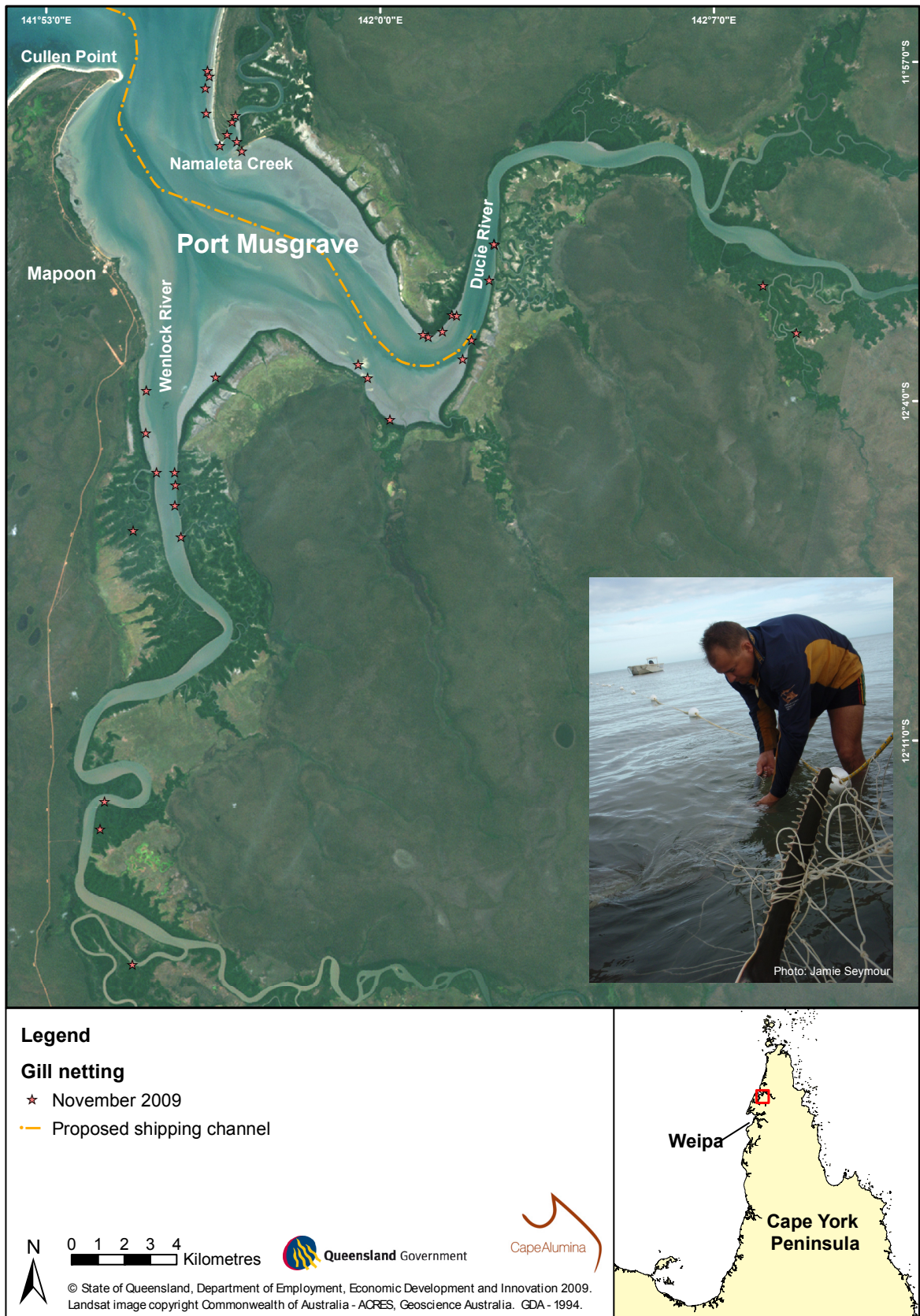


Figure 4: Location of gill netting in the November 2009 survey.

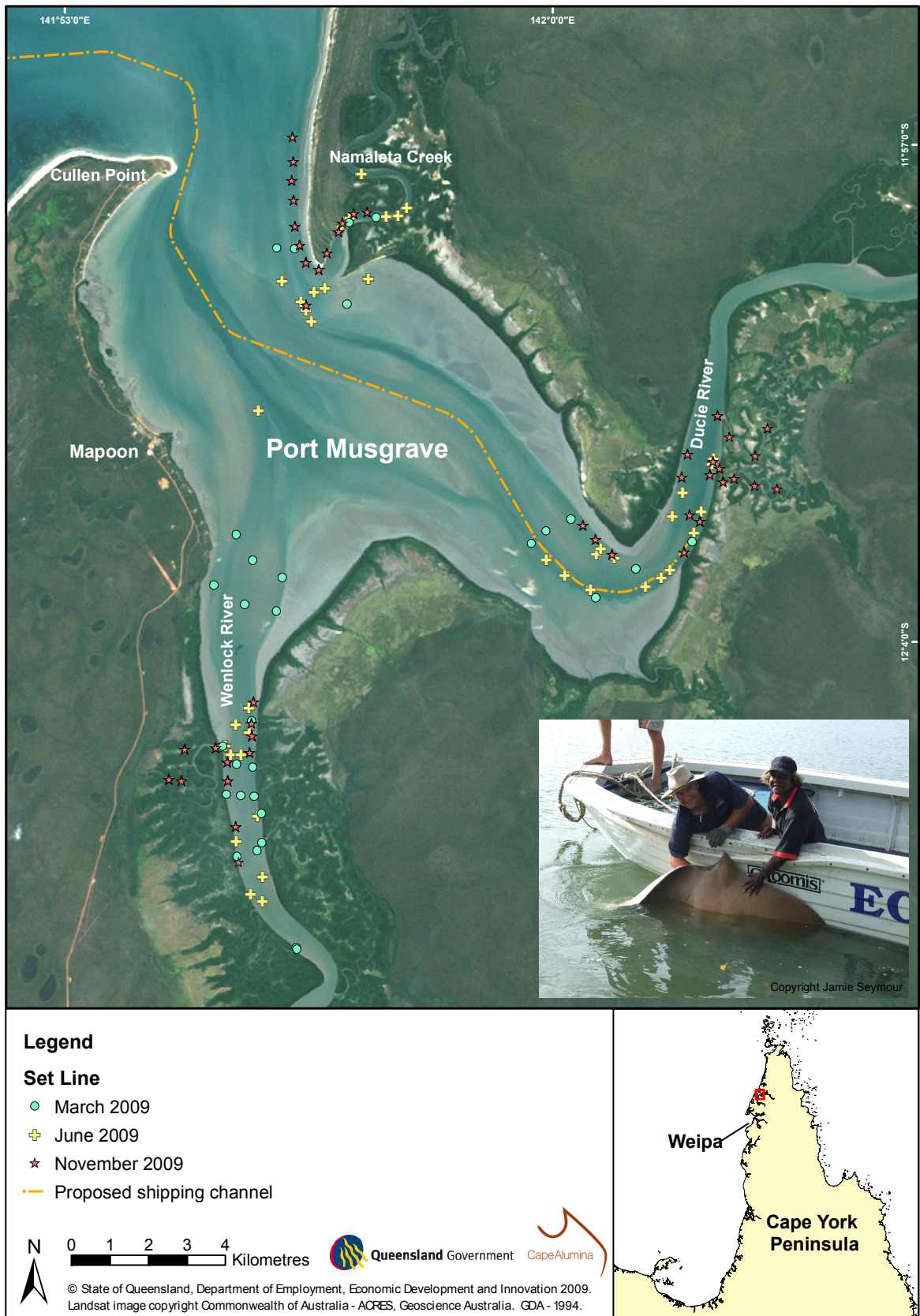


Figure 5: Location of set lines for each of the three surveys; March, June and November 2009.

### **Beam trawling**

Beam trawling is a common method used to survey fauna diversity on seagrass meadows in tropical bays and estuaries (Blaber et al. 1989). Beam trawling was trialled during the first survey in March with the soft mud substrate, randomly scattered mangrove/timber, oyster covered rocks and other snags making it difficult to obtain consistent repeatable trawls. In addition, a comprehensive seagrass survey in 2008 of the Port Musgrave study area completed by the Fisheries Queensland Habitat Assessment Team found that seagrass was not present in the Ducie River, Wenlock River or Namaleta Creek (M. Rasheed, Fisheries Queensland pers. comm. 2009). In light of a lack of both consistent trawls and seagrass meadows it was decided that an alternative method to beam trawling would be required. Cast netting was found to be a good alternative as it was better both logistically and in terms of data consistency.

### **Cast Netting**

Cast netting was used to target invertebrates, in particular prawns and bait fish. A multi-strand monofilament net of 25 mm stretch mesh, 8 ply and 305 cm depth was used. The cast net had deep side pockets to reduce the likelihood of animals escaping and was thrown from a small craft by the same operator for all the surveys to reduce sampling bias. Only those casts with a maximum spread of greater than 85% were recorded. The sampling period was always low tide; it was assumed this period provided the greatest opportunity to access fauna as they were forced out and away from the complex root structures of the fringing mangroves and onto the edges of the mud bank.

At each of the three sites, Namaleta Creek, Ducie River and Wenlock River, cast netting was done at three locations with 20 cast nets at each location (Figure 6). The same locations were netted each survey; for the three surveys combined a total of 540 cast net shots were done. Cast net samples from each location were sorted with individual animals measured and returned to the water. Some animals were frozen for processing back in the laboratory due either to time constraints and/or a need for taxonomic verification.

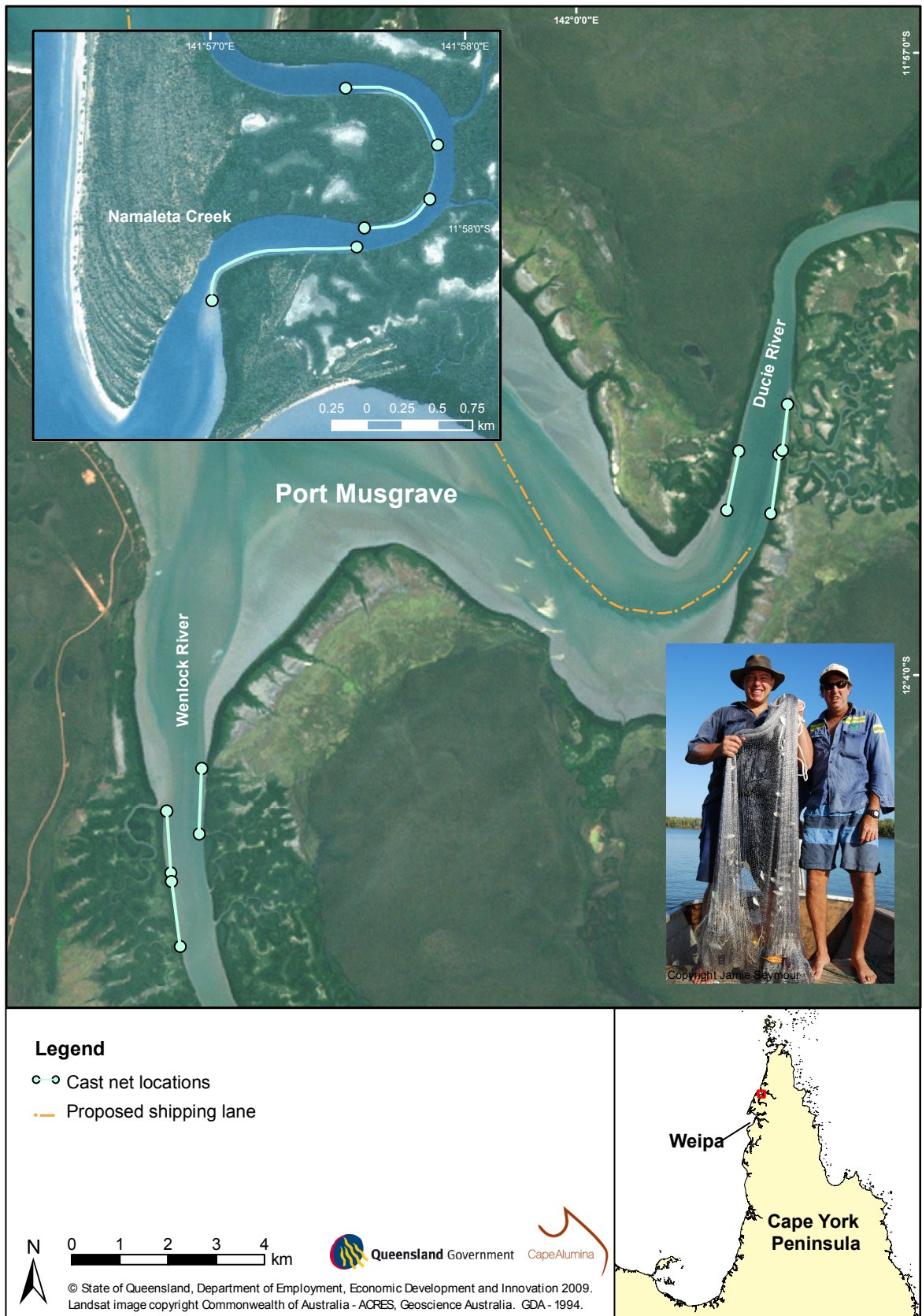


Figure 6: Cast net locations at each of the three survey sites.

### **Crab Pots**

The population structure and abundance of Giant Mud Crabs (*S. serrata*) was assessed by investigating size and number of crabs caught using round collapsible Munyana pots of 1 m diameter and four funnels. At each of the three survey sites, 15 pots were strategically placed every 150 m apart along the mangrove fringes on either side of the river, that is, 30 pots were placed at each survey site. For each of the three surveys, crab pots were placed in the same locations (Figure 7).

Pots were set on an incoming tide with fresh local bait (including Mullet, Blue and King Threadfin Salmon and Queenfish) and allowed to fish for 12 hours. For all Giant Mud Crabs specimens caught gender was recorded and carapace width measured to the nearest millimetre. Crabs infected with a parasite barnacle (*L. ihlei*) were identified from abdominal flap deformity or presence of parasite egg sac. Giant Mud Crab abundance was reported as number of crabs/pot lift (crabs/pot lift).

### **Visual census**

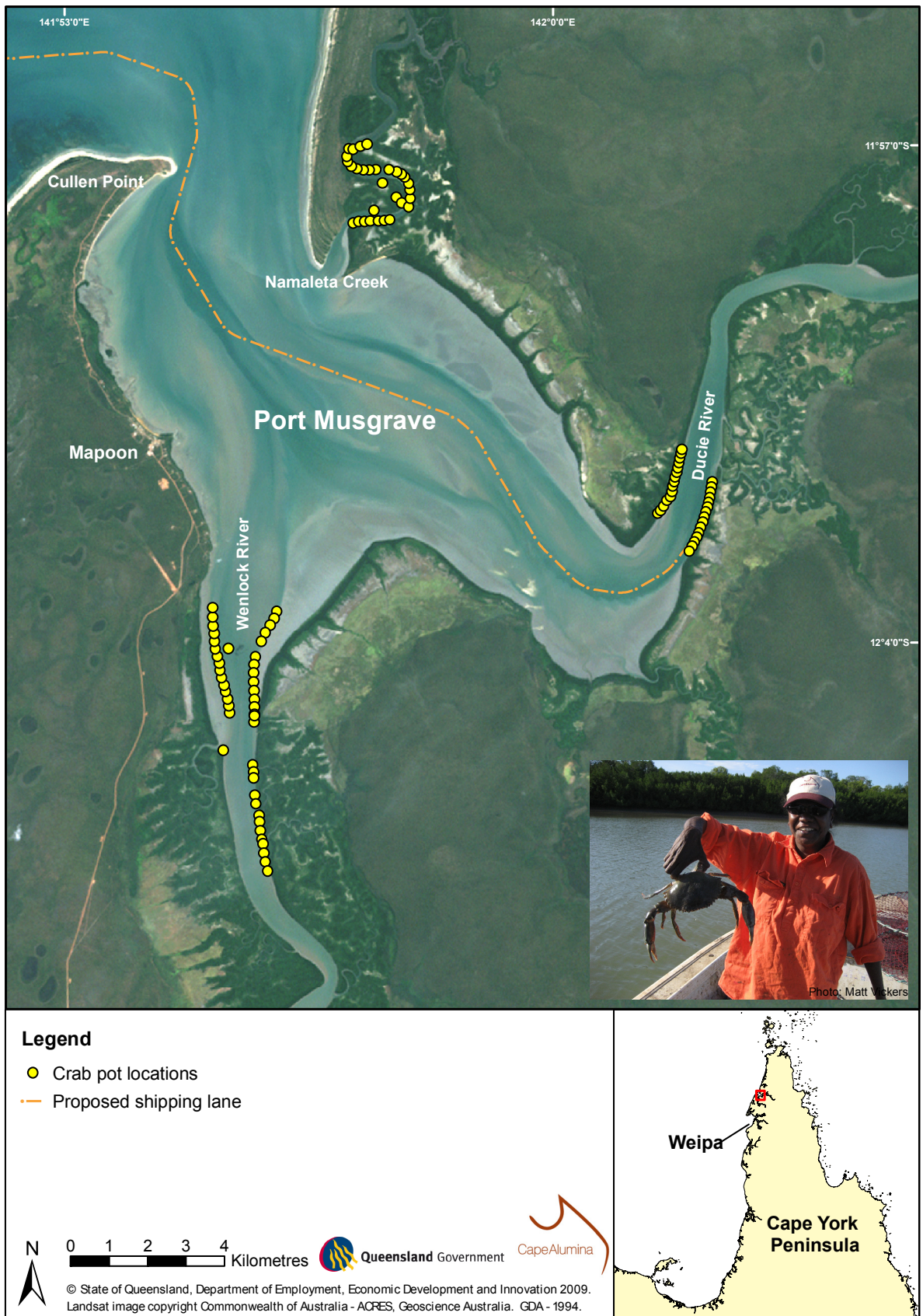
Jellyfish were monitored by visual census. Medusae of the major species of pelagic cnidarians were originally to be tagged and recaptured to generate population estimates. However, due to the low medusae numbers, the number of medusae per hour was calculated by recording the numbers of medusae for each species seen over a defined time period from a boat travelling at four knots. No attempt was made to differentiate the numbers of medusae recorded from each of the three survey sites as the numbers recorded were small.

Some sea snakes were also caught incidentally. Where possible, jellyfish and sea snakes collected in the dip nets were identified and recorded in the field and immediately returned to the ocean.

#### **2.1.3 Incidental Observations**

Counts of species of conservation importance that were not typically caught in conventional survey gear were obtained on an opportunistic basis using visual observation surveys. Sea snakes (Hydrophiidae spp.) and jellyfish that were observed in addition to those sampled with dip nets were recorded. Saltwater Crocodiles (*C. porosus*) were not a target species given the risk hazards associated with working with these animals and individuals were avoided wherever possible. The presence and distribution of Saltwater Crocodiles in the Port Musgrave study area were predominantly recorded through incidental observations (some were caught with conventional fishing gear). Other species recorded by incidental observation were Dugong (*D. dugon*), Australian Snubfin Dolphin (*O. heinsohni*), Indo-Pacific Hump-backed Dolphin (*Sousa chinensis*), Green Turtle (*C. mydas*), Flatback Turtle (*N. depressus*) and Pacific Ridley Turtle (*L. olivacea*).

All incidental observation data was obtained whilst operating on the water. Once a specimen was sighted a visual fix was noted and the position recorded using a GPS. This data was mapped using GIS to establish a spatial recognition of the species distribution in the Port Musgrave study area.



**Figure 7: Crab pot locations at each of the three survey sites.**

#### **2.1.4 Data Analysis**

Data was collated in Microsoft Excel and analysed in SPSS version 18.

##### **Diversity Index and Evenness**

Species and numbers of individuals captured during the three surveys from all fishing methods (gill net, set lines, cast net, crab pots, visual census) were combined to determine the species diversity and species evenness for each site and survey period. Incidental observation data was not used in the calculation of the diversity index.

The Shannon-Weiner diversity index was used to calculate the diversity of each site for each survey period and then used to independently calculate the Evenness (or Homogeneity or Relative Diversity) for each survey at each site. Both the Shannon-Weiner and Evenness calculated for each site and survey period were analysed using general linear model analysis. As no replication was possible for these indices only main order effects (namely survey site and survey period) were tested for their effects on these indices.

##### **Catch Per Unit Effort (CPUE)**

With respect to the gill net surveys, the relative abundance and distribution of the catches of target species were examined for differences across the surveyed sites and over the three survey periods; that is: Barramundi (*L. calcarifer*); Giant Queenfish (*S. commersonianus*); shark (*Carcharhinus* spp., *G. glyphis* excluded); four species of sawfish (*A. cuspidata*, *P. zijssron*, *P. clavata*, *P. microdon*); and Speartooth Shark (*G. glyphis*) These species were analysed as: Barramundi and Giant Queenfish are the dominant fish caught in the commercial gill net fishery; *Carcharhinus* species are the target species in the N3 and N9 components of the GOCIFF; and sawfish and Speartooth Shark were the shark Species of Conservation Interest targeted in these surveys.

Catch data from the net sizes 4.25, 6.5, 8 and 10 inch net were used in the analyses of CPUE for Barramundi, Giant Queenfish and Speartooth Shark. The 19 inch net catch data was not used for CPUE as it is not a recognised net size used for capture of these animals and given the size of the animals is ineffective in catching these species. For shark (*Carcharhinus* spp), the catch data from the net sizes 6.5, 8 and 10 inch net were used in the analyses to provide comparative data to the commercial GOCIFF. The 6.5, 8 and 10 inch nets are the sizes available to use in the N3 component, while the N9 component is restricted to 6.5 inch nets. For sawfish the catch data from the 10 and 19 inch nets were used in the analyses of CPUE as these nets were set to specifically target sawfish.

The effect of site (Ducie River, Namaleta Creek , Wenlock River) and survey period (March, June, November) on the CPUE of these species was analysed by a general linear model analysis (ANOVA) using SPSS version 18. All CPUE were expressed as number of animals per hour per 50m of net.

##### **Population estimates**

The tag and recapture data from the three surveys (March, June and November) was to be used to generate population estimates of the tagged species using Bailey's triple

catch and Peterson Mark and Recapture methods. However, even though large numbers of animals were tagged, the recapture rate for all tagged species was so low as to make reliability of population estimates to be unreliable. As such, no attempt was made to determine the population sizes of any of the tagged species.

As population estimates could not be determined, CPUE was used as a measure of relative abundance of the species of commercial and conservation interest, as described above. To allow CPUE's to be compared between sites and surveys similar sampling effort was used at all survey sites and periods. Although this does not allow the overall abundance of species to be determined it does allow for variations between sites and survey periods to be analysed.

## **2.2 Fishery Dependent Data from Port Musgrave**

### **2.2.1 Commercial Fishery**

Historical catch records for the commercial gill net catches (Gulf of Carpentaria Inshore Finfish Fishery N3 and N9 symbols) and commercial crab fishery catches (Queensland Commercial Crab Fisheries C1 symbol) were extracted from the CFISH database for the years 2002 to 2008. The records include catch (species and weight) and effort (date, type and quantity of gear used). The commercial logbook 30 nm x 30 nm grid references AB6 and AB7 that include Port Musgrave were used (Figure 1).

The finer spatial resolution of a 6 nm x 6 nm grid could not be used due to Fisheries Queensland confidentiality rules that apply where there are limited number of commercial operators, as is the case in Port Musgrave. The 30 nm x 30 nm grid includes catch data from the N9 fishery that does not operate in Port Musgrave however the data is still relevant as some species captured in the N9 fishery use Port Musgrave habitats in various phases of their life history.

The commercial gill net catches of sharks include some species that are not marketable; for this analysis of the historic commercial catch data only marketable sharks were included and these were grouped together as 'Shark' (Carcharhinidae spp.). In the logbooks not all sharks are reported as individual species, with some grouped in a category. The categories extracted from the logbook data and grouped as 'Shark' included: Blacktip Whalers, Shark Australian Blacktip, Shark Whaler Unspecified, Shark Sorrah, Creek Whaler and Shark Pigeye.

The most dominant commercial species caught over the period 2002 to 2008 from the gill net fishery were determined by investigating the average annual catch of all logbook species. The annual catch per unit of effort (CPUE kg/boat/day) for finfish (including shark) and Giant Mud Crabs was calculated by summing the total annual catch divided by the number of corresponding boat effort days. Temporal patterns in the catch of 'Shark', Grey Mackerel (*S. semifasciatus*) and Barramundi (*L. calcarifer*) were investigated by determining the average monthly catch. There was insufficient data in the AB6 and AB7 grid references to warrant analysing average monthly catch for Threadfin Salmon (*P. macrochir* and *E. tetradactylum*) another commercially important group in the GoC.

### **2.2.2 Recreational Fishery**

Information on the numbers of fish retained or released and on the total weight of fish retained by commercial Charter Boat operations in the Port Musgrave region was obtained from the CFISH database for the years 2000 to 2008. The monthly CPUE was calculated for total catch based on the average combined species weights for each month and the total effort (boat days) (kg/boat/day).

Recreational anglers tag and recapture data was obtained from INFO-FISH Services for the years 1986 to 2009 for fish tagged and released in in the estuarine and freshwater sections of Port Musgrave, Ducie River and Wenlock River. The numbers of the main fish species tagged were shown as a percent of the total recreational catch pooled for 1986 to 2009.

### **2.2.3 Indigenous Fishery**

A Community Fisheries Resource Assessment Project was run in parallel with the three independent surveys and was driven by Mapoon Aboriginal Community through the employment of a local person working part-time for twelve months. A species inventory of the fisheries resources utilised by the Indigenous community was collated. Species of significance to community were identified and their harvest quantified on an annual basis. In addition to monitoring the catch within the Indigenous community, the program incorporated catch statistics of recreational fishers visiting the area and local residents. The results of this Community Fisheries Resource Assessment Project are presented in Appendix A.

The Indigenous Fishery in Port Musgrave area was also assessed in a separate study funded as part of the Social Impact Assessment and forms a separate report with the information to be included in the main Environmental Impact Assessment.

## **2.3 Species of Conservation Interest (SOCI)**

A desk top assessment of the SOCI and protected species of the Port Musgrave study area was conducted using available literature, commercial logbook data and the online resource of the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) Protected Matters Search Tool for EPBC Act protected species. The EPBC Protected Matters Search Tool was used with a 30 km buffer around Port Musgrave (latitude 12.02008 and longitude 141.9399), accessed on 4th December 2009. Published sources of information were reviewed and crocodile and turtle specialists contacted to determine the known habitat requirements of rare and threatened species and their likelihood of occurrence in the Port Musgrave area.

Commercial fishers report in their logbooks on the number and status of interactions with SOCI protected under the Commonwealth EPBC Act, *Queensland Nature Conservation Act 1992* and *Fisheries Act 1995* and *Regulations 2008*. The most recent 2008 data was extracted from the SOCI logbook database for the GoC and tabulated by species, total number of interactions and fate of the animal.

## 3.0 Results

### 3.1 Fishery Independent Surveys of Port Musgrave

#### 3.1.1 Fisheries Resources

A total of 6407 individual animals from 132 species were recorded over the three surveys. Of these 126 species there were: 72 fish species, 29 shark and ray species, six reptile species, two dolphin species, five jellyfish species and 12 crustaceans (crab and prawn species). A full species list of animals recorded by capture method or observation is provided in Appendix B.

There were a number of protected species recorded: 19 Speartooth Sharks, two Freshwater Sawfish, 10 Green Sawfish, eight Dwarf Sawfish, five Narrow Sawfish, 50 Queensland Groper, 24 Australian Snubfin Dolphin, one Flatback Turtle, 90 Saltwater Crocodiles and 55 sea snakes (Appendix B). No Dugongs were captured or observed during the surveys. Details on these protected species are in Section 3.3.

The diversity and Evenness of species within the populations captured during the surveys did not vary significantly among the three sites or among the three surveys. That is, neither the survey site ( $F=0.065$ ,  $df=2*4$ ,  $p=0.938$ ) or the time of the survey ( $F=2.858$ ,  $d.f.=2*4$ ,  $p=0.170$ ) had a significant effect on the diversity index. Similarly these factors did not affect the Evenness of the collected samples (site  $F=0.068$ ,  $df=2*4$ ,  $p=0.935$ ), (survey period  $F=2.916$ ,  $df=2*4$ ,  $p=0.166$ ) (Table 1).

**Table 1: Shannon-Weiner diversity indices and Evenness for each site and each survey period.**

Date	Site	Diversity	Evenness
March	Ducie	1.092	0.522
March	Wenlock	1.224	0.585
March	Namaleta	1.200	0.574
June	Ducie	1.238	0.592
June	Wenlock	1.187	0.568
June	Namaleta	1.284	0.614
November	Ducie	1.362	0.651
November	Wenlock	1.347	0.644
November	Namaleta	1.243	0.595
<b>Mean</b>		1.242	0.594

The species captured and their relative abundance and distribution are presented by gear types below.

#### Gill nets

For all species captured by gill nets at all sites and surveys, the Wenlock River had the highest relative abundance (CPUE) of the three sites (Figure 8). The March and June surveys had variable but similar catch rates at all three survey sites but lower catch rates in November for both the Ducie River and Namaleta Creek sites.

The catch rates for netting effort combined were highly variable; the lowest catch rate was in the Ducie River in November and the highest in the Wenlock River in November (Figure 8). The variability in the data, as shown by the 95%CI, was also high and

affected by both time of year and geographic location (site). In terms of discriminating statistically between times, sites and possible treatments (control and impact sites), this high variability makes drawing valid conclusions difficult.

Grouping the combined catch rate by net sizes (Figure 9) demonstrated a similar pattern in variability. The smaller mesh nets had the highest catch rates by number of fish but this differed between river systems. The highest number of fish was captured in the Wenlock River with the 8 inch net (Figure 8).

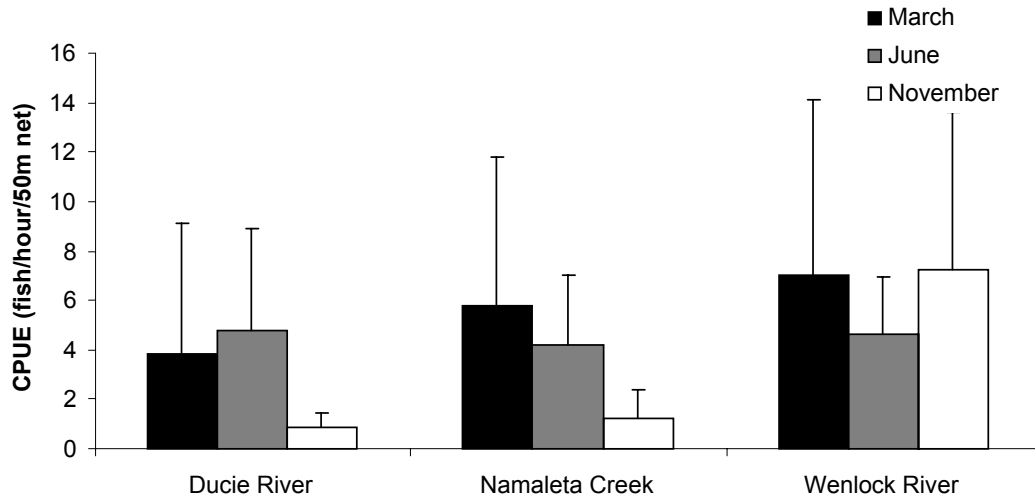


Figure 8: Gill net catch (+95%CI) at each survey site for each survey period.

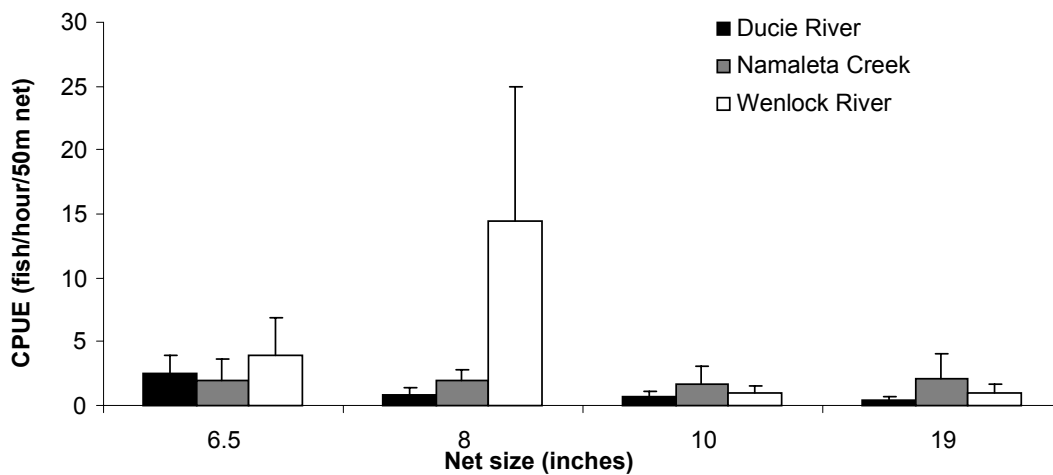


Figure 9: Gill net catch (+95%CI) for each net size at each survey site.

### Target Species Catches (CPUE)

#### Barramundi

A total of 372 Barramundi were captured in gill nets during this study. The size range of Barramundi (*L. calcarifer*) sampled in this study was biased to the net sizes used; hence fewer were captured around the 50 to 65 cm size class size in the length-frequency histogram (Figure 10).

The catch rates of Barramundi were highest in the Ducie River in March and highest in the Wenlock River in the June survey, however in November there was no significant

difference in the CPUE among all three survey sites (Figure 11). That is, there was a significant interaction between month and location in CPUE of Barramundi ( $F=2.36$ ,  $df=4*202$ ,  $p=0.05$ ). There was no significant effect of location or month on CPUE ( $F=0.18$ ,  $df=2*202$ ,  $p=0.83$ ;  $F=0.4$ ,  $df=2*202$ ,  $p=0.40$  respectively).

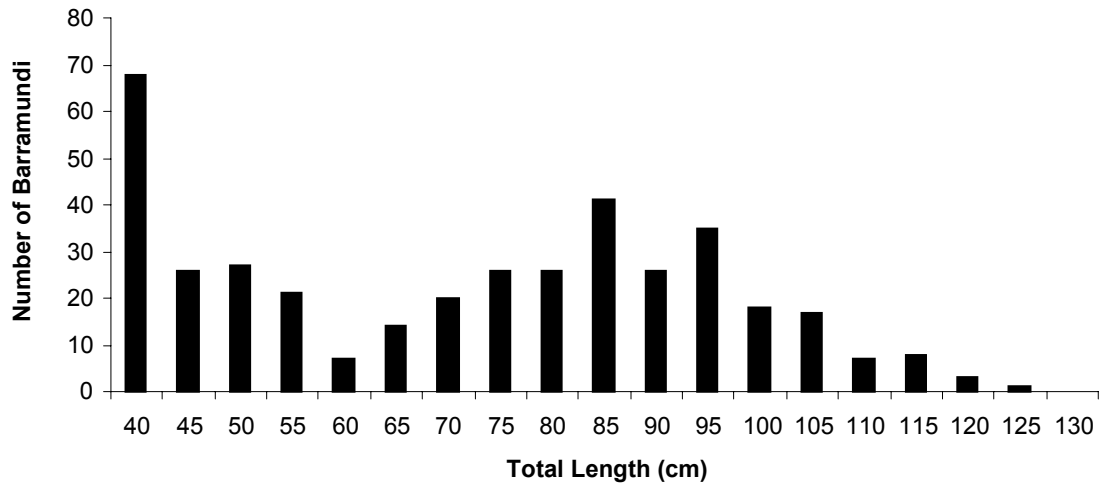


Figure 10: Size frequency of Barramundi (*Lates calcarifer*) caught from the three survey sites and three survey periods combined.

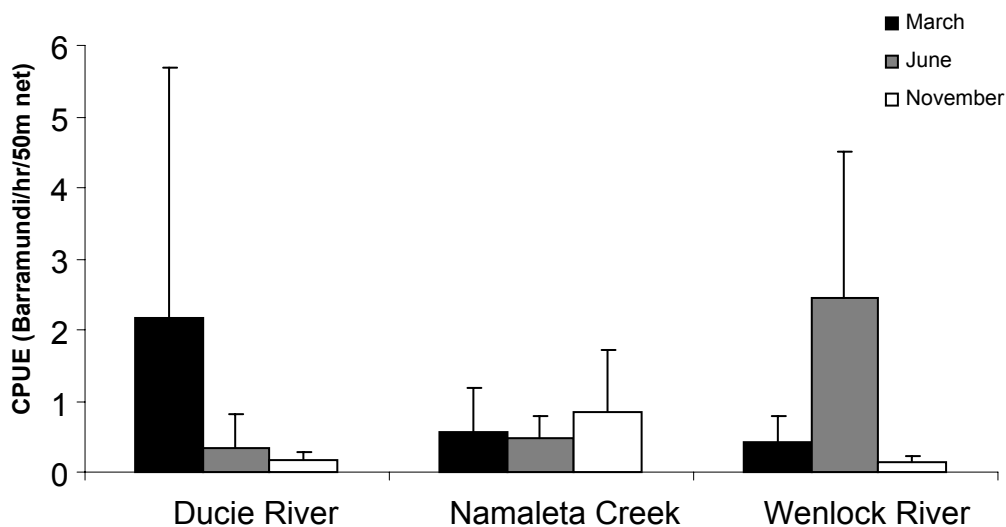


Figure 11: Catch (+95%CI) of Barramundi caught at each survey site for each survey period.

### Giant Queenfish

A total of 509 Giant Queenfish (*S. commersonianus*) were caught in gill nets across the three survey periods, ranging in fork length from 17 to 105 cm (Figure 12).

There was a significantly higher relative abundance (CPUE) of Giant Queenfish in Namaleta Creek than in the other two sites ( $F=8.2$ ,  $df=2*264$ ,  $p=0.0005$ ). However there was no effect of survey period on the CPUE for Giant Queenfish ( $F= 1.1$ ,

df=2\*264, p=0.321) (Figure 13). Similarly there was no interaction between site and survey period on CPUE (F=1.4, df=4\*264, p=0.22).

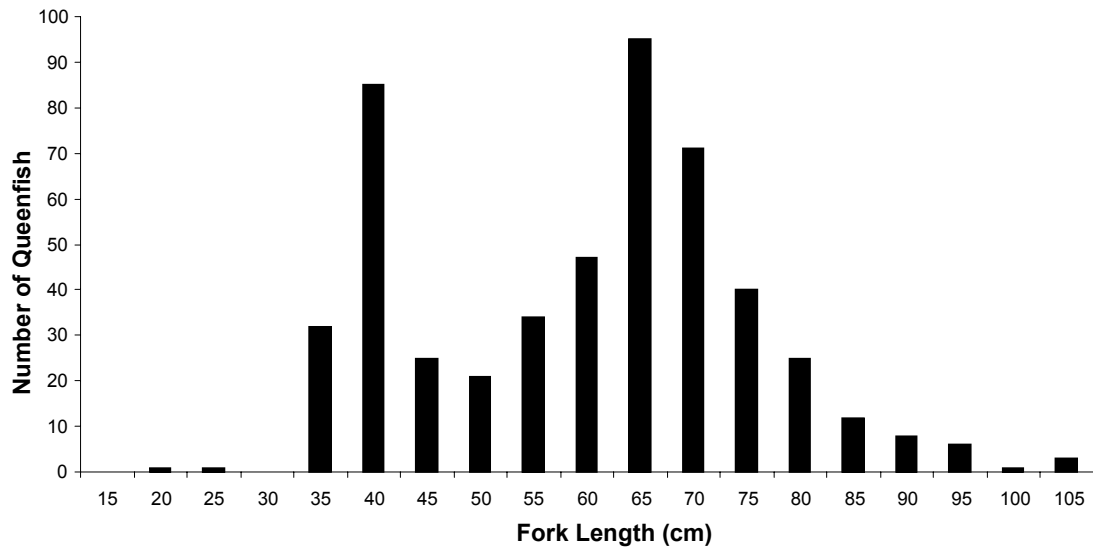


Figure 12: Size frequency of Giant Queenfish caught from the three survey sites and three survey periods combined.

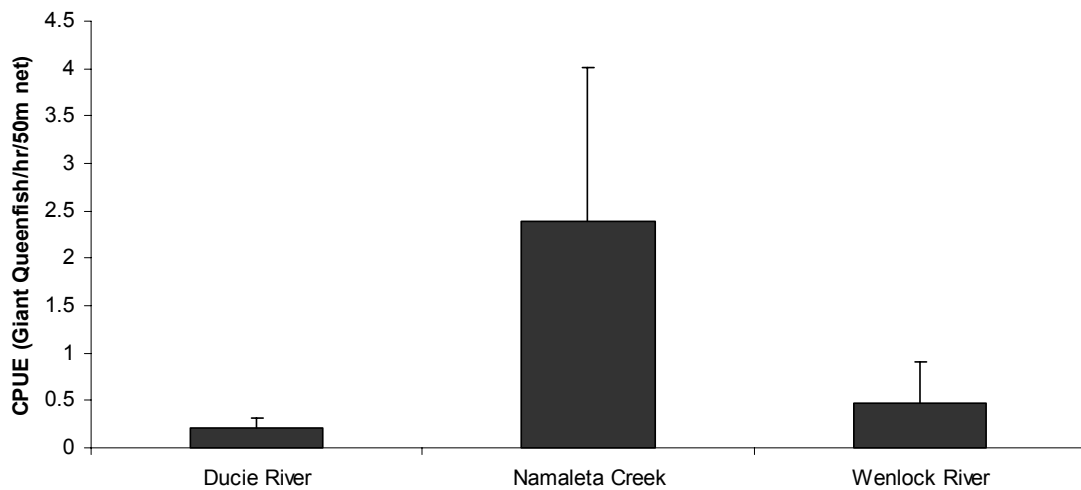


Figure 13: Catch (+95%CI) of Giant Queenfish caught at the three survey sites for the three survey periods combined.

### Shark

A total of 264 sharks (all Carcharhinidae species combined, *G. glyphis* excluded) were caught in gill nets across the three survey periods. The size frequency of sharks was based on the Carcharhinidae species (*G. glyphis* excluded) for which total FL was measured: *Carcharhinus amblyrhynchoides*, *Carcharhinus amboinensis*, *Carcharhinus cautus*, *Carcharhinus leucas*, *Carcharhinus limbatus*, *C. limbatus/tilstoni* and *Carcharhinus tilstoni*; a few specimens of these animals were not measured. The size of these *Carcharhinus* spp. for all sampling sites and survey periods combined (using 6.5, 8 and 10 inch mesh), ranged from 45 cm to 218 cm fork length (Figure 14). This study indicated that all the Port Musgrave survey sites are used by neonate, juvenile and mature *Carcharhinus* spp. (Figure 14).

Graceful Shark (*C. amblyrhynchoides*) and the Blacktip Shark complex *C. limbatus/tilstoni* were the most dominant carcharhinid species captured in the gill nets across all sites and survey periods (Figure 15). This species composition calculation included all specimens of the carcharhinid species used in the size frequency calculations although *C. limbatus* and *C. tilstoni* were combined with the *C. limbatus/tilstoni* complex.

There was a significant effect of survey site ( $F=4.90$ ,  $df=2*248$ ,  $p=0.008$ ), survey period ( $F=4.03$ ,  $df=2*248$ ,  $p=0.019$ ) and an interaction of the two ( $F=2.54$ ,  $df=4*248$ ,  $p=0.04$ ), on the CPUE of sharks caught during this study. The relative abundance of sharks (*Carcharhinus* spp.) was highest in the Namaleta Creek and in June. In the the Wenlock River the relative abundance was highest during the March survey (Figure 17, Figure 18).

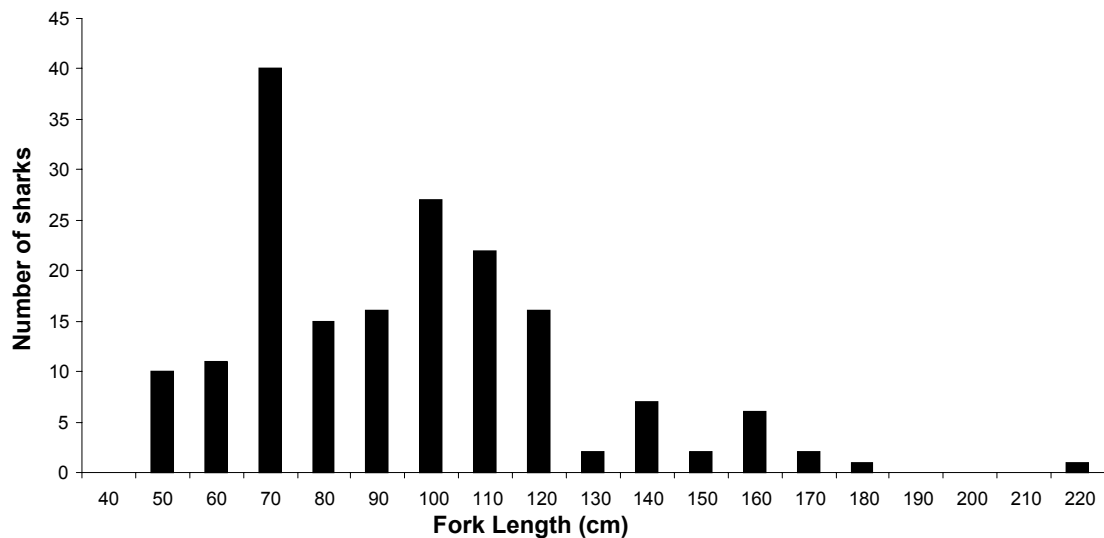


Figure 14: Size frequency of sharks (*Carcharhinus* spp.) caught from the three survey sites and three survey periods combined (n = 178).

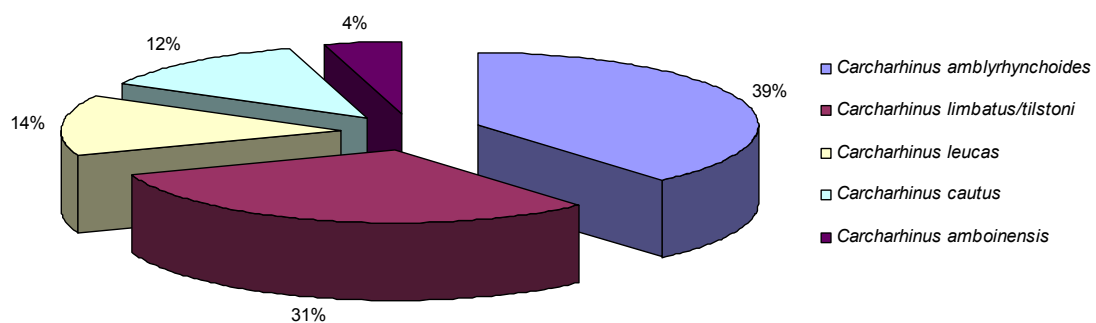
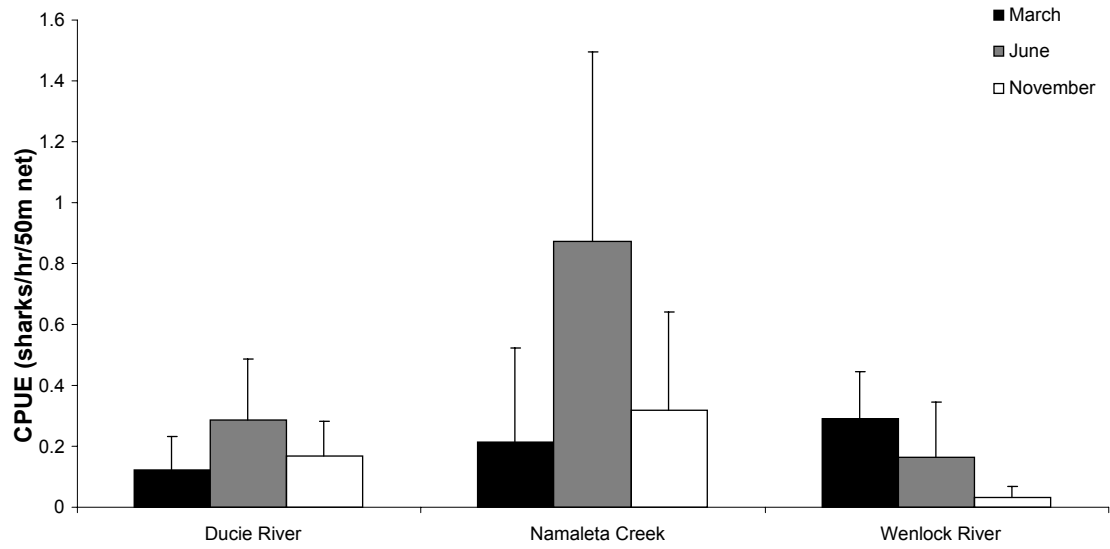
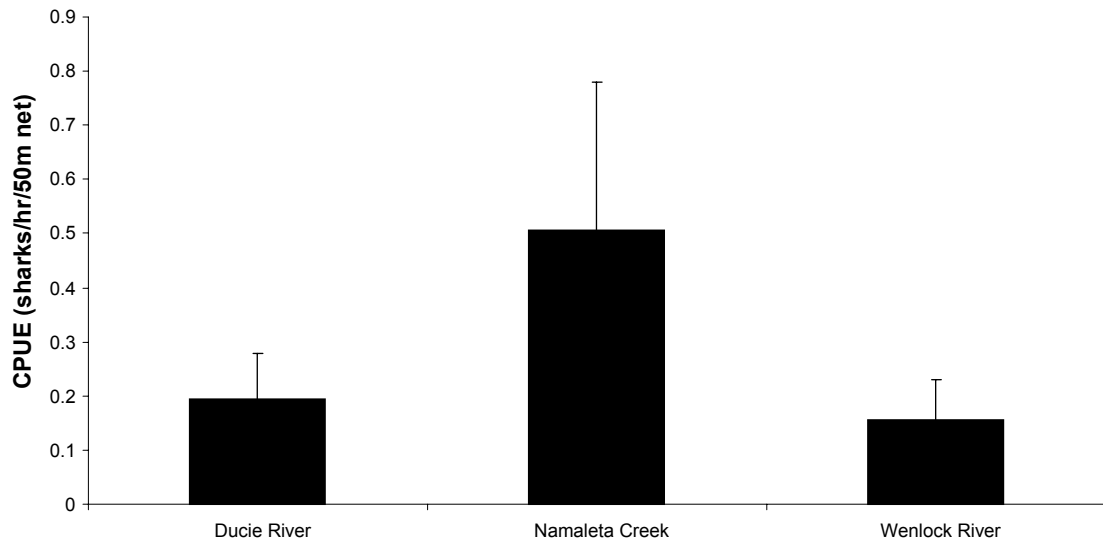


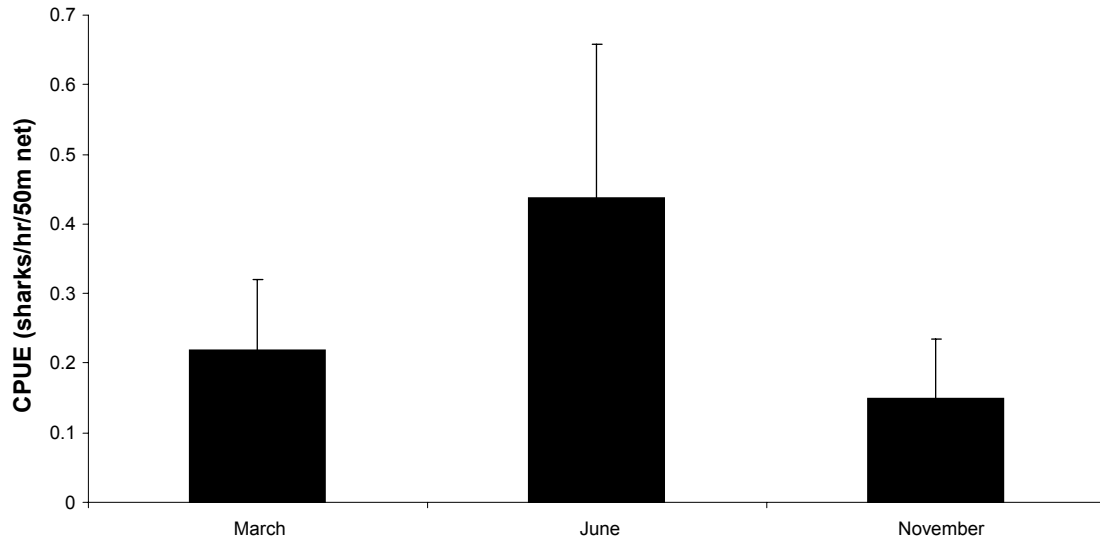
Figure 15: Species composition of sharks (*Carcharhinus* spp.) caught from the three survey sites and three survey periods combined (n = 202).



**Figure 16: Catch (+95%CI) of sharks (*Carcharhinus* spp.) caught at each survey site for each survey period.**



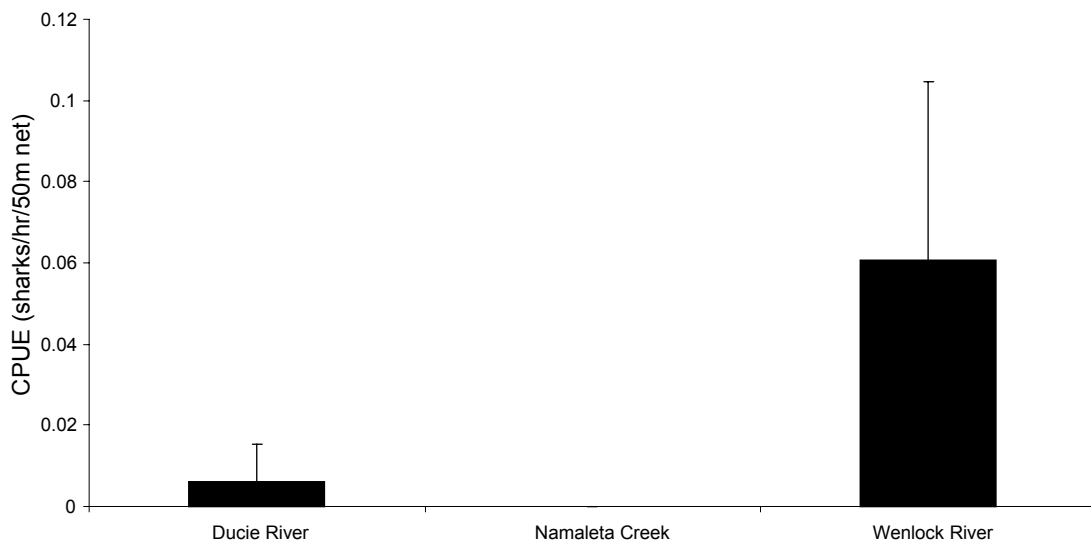
**Figure 17: Catch (+95%CI) of sharks (*Carcharhinus* spp.) caught at each survey site for the three survey periods combined.**



**Figure 18: Catch (+95%CI) of sharks (*Carcharhinus* spp.) caught in each survey period for all survey sites combined.**

### Spertooth Shark

A detailed description of all Spertooth Shark captured is in Section 3.3.2. This catch information refers to those Spertooth Sharks that were captured in gill nets. The relative abundance (CPUE) of Spertooth Shark was higher in the Wenlock River than at the other two sites, that is, there was a significant effect of site on the CPUE for Spertooth Sharks ( $F=5.4$ ,  $df=2*264$ ,  $p=0.005$ ) (Figure 19). The relative abundance of Spertooth Sharks did not vary among the three surveys, that is, the time of the survey had no statistically significant effect on CPUE ( $F=0.1$ ,  $df=2*264$ ,  $p=0.89$ ). There was no statistically significant interaction between the time of the survey and the survey site ( $F=0.06$ ,  $df=4*264$ ,  $p=0.99$ ) on the CPUE for Spertooth Sharks.



**Figure 19: Catch (+95%CI) of Spertooth Shark caught at each survey site for the three survey periods combined.**

### Sawfish

A detailed description of all sawfishes captured is in Section 3.3.2. All sawfish were captured in gill nets and the following provides information on the relative catches across the sites and surveys for each species of sawfish.

#### Narrow sawfish

The relative abundance of Narrow Sawfish did not vary among the survey sites or survey periods. That is, there was no effect of survey site, time of survey or an interaction of the two on the CPUE for Narrow Sawfish ( $F=0.167$ ,  $df=2*107$ ,  $p=0.847$ ;  $F=0.285$ ,  $df=2*107$ ,  $p=0.752$ ;  $F=0.261$ ,  $df=4*107$ ,  $p=0.903$ ).

#### Green sawfish

The 10 Green Sawfish recorded from the 10 and 19 inch nets were all captured in June with none encountered in the March or November surveys, that is, the survey period had a significant effect on the CPUE of Green Sawfish ( $F=8.32$ ,  $df=2*107$ ,  $p=0.0005$ ). The relative abundance of Green Sawfish did not vary among the three sites, that is, there was no effect of site or an interaction between site and survey date on the CPUE for Green Sawfish ( $F=1.50$ ,  $df=2*107$ ,  $p=0.227$ ;  $F=1.95$ ,  $df=4*107$ ,  $p=0.107$ ).

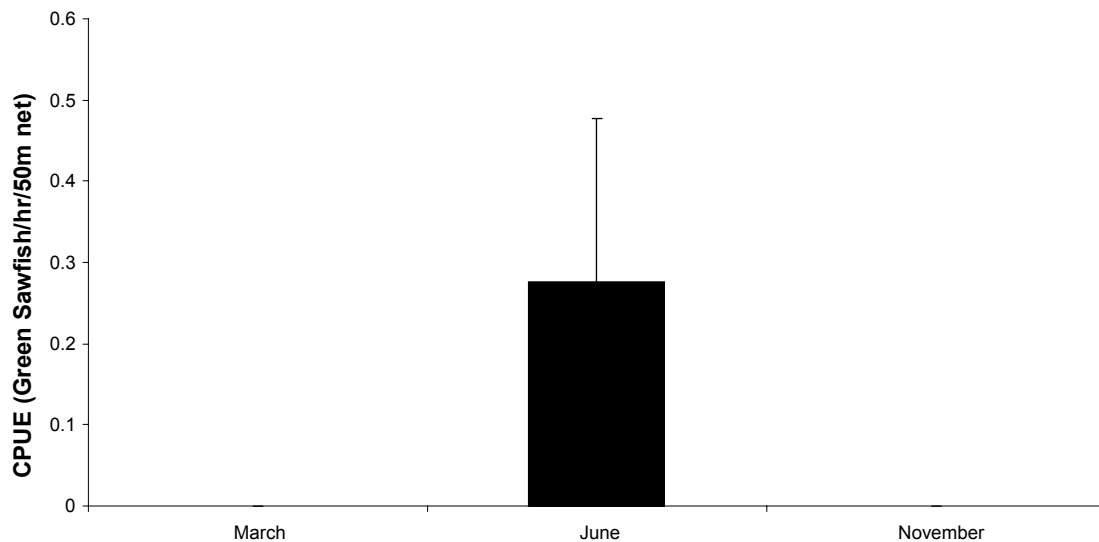


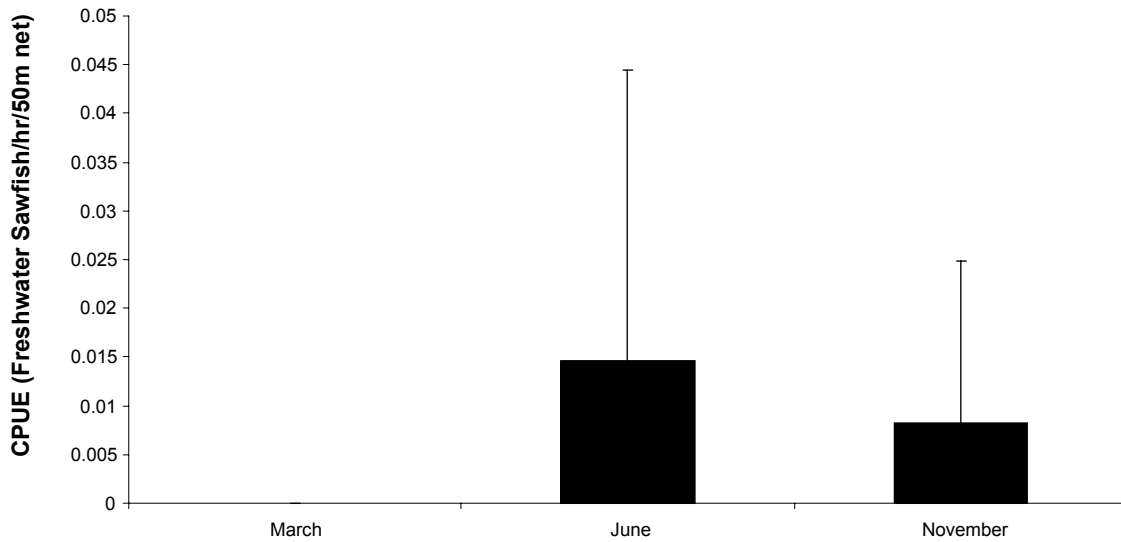
Figure 20: Catch (+95%CI) of Green Sawfish caught in each survey period for all survey sites combined.

#### Dwarf sawfish

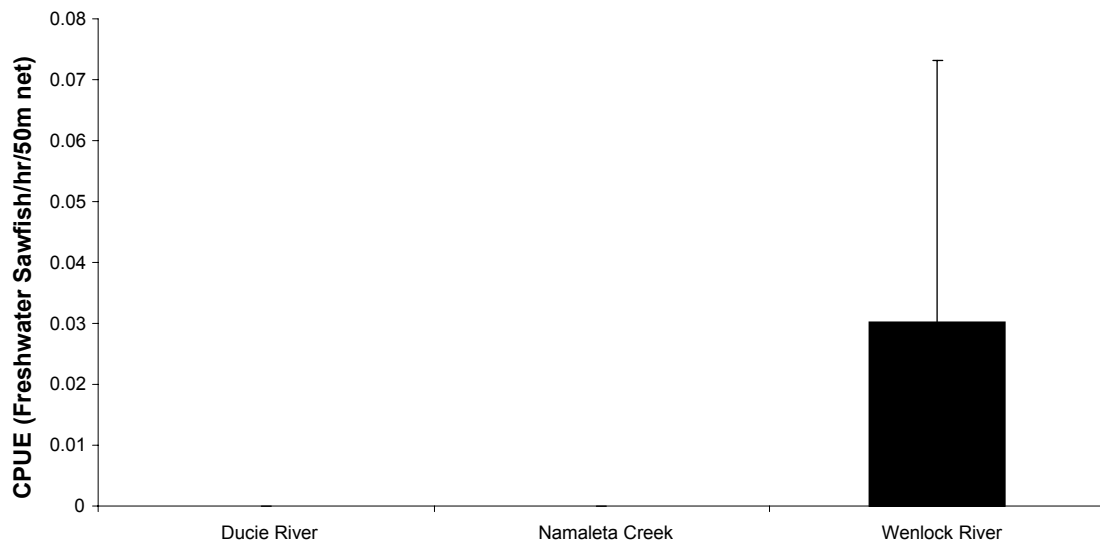
The relative abundance of Dwarf Sawfish did not vary among the survey sites or survey periods. That is, there was no effect of survey site, time of survey or an interaction of the two ( $F=0.506$ ,  $df=2*107$ ,  $p=0.604$ ;  $F=0.711$ ,  $df=2*107$ ,  $p=0.493$ ;  $F=1.01$ ,  $df=4*107$ ,  $p=0.403$  respectively).

#### Freshwater sawfish

Freshwater Sawfish were caught with 10 and 19 inch nets only in the Wenlock River with a higher relative abundance in June compared to November; none were captured in March. That is, there was a significant effect of survey period ( $F=10.939$ ,  $df=2*109$ ,  $p<0.0005$ ), survey site ( $F=26.514$ ,  $df=2*109$ ,  $p<0.0005$ ) and an interaction of the two ( $F=10.034$ ,  $df=4*109$ ,  $p<0.0005$ ) (Figure 21, Figure 22).



**Figure 21** Catch (+95%CI) of Freshwater Sawfish caught in each survey period for all survey sites combined.



**Figure 22:** Catch (+95%CI) of Freshwater Sawfish caught at each survey site for the three survey periods combined.

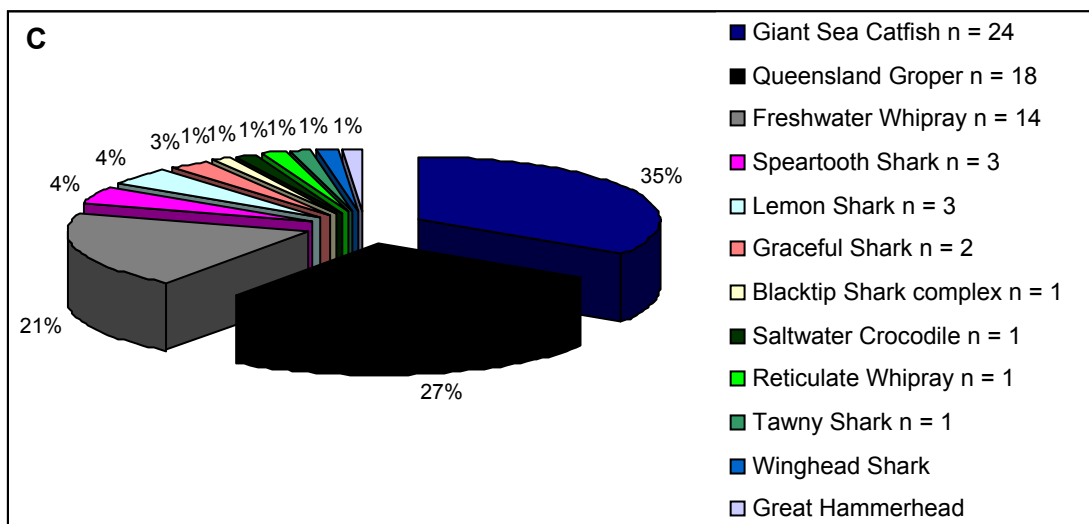
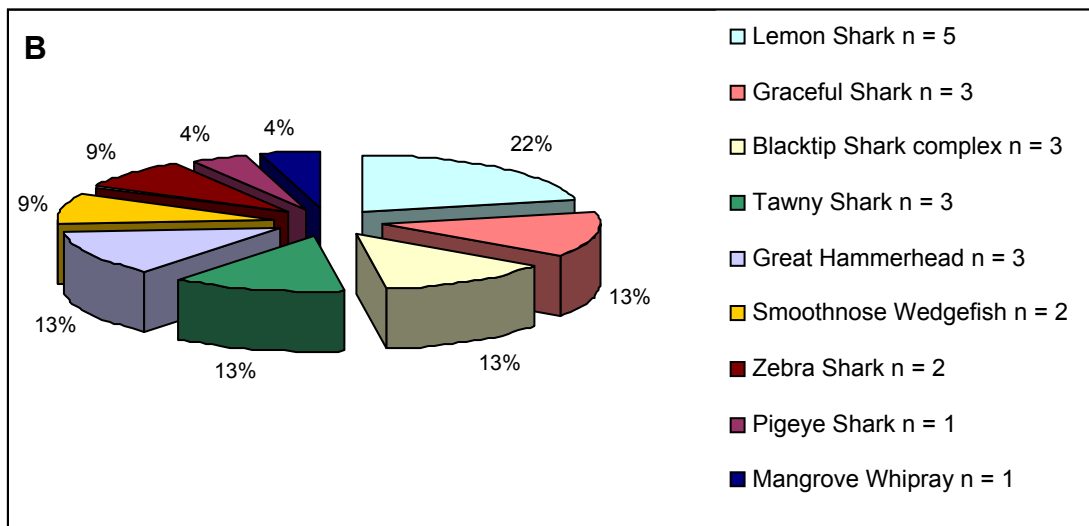
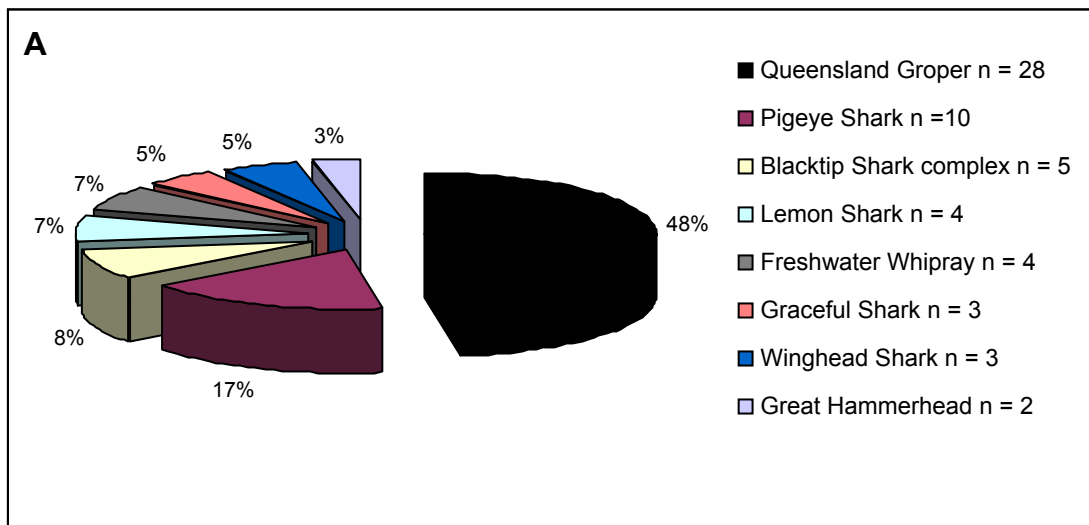
### Set Lines

A total of 16 species from nine families were captured over the three surveys by set lines (Table 2). Species composition varied among the three survey sites with the three most abundant species, Queensland Grouper (*E. lanceolatus*), Giant Sea Catfish (*Netuma thalassina*) and Freshwater Whipray (*H. dalyensis*) caught in the Wenlock River and Ducie River but not in Namaleta Creek (Table 2, Figure 23). Some species were only caught at one site, for example, Speartooth Shark and Giant Sea Catfish (*N. thalassina*) were only caught in the Wenlock River while Zebra Shark (*Stegostoma fasciatum*), Smoothnose Wedgefish (*Rhynchobatus laevis*) and Mangrove Whipray (*Himantura granulata*) were only recorded in Namaleta Creek (Figure 23). The highest number of species were recorded from the Wenlock River (n = 12), followed by

Namaleta Creek ( $n = 9$ ) and Ducie River ( $n = 8$ ) respectively (Figure 23). There appeared to be no seasonal variation in abundance (using the 95%CI) within the three survey sites or between the survey sites (Figure 24) although the Wenlock River appeared to have a higher species diversity with total numbers of species greater in March and November than at the two other sites, Namaleta Creek and Wenlock River (Figure 24 and Figure 25).

**Table 2: Species list and CPUE (fish/set) for fish, sharks and rays captured with set lines at each survey site and survey period.**

Family	Species	Common Name	March			June			November			Total
			Ducie River	Namaleta Creek	Wenlock River	Ducie River	Namaleta Creek	Wenlock River	Ducie River	Namaleta Creek	Wenlock River	
Ariidae	<i>Netuma thalassinus</i>	Giant Sea Catfish			2			16			6	24
Carcharhinidae	<i>Carcharhinus amblyrhynchoides</i>	Graceful Shark				2		1	1	3	1	8
Carcharhinidae	<i>Carcharhinus amboinensis</i>	Pigeeye Shark	4			5	1		1			11
Carcharhinidae	<i>Carcharhinus limbatus/tilstoni</i>	Blacktip Shark complex	1	2	1	1	1		3			9
Carcharhinidae	<i>Glyphis glyphis</i>	Speartooth Shark			1			1			1	3
Carcharhinidae	<i>Negaprion acutidens</i>	Lemon Shark				2	2	1	2	3	2	12
Crocodylidae	<i>Crocodylus porosus</i>	Saltwater Crocodile									1	1
Dasyatidae	<i>Himantura dalyensis</i>	Freshwater Whipray	1		8	1		2	2		4	18
Dasyatidae	<i>Himantura granulata</i>	Mangrove Whipray								1		1
Dasyatidae	<i>Himantura uarnak</i>	Reticulate Whipray									1	1
Ginglymostomatidae	<i>Nebrius ferrugineus</i>	Tawny Shark					3				1	4
Rhinobatidae	<i>Rhynchobatus laevis</i>	Smoothnose Wedgefish								2		2
Serranidae	<i>Epinephelus lanceolatus</i>	Queensland Groper	3		5	14		9	11		4	46
Sphyrnidae	<i>Eusphyra blochii</i>	Winghead Shark			1				3			4
Sphyrnidae	<i>Sphyrna mokarran</i>	Great Hammerhead				1			1	3	1	6
Stegostomatidae	<i>Stegostoma fasciatum</i>	Zebra Shark					1			1		2
<b>Total number species</b>			4	1	6	7	5	6	8	6	10	16
<b>Total number of fish</b>			9	2	18	26	8	30	24	13	22	152
<b>Number of sets</b>			29	10	54	84	42	63	72	54	80	488
<b>CPUE (fish/set)</b>			<b>0.31</b>	<b>0.20</b>	<b>0.33</b>	<b>0.31</b>	<b>0.19</b>	<b>0.48</b>	<b>0.33</b>	<b>0.24</b>	<b>0.28</b>	<b>0.31</b>



**Figure 23: Species caught with set lines in the Ducie River (A), Namaleta Creek (B) and Wenlock River (C) for the three survey periods combined.**

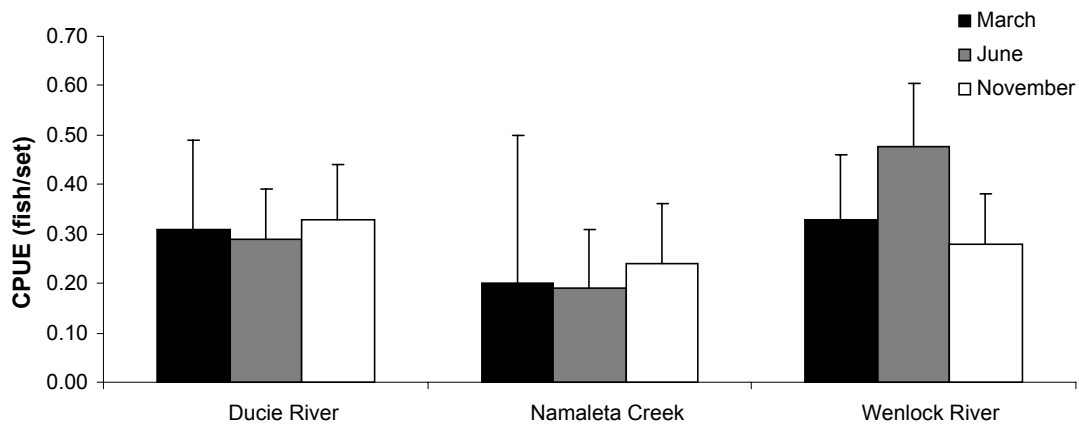


Figure 24: Set line catch (+95%CI) at each survey site for each survey period.

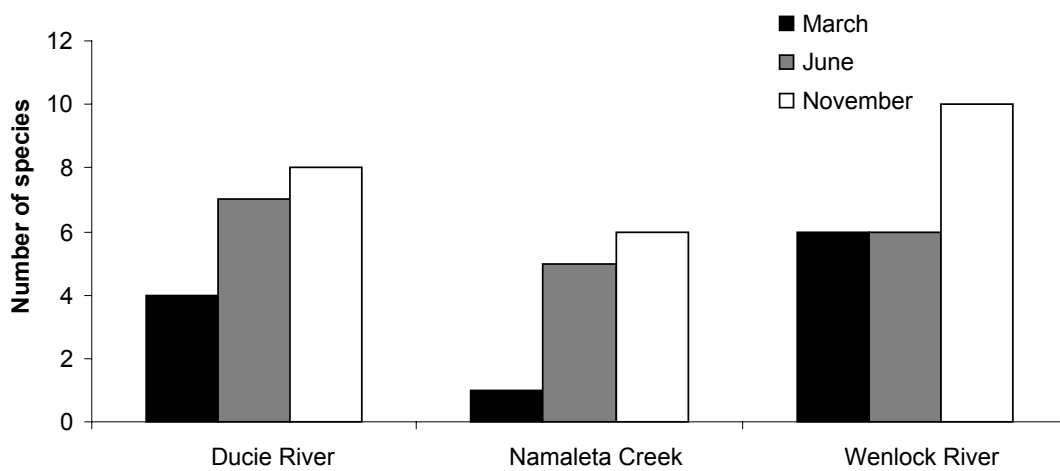
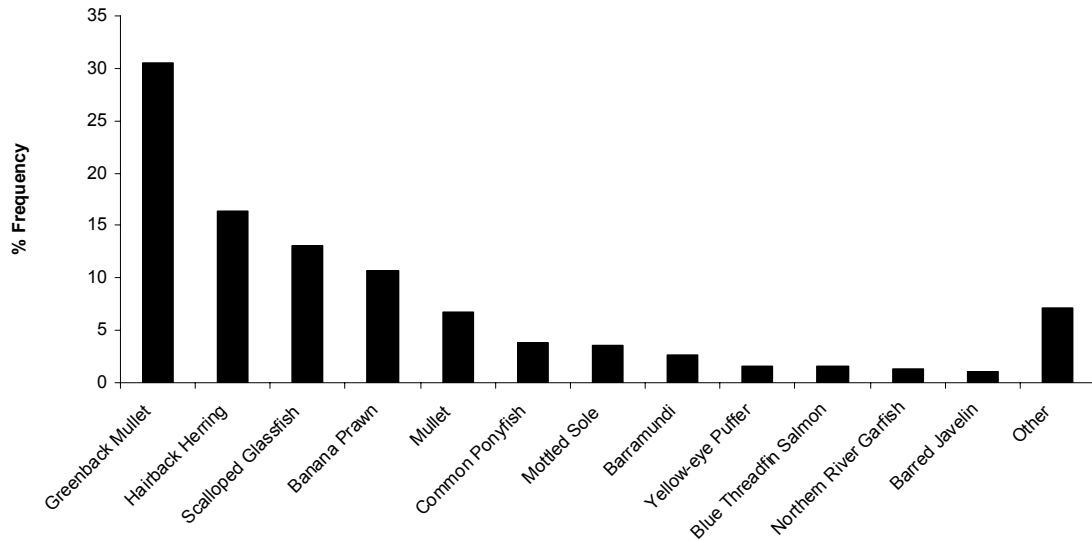


Figure 25: Numbers of species caught in set lines at each survey site for each survey period.

### Cast Nets

A total of 2954 specimens from 56 species and 38 families were recorded in cast nets during the study. A total species list and numbers of specimens sampled in cast nets during the study is in Appendix B. The families represented by the highest number of species were Leiognathidae, Mugilidae, and Tetraodontidae each with four species (Appendix B). The species most frequently captured in the cast nets during the study was Greenback Mullet (*L. subviridis*) (Figure 26). The category 'other' consisted of 209 specimens from 44 species.



**Figure 26: Top 12 species captured in cast nets from the three survey sites and three survey periods combined.**

### Crab Pots

A combined catch of 357 Giant Mud Crabs, an average of 1.23 crabs per pot lift, was caught during the March, June and November 2009 surveys (Figure 27, Figure 28). The Wenlock River consistently had the highest CPUE and the highest numbers of crabs caught for the three sites surveyed (Figure 27, Figure 29). Crab catch rates were highest in the June survey peaking at 2.37 per pot lift (Figure 29). This trend in seasonal abundance is consistent with the historic commercial crab catch in the area (Gould et al. 1999).

The relative abundance (CPUE) was highest in the Wenlock River followed by Namaleta Creek and then the Ducie River (Figure 27). That is, there was a significant effect of site ( $F=4.43, df=2*261, p=0.013$ ) and survey date ( $F=13.93, df=2*261, p=0.0005$ ) on the CPUE of crabs, however there was no interaction between the two ( $F=1.489, df=4*261, p=0.206$ ) (Figure 27, Figure 28).

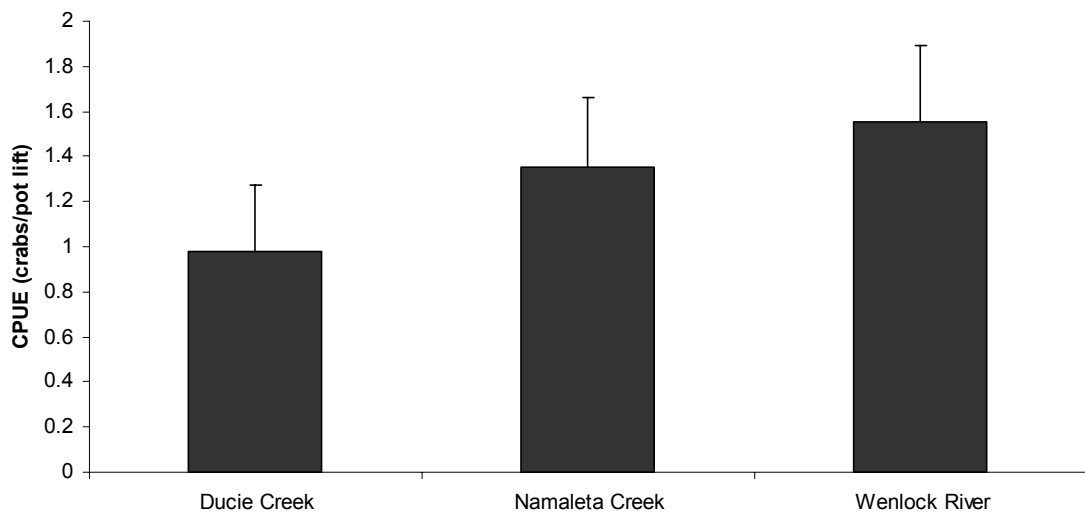
Of the 357 crabs caught, 75% were males, 25% were female and in 18% of specimens the crab was infected with a parasitic barnacle (*L. ihlei*). The ratio of males to females was consistently greater at all sites. There was a strong seasonality in the number of crabs caught with March survey data indicating recruitment occurred after this survey period. This is indicative of the bi-modal pattern in crab size frequency data (Figure 30).

Overall, strong gender differences were apparent in the abundance and size of Giant Mud Crabs caught (Figure 30). More mature male crabs were taken than female crabs and immature male crabs in the March survey. A possible explanation for this occurrence might be male dominance preventing smaller crabs from entering the pot (pot selectivity) or female crabs are occupying different habitat (offshore marine water) engaging in seasonal spawning behaviour. Hence within the data it is evident there is developmental stage-specific seasonality. Although only a preliminary data set, it is possible to model the annual pattern of juvenile crab abundance. Furthermore with an on going monitoring program a better understanding of the Giant Mud Crab population demographic can be obtained.

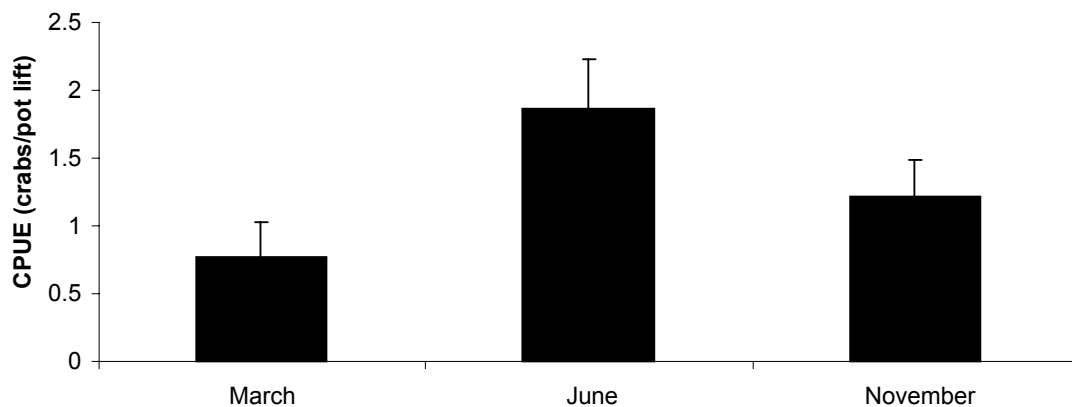
The average size for Giant Mud Crabs was significantly different between survey periods and between sexes. The average size was significantly larger in the March survey and was biased towards mature male crabs (Figure 30).

In this study parasitised crabs were identified by the presence of parasite externae (Figure 31). A total of 46 (13%) of the crabs caught in the June and November surveys were classified as parasitised by a barnacle (*L. ihlei*). Parasitism was not recorded in March survey. Of the 261 crabs recorded in June and November, only juvenile crabs up to 13 cm in carapace width were infected (Figure 30). Other studies report the parasite is known to mainly affect juvenile Giant Mud Crabs, although crabs of any age may be infected (Reinhard 1950; Weng 1987; Knuckey et al. 1995).

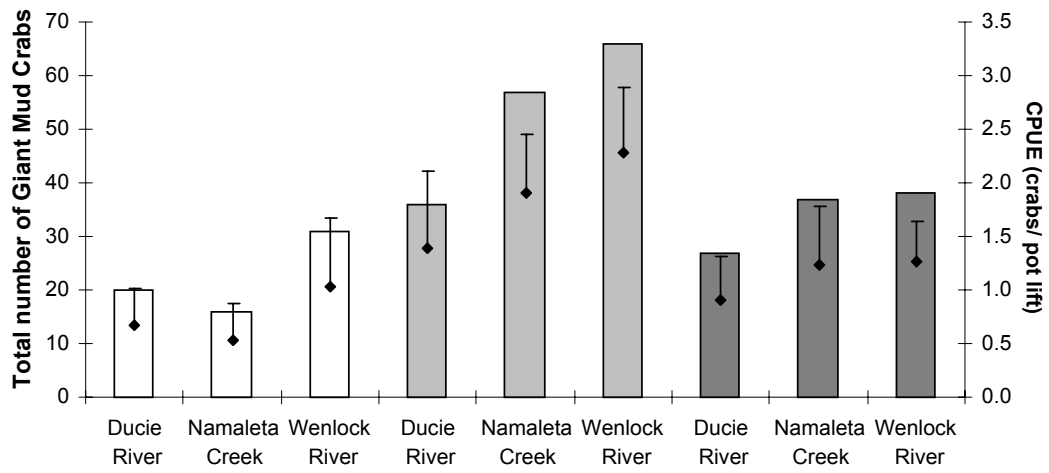
The relative abundance (CPUE) was higher in June than November than March while the CPUE was highest in Wenlock River followed by Namaleta Creek and the Ducie River. That is, there was a significant effect of site ( $F=4.43, df=2*261, p=0.013$ ) and survey date ( $F=13.93, df=2*261, p=0.0005$ ) on the CPUE of crabs, however there was no interaction between the two ( $F=1.489, df=4*261, p=0.206$ ) (Figure 27, Figure 28).



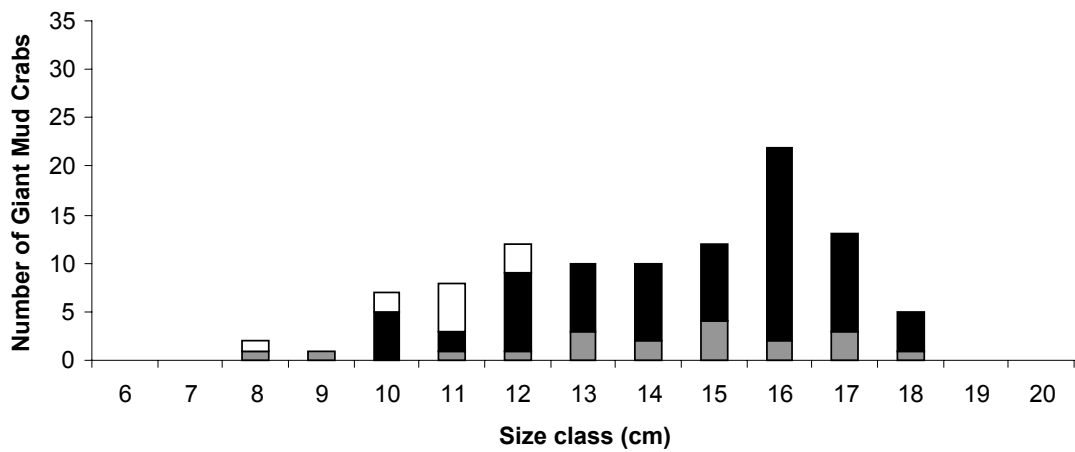
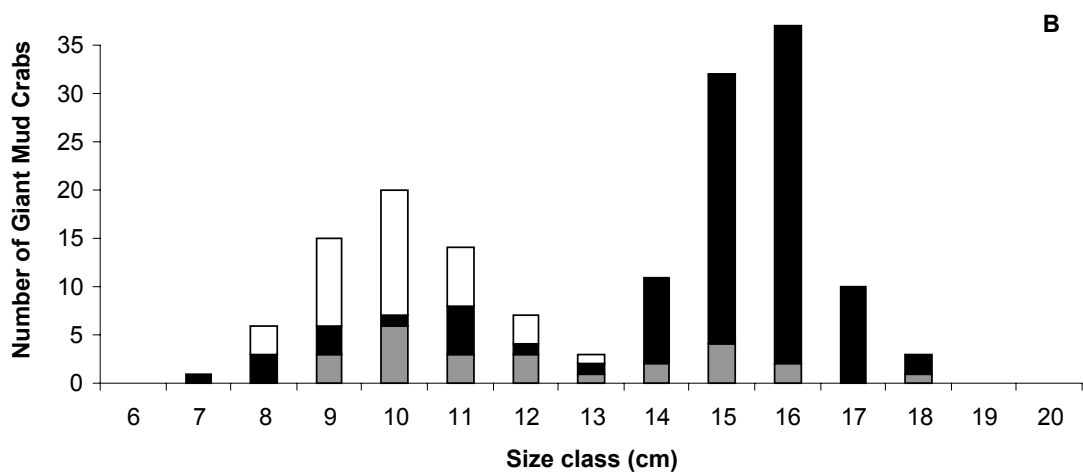
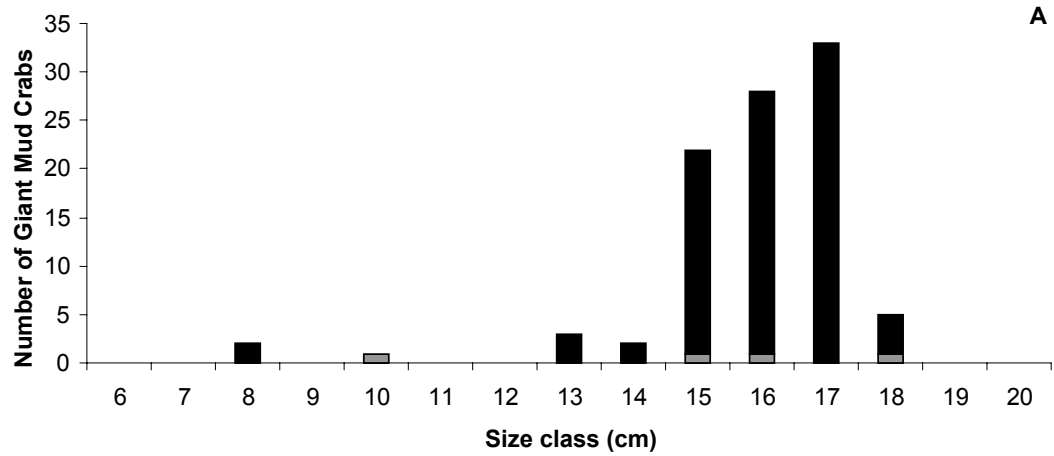
**Figure 27: Catch (+95%CI) of Giant Mud Crabs at each survey site for all three survey periods combined.**



**Figure 28: Catch (+95%CI) of Giant Mud Crabs in each survey period for all surveys sites combined.**



**Figure 29: Total number and catch (+95%CI) of Giant Mud Crabs at the survey sites for March (white), June (light grey) and November (dark grey) surveys.**



**Figure 30: Size frequency of male (black), female (grey) and parasitised (white) Giant Mud Crabs caught at the survey sites for (A) March (n = 96), (B) June (n = 159) and (C) November (n = 102).**



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**Figure 31: Giant Mud Crab (*Scylla serrata*) infected with the parasite *Loxothylacus ihlei*.**

### Jellyfish

Five species of jellyfish were recorded on the surveys. The abundance of jellyfish recorded varied greatly over the surveys; one in March, nine in July and 72 in November. The most dominant species in the November survey were *Phyllorhiza punctata* and *Chironex fleckeri* (Table 3).

**Table 3: Number of medusa caught for the three surveys.**

Common Name	Species	March	Hrs	Jellies /hr	July	Hrs	Jellies /hr	Nov	Hrs	Jellies /hr
Jelly Blubber	<i>Catostylus mosaicus</i>	1	25	<0.1	3	15	0.2	2	19	0.1
Jellyfish	<i>Netrastoma sp.</i>	0	25	0	1	15	0.1	0	19	0
Box jellyfish	<i>Chironex fleckeri</i>	0	25	0	0	15	0	24	19	1.3
Lion's Mane Jellyfish	<i>Cyanea capillata</i>	0	25	0	5	15	0.3	8	19	0.4
Brown Jellyfish	<i>Phyllorhiza punctata</i>	0	25	0	0	15	0	38	19	2
Total		1			9			72		

## 3.2 Fishery Dependent Data from Port Musgrave

### 3.2.1 Commercial Gillnet Fishery

Varying number of operators worked the Port Musgrave region (commercial logbook grid references AB6 & AB7) with subsequent variable effort (Figure 32). The highest recorded landing was 111 tonne in 2002 (Figure 33) that had a GVP of \$548K; this value equates to 4% of the total GVP for the GoC net fishery.

Over the period from 2002 to 2008, Grey Mackerel, 'Shark' (Carcharhinidae) and Barramundi had the highest average annual catch and were the highest species landed by weight, consisting of 41%, 32% and 14% of the total landings respectively (Figure 34, Table 4). The species category "other" which had a total landing of 8.2 tonne consists conservatively of 20 species of minor commercial value (Table 4).

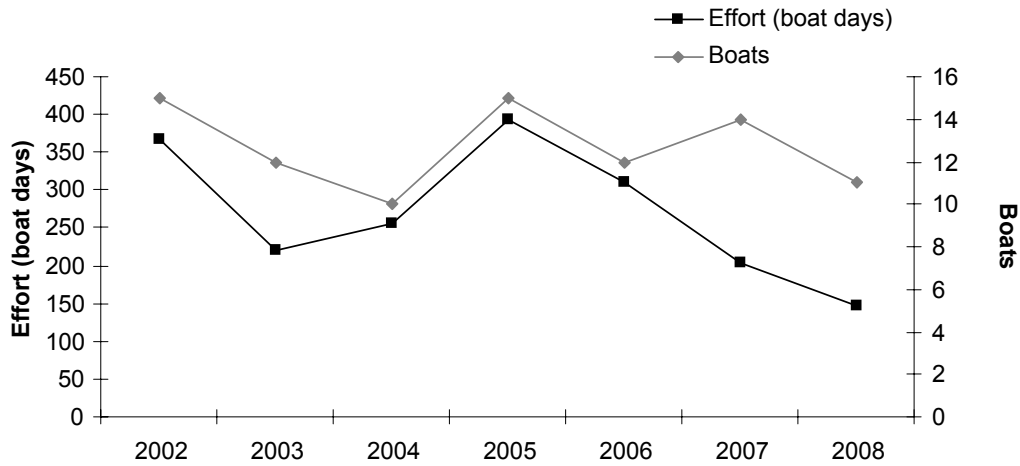


Figure 32: Total number of boats and fishing effort (boat days) in the Port Musgrave commercial net fishery for the years 2002 to 2008 (Source: CFISH database October 2009).

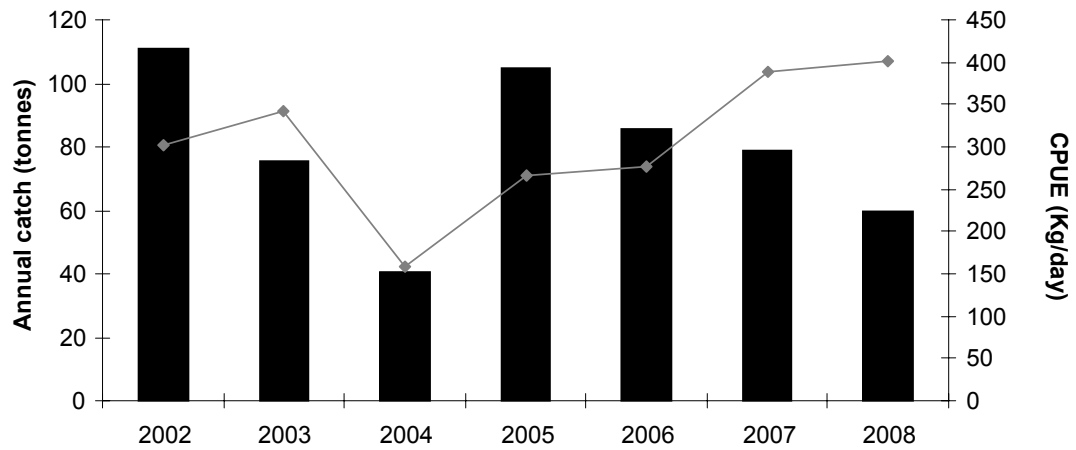


Figure 33: Annual commercial gill net catch in tonnes (columns) and catch per unit of effort (kg/per day) for AB6 & AB7 logbook grid references for the years 2002 to 2008 (Source: CFISH database October 2009).

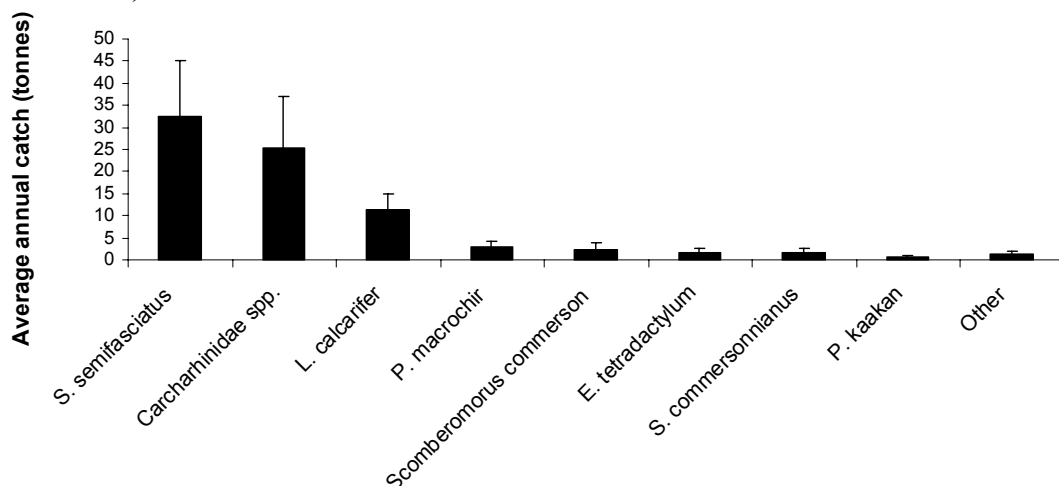


Figure 34: Average catch (tonnes) (+95%CI) of target species caught in the AB6 & AB7 logbook grids for the years 2002 to 2008 (Source: CFISH database October 2009).

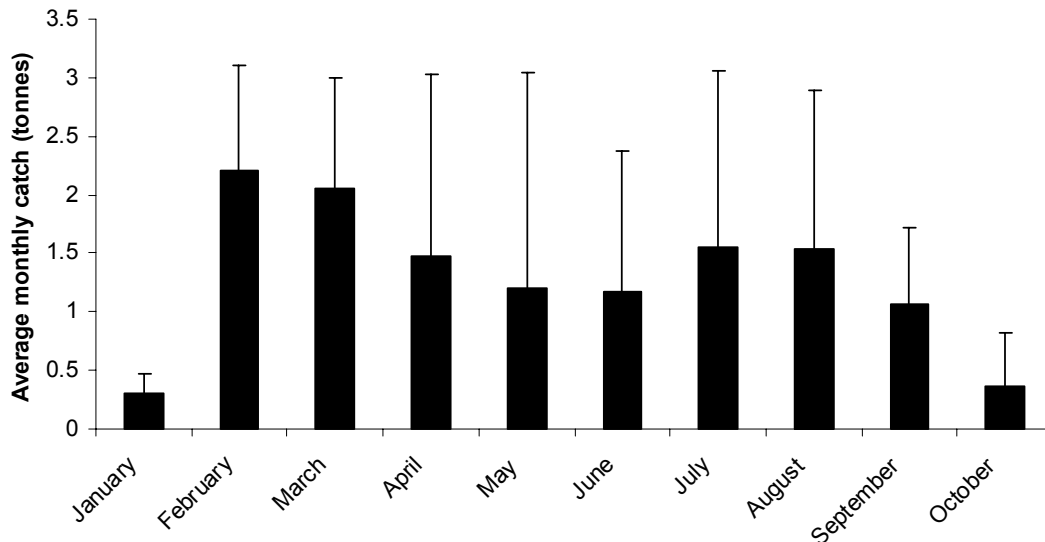
**Table 4 : Species categories of combined commercial landings in the Port Musgrave area for the years 2002 to 2008 (Source: CFISH database October 2009).**

Family	Species	Common Name	Catch tonnes (2002 - 2008)	% of total Catch
Scombridae	<i>Scomberomorus semifasciatus</i>	Grey Mackerel	227.6	41
Mixed Shark		'Shark'	179.2	32
Centropomidae	<i>Lates calcarifer</i>	Barramundi	78.4	14
Polynemidae	<i>Polydactylus macrochir</i>	King Threadfin Salmon	20.5	4
Scombridae	<i>Scomberomorus commerson</i>	Spanish Mackerel	15.8	3
Polynemidae	<i>Eleutheronema tetradactylum</i>	Blue Threadfin Salmon	10.7	2
Carangidae	<i>Scomberoides commersonnianus</i>	Giant Queenfish	10.5	2
Haemulidae	<i>Pomadasyds kaakan</i>	Barred Javelin	5.2	1
Other			8.2	1
<b>Total</b>			<b>556.1</b>	
<b>Other</b>				
Ariidae	<i>Netuma thalassina</i>	Giant Sea Catfish	0.02	
Carangidae	<i>Parastromateus niger</i>	Black Pomfret	0.68	
Carangidae	Carangidae spp.	Trevally	0.02	
Carangidae	<i>Trachinotus blochii</i>	Snubnose Dart	0.01	
Hemigaleidae	<i>Hemipristis elongata</i>	Fossil Shark	0.08	
Hemiramphidae	Hemiramphidae spp.	Garfish	0.16	
Lobotidae	<i>Lobotes surinamensis</i>	Tripletail	0.26	
Lutjanidae	<i>Lutjanus russellii</i>	Tropical Snapper	0.59	
Lutjanidae	<i>Lutjanus malabaricus</i>	Saddletail Snapper	0.20	
Lutjanidae	<i>Lutjanus johnii</i>	Golden Snapper	0.13	
Lutjanidae	<i>Lutjanus erythropterus</i>	Crimson Snapper	0.13	
Mugilidae	Mugilidae spp.	Mullet	0.26	
Mugilidae	<i>Liza vaigiensis</i>	Diamondscale Mullet	0.04	
Portunidae	<i>Scylla serrata</i>	Mud Crab	0.41	
Pristidae	Pristidae spp.	Sawfish	0.08	
Rachycentridae	<i>Rachycentron canadum</i>	Cobia	1.39	
Sciaenidae	<i>Nibea squamosa</i>	Scaly Jewfish	0.42	
Sciaenidae	<i>Protonibea diacanthus</i>	Black Jewfish	1.40	
Scombridae	Scombridae spp.	Mackerel	0.18	
Serranidae	Serranidae spp.	Cod	0.04	
		Bait fish	0.98	
		Fish - unspecified	0.62	
		Fish - mixed reef	0.08	
		Crab	0.02	
<b>Total</b>			<b>8.18</b>	

### **Barramundi**

Barramundi (*L. calcarifer*) are the third most commonly landed species (by weight) by commercial gill net fishers in the Port Musgrave region (Figure 34). On average the monthly catch of Barramundi is reasonably consistent from month to month although there is a general trend to be highest in the months preceding the wet season (February 2.2 tonne and March 2.1 tonne) (Figure 35). The abundance of Barramundi in the GoC is reported to be higher at this time of the year due to recruitment into the fishery after the three month net closure over the wet season (October to January). Magro et al. (1997) also reported that gill net fishing conditions are most favourable at the beginning of the annual fishing season, when run-off from flooded rivers discolours coastal waters and reduces net visibility.

The extremely high monthly variability in commercial Barramundi harvest, shown by the broad and overlapping 95%CI of the mean catch (Figure 35), is apparent across a number of species and fisheries. This appears to be an inherent characteristic of tropical species that live in habitats that are subject to monsoonal river flows (Halliday et al. 2001; Robins et al. 2005).



**Figure 35: Average monthly Barramundi catch (+95%CI) for the commercial logbook grid references AB6 & AB7 for the years 2002 to 2008 (Source: CFISH database October 2009).**

### **Threadfin Salmon**

Although Threadfin Salmon (*E. tetradactylum* and *P. macrochir*) are important commercial and recreational species in the GoC, the CFISH logbook dataset show very little caught in this region. The available commercial records are not considered representative of the importance of this species to the communities.

### **Grey Mackerel**

Grey Mackerel (*S. semifasciatus*) is the most important species commercially harvested in the Port Musgrave region and forms a large proportion of the income for N9 net fishers and some N3 fishers. The catch of Grey Mackerel in the Port Musgrave region tended to be higher between the months of April to August (Figure 36). There was high variability in the monthly catch rates as seen in other tropical finfish species. The start of spawning period for this species is thought to occur in the late dry season (September to October) with aggregations known to occur in inshore waters off Port Musgrave (Cameron and Begg 2002).

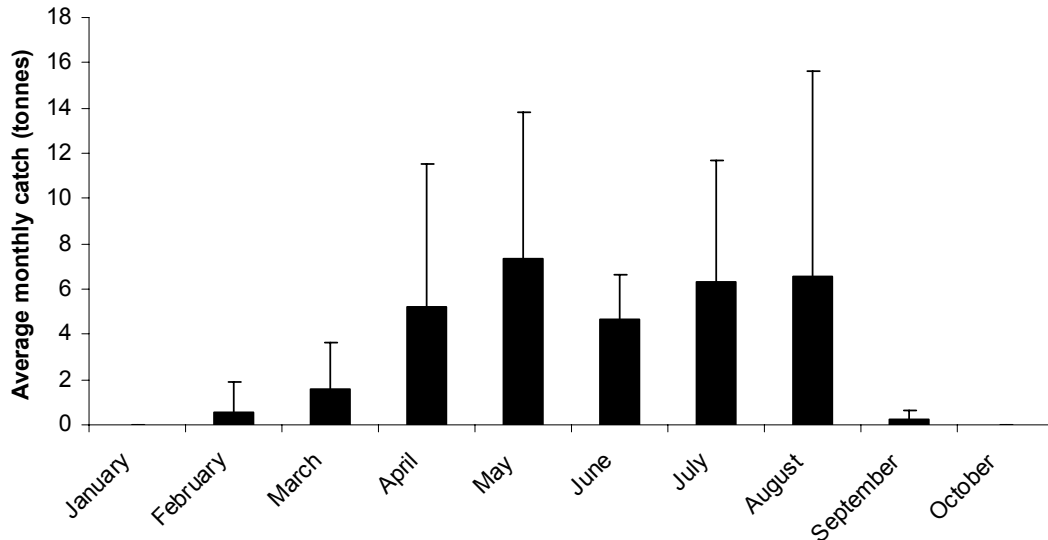


Figure 36: Average monthly Grey Mackerel catch (+95%CI) for the commercial logbook grid references AB6 & AB7 for the years 2002 to 2008 (Source: CFISH database October 2009).

### 3.2.2 Shark (Carcharhinidae spp.)

The offshore N9 and inshore N3 net fishers target shark in addition to finfish species. The main target shark species is the Blacktip shark complex that consists of two closely related species, the Australian Blacktip Shark (*C. tilstoni*) and the Common Blacktip Shark (*C. limbatus*), that cannot be separated in the field using external characteristics. Another significant component of the shark catch is the Spot-tail Shark (*C. sorrah*) (Stapley and Rose 2009). There was a peak in 'Shark' (Carcharhinidae spp.) catch over May, June and July but again there was high variability in the monthly catch rates (Figure 37). The maximum catch was in June and the catch rates declined to very low numbers from October to February primarily due to the seasonal net closure for spawning Barramundi.

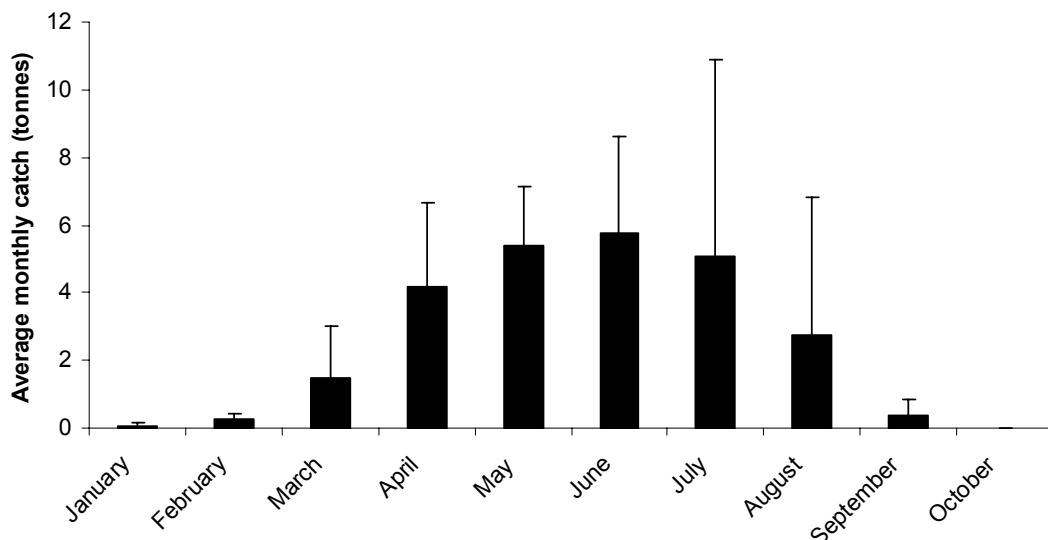


Figure 37: Average monthly 'Shark' (Carcharhinidae spp.) catch (+95%CI) for the commercial logbook grid references AB6 & AB7 for the years 2002 to 2008 (Source: CFISH database October 2009).

### 3.2.3 Crab fishery

There is relative little effort in the Port Musgrave region in comparison to other regions of the GoC where sealed road access is available, such as Karumba. The crabbing effort (boat days) in Port Musgrave appears to have declined in boat days and number of fishers involved since 2005 and 2006 respectively (Figure 38). This was also reflected in the annual catch which has declined since 2006 by more than 60% (4000 tonnes) however the underlining catch per unit of effort has not declined but has apparently increased (Figure 39). The increase is most likely an artefact of the extremely low effort recorded particularly in 2008.

The pattern of inter-annual catch in tonnes is variable (as seen by the very wide 95%CI on means from 2002 to 2008) but the trend has been for high catches post wet season (April, May and June) (Figure 40). Very low catches were recorded over the months of November, December and January and were probably due to the reduced fishing effort during the Barramundi net closure. Until recently the Barramundi fishers were dual endorsed for the crab fishery.

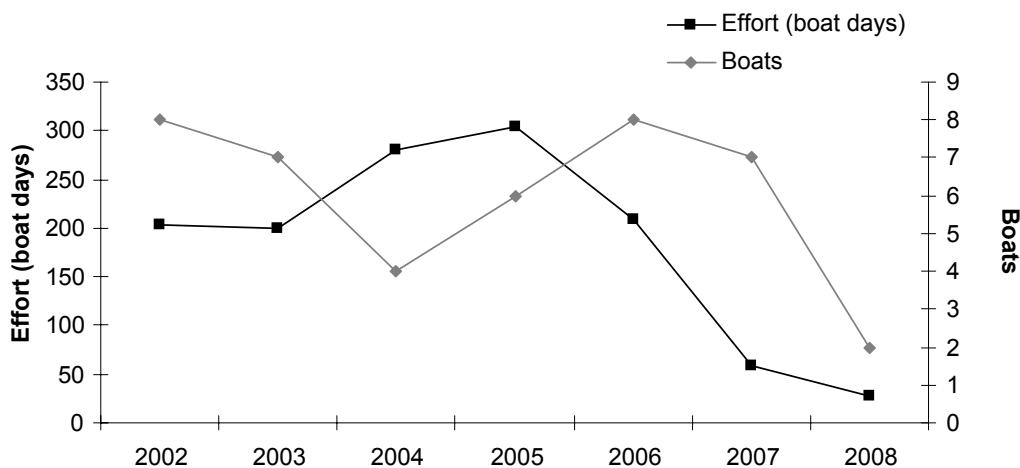


Figure 38: Total number of boats and fishing effort (boat days) in the Port Musgrave commercial crab fishery for the years 2002 to 2008 (Source: CFISH database October 2009).

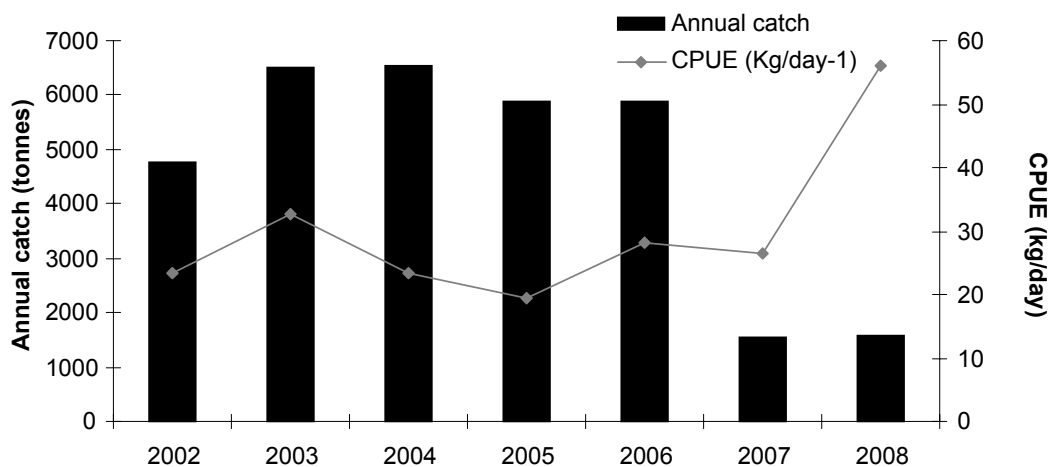
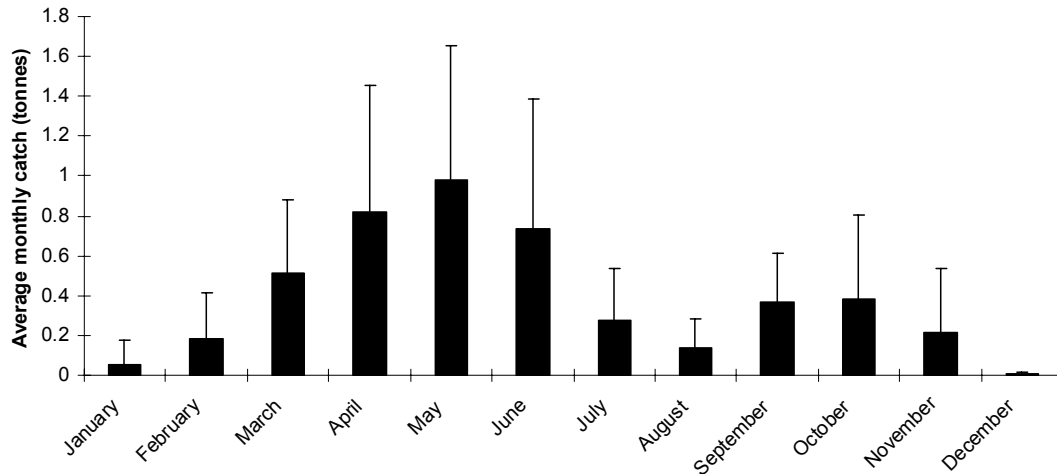


Figure 39: Annual Giant Mud Crab catch (columns) and catch per unit of effort (CPUE kg/day) for the commercial logbook grid reference AB6 & AB7 for the years 2002 to 2008 (Source: CFISH database October 2009).



**Figure 40: Average monthly Giant Mud Crab catch (tonnes) (+95%CI) for the commercial logbook grid reference AB6 & 7 for the years 2002 to 2008 (Source: CFISH database October 2009).**

### 3.2.4 Charter Boat and Recreational Fisheries

#### Commercial charter operations

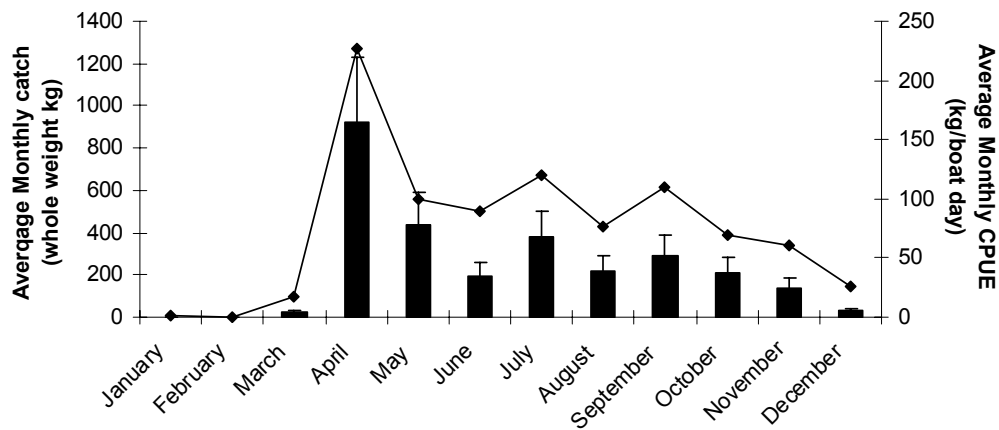
Over the last nine years a maximum of 12 commercial tour operators have been working in the AB6 & AB7 commercial logbook grids that encompass the Port Musgrave area (Figure 1). Commercial tour operators caught 25744 kg of fish between 2000 and 2008 (Table 5). Fishing effort was greatest in 2003 (167 days) however the highest catch (by weight) was recorded in 2004 (5584 kg). Catch and effort data indicates a seasonal trend in the abundance of fish in the area with April being the most productive fishing month for commercial tour operators (Figure 41). Monthly catch data was limited for December to February across all the years analysed, a factor most likely influenced by the wet season; a period of uncomfortable fishing conditions and unstable weather patterns.

A total of 10 species were recorded in the total catch of commercial tour operators. This number of species is substantially less than the number of species recorded in the Mapoon Community Fisheries Resource Assessment data (Appendix A, 50 species). This anomaly in the data is most likely due to trophy fishing from sports fishers or poor logbook reporting.

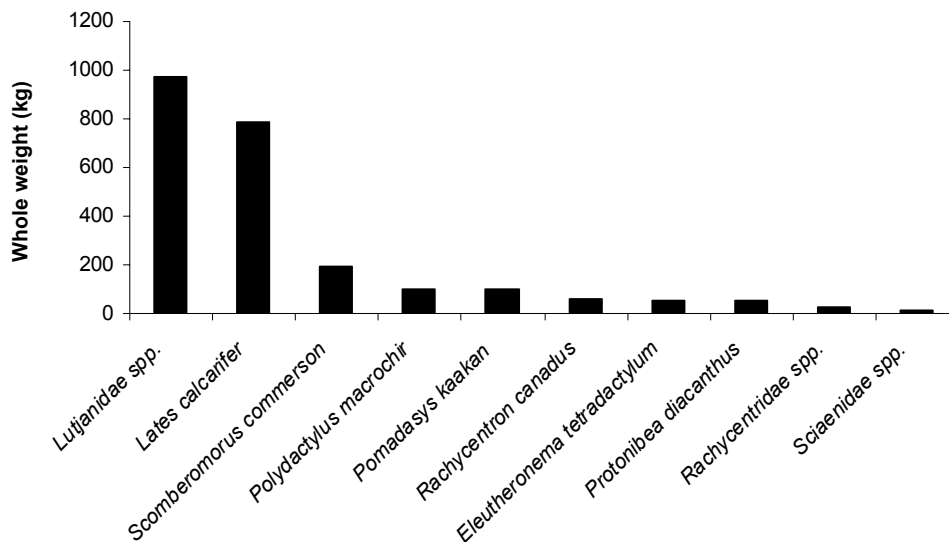
Species composition was recorded as a measure of whole weight in the commercial charter fishery logbook program and was dominated by Snappers (*Lutjanidae* spp.), Barramundi (*L. calcarifer*), and Spanish Mackerel (*S. commerson*) (Figure 42). These findings are in contrast to the independent gill net survey data where Snappers (*Lutjanidae* spp.) were not recorded (Section 3.1). Barramundi and Spanish Mackerel are a shared resource between the commercial net fishers and the commercial charter operators in Port Musgrave and these two species were among the top three most abundant families recorded in the independent gillnet surveys for the area (Section 3.1).

**Table 5: Total weight and percent of fish kept and fish released alive by commercial tour operators in Port Musgrave for the years 2000 to 2008 (Source CFISH database as at 12 September 2009).**

Year	Number of Operators	Days	CPUE (kg /boat day)	Whole Weight		
				Retained %	Discard %	Total (kg)
2000	10	87	29.6	13	87	2576
2001	7	114	36.9	5	95	4212
2002	10	152	34.9	10	90	5312
2003	12	167	27.2	10	90	4537
2004	8	73	76.5	9	91	5584
2005	7	37	46.5	8	92	1719
2006	5	20	14.4	9	91	287
2007	6	52	9.2	15	85	477
2008	6	52	20.0	7	93	1039
<b>Total</b>	<b>71</b>	<b>754</b>	<b>34</b>			<b>25744</b>



**Figure 41: Average monthly commercial charter operator catch (kg) ( $\pm$  SE) and average monthly catch per unit of effort (kg/boat day) for the years 2000 to 2008 (Source CFISH database as at 12 September 2009).**



**Figure 42: Total weight of species recorded in the CFISH database for commercial log book grids AB6 & AB7 for the years 2000 to 2008 (as at 12 September 2009).**

## Recreational Fishery

Recreational anglers that fish in the Port Musgrave area include both community residents and visitors to the area and they both utilise a large proportion of Port Musgrave including the Ducie River, Wenlock River and Namaleta Creek. A full discussion of the recreational fishing in the area is presented in the Community Fisheries Resource Assessment Report (Appendix A).

The INFO-FISH Services database reported that a total of 1223 fish have been tagged and released from 1986 to 2009 in either the freshwater or estuarine sections of the Wenlock River, Ducie River or Port Musgrave. Data obtained from INFO-FISH Services database was not specific enough to be analysed on a temporal seasonal scale or at a resolution fine enough to exclude freshwater species such as Sooty Grunter (*Hephaestus fuliginosus*) (Figure 43). The data indicated that Barramundi, at 90% of the total fish tagged and released, are an important angling species targeted by recreational fishers (Figure 43). This data is biased heavily towards sports fishing species that does not include other common species in the area such as catfishes.

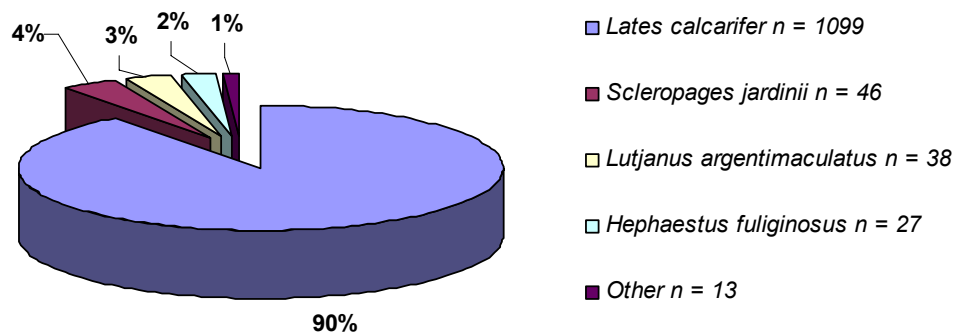


Figure 43: The main species tagged by recreational anglers as a percent of the total recreational catch pooled for the years 1986 to 2009 (Source INFO-FISH Services).

## 3.3 Species of Conservation Interest (SOCI)

### 3.3.1 Desktop Assessment

The EPBC Protected Matters Online Search Tool returned a number of marine threatened and migratory species. These included 12 species of National Environmental Significance (NES), 15 migratory species and 71 Other Protected Matter species. The following marine species were listed:

- National Environmental Significance
  - Whales - two species (endangered, vulnerable)
  - Turtles - six species (endangered, vulnerable)
  - Sharks - four species (vulnerable)
- Migratory species
  - Whales - four species
  - Dolphins - two species
  - Dugong - one species

- ▶ Reptiles - seven species
- ▶ Sharks - one species
- Other Protected Matters
  - ▶ Whales - four species
  - ▶ Dolphins - seven species
  - ▶ Dugong - one species
  - ▶ Reptiles - 27 species
  - ▶ Fishes - 32 species

The habitat requirements of the NES threatened species and the marine migratory species identified in the searches and an assessment of the availability of that habitat in the Port Musgrave study area is summarised in Table 6. The status of these species under the EPBC Act and the Queensland *Nature Conservation Act 1992* (NCA) is also included in Table 6. The full EPBC Protected Matters Search Tool results are provided in Appendix C.

The EPBC Protected Matters Report did not include two elasmobranchs that are known to inhabit Port Musgrave: Speartooth Shark (*G. glyphis*) and Narrow Sawfish (*A. cuspidata*). Speartooth Shark is listed under the EPBC Act as critically endangered and has been reported to inhabit the Wenlock River, Ducie River and surrounding waters of Port Musgrave (Peverell et al. 2006). The Speartooth Shark is also protected under the *Queensland Fisheries Act 1995* and *Regulations 2008* as are all species of Sawfish and one finfish species Queensland Groper (*E. lanceolatus*) that also occurs in Port Musgrave. The Narrow Sawfish is not listed under the EPBC Act, but considered critically endangered by the IUCN Red List (IUCN 2009). More detail on the conservation status of Speartooth Shark and sawfish is presented in the ecological descriptions (Section 1.3).

The Irrawaddy Dolphin (*O. brevirostris*) was listed in the EPBC Protected Matters Report. It is thought that in northern Australian waters this species is now considered to be the Australian Snubfin Dolphin (*O. heinsohni*). In addition two other species of Bottlenose Dolphins, *Tursiops aduncus* and *Tursiops truncatus*, listed as Marine Migratory Species under the EPBC Act were not included in the EPBC Protected Matters Report, although they are known to occur in the area.

These additional species that were not included in the EPBC Protected Matters Report but that are listed under the EPBC Act and known to occur in the area were included in Table 6; that is, Speartooth Shark, Australian Snubfin Dolphin and Bottlenose Dolphins.

**Table 6: Summary of fauna desktop assessment and survey observations for National Environmental Significance and Marine Migratory Species.**

Species name	Common name	EPBC Act status <sup>2</sup>	NCA status <sup>3</sup>	Survey status and reported occurrences	Habitat requirements of species	Likelihood of occurrence and habitat availability in Port Musgrave.
<b>Mammals</b>						
<i>Balaenoptera musculus</i>	Blue Whale	E M	Not listed	Not detected	Blue whales are predominantly found offshore and are known to seasonally migrate around the Australian coastline (DEH 2005). The only known areas of significance to Blue Whales are feeding areas around the southern continental shelf, notably the Perth Canyon, in Western Australia, and the Bonney Upwelling and adjacent upwelling areas of South Australia and Victoria (DEH 2005). There are no records of Blue Whale sightings or stranding in the Gulf of Carpentaria (DEWR 2009).	Highly unlikely to occur in Port Musgrave.
<i>Megaptera novaeangliae</i>	Humpback Whale	V M	V	Not detected	Humpback whales are predominantly found offshore and are known to seasonally migrate around the Australian coastline. Calving is thought to occur in two locations; the Great Barrier Reef in Queensland and south of the Kimberley in Western Australia. Two out of seven recognised southern hemisphere populations spend winter in warm shallow northern Australian waters where the species breed (Van Dyck and Strahan 2008). There are no records of Humpback Whale sightings or stranding in the eastern Gulf of Carpentaria (DEWR 2009).	Highly unlikely to occur in Port Musgrave.
<i>Balaenoptera edeni</i>	Byrde's Whale	M	Not listed	Not detected	Bryde's Whales have a global distribution in tropical and temperate waters in both oceanic and inshore waters. They have been recorded from all Australian states except the Northern Territory and the inshore animals appear to be limited to the 200 m isobar, resident in areas with suitable prey stocks of pelagic shoaling fishes (DEWHA 2009). There are no records of Bryde's Whale sightings or stranding in the eastern Gulf of Carpentaria (DEWR 2009).	Highly unlikely to occur in Port Musgrave.
<i>Dugong dugon</i>	Dugong	M	V	Not detected	Dugong have a global distribution and are known to inhabit tropical and subtropical coastal and island waters. In Australia, Dugong are known from Shark Bay in Western Australia (Marsh et al. 2002) across northern Australia and south to the north coast of New South Wales. Dugongs are abundant at many locations in the GoC and are usually associated closely with seagrass beds which they feed upon. A major proportion of dugongs in the GoC occur in the region of the Wellesley Islands,	Highly likely to occur. Habitat suitable to this species was present within the Port Musgrave study area. Anecdotal hunting records from Traditional Owners residing in Port Musgrave strongly suggest they have a seasonal

Species name	Common name	EPBC Act status <sup>2</sup>	NCA status <sup>3</sup>	Survey status and reported occurrences	Habitat requirements of species	Likelihood of occurrence and habitat availability in Port Musgrave.
					the Sir Edward Pellew Group, and Blue Mud Bay. Of the estimated 27602 (± 3110) Dugongs in the Gulf of Carpentaria, only 15% occur in the waters of the Queensland coast, reflecting the much greater area of seagrass along the Northern Territory coast (Saalfield and Marsh 2004).	abundance within Port Musgrave (G. Manatan, Mapoon Aboriginal Community Resident pers. comm. 2009).
<i>Orcinus orca</i>	Killer Whale, Orca	M	Not listed	Not detected	Killer whales have a global distribution and are found predominantly in cooler waters. There is only one sighting record of this species in the Northern Territory (Chatto & Warneke 2000). There are no records of Killer Whale sightings or stranding in the Queensland section of the Gulf of Carpentaria (DEWR 2009).	Unlikely to occur in Port Musgrave.
<i>Orcaella heinsohni</i>	Australian Snubfin Dolphin	M	R (for <i>Orcaella brevirostris</i> )	<b>Detected</b>	The Australian Snubfin Dolphin is endemic to Australia but may also occur in Papua New Guinea (Beasley et al. 2005). Previously the Australian Snubfin Dolphin was identified incorrectly as the widely distributed Irrawaddy dolphin ( <i>Orcaella brevirostris</i> ). In Australia this species occurs in shallow coastal areas often near estuary and river mouths from southern Queensland to northern Western Australia (Van Dyck and Strahan 2008). The species is known to occur in the Gulf of Carpentaria.	<b>Known to occur</b> Habitat suitable to this species was present within the Port Musgrave study area.
<i>Sousa chinensis</i>	Indo-Pacific Humpback Dolphin	M	R	<b>Detected</b>	Indo-Pacific Humpback Dolphins usually inhabit shallow coastal waters of less than 20 m depth and are often associated with rivers and estuarine systems, enclosed bays and coastal lagoons, including those that have been highly modified for human use (Corkeron et al. 1997; Hale et al. 1998). This species has been recorded during marine turtle surveys around the Weipa region (Col Limpus, DERM pers. comm. 2009).	<b>Known to occur</b> Habitat suitable to this species was present within the Port Musgrave study area.
<i>Tursiops aduncus</i> and <i>Tursiops truncatus</i>	Bottlenose dolphins	M	R	<b>*Detected</b>	Wide ranging species that occurs in inshore and nearshore coastal waters to a depth of approximately 50 m.	<b>Known to occur</b> Habitat suitable to this species was present within the Port Musgrave study area. The species was observed in Port Musgrave during field investigations by WorleyParsons.

Species name	Common name	EPBC Act status <sup>2</sup>	NCA status <sup>3</sup>	Survey status and reported occurrences	Habitat requirements of species	Likelihood of occurrence and habitat availability in Port Musgrave.
<b>Reptiles</b>						
<i>Caretta caretta</i>	Loggerhead Turtle	E M	E	Not detected	Warm temperate to tropical marine areas world wide. Area around Port Musgrave is a known migration route (IOSEA 2009). Preferred habitat is rocky reef and they feed mainly on molluscs and crabs (Wilson and Swan 2003; C. Limpus, DERM pers. comm. 2009). Known as a bycatch species in the Northern Prawn Fishery that operates offshore in marine waters (Stobutzki et al. 2002).	May occur Habitat suitable to this species was present within the Port Musgrave study area.
<i>Chelonia mydas</i>	Green Turtle	V M	V	<b>*Detected</b>	Coastal waters in particular seagrass beds. The Wellesley Island area in the south-western corner of the GoC is a significant nesting site (Limpus and Miller 2008) The area around Port Musgrave is a known migration route (IOSEA 2009; C. Limpus DERM pers. comm. 2009). Juveniles are carnivorous and adults graze on sea grasses and seaweeds (Wilson and Swan 2003). Known as a bycatch species in the NPF that operates offshore in marine waters (Stobutzki et al. 2002).	<b>Known to occur.</b> Habitat suitable to this species was present within the Port Musgrave study area. Indigenous hunting tag returns confirm distribution (C. Limpus, DERM pers. comm. 2009)
<i>Dermochelys coriacea</i>	Leatherback Turtle	E M	E	<b>*Detected</b>	Open ocean areas from temperate to tropical areas where it breeds in mid-eastern Queensland, eastern Malaysia and Central America (TSSC 2008). Area around Port Musgrave is a known migration route (IOSEA 2009). Feeds mainly on gelatinous marine invertebrates (Wilson and Swan 2003).	<b>Known to occur.</b> Habitat suitable to this species was present within the Port Musgrave study area. Known to inhabit Port Musgrave (C. Limpus, DERM pers. comm. 2009).
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	V M	V	Not detected	Open ocean areas around the world from temperate to tropical areas. Hawksbill turtle nesting sites occur on islands adjacent to Arnhem Land and north-eastern Cape York. The main feeding habitat for the species tends to be tidal and sub-tidal reefs (Limpus and Miller 2008; Limpus 2009). Area around Port Musgrave is a known migration route and known nesting site (IOSEA 2009). They prefer hard substrate supporting mixed algae and soft invertebrate communities (C. Limpus, DERM pers. comm. 2009).	May occur Habitat suitable to this species was present within the Port Musgrave study area.
<i>Lepidochelys olivacea</i>	Pacific Ridley, Olive Ridley	E M	E	<b>*Detected</b>	Tropical oceans of Atlantic, Indian and Pacific. Australian distribution restricted to Northern Territory and Cape York Peninsula (Wilson and Swan 2003). Inhabits coastal	<b>Known to occur.</b> Habitat suitable to this species was present in the Port

Species name	Common name	EPBC Act status <sup>2</sup>	NCA status <sup>3</sup>	Survey status and reported occurrences	Habitat requirements of species	Likelihood of occurrence and habitat availability in Port Musgrave.
					waters including but not limited to reefs. The species forages in benthic habitats over a range of depths from a few metres to hundreds of metres, and consumes crabs, molluscs and other benthic invertebrates (Wilson and Swan 2003). Area around Port Musgrave is a known migration route, feeding and nesting site (IOSEATURTLES 2009, C. Limpus, DERM pers. comm. 2009). Known as a bycatch species in the NPF that operates offshore in marine waters (Stobutzki et al. 2002).	Musgrave study area. Low density nesting is known to occur in Port Musgrave (C. Limpus, DERM pers. comm. 2009)
<i>Natator depressus</i>	Flatback Turtle	V M	V	<b>Detected</b>	Restricted distribution in Australia from the Kimberley coast in Western Australia to Queensland's east coast. Coastal waters including but not limited to shallow water habitats. Nesting is confined to Australia with scattered but significant nesting occurring on the western beaches of Cape York (Bell 2003). The species forages in shallow inshore areas and feeds on soft corals, sea cucumbers, and jellyfish (Wilson and Swan 2003). Area around Port Musgrave is a known migration route, feeding and nesting site (IOSEATURTLES 2009, C. Limpus, DERM pers. comm. 2009). Known as a bycatch species in the NPF that operates offshore in marine waters (Stobutzki et al. 2002).	<b>Known to occur</b> Habitat suitable to this species was present in the Port Musgrave study area. A single nest has been recorded in Port Musgrave (C. Limpus, DERM pers. Comm. 2009)
<i>Crocodylus porosus</i>	Saltwater Crocodile	M	V	<b>Detected</b>	Global distribution from South East Asia to northern Australia (Read et al. 2007). The species is thought to be close to extinction in Indochina and its distribution in Australia extends from Gladstone on the Queensland east coast to Broome in Western Australia (M. Read, GBRMPA pers. comm. 2009). Saltwater crocodiles are semi-aquatic and inhabit reefal, coastal, and inland waterways throughout tropical and temperate Australia. They can be found hundreds of kilometres upstream in rivers (Read et al. 2004a). The Wenlock and Ducie River systems have specifically been classified as being excellent to good nesting habitat with high population densities of animals (Messel et al. 1981; Read et al. 2004a).	<b>Known to occur</b> Habitat suitable to this species was present in the Port Musgrave study area. Immature and mature specimens recorded in March, June and November surveys.
<b>Sharks</b>						
<i>Glyphis glyphis</i>	Spertooth Shark	CE	Not listed	<b>Detected</b>	In Australia the species is restricted to tidal rivers and estuaries within Northern Territory (NT) and Queensland. Known from six rivers/creeks in the NT and Wenlock River	<b>Known to occur.</b> Habitat suitable to this species was present in the Port

Species name	Common name	EPBC Act status <sup>2</sup>	NCA status <sup>3</sup>	Survey status and reported occurrences	Habitat requirements of species	Likelihood of occurrence and habitat availability in Port Musgrave.
					and Ducie River in Queensland (Stevens et al. 2005, Peverell et al. 2006). Historically known from Bizant River and Normanby River on Queensland east coast (Peverell et al. 2006). Known range extends into three distinct geographical locations, Van Diemen Gulf (NT), Port Musgrave (Qld Gulf of Carpentaria) and Princess Charlotte Bay (east coast Qld). Speartooth shark population is estimated to occur over a total habitat area of 502km <sup>2</sup> (Stevens et al. 2005). The species is known to tolerate salinity concentrations of between 0 to 35 ppt (L. Jnr Squire, Cairns Marine pers comm. 2009).	Musgrave study area. Immature specimens caught in March, June and November 2009 surveys.
<i>Pristis clavata</i>	Dwarf Sawfish	V	Not listed	<b>Detected</b>	Global distribution restricted to Australian waters. Species known from Port Musgrave in Queensland Gulf of Carpentaria to the Pilbara in Western Australia (Peverell, et al. 2005, Stevens et al. 2005). There are no records of Dwarf Sawfish on Queensland east coast (Stevens et al. 2005). The species is known to inhabit inshore coastal waters (water 2–3 m depth) and estuarine systems (Peverell et al. 2005; Thorburn et al. 2007 Known as a bycatch species in the NPF that operates offshore in marine waters (Stobutzki et al. 2002).	<b>Known to occur.</b> Habitat suitable to this species was present in the Port Musgrave study area.  Immature specimens caught in March, June and November 2009 surveys.
<i>Pristis microdon</i>	Freshwater Sawfish	V	Not listed	<b>Detected</b>	Freshwater sawfish are thought to have a global distribution (DEWHA 2009). In Australia the species is known from the Fitzroy River in Western Australia to Princess Charlotte Bay on the east coast of Queensland (Peverell et al. 2005; Last and Stevens 2009). The species inhabits freshwater rivers, inshore and offshore coastal waters (Last and Stevens 2009). Known as a bycatch species in the NPF (Stobutzki et al. 2002). The species is known to tolerate salinity concentrations of between 0 to 35 ppt (L. Jnr Squire, Cairns Marine pers. comm. 2009).	<b>Known to occur.</b> Habitat suitable to this species was present in the Port Musgrave study area.  Immature and mature specimens caught in March, June and November surveys.
<i>Pristis zijsron</i>	Green Sawfish	V	Not listed	<b>Detected</b>	Green Sawfish are known from the northern Indian Ocean. Although their current population status is unknown it is believed they may be extinct from south-east Asia (Stevens et al. 2005). In Australia Green Sawfish are more abundant in the tropics although they range into temperate waters as far south as Perth on the west coast and Sydney on the east coast (Last and Stevens 2009). The species inhabits inshore and offshore coastal waters	<b>Known to occur.</b> Habitat suitable to this species was present in the Port Musgrave study area.  Immature and mature specimens caught in March, June and November 2009

Species name	Common name	EPBC Act status <sup>2</sup>	NCA status <sup>3</sup>	Survey status and reported occurrences	Habitat requirements of species	Likelihood of occurrence and habitat availability in Port Musgrave.
					(Peverell et al 2005; Last and Stevens 2009). Known as a bycatch species in the NPF (Stobutzki et al. 2002).	surveys.
<i>Rhincodon typus</i>	Whale Shark	V	Not listed	Not detected	Whale sharks have a global distribution and are known to inhabit warm temperate waters, with a preference for pelagic environments near the edge of the continental shelf (Last and Stevens 2009). Critical habitat in Australia includes Ningaloo Reef in Western Australia, the Coral Sea and Christmas Island (DEWHA 2009). Areas with high nutrient levels and seasonal availability of tropical krill and baitfishes may form critical habitat (DEWHA 2009). Whale sharks are known to inhabit inshore coastal waters that are turbid and are seasonally influenced by freshwater during the tropical wet season (monsoonal weather pattern).	May occur Habitat suitable to this species was present within the Port Musgrave area though habitat within the vicinity of the proposed development is shallower than the species preferred depth range.

\* Validated record of occurrence from other sources outside this study

# Marine migratory species

**EPBC Status Codes** = Endangered (E), Vulnerable (V).

**NCA Status Codes** = Endangered (E), Vulnerable (V), Rare (R).

### 3.3.2 Fisheries Independent Survey

The protected species captured across the three surveys were: 19 Speartooth Sharks, two Freshwater Sawfish, 10 Green Sawfish, eight Dwarf Sawfish, five Narrow Sawfish and 50 Queensland Groper. Two Indo-Pacific Hump-backed Dolphins and 24 Australian Snubfin Dolphins were observed (none captured); 34 Saltwater Crocodiles were observed and 11 captured; one Flatback Turtle was observed and 27 sea snakes were observed and one was captured. These species and all other animals captured and observed during this study are listed by fishing gear in Appendix B. The locations of these species interactions are mapped below. No Dugongs were observed or captured during the surveys.

#### Speartooth Shark and sawfish

Nineteen Speartooth Shark were captured during the surveys; 14 in gill nets, three in set lines, and two in crab pots (Appendix B). They were caught in the Ducie and Wenlock Rivers from the mouth to upper tidal reaches (Figure 45). All but one of the Speartooth Sharks were examined to stage sexual maturity and were found to be immature. The largest Speartooth Shark captured was a 215 cm TL female that was released alive and as such the stage of sexual maturity could not be determined. It was assumed to be immature based on size (Figure 44; Table 7).

Twenty five sawfish were captured during the surveys, all in gill net (Figure 46; Appendix B). Of the five Narrow Sawfish captured, the mature specimen was caught in the main channel of the Wenlock River whilst the smaller juvenile specimens were caught on shallow mud flats (<2 m water depth) in the Ducie River and Wenlock River respectively. Two Freshwater Sawfish were captured in the mouth of the Wenlock River, both of which were mature. Mature and immature specimens of 10 Green Sawfish (*P. zijsron*) were captured in the Wenlock River, in Port Musgrave and along the coastal foreshores. Eight specimens of immature Dwarf Sawfish (*P. clavata*) were captured in the Wenlock River, and along the foreshores of Port Musgrave and coastal foreshores (Figure 44; Appendix B). All *Pristis* species were captured on shallow mud or sand flats (<2 m water depth). The classifications of immature/mature were based on the observation of clasper development in males and reported size at maturity in females (Peverell 2008) (for more detail on sexual maturity refer to sawfish synopsis Section 1.3.2).

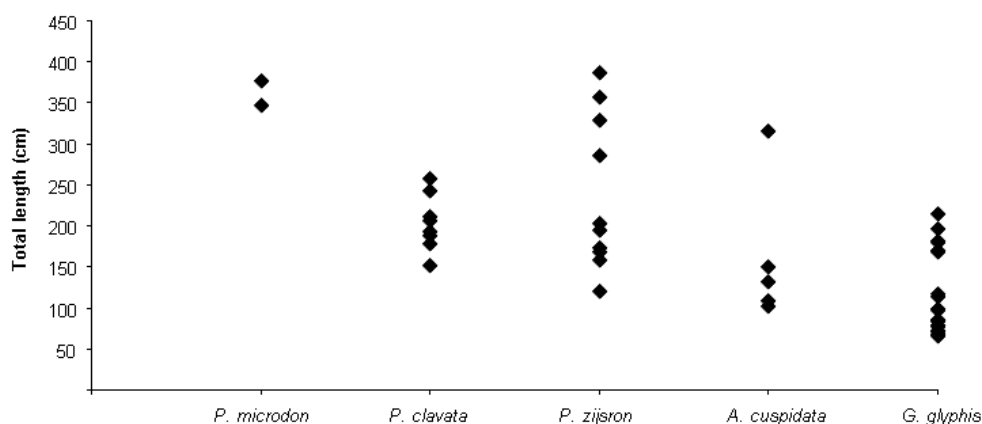


Figure 44: Total length of all specimens of sawfish species and Speartooth Shark captured from the Ducie River, Namaleta Creek and Wenlock River in the March, June and November surveys.

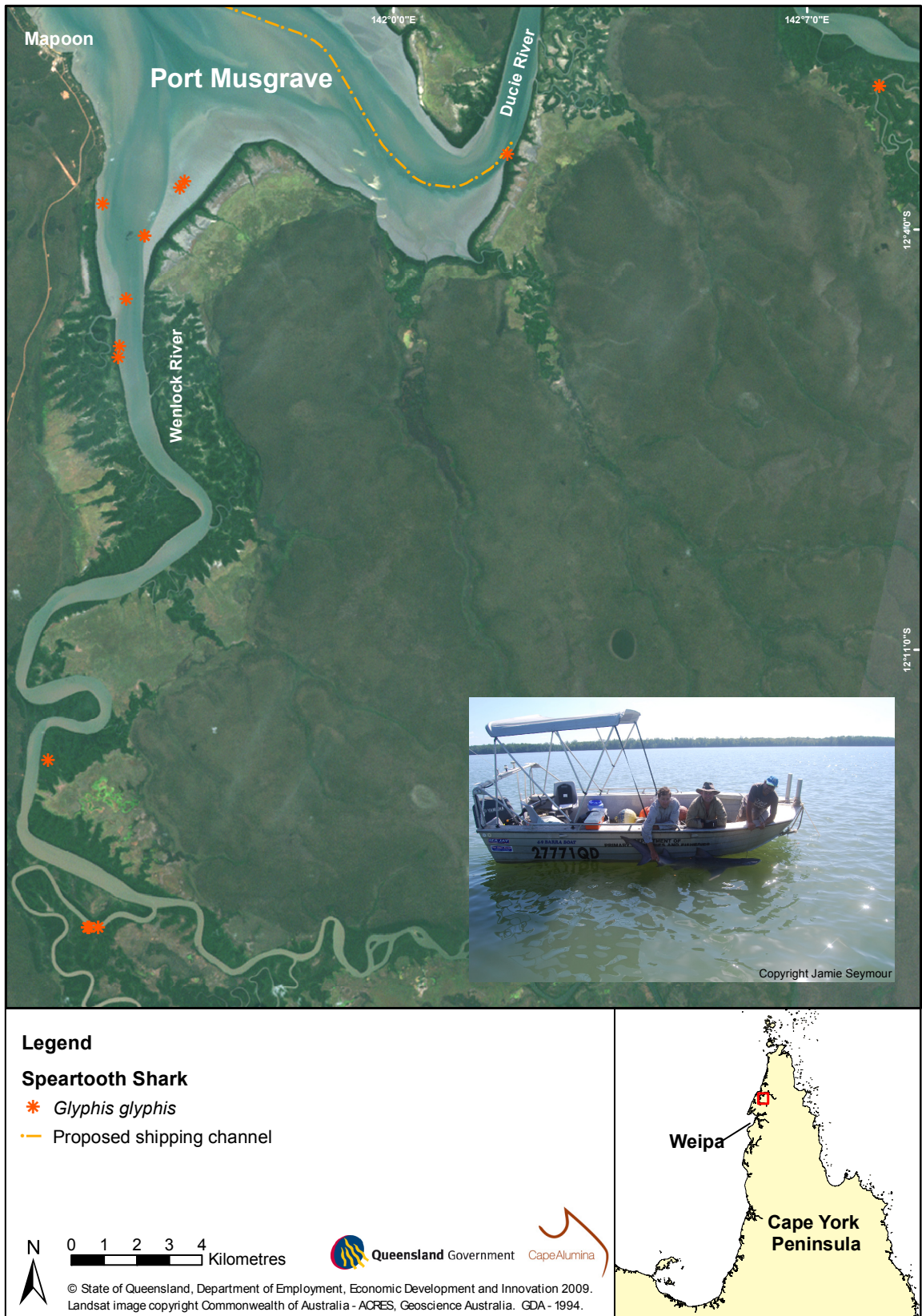


Figure 45: Spartoosh Shark capture locations.

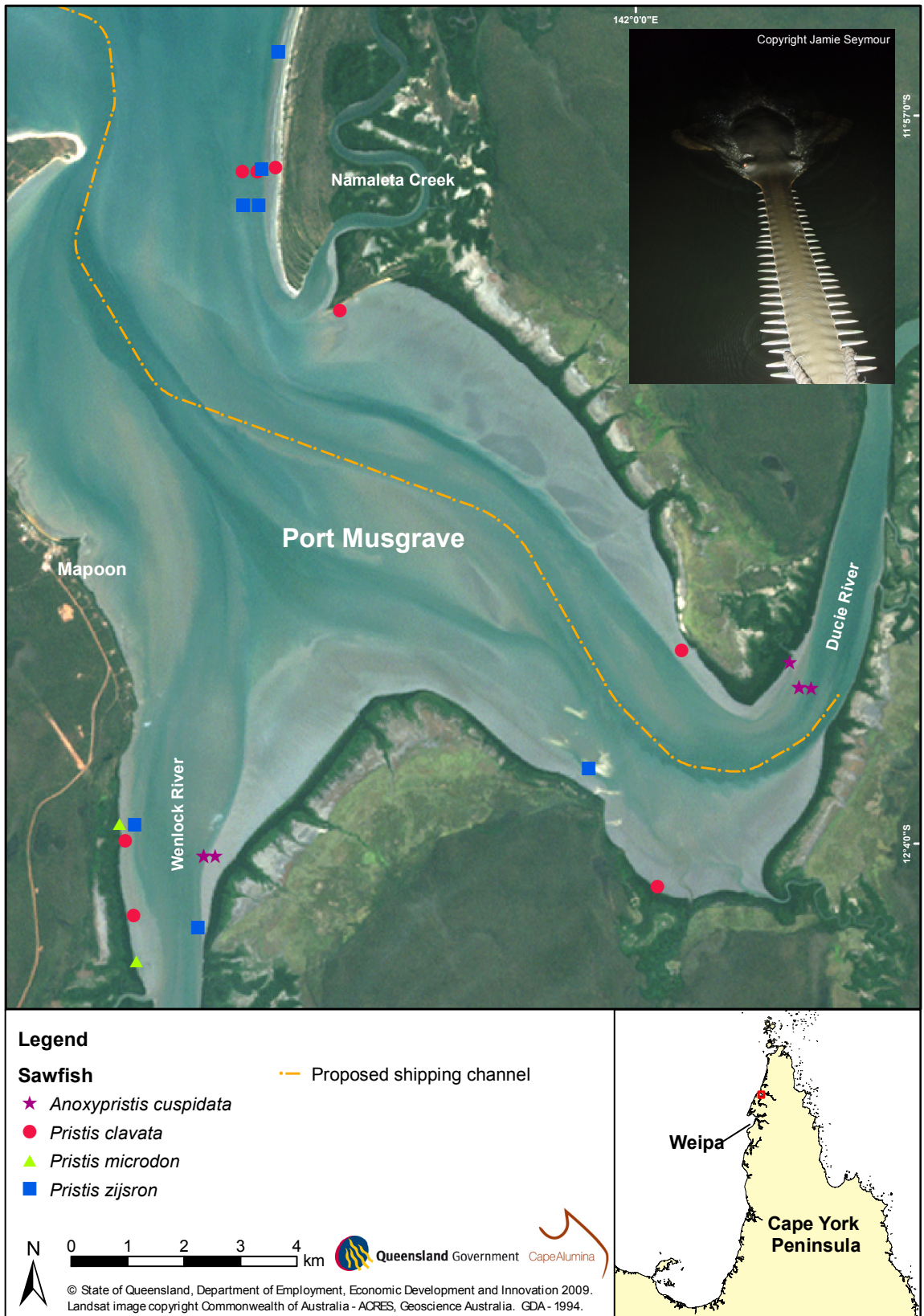


Figure 46: Sawfish capture locations.

### **Sawfish Tag and Release**

A total of two Freshwater Sawfish, three Dwarf Sawfish, six Green Sawfish and three Narrow Sawfish were tagged and released during the study (Table 7). No Freshwater Sawfish or Narrow Sawfish were recaptured. Multiple recaptures were evident for both Dwarf Sawfish and Green Sawfish (Table 8). Of the three Dwarf Sawfish tagged, one specimen was recaptured four times and another specimen recaptured twice. Similarly of the six Green Sawfish tagged one specimen was recaptured three times whilst another two animals were recaptured once (Table 8).

Nearly all recaptured Dwarf and Green Sawfish were caught in the immediate vicinity (same site) of their release location within a 24 hour period. The only specimen recaptured during the same survey period and in a site different to its original tagging location was a sub-adult Dwarf Sawfish (156 cm TL), tag number FR2068 (Figure 48). On release this specimen moved from the Ducie River to Namaleta Creek, an approximate distance of 13.7 km in 57 hours (Figure 47). Green Sawfish tag number FR1891 also showed movement away from its original tag location; however only after it was recaptured in the same site two times within 24 hours. Tag number FR1891 was recaptured a third time after moving approximately 12 km from the Namaleta Creek foreshore to the Ducie River mouth in 236 days (Table 8; Figure 47).

The minimum and maximum days at liberty for sawfishes recaptured in this study, excluding animals recaptured within a 24 hour period, varied from 91 days (FR2068) and 236 days (FR1891) (Table 8). All recaptured sawfish which had been at liberty for extended periods of time experienced exceptionally fast growth and were in excellent body condition. These growth rates and body condition are clear evidence of good health with all specimens not demonstrating any ill effects from their capture ordeal. In particular Dwarf Sawfish tag number FR2068 suffered two debilitating wounds on its first recapture, one from a shark and another from a crocodile whilst entangled in the net. On inspection of the wound during its fourth recapture, the wounds had healed with only a scar remaining (Figure 48). Dwarf sawfish obviously have the ability to recover from severe injury, hence giving rise to the conclusion sawfish are a robust group of fishes.

The capture and tag and recapture information for Dwarf sawfish and Green Sawfish, although very limited, indicated that both species utilised the estuarine and coastal marine habitat between the Namaleta Creek and Ducie River mouth in both their juvenile and adult life stages. Very little information can be drawn from these points in time, with information on habitat utilisation over space and time lacking. Both species did however demonstrate restricted site fidelity both in the short term (a few days) and over the longer period (months) for shallow mud and sand habitat (< 2 m water depth) in Port Musgrave.

**Table 7: Running total of tagged and recaptured specimens (MR–March recapture, JR–June recapture and NR–November recapture). November numbers are the total number of animals tagged and recaptured over the three surveys. Maximum and minimum size range (carcharhinids–TL and batoids–DW) for March, June and November surveys.**

Common Name	Species	March	MR	June	JR	November	NR	Size TL or DW (cm)	
								Min	Max
Speartooth Shark	<i>Glyphis glyphis</i>	6	0	12	0	13	0	67	215
Freshwater Sawfish	<i>Pristis microdon</i>	0	0	1	0	2	0	348	378
Dwarf Sawfish	<i>Pristis clavata</i>	2	3	2	2	3	0	194	258
Green Sawfish	<i>Pristis zijsron</i>	1	2	4	1	6	2	158	357
Narrow Sawfish	<i>Anoxypristis cuspidata</i>	1	0	2	0	3	0	109	150
Queensland Groper	<i>Epinephelus lanceolatus</i>	1	0	22	0	34	0	89	206
Freshwater Whiptail Ray	<i>Himantura dalyensis</i>	5	0	7	0	13	0	92	205
Lemon Shark	<i>Negaprion acutidens</i>	0	0	1	0	4	0	199	222
Blacktip Whaler Shark	<i>Carcharhinus limbatus/tilstoni</i>	0	0	0	0	3	0	152	220
Great Hammerhead	<i>Sphyrna mokarran</i>	0	0	0	0	3	0	144	235
Winghead Shark	<i>Eusphyra blochii</i>	0	0	0	0	2	0	155	158
Smooth Nose Wedgefish	<i>Rhynchobatus laevis</i>	0	0	0	0	2	0	186	213
Graceful Shark	<i>Carcharhinus amblyrhynchoides</i>	0	0	0	0	1	0	115	115
Mangrove Whipray	<i>Himantura granulata</i>	0	0	0	0	1	0	122	122
Reticulated Whipray	<i>Himantura uarnak</i>	0	0	0	0	1	0	124	124
Tawny Shark	<i>Nebrius ferrugineus</i>	0	0	0	0	1	0	263	263
Zebra Shark	<i>Stegostoma fasciatum</i>	0	0	0	0	1	0	170	170
<b>Total</b>						<b>93</b>			

**Table 8: Sawfish species recaptured.**

Species and total length	Tag Number	Capture Date	Site	Movement (km)	Liberty days
Dwarf Sawfish (232 cm TL)	FR2068	23/03/2009*	Ducie River	0	0
		24/03/2009	Ducie River	2.5	1
		25/03/2009	Namaleta Creek	9.1	1
		25/03/2009	Namaleta Creek	3.1	0
		22/06/2009	Ducie River	15	89
		<b>Total</b>		<b>29.7</b>	<b>91</b>
Dwarf Sawfish (194 cm TL)	FR1883	25/03/2009*	Namaleta Creek	0	0
		25/03/2009	Namaleta Creek	0	0
		19/06/2009	Namaleta Creek	0.2	86
		<b>Total</b>		<b>0.2</b>	
Green Sawfish (241cm TL)	FR1891	24/03/2009*	Namaleta Creek	0	0
		25/03/2009	Namaleta Creek	0	1
		25/03/2009	Namaleta Creek	0	0
		15/11/2009	Ducie River	12	235
		<b>Total</b>		<b>12</b>	<b>236</b>
Green Sawfish (158 cm TL)	FR2110	19/06/2009*	Namaleta Creek	0	0
		11/11/2009	Namaleta Creek	1.7	145
		<b>Total</b>		<b>1.7</b>	<b>145</b>
Green Sawfish (173 cm TL)	FR2120	19/06/2009*	Namaleta Creek	0	0
		19/06/2009	Namaleta Creek	0	0
		<b>Total</b>		<b>0</b>	<b>0</b>

\*Captured and tagged

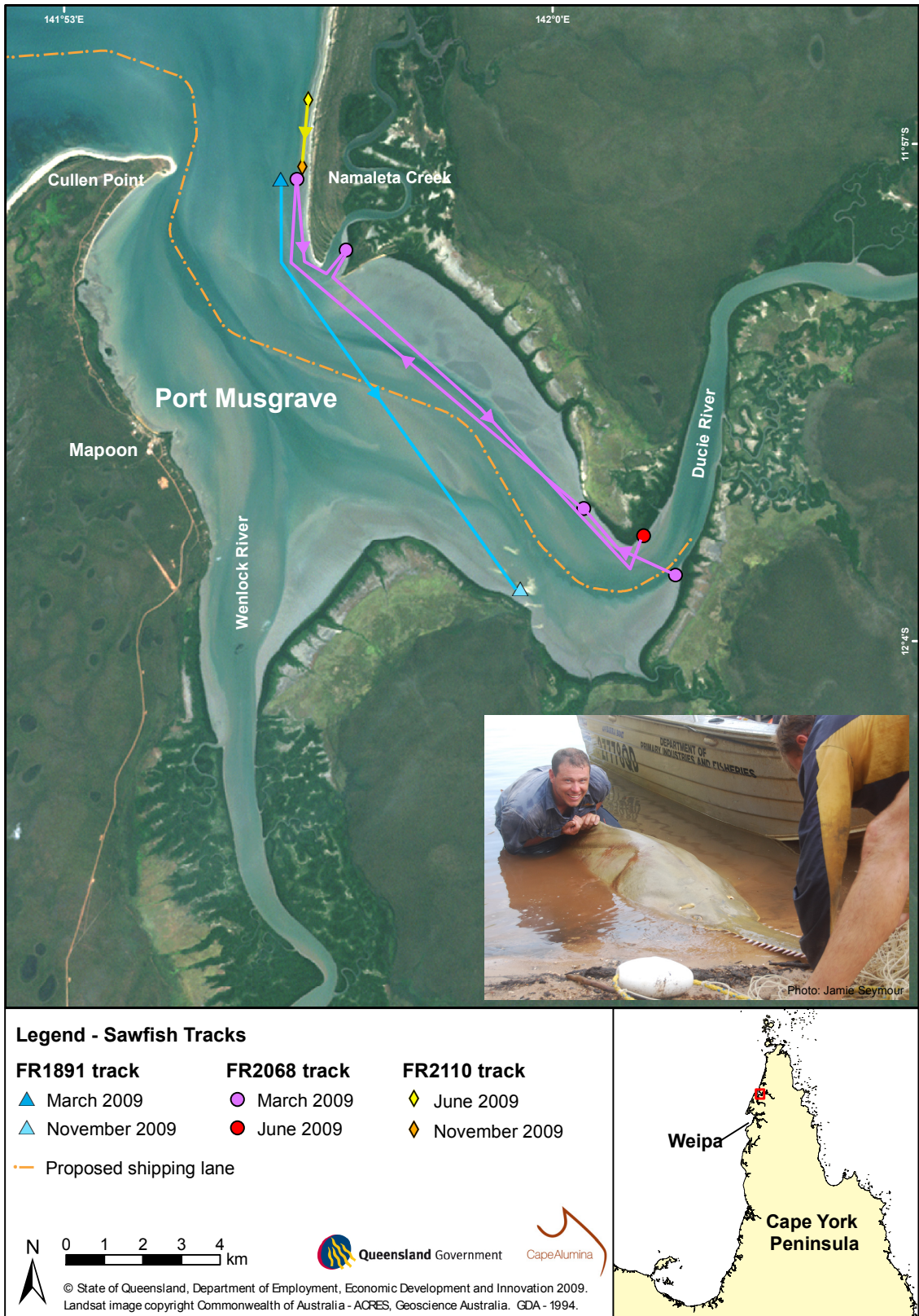
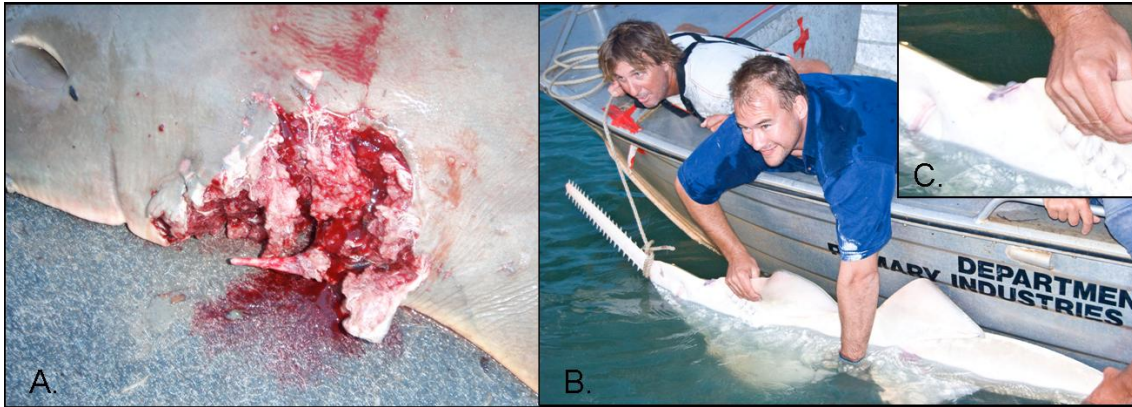


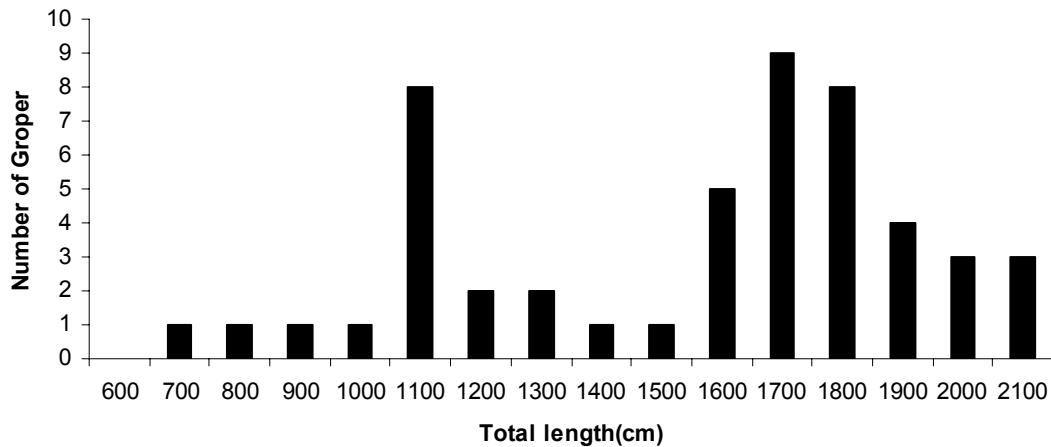
Figure 47: Movement patterns of tagged sawfish.



**Figure 48: Dwarf Sawfish attacked by a crocodile and shark while in the net (A), recaptured four months later (B), with wounds almost fully healed (C).**

### Queensland Groper

A total of 50 Queensland Groper were captured in the survey. The species distribution was more heavily concentrated in the Ducie River and Wenlock River survey sites (Figure 50). Only one Queensland Groper was recorded in the Namaleta Creek site in comparison to 29 in the Ducie River and 20 in the Wenlock River. The size range of Queensland Groper varied between 67 and 206 cm TL. The most prolific size classes recorded (by number) were animals of around the 110 cm and 160 to 190 cm TL (Figure 49). The smaller class Groper were predominantly caught in the creeks and tributaries of the Ducie and Wenlock Rivers whilst the larger specimens were caught in the open channels of the rivers.



**Figure 49: Length-frequency data of Queensland Groper (n = 50) for animals captured in the March, June and November surveys across all survey sites.**

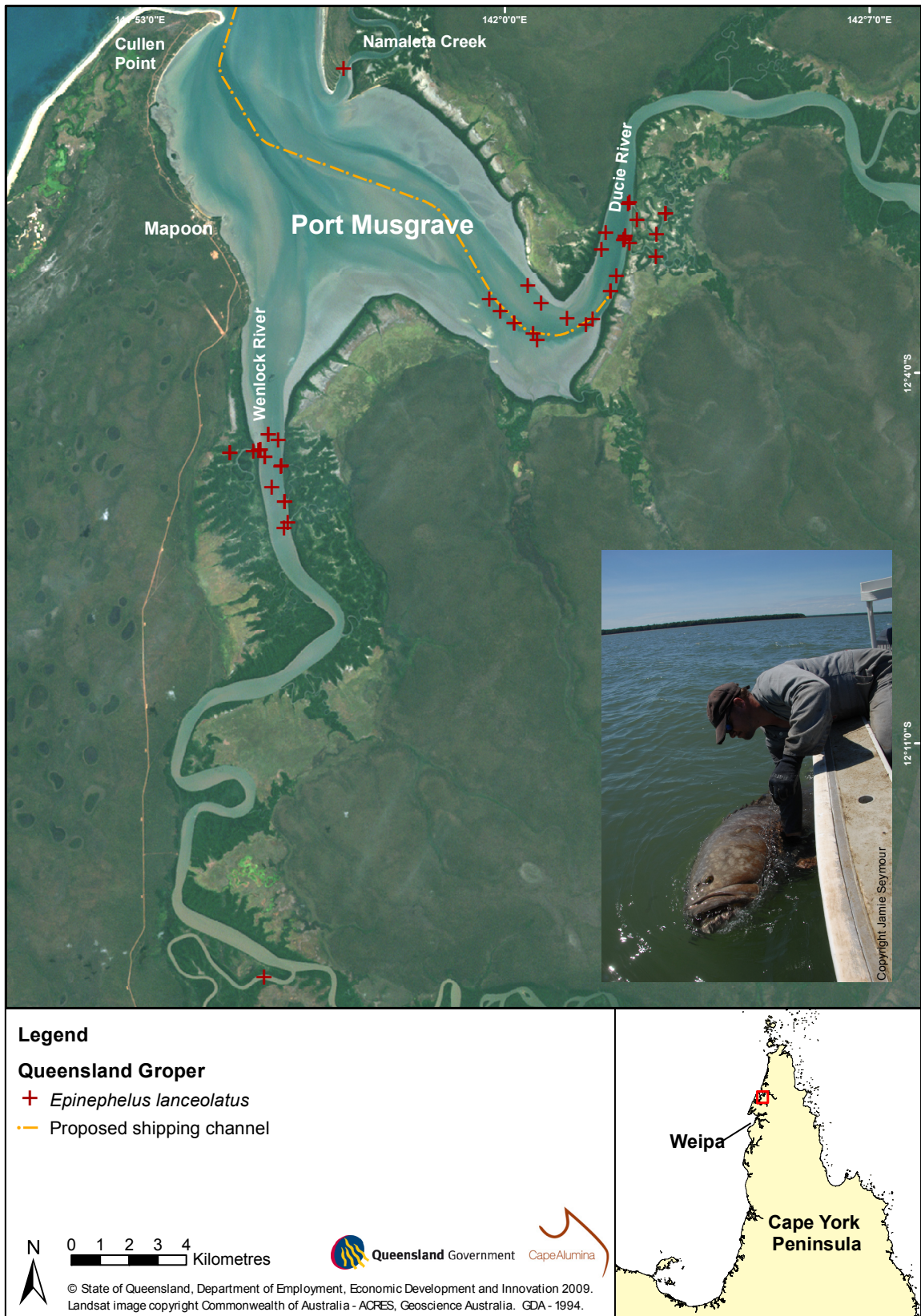


Figure 50: Queensland Groper capture locations.

### **Saltwater Crocodile**

A total of 45 Saltwater Crocodiles were recorded in the survey with numbers more heavily concentrated around the mud flats of the Wenlock River mouth although their distribution was extended to all survey locations with two animals observed in the vicinity of Cullen point (Figure 51). Saltwater Crocodiles were recorded in March, June and November surveys. The safest and most productive method of recording Saltwater Crocodile was by observation; however 10 animals were captured incidentally in gill net operations and one on set line (Appendix B). The size range of animals recorded during the survey was estimated to be between 150 cm to 450 cm TL.

### **Sea snakes**

A total of 28 sea snakes were recorded in the survey comprising at least three species (one specimen was not identified) (Appendix B). One snake was captured and 27 were observed and identified off the stern of the mother vessel at night. The species recorded were: Plain Sea Snake (*Hydrophis inornatus*); Elegant Sea Snake (*Hydrophis elegans*) and the Arafura Filesnake (*Acrochordus arafurae*). Of these, The Plain Sea Snake was far more abundant (n = 24) than the other species (Figure 52; Appendix B).

### **Dolphin**

Two dolphins were observed, an Australian Snubfin Dolphin (*O. heinsohni*) and an Indo-Pacific Hump-backed Dolphin (*S. chinensis*).

### **Turtle**

A single Flatback Turtle (*N. depressus*) was recorded mid-morning along the northern foreshore of Port Musgrave approximately 6 km from the entrance of the Namaleta Creek (Figure 52). The turtle was observed breaking the surface and was recorded during the jellyfish visual census in the November survey. No attempt was made to capture the animal; however visual species identification was made from a distance of less than 5 m.

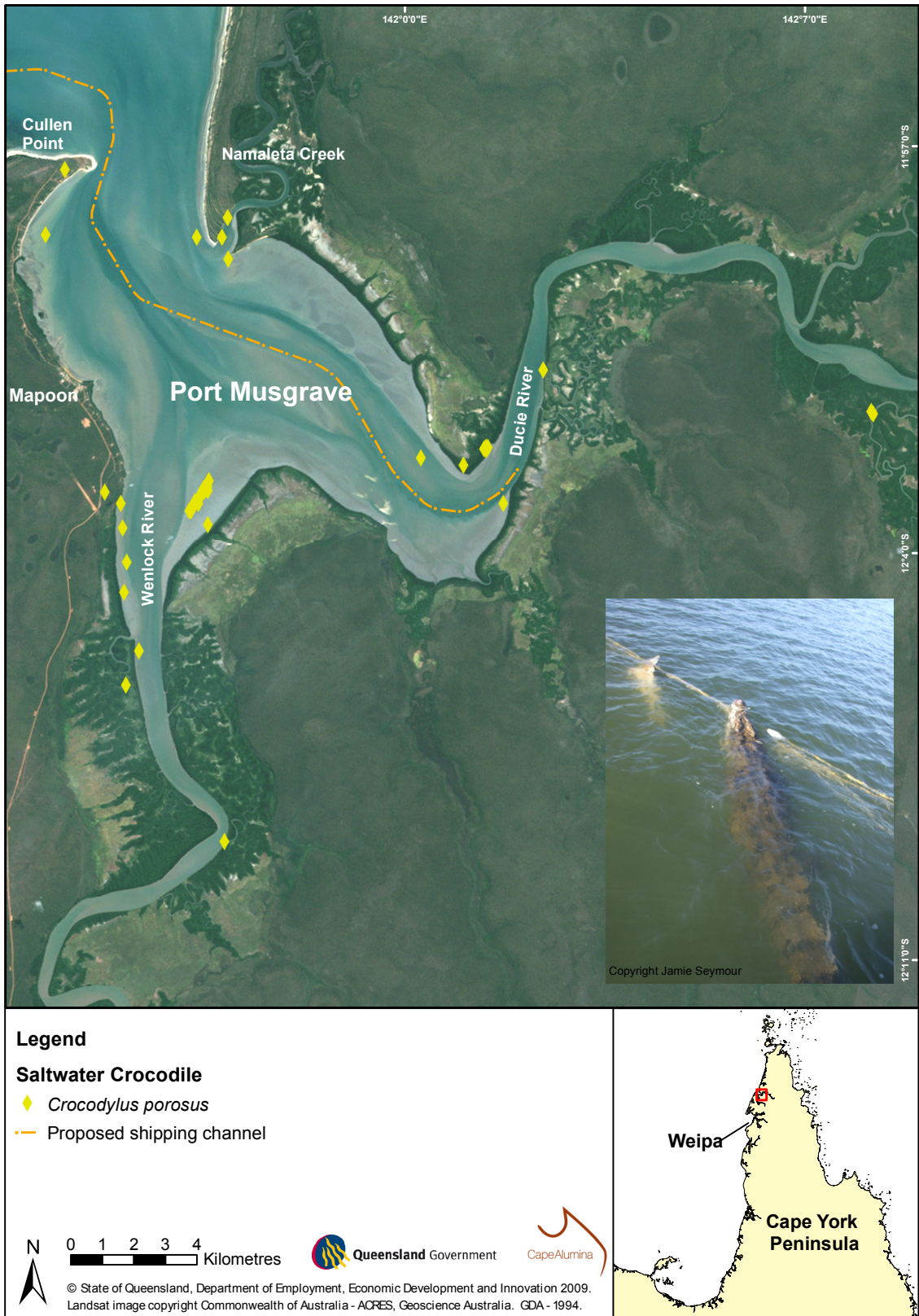


Figure 51: Saltwater Crocodile observation and capture locations.

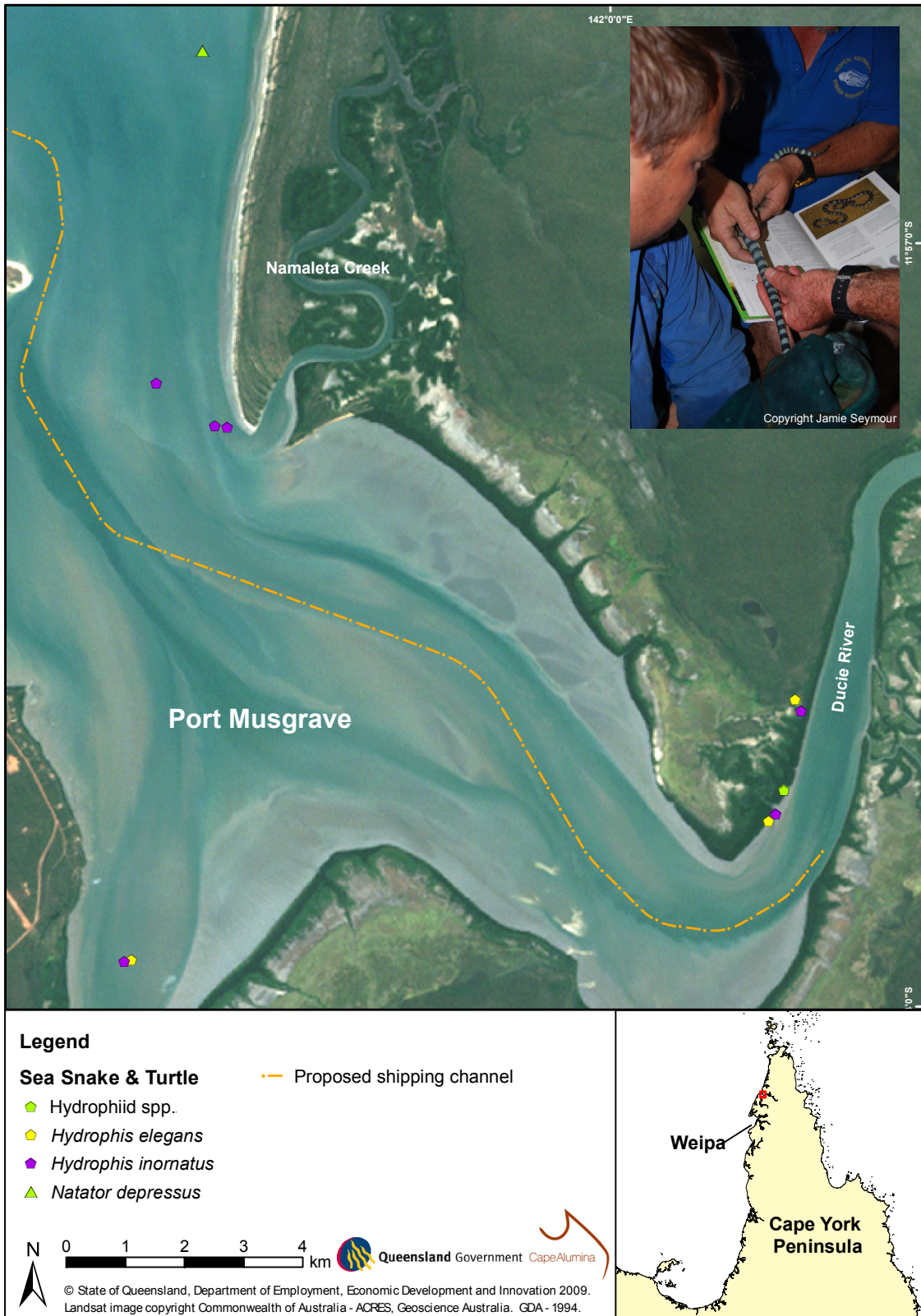


Figure 52: Sea snake and turtle observation locations.

### 3.3.3 Population Estimates

Population estimates based around Peterson mark recapture analysis were statistically unreliable due to low sample numbers and low recapture rates. In most cases for sawfish species, the recapture rates were close to 100% (Table 7). This suggests that the total number of marked and released animals is an indication of the total population size (this would also suggest a closed local population).

For other species, such as Speartooth Shark, no recaptured animals were recorded suggesting that alternatively; the population was extremely large, the marked animals were either dying or leaving the area, or they were “trap shy” (i.e. were not being recaptured).

For Queensland Groper, although no tag returns were recorded (out of a total of 34 tagged individuals), no mortalities were observed in the field, suggesting a high dilution factor which would give a very large population estimate (Table 7). There were relatively large numbers of Queensland Groper caught over the length of the project, with sampling conducted in the same site locations, which would also suggest low site fidelity as well as a large population.

Dwarf Sawfish and Green Sawfish in comparison showed high site fidelity (multiple recaptures from the same sampling sites) but were recaptured equally between two sampling sites suggesting a reasonably large home range (Table 8). One caveat that must be made is that the numbers tagged were low, three Dwarf Sawfish and six Green Sawfish, making conclusions speculative. Population estimates are also difficult for this reason.

Unpublished data by the author suggests that survival rates of Speartooth Shark, sawfish and Queensland Groper captured by the means employed in this study are extremely high (close to 100%). One condition that was placed on the tagging process was that only the very fittest of captured animals were tagged and released. Post release survival of an immature Dwarf Sawfish was observed first hand in this study (Figure 48). This animal was recaptured four times over the period of this study (Table 7) after surviving not only the tagging but initial attacks from a crocodile and shark whilst in the nets. This demonstrates the survival strength of this animal.

### **SOCI Commercial Logbooks**

The Gulf of Carpentaria SOCI logbook program provided limited information on the distribution and range of protected species in the GoC. No protected species were recorded in the SOCI logbook program specifically for the Port Musgrave area. An analysis of the most recent SOCI log book data (2008) identified a total of 24 protected species interactions from 22000 fishing effort days in the GoC (Table 9). Of the four species recorded, the most commonly caught were Saltwater Crocodile (*C. porosus*), which are protected under the *Nature Conservation Act 1992*.

The number of protected species recorded in this study is considerably higher than those reported in the SOCI logbook program. Independent reporting from the fisheries observer program in the GOCIFF also indicates a higher rate of protected species interaction than the SOCI logbook program (Stapley and Rose 2009).

**Table 9: SOCI interactions in 2008 from the Gulf of Carpentaria commercial logbooks.**

<b>Common Name</b>	<b>Species</b>	<b>Gillnetting</b>	<b>Crab Pots</b>	<b>Total Interactions</b>
Narrow Sawfish	<i>Anoxypristis cuspidata</i>	1		1
Saltwater Crocodile	<i>Crocodylus porosus</i>	11	1	12
Freshwater Sawfish/ Dwarf Sawfish	<i>Pristis microdon/P. clavata</i>	10		10
Bottlenose Dolphin	<i>Tursiops truncatus</i>	1		1
				24

## 4.0 Discussion

This report establishes baseline information (historic and current) on the fisheries, invertebrate and aquatic values of Port Musgrave and the lower reaches of Namaleta Creek, Ducie and Wenlock Rivers. It represents a multi-dimensional study, focusing on the results from a series of comparative gill net, set line, cast net, crab pot and visual census surveys, but also incorporates an assessment of the commercial fisheries catch and effort data, charter operator data, recreational fisher data, and importantly, Indigenous community subsistence/recreational fishing surveys. The latter dimension is often the most poorly documented facet of studies on fished resources so it has been presented in detail separately as Appendix A of this document.

As a baseline study the report concentrated on documenting, tabulating and describing the fisheries resources (Table 2, Table 4, Table 6, Table 8; Appendix B), restricting the analysis to simple parametric descriptive statistics and not attempting sophisticated spatial modelling. The key species were identified as being important because of their conservation status and value to the Traditional Owners, and were assessed in terms of their population size and utilisation of habitats being surveyed.

### **Objective 1: Characterise fish and invertebrate resources.**

#### Major findings

##### Overview:

- Species diversity derived from surveys conducted during this study are consistent with previous studies in the Western Cape York (e.g. Blaber et al. 1989, 1990a and b, 1995) and no significant differences were observed in the Shannon-Weiner diversity index between the control sites (Namaleta Creek and Wenlock River) and potential impact site (Ducie River) (Section 3.1.1, Table 1).
- Given no spatial differences, the species data were grouped as a survey time - series but we did not identify any statistically significant seasonal changes in the diversity indices (Shannon-Weiner) across the wet-dry season surveys.

In general the fisheries resources of Port Musgrave appear to be in good health, comparable with other commercially and recreationally fished areas in the GoC. The most relevant comparison, geographically and in terms of habitat types, would be the Albatross Bay region and in particular the Embley Estuary (Section 1.2.1). CSIRO has undertaken comprehensive surveys of the fish fauna in these systems (Blaber et al. 1989, 1990a and b, 1995; Cyrus and Blaber 1992) and the list of species (Appendix B) and dominant species observed in this study are consistent between Port Musgrave and the Albatross Bay region. The commercially important species found in the Port Musgrave surveys were: Barramundi (*L. calcarifer*), Blue Threadfin Salmon (*E. tetradactylum*), King Threadfin Salmon (*P. macrochir*), Blacktip Shark complex (*C. limbatus/tilstoni*) and juvenile Grey Mackerel (*S. semifasciatus*). Species of recreational importance such as Giant Queenfish (*S. commersonianus*) and Barramundi were identified (Figure 42, Figure 43) and these stocks currently support commercial charter operations (Section 1.2.2 and Table 5).

From the three Port Musgrave surveys, a total of 6407 individual animals from 126 species were recorded. Of these there were: 72 fish species, 29 shark and ray species, six reptile species, two dolphin species, five jellyfish species and 12 crustaceans (crab and prawn species). In comparison, using gill nets and a beach seine rather than cast nets, Blaber et al. (1995) identified 118 fish species in the shallow inshore waters south of the Embley Estuary, with the communities dominated by Giant Queenfish (*S. commersonnianus*), Milkfish (*C. chanos*) and Blue Threadfin Salmon (*E. tetradactylum*). The number of species in these inshore waters was less than inside the Embley Estuary where 197 species were recorded. The greater number of species was most likely due to the sampling of more diverse habitats (Blaber et al. 1989, 1995). The current surveys of Port Musgrave were constrained to the proposed development area and adjacent areas (as control sites) so the habitats sampled were also constrained.

Commercial quantities of Giant Mud Crab were observed in the pot surveys of Port Musgrave, (Figure 27, Figure 28). A combined catch of 357 mud crabs, an average of 1.23 crabs per pot lift, was caught during the March, June and November 2009 surveys (Figure 27, Figure 28). The Wenlock River consistently had the highest CPUE and the highest numbers of crabs caught for the three sites surveyed (Figure 27, Figure 29). Crab catch rates were highest in the June survey, peaking at 2.37 per pot lift (Figure 29). This trend in seasonal abundance is consistent with the historic commercial crab catch in the area (Gould et al. 1999).

Commercial logbook catch-data (DEEDI CFISH commercial catch-effort logbook database) for the area indicate the Giant Mud Crab fishery is relatively healthy when compared to other more heavily fished adjacent areas, such as Albatross Bay (Weipa). The time-series of catch and effort for this fishery (Figure 38, Figure 39) show a drop in catch and effort over the last two years, with an apparent increase in the CPUE. This was due in part to a change in the management policy removing the Giant Mud Crab licence endorsement from the inshore gill net N3 fishery in 2008 (M. Lightower, DEEDI Fisheries Manager pers. comm. 2010) and in part to the loss of a highly productive commercial fisher in 2007. The rise in CPUE is not due to an increase in the underlying crab population but was an artefact of reduced effort caused by management policy.

The pot surveys also identified juvenile Giant Mud Crabs as being infected with low levels of a parasite barnacle (*L. ihlei*) (Figure 30). The incidence of this parasite has been linked peripherally to environmental stress (Knuckey et al. 1995) so the Port Musgrave surveys have established a “natural” incidence level prior to the proposed development.

The major finding of our review of commercial logbook catch and effort data (Section 3.2) was that the inter-annual catch and fishing effort has been variable (Figure 32, Figure 38) with a slight decline in recent years in the gill net and crab fishery of Port Musgrave. Both effort and catch has decreased but the catch per unit of effort has remained relatively stable; given CPUE is a reliable indicator of the underlying abundance then stocks of fished resources appear healthy.

## **Objective 2: Changes in the resources over time.**

**Caveat:** Only three, 10 day field surveys were completed, covering one wet season, one dry season and a pre-wet season period. This short time series of observations limits the inferences that can be drawn about temporal changes in abundance of species at the sites surveyed.

Long-term temporal changes can only be inferred from the commercial catch-effort logbook time-series. The main seasonal drivers for the fisheries resources and fishing industry of the Port Musgrave area are the monsoonal wet-dry climate/environmental cycle and the management imposed seasonal closure of the Barramundi fishery over October to January (this has varied in duration between years).

For the major commercial categories recorded (Section 3.2), although there has been considerable variation in catch and effort between years, there has not been a consistent trend in the overall standardised “catch per unit effort” (CPUE) (Figure 32, Figure 38).

Within the nine month time-frame of the field surveys there appears to be no temporal trend in the catch of Barramundi, although there was a significant variation in the relative abundance of Barramundi between sites and survey periods. This study was unable to determine the reasons for these variations; however difference in system size and water quality parameters may drive this. Barramundi is known to spawn in the wet season is therefore protected by the current seasonal closure of the inshore gill-net fishery (Garrett and Williams 2002). The closure also coincidentally protects other wet season spawners (such as the Mangrove Jack).

Other spatial or temporal variations were observed and give an insight into the likely variability in the fisheries resources and Species of Conservation Interest. The following discussion needs to be read in the context of the species synopsis, presented in Section 1.3, and the summary of National Environmental Significance species information provided in Table 6.

- Changes in spatial distribution and abundance were observed for Giant Queenfish and Queensland Groper. Giant Queenfish were found more commonly at the Namaleta Creek survey site. This was not unexpected as the Namaleta Creek is characterised as being more oceanic than the other two sites (Section 2.1.2) and Giant Queenfish are known to be a pelagic species. The findings of this study are similar to those reported for Giant Queenfish populations in Albatross Bay, Weipa (Blaber et al. 1990a and b).
- The relative abundance of Queensland Groper was lower in the Namaleta Creek in comparison to the Ducie River and Wenlock River. This is almost certainly a reflection of the habitat complexity differences between the Namaleta Creek and the other two sites. The Namaleta Creek is characterised as being shallow, slow flowing and appears to be less structurally diverse than the other two systems. This preference by Queensland Groper for highly complex habitat is supported by studies conducted on Goliath Gropers in the United States (Frias-Torres 2006; Section 1.3.3). As such the planned

establishment of a loading facility would increase the structural diversity of the habitat and likely benefit the Queensland Groper population in the immediate area.

- Although only small numbers of Speartooth Shark were recorded (Appendix B), their relative abundance was higher in the Wenlock River than the other two sites. The absence of Speartooth Shark in the Namaleta Creek was possibly because of the clear water and low flow (characteristic of Namaleta Creek), which does not match the species habitat preference (Peverell et al. 2006). However, the low relative abundance of Speartooth Shark in the Ducie River, in comparison to the Wenlock River, was not easily explained. Both river systems share similar physical characteristics and anecdotal evidence from commercial net fishers in the area suggest that there are larger numbers of Speartooth Shark present in the Ducie River than recorded in this study. Published data for the Wenlock River also shows CPUE's that may be higher than those recorded in the current surveys. The Pillans et al. (2008) study in the Wenlock River recorded 29 Speartooth sharks captured in a three week line-fishing survey. This catch rate compares to the 19 Speartooth Sharks caught in the Port Musgrave surveys over an aggregate 4.3 week period (Appendix B). Peverell (2006) found the CPUE for Speartooth Shark was greater than that for the more easily recognised Bull Shark in the Port Musgrave system.

The current surveys in Port Musgrave captured the largest Speartooth Shark on record so far (Table 7; Section 1.3.1 1), but this study also only recorded immature animals (there are no published records of mature Speartooth Shark). The absence of mature sharks (based on known size of juveniles) from the surveys and presence of neonate individuals in the March survey (juvenile with open umbilical scar), is highly suggestive that the Ducie and Wenlock Rivers are nursery habitat for this species. Of concern is that Speartooth Shark were captured at Cape Alumina's proposed loading facility site in the Ducie River (Figure 45).

- Narrow Sawfish (Section 1.3.2): There was no change in the relative abundance of this species with survey site and survey period. This species is not of National Environmental Significance and is the most common sawfish species found in the GoC with a wide distribution (Peverell 2005). The habitats surveyed in this study are not considered "preferred habitat" for this species, with juvenile animals commonly found along inshore coastal foreshores and mature animals found in offshore marine waters. This preference for these habitat types may have contributed to the low CPUE for this species in the habitats of the study area.
- Green Sawfish (Section 1.3.2): The relative abundance of immature and mature Green Sawfish in Port Musgrave was extremely low with only small numbers of animals caught and a high percentage of tag recaptures (Table 7, Table 8; Figure 47). The best estimate is a very small population of Green Sawfish in the study area.
- Dwarf Sawfish (Section 1.3.2): The relative abundance of immature and mature Dwarf Sawfish in Port Musgrave was extremely low with only small numbers of

animals caught and a high percentage of tag recapture (Table 7, Table 8, Figure 47). As with the Green Sawfish this suggests population numbers in Port Musgrave are small. Tag and recapture data also demonstrated that the species may utilise the entire Port Musgrave Bay. Published literature also suggests that habitat types surveyed in this study may act as nursery habitat for this species (Thorburn et al. 2008). The tagged Dwarf Sawfish in this study exhibited similar site fidelity characteristics as those reported by Stevens et al. (2008).

- Freshwater Sawfish (Section 1.3.2): The relative abundance (CPUE) of Freshwater Sawfish in Port Musgrave was extremely small with only two mature individuals captured (Figure 21, Figure 22; Appendix B). However these records further support the limited literature that suggests mature individuals, rather than being obligate freshwater animals, do spend periods of time during the monsoon dry season in estuarine environments (Peverell 2008). The apparent absence of mature Freshwater Sawfish in other estuarine systems (Peverell 2005) suggests that the Port Musgrave study area may be important for this species.
- Saltwater Crocodiles (Section 1.3.4): Saltwater Crocodiles ranging from immature to mature sizes were observed at all three survey sites and survey periods. The number of Saltwater Crocodiles was larger in the Wenlock River in comparison to the other two survey sites (Figure 51; Appendix B). These results are similar to the published literature (Read et al. 2004a). Modification to habitat may impact on the population numbers of crocodiles (Read et al. 2004a, 2004b) such as building the loading facility. Namaleta Creek could be expected to act as a refugia for subadult estuarine crocodiles excluded from the Wenlock and Ducie Rivers (Messel et al. 1981).
- Cetacean and turtles: Two species of dolphin were recorded in Port Musgrave during the study (Appendix B). No Dugongs and only one Flatback Turtle was observed (on the Namaleta foreshore).

**Objective 3: Describe the likely impacts on the resources attributable to the proposed development with respect to a nearby undeveloped/control site.**

The current study has established the baseline data on the species composition and relative abundance of fisheries resources in the area of the proposed development, before any site-works are begun. This baseline will allow a statistically robust “before and after” comparison of the proposed development area, subsequent to completion of the site-works, referenced against the adjacent undeveloped areas.

Prior to such a comparison only general inferences of the likely impact(s) can be drawn:

The commercial and recreational take of Barramundi and other targeted species may be effected in two ways;

- Displacement of fishing effort; a 200 m exclusion zone is required around port facilities plus further displacement due to the presence of additional/ wider

navigational channels. The impact of these spatial exclusions on fished stocks would be the concentration of fishing effort in alternative/ adjacent areas, increasing the risk of depleting local populations.

- An increase in recreational fishing pressure from improved road access, new boat launching facilities, and additional mine personal (similar to Weipa/ COMALCO development).

Queensland Groper is commonly found around port facilities and proposed additional structures may provide added habitat for this species.

The spatial distribution of the commercial fishery is currently mainly outside areas directly impacted by the proposed development. Furthermore the commercial fishing effort in the inshore net and crab fisheries of the area is small relative to the rest of the GoC and has been declining over the last decade; therefore despite the displacement, a major impact due to the development would not be anticipated.

**Objective 4 Assess the impacts on population and habitat utilisation of key species and Species of Conservation Interest in the area in relation to fluctuating environmental change.**

This study recorded, either by direct capture or by field observation, the occurrence of at least 13 species of high conservation status in the Port Musgrave region (Table 6; Appendix B). These include:

- Speartooth Shark (*G. glyphis* – referred to as *Glyphis sp.* A until 2008) that are Critically Endangered under the Environment Protection Biodiversity Conservation Act 1999 (EPBC Act) (Section 1.3.1);
- Four sawfish species: Freshwater Sawfish (*P. microdon*), Green Sawfish (*P. zijsron*) and Dwarf Sawfish (*P. clavata*) that are all Vulnerable under the EPBC Act and Narrow Sawfish (*A. cuspidata*) are listed as Critically Endangered on the IUCN Red List (IUCN 2009) (Section 1.3.2);
- Protected iconic Queensland species (Table 6); Queensland Groper (*E. lanceolatus*) and Australian Snubfin Dolphin (*O. heinsohni*).
- Other species of conservation concern that are known to utilise the habitat in the Port Musgrave region include Green Turtle (*C. mydas*), Flatback Turtle (*N. depressus*), Pacific Ridley Turtle (*L. olivacea*), Dugong (*D. dugon*), Saltwater Crocodile (*C. porosus*) and sea snakes (Hydrophiidae spp.).

Tag-return population estimates of protected species present in the study area were statistically unreliable given the low numbers of animals tagged and recaptured. However, the low number of animals captured in these intensive surveys indicated a low resident population of sawfish; only eight Dwarf Sawfish, ten Green Sawfish and two Freshwater Sawfish were caught. Although Narrow Sawfish were recorded in the Ducie River and Wenlock River study sites anecdotal reports from fishers and the community suggest that they may inhabit more inshore coastal areas.

The Speartooth Shark (*G. glyphis*) has the most restricted distribution of all the Species of Conservation Interest observed in the Port Musgrave area. Although this species has only recently been fully described (therefore previously difficult to identify), the only

recorded observation of a *G. glyphis* population in the Gulf of Carpentaria has been in the Port Musgrave region. For this critically endangered species in particular, due care in the planning of marine works would be required as would the ongoing monitoring of its status while work was in progress.

In terms of the impact of fluctuating environmental change; there was a very high level natural variability observed in all measures of abundance across all species in the current study. This was observed within survey sites, across surveys and across sampling gear type.

- The implication of such levels of variation is that statistical comparison of data between “sites” or “times” can be obscured by the inherent variability within the “site” or “time” data. It effectively reduces the statistical power of such comparisons.
- The source of this variation in the data can be “observer error” or “process error”; in tropical habitats the latter is usually larger and includes the environmental effects of variable weather/ climate and sea conditions, as well as habitat change due to tropical storms.

A further implication is that very careful statistical design will be required to determine any future environmental impact. Such an impact will have to be large and unambiguous to be statistically significant.

**Objective 5 Identify the possible consequences of the proposed impact on associated fisheries and Traditional Owners in the area.**

A discussion of the likely impacts of the proposed development is included in the Community Fisheries Resources Assessment Project (Appendix A). Detailed assessment of the potential impact of the proposed development to the Traditional Owners is also provided in a Social Impact Assessment study; another element of the Environmental Impact Assessment presented in a separate report.

## 5.0 Conclusions

- This report provides comprehensive baseline information (historic and current) on the fisheries and aquatic values of Port Musgrave and the lower reaches of Namaleta Creek, Ducie and Wenlock Rivers, and most importantly documents the variation in observed abundance of fisheries resources at these sites, critical to the design of appropriate statistical analysis of environmental impacts.
- The species composition, relative abundance (CPUE) and spatial distribution of the major species present has been compiled for both the proposed development area and adjacent undeveloped “control sites”, to provide the basis for a robust BEFORE, AFTER, CONTROL, IMPACT (BACI) analysis of the potential impact(s) of the proposed development on the fisheries resources of Port Musgrave and the lower reaches of Namaleta Creek, Ducie and Wenlock Rivers.
- Namaleta Creek was found to be sufficiently different, both physically and in its fisheries resources, from the proposed development site in the Dulcie River to limit its value a control. The Wenlock River, however, was very similar both physically and in its fisheries resources, therefore would provide an excellent control site. The three survey sites combined provided the full range of the species that could be expected in the wider Port Musgrave area.
- A potential issue identified by this study is the presence of the Spertooth Shark (*G. glyphis*), which has the most restricted distribution of all the Species of Conservation Interest observed in the Port Musgrave area. Although this species has only recently been fully described (therefore previously difficult to identify) the only recorded observation of a *G. glyphis* population in the Gulf of Carpentaria has been in the Port Musgrave region. For this critically endangered species in particular, due care in the planning of marine works would be required as would the ongoing monitoring of its status while work was in progress.

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Appendix A Community Fisheries Resource  
Assessment Project

# Mapoon Aboriginal Community Fisheries Resources Assessment October 2009



**Tim Dudgen (Mapoon Aboriginal Community)**

**Stirling Peverell and Damian Rigg (Marine Fisheries Group)**



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**Cover photo:** Rhonda Parry of Mapoon Aboriginal community and Project Biologist Stirling Peverell (Marine Fisheries Group, Sustainable Fisheries, Department of Employment, Economic Development and Innovation-DEEDI) handle a mature Freshwater Whipray (*Himantura dalyensis*) before its live release. (Photo J Stapley, Fisheries Queensland DEEDI).

On 26 March 2009, the Department of Primary Industries and Fisheries was amalgamated with other government departments to form the Department of Employment, Economic Development and Innovation.

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## Contents

Summary.....	1
1.0 Introduction.....	2
2.0 Methods.....	4
3.0 Results & Discussion.....	6
4.0 References.....	22
Appendix A: Fisheries Resource Monitoring Manual (extracts provided, full document available from authors) .....	23

## List of Tables

Table 1: Demographic classification of survey participants.....	5
Table 2: Numbers of species recorded by gear type in the creel surveys; Species of Conservation Interest are in grey text. ....	11

## List of Figures

Figure 1: Location of fishing sites from creel surveys between 16/6/09 and 30/11/09. 7	
Figure 2: Average number ( $\pm 95\%CI$ ) of male, female and children from 74 creel surveys representing local community residents (clear column $n = 221$ fishers) and 67 creel surveys representing non-community residents (grey column $n = 227$ fishers). ..	8
Figure 3: Frequency of fishing gear types used as a percent of total hours fished (1903 hours) by fishers surveyed in the Port Musgrave area. ....	9
Figure 4: Number of species caught by gear type from creel surveys undertaken in the Port Musgrave area between 16/6/09 and 31/11/09.....	10
Figure 5: Catch (CPUE) ( $+95\%CI$ ) for line fishing, hand spearing and hooking used by community (black column) and non-community fishers (grey column) in the Port Musgrave Community monitoring creel survey. ....	14
Figure 6: Catch (CPUE) ( $95\%CI$ ) for bait nets and gill nets used by community (black column) and non-community fishers (grey column) in the Port Musgrave Community monitoring creel survey. ....	14
Figure 7: Top 10 most commonly recorded species in the Port Musgrave creel surveys. ....	15
Figure 8: Barramundi length-frequency data from 53 creel surveys undertaken in the Port Musgrave area between 16/6/09 and 31/11/09, $n = 94$ . ....	16
Figure 9: Top five species caught (by number $n = 569$ ) by local community boat based fishermen using line fishing, trolling, bait fishing, and crab potting.....	17
Figure 10: Top five species caught (by number $n = 1536$ ) by non-local community boat based fishermen using line fishing, bait fishing and crab potting.....	17
Figure 11: Top five species caught (by number $n = 1115$ ) by local community shore based fishermen using line fishing, crab potting, bait fishing and hand spearing. ....	18
Figure 12: Location and number of Species of Conservation Interest recorded from creel surveys.....	20

## Summary

One hundred and forty creel surveys of recreational/ subsistence fishers were conducted between 16/06/09 and 30/11/09 representing 504 people. Community residents were represented evenly in the surveys (52% of participants) with only 39 people identified as residing outside Queensland. Line fishing was the dominant gear type used by anglers followed by crab pot gear.

Of those local residents interviewed a large percentage was male (55%), although women and children actively participated in fishing activities. Fishing was not only seen as a means to obtain food but an opportunity to spend quality time with family and friends. Pikey Bream (*Acanthopagrus berda*) was the most abundant species recorded from a total of 68 species from 30 Families. Giant Mud Crab (*Scylla serrata*) and Barramundi (*Lates calcarifer*) were also species of importance to both community and non-community fishers.

In addition to Barramundi, Diamondscale Mullet (*Liza vagiensis*) and Blue Threadfin Salmon (*Eleutheronema tetradactylum*) were also important finfish species to community, especially shore based fishers. The availability of a boat appeared to influence what species fishers in the community targeted, with boat fishers preferring to target reef fish. Non-community boat fishers demonstrated a preference for estuarine species such as Barramundi and Black Jewfish (*Protonibea diacanthus*).

Protected Species of Conservation Interest were recorded in the creel survey data; turtles including the Hawksbill Turtle (*Eretmochelys imbricate*) and Green Turtle (*Chelonia mydas*); Saltwater Crocodile (*Crocodylus porosus*); dolphins including the Australian Snubfin Dolphin (*Orcaella heinsohni*); Dugong (*Dugong dugon*); and sawfish (Pristidae spp.). The critically endangered Speartooth Shark (*Glyphis glyphis*) was not recorded in the catch of anglers, although a number of unidentified Whaler Shark species were recorded.

This report is essentially a “snap shot” of community and non-community fishers that use the Port Musgrave area. From the information obtained in this report it is evident that Mapoon Aboriginal community have a strong connection with the fisheries resources in Port Musgrave. Their connection with the resource is varied within the community depending on boat access. However, it is clear that the community relies on these resources as a means of food. Although not clearly evident in the report, there is also a connection between family and fishing, with this social activity being a catalyst to draw family members together.

There is an opportunity for the Mapoon Aboriginal Council to capitalise on the relatively pristine fisheries resources in the Port Musgrave area as the area is seen by many recreational anglers as a desirable location to visit. The inshore reefs off Cullen Point, in particular, have many of the desirable finfish species recreational anglers target on the east coast of Queensland such as Small Mouth Nannygai (*Lutjanus erythropterus*), Largemouth Nannygai (*Lutjanus malabaricus*) and Coral Trout (*Plectropomus* spp.). There are also what appear to be healthy Giant Mud Crab, Barramundi and Black Jewfish stocks in Port Musgrave and its rivers and creeks.

# 1.0 Introduction

Information on Indigenous and recreational catch in Queensland (Qld) is limited and is a fundamental knowledge gap within fisheries management that impedes the ability to sustainably manage the States fisheries resources. Other Australian State and Territory fishery agencies face a similar scenario where Indigenous/ Traditional owner catch information does not exist or the information does not exist in a format directly comparable with the commercial production figures (Higgs et al. 2007).

The National Recreational and Indigenous Fishing Survey (NRIFS) identified a State wide telephone survey followed by a recreational diary program as the most effective method to capture recreational fisheries data in Queensland (Henry and Lyle 2003; Higgs et al. 2007). This approach is satisfactory if the program objective is to obtain information on a broad spatial scale. However data on a finer regional or community spatial scale is not captured in sufficient detail. Higher resolution recreational and indigenous catch data is necessary when evaluating proposed impacts on local fisheries resources.

The NRIFS survey identified that Indigenous fishers across northern Australia harvested fisheries resources using line, net and traps from offshore, inshore, coastal, river and lake habitats (Henry and Lyle 2003). The species composition was dominated by finfish; however non-fish species (crabs and shell fish) were also taken. Harvest statistics were collected for protected species with reptile and mammal species recorded, but there were no records of protected finfish, shark or ray species.

Data from the NRIFS indicated Indigenous fishers in Qld harvested 24 finfish species (Henry and Lyle 2003). This is a conservative estimate with many species being grouped into common names such as sharks and rays, snappers and small baitfish. A recommendation from the NRIFS report identified the need for States/ Territories to report on recreational fishing on a regional scale.

In Queensland, information on recreational catch has in the past been derived through Recreational Fishing (RFISH) surveys by Queensland Primary Industries and Fisheries (QPIF now Fisheries Queensland, DEEDI). Catch information was obtained by random telephone surveys of Queensland residents. The surveys were conducted in 1997, 1999, 2002 and 2005. As recommended by NRIFS the Department also introduced a recreational fishing diary in 2005.

Only those species predominantly caught by recreational fishers in saltwater and freshwater were presented in the Fisheries Queensland diary program report (McInnes 2008). Absent from the data was information on the interaction recreational anglers have with protected species, such as Speartooth Shark (*Glyphis glyphis*) and sawfish (Pristidae spp.). The program also offers no quality assurance on the accuracy of species identification by anglers. This is an issue facing all voluntary logbook programs (Pollock et al. 1994). The level of representation of the Indigenous sectors of the recreational fishing community in the data collected by the program is not clear.

Information on the catch of recreational anglers obtained from the phone survey poll and voluntary diary program have provided Qld fisheries managers with the ability to track changes in the catch characteristics of recreationally important species, like Common Coral Trout (*Plectropomus leopardus*), Barramundi (*L. calcarifer*) and Australian Bass (*Macquaria novemaculeata*). Prolonged drought conditions across Qld have seen a marked reduction in the catch of freshwater species (McInnes 2008).

Apart from the broad scale survey undertaken by NRIFS, there has been no other published survey undertaken to quantify the level of Indigenous harvest of fisheries resources in Queensland. Council rangers in Kowanyama, an Aboriginal community located in the northern Gulf of Carpentaria, have been recording recreational catch and effort information for fishers camping under permit in the Topsy creek camp ground. This data is currently unpublished.

Additional to the voluntary data supplied by campers, an unquantified number of “door to door” community surveys were completed by Kowanyama rangers in 2002; however this method yielded very poor results (D. Foster, Fisheries Queensland Project Officer pers. comm. 2004). In 2003 roving creel surveys were conducted across several river and creek systems within Kowanyama homeland with these results yet to be published.

A number of issues have been identified that have limited the success of the Kowanyama recreational angler programs. These issues were: a lack of compliance with the diary system by visiting fishers; poor recollection of previous fishing activities by community residents; and lack of continued funding to support the community ranger program and program support staff.

In the absence of information on recreational and Indigenous fishing in the western Cape York region it was necessary to design and implement a recreational-Indigenous community fishery monitoring program at Mapoon. Information from this program will contribute to the process of evaluating the importance of fisheries resources to the Mapoon community in social and economic terms. The Traditional Owners in the Port Musgrave area include a number of clan groups: The Mapoon township are the Tjungdji clan group; on the northern side of Port Musgrave there are the Warrangku clan group and the Angkamuthi clan group (Native Title claimants); and at the mouth of the Ducie River there are the Taepathiggi clan group that are also at the mouth of the Wenlock River along with the Mpakwithi clan group.

The objective of the monitoring program was to:

- (1) Identify key species of importance to the Traditional Owners of the area and to quantify the use of fisheries resources.
- (2) Quantify the use of fisheries resources by tourists, non-community visitors and non-traditional owners.
- (3) Identify possible social impacts the proposed development might have on fishers accessing the fisheries resources of Port Musgrave.

## 2.0 Methods

The data compiled in this report is from 141 on site (within the Port Musgrave area) creel surveys (or more correctly, Esky surveys) undertaken between 16/06/09 and 30/11/09 (167 days). Not all creel surveys were conducted on site where fishing occurred. The creel surveys were undertaken on an opportunistic basis with interviews conducted at nine point sources: Cullen Point (n = 89), Private Resident (n = 24), Red Beach (n = 10), Pete's Corner (n = 8), Clough's Landing (n = 3), Old Mission House (n = 2), Toongu Boat Ramp (n = 2), Cemetery (n = 1), and Mapoon Council (n = 1). In the situation where the interview location was at a private residence, the data was grouped with the person's name removed from the reporting process. This was to respect the privacy of creel survey participants.

Creel survey interviews were conducted by a local resident with extensive fisheries knowledge. The average time required to complete each interview was approximately 20 minutes. The local resident was employed by Cape Alumina (two days per week) to complete the creel surveys. The resident was initially identified by the community Trustees, with "on the ground training" in creel survey methodology provided by Fisheries Queensland project staff. Training was provided in March and June after the completion of the associated independent fisheries resource monitoring surveys. Training material was supplied in the form of a fisheries resource monitoring manual; relevant extracts of which are provided in Appendix A.

A separate creel survey form was filled out for each group interviewed and information on fishing catch, effort and protected species observed obtained from survey participants. An identification guide for finfish, shark, ray, reptile and mammal species was provided to reduce error during the reporting procedure. Common names used were Standard Names from Codes for Australian Aquatic Biota whereby the standard uses capitals for all parts of the name, for example Pikey Bream (<<http://www.cmar.csiro.au/caab>>). In some cases the local name was also included to minimise confusion among fishers. Measurements of catch were obtained on an opportunistic basis. All creel survey forms were collated at the end of the month and forward to Fisheries Queensland project staff for database entry, analyses and reporting.

Fishing effort and species caught were recorded for each fishing gear type, along with the number and gender of people per group and those actually fishing. The demographics of survey participants were grouped into four main categories (Table 1) and fine scale geographic resolution was based on Australian post codes. For ease of analysis the four categories were grouped into two; community fishers and non-community fishers. When a community fisher was present during fishing operations the trip was classified under community as the trip outcome was biased by local fisher knowledge of the area. Only the top ten post codes (according to summed number of participants) were reported, with the category 'other' consisting of Pimlico, Charters Towers, Shelford and Cow Bay post codes.

Catch per unit of effort (CPUE) was calculated for line fishing (included trolling), hooking, and hand spearing and reported for each method as average number of fish per hour per fisher. Fisher hour was calculated by multiplying the number of fishers

by the total number of hours fished. Hooking is an indigenous fishing method used to capture Giant Mud Crabs (*Scylla serrata*); a straight length of wire with a half loop at the end (which is the width of a Giant Mud Crab carapace) is inserted into the crab hole and the crab forcibly dragged out. The traditional method of reporting commercial or recreational Giant Mud Crab catch per unit effort (CPUE crabs per pot lift) was not used in this assessment as the incidence of hooking and the number of crab pots used by fishers was not consistently reported. This made direct comparisons with the surveys undertaken as part of the Fisheries Resources study of Port Musgrave difficult. In addition, gillnet and bait net CPUE was not calculated with net length or size, as this information was not available. Hence the CPUE for gill net and bait net data is reported as average number of fish per net soak hour.

The number of protected species observations and their spatial reference was recorded. Turtle and dolphin species were grouped into generic reporting names Cheloniidae spp. and Delphinidae spp. as species identification was thought to be questionable, given the unknown identification skills of most community members and that observations were usually made at a distance. “Best guess” species names were included in the mapping of turtle and dolphin, however they should be treated as indicative and with a degree of caution. ARC GIS software was used to generate all of the maps and MS Excel and Access were used to collate and analyse the creel survey data.

**Table 1: Demographic classification of survey participants.**

<b>Classification</b>	<b>Definition</b>
Tourist	Person that lives outside the local area
Community Resident	Person that lives in Mapoon
Visitor	Person that lives in the local area and frequents Mapoon
Contractor	Person that works in Mapoon and has short term residency

### **3.0 Results & Discussion**

A total of 141 creel surveys were conducted representing 504 people of whom 448 actively participated in fishing activities. The percentage of local residents and people visiting from postcodes outside the Weipa region were evenly represented in the creel surveys. Only four fishing groups represented areas of origin outside Queensland, and these included; New Zealand, Sydney (New South Wales) and Shelford (Victoria). Local Mapoon community people represented 52% (n = 258) of survey participants of which 86% (n = 221) actively fished. From the creel survey data it is apparent that community and non-community fishers utilise a large proportion of Port Musgrave, including the Ducie River, Wenlock River and Namaleta creek (Figure 1).

Of the 448 people surveyed that were fishing, males from community and non-community dominated the gender analysis with the average number of males per interview group higher in the non-community group (2.85 compared to 1.7) (Figure 2). The number of female and children observed fishing was on average higher for community than for non-community fishing groups. This is most likely a reflection of family ties and the importance local community accord fishing as a communal/social activity.

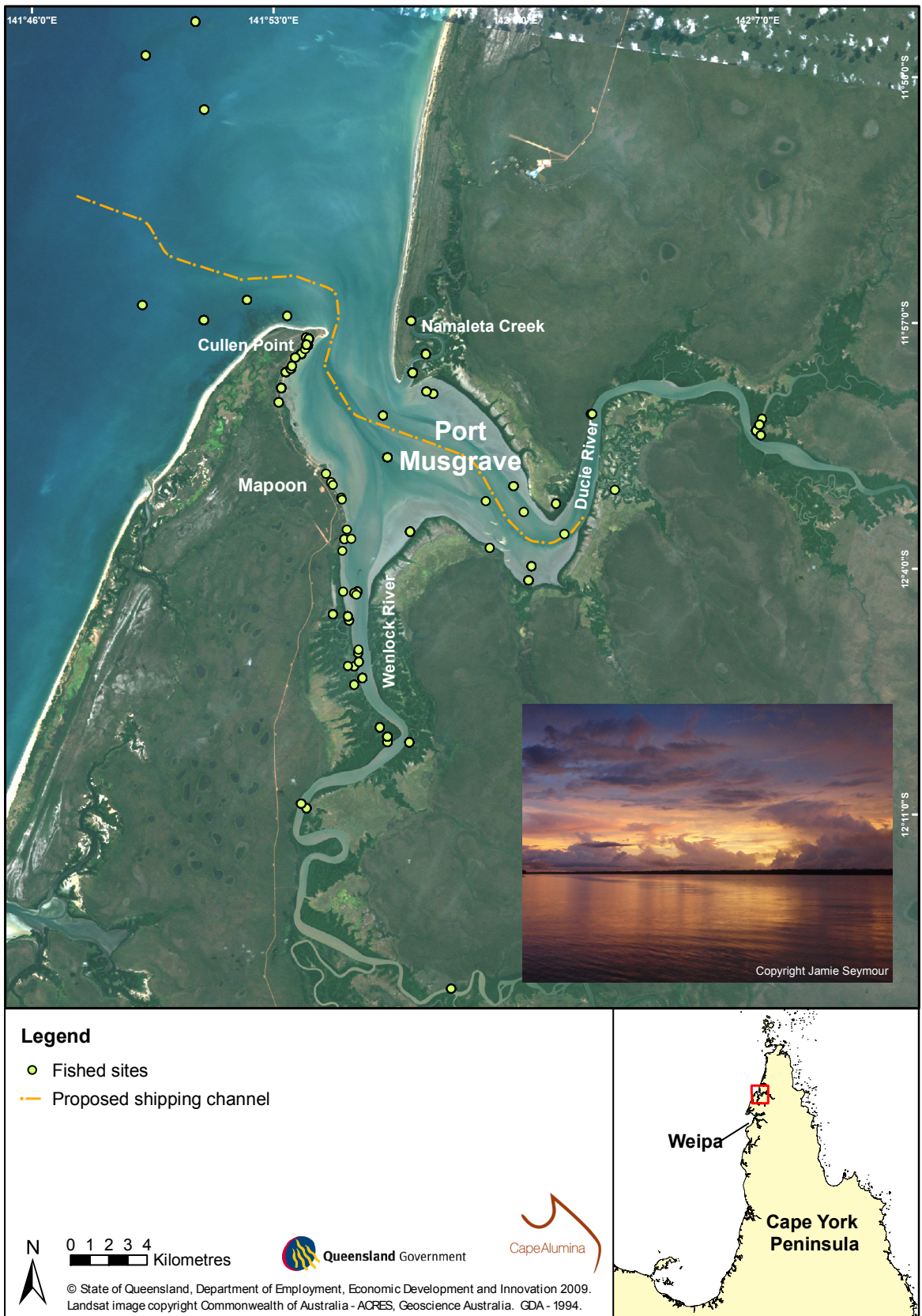
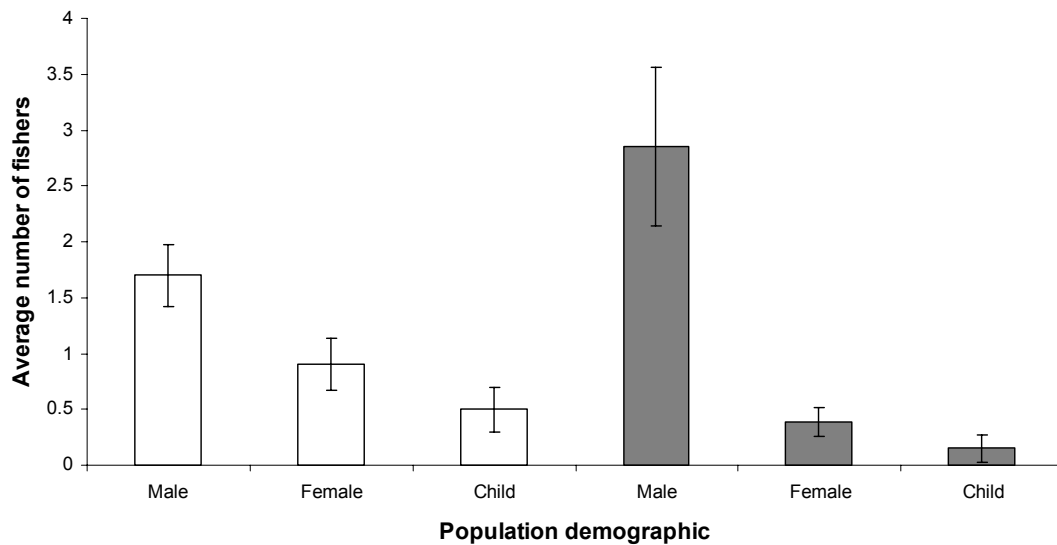


Figure 1: Location of fishing sites from creel surveys between 16/6/09 and 30/11/09.



**Figure 2: Average number ( $\pm 95\%$ CI) of male, female and children from 74 creel surveys representing local community residents (clear column n = 221 fishers) and 67 creel surveys representing non-community residents (grey column n = 227 fishers).**

Of the 258 community residents interviewed from 74 creel surveys, 86% were actively participating in recreational/ subsistence fishing. The other 14% identified recreational fishing as a social activity and a good opportunity to spend time with family and friends (T. Dudgeon, Community Monitoring Project Officer pers. comm. 2010). The creel survey data for the community indicated more adult males (55%, n = 123) participated in fishing activities compared to females (30%, n = 66) and children (15%, n = 34). Contrary to this finding were observations by Fisheries Queensland staff (who have been undertaking research activities in the Mapoon area over the past six years) that suggested local women and children were equally as involved in fishing activities as men (S. Peverell, Fisheries Queensland Fisheries Biologist pers. comm. 2010).

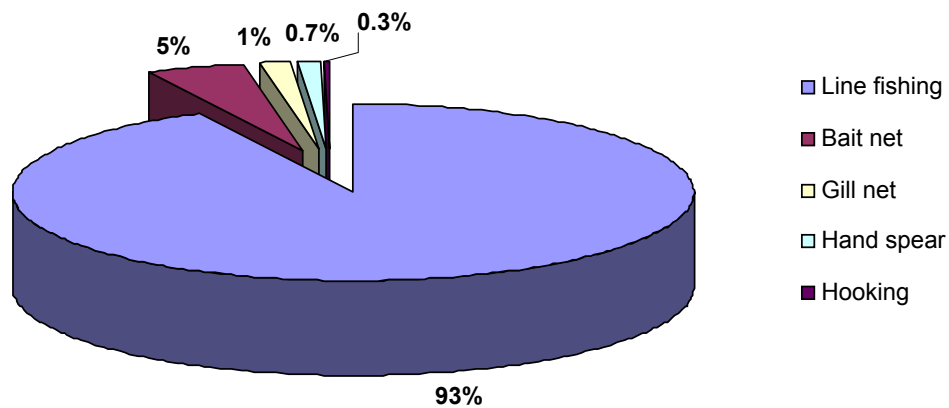
Non-community residents, visitors and contractors, were represented in 67 creel surveys and comprised 48% of the number of people interviewed. Of the groups that travelled to Mapoon, 95% of people identified fishing as the primary reason for visiting the area. When the data was analysed by gender, 98% of adult males visiting the area (n = 194) recreationally fished. Children were represented in the survey data of visitors and contractors (n = 11), and like adult males, nearly all participated in recreational fishing activities (n = 10). Hence recreational fishing is an important social activity for people wishing to visit Mapoon.

Of the 141 fishing parties interviewed, a total of 1903 fishing hours was reported. Line fishing (91% of total fishing hours) was the dominant activity/ gear type used by both community and non-community fishers, and this gear recorded the highest species diversity (n = 54) (Figure 3, Figure 4). Community fishers were represented in 44% of line fishing effort. Fishing effort could not be determined for crab potting, although this activity was represented in 37 creel surveys. Fishers of non-community origin made up 81% of the total number of groups that participated in crabbing. This was most likely due to the greater

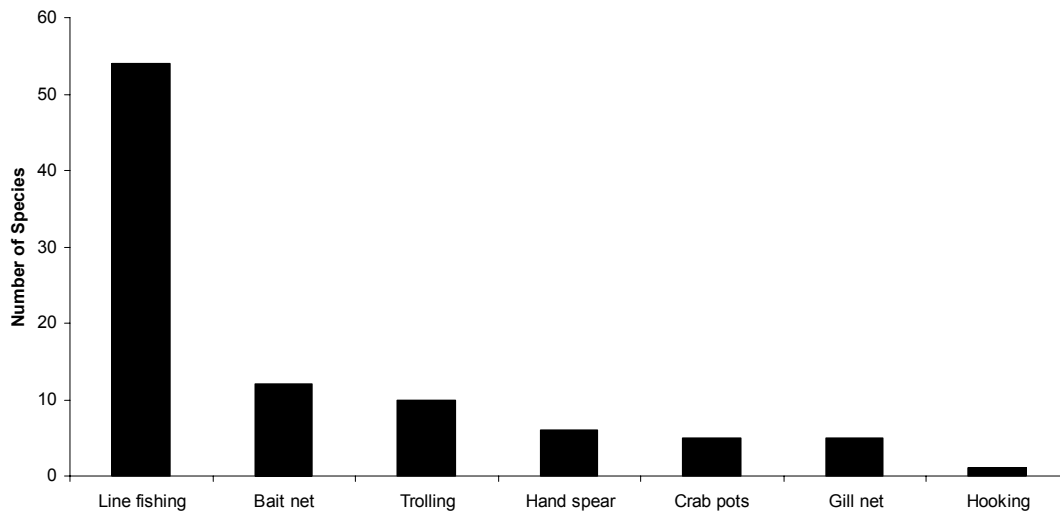
number of non-community fishers (n = 53) that used small craft to fish compared to shore bound community fishers (n = 20).

Of the other four types of fishing apparatus identified in the creel survey data, bait netting was the second most commonly used gear type accounting for 5% of the total fishing effort (86 hours) and the second highest species diversity (Figure 3, Figure 4). This form of fishing was used to obtain bait to be used to catch more desirable and larger species such as Barramundi. As fresh bait cannot be obtained from the local shop and fishers catch their own fresh bait.

The remaining gear types, gill netting (23 hours), hand spearing (22 hours) and hooking (6 hours) accounted for just over 2% of the total fishing effort. These gear types were only used by community fishers. Hooking and spearing was mainly used by fishers to target Giant Mud Crab whilst gill netting was used to target Diamondscale Mullet (*L. vagiensis*). Although hooking and gill netting is listed as illegal fishing techniques for recreational fishers under the *Fisheries Act 1994 (Regulation 2000)*, Traditional Owners are permitted to undertake this activity for customary purposes. Spearing as a fishing apparatus has featured in Aboriginal culture for centuries and is still mentored to the younger generation in most communities.



**Figure 3: Frequency of fishing gear types used as a percent of total hours fished (1903 hours) by fishers surveyed in the Port Musgrave area.**



**Figure 4: Number of species caught by gear type from creel surveys undertaken in the Port Musgrave area between 16/6/09 and 31/11/09.**

All but one of the 141 creel surveys recorded information relating to the use of a boat. A total of 73 creel surveys (52%) identified the use of a small boat for fishing purposes. Of the 67 creel surveys where fishers did not use a boat, 81% were identified as community residents. Fishers that do have access to a small boat are restricted to a few fishing locations; the most commonly sought location for locals is Cullen Point (Figure 1). Fishers with access to small boats travelled excess of 40 kilometres (km) in round trips, launching from Cullen Point to fish the Wenlock and Ducie river systems. Fishers also targeted reef fish species such as Coral Trout (*Plectropomus* spp.), Sweetlips (*Diagramma labiosum*), Emperors (Lethrinidae and Lutjanidae spp.) on Dog reef which is located approximately five km offshore from Port Musgrave (Figure 1; Table 2).

**Table 2: Numbers of species recorded by gear type in the creel surveys; Species of Conservation Interest are in grey text.**

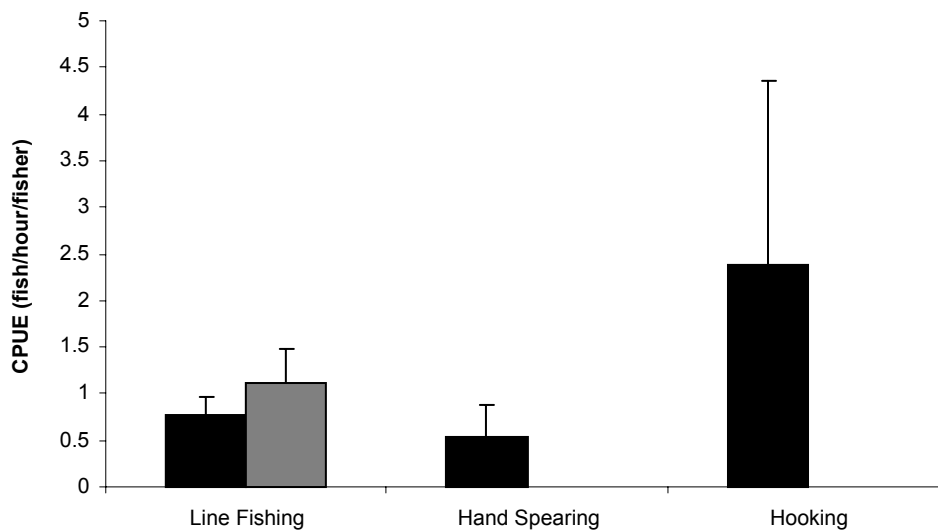
Genus species	Common name	Bait net	Crab pots	Gill net	Hand spear	Hooking	Line fishing	Observation	Total
<i>Acanthopagrus berda</i>	Pikey Bream	173	57	19	0	0	198		447
<i>Liza vagiensis</i>	Diamondscale Mullet	0	0	303	1	0	0		304
<i>Eleutheronema tetradactylum</i>	Blue Threadfin Salmon	67	57	16	1	0	148		289
<i>Lates calcarifer</i>	Barramundi	64	71	7	0	1	126		269
<i>Protonibea diacanthus</i>	Black Jewfish	48	74	0	0	0	128		250
<i>Lethrinus laticaudis</i>	Grass Emperor	0	14	0	0	0	118		132
<i>Crocodylus porosus</i>	Saltwater Crocodile	0	0	0	0	0	0	129	129
<i>Pomadasys kaakan</i>	Barred Javelin/ Grunter	24	31	0	0	0	71		126
Mugilidae spp.	Mullet	50	20	0	0	0	40		110
<i>Scomberoides commersonianus</i>	Giant Queenfish	13	18	8	0	0	64		103
<i>Arius</i> spp.	Catfish	25	24	0	0	0	40		89
<i>Lutjanus malabaricus</i>	Saddletail Snapper/ Largemouth Nannygai	0	15	0	0	0	60		75
<i>Scylla serrata</i>	Giant Mud Crab	2	38	2	5	11	16		74
Delphinidae spp.	Dolphin						0	54	54
<i>Lutjanus argentimaculatus</i>	Mangrove Jack	13	15	0	0	0	26		54
<i>Lutjanus johnii</i>	Golden Snapper	1	3	0	0	0	45		49
Scombridae spp.	Tuna Mackerel	0	0	0	0	0	46		46
<i>Lutjanus erythropterus</i>	Crimson Snapper/ Smallmouth Nannygai	0	1	0	0	0	43		44
<i>Lutjanus sebae</i>	Red Emperor	0	5	0	0	0	38		43
<i>Epinephelus coioides</i>	Goldspotted Rockcod	8	7	0	0	0	24		39
<i>Carcharhinus sorrah</i>	Spot-tail Shark	0	0	0	0	0	36		36
<i>Epinephelus quoyanus</i>	Longfin Rockcod	0	3	0	0	0	32		35
<i>Polydactylus macrochir</i>	King Threadfin Salmon	8	9	0	0	0	12		29
<i>Plectropomus leopardus</i>	Common Coral Trout	0	6	0	0	0	22		28
<i>Ambassis</i> spp.	Perchlet	28	0	0	0	0	0		28
<i>Carcharhinus</i> spp.	Whaler Shark	4	4	0	0	0	17		25
<i>Epinephelus lanceolatus</i>	Queensland Groper	5	6	0	0	0	12		23

Genus species	Common name	Bait net	Crab pots	Gill net	Hand spear	Hooking	Line fishing	Observation	Total
<i>Cheloniid spp.</i>	Marine Turtle	0	0	0	0	0	0	22	22
<i>Scomberomorus commerson</i>	Spanish Mackerel	3	4	0	0	0	11		18
Hemiramphidae spp.	Garfish	15	0	0	0	0	0		15
<i>Sphyaena barracuda</i>	Great Barracuda	1	0	0	0	0	11		12
<i>Rhizoprionodon acutus</i>	Milk Shark	0	0	0	0	0	11		11
<i>Choerodon schoenleinii</i>	Blackspot Tuskfish	0	1	0	0	0	8		9
<i>Lutjanus russellii</i>	Moses' Snapper	0	0	0	0	0	9		9
<i>Netuma thalassina</i>	Giant Sea Catfish	2	2	0	0	0	4		8
<i>Caranx ignobilis</i>	Giant Trevally	0	0	0	0	0	6		6
<i>Carcharhinus brachyurus</i>	Bronze Whaler	0	0	0	0	0	5		5
<i>Carcharhinus tilstoni/ limbatus</i>	Blacktip Shark complex	0	0	0	0	0	5		5
<i>Negaprion acutidens</i>	Lemon shark	0	0	2	0	0	3		5
<i>Platycephalus spp.</i>	Flathead	2	0	0	0	0	3		5
<i>Rhinobatos typus</i>	Giant Shovelnose Ray	1	0	0	0	0	4		5
<i>Orcaella heinsohni</i>	Australian Snubfin Dolphin	0	0	0	0	0	0	5	5
<i>Carcharhinus leucas</i>	Bull Shark	0	2	0	0	0	2		4
<i>Rhizoprionodon taylori</i>	Australian Sharpnose Shark	0	0	0	0	0	4		4
<i>Carangoides fulvoguttatus</i>	Turrum/Gold Spot Trevally	0	0	0	0	0	3		3
<i>Plectropomus maculatus</i>	Barcheek Coral Trout	0	0	0	0	0	3		3
<i>Sillago spp.</i>	Whiting	3	0	0	0	0	0		3
<i>Argyrops spinifer</i>	Frypan Bream	0	0	0	0	0	3		3
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	0	0	0	0	0	0	3	3
Caesionidae spp.	Fusilier	0	0	0	0	0	2		2
<i>Pastinachus atrus</i>	Cowtail Stingray	0	0	0	2	0	0		2
<i>Nebrius spp.</i>	Tawny Shark	0	0	0	0	0	2		2
<i>Nibea squamosa</i>	Scaly Jewfish	0	1	0	0	0	1		2
<i>Scomberomorus semifasciatus</i>	Grey Mackerel	0	0	0	0	0	2		2
<i>Cephalopholis sonnerati</i>	Tomato Rockcod	0	0	0	0	0	2		2
<i>Eusphyra blochii</i>	Winghead Shark	0	0	0	0	0	2		2

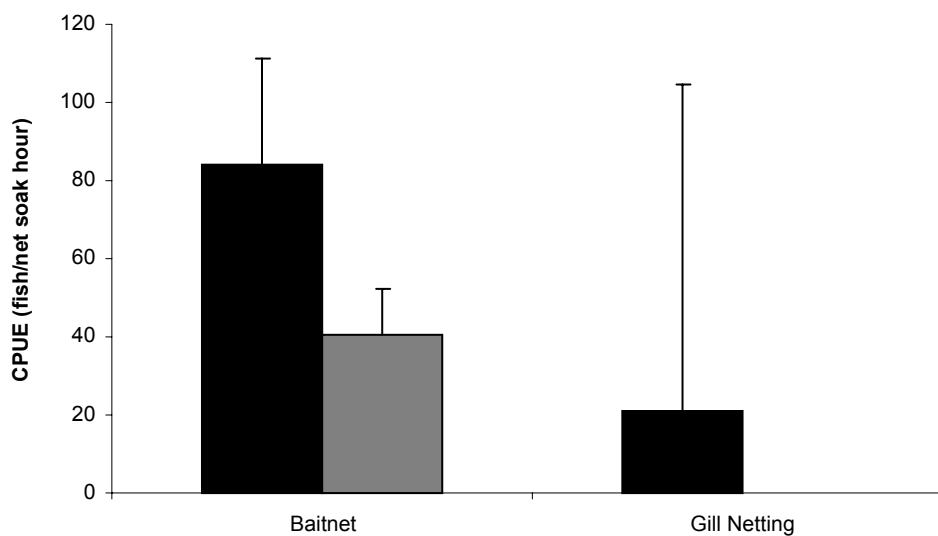
Genus species	Common name	Bait net	Crab pots	Gill net	Hand spear	Hooking	Line fishing	Observation	Total
<i>Sphyrna mokarran</i>	Great Hammerhead	0	0	0	0	0	2		2
<i>Gnathanodon speciosus</i>	Golden Trevally	0	0	0	0	0	1		1
<i>Chironex fleckeri</i>	Box Jellyfish	0	0	0	1	0	0		1
<i>Diagramma labiosum</i>	Painted Sweetlips	0	0	0	0	0	1		1
<i>Lethrinus</i> spp.	Emperor/ Brown Striped Snapper	0	0	0	0	0	1		1
<i>Scylla olivacea</i>	Orange Mud Crab	0	0	0	1	0	0		1
<i>Rachycentron canadum</i>	Cobia	0	0	0	0	0	1		1
<i>Parastromateus niger</i>	Black Pomfret	0	0	0	0	0	1		1
<i>Epinephelus malabaricus</i>	Blackspotted Rockcod	0	0	0	0	0	1		1
<i>Chelonia mydas</i>	Green Turtle	0	0	0	0	0	0	1	1
<i>Dugong dugon</i>	Dugong	0	0	0	0	0	0	1	1
Pristidae spp.	Sawfish	0	0	0	0	0	0	1	1
<b>Total</b>		<b>560</b>	<b>488</b>	<b>357</b>	<b>11</b>	<b>12</b>	<b>1470</b>	<b>216</b>	<b>3120</b>

### Fisheries Resources

Sixty eight species from 30 Families were recorded in the creel surveys (Table 2). Although not directly comparable it was evident from the CPUE that bait netting and gill netting were the most effective means of capturing large numbers of fish, in comparison to line fishing, hand spearing and hooking (Figure 5, Figure 6). The ability of both community and non-community fishers to catch fish appears to be similar as the overlapping 95%CI indicated no significant difference in the CPUE (Figure 5). The relatively high CPUE for hand spears and hooking, two exclusively community fisher fishing techniques, suggests these methods were a productive means of targeting Giant Mud Crab and other species found in the intertidal zone (Figure 5).



**Figure 5: Catch (CPUE) (+95%CI) for line fishing, hand spearing and hooking used by community (black column) and non-community fishers (grey column) in the Port Musgrave Community monitoring creel survey.**



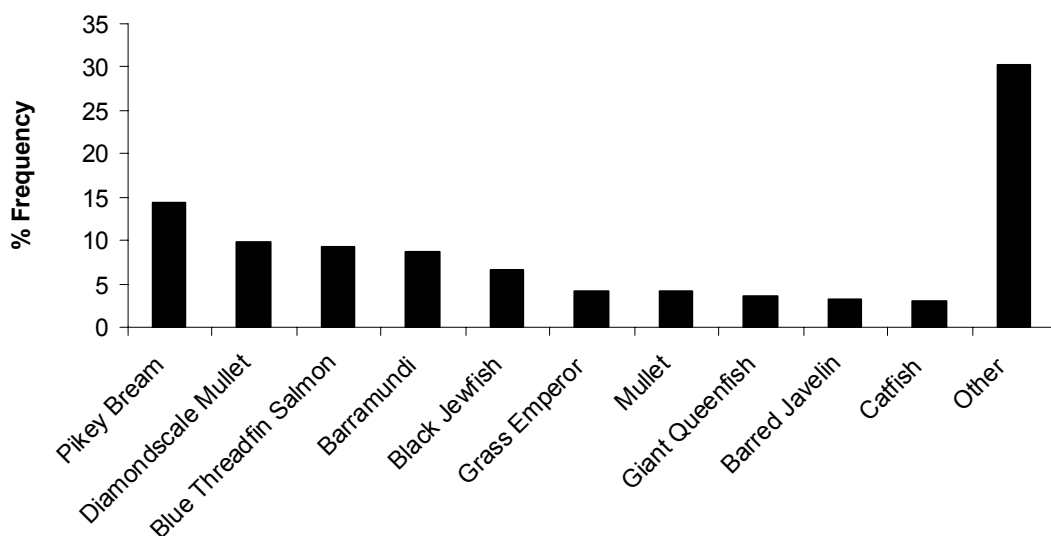
**Figure 6: Catch (CPUE) (95%CI) for bait nets and gill nets used by community (black column) and non-community fishers (grey column) in the Port Musgrave Community monitoring creel survey.**

Pikey Bream (*A. berda*) was the most dominant species (by number) recorded (14%) and was caught using a variety of fishing apparatus including bait net, crab pot, gill net and line fishing (Figure 7; Table 2). The Diamondscale Mullet (*L. vagiensis*) was the second most common species (10%) recorded and was captured only with gill nets (Figure 7; Table 2). The category 'other' represented 55 species (Figure 7).

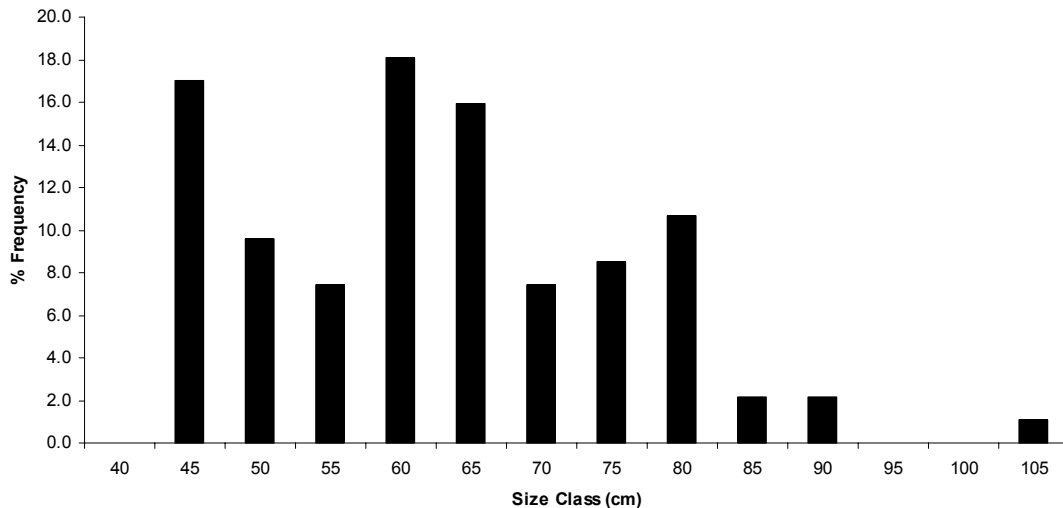
As mentioned previously the total effort hours for gill net was low (23 hours), hence there are difficulties with comparisons across gear types when the result can be biased towards a particular gear type. It does highlight the importance of this method to community in relation to catching this species, as they are not commonly caught by line fishermen. Diamondscale Mullet are a target species for community due to the high fish oil content in the flesh in comparison to other species (G. Manatan, Mapoon Community Traditional Owner pers. comm. 2009).

The commercially important Blue Threadfin Salmon (9%) and Barramundi (9%) were captured in similar numbers than Diamondscale Mullet although they were caught using bait net, crab pot, gill net and line fishing (Table 2). The fact they were apparently caught using crab pot apparatus suggested there may have been some anomalies in the recording process. If future monitoring is conducted, the data recording sheet may require modification to eliminate such errors or more on-the-ground training of the Community Project Officer may be required. Length-frequency data recorded was limited. Ninety four Barramundi were measured with a wide range of size classes recorded, 45 cm to 105 cm total length, that indicated mature and immature Barramundi were present (Figure 8).

The Grass Emperor (*Lethrinus laticaudis*) was among the top 10 species recorded (Figure 7; Table 2). This species is known to inhabit inshore reefs and was reported in the creel surveys by community and non-community fishers that identified with using a boat. These fishers were found to frequent the inshore reefs off Cullen Point. Of the 'other' fish recorded (55 species), 44% were commonly caught in inshore reefs.



**Figure 7: Top 10 most commonly recorded species in the Port Musgrave creel surveys.**



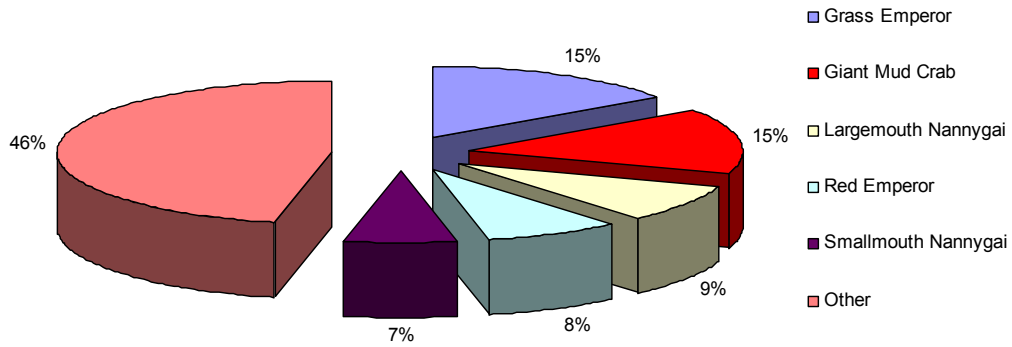
**Figure 8: Barramundi length-frequency data from 53 creel surveys undertaken in the Port Musgrave area between 16/6/09 and 31/11/09, n = 94.**

Analysis of the boat catch data from community, non-community fishers and community shore based fishers indicated that different species were caught among the three groups. It appeared community fishers with access to a boat caught more reef fish species than estuarine species. A total of 569 fish from 43 species were caught by community boat fishers. Besides the ‘other’ group of fish, the most dominant species caught were Grass Emperor (15%), Giant Mud Crab (15%), Largemouth Nannygai (9%) and Red Emperor (*Lutjanus sebae*) (8%) (Figure 9; Table 2).

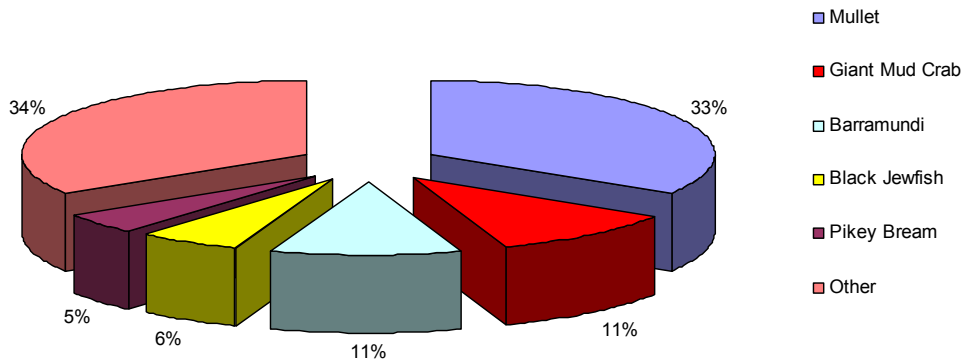
In comparison, non-community fishers with access to a boat appeared to target fish species of estuarine origin. This difference in fish species targeted could be influenced by the size of the boats used, with community fishers possessing much larger trailer boats than those of non-community fishers. This would limit the distance fishers are prepared to travel especially in unfamiliar territory in a remote location. A total of 1536 fish from 49 species were caught by non-community boat fishers. Besides the ‘other’ group of fish, the most dominant animals caught were Mullet (*Mugilidae* spp.) (33%), Giant Mud Crab (11%), Barramundi (11%) and Black Jewfish (*P. diacanthus*) (6%) (Figure 10). Although Mullet were the most dominant fishes recorded, they are considered baitfish and were most likely used to capture the other target species, namely Barramundi and Black Jewfish. It is common knowledge in the Mapoon Community that Black Jewfish are caught in the “jew hole” located approximately 10.5 km upstream of the Ducie River (T. Dugden Community Monitoring Project Officer pers. comm. 2009).

The composition of the top five most common species captured by shore based community fishers was different from both community boat fishers and non-community boat fishers. A total of 1115 specimens were captured representing 29 species. The most dominant fish recorded were Mullet (52%), Pikey Bream (18%) and Blue Threadfin Salmon (7%) (Figure 11). The high number of Mullet (*Mugilidae* spp.) represented in the data was again biased towards the use of gill net apparatus. Community fishers walk the net out on the mud/ sand bank at low tide and leave it out to fish until the following low tide, whereupon they retrieve it and harvest the fish.

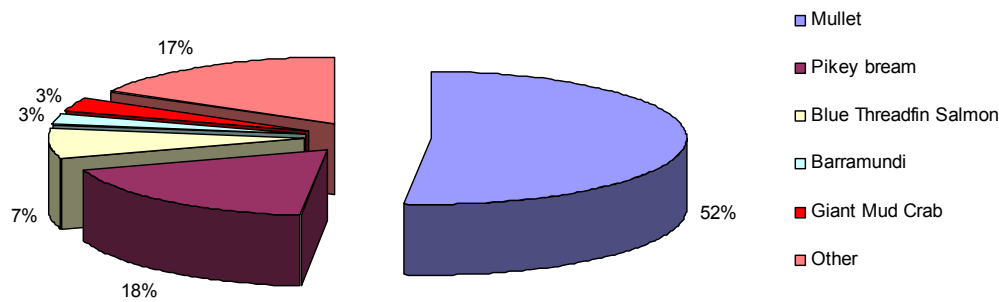
Cullen Point was the most frequently visited location for shore based community fishers and Pikey Bream and Blue Threadfin Salmon were commonly caught from this location.



**Figure 9: Top five species caught (by number n = 569) by local community boat based fishermen using line fishing, trolling, bait fishing, and crab potting.**



**Figure 10: Top five species caught (by number n = 1536) by non-local community boat based fishermen using line fishing, bait fishing and crab potting.**



**Figure 11: Top five species caught (by number n = 1115) by local community shore based fishermen using line fishing, crab potting, bait fishing and hand spearing.**

### Species of Conservation Interest

A total of 216 animals from five protected species and species groups were observed from 69 creel surveys; Saltwater Crocodile, dolphins, turtles, Dugong and sawfish (Table 2; Figure 12). The two most common protected species reported in the creel surveys were Saltwater Crocodiles (n = 129) and dolphins (n = 54) (Table 2; Figure 12). There are at least two species of dolphins known to occur in the area: Australian Snubfin Dolphin (*Orcaella heinsohni*) and Indo-Pacific Hump-backed Dolphin (*Sousa chinensis*) (Section 3.3.1 in the main document). Saltwater Crocodile was the most widely distributed species observed in Port Musgrave (Figure 12). It was recorded in the upper reaches of the Ducie River and Wenlock River; on the Namaleta Creek foreshore; on the foreshores of the Mapoon community; and along Cullen Point. Dolphins were also recorded in the Ducie River and Wenlock River; on the Namaleta Creek foreshore and in inshore coastal waters off Cullen Point (Figure 12). Marine turtles were recorded in Port Musgrave, albeit only near Namaleta Creek with the remaining sightings occurring in inshore coastal waters off Cullen Point and further offshore (Figure 12). In addition to the two identified species, Green Turtle (*Chelonia mydas*) and Hawksbill Turtle (*Eretmochelys imbricata*), there are four other species of turtles that are known to occur in the area: Loggerhead Turtle (*Caretta caretta*), Leatherback Turtle (*Dermochelys coriacea*), Olive Ridley Turtle (*Lepidochelys olivacea*) and Flatback Turtle (*Natator depressus*).

A sawfish of unknown species was recorded on the mud flats in front of the Mapoon Community (Figure 12), a known feeding area for Green Sawfish (*Pristis zijsron*) (Peverell and Pillans 2004). One Dugong (*Dugong dugon*) was recorded in this Community Monitoring Assessment in inshore coastal waters off Cullen Point (Figure 12). Dugong feeding trails on seagrass meadows have been recorded in Port Musgrave by the Fisheries Queensland Seagrass Monitoring Group and this record of occurrence is consistent with anecdotal reports from traditional hunters in Mapoon Community (G. Manatan, Mapoon Community Traditional Owner pers. comm. 2009). One Queensland Grouper (*Epinephelus lanceolatus*) was recorded upstream in the Ducie River (Figure 12). Given the large numbers of Queensland Grouper recorded in

the associated Fisheries Resource monitoring surveys of Port Musgrave this single record is surprisingly low, although heavy fishing gear not commonly used by recreational anglers was used in the fisheries independent surveys. Queensland Groper may have broken free from the lighter fishing tackle and hence not been recorded.

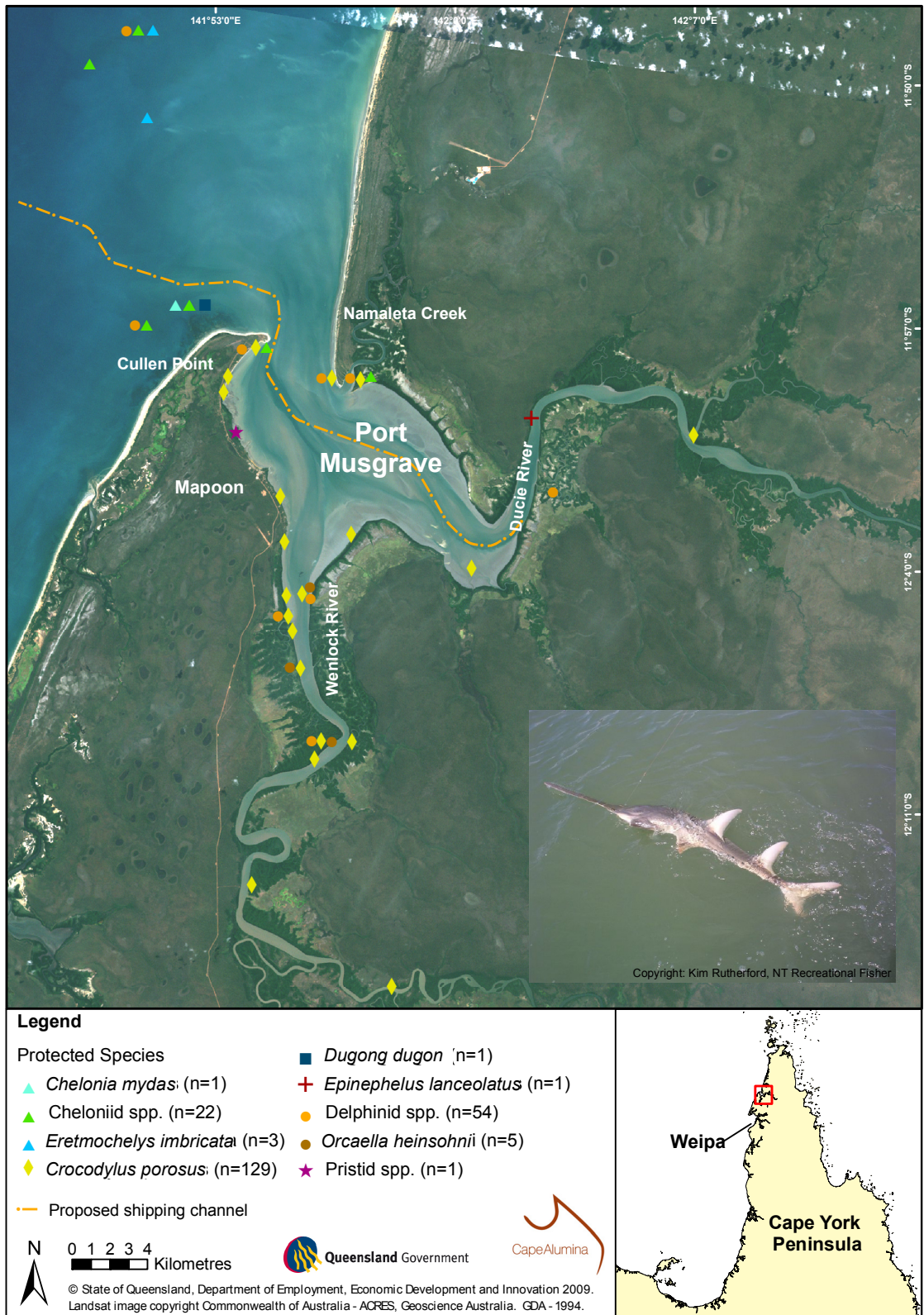


Figure 12: Location and number of Species of Conservation Interest recorded from creel surveys.

### **Threats and potential impacts**

It is difficult to quantify the potential impacts and threats the proposed port development will have on community and visiting recreational anglers to the region. Typically port developments have brought infrastructure to remote regions and this has in turn provided better access and facilities for community and tourists alike. Fishing pressure in these developed areas normally goes up and not down, for example, as occurred in Weipa. Hence, there is a challenge for developers, regulators and conservation management authorities. The considerations of the Traditional Owners in the Port Musgrave area (five clan groups) and the potential impact of the proposed development to these groups are assessed in more detail in a Social Impact Assessment study; another element of the Environmental Impact Assessment presented in a separate report.

Many Species of Conservation Interest occur in the Port Musgrave region, in particular the critically endangered Speartooth Shark (*Glyphis glyphis*) and vulnerable Freshwater Sawfish (*Pristis microdon*), Dwarf Sawfish (*Pristis clavata*) and Green Sawfish (*P. zijsron*). As shown in this assessment and the independent Fisheries Resource monitoring surveys of Port Musgrave there are also a number of protected reptile and cetacean species known to inhabit Port Musgrave.

It is possible Species of Conservation Interest may be displaced from their natural habitat in Port Musgrave through direct (removal of animal through incidental capture) or indirect (increased boat traffic or noise pollution) pressures. In the associated independent Fisheries Resource surveys, immature Speartooth Shark were captured with injuries sustained from recreational fishing (wire trace and hook in mouth). With no information on post release mortality, quantifying the true impact of line fishing on this species is not possible.

The development of a port facility will almost certainly limit access to certain fishing locations for community and non-community fishers. It is a regulatory requirement that exclusion zones are placed around sites of navigational importance, such as swing basins for large ships. This may impede any future development of Mapoon Community where income either directly (commercial fishing enterprise) or indirectly (camping ground) is drawn from fishing. As reported in this Community Monitoring Assessment, community and non-community fisher utilise most areas of Port Musgrave including the Ducie River and Wenlock River. The area also contains inshore reefs and estuarine habitats known to support healthy populations of desirable sportfish (Barramundi, Giant Queenfish (*Scomberoides commersonianus*), Tuna Mackerel (*Scombridae* spp.) and high quality eating fish (Coral Trout, Largemouth Nannygai and Smallmouth Nannygai).

## 4.0 References

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Peeverell S.C. and Pillans R. (2004) Determining feasibility of acoustic tag attachment and documenting short-term movements in *Pristis zijsron* (Bleeker, 1851). Report to the National Oceans Office, Department of Primary Industries and Fisheries.

Pollock K.H., Jones C.M., and Brown T. (1994) Angler survey methods and their application in fisheries management. *American Fisheries Society Special Publication*, No. 25.

Appendix A: Fisheries Resource Monitoring Manual  
(extracts provided, full document available from  
authors)

# Mapoon Community Fishing Monitoring Methods

## Background to the survey.

The purpose of the community monitoring program within the scope of the larger monitoring program is to:

- Identify key species of importance to the Traditional Owners of the area
- Quantify the use of fisheries resources by the Traditional Owners through collecting data on the species, numbers and sizes taken
- Quantify the use of fisheries resources by tourists, non-community visitors and non-traditional owners through collecting data on the species, numbers and sizes taken
- Identify the consequences of the proposed impact on Traditional Owners in terms of the impacts on the key fisheries species utilised
- Gain valuable data on the distribution of rare and iconic species in the area

## Start date, personnel.

The esky surveys (basically roving “creel” surveys) were initiated as soon as possible following discussions with community members, Wild Rivers Officers and Fisheries Queensland staff involved with the task. This was the start of April 2009 and continued until the end of 2009. The survey covered a period of time that spanned the end of the wet season through the dry season and into the start of the next wet season. The amount of time spent per week interviewing fishers was determined based on the availability of personnel and the most appropriate time(s) to sample to achieve the greatest data set. This was determined by negotiation so that the outcomes of the project were met.

Initially it was proposed that the Rangers perform daily esky surveys at Cullen Point from 4pm to 6pm. Other surveys would be performed on an opportunistic basis as time and opportunity permits, the data collected by the Wild Rivers Rangers would be supplemented by the surveys conducted by the part time community officer.

Personnel for the project included a community officer located in Mapoon employed on a part time basis (2 days per week), involvement from a number of the Wild Rivers Rangers in the area, a project officer based in Cairns to oversee the project, as well as involvement from the Head Project Officer.

## Supporting documents.

Along with this document there are a number of other documents which were developed to support the collection of data and form part of this methods document. They are:

**Checklist 1 Esky Survey** (a day planner designed to assist staff performing the interviews in time planning and data collection for that day)

**Checklist 2 Esky Survey** (a day planner to assist staff in assembling the required equipment to perform the survey)

**How to Measure the Catch**

**Esky Survey Datasheet**

**Species ID list**

## How to conduct a survey.

Firstly, assemble the data and checklists as listed above and plan for when the sampling is going to occur. Go through and fill out the two checklists prior to leaving

the office/ base for the day. Ensure that all required materials are taken as per checklist 2.

When conducting the interviews

- Use a separate datasheet for each group
- Try to interview all anglers in the location within the time allocated
- Begin by explaining to the group what it is that you are doing, i.e. *“We are looking at the fishing activities around the area to build a picture of the traditional owner and visitor use of the fisheries resources to establish possible impacts of the development of a port facility at Port Musgrave.”*
- Keep in mind that the survey is optional, so ask if the fishers want to participate in the survey first, and ask them to measure the catch for you using your equipment so that damage / handling by you is minimised or non-existent.

Once the surveys have been completed at the end of that day, the datasheets should be returned to the office/ base and the data entered into the laptop onto the database which has been established for that purpose, as soon as possible. Ensure all the fields are filled out and photocopy the original datasheets and post to Fisheries Queensland on a weekly basis. Data entered for the week should also be emailed to Fisheries Queensland weekly for verification in conjunction with the photocopied datasheets which have been forwarded on. Original datasheets should be stored within the office/ base securely.

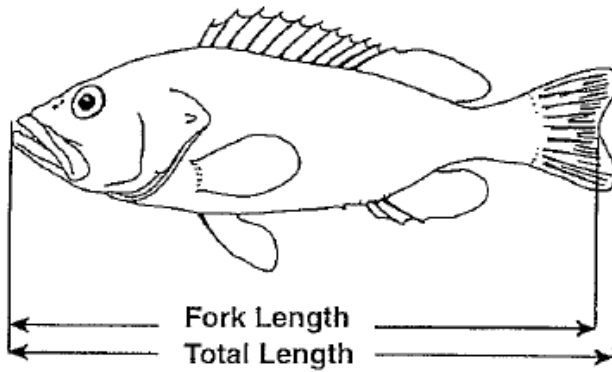
As a pilot study, and in addition to the surveys recorded on the datasheets, it is proposed that the PDAs currently in use by the Wild Rivers Rangers would be loaded with the fields from the datasheets and the survey information entered here simultaneously. Once the effectiveness of this method of data collection has been evaluated further decisions regarding moving to this form of data collection exclusively will be made.

## **How to Measure the Catch**

### **Measurement of fish, sharks, rays and sawfish.**

There are two basic methods for measuring the length of fish; fork length and total length (Figure 1). For all species other than those with a rounded tail use the fork length measurement. Place the fish (shark, sawfish) with the head towards the end of the measuring board with the end on it and measure to the nearest centimetre at the fork of the tail (as below). Do this for all the catch and record fork length and the number of animals for each individual species on the datasheet. The only exceptions to this are ray species, where the disc width is measured in the same fashion as total length, but across the animal so as to not include the tail; and species with a rounded tail where we will use the total length measurement as below.

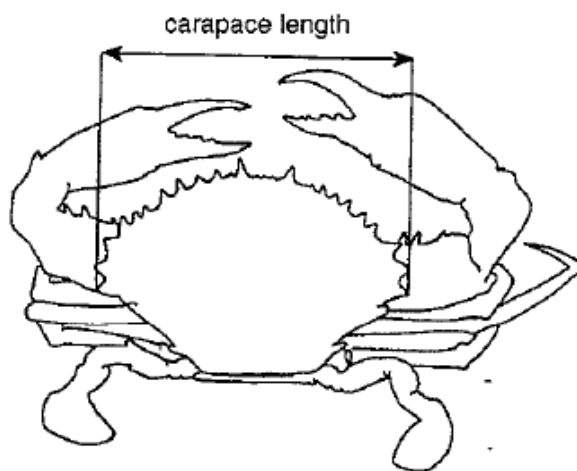
Any animals which have been eaten already or used for bait can be estimated for fork or total length and included in the catch data also, but a note must be made that the animal(s) in this category were estimated and not sighted.



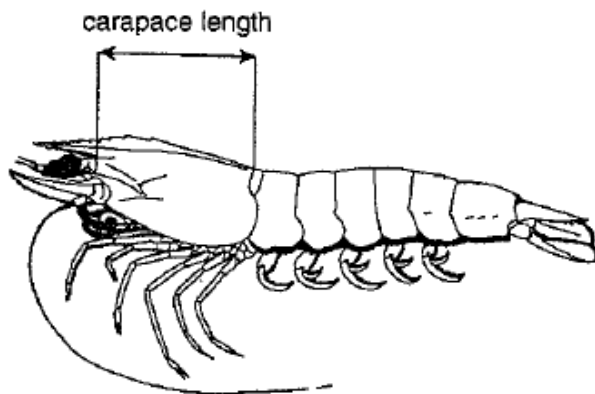
**Figure 1:** Methods for measuring the length of fish, sharks, and sawfish.

**Measurement of crabs, crayfish and prawns.**

For mud crabs, measurement must be made across the broadest part of the carapace as indicated below (Figure 2). Prawns need not be measured but simply counted into two categories; large and small. Crayfish however must be measured by looking at the carapace length (Figure 3). Measure the carapace width or carapace length respectively of all the individual species, and then record them on the datasheet.



**Figure 2:** Carapace length measurement for crabs.



**Figure 3:** Carapace length measurement for crayfish.

## Esky Survey

### Part 1: Identification (Fill in all details and circle correct answers)

Date: \_\_\_\_\_ Time: \_\_\_\_\_ am / pm Interview Site: \_\_\_\_\_ Recorder: \_\_\_\_\_  
 Hours fished: \_\_\_\_\_ Family group: Yes / No Home p/code: \_\_\_\_\_  
 Community resident / Tourist / Visitor / Contractor \_\_\_\_\_ Subsistence fishing: Yes / No  
 Boat: Yes / No Total number of people fishing at the site: \_\_\_\_\_  
 No. of people in the interview group M: \_\_\_\_\_ F: \_\_\_\_\_ C: \_\_\_\_\_ Number fishing: M: \_\_\_\_\_ F: \_\_\_\_\_ C: \_\_\_\_\_

### Part 2: Gear used in the fishing activity (Indicate number next to the gear used)

Spear gun \_\_\_\_\_ Line Fishing \_\_\_\_\_ Gill net \_\_\_\_\_ Bait net \_\_\_\_\_  
 Hand spear \_\_\_\_\_ Trolling \_\_\_\_\_ Crab pots \_\_\_\_\_ Other \_\_\_\_\_

### Part 3: Details of the catch

Did you catch these fish in the study areas? (Yes / No)

Number and length (cm) of animals caught in each study area

Key: Fate: Kept (K), Released Alive (RA), Released Dead (RD).  
 Sex: For sharks and crabs Male (M), Female (F), Parasitised (P) crabs.  
 Gear type: Gill nets. Record: mesh size, length, mesh drop of net and soak time.  
 Site: descriptive location within the grid if possible (i.e. mouth of namaleta, red beach ect).

Gear Type	Species	Number	Site	Length (cm)	Fate	Sex

### Part 4: Time spent using fishing gear in study areas (= Effort)

(Fill in the number of hours spent using each fishing gear type in each survey location.)

Gear Type	Site(s)	Hours
Spear gun		
Hand spear		
Line fishing		
Gill net		
Trolling		

Bait net		
Other		

**Crab pots**

Site(s)	Number	Soak Time (hours)

**Part 5: Notes / Comments / Protected Species Observations:**

<b>Notes:</b>
<b>Comments:</b>
<b>Protected Species Observations:</b>



## Appendix B Species List

Species list and numbers of specimens captured by each survey technique from Ducie River, Wenlock River and Namaleta Creek for March, June and November surveys. Species of Conservation Interest are highlighted.

Family	Species	Common name	Survey Technique				Total
			Gillnet	Cast net	Set line	Potting	
<b>Sharks and rays</b>							
Carcharhinidae	<i>Carcharhinus amblyrhynchoides</i>	Graceful Shark	78		8	1	87
Carcharhinidae	<i>Carcharhinus amboinensis</i>	Pigeeye Shark	9		11		20
Carcharhinidae	<i>Carcharhinus cautus</i>	Nervous Shark	25			2	27
Carcharhinidae	<i>Carcharhinus leucas</i>	Bull Shark	28				28
Carcharhinidae	<i>Carcharhinus limbatus</i>	Common Blacktip Shark	12				12
Carcharhinidae	<i>Carcharhinus limbatus/tilstoni</i>	Blacktip Shark complex	42		5	1	48
Carcharhinidae	<i>Carcharhinus tilstoni</i>	Australian Blacktip Shark	8				8
Carcharhinidae	<i>Glyphis glyphis</i>	Speartooth Shark	14		3	2	19
Carcharhinidae	<i>Negaprion acutidens</i>	Lemon Shark	29		12		41
Carcharhinidae	<i>Rhizoprionodon taylori</i>	Australian Sharpnose Shark	33				33
Dasyatidae	<i>Himantura dalyensis</i>	Freshwater Whipray	1		18		19
Dasyatidae	<i>Himantura granulate</i>	Mangrove Whipray	1		1		2
Dasyatidae	<i>Himantura uarnak</i>	Reticulate Whipray	3		1		4
Dasyatidae	<i>Pastinachus atrus</i>	Cowtail Stingray	1				1
Ginglymostomati dae	<i>Nebrius ferrugineus</i>	Tawny Shark			4		4
Hemigaleidae	<i>Hemipristis elongate</i>	Fossil Shark	1				1
Myliobatidae	<i>Aetobatus narinari</i>	Whitespotted Eagle Ray	13				13
Myliobatidae	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	32				32
Pristidae	<i>Anoxypristis cuspidate</i>	Narrow Sawfish	5				5
Pristidae	<i>Pristis clavata</i>	Dwarf Sawfish	8				8
Pristidae	<i>Pristis microdon</i>	Freshwater Sawfish	2				2
Pristidae	<i>Pristis zijsron</i>	Green Sawfish	10				10
Rhinobatidae	<i>Glaucostegus typus</i>	Giant Shovelnose Ray	12	2			14
Rhinobatidae	<i>Rhynchobatus laevis</i>	Smoothnose Wedgefish	4		2		6
Rhinobatidae	<i>Rhynchobatus australiae</i>	Whitespotted Wedgefish	12				12

Family	Species	Common name	Survey Technique				Total
			Gillnet	Cast net	Set line	Potting	
Sphyrnidae	<i>Eusphyra blochii</i>	Winghead Shark	28		4		32
Sphyrnidae	<i>Sphyrna lewini</i>	Scalloped Hammerhead	1				1
Sphyrnidae	<i>Sphyrna mokarran</i>	Great Hammerhead	6		6		12
Stegostomatidae	<i>Stegostoma fasciatum</i>	Zebra Shark			2		2
<b>Fish</b>							
Ambassidae	<i>Ambassis nalu</i>	Scalloped Glassfish		385			385
Aploactinidae	<i>Bathyploactis ornatissimus</i>	Ornate Velvetfish		1			1
Ariidae	Ariidae spp.	Forktail catfish	7			1	8
Ariidae	<i>Ariopsis paucus</i>	Salmon catfish	81			41	122
Ariidae	<i>Cinetodus froggatti</i>	Smallmouth Catfish	11				11
Ariidae	<i>Neoarius graeffei</i>	Blue Catfish	28	1			29
Ariidae	<i>Netuma thalassina</i>	Giant Sea Catfish	15		24	13	52
Ariidae	<i>Plicofollis argyropleuron</i>	Longsnout Catfish		10			10
Belonidae	<i>Strongylura strongylura</i>	Blackspot Longtom	1	6			7
Callionymidae	<i>Repomucenus cf macdonaldi</i>	Greyspotted Dragonet		5			5
Carangidae	<i>Carangoides fulvoguttatus</i>	Turrum	1				1
Carangidae	<i>Caranx ignobilis</i>	Giant Trevally		2			2
Carangidae	<i>Parastromateus niger</i>	Black Pomfret	4				4
Carangidae	<i>Scomberoides commersonianus</i>	Giant Queenfish	509	2			511
Carangidae	<i>Trachinotus blochii</i>	Snubnose Dart	10				10
Centropomidae	<i>Lates calcarifer</i>	Barramundi	372	79			451
Centropomidae	<i>Psammoperca waigiensis</i>	Sand Bass				1	1
Chanidae	<i>Chanos chanos</i>	Milkfish	12				12
Chirocentridae	<i>Chirocentrus dorab</i>	Dorab Wolf Herring	2				2
Clupeidae	<i>Escualosa thoracata</i>	White Sardine		4			4
Clupeidae	<i>Nematalosa come</i>	Hairback Herring	27	482			509
Drepanidae	<i>Drepane punctata</i>	Sicklefish	9	1			10
Eleotridae	<i>Butis butis</i>	Crimson tip Gudgeon		1			1

Family	Species	Common name	Survey Technique				Total
			Gillnet	Cast net	Set line	Potting	
Elopidae	<i>Elops hawaiiensis</i>	Hawaiian Giant Herring	1	1			2
Engraulidae	<i>Thryssa hamiltonii</i>	Hamilton's Thryssa					0
Gerreidae	<i>Gerres filamentosus</i>	Threadfin Silverbidy		1			1
Gerreidae	<i>Gerres ovatus</i>	Common Silverbidy		5			5
Gobiidae	<i>Boleophthalmus birdsongi</i>	Birdsong's Mudskipper		1			1
Gobiidae	<i>Brachyamblyopus coecus</i>	Blind Goby		1			1
Gobiidae	<i>Periophthalmodon freycineti</i>	Giant Mudskipper		7			7
Haemulidae	<i>Plectorhinchus gibbosus</i>	Brown Sweetlips	6				6
Haemulidae	<i>Pomadasys kaakan</i>	Barred Javelin	20	32		2	54
Hemiramphidae	<i>Arrhamphus sclerolepis</i>	Snubnose Garfish		1			1
Hemiramphidae	<i>Zenarchopterus buffonis</i>	Northern River Garfish		40			40
Leiognathidae	<i>Gazza minuta</i>	Toothed Ponyfish		7			7
Leiognathidae	<i>Leiognathus splendens</i>	Blacktip Ponyfish		1			1
Leiognathidae	<i>Leiognathus equulus</i>	Common Ponyfish		115			115
Leiognathidae	<i>Secutor ruconius</i>	Ponyfish		1			1
Leptobramidae	<i>Leptobrama muelleri</i>	Beach Salmon	5				5
Lobotidae	<i>Lobotes surinamensis</i>	Tripletail	3				3
Lutjanidae	<i>Lutjanus johnii</i>	Golden Snapper				1	1
Mugilidae	<i>Liza subviridis</i>	Greenback Mullet		900			900
Mugilidae	<i>Liza vaigiensis</i>	Diamondscale Mullet	21	1			22
Mugilidae	<i>Valamugil buchanani</i>	Bluetail Mullet	6				6
Mugilidae	<i>Valamugil perusii</i>	Mullet		198			198
Mugilidae	<i>Valamugil seheli</i>	Bluespot Mullet	1	6			7
Platycephalidae	<i>Platycephalus indicus</i>	Bartail Flathead		6			6
Plotosidae	<i>Plotosus canius</i>	Eel Catfish		24			24
Polynemidae	<i>Eleutheronema tetradactylum</i>	Blue Threadfin Salmon	581	46		1	628
Polynemidae	<i>Polydactylus macrochir</i>	King Threadfin Salmon	42				42
Pseudomugilidae	<i>Pseudomugil</i> spp.	Blue Eye		10			10
Scatophagidae	<i>Scatophagus argus</i>	Spotted Scat	1	2			3

Family	Species	Common name	Survey Technique					Total
			Gillnet	Cast net	Set line	Potting	Observation	
Sciaenidae	<i>Nibea soldado</i>	Silver Jewfish	20	3		1		24
Sciaenidae	<i>Protonibea diacanthus</i>	Black Jewfish	16					16
Scombridae	<i>Scomberomorus commerson</i>	Spanish Mackerel	1					1
Scombridae	<i>Scomberomorus munroi</i>	Spotted Mackerel	1					1
Scombridae	<i>Scomberomorus semifasciatus</i>	Grey Mackerel	3					3
Serranidae	<i>Epinephelus coioides</i>	Goldspotted Rockcod					28	28
Serranidae	<i>Epinephelus lanceolatus</i>	Queensland Groper	4		46			50
Siganidae	<i>Siganus guttatus</i>	Orangespotted Spinefoot		1				1
Sillaginidae	<i>Sillago sihama</i>	Northern Whiting		9				9
Soleidae	<i>Pardachirus rauteri</i>	Mottled Sole		106				106
Sparidae	<i>Acanthopagrus berda</i>	Pikey Bream	6	29		11		46
Sphyraenidae	<i>Sphyraena barracuda</i>	Great barracuda		1				1
Terapontidae	<i>Terapon theraps</i>	Largescale Grunter		2				2
Tetraodontidae	<i>Arothron immaculatus</i>	Yellow-eye Puffer		47				47
Tetraodontidae	<i>Arothron manilensis</i>	Narrowlined Puffer				2		2
Tetraodontidae	<i>Chelonodon patoca</i>	Milkspot Toadfish		5		1		6
Tetraodontidae	<i>Tetraodon erythrotaenia</i>	Redstripe Toadfish		3				3
Tetraodontidae	<i>Marilyna meraukensis</i>	Merauke Toadfish		19		4		23
Toxotidae	<i>Toxotes chatareus</i>	Sevenspot Archerfish	6	1				7
Triacanthidae	<i>Triacanthus nieuhofi</i>	Silver Tripodfish	1					1
<b>Mammals</b>								
Delphinidae	<i>Orcaella heinsohni</i>	Australian Snubfin Dolphin					24	24
Delphinidae	<i>Sousa chinensis</i>	Indo-Pacific Hump-backed Dolphin					2	2
<b>Reptiles</b>								
Cheloniidae	<i>Natator depressus</i>	Flatback Turtle					1	1
Crocodylidae	<i>Crocodylus porosus</i>	Saltwater Crocodile	10		1		34	45
Hydrophiidae	Hydrophiidae spp.	Sea Snake				1		1

Family	Species	Common name	Survey Technique					Total
			Gillnet	Cast net	Set line	Potting	Observation	
Hydrophiidae	<i>Hydrophis inornatus</i>	Plain Sea Snake					24	24
Hydrophiidae	<i>Hydrophis elegans</i>	Elegant Sea Snake					2	2
Acrochordidae	<i>Acrochordus arafurae</i>	Arafura Filesnake					1	1
<b>Crabs and Prawns</b>								
Dorippidae	<i>Dorippe frascone</i>	Crab		2				2
Eriphiidae	Eriphiidae spp.	Crab				21		21
Paguroidea	Paguroidea spp.	Hermit Crab				12		12
Palaemonidae	<i>Macrobrachium</i> spp.	Longclawed Freshwater Prawn		1				1
Penaeidae	<i>Fenneropenaeus merguensis</i>	Banana Prawn		630		2		632
Penaeidae	<i>Penaeus monodon</i>	Black Tiger prawn		8		6		14
Portunidae	<i>Portunus (Portunus) pelagicus</i>	Blue Swimmer Crab				21		21
Portunidae	<i>Scylla olivacea</i>	Orange Mud Crab				19		19
Portunidae	<i>Scylla serrata</i>	Giant Mud Crab	7	3		357		367
Portunidae	<i>Thalamita crenata</i>	Mangrove Crab		1		7		8
Squillidae	<i>Erugosquilla woodmasoni</i>	Mantis Shrimp		1				1
Xanthidae	Xanthidae spp.	Rock Crab				3		3
<b>Jellyfish</b>								
Catostylidae	<i>Catostylus mosaicus</i>	Jelly Blubber	1				5	6
Cepheidae	<i>Netrostoma</i> spp.	Jellyfish					1	1
Chirodropidae	<i>Chironex fleckeri</i>	Box Jellyfish					24	24
Cyaneidae	<i>Cyanea capillata</i>	Lion's Mane Jellyfish					13	13
Mastigiidae	<i>Phyllorhiza punctata</i>	Brown Jellyfish					38	38
<b>Total</b>			<b>2270</b>	<b>3259</b>	<b>148</b>	<b>562</b>	<b>169</b>	<b>6407</b>

## Appendix C EPBC Protected Matters Online Search Tool



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## Protected Matters Search Tool

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EPBC Act Protected Matters Report

4 December 2009 10:42

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the [caveat](#) at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at <http://www.environment.gov.au/atlas> may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at

<http://www.environment.gov.au/epbc/assessmentsapprovals/index.html>

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This map may contain data which are  
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© PSMA Australia Limited

**Search Type:** Point  
**Buffer:** 30 km  
**Coordinates:** -12.02008,141.9398



**Report Contents:** [Summary](#)  
[Details](#)

- [Matters of NES](#)
- [Other matters protected by the EPBC Act](#)
- [Extra Information](#)

[Caveat](#)  
[Acknowledgments](#)

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## Summary

### Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance

that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see <http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html>.

<b>World Heritage Properties:</b>	None
<b>National Heritage Places:</b>	None
<b>Wetlands of International Significance: (Ramsar Sites)</b>	None
<b><u>Commonwealth Marine Areas:</u></b>	Relevant
<b>Threatened Ecological Communities:</b>	None
<b><u>Threatened Species:</u></b>	20
<b><u>Migratory Species:</u></b>	31

#### **Other Matters Protected by the EPBC Act**

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage/index.html>.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at <http://www.environment.gov.au/epbc/permits/index.html>.

<b>Commonwealth Lands:</b>	None
<b>Commonwealth Heritage Places:</b>	None

<b>Places on the RNE:</b>	None
<b><u>Listed Marine Species:</u></b>	73
<b><u>Whales and Other Cetaceans:</u></b>	11
<b>Critical Habitats:</b>	None
<b>Commonwealth Reserves:</b>	None

### Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

<b>State and Territory Reserves:</b>	None
<b>Other Commonwealth Reserves:</b>	None
<b>Regional Forest Agreements:</b>	None

### Details

#### Matters of National Environmental Significance

Commonwealth Marine Areas [ [Dataset Information](#) ]

Approval may be required for a proposed activity that is likely to have a significant impact on the environment in a Commonwealth Marine Area, when the action is outside the Commonwealth Marine Area, or the environment anywhere when the action is taken within the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

EEZ and Territorial Sea

Threatened Species [ [Dataset Information](#) ]

	Status	Type of Presence
<b>Birds</b>		
<a href="#"><i>Erythrotriorchis radiatus</i></a> Red Goshawk	Vulnerable	Species or species habitat likely to occur within area
<a href="#"><i>Rostratula australis</i></a> Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
<b>Mammals</b>		
<a href="#"><i>Balaenoptera musculus</i></a> Blue Whale	Endangered	Species or species habitat may occur within area
<a href="#"><i>Dasyurus hallucatus</i></a> Northern Quoll	Endangered	Species or species habitat likely to occur within area
<a href="#"><i>Megaptera novaeangliae</i></a> Humpback Whale	Vulnerable	Species or species habitat may occur within area
<a href="#"><i>Notomys aquilo</i></a> Northern Hopping-mouse	Vulnerable	Species or species habitat may occur within area
<a href="#"><i>Xeromys myoides</i></a>	Vulnerable	Species or species habitat may

Water Mouse, False Water Rat occur within area

## Reptiles

[\*Caretta caretta\*](#)  
Loggerhead Turtle Endangered Species or species habitat may occur within area

[\*Chelonia mydas\*](#)  
Green Turtle Vulnerable Species or species habitat may occur within area

[\*Dermochelys coriacea\*](#)  
Leatherback Turtle, Leathery Turtle, Luth Endangered Species or species habitat may occur within area

[\*Eretmochelys imbricata\*](#)  
Hawksbill Turtle Vulnerable Species or species habitat may occur within area

[\*Lepidochelys olivacea\*](#)  
Olive Ridley Turtle, Pacific Ridley Turtle Endangered Species or species habitat may occur within area

[\*Natator depressus\*](#)  
Flatback Turtle Vulnerable Breeding likely to occur within area

## Sharks

[\*Pristis clavata\*](#)  
Dwarf Sawfish, Queensland Sawfish Vulnerable Species or species habitat may occur within area

[\*Pristis microdon\*](#)  
Freshwater Sawfish Vulnerable Species or species habitat likely to occur within area

[\*Pristis zijsron\*](#)  
Green Sawfish, Dindagubba, Narrowsnout Sawfish Vulnerable Species or species habitat may occur within area

[\*Rhincodon typus\*](#)  
Whale Shark Vulnerable Species or species habitat may occur within area

## Plants

[\*Arenga australasica\*](#)  
Australian Arenga Palm Vulnerable Species or species habitat likely to occur within area

[\*Dendrobium bigibbum\*](#)  
Cooktown Orchid Vulnerable Species or species habitat may occur within area

[\*Dendrobium johannis\*](#)  
Vulnerable Species or species habitat likely to occur within area

Migratory Species [ [Dataset Information](#) ]

Status Type of Presence

## Migratory Terrestrial Species

### Birds

[\*Coracina tenuirostris melvillensis\*](#)  
Melville Cicadabird Migratory Species or species habitat may occur within area

[\*Haliaeetus leucogaster\*](#)  
White-bellied Sea-Eagle Migratory Species or species habitat likely to occur within area

<a href="#"><u>Hirundapus caudacutus</u></a> White-throated Needletail	Migratory	Species or species habitat may occur within area
<a href="#"><u>Hirundo rustica</u></a> Barn Swallow	Migratory	Species or species habitat may occur within area
<a href="#"><u>Merops ornatus</u></a> Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
<a href="#"><u>Monarcha melanopsis</u></a> Black-faced Monarch	Migratory	Species or species habitat may occur within area
<a href="#"><u>Myiagra cyanoleuca</u></a> Satin Flycatcher	Migratory	Species or species habitat likely to occur within area

### **Migratory Wetland Species**

#### **Birds**

<a href="#"><u>Ardea alba</u></a> Great Egret, White Egret	Migratory	Species or species habitat may occur within area
<a href="#"><u>Ardea ibis</u></a> Cattle Egret	Migratory	Species or species habitat may occur within area
<a href="#"><u>Rostratula benghalensis s. lat.</u></a> Painted Snipe	Migratory	Species or species habitat may occur within area

#### **Migratory Marine Birds**

<a href="#"><u>Apus pacificus</u></a> Fork-tailed Swift	Migratory	Species or species habitat may occur within area
<a href="#"><u>Ardea alba</u></a> Great Egret, White Egret	Migratory	Species or species habitat may occur within area
<a href="#"><u>Ardea ibis</u></a> Cattle Egret	Migratory	Species or species habitat may occur within area
<a href="#"><u>Calonectris leucomelas</u></a> Streaked Shearwater	Migratory	Species or species habitat may occur within area
<a href="#"><u>Puffinus leucomelas</u></a> Streaked Shearwater	Migratory	Species or species habitat may occur within area
<a href="#"><u>Sterna albifrons</u></a> Little Tern	Migratory	Species or species habitat may occur within area

#### **Migratory Marine Species**

#### **Mammals**

<a href="#"><u>Balaenoptera edeni</u></a> Bryde's Whale	Migratory	Species or species habitat may occur within area
<a href="#"><u>Balaenoptera musculus</u></a> Blue Whale	Migratory	Species or species habitat may occur within area
<a href="#"><u>Dugong dugon</u></a> Dugong	Migratory	Species or species habitat likely to occur within area
<a href="#"><u>Megaptera novaeangliae</u></a>	Migratory	Species or species habitat may

Humpback Whale		occur within area
<a href="#"><u>Orcaella brevirostris</u></a>	Migratory	Species or species habitat may occur within area
Irrawaddy Dolphin		
<a href="#"><u>Orcinus orca</u></a>	Migratory	Species or species habitat may occur within area
Killer Whale, Orca		
<a href="#"><u>Sousa chinensis</u></a>	Migratory	Species or species habitat may occur within area
Indo-Pacific Humpback Dolphin		

### Reptiles

<a href="#"><u>Caretta caretta</u></a>	Migratory	Species or species habitat may occur within area
Loggerhead Turtle		
<a href="#"><u>Chelonia mydas</u></a>	Migratory	Species or species habitat may occur within area
Green Turtle		
<a href="#"><u>Crocodylus porosus</u></a>	Migratory	Species or species habitat likely to occur within area
Estuarine Crocodile, Salt-water Crocodile		
<a href="#"><u>Dermochelys coriacea</u></a>	Migratory	Species or species habitat may occur within area
Leatherback Turtle, Leathery Turtle, Luth		
<a href="#"><u>Eretmochelys imbricata</u></a>	Migratory	Species or species habitat may occur within area
Hawksbill Turtle		
<a href="#"><u>Lepidochelys olivacea</u></a>	Migratory	Species or species habitat may occur within area
Olive Ridley Turtle, Pacific Ridley Turtle		
<a href="#"><u>Natator depressus</u></a>	Migratory	Breeding likely to occur within area
Flatback Turtle		

### Sharks

<a href="#"><u>Rhincodon typus</u></a>	Migratory	Species or species habitat may occur within area
Whale Shark		

### Other Matters Protected by the EPBC Act

Listed Marine Species [ <a href="#"><u>Dataset Information</u></a> ]	Status	Type of Presence
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### Birds

<a href="#"><u>Anseranas semipalmata</u></a>	Listed - overfly marine area	Species or species habitat may occur within area
Magpie Goose		
<a href="#"><u>Apus pacificus</u></a>	Listed - overfly marine area	Species or species habitat may occur within area
Fork-tailed Swift		
<a href="#"><u>Ardea alba</u></a>	Listed - overfly	Species or species habitat may occur within area
Great Egret, White Egret		

	marine area	
<a href="#"><u>Ardea ibis</u></a> Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
<a href="#"><u>Calonectris leucomelas</u></a> Streaked Shearwater	Listed	Species or species habitat may occur within area
<a href="#"><u>Haliaeetus leucogaster</u></a> White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
<a href="#"><u>Hirundapus caudacutus</u></a> White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
<a href="#"><u>Hirundo rustica</u></a> Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
<a href="#"><u>Merops ornatus</u></a> Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
<a href="#"><u>Monarcha melanopsis</u></a> Black-faced Monarch	Listed - overfly marine area	Species or species habitat may occur within area
<a href="#"><u>Myiagra cyanoleuca</u></a> Satin Flycatcher	Listed - overfly marine area	Species or species habitat likely to occur within area
<a href="#"><u>Rostratula benghalensis s. lat.</u></a> Painted Snipe	Listed - overfly marine area	Species or species habitat may occur within area
<a href="#"><u>Sterna albifrons</u></a> Little Tern	Listed	Species or species habitat may occur within area
<b>Mammals</b>		
<a href="#"><u>Dugong dugon</u></a> Dugong	Listed	Species or species habitat likely to occur within area
<b>Ray-finned fishes</b>		
<a href="#"><u>Acentronura tentaculata</u></a> Hairy Pygmy Pipehorse	Listed	Species or species habitat may occur within area
<a href="#"><u>Campichthys tricarinatus</u></a>	Listed	Species or species habitat may

Three-keel Pipefish		occur within area
<a href="#"><i>Choeroichthys brachysoma</i></a> Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Choeroichthys suillus</i></a> Pig-snouted Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Corythoichthys amplexus</i></a> Fijian Banded Pipefish, Brown-banded Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Corythoichthys flavofasciatus</i></a> Yellow-banded Pipefish, Network Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Corythoichthys intestinalis</i></a> Australian Messmate Pipefish, Banded Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Corythoichthys ocellatus</i></a> Orange-spotted Pipefish, Ocellated Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Corythoichthys schultzi</i></a> Schultz's Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Cosmocampus maxweberi</i></a> Maxweber's Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Doryrhamphus dactyliophorus</i></a> Ringed Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Doryrhamphus excisus</i></a> Indian Blue-stripe Pipefish, Blue-stripe Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Doryrhamphus janssi</i></a> Cleaner Pipefish, Janss' Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Festucalex cinctus</i></a> Girdled Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Halicampus brocki</i></a> Brock's Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Halicampus dunckeri</i></a> Red-hair Pipefish, Duncker's Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Halicampus grayi</i></a> Mud Pipefish, Gray's Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Halicampus spinirostris</i></a> Spiny-snout Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Haliichthys taeniophorus</i></a> Ribbioned Seadragon, Ribbioned Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><i>Hippichthys cyanospilos</i></a>	Listed	Species or species habitat may

Blue-speckled Pipefish, Blue-spotted Pipefish		occur within area
<a href="#"><u>Hippichthys penicillus</u></a> Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><u>Hippocampus angustus</u></a> Western Spiny Seahorse, Narrow-bellied Seahorse	Listed	Species or species habitat may occur within area
<a href="#"><u>Hippocampus histrix</u></a> Spiny Seahorse	Listed	Species or species habitat may occur within area
<a href="#"><u>Hippocampus kuda</u></a> Spotted Seahorse, Yellow Seahorse	Listed	Species or species habitat may occur within area
<a href="#"><u>Hippocampus planifrons</u></a> Flat-face Seahorse	Listed	Species or species habitat may occur within area
<a href="#"><u>Hippocampus spinosissimus</u></a> Hedgehog Seahorse	Listed	Species or species habitat may occur within area
<a href="#"><u>Micrognathus brevirostris</u></a> Thorn-tailed Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><u>Solegnathus hardwickii</u></a> Pipehorse	Listed	Species or species habitat may occur within area
<a href="#"><u>Solenostomus cyanopterus</u></a> Blue-finned Ghost Pipefish, Robust Ghost Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><u>Syngnathoides biaculeatus</u></a> Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><u>Trachyrhamphus bicoarctatus</u></a> Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
<a href="#"><u>Trachyrhamphus longirostris</u></a> Long-nosed Pipefish, Straight Stick Pipefish	Listed	Species or species habitat may occur within area
<b>Reptiles</b>		
<a href="#"><u>Acalyptophis peronii</u></a> Horned Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Aipysurus duboisii</u></a> Dubois' Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Aipysurus eydouxii</u></a> Spine-tailed Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Aipysurus laevis</u></a> Olive Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Astrotia stokesii</u></a> Stokes' Seasnake	Listed	Species or species habitat may occur within area

<a href="#"><u>Caretta caretta</u></a> Loggerhead Turtle	Listed	Species or species habitat may occur within area
<a href="#"><u>Chelonia mydas</u></a> Green Turtle	Listed	Species or species habitat may occur within area
<a href="#"><u>Crocodylus johnstoni</u></a> Freshwater Crocodile	Listed	Species or species habitat may occur within area
<a href="#"><u>Crocodylus porosus</u></a> Estuarine Crocodile, Salt-water Crocodile	Listed	Species or species habitat likely to occur within area
<a href="#"><u>Dermochelys coriacea</u></a> Leatherback Turtle, Leathery Turtle, Luth	Listed	Species or species habitat may occur within area
<a href="#"><u>Disteira kingii</u></a> Spectacled Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Disteira major</u></a> Olive-headed Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Enhydrina schistosa</u></a> Beaked Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Eretmochelys imbricata</u></a> Hawksbill Turtle	Listed	Species or species habitat may occur within area
<a href="#"><u>Hydrelaps darwiniensis</u></a> Black-ringed Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Hydrophis atriceps</u></a> Black-headed Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Hydrophis elegans</u></a> Elegant Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Hydrophis gracilis</u></a> Slender Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Hydrophis mcdowelli</u></a>	Listed	Species or species habitat may occur within area
<a href="#"><u>Hydrophis ornatus</u></a> a seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Hydrophis pacificus</u></a> Large-headed Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Lapemis hardwickii</u></a> Spine-bellied Seasnake	Listed	Species or species habitat may occur within area
<a href="#"><u>Laticauda colubrina</u></a> a sea krait	Listed	Species or species habitat may occur within area
<a href="#"><u>Laticauda laticaudata</u></a> a sea krait	Listed	Species or species habitat may occur within area
<a href="#"><u>Lepidochelys olivacea</u></a> Olive Ridley Turtle, Pacific Ridley Turtle	Listed	Species or species habitat may occur within area
<a href="#"><u>Natator depressus</u></a>	Listed	Breeding likely to occur within

Flatback Turtle		area
<a href="#"><i>Pelamis platurus</i></a> Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans [ <a href="#">Dataset Information</a> ]	Status	Type of Presence
<a href="#"><i>Balaenoptera edeni</i></a> Bryde's Whale	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Balaenoptera musculus</i></a> Blue Whale	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Delphinus delphis</i></a> Common Dolphin, Short-beaked Common Dolphin	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Grampus griseus</i></a> Risso's Dolphin, Grampus	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Megaptera novaeangliae</i></a> Humpback Whale	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Orcaella brevirostris</i></a> Irrawaddy Dolphin	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Orcinus orca</i></a> Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Sousa chinensis</i></a> Indo-Pacific Humpback Dolphin	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Stenella attenuata</i></a> Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area
<a href="#"><i>Tursiops aduncus</i></a> Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area
<a href="#"><i>Tursiops truncatus s. str.</i></a> Bottlenose Dolphin	Cetacean	Species or species habitat may occur within area

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### Caveat

The information presented in this report has been provided by a range of data sources as [acknowledged](#) at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the [migratory](#) and [marine](#) provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as [extinct or considered as vagrants](#)
- some species and ecological communities that have only recently been listed
- [some terrestrial species](#) that overfly the Commonwealth marine area
- migratory species that are very [widespread, vagrant, or only occur in small numbers](#).

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

## **Acknowledgments**

This database has been compiled from a range of data sources. The Department acknowledges the following custodians who have contributed valuable data and advice:

- [New South Wales National Parks and Wildlife Service](#)

- [Department of Sustainability and Environment, Victoria](#)
- [Department of Primary Industries, Water and Environment, Tasmania](#)
- [Department of Environment and Heritage, South Australia Planning SA](#)
- [Parks and Wildlife Commission of the Northern Territory](#)
- [Environmental Protection Agency, Queensland](#)
- [Birds Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Queensland Herbarium](#)
- [National Herbarium of NSW](#)
- [Royal Botanic Gardens and National Herbarium of Victoria](#)
- [Tasmanian Herbarium](#)
- [State Herbarium of South Australia](#)
- [Northern Territory Herbarium](#)
- [Western Australian Herbarium](#)
- [Australian National Herbarium, Atherton and Canberra](#)
- [University of New England](#)
- Other groups and individuals

[ANUcliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University](#) was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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[Department of the Environment, Water, Heritage and the Arts](#)

GPO Box 787 Canberra ACT 2601 Australia

Telephone: +61 (0)2 6274 1111

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