Fisheries Long Term Monitoring Program

Summary of the Gulf of Carpentaria Developmental Finfish Trawl Fishery survey results: 2004-2006

June 2008

Queensland Government
Department of Primary Industries and Fisheries

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Front cover image provided by Jason Stapley.

The Department of Primary Industries and Fisheries (DPI&F) seeks to maximise the economic potential of Queensland's primary industries on a sustainable basis.

Contents

Acronyms

DEH	Department of the Environment and Heritage
DEWHA	Department of the Environment, Water, Heritage and the Arts
DFTF	Gulf of Carpentaria Developmental Finfish Trawl Fishery
DPI&F	Department of Primary Industries and Fisheries
EPBC Act	Environment Protection and Biodiversity Conservation Act
GSI	Gonosomatic indices
LTMP	DPI&F Fisheries Long Term Monitoring Program
PMS	Performance Measurement System
QFJA	Queensland Fisheries Joint Authority
TAC	Total Allowable Catch
TL	Total Length

Summary

The Gulf of Carpentaria Developmental Finfish Trawl Fishery (DFTF) predominantly captures tropical red snappers including the crimson snapper (*Lutjanus erythropterus*) and the saddletail snapper (*Lutjanus malabaricus*), however a variety of other valuable species are also retained as saleable product. Both crimson and saddletail snapper are commonly caught in northern Australian waters. They inhabit coastal and inshore reefs. Mixed aggregations occur over shoals, hard or sandy-mud substrate, and sponge and gorgonian dominated habitats (FAO 2001). Both species are long-lived with low natural mortalities. They are slow growing once reproductively mature and have protracted spawning periods throughout the year (Fry *et al.* in press).

The DFTF is managed by the Queensland Government Department of Primary Industries and Fisheries (DPI&F) and the Queensland Fisheries Joint Authority (QFJA) operating under Queensland's *Fisheries Act 1994*, the *Fisheries Regulation 1995* and Developmental fishing Policy. The DFTF is a commercial quota managed fishery with a maximum allowable level of 1500 tonnes (t) of crimson snapper, saddletail snapper, red emperor and other emperor with a commercial Total Allowable Catch (TAC) set annually. The current commercial TAC is set at 1250 t (DPI&F 2007a).

Reported total catch for this developmental fishery was variable between 1998 and 2001 with as little as 7 t reported in 2001 (DPI&F 2007a). Since 2001, total catch has increased each year with 613 t reported in 2006 ($2.5M AUD) (DPI&F 2007a). The crimson and saddletail snapper together comprise 55% of the average total annual catch by weight (2002-2005), with 36% and 19% for each species respectively (DPI&F 2007b).

The key objectives of the DPI&F Fisheries Long Term Monitoring Program (LTMP) were to analyse the sub-sample of crimson and saddletail snappers collected by DPI&F fisheries observers from commercial fishing operations to provide biological data to fisheries management including:

- Fish length to weight relationships
- Reproductive indices (gonosomatic indices - the ratio of the weight of a fish's ovary or testis to its total body weight)
- Reproductive stage data (macroscopic)
- Sex ratios

A key finding was that a single length to weight relationship was identified for both saddletail and crimson snapper for both sexes and these were identical between the northern and southern fished regions.

Results also supported Fry *et al.*'s (in press) finding, that spawning is likely to occur all year round for both species with possible peaks in the warmer months between July and April. The macroscopic reproductive stage data showed that the majority of males sampled were reproductively inactive for both species throughout the year, while a substantially greater proportion of females sampled were reproductively active during the year. The sex ratio showed that there were slightly higher numbers of females than males for both species in the samples pooled across all surveys and that there were more immature individuals in the northern samples when compared to the southern.

Further samples for both crimson and saddletail snapper from each month throughout the year would be required to accurately detect any peaks in reproductive activity and to determine opaque band formation for ageing.

Long Term Monitoring Program background

The Department of Primary Industries and Fisheries (DPI&F), Queensland, manages the State's fish, mollusc and crustacean species and their habitats. As part of this commitment, DPI&F monitors the condition of, and trends in, fish populations and their associated habitats. This information is used to assess the effectiveness of fisheries management strategies and helps ensure that the fisheries remain ecologically sustainable.

DPI&F uses the information to demonstrate that Queensland's fisheries continue to comply with national sustainability guidelines, allowing exemption from export restrictions under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999*.

DPI&F initiated a state wide Long Term Monitoring Program (LTMP) in 1999, in response to a need for enhanced data for the assessment of Queensland's fisheries resources. The LTMP is managed centrally by a steering committee, with operational aspects of the program managed regionally from the Southern and Northern Fisheries Centres located at Deception Bay and Cairns respectively. The regional teams are responsible for organising and undertaking the collection of data to be used for monitoring key commercial and recreational species, and for preparing data summaries and preliminary resource assessments.

A series of stock assessment workshops in 1998 identified the species to include in the LTMP. The workshops used several criteria to evaluate suitability including:

- the need for stock assessment based on fishery independent data
- the suitability of existing datasets
- the existence of agreed indicators of resource status
- the practical capacity to collect suitable data.

Resources monitored in the program include saucer scallops, spanner crabs, stout whiting, yellowfin bream, sand whiting, dusky flathead, rocky reef fish, eastern king prawns, blue swimmer crabs, sea mullet and tailor in southern Queensland; tiger and endeavour prawns and coral trout and redthroat emperor in northern Queensland; and mud crabs, barramundi, spotted and Spanish mackerel and freshwater fish in both regions. Various sampling methods are used to study each species.

The LTMP collects data for resource assessment (ranging from analyses of trends in stock abundance indices to more complex, quantitative stock assessments) and management strategy evaluations.

Stock assessment models have already been developed for saucer scallops, spanner crabs, stout whiting, mullet, tailor, barramundi, tiger and endeavour prawns, redthroat emperor, and spotted and Spanish mackerel. In some cases, management strategy evaluations have also been completed and the data collected in the LTMP proved integral to these activities.

The assessments and evaluations have allowed options for improvements to the management of Queensland's fisheries resources. Enhancements to ongoing monitoring have also been identified, particularly to address the increasing demand for high quality data for dynamic fish population models.

Through the ongoing process of collecting and analysing LTMP data, and incorporating these data into regular assessments and refining monitoring protocols as required,

DPI&F is enhancing its capacity to ensure that Queensland's fisheries resources are managed on a sustainable basis.

Introduction

The Gulf of Carpentaria Developmental Finfish Trawl Fishery (DFTF) is a limited entry, quota-managed, semi-demersal trawl fishery. It has operated under jurisdiction of the Queensland Fisheries Joint Authority (QFJA) since June 1998. The QFJA, established under Queensland's *Fisheries Act 1994*, operates under complex management arrangements set up under the Offshore Constitutional Settlement agreement and resulting Memorandum of Understanding between the Queensland and the Northern Territory Governments and the Australian Government. The QFJA provides the Australian Government and Queensland to jointly manage the fishery due to the likelihood of shared resources with adjacent national and international jurisdictions. The DFTF remains a developmental fishery, subject to the Policy, and any change to licensed status will depend on the fishery demonstrating commercial viability, social acceptability and ecological sustainability.

Five developmental fishing permits have been issued since 1998 however; only two were active in 2006. The commercial fishing fleet within the DFTF predominantly capture tropical red snappers including the crimson snapper (*Lutjanus erythropterus*) and the saddletail snapper (*Lutjanus malabaricus*), however a variety of other valuable species are also retained as saleable product.

Both the crimson and saddletail snappers inhabit waters throughout the Indo-West Pacific region extending from northern Australia to southern Japan and from the Persian Gulf to Papua New Guinea (FAO 2001). They are found on coastal and inshore reefs but frequently occur as mixed aggregations over shoals, hard or sandy-mud substrate, sponge and gorgonian-dominated habitats (FAO 2001). Both species are long-lived with low natural mortalities. They are slow growing once reproductively mature and have protracted spawning periods throughout the year (Fry *et al.* In Press). The maximum sizes for crimson and saddletail snapper are 600 mm and 1000 mm total length (TL) respectively, but are commonly caught at 450-500 mm (FAO 2001).

The DFTF has a maximum commercial Total Allowable Catch of 1500 tonnes (t) of crimson snapper, saddletail snapper, red emperor and other emperors (DPI&F 2007a). Reported total catch for this developmental fishery was variable between 1998 and 2001 with as little as 7 t reported in 2006 (DPI&F 2007a). However since 2001 total catch has increased each year with 613 t reported in 2006 (2.5M AUD) (DPI&F 2007a). The crimson and saddletail snapper together comprise 55% of the average total annual catch by weight, with 36% and 19% for each species respectively (2002-2005, DPI&F 2007a). The remaining 45% include mangrove jack (*Lutjanus argentimaculatus*) at 15%, golden snapper at 6% (*Lutjanus johnni*), painted sweetlips (Haemulidae) at 7%, goldband snapper (*Pristipomoides multidens*) at 4%, and other species fill the remaining 12% of the catch (DPI&F 2007a).

The Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), administered by the Department of the Environment, Water Heritage and the Arts (DEWHA) provides guidelines and principles against which a fishery is assessed in order to be exempt from export controls. Associated with the EPBC Act are 'Guidelines for the Ecologically Sustainable Management of Fisheries' which are specifically designed to seek to ensure that not only target species in a fishery are sustainably managed but also associated bycatch and by-product, maintaining ecosystem structure, productivity, function and biodiversity, as well as giving due consideration to endangered, protected or threatened species or ecosystems. Recommendations from the Department of the Environment and Heritage (DEH), now DEWHA, for this fishery from a 2004 assessment included the need to conduct data collection programs that will enable the monitoring of fishery management performance measures for target, by-product, bycatch, and protected species and impacts on the ecosystem (DEH 2004). A Performance Measurement System (PMS) was developed for the DFTF in consultation with the Gulf Management

Advisory Committee (Gulf MAC) in 2006. The PMS is awaiting final DPI&F implementation.

This report relates to a preliminary monitoring program conducted between December 2004 and March 2006. Biological samples were collected by DPI&F fishery observers from six trips onboard licensed DFTF vessels and were processed by LTMP staff at the Northern Fisheries Centre, Cairns. Essential biological data were collected from these samples for crimson and saddletail snapper necessary for stock assessment and improved management of these species.

Objectives

The objectives of the monitoring for the DFTF were to provide biological data for the stock assessment of crimson and saddletail snapper. The information collected included:

- length, sex, and age structures of the commercial catches
- temporal distributions of spawning events.

Biological data was also collected for other species, including mangrove jack (*Lutjanus argentimaculatus*) although this data has not been presented in this report. Further detail on this information collected can be found in DPI&F 2006a.

This report is a summary of the data collected from samples of crimson and saddletail snapper caught in the DFTF between December 2004 and March 2006 and provides;

- Length to weight relationships
- Standard length to fork length relationships
- Reproductive indices (Gonosomatic indices)
- Reproductive stage data (macroscopic)
- Sex ratios across size classes.

Fish ageing information is not presented in this report, and will be presented in future reports as the data become available.

Methods

A sub-sample of the total catch for each survey was collected by DPI&F fishery observers during six trips undertaken between December 2004 and March 2006. The aim of the observer trips was to obtain a representative sub-sample of 20 individual fish from each 2 cm size class for crimson and saddletail snapper. Details of the sampling regime can be found in the DFTF Fisheries Observer Program Manual 2006 (DPI&F 2006b).

Fish samples were processed at DPI&F Northern Fisheries Centre in Cairns for processing in the laboratory. Parameters recorded from individual fish included fork, total and standard lengths (mm), total weight (g), gonad weight (g), and gonad reproductive stage (as per Davis 1982). Otoliths were extracted using methods outlined in DPI&F (in press.) and sent to the Central Ageing Facility for ageing.

Sites

The DFTF operates in Gulf of Carpentaria waters beyond 25 nautical miles from the Queensland coast to the boundary of the Australian Fishing Zone (Figure 1). The western edge of the fishery is the Queensland – Northern Territory border and the

southern boundary is 15° S (Roelofs and Stapley 2004). In 2005, most of the fishing effort was concentrated in the eastern sector of the DFTF, near Weipa (DPI&F 2007).

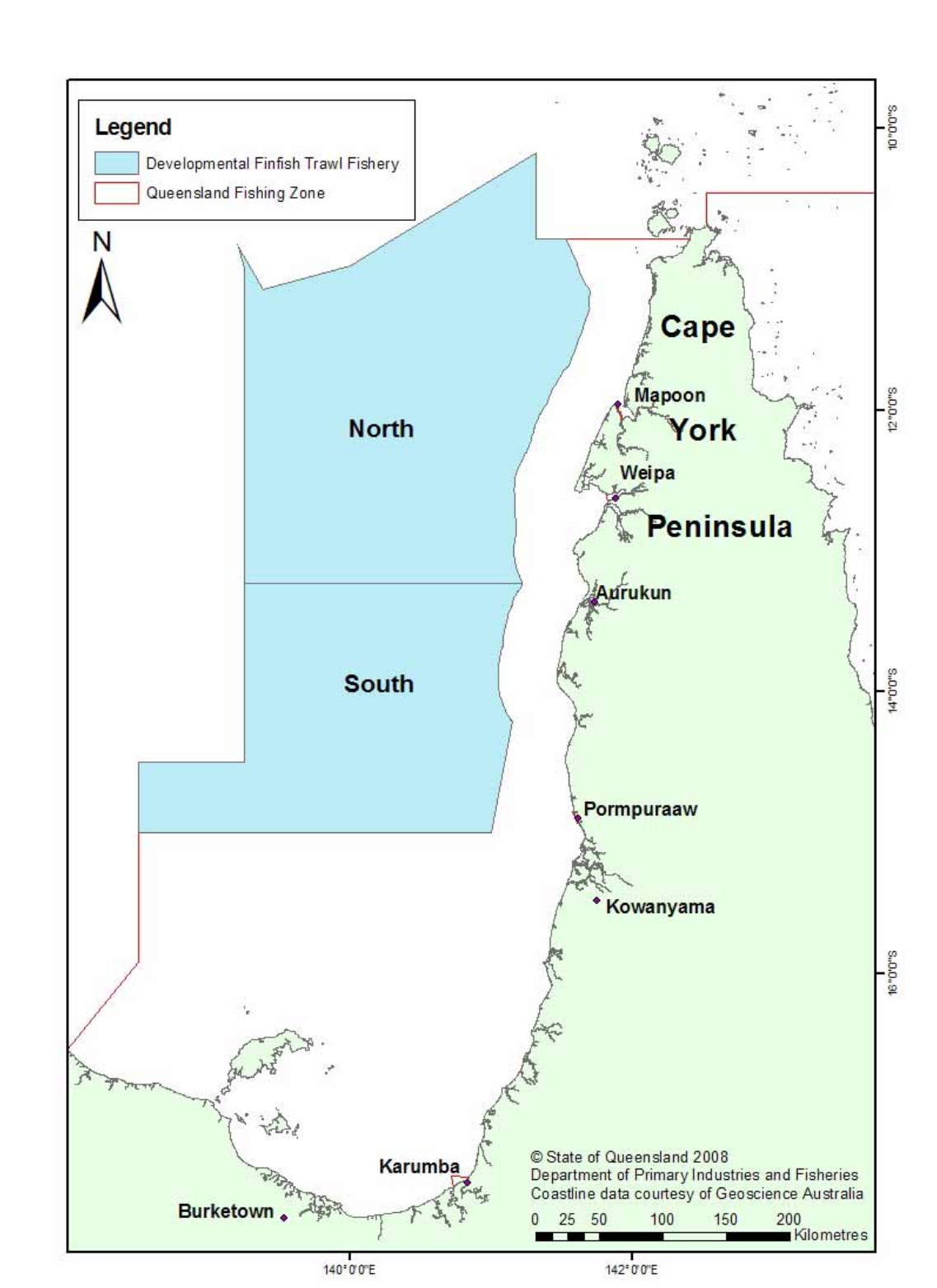

Figure 1. Sampling area between December 2004 and March 2006.

Within the allocated trawling grounds, the DFTF vessels operate in two distinct trawl regions, a northern and a southern region (Fig 1). Fishing has been conducted in the northern region since 1990 (Roelofs and Stapley 2004), but has only been allowed in the southern region since mid 2004. Samples collected were distinguished by region to enable any regional trends to be identified. Samples were collected from commercial

operations in the southern region in June and December 2005 and the northern region in December 2004, March and October 2005, and March 2006.

Times

Commercial fishing within the DFTF occurs year round. The six observer trips were conducted during December 2004, March, June, October and December 2005, and March 2006. Each trip consisted of approximately six fishing days, subject to availability by the fishers and weather. For further details see DPI&F (2006b).

Fishing gear

Descriptions of gear types and on board sampling procedures are available in the DPI&F Fishery Observer Program Manual (DPI&F 2006b).

Data summaries and analysis

In the laboratory, the reproductive organs were macroscopically staged based on the Davis (1982) staging system. The stages have been grouped in order to simplify the reproductive stages of crimson and saddletail snapper in this report (Table 1). Grouping of the reproductive stages in this manner improves the precision of the interpretation of this information.

Table 1. Grouping of the reproductive stages based on the macroscopic staging system by Davis (1982).

Reproductive Stage Grouping	Davis (1982) reproductive staging classifications
Developing	Immature (stage 1), Developing (stage 2) and Maturing (stage 3)
Ripe	Mature (stage 4) and Ripe (stage 5)
Spent	Spent (stage 6)

The low number of fish samples collected in June 2005 were excluded from the calculation of the reproductive gonosomatic indices (GSI). This resulted from onboard filleting of product, and therefore some loss of gonad tissue for weight measurements.

Results and discussion

Morphometric measurements

Length to weight relationships

A strong relationship is evident between fork length (mm) and total weight (g) for both species and regions (Figure 2 and Figure 3), as confirmed by the high R squared values (Appendix A, Table 2). Such a relationship will allow accurate length to weight conversion for both species for future monitoring.

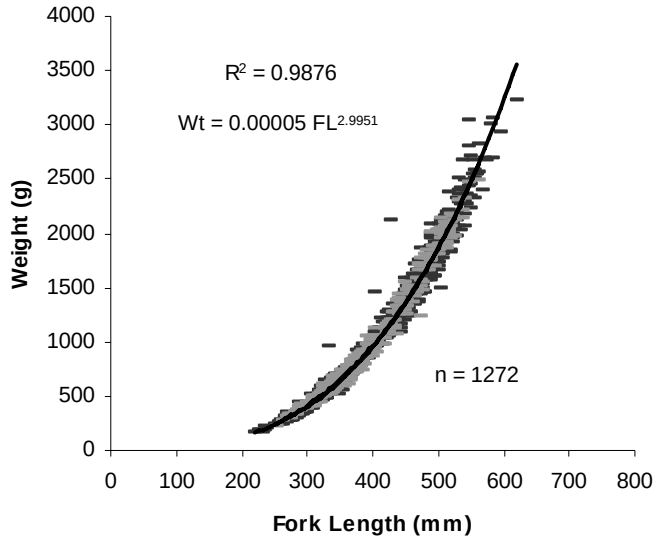

Figure 2. Relationship between fork length (mm) and total weight (g) for the crimson snapper, *Lutjanus erythropterus*, from combined regions and sexes. Sample size (n) is 1272.

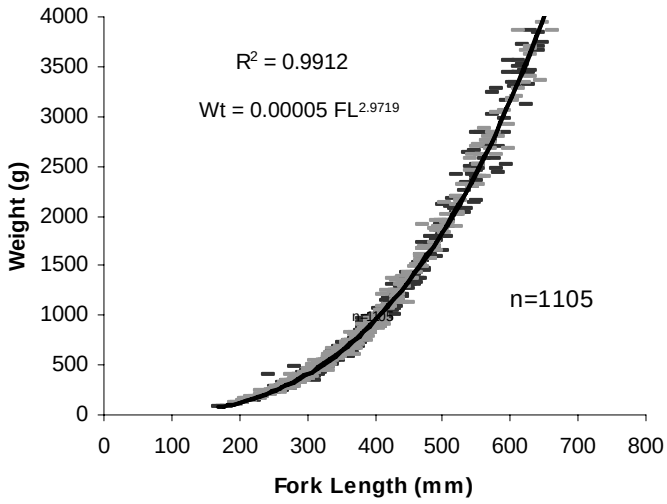

Figure 3. Relationship between fork length (mm) and total weight (g) for the saddletail snapper, *Lutjanus malabaricus,* from combined regions and sexes. Sample size (n) is 1105.

Standard length to fork length relationships

A strong relationship is evident between standard length (mm) and fork length (mm) for samples collected from the northern and southern trawl regions of the Gulf of Carpentaria for the crimson snapper (R^2 = 0.9609) (Figure 4) and the saddletail snapper (R^2 = 0.9682) (Figure 5). This information has been included for future length conversions as fish tails are commonly damaged during trawl shots. Several length measurements are recorded to ensure an accurate length measurement is obtained.

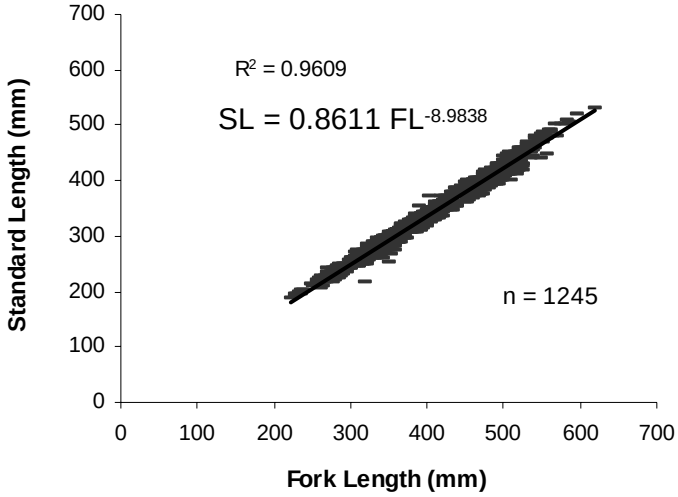

Figure 4. Relationship between fork length (mm) and standard length (mm) for the crimson snapper, *Lutjanus erythropterus*. Both regions and sexes are combined. Sample size (n) is 1245.

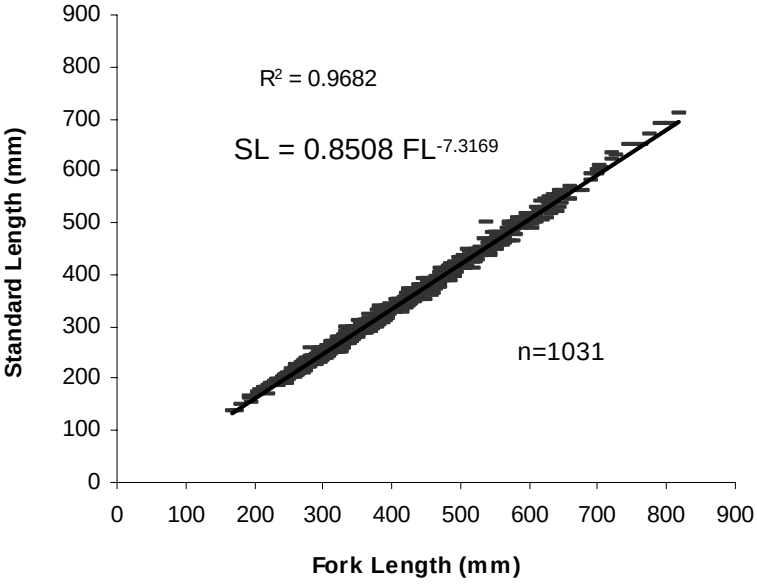

Figure 5. Relationship between fork length (mm) and standard length (mm) for the saddletail snapper, *Lutjanus malabaricus*. Both regions and sexes are combined. Sample size (n) is 1031.

Gonosomatic indices

The gonosomatic indices (GSI) suggest that female snapper exhibit spawning throughout the year with three small peaks of heightened activity in March 2005 and 2006, and December 2005 surveys (Figure 6 and Figure 7). These results may be attributed to coincidental sampling over heightened spawning activity, i.e. over particular lunar cycles. Each of these surveys was within one to two days before or after the new moon. Ideally GSI values from each month of a single year would be required to verify any spawning peaks in Gulf of Carpentaria populations.

The mean GSI results for male snapper indicate that there is a small amount of variation in sperm production throughout the year for both species of snapper (Figure 6 and Figure 7). This low, relatively stable, mean GSI is common for tropical male lutjanids (Fry *et al*. In Press). It suggests no specific period of increased reproductive activity, but rather an extended spawning phase lasting throughout most of the year. This low standing energy investment in reproduction i.e. low GSI values, are common traits of continuous spawners compared with annual spawners that have GSI values of 10% - 30% of their total body weight during spawning (Mees 1993).

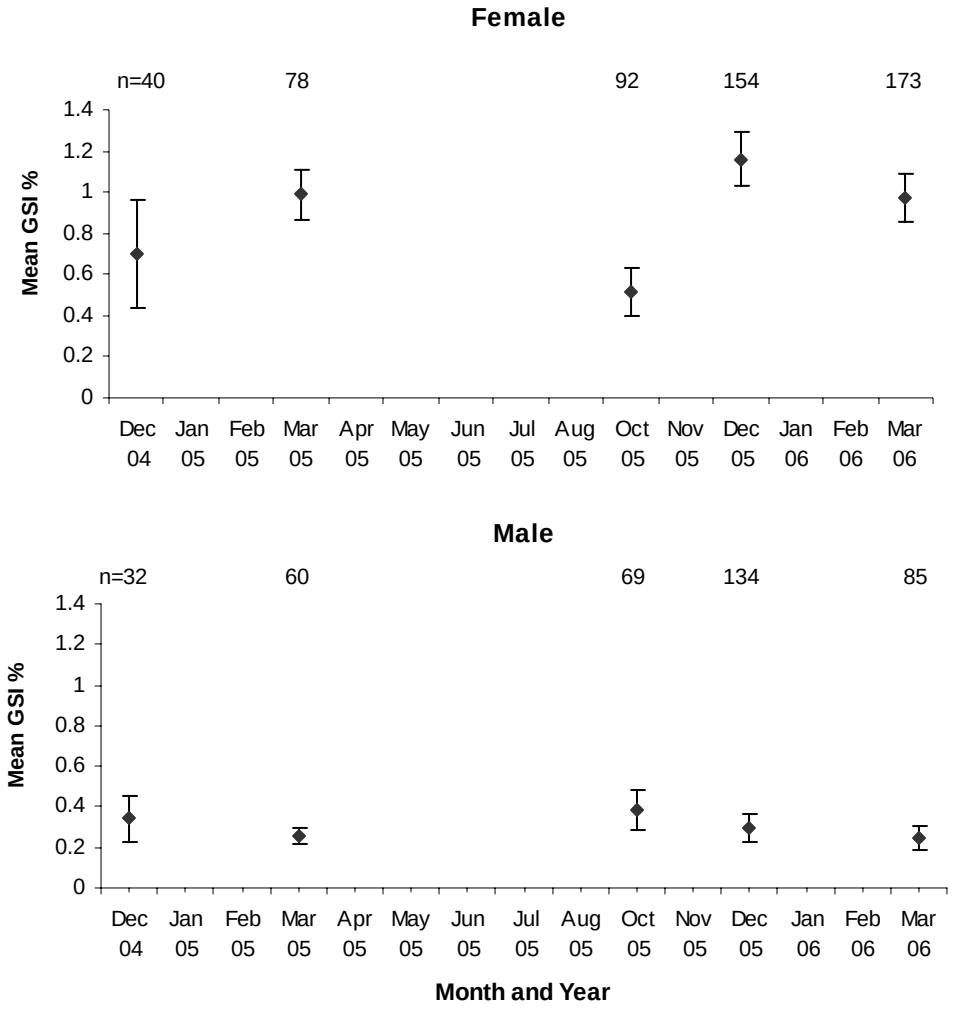

Figure 6. Mean Gonosomatic Indices (GSI) for female and male crimson snapper, *Lutjanus erythropterus,* with 95% confidence intervals. Sample sizes (n) are given above each mean value.

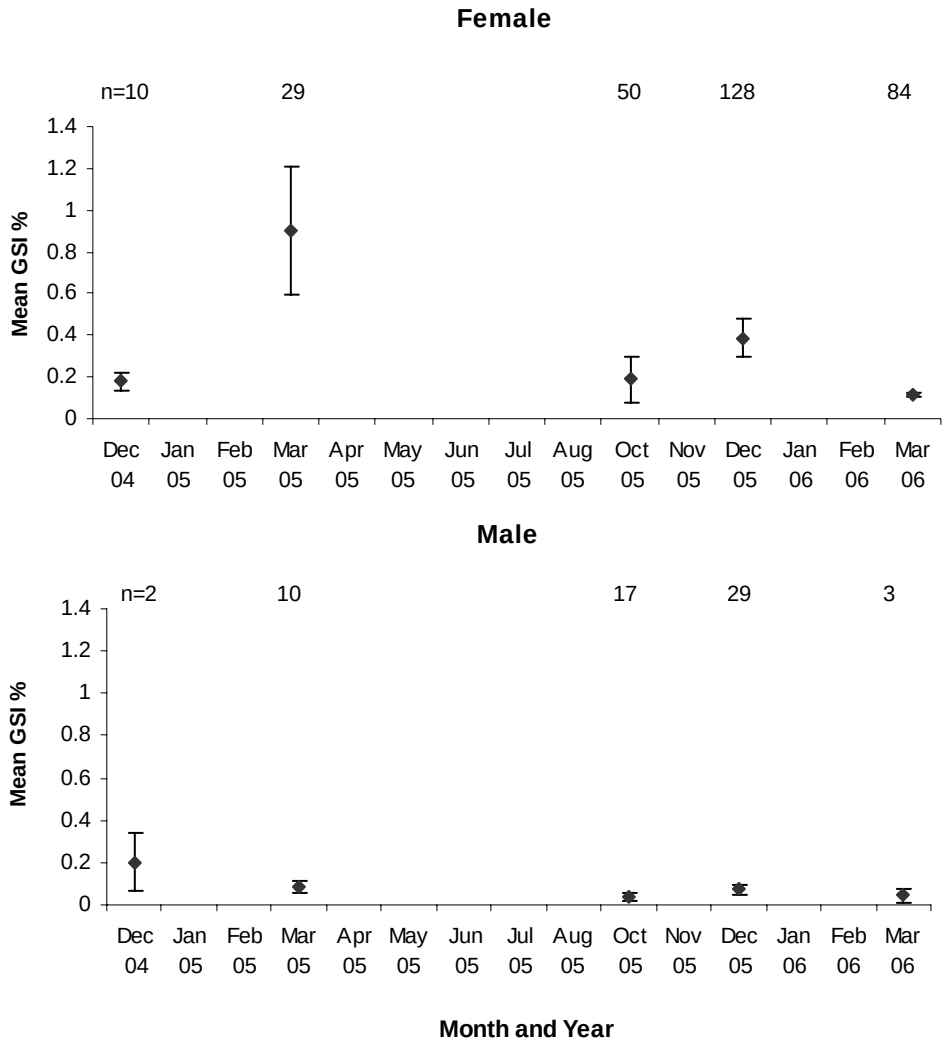

Figure 7. Mean Gonosomatic Indices (GSI) for female and male saddletail snapper, *Lutjanus malabaricus,* with 95% confidence intervals. Sample sizes (n) are given above each mean value.

Macroscopic reproductive stage data

The majority of male crimson and saddletail snapper were reproductively inactive or developing throughout the year. Female crimson snapper demonstrated a higher frequency of reproductive activity throughout the sampling (Figure 8).

Ripe female saddletail snapper ovaries were present in all trips in small proportions, except for March 2006 when they were absent (Figure 9). Only two spent ovaries were identified from all surveys and these were collected during the March 2005 trip.

The macroscopic reproductive staging indicated a prolonged spawning period by both lutjanid species. More females were classified as ripe or spent compared to males. Due to the serial spawning capability of tropical snapper the ovaries of females can show multiple oocyte stages concurrently (Fry *et al*. In Press). The June 2005 trip sample was the only exception possibly indicating a decline in spawning activity at the start of the cooler winter months.

Both the GSI and macroscopic reproductive staging of crimson and saddletail snapper samples support previous results on the reproductive seasonality of tropical lutjanids, where insular populations have a more or less continuous year-round spawning pattern with peaks of reproductive activity in the spring and autumn (Fry *et al*. in press).

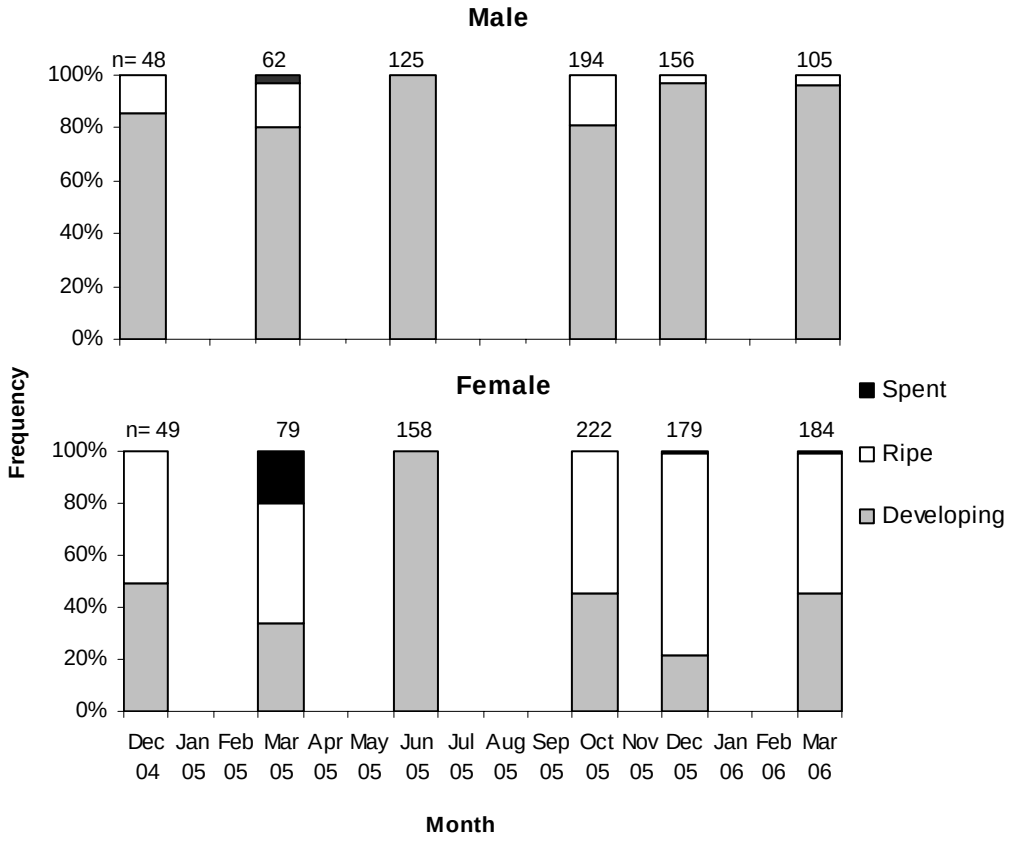

Figure 8. Frequencies of reproductive stages of testes from male and ovaries from female crimson snapper, *Lutjanus erythropterus* caught in the Gulf of Carpentaria. Sample sizes (n) are given above each column.

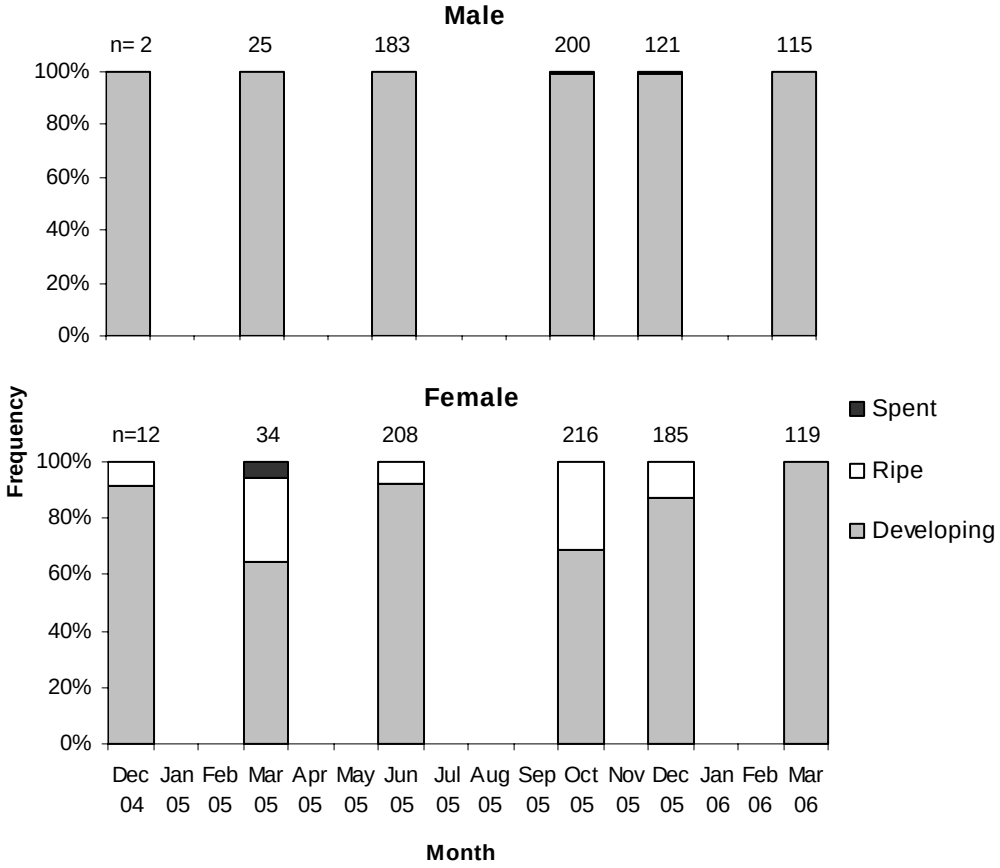

Figure 9. Frequencies of reproductive stages of testes from male and ovaries from female saddletail snapper, *Lutjanus malabaricus,* caught in the Gulf of Carpentaria. Sample sizes (n) are given above each column.

Sex ratio

Sex ratios for crimson snapper sampled from the northern and southern regions appear to be relatively even for size classes where sex could be determined macroscopically (Figure 10), (Appendix, Table 3). Larger numbers of smaller fish for which sex could not be determined were sampled in the north region.

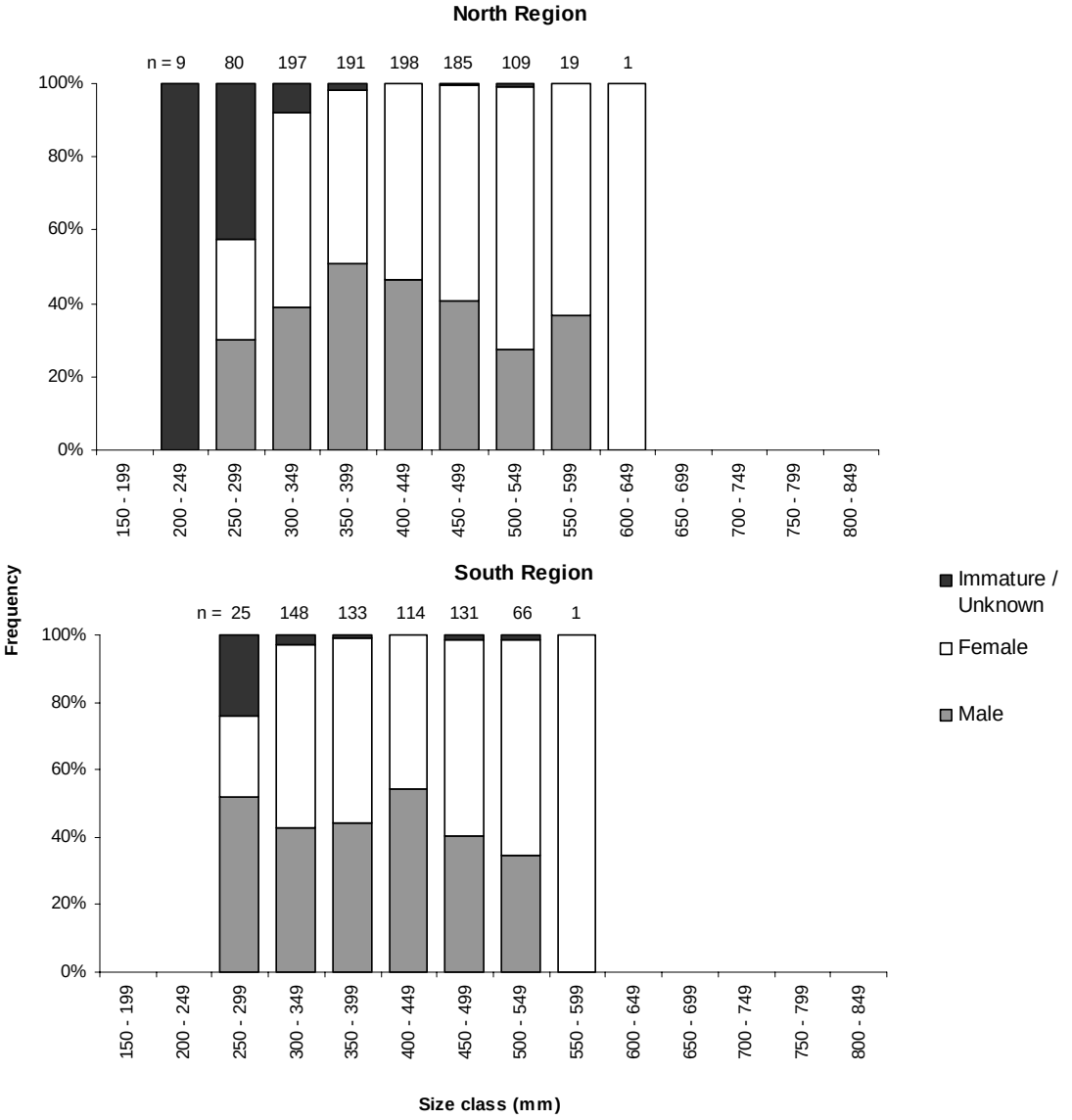

Figure 10. Percentage of male and female crimson snapper within each 50 mm fork length size class for the north and south regions. Sample sizes (n) are given above each column. Those individuals that were immature or could not definitively be assigned a sex were pooled.

Females dominated numerically in both regions (Figure 11), (Appendix, Table 3). Sex ratio figures for saddletail snapper indicate slightly higher frequencies of females present in each population than males. There are also an increased number of individuals of unknown sex in the northern region for both species. This could be due to a larger population of juveniles inhabiting the north region or greater fishing pressure removing the larger fish from the population.

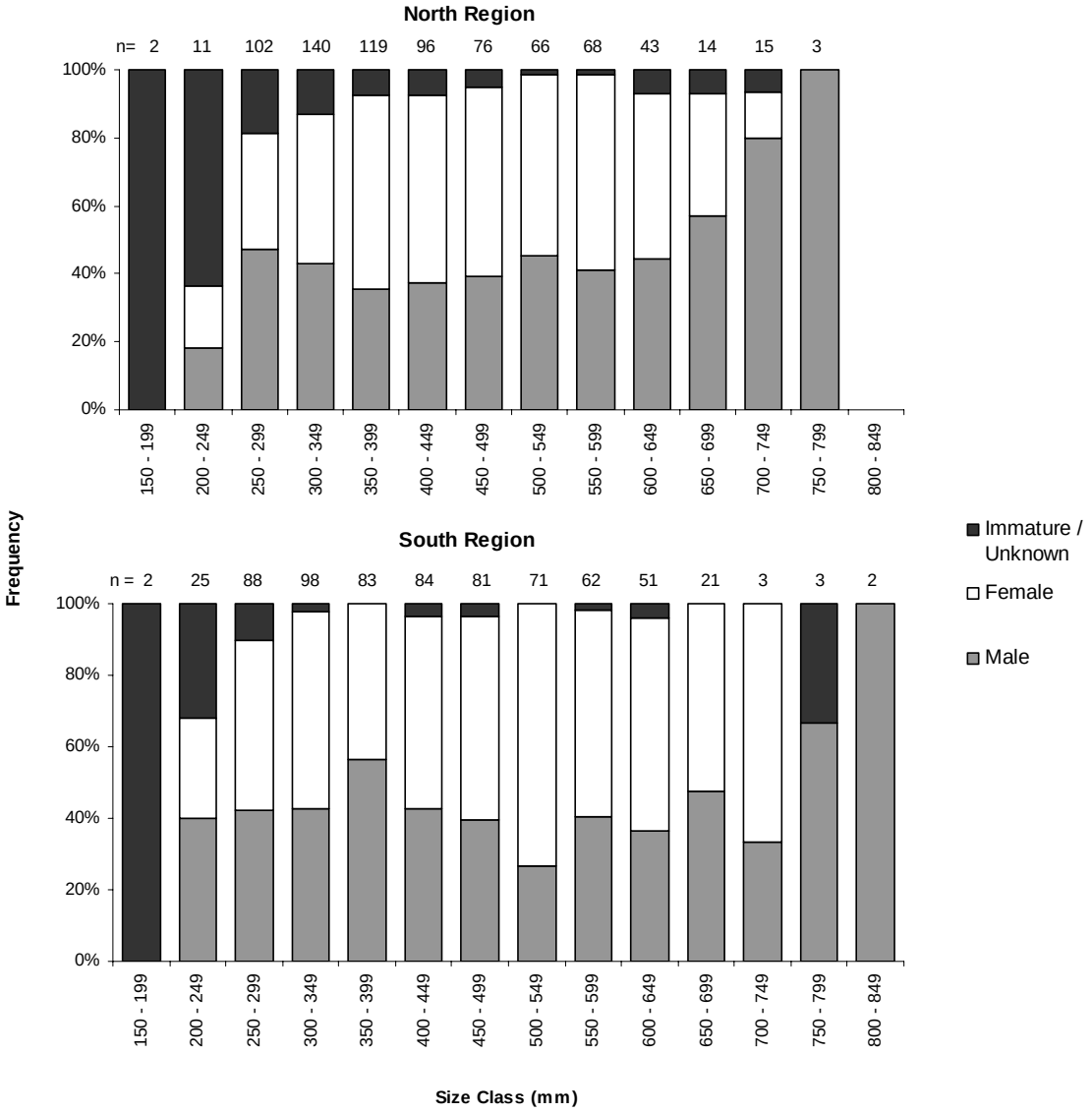

Figure 11. Percentage of male and female saddletail snapper within 50 mm fork length size classes for the north and south regions. Sample sizes (n) are given above each column. Those individuals that were immature or could not definitively be assigned a sex were pooled.

Conclusions

Results from the data indicate that within the fishery:

- Crimson and saddletail snapper are likely to display protracted spawning periods throughout the year, although monthly sampling would be required to more accurately describe these spawning periods.
- Crimson and saddletail snapper sampled show a higher frequency of females than males.
- There is a strong relationship between length and weight in both the northern and southern fished regions.

Otolith samples for assessing age for crimson and saddletail snapper have been collected and estimated age data will be presented in a future report.

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Appendix

Table 2. Formulas and R^2 values of length / weight relationships for crimson and saddletail snapper caught in northern and southern regions of the Gulf of Carpentaria Developmental Finfish Trawl Fishery.

Species Common Name	Species Scientific Name	Region	Formula	R^2 value
Crimson snapper	*Lutjanus erythropterus*	North	$Wt = 0.00005FL^{2.9951}$	0.9876
		South	$Wt = 0.00005FL^{2.9404}$	0.9869
Saddletail snapper	*Lutjanus malabaricus*	North	$Wt = 0.00005FL^{2.9719}$	0.9912
		South	$Wt = 0.00005FL^{2.9524}$	0.9932

Table 3. Percentage of males to females for each species.

Species Common Name	Species Scientific Name	Region / Percentage		Male	Female	Unknown	Total
Crimson snapper	*Lutjanus erythropterus*	North	total number	402	523	64	989
			%	40.6	52.8	6.4	
		South	total number	273	331	14	618
			%	44.1	53.5	2.2	
Saddletail snapper	*Lutjanus malabaricus*	North	total number	318	364	73	755
			%	42.1	48.2	9.6	
		South	total number	282	362	31	675
			%	41.7	53.6	4.5	