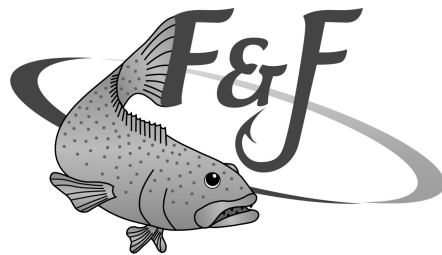


CRC REEF RESEARCH CENTRE TECHNICAL REPORT NO. 57

COLLATION AND REVIEW OF ISLANDER COMMERCIAL CATCH HISTORY (1988-2003) IN THE EASTERN TORRES STRAIT REEF LINE FISHERY

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Non-Technical Summary

R02/1183	Collation and review of Islander commercial catch history (1988-2003) in the eastern Torres Strait reef line fishery
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Objectives:

1. Collate the Torres Strait Islander commercial catch records from community freezer operators on respective islands throughout the eastern Torres Strait.
2. Enter the catch records into an appropriate database.
3. Review and analyse the Islander commercial catch records to determine spatial and temporal patterns in the eastern Torres Strait reef line fishery.
4. Review current Islander data recording methods and where appropriate suggest a range of alternate strategies to help improve data quality and reliability.

Summary:

This project arose in response to major concerns expressed by all stakeholder groups over the lack of documented information about the current status and exploitation of the eastern Torres Strait reef line fishery. These concerns were primarily driven by questions about the sustainability of current harvest rates of key reef fish species within the Torres Strait and perceived risks of over-exploitation of reef fish resources in some areas.

Commercial harvest of reef fish in the eastern Torres Strait is shared between Torres Strait Islanders and non-indigenous fishers, however, to date no formal assessment of the fishery has been conducted and no allocation strategies exist. Consequently, there was an urgent need for research into the harvest and effort characteristics of the eastern Torres Strait reef line fishery to resolve ever-increasing resource allocation and sustainable utilisation issues.

To assist in the resolution of these issues it was necessary to accurately document the commercial catch histories of both Torres Strait Islanders and non-indigenous fishers. Historical catch records exist for commercial non-indigenous fishers in the form of the Queensland Department of Primary Industries and Fisheries and the former Queensland Fisheries Management Authority compulsory logbook program. In contrast, the commercial catch records of the Torres Strait Islanders exist in the form of various sales dockets and other disparate sources of Council and private freezer records.

In this project, therefore, we collated and reviewed historical Islander community (*i.e.*, commercial) catch records for the eastern Torres Strait reef line fishery. Islander commercial harvest and effort information were derived from individual catch and transshipment records that were voluntarily provided by the Council freezer operators on each of the main reef line fishing communities of Darnley (Erub), Murray (Mer) and Yorke (Masig) Islands. Annual reported community harvest of reef fish from these islands, based on individual catch records, reached almost 29 tonnes in 2002 from 1064 days of fishing effort and 111 individual fishers; albeit given significant issues with data completeness and reliability. Overall patterns of harvest, effort and species composition in the fishery also varied among islands, years and months. Coral trout and other demersal finfish were the main species

harvested by Islander fishers on Murray and Darnley Islands, while mackerel dominated the harvest of fishers on Yorke Island.

Knowledge of historical commercial fishing patterns of the Torres Strait Islanders will enable Islanders and the relevant management agencies to approach future management decisions from a more informed basis, particularly those concerning resource allocation and sustainable harvesting strategies. However, to ensure the collection of an on-going time series of reliable and informative catch and effort data for the fishery, measures should be considered to implement a more structured and rigorous reporting system for the Islander harvest in the future. Similarly, attempts should be made to ensure the collation of historical catch records from the remaining Council and private freezer operators not gathered in this project. This would then enable the historical fishing patterns in community harvest rates for all Torres Strait fisheries to be evaluated, not just for the reef line fishery, and more importantly, ensure the preservation of this invaluable information.

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Introduction

The harvest of marine resources is fundamental to the livelihood of Torres Strait Islanders for reasons of tradition, culture, economics and subsistence. Torres Strait Islanders have a long-standing affiliation with the marine environment and the resources upon which they depend (Johannes and MacFarlane 1991). Although Torres Strait Islanders have harvested marine resources for subsistence and cultural reasons for centuries, today commercial fishing is the most economically important industry in the Torres Strait and provides the greatest opportunity for financial independence of Islander communities (Anonymous 2003). Prawn, tropical rock lobster, Spanish mackerel, barramundi, pearl shell, crab, trochus, beche de mer and reef fish are all harvested commercially in the Torres Strait. However, for most of these fisheries ecologically sustainable harvest rates are not known, and the information upon which these rates are estimated is limited.

Traditionally, reef fish have been harvested by Torres Strait Islanders for subsistence using a variety of methods including spear, hook and line, stone walled traps (*sai*) and poison (Fuari 1991, Johannes and MacFarlane 1991, Poiner and Harris 1991). Today, however, reef fish are harvested for both subsistence and commerce, using modern hook and line methods, although traditional methods are still sometimes used (Mapstone *et al.* 2003). Historically, harvest of reef fish was concentrated on fringing shallow reef-flat habitats or home reefs associated with each island, whereas today Islanders have the capacity and economic motivation to fish further afield. Those species that are harvested commercially are typically sold to the community or Council freezer of the fisher's home island (*i.e.*, community fishing), while those that are harvested, but not sold, are kept for subsistence (*i.e.*, traditional fishing) (Johannes and MacFarlane 1991, Mapstone *et al.* 2003).

Commercial harvest of reef fish in the Torres Strait is shared between Torres Strait Islanders and non-indigenous fishers, which has led to conflict over allocation of the resource. Non-indigenous fishers have harvested reef fish since the 1950s (Haysom 2001), and in more recent years have harvested up to 164 tonnes per year (Mapstone *et al.* 2003). Both sectors have access to the same fishing grounds in the eastern and central Torres Strait, where most of the effort and conflict in the fishery is located, and target the same suite of species (Mapstone *et al.* 2003) (Fig. 1). Commercial line fishing in the western Torres Strait is illegal (Anonymous 2003). Coral trouts (*Plectropomus* spp.), emperors (*Lethrinus* spp.), tropical snappers (*Lutjanus* spp.) and a variety of cods (*Epinephelus* spp.) are the main targeted species of the reef line fishery in the eastern Torres Strait for both Islanders and non-indigenous fishers (Poiner and Harris 1991, Mapstone *et al.* 1996, Anonymous 2003).

In recent years, major concerns have been expressed by Islanders, non-indigenous fishers and management agencies over the lack of documented information about the current status and exploitation of the reef line fishery in the eastern Torres Strait. These concerns are primarily driven by questions about the sustainability of current harvest rates of key reef fish species and perceived risks of their over-exploitation in some areas. Existing information about the fishery and its associated targeted fish stocks is also limited and patchily distributed (Mapstone *et al.* 2003). Only the studies of Poiner and Harris (1991) and Harris *et al.* (1994) have provided information on the significance and relative magnitude of reef fish harvest to Torres Strait Islanders. Poiner and Harris (1991) conducted an extensive monitoring study on Yorke (Masig) Island between 1984 and 1986 and estimated that about 20 tonnes of Spanish mackerel and 3 tonnes of reef fish were harvested on the island each year. Similarly, Harris *et al.* (1994) identified the significance of reef fish to Torres Strait Islanders between 1991 and 1993 and estimated that about 16 tonnes was harvested each year in the eastern Torres Strait.

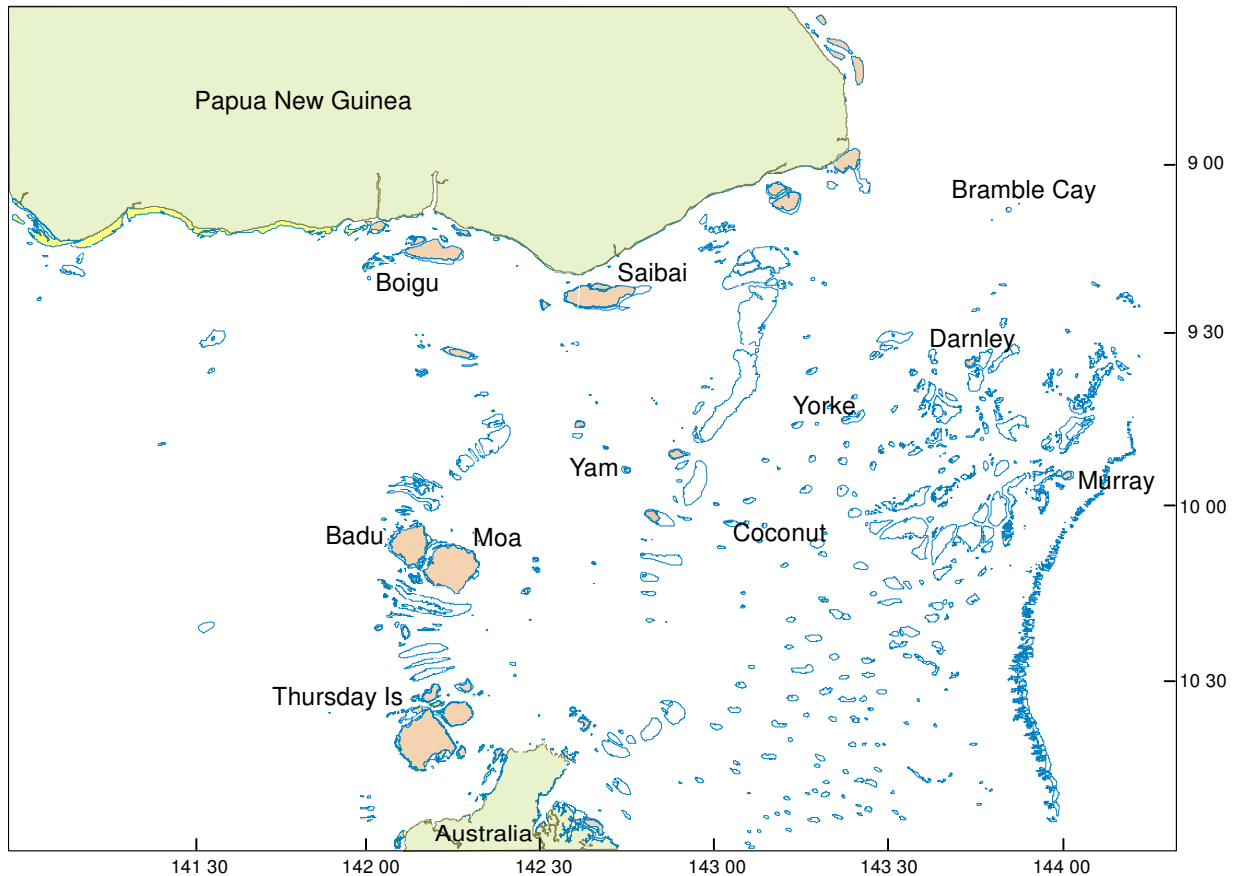


Fig. 1. The eastern Torres Strait and main islands associated with the Islander reef line fishery, Darnley (Erub), Murray (Mer) and Yorke (Masig) Islands (1988-2003).

Despite the significance of the reef fish resource to Torres Strait Islanders and non-indigenous fishers, no formal assessment of the reef line fishery has been undertaken and no allocation or management strategies are in place that addresses the special circumstances that exist in the Torres Strait. Research into the catch and effort characteristics of the reef line fishery is needed to resolve ever-increasing resource allocation and sustainable utilisation issues. In a recent review of the status of the reef line fishery in the eastern Torres Strait, Mapstone *et al.* (2003) recommended that it was necessary to accurately document the commercial catch histories of both Torres Strait Islanders and non-indigenous fishers to assist in the resolution of these issues. Historical catch records since 1988 exist for commercial non-indigenous fishers in the form of the Queensland Department of Primary Industries and Fisheries (QDPI&F) and former Queensland Fisheries Management Authority (QFMA) compulsory logbook program (Williams 2002), and have been previously reviewed and summarised (Mapstone *et al.* 1996, 2003). In contrast, commercial catch records for Torres Strait Islanders exist in the form of various sales docketts and other disparate sources of Council and private freezer pay books, that prior to our study were yet to be examined. Mapstone *et al.* (2003) further recommended that the information from these freezer records needed to be collated and entered into an appropriate database to enable an assessment of current and historical commercial fishing patterns of Torres Strait Islanders in the reef line fishery.

Objectives

Knowledge of historical commercial fishing patterns of Torres Strait Islanders will assist in an assessment of the reef line fishery and enable Torres Strait Islanders, non-indigenous fishers and the relevant management agencies to approach future management decisions from a more informed basis, particularly those concerning resource allocation and sustainable harvesting strategies. The objectives of this project, therefore, included the following:

1. Collate the Torres Strait Islander commercial catch records from community freezer operators on respective islands throughout the eastern Torres Strait.
2. Enter the catch records into an appropriate database.
3. Review and analyse the Islander commercial catch records to determine spatial and temporal patterns in the eastern Torres Strait reef line fishery.
4. Review current Islander data recording methods and where appropriate suggest a range of alternate strategies to help improve data quality and reliability.

Methods

CRC Reef Fishing and Fisheries (F&F) researchers visited each of the main eastern Torres Strait (ETS) Islands that are involved in the reef line fishery and operate a community freezer (Darnley (Erub), Murray (Mer) and Yorke (Masig) Islands) between 28/04/2003 and 02/05/2003 (Fig. 1). Islander commercial catch and effort data were collected from the operators of the community freezer facilities at each of the three islands. These data were voluntarily supplied, and generally took the form of sales dockets resulting from the sale of catch of reef fish, crustaceans, molluscs and beche de mer.

Individual data records were collected using a 4MP digital camera. Images of these records were downloaded to a laptop computer and transferred and stored on CD. A total of 4500 images were collected. This method proved very efficient and more practical than creating paper copies.

Historical records obtained from community operated freezers consisted of purchases from fishers (*i.e.*, individual catch records) and/or sales to mainland wholesalers (*i.e.*, transshipment records). The individual catch records contained more detail in terms of catch and effort information than the transshipment records, and hence form the basis of our report. The transshipment records were used to validate the completeness of the individual catch records.

Individual catch and transshipment records were entered into an ACCESS database at the CRC Reef Research Centre, James Cook University. Once entered into the database, both the individual catch and transshipment records required some manipulation to ensure consistency across all records prior to analysis. Catch was recorded in several categories of product type (*e.g.*, whole, fillet, trunk, gilled and gutted) when it was weighed, and varied from island to island, between individual fishers, and through time; probably as a result of the combination of individual preferences of fishers, changes in processing procedures at the community freezers, and market demand. All product weights for reef fish and mackerel, therefore, were converted to fresh whole weight to enable the varying records to be comparable. Conversion factors for coral trout, cod and mixed reef fish were derived from recovery rate data collected from the same species groups as those harvested in the east coast reef line fishery on the Great Barrier Reef (GBR), as part of the CRC Reef Effects of

Line Fishing (ELF) Project (Mapstone *et al.* 2004). Conversion factors for mackerel species were derived from recovery rate data for Spanish mackerel (Mackie *et al.* 2003) (Table 1). If the product type was not specified in the freezer records then it was assumed to be whole fish, and no conversion factor was applied. Similarly no conversion factors were applied to shark reported in the freezer records because of their low occurrence in the harvest (average 3% of yearly harvest of Other finfish on Murray Island only) and that the majority of the shark harvest was reported as trunk or unspecified product type (>90%).

Table 1. Reef fish species group conversion factors used to convert different product types to common whole weight (kg). Conversion factors for coral trout, cod and other reef fish species groups obtained from the CRC Reef Effects of Line Fishing (ELF) Project (Mapstone *et al.* 2004; unpublished data) and mackerel species groups from Mackie *et al.* (2003).

Product type	Species group conversion factors			
	Coral trout	Cod	Other reef fish	Mackerel
Whole	1.000	1.000	1.000	1.000
Fillet	2.000	3.000	3.000	1.608
Gilled and gutted	1.100	1.100	1.100	1.048
Trunk	-	-	-	1.176

Commercial harvest of marine resources by Islanders in the eastern Torres Strait is not limited to line fishing, but also involves diving to harvest tropical rock lobster, beche de mer and trochus. Although these species were reported in the individual catch and transshipment records, these dive related fisheries were outside the scope of our report, which was focussed on the reef line fishery. A brief summation of the harvest of these species, however, can be found in Appendix 1.

Individual catch records were allocated an effort category based on the type of species recorded to differentiate the harvest method from line fishing, diving or both. If only finfish species were recorded, effort associated with the harvest of these species was categorised as line fishing effort. In contrast, if only dive associated invertebrate species were recorded then effort was categorised as diving effort. A combined category of line fishing and diving was allocated to effort where both finfish and dive associated invertebrate species were recorded on the same day. All data presented in our report are based on any records in which finfish were recorded (*i.e.*, line fishing and line fishing plus diving effort), unless otherwise stated. We have also assumed that each individual catch record (*i.e.*, each sales docket) was equivalent to one day of fishing effort by an individual fisher. This assumption was validated to some extent during discussions with Islander fishers who indicated that the vast majority of fishing trips were single day trips and that it was uncommon for the catch from two fishers to be sold collectively. All analyses of effort, therefore, are based on this assumption.

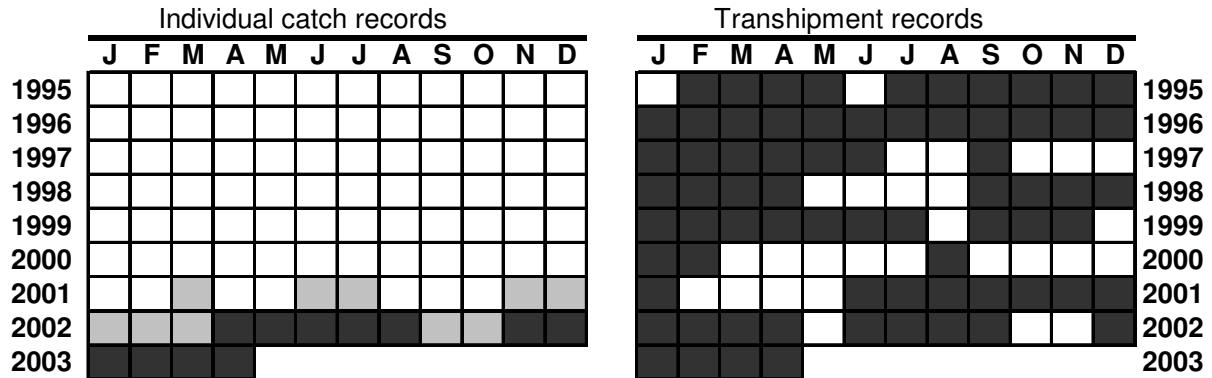
Results

Distribution of data

Individual catch and transshipment records were collected from the main eastern Torres Strait Islands involved in the reef line fishery; Darnley, Murray and Yorke Islands. Both these record types, however, were not complete in all years and the distribution of available data varied among Islands (Tables 2-4). Also, records were only available for the first four months of 2003, as records were collected in April 2003.

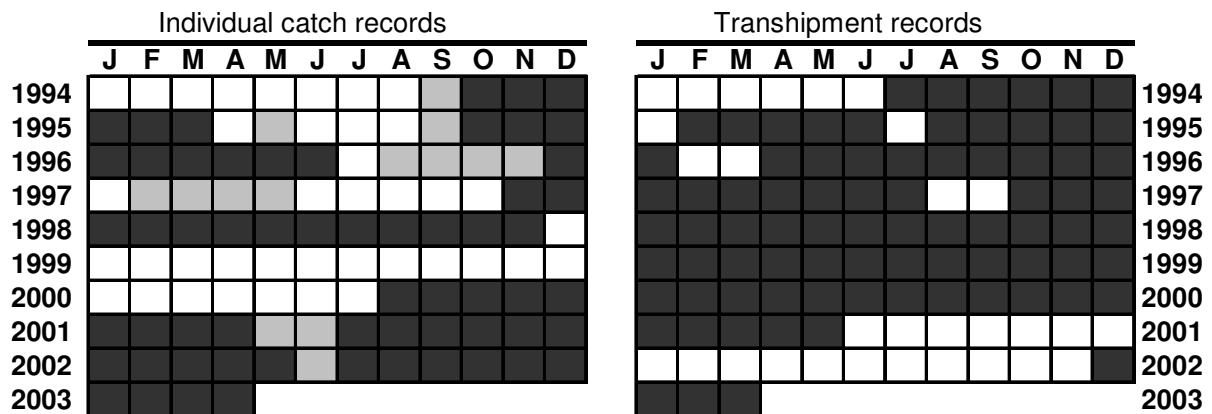
Individual catch records for Darnley Island were only available from March 2001 to April 2003, while transshipment records were available from February 1995 to April 2003 (Table 2). There was a significant lack of transshipment records in 2000.

Table 2. Annual and monthly distribution of individual catch and transshipment records for Darnley Island. No records = □, less than 10 records = ◻, 10 or more records = ◼.



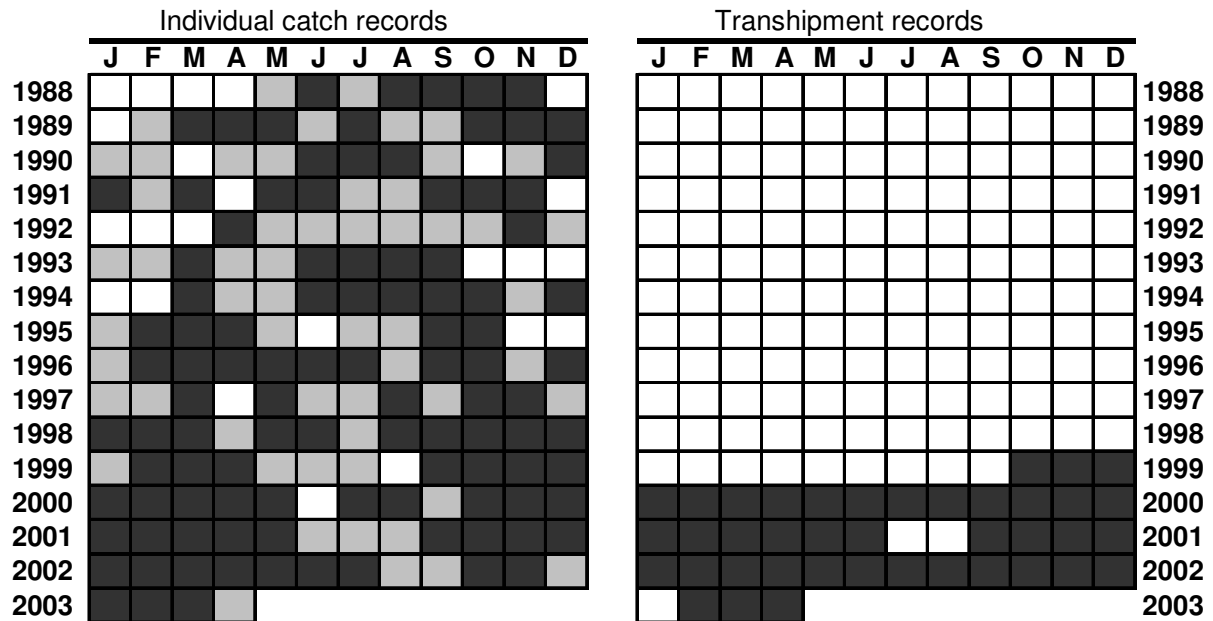
Individual catch records for Murray Island were available from September 1994 to April 2003, while transshipment records were available from July 1994 to March 2003 (Table 3). Notably, there was a significant lack of individual catch records in 1997, 1999 and 2000, and transshipment records in 2001 and 2002 (Table 3).

Table 3. Annual and monthly distribution of individual catch and transshipment records for Murray Island. No records = □, less than 10 records = ◻, 10 or more records = ◼.



Individual catch records for Yorke Island were the most comprehensive of the three Islands (Table 4). Individual catch records were available from May 1988 to April 2003, while transshipment records were available from October 1999 to April 2003 (Table 4).

Table 4. Annual and monthly distribution of individual catch and transhipment records for Yorke Island. No records = □, less than 10 records = ◻, 10 or more records = ◼.



Total harvest and effort

The reported community (*i.e.*, commercial) total finfish harvest and effort of Islanders in the eastern Torres Strait reef line fishery were reasonably well correlated through time (Fig. 2). Total finfish harvest and effort reported in the individual catch records appeared to increase after a relatively stable period in the late 1980s and early 1990s; increasing in 2002 to 29 tonnes of total finfish harvested from 1064 days of fishing. The apparent increase in total harvest and effort, however, also coincided with an increased availability of catch records across Islands (Tables 2-4); questioning whether the trends were a true reflection of the fishery or more an extension of the data. Likewise, major fluctuations in the total harvest and effort from year to year may be attributed to a lack of records for a given year from a particular Island, rather than any change in fishing practices or variations in the underlying fish populations. Although the availability of data was variable among Islands, the more consistent availability of catch records and relatively stable trend in annual finfish harvest from Yorke Island since 1988 suggest that annual harvest has not increased or decreased significantly, at least on Yorke Island. The reported total finfish harvest and effort were undoubtedly an underestimate, particularly in the early years when data records were limited. The majority of the reported community harvest of finfish in the eastern Torres Strait reef line fishery was from fishers of Murray Island, with typically lower but variable harvests from those of Darnley and Yorke Islands. Concomitantly, the relative population on Murray Island (~450 people) was also greater than those on Darnley (~375) and Yorke Islands (~288) (see Torres Strait Regional Authority Community Profiles 2004).

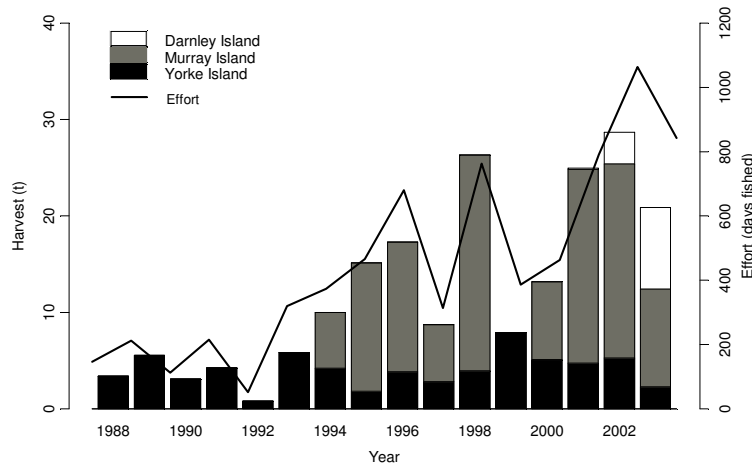


Fig. 2. Nominal annual total finfish harvest (t) and effort (days fished) from individual catch records for Darnley, Murray and Yorke Islands (1988-2003). Effort (days fished) is aggregated for all three Islands. Data for 2003 only includes records from January to April. The apparent increase in total harvest and effort was most likely due to an improvement in catch reporting, rather than any significant changes in fishing practices or variations in the underlying fish populations.

The reported distribution of fishing effort between different methods has remained relatively consistent through time in the eastern Torres Strait (Fig. 3). Line fishing effort was generally greater than diving effort, except between 1988 and 1992, indicating the importance of the reef line fishery to eastern Torres Strait Islanders. In addition, not all the dive related data were available for Yorke Island, as beche de mer and other demersal invertebrate species were sold over the years to private operators on the Island, and hence, were not reported in the Council freezer logbooks, upon which this report was based (Morris, pers. com.). The relatively small proportion of the total annual effort represented by the combined line fishing and diving effort category suggested that there was very little overlap of these fishing methods, and hence these can be considered as discrete fisheries (Fig. 3).

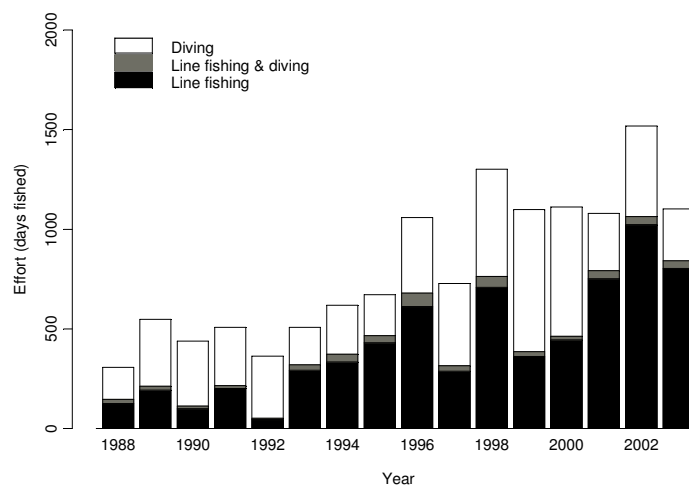


Fig. 3. Nominal annual distribution of effort (days fished) among the different fishing methods for Darnley, Murray and Yorke Islands combined (1988-2003). Data for 2003 only includes records from January to April. Overall height of bars indicates total effort.

Islander line fishing effort in the eastern Torres Strait was unevenly distributed within years, with typically almost twice as many days spent fishing in October to March (average 1988-2003, 55-77 days) compared to April through September (25-37 days) (Fig. 4). This strong and consistent seasonal pattern in fishing effort was most likely a result of prevailing south east trade winds preventing Islanders, a characteristically small boat fleet (< 5m), from operating in such conditions throughout late autumn, winter and early spring.

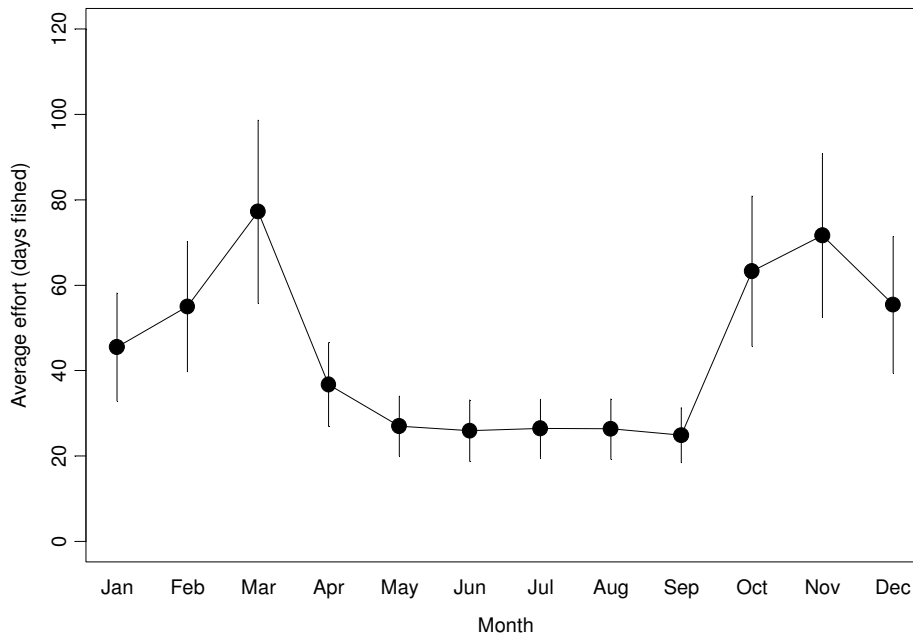


Fig. 4. Average monthly effort (days fished) for line fishing only in the eastern Torres Strait (data for Darnley, Murray and Yorke Islands combined) from 1988 to 2003. Includes effort for which there was only finfish recorded. Vertical error bars are standard errors.

Harvest composition

A total of 18 species or species groups of finfish were reported in the individual catch records from Darnley, Murray and Yorke Islands (Table 5). For the purpose of this report these species or species groups were amalgamated into three main finfish categories: 1) Coral trout – containing all coral trout species; 2) Mackerel – containing Spanish mackerel, salmon or shark mackerel and other small mackerels; and 3) Other finfish – containing all other finfish which were not included in the previous two categories.

Overall in the eastern Torres Strait Islander reef line fishery, Coral trout formed the greatest proportion of the total annual harvest (up to 14.2 tonnes in 2002), followed by Other finfish (8.6 tonnes in 1998) and Mackerel (7.6 tonnes in 1999) (Fig. 5). The harvest composition varied markedly among Islands. A large proportion of the annual reported harvest of Coral trout and Other finfish was taken by fishers on Murray Island, followed by those on Darnley and Yorke Islands, respectively (Fig. 5). In contrast, the majority of the annual reported Mackerel harvest was taken by fishers on Yorke Island, with smaller quantities harvested by fishers on Murray and Darnley Islands.

The lack of individual catch records for Darnley Island (Table 2) in particular is problematic, but generally the harvest composition was similar to Murray Island, comprising mostly Coral trout and Other finfish. The availability and incompleteness of the catch records in general also made it difficult to postulate about inter-annual trends in harvest of the Islander reef line fishery in the eastern Torres Strait.

Table 5. Individual species and species groups of finfish reported in the individual catch records for Darnley, Murray and Yorke Islands.

Common name	Scientific name	Islander name	Harvest category
Coral trout	<i>Plectropomus spp.</i>	Withy, Pakor	Coral trout
Mackerel (unspecified)	Unknown mackerel	Duboi, Dabor	Mackerel
Salmon mackerel	<i>Grammatorcynus bicarinatus</i>	Duboi	Mackerel
Spanish mackerel	<i>Scomberomorus commerson</i>	Duboi	Mackerel
Barramundi cod	<i>Cromileptes altivelis</i>	Gorom	Other finfish
Barracuda	<i>Sphyraena spp.</i>	Mugaral	Other finfish
Emperor	<i>Lethrinus spp.</i>		Other finfish
Goldlined rabbitfish	<i>Siganus lineatus</i>	Parsar	Other finfish
Jobfish	<i>Aprion spp.</i>		Other finfish
Mullet	<i>Mugil spp.</i>		Other finfish
Maori wrasse	<i>Cheilinus undulatus</i>		Other finfish
Mixed reef fish	Unknown reef fish		Other finfish
Reef cod	Serranidae 'reef cod'		Other finfish
Red emperor	<i>Lutjanus sebae</i>	Patu	Other finfish
Rainbow runner	<i>Elagatis bipinnulata</i>		Other finfish
Shark (unspecified)	Unknown shark		Other finfish
Stripey bass	<i>Lutjanus carponotatus</i>		Other finfish
Trevally	Unknown carangid	Gaigai	Other finfish

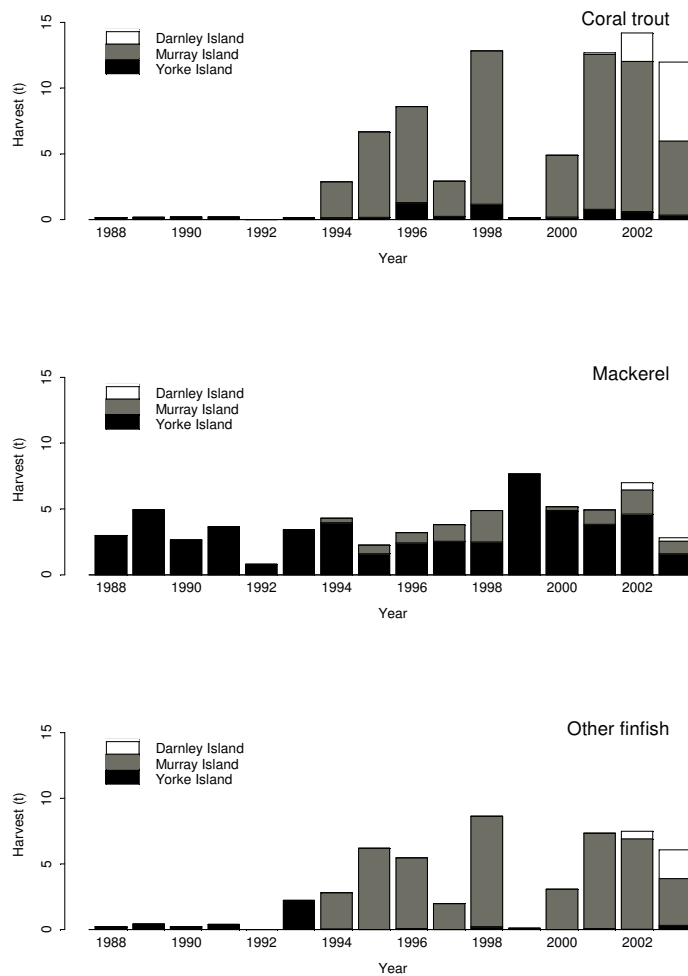


Fig. 5. Total annual harvest (t) of Coral trout, Mackerel and Other finfish for Darnley, Murray and Yorke Islands. Overall heights of bars indicate the total annual reported harvest for the eastern Torres Strait (all three islands combined).

Effort composition

The total number of Islander fishers who reported harvest of finfish for commercial sale in the eastern Torres Strait varied considerably among Islands and between years; albeit given the data constraints (Fig. 6A). A total of between 5 and 43 fishers reported harvest of finfish on Darnley Island in any given year (2001-2003), between 24 and 77 fishers on Murray Island (1994-2003), and between 9 and 39 fishers on Yorke Island (1988-2003).

Not unexpectedly, the annual total number of days fished in the eastern Torres Strait (up to 1064 days in 2002) was closely correlated with the annual number of fishers (up to 111 fishers in 1996 and 2002) (Fig. 6B). Similar to total annual harvest, effort in terms of days fished and number of fishers was likely to be relatively stable over time, at least on Yorke Island, due to the more consistent availability of individual catch records from Yorke Island.

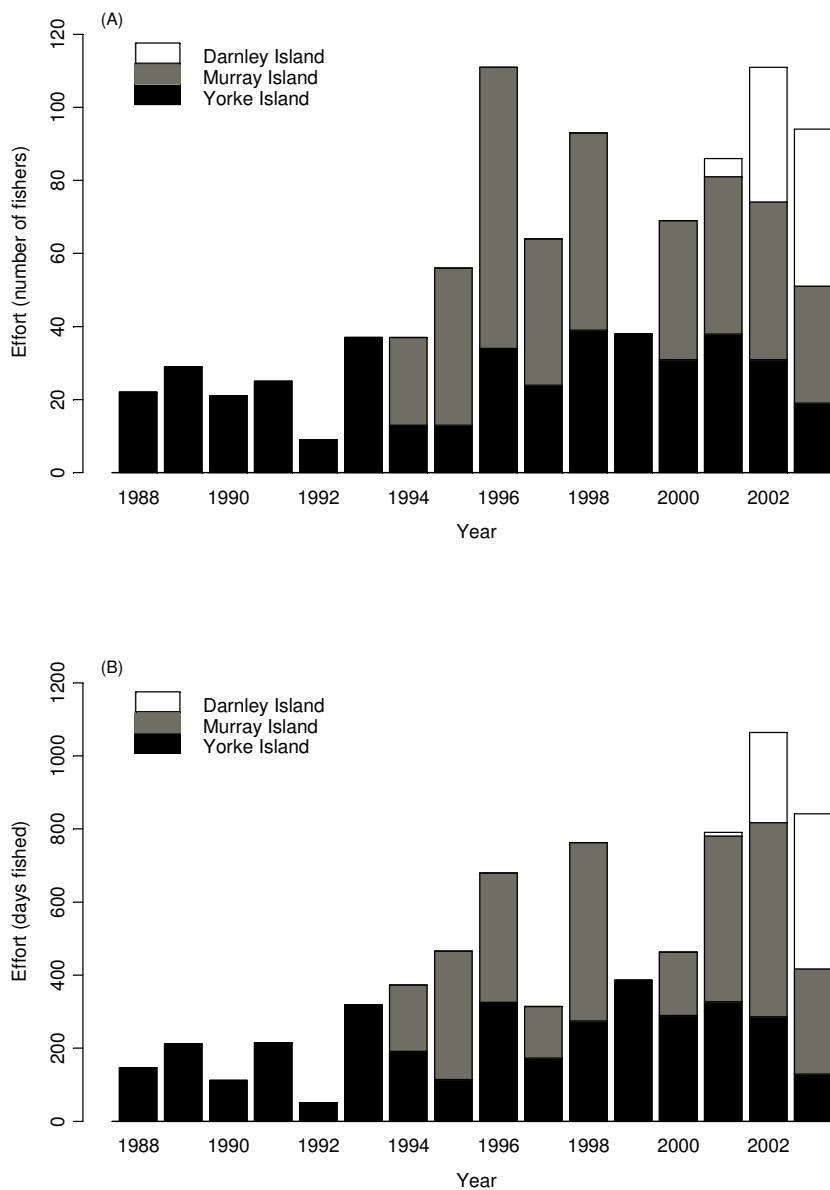


Fig. 6. Annual total effort in (A) number of fishers and (B) days fished reported for Darnley, Murray and Yorke Islands. Overall heights of bars indicate total annual reported effort for the eastern Torres Strait (all three islands combined).

The distribution of effort (days fished) between line fishing and diving was relatively consistent among years, but differed among islands (Fig. 7). Line fishing was the predominant fishing method reported from Darnley Island (average \pm standard deviation 2001-2003; $61 \pm 13\%$) and Murray Island (1994-1998, 2000-2003; $81 \pm 13\%$). In contrast, diving was the main fishing activity reported on Yorke Island (1984-2003; $60 \pm 13\%$), even given the fact that there were known dive related data not available. Notably, the relatively small amount of effort that combined both line fishing and diving indicated that there was very little overlap between the two activities, and supported our reasons for separating catch records based on effort category for the purpose of focusing the analyses only on finfish.

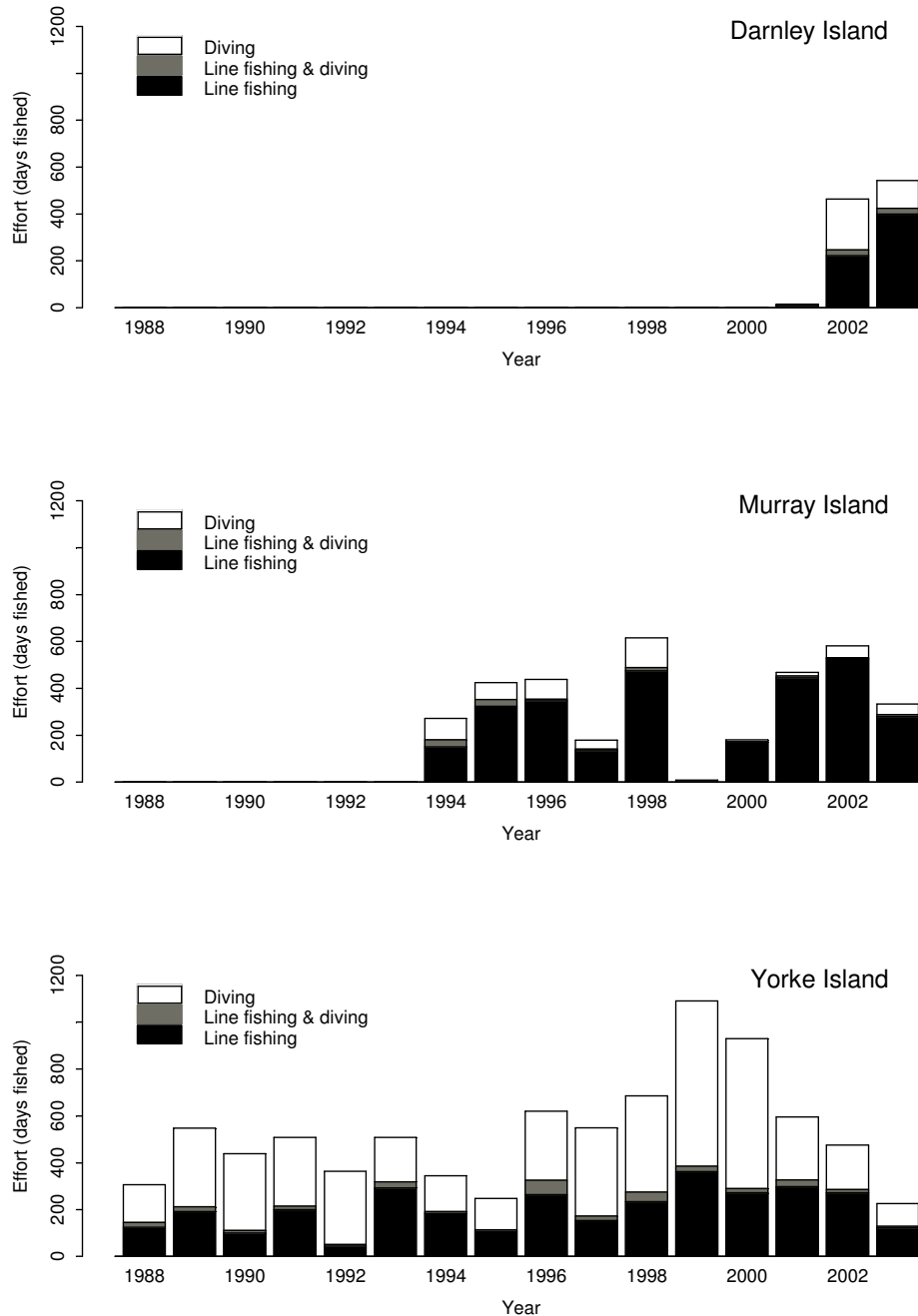


Fig. 7. Annual distribution of effort (days fished) among the different fishing methods for Darnley, Murray and Yorke Islands. Overall height of bars indicates annual total effort.

Latent effort was also prominent in the Islander reef line fishery. On each island, individual fishers were ranked based on the number of days that they had fished in each year, where the fisher with the most days fished was assigned “Fisher rank 1”. The number of days fished by each fisher rank in each year was then averaged across all years to examine the distribution of fishing effort among individual fishers. Annual effort was unequally distributed among individual fishers, with most fishing being done by a small number of fishers (Fig. 8). This pattern was consistent among all three islands (Fig. 8). Approximately 25%, 50% and 75% of the effort on Darnley Island was exerted by 7%, 16% and 30% of the fishers, on Murray Island 3%, 9% and 22% of the fishers, and on Yorke Island 3%, 12% and 30% of the fishers, respectively (Fig. 8).

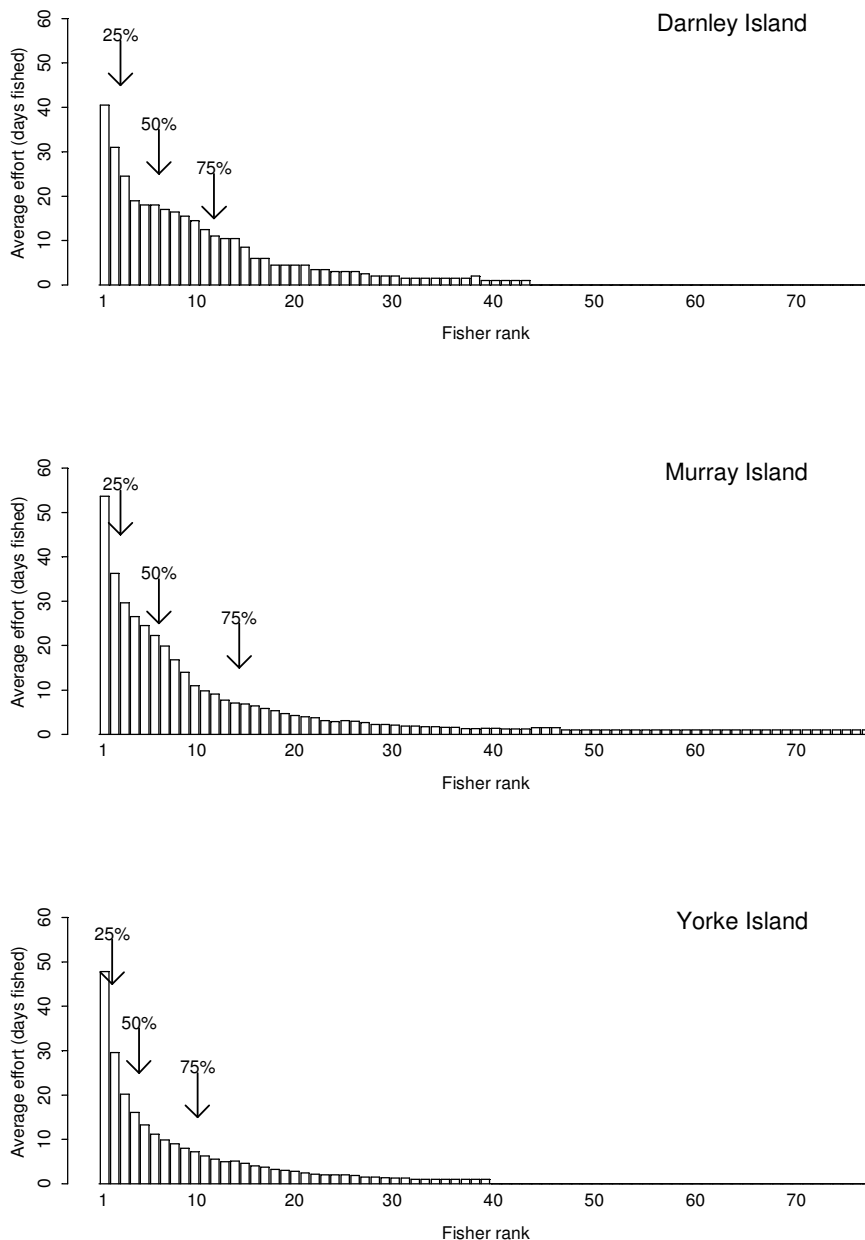


Fig. 8. Average number of days fished per year by individual fishers from Darnley, Murray and Yorke Islands. The most active fisher within each year was ranked 1, such that the rank order of individual fishers may have varied among years. The 25th, 50th and 75th percentiles of the total annual effort for each island are indicated by the arrows. For example, on average, 1 to 2 fishers on each Island accounted for about 25% of the annual fishing effort.

The highest ranked fisher from each island, on average, fished for approximately 50 days per year, while 58%, 75% and 66% of fishers from Darnley, Murray and Yorke Islands, respectively, averaged less than 5 days of fishing per year (Fig. 8). Although the individual catch records do not account for multiple fishers, these results suggest the existence of latent effort in the Islander commercial reef line fishery and that the uptake of this latency, mostly through an increase in effort by less active fishers, could potentially be significant. The potential for more active fishers to increase their current levels of effort, however, may be less likely given that the Islander commercial fishery operates from small boats that are frequently restricted by adverse weather. Although not shown, a similar pattern was observed when effort was substituted by harvest, with 75% of the annual harvest being accounted for by approximately 25% of the fishers.

Harvest rates

Estimated harvest rates, or catch per unit effort (CPUE), of finfish in the eastern Torres Strait reef line fishery varied among the different Islands over the years (Fig. 9). Similar to the total harvest and effort patterns, average CPUE for Coral trout and Other finfish was greater for fishers from Murray Island (Coral trout: 21.2 ± 3.9 kg/day; Other finfish: 15.3 ± 2.0 kg/day) than Darnley Island (Coral trout: 11.5 ± 3.8 kg/day; Other finfish: 3.7 ± 2.0 kg/day) and Yorke Island (Coral trout: 1.6 ± 1.2 kg/day; Other finfish: 2.3 ± 2.3 kg/day), respectively. In contrast, average harvest rates of Mackerel were greater for fishers on Yorke Island (15.8 ± 4.8 kg/day) than Murray Island (3.4 ± 2.3 kg/day) and Darnley Islands (1.4 ± 1.2 kg/day). Generally, harvest rates were relatively stable over time, although slight declines were evident in recent years for Coral trout and Other finfish on Murray Island and Mackerel on Yorke Island (Fig. 9). The relatively low harvest rates for Coral trout and Other finfish on Yorke Island and Mackerel on Darnley and Murray Islands were most likely a reflection of the targeting behaviour of the fishers on the respective Islands, rather than any changes in the underlying fish population abundances.

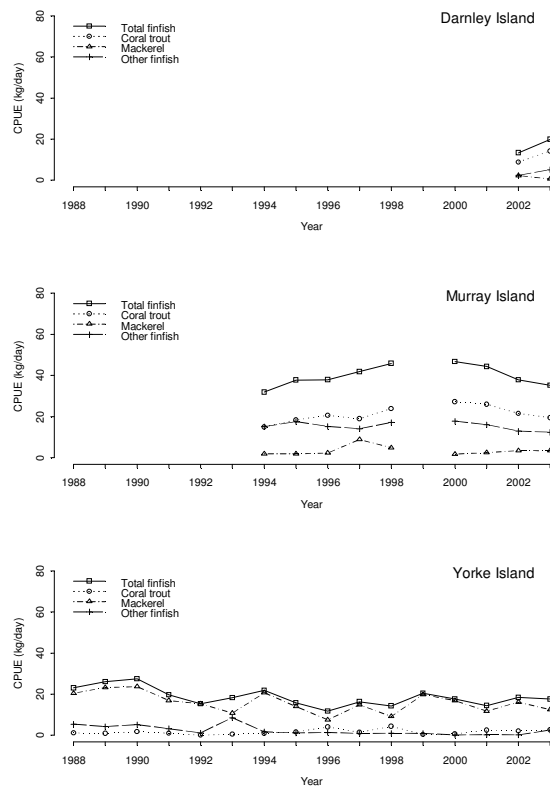


Fig. 9. Catch per unit effort (CPUE – kgs/day) of total finfish, Coral trout, Mackerel and Other finfish for Darnley, Murray and Yorke Islands. Total finfish is the sum of Coral trout, Mackerel and Other finfish.

Data validation

Total finfish harvests reported in the individual catch records differed to those reported in the transshipment records for each Island (Fig. 10). Transshipment records were more comprehensive than the individual catch records for Darnley Island, while less so for Murray and Yorke Islands. Validation of harvests from the individual catch records, therefore, is difficult considering that similar issues in data availability exist for the transshipment records. The relative magnitude of the total finfish harvests reported in the different data sources, varied among Islands with the average difference between the transshipment and individual catch records in years where both data were available being 2.3 ± 1.2 tonnes (2001-2003), 11.6 ± 6.8 tonnes (1995-1998, 2000-2003) and 2.6 ± 1.5 tonnes (1999-2003) for Darnley, Murray and Yorke Islands, respectively.

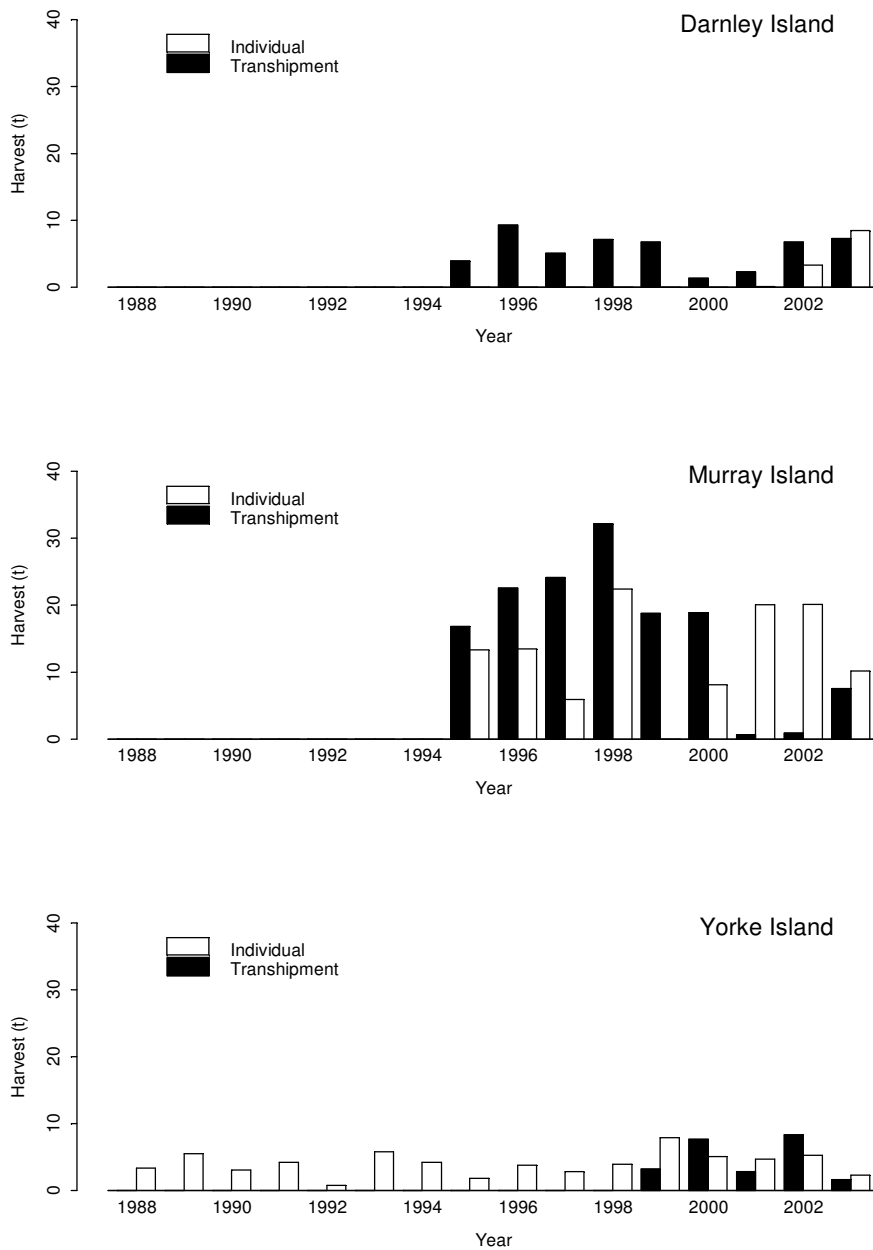


Fig. 10. Annual total finfish harvest reported in the individual catch and transshipment records for Darnley, Murray and Yorke Islands.

Discussion

The reef line fishery is a culturally and commercially important resource for the communities of the eastern Torres Strait, and historically has also supported a relatively small, but valuable non-indigenous commercial fishing fleet. Despite the significance of this resource, however, no formal assessment of the fishery has been undertaken. An initial and imperative step in this process is the collation and analysis of the commercial catch histories of both Torres Strait Islanders and non-indigenous fishers to provide an historical context of the relative levels of harvest that the resource has supported. Although this information exists and has previously been analysed for the commercial non-indigenous fishers (Mapstone *et al.* 1996, 2003, Williams 2002), until our study, analogous information for the Islander fishers were yet to be examined for the eastern Torres Strait reef line fishery.

Collation of individual catch records from Council operated freezers and associated transshipment records on Darnley (Erub), Murray (Mer) and Yorke (Masig) Islands provided an insight into the relative harvest and effort rates of Torres Strait Islanders in the eastern Torres Strait reef line fishery. Annual reported community (*i.e.*, commercial) harvest of reef fish from these islands, based on individual catch records, reached almost 29 tonnes in 2002 from 1064 days of fishing effort and 111 individual fishers. Although there were obvious issues with data completeness, the individual catch records indicated that Islander harvest of reef fish in the eastern Torres Strait has increased in recent years since the study of Harris *et al.* (1994) who estimated that about 16 tonnes of reef fish were harvested in the early 1990s. In contrast, commercial non-indigenous fishers, as reported in compulsory Queensland Department of Primary Industries and Fisheries (QDPI&F) logbooks, have historically harvested up to almost 164 tonnes of reef fish in 1998 from 4122 line (*i.e.*, dory) days and 26 fishing operations (Mapstone *et al.* 2003).

In recent years, commercial non-indigenous harvest and effort have reduced considerably, most likely through management intervention (*i.e.*, going to a single jurisdiction in 1999) and changes in fishing practices (*i.e.*, fishers moving into the lucrative live fish market of the east coast reef line fishery on the GBR). As a moratorium exists on the harvest of live fish in the Torres Strait reef line fishery, there are now only three to six fishing operations actively targeting reef fish in the fishery. Actual harvest rates or catch per unit effort (CPUE) of total reef fish were quite similar between fishers on Murray Island (1994-1998, 2000: 40.4 ± 5.6 kg/day), the main island in the eastern Torres Strait reef line fishery in terms of magnitude of harvest and effort, and commercial non-indigenous fishers (45.4 ± 10.2 kg/day); indicating similar fishing efficiency between the different fishing sectors. However, interpretation of these catch rates need to be viewed with caution given the broad assumptions in catch reporting (*i.e.*, each individual catch record was equivalent to one day of fishing effort by an individual fisher).

Overall patterns of harvest, effort and species composition in the eastern Torres Strait reef line fishery varied significantly among islands and years; albeit given the hiatus in data availability. Coral trout and other demersal finfish species comprised the majority of the harvest on Murray and Darnley Islands, while mackerel were the dominant species harvested on Yorke Island. Coral trout are also the main target species for non-indigenous commercial fishers in the reef line fishery (Williams 2002). Commercial catches of coral trout in the eastern Torres Strait are typically comprised of four main species (*Plectropomus leopardus*, *P. maculatus*, *P. areolatus* and *P. laevis*) (Mapstone *et al.* 2003), although the relative proportions of these species cannot be assessed from current reporting systems for either the Islander or non-indigenous fishing sectors. Furthermore, although there is a current moratorium on the sale of live reef fish in the Torres Strait (Anonymous 2003), there is the potential for expansion into this lucrative export market, which would most likely result in

changing fishing practices and greater targeting of highly valued market driven species such as coral trout, particularly in the Islander sector.

Torres Strait Islanders also demonstrate significant within-year variation in their fishing patterns in the reef line fishery. Increasing levels of Islander fishing effort over the monsoonal summer months coincides with the period in which the non-indigenous commercial fishing fleet return to the mainland because of a hiatus (December to February) in the mother-ship transportation service that is used to offload product and replenish supplies. A significant period of the peak Islander fishing effort, therefore, is also when there is restricted non-indigenous effort; limiting potential conflict between the sectors. Likewise, potential conflict may be reduced during the south-east trade winds during winter months because of the current nature of the small boat (< 5m) Islander fishery being restricted in its extent, duration and frequency of fishing during this period. However, increased capitalisation in the Islander sector via larger vessels that would enable more expansive fishing effort may lead to greater conflict over allocation of the reef fish resource between the fishing sectors.

Latent (*i.e.*, potential unused) effort of both Islanders and non-indigenous commercial fishers is a major concern in the eastern Torres Strait reef line fishery. Until recently, latent effort in the commercial non-indigenous sector of the fishery existed in the form of unused fishing licences and in the potential for increased effort in the use of those licences that were only used occasionally (Mapstone *et al.* 2003). Likewise, there is significant latent effort in the Islander sector of the fishery, in both the number of fishers and days fished, where currently most of the reef fish are harvested by only a few fishers on each island. Recent management intervention has addressed these issues for the non-indigenous sector, but similar measures may need to be considered for the Islander sector to ensure the long-term sustainability of the resource.

The Islander harvests of reef fish derived from the individual catch and transshipment records can only be considered as conservative (*i.e.*, minimum) estimates for the eastern Torres Strait because of severe data limitations associated with catch reporting for some islands in some years. Although the transshipment records ideally may have been used to validate the harvests reported in the individual records, the disparity in data coverage between the two reporting systems meant that this was not possible. In addition, these estimates do not include reef fish harvested for subsistence and were only based on the three eastern Torres Strait Islands that have operated Council freezers. Islander fishers from these islands have also sold their harvest to other islands besides their own over the years, depending on the operations of their respective Council freezers. Historically, however, these were also the main islands involved in the fishery, and thus would be assumed to represent the majority of the Islander reef line harvest (Johannes and McFarlane 1991, Poiner and Harris 1991). Similar limitations also exist with the effort information derived from the catch records. Our assumption of each individual catch record equating to one day of fishing effort for an individual fisher does not account for actual time spent fishing, multiple fisher trips or multiple day trips. However, the occurrence of the latter activity is most likely limited because of the nature of the typically small boat Islander fishery. Estimates of effort for the Islander sector, therefore, can only be derived at a coarse daily level; a problem similarly encountered with the non-indigenous commercial sector who also report harvest only at the daily level. Provisions need to be made in the catch reporting systems of both sectors, therefore, to enable finer measures of effort to be reported such as the number of fishers, search times and hours spent fishing.

Information derived from the Islander catch records is invaluable in ascertaining relative gross levels of harvest. However, measures should be undertaken to improve the data coverage, quality and reliability that is collected from this reporting system for it to be more useful in future assessments of the fishery. For example, it is not currently possible to determine whether the apparent increasing trends in total harvest and effort are real,

because of the current limitations with data coverage. Consequently, it is imperative to continue a data reporting system, but in a more comprehensive manner than what currently occurs to enable a meaningful time series of harvest and effort information to be collated. Such information is critical for evaluating trends in the underlying fish populations upon which the harvests are based and are required for future assessment models to evaluate the status of the fishery. The establishment of an on-going structured, consistent reporting system for the Torres Strait, therefore, should be considered for future Islander harvests. This system should encourage finer scale reporting than what currently occurs, such as the specification of harvest at the actual species level rather than aggregated species groups, spatial information at the reef level, and effort measures more reflective of actual fishing pressure.

The collation of harvest and effort information from the remaining Council and private freezer operators in the Torres Strait that were not covered in our study, should also be considered a priority for future research. Although our study enabled the collation of historical Islander catch and effort information for the main eastern Torres Strait Islands associated with the reef line fishery, everything possible must be done to collate information from the remaining Island freezers. These include three freezers on Badu Island, one each on Coconut (Poruma) and Yam (Iama) Islands, and a number on Thursday (Waibene) Island. This would then enable the historical fishing patterns in community harvest rates for all Torres Strait fisheries to be evaluated, not just for the reef line fishery, and more importantly ensure the preservation of this invaluable information.

The eastern Torres Strait reef line fishery is an important resource to Torres Strait Islanders and non-indigenous commercial fishers, and has the potential to support increased economic and social gains provided informed and sustainable management strategies are implemented. Information derived from our study on the historical community fishing patterns of Torres Strait Islanders is an integral first step in evaluating sustainable harvest rates in the fishery. Likewise, future research should also gather information on traditional fishing patterns, as well as fundamental biological information on the key target species in the fishery. Information from this research will provide direct benefits to the assessment and management of the eastern Torres Strait reef line fishery. Knowledge of the historical community fishing patterns of Torres Strait Islanders will enable Islanders and the relevant management agencies to approach future management decisions from a more informed basis, particularly those concerning resource allocation and sustainable harvest strategies.

Recommendations

In summary, we provide the following recommendations for consideration in the future monitoring of the Islander reef line fishery in the eastern Torres Strait to improve data quality and reliability and assist in the long-term sustainability of the resource:

- Implement an on-going structured reporting system consistent across the Torres Strait with more refined measures of species harvest, spatial resolution of fishing activities and fishing effort.
- Collect historical harvest information from all Council and private freezer operators in the Torres Strait to ensure the preservation of these data and enable a more comprehensive assessment of Islander fishing practices.
- Collect and analyse information on traditional (*i.e.*, subsistence) Islander harvest of reef fish in the Torres Strait to complement community (*i.e.*, commercial) harvest information for input into a formalised assessment and management strategy evaluation of the fishery.
- Address the issue of latent effort in the Islander sector of the fishery.

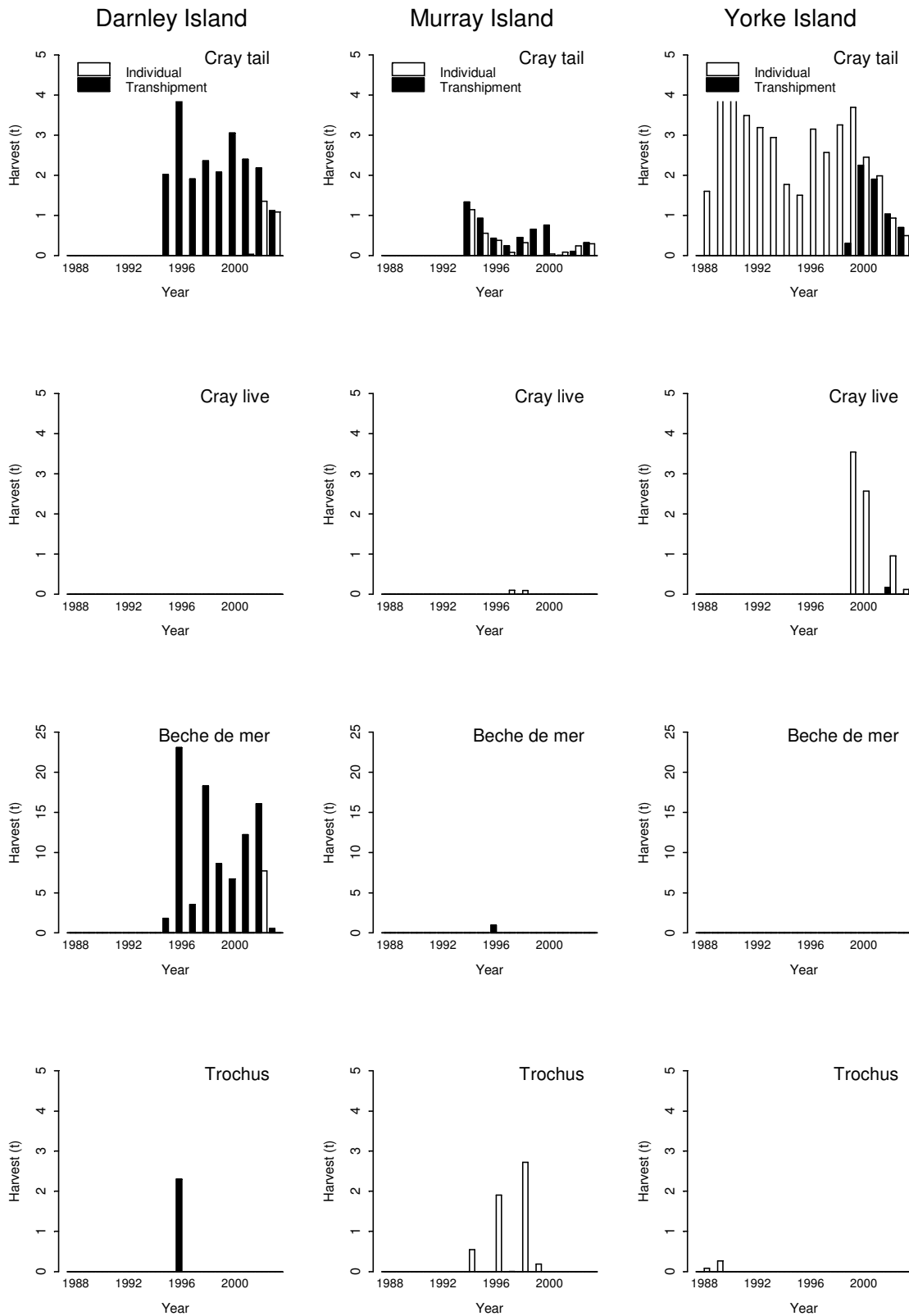
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Appendix 1: Summation of Dive Associated Fisheries

The following page contains information summarising the dive associated fisheries harvests (cray tail, cray live, beche de mer and trochus) that were reported in the individual catch and transshipment records. Beche de mer reported for Darnley Island includes red surf, black teat and white teat fish, and for Yorke Island, red surf and black teat fish. Trochus harvest includes that reported as green, meat and shell.

Appendix 1. Harvest (t) of dive associated fisheries (cray tail, cray live, beche de mer and trochus) reported in the individual catch and transhipment records for Darnley, Murray and Yorke Islands. Reported transhipment cray tail harvest for Yorke Island in 1989 and 1990 was about 4.5 tonnes and 4.1 tonnes, respectively. The apparent recent declines in cray tail for Yorke Island and the few records of beche de mer on Murray and Yorke Islands were due to sale of harvest to other operators, besides Council freezers.



Appendix 2: Intellectual Property

No patentable or marketable products or processes have arisen from this research. All results will be published in scientific and non-technical literature. The raw data from Islander Council pay books and transshipment records remains the intellectual property of the respective Councils. Raw catch data provided by individual fishers to project staff remains the intellectual property of the fishers. Intellectual property accruing from the analysis and interpretation of raw data vests jointly with the Australian Fisheries Management Authority, CRC Reef Research Centre and the Principle Investigator.

Appendix 3: Staff

Principle Investigator:	Gavin Begg
Co-Investigator:	Cameron Murchie
Database Manager:	Gary Carlos
Liaison Officer:	Annabel Jones
Administrative Officer:	Iesha Stewart

Appendix 4: CRC Reef F&F Project Torres Strait Line Fishery Information Sheets

The following pages contain information sheets that were distributed to each of the individual islands that participated in the project.