Long-term Abundance Index for Goldband Snapper in the Timor Sea

A Pilot Study

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FISHERIES
RESEARCH &
DEVELOPMENT
CORPORATION

Project T94/155

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NON-TECHNICAL SUMMARY

Goldband snapper (*Pristipomoides multidens, Pristipomoides typus, Pristipomoides filamentosus*), are the target species of the Timor Reef fishery, one of the Northern Territory's most valuable fisheries. The primary fishing method for capturing these species is the vertical long line which is locally known as a dropline. Over recent years there has been a substantial increase in landed catch of goldband snapper, from 84 t in 1990 to 320 t in 1994. Knowledge of goldband snapper biology and population dynamics is scant. Present estimates of sustainable yield are based on limited information from fishers monthly logbooks, trawl surveys and the literature. Ramm (1995) has estimated that the sustainable yield for goldband snapper in the NT sector of the Timor Sea is 426-1290 t/year. However, the catch and effort data used in these models have some inherent problems due to:

- rapid advances in technology since the fishery's inception (particularly the use of Global Positioning Systems);
- the small number of operators with different levels of skill and experience; and
- the high turnover of these operators.

These factors may have resulted in fluctuations in catch per unit effort (CPUE) which might reflect changes in fishing operations rather than changes in abundance. With these concerns in mind, the Fisheries Division felt that there was a need to refine the estimates by obtaining better information on the Timor Reef fishery. The overall aim of this pilot project was to investigate the feasibility of developing a repeatable sampling strategy. Therefore, CPUE obtained in this manner could be used as an independent index of abundance for long-term monitoring of the fishery.

Sampling was confined to commercial grounds in the Timor Box (Fig. 1). A total of 10 areas were chosen. Each area was 50 sq nautical miles. Seven of these areas were recommended by Timor Reef licensees, and the other three areas were chosen to cover the maximum amount of commercial ground. We were interested in areas which would provide reliable, rather than large, catches. Two types of sampling gear were used: commercially rigged droplines which were the main sampling method and a trammel net, which was used as a complementary method. To determine the most effective hook size for goldband snapper, 10/0 and 13/0 tuna circle hooks were used. The trammel net was used to capture a wider size range of the target species. It also provided information on what species coexist with goldband snapper, and whether fish were present when dropline catches were poor. The trammel net used in this project was a modified version of trammel nets commonly used in shallow water, northern hemisphere fisheries.

Discussions were held with the skipper to determine the best search strategy, that is, which search path would cover the maximum amount of area while optimising the time spent on "likely" goldband snapper ground. A maximum of two hours fishing per school was allocated, then fishing would cease and a new school would be sought. We aimed for 12 hours fishing time per area. Occasionally it was not possible to achieve this if catches were very poor and the majority of time was spent searching. A maximum of two days was spent in each area.

One of the aims of this pilot project was to find sampling areas which could be used for long-term monitoring, therefore an important criterion for an area was repeatablity.
When results were analysed statistically, no significant difference was found among areas sampled one month apart. However, there was a significant difference when these areas were resampled six months later; all showed lower catch rates. These results indicate that there is a seasonal influence, and for long-term monitoring it is important to sample during the same period of the year. We have identified two areas which gave repeatable results when sampled at the same time of the year. Some sites in the western section of the study area also gave high catches and may have been suitable for long-term monitoring, but due to time constraints could not be resampled.

A trammel net and an underwater video camera were used to investigate whether poor dropline catches were due to absence of fish or to fish not biting. Of the 22 shots with the trammel net, we found that on 11 occasions the trammel net caught more fish than droplines at the same location. Usually this occurred when good marks of fish were seen on the sounder, yet almost none were caught on the droplines. In many cases fish caught in the trammel net were gorged with small bait fish. Video footage taken at the same time shows schools of fish swimming around the baited lines, but not biting.

For goldband snapper we found that the trammel net provided a larger size range of fish than the droplines. When dropline and trammel net were compared for all species the results were more pronounced: sizes ranged between 110-2560 mm FL for the trammel net compared with 206-830 mm FL for the dropline. The trammel net also provided good information on species composition. Fifty-nine species were recorded from the trammel net compared with 27 species from the dropline.

The size range and number of goldband snapper caught with size 10/0 and size 13/0 tuna circle hooks was not significantly different.

In conclusion this study has achieved its objectives by identifying sampling areas and strategies suitable for the Timor Reef fishery. Therefore, CPUE obtained in this manner could be used as an independent index of abundance for long-term monitoring of the fishery.

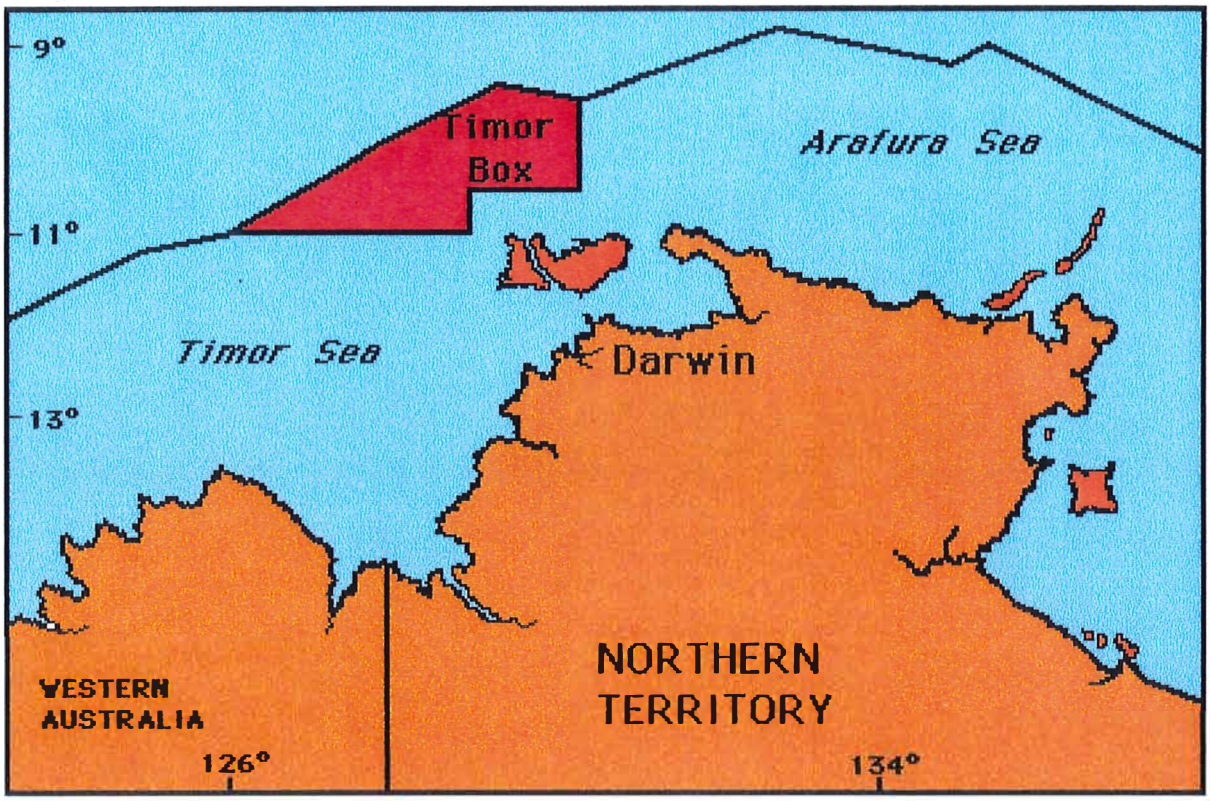


Figure 1. Location of the Timor Box in relation to Darwin.

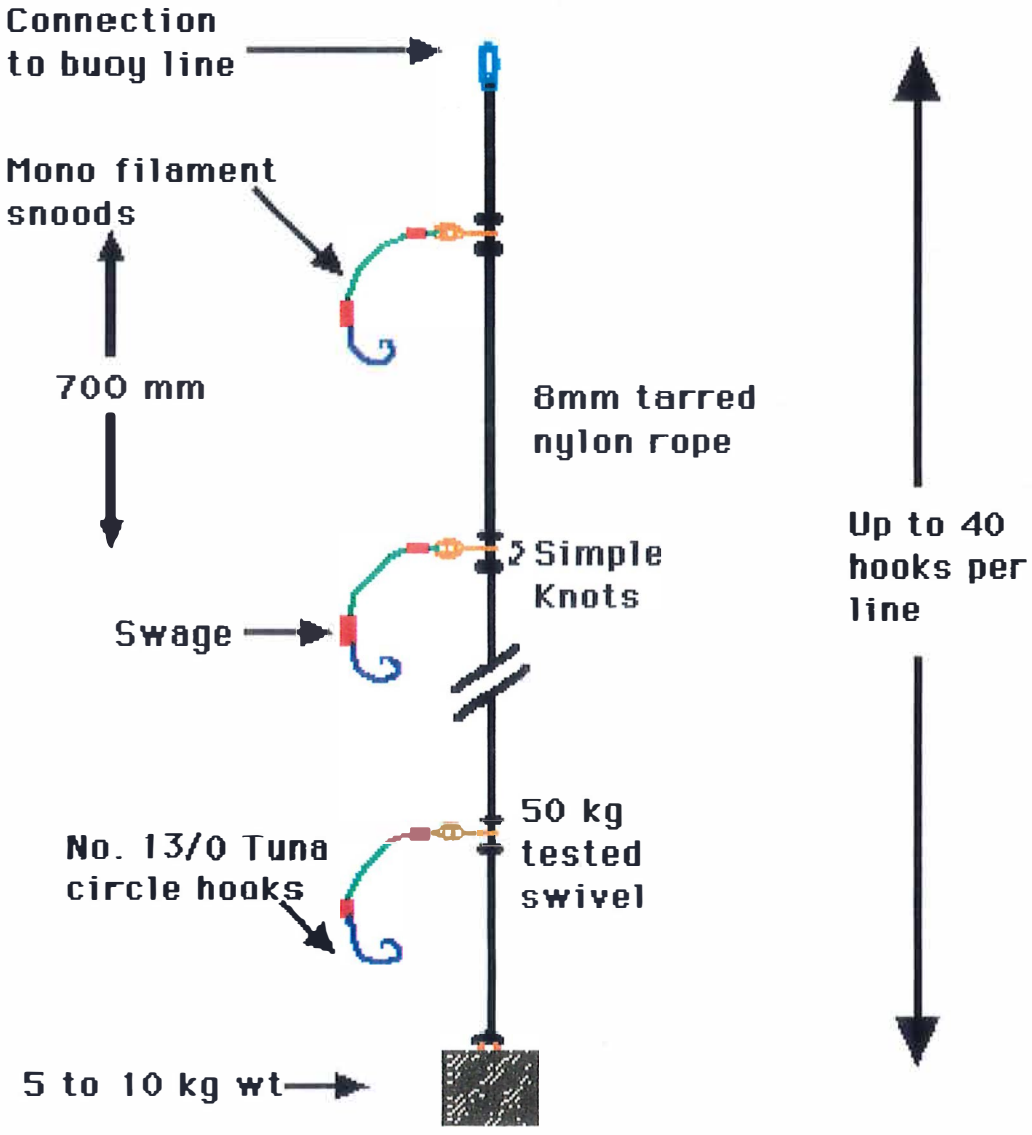


Figure 2. Diagram showing lower section of project dropline.

BACKGROUND

In the Northern Territory, the term "goldband snapper" commonly refers to *Pristipomoides multidens, Pristipomoides typus and Pristipomoides filamentosus* which are grouped together for marketing purposes. Throughout this report the general term "goldband snapper" will be used to refer to all three *Pristipomoides* species unless otherwise specified.

Goldband snapper is the target species of the Timor Reef fishery, one of the Northern Territory's major fisheries. This offshore fishery is concentrated in an area commonly referred to as the Timor Box (Fig. 1). The primary fishing gear used is vertical long-line, locally known as a dropline. The average vessel in this fishery ranges in length from 12-20 m, and most are highly manoeuvrable planning hull craft.

This fishery has developed rapidly from one operator in 1987 to one of the NT's most valuable fisheries. Over recent years there has been a substantial increase in landed catch of goldband snapper from 84 t in 1990 to 320 t in 1994. Declaration of the Timor Reef fishery as a managed fishery occurred in 1994. There are presently 20 licences in this fishery, although only eight are active.

Knowledge of goldband snapper biology and population dynamics is scant. Present estimates of sustainable yield are based on limited information from fishers monthly logbooks, trawl surveys and the literature. Ramm (1995) estimated that the sustainable yield for goldband snapper in the NT sector of the Timor Sea is 426-1290 t/year. This estimate was based on the following assumptions:

- snappers are uniformly distributed between trawlable and non-trawlable habitats;
- there is no large scale seasonal and/or annual movements of snappers; and
- goldband snapper have growth and reproduction parameters similar to *Lutjanus malabaricus* (saddletail snapper) on the Northwest Shelf of Western Australia.

The validity of these assumptions is uncertain because of limited knowledge of the biology, population dynamics and distribution of goldband snapper in the Timor Sea. The catch and effort data used in these models also have some inherent problems due to:

- rapid advances in technology since the fishery's inception (particularly the use of Global Positioning Systems);
- the small number of operators with different levels of skill and experience; and
- the high turnover of these operators.

These factors may result in fluctuations in catch per unit effort (CPUE) which might reflect changes in fishing operations rather than changes in abundance. With these concerns in mind, the Fisheries Division felt that there was a need to refine the population parameter estimates by obtaining better information on the Timor Reef fishery. The aim of this pilot project was to investigate the feasibility of developing a repeatable sampling methodology. Therefore, CPUE obtained in this manner could be used as a fishery independent index of abundance for long-term monitoring of the fishery.

Anecdotal information from fishers indicated goldband snapper are usually found on rough bottom or along the edges of reefs. Hence trawling was not considered a practical sampling method for these grounds. Droplining, which is the main commercial method for catching goldband snapper was used as the prime sampling method. We were concerned that this method may be biased due to hook selectivity and the need for fish to be attracted to bait. Factors such as variation in feeding pattern or a preference for live bait in the sampling area can have a significant effect on catch rates. For this reason, a trammel net was used as a complementary method to obtain a wider size range of the target species, and provide information on what other species coexist with goldband snapper. We also anticipated that the trammel net would provide an alternative sampling method when fish were not attracted to the baited lines.

Acoustic information from an echosounder was incorporated into the sampling strategy. Anecdotal information from a wide variety of sources (fishers from Hawaii, Japan and the NT) have reported that goldband snapper forms a distinctive "Christmas tree" pattern on the echosounder. Therefore by using a skipper experienced in discerning "goldband snapper marks" we were able to increase our sampling efficiency by targeting these marks.

The proposal was supported by the NT Fisheries Research and Development Advisory Committee in July 1994 and funding was obtained from the Fisheries Research and Development Corporation (NT Proactive Trust Fund).

OBJECTIVES

The major objectives of the pilot study were to:

- develop techniques for obtaining repeatable indices of relative abundance for goldband snapper (*Pristipomoides* spp), and other major commercial species, which are applicable to habitats commonly found in the Timor Sea; and
- obtain additional information on the spatial and seasonal distribution of goldband snapper and other major commercial species in the Timor Sea.

The results from this pilot study will assist in the development of regular, long-term surveys of goldband snapper in the Timor Sea.

METHODS

Consultation

The first stage of this project was a consultative phase with fishers. This took place in two steps.

1. Informal discussions with fishers took place during October 1994 to obtain information on what factors may influence sampling. During this period many fishers reported low catches, even though good fish marks showed on the echo sounder. They suspected that goldband snapper were probably feeding on exceptionally large schools of

bait fish which had recently appeared in the area, in preference to the baited lines. There was concern that this may be a problem during the proposed study period.

We also needed a sampling method which:

(a) would ensure that a representative size range of the target species was caught; and
(b) gave an indication about the species composition of other fish in this habitat.

After discussions with the Division's gear technologist it was decided that a trammel net would meet these requirements. The trammel net would be used to complement the main sampling technique, droplining.

2. Formal discussions with Industry. A meeting was held with industry on 21 November 1994. The purpose of this meeting was to discuss the objectives of the project, the proposed sampling strategy and obtain information about which areas would be suitable sampling sites. Letters were sent to all licence holders inviting them to attend or to contact the Division if they were unable to attend, but wished to contribute. The response was positive: of the eight regular fishers, five attended the meeting, apologies were sent from several other licensees. Discussions were very constructive and seven areas were identified as potential sampling sites which would fulfil sampling requirements. Results from recent trammel net gear trials were presented and use of the trammel net as a complementary sampling method was endorsed.

Vessel and Gear

A 17 m fishing vessel "San Pasquale II", was chartered to undertake four sampling trips in the Timor Box. This vessel is a fibre glass planning hull vessel typical of many of the dropline boats. Both the skipper and crew had considerable experience in this fishery.

Dropline description
Two hydraulic dropline winches were used. Each dropline rig consisted of a weighted mainline with 15 hooks attached to mono filament snoods. These were set at regular intervals on the lower section of the line (Fig. 2). Two different hook sizes were chosen: 13/0 tuna circle (standard commercial size) and 10/0 tuna circle (smallest size available). The purpose of using two different hook sizes was to investigate whether hook size has a significant influence on the number of goldband snapper caught and the size range of these fish. One dropline rig was set with small hooks, the other with standard hooks. Both lines were deployed simultaneously. The soak time for droplines during the study was five minutes. Hooks were baited with squid.

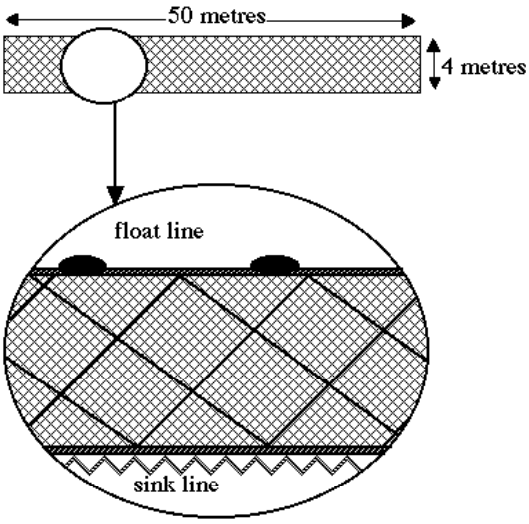
Trammel Net description
Our trammel net was modified to operate in deep water (to 200 m) and to target schools of goldband snapper. It consisted of a loosely hung centre wall of 55 mm stretched mesh mono-filament netting and was bordered on each side by tightly hung walls of 175 mm stretched mesh mono-filament netting. The net was 50 metres in length by 4 metre depth, (a detailed plan is shown in Fig. 3). Fish swimming through the large outer meshes encounter the smaller centre panel of net and push their way through the

opposite large outer meshes. This results in fish becoming trapped in the pockets that are formed (Fig. 4). The outer meshes on one side of the net must be a mirror image of the outer meshes on the opposite side. If not, it would be difficult for fish to form their own capture pockets. Apart from the three walls of netting, trammel nets are rigged in a similar way to gill/tangle nets (ie buoyancy along the top edge and ballast along the lower edge). The net was normally set near the droplines on hard coral bottom.

To overcome the problem of the net tangling during setting in deep water, we attached a 200 m rope with an anchor, to the leading end of the net. This in conjunction with the bouyline allowed us to keep the net stretched until it was very close to the sea bed. The net was set in the following manner. Once a school of fish was located on the fish finder, the skipper determined the current speed and direction. He then positioned the vessel directly up-current from the target and proceeded to set the anchor and rope, followed by the net.

As the trammel net was a complementary method to droplining, its use was dependant on how much time was available at the dropline site. It was normally set overnight and where possible reset in the same position for a day shot.

OVERALL NET DIMENSIONS



PANEL DIMENSIONS

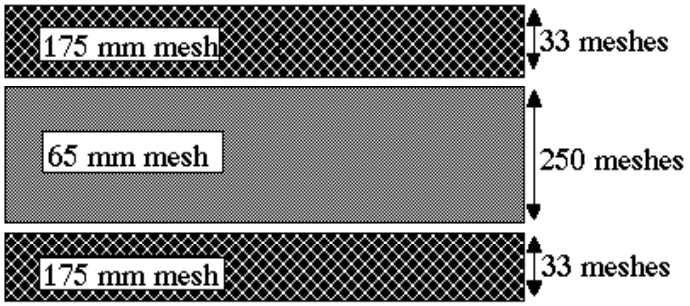


Figure 3. Trammel Net dimensions.

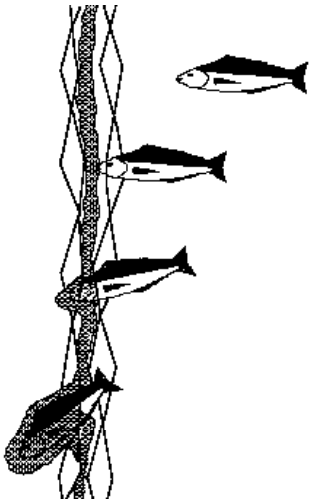


Figure 4. Diagram depicting how fish are captured by trammel net used during this project.

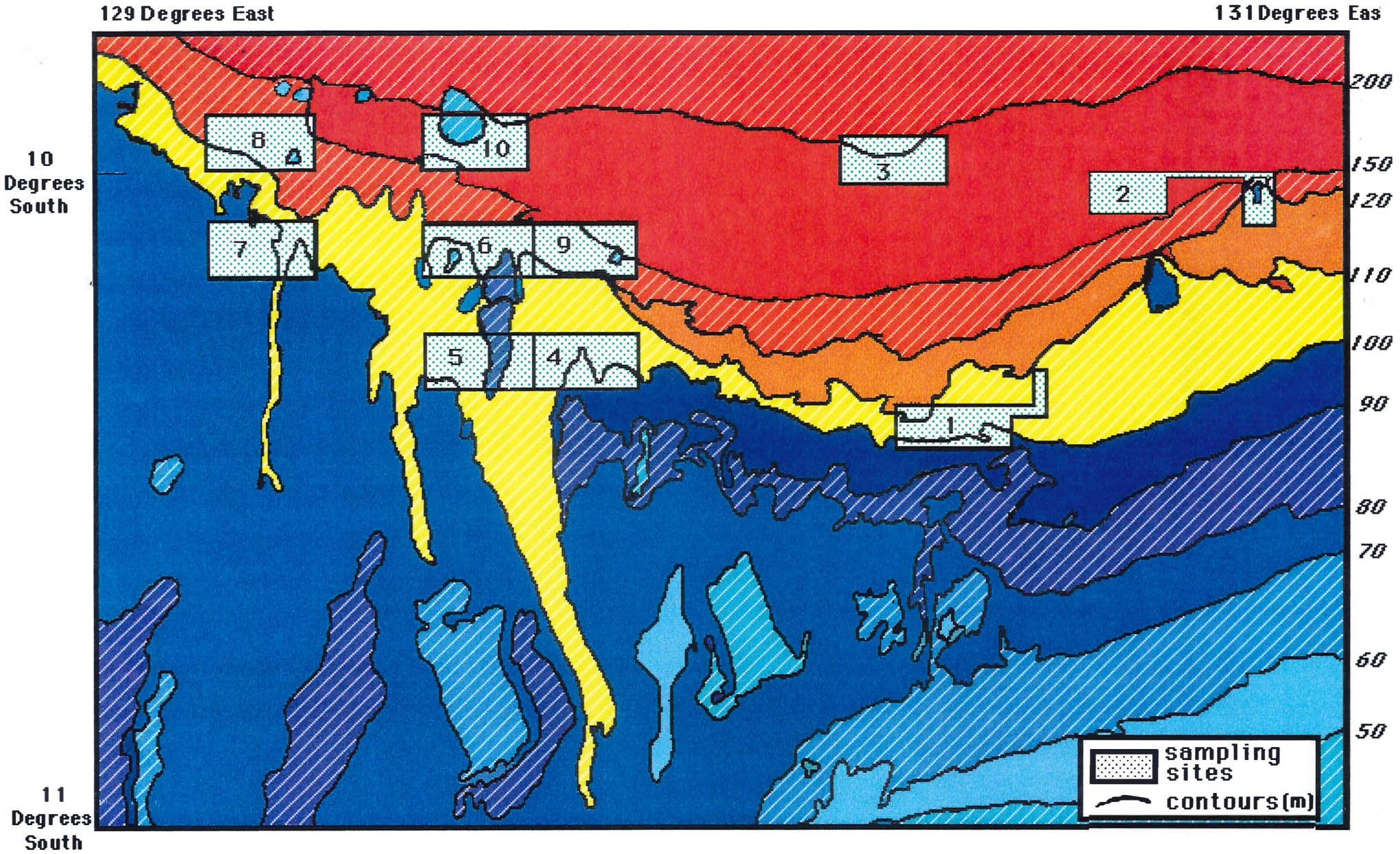


Figure 5. Areas sampled during the study

Area

Sampling was confined to commercial grounds known as the Timor Box (Fig. 1). The main bottom type in the sampling area was sand and gravel. This was determined from sediment charts (Van Andel and Veevers, 1967) and verified from underwater video footage taken during the survey.

A total of ten sampling areas, each 50 sq nautical miles were chosen for this study. Seven of these areas were recommended by fishers, and the other three were chosen to cover the maximum amount of commercial ground (Fig. 5).

Sampling Strategy

Prior to entering the sampling area, discussions were held with the skipper to determine the best search path to cover the maximum amount of area while optimising the time spent on "likely" goldband ground. This was based upon the skipper's past fishing experience in the area and on bathymetric charts. Generally, searching would be carried out along the sides of reefs in a systematic fashion. Once a school of fish was located on the sounder, it would be fished until the school broke up or fish stopped biting. A maximum of two hours fishing per school was allocated, then fishing would cease and a new school would be sought. To ensure that we were not fishing the same school, a minimum distance of 0.5 nautical mile was travelled before fishing commenced again. A standard soak time of five minutes per line was used.

Fishing time and searching time were noted separately, and we aimed for 12 hours fishing time per area. Occasionally it was not possible to achieve this if catches were very poor and the majority of time was spent searching. A maximum of two days was spent in each area. Adjacent areas were not sampled directly after each other, except on one occasion when time precluded moving (areas 4 & 5). During the sampling period February to April, two areas were repeated to determine how reliable these areas were for long-term sampling. Three areas were repeated six months later to determine if there was a seasonal influence.

All fish were measured, and sex and gonad stage was recorded on over 95% of the commercial species. Otoliths were collected from the major commercial species for ageing studies, and gonads were collected for histological confirmation of field staging.

A video camera in a waterproof housing was attached to the dropline to film schools of fish that were seen on the echo sounder. There were several reasons for using the underwater camera:

- To verify schools of fish that were seen on the echo sounder, but not biting;
- To obtain a better idea of what bottom type goldband snapper was found in; and
- To obtain a better understanding of fish behaviour with respect to the baited lines.

Spatial Distribution

Due to a cyclone alert trip 3 was cut short, preventing us from completing studies on spatial distribution in areas shallower than 80m. As funds were insufficient to charter a vessel, we were unable to finish this work in the planned sampling area (which entailed two days travelling). An operator who was aware of our problem offered assistance by allowing Fisheries staff to "piggy back" on a commercial fishing operation. An area was chosen which suited both the fisher's commercial and our research requirements. The sampling area was divided into four depth ranges: 0-10 m,
11-20 m, 21-30 m, 31-40 m. One day was spent sampling each depth range. Unfortunately sampling was not completed in the 31-40 m depth range as a broken winch prevented further fishing. Two trammel nets were used. One net (175 & 65 mm mesh) was identical to previous trips, the other net was a small mesh size (100 & 25 mm) and half the depth, the length remained the same. This smaller mesh net was included to increase the potential size range of fish sampled, and hopefully to capture juvenile snappers. Two handlines with size 4/0 hooks baited with a squid-prawn mixture were also used. All gear was used side by side for a two hour sampling period. To investigate whether time of day influenced catch, we sampled at the same time each day. There were three sampling times, 0530-0730, 1130-1330, and 1600-1800 hours.

RESULTS

Repeatability of Sampling Areas

The main aim of this pilot project was to find sampling areas which could be used for long-term monitoring of the Timor Reef fishery, therefore an important criterion for an area was repeatablity.

When results were analysed using a 2 factor ANOVA, no significant difference in CPUE for goldband snapper was found among areas sampled one month apart ($F=0.01$, $df=1,16$ $P>0.05$). There was a significant difference between areas resampled 6 months later; which all showed lower catch rates for goldband snapper ($F=3.50$, $df=1,16$, $P<0.05$).

These results indicate that there is a seasonal influence, and for long-term monitoring it is important to sample during the same period of the year. We have identified two areas (5 & 8) which gave repeatable results when sampled at the same time of the year. There were other areas (all in the western section of the Timor Box) which also gave high catches and may have been suitable for long-term monitoring, but due to time constraints could not be resampled (Table 1).

Table 1. CPUE (Number of fish/line/hr) for all sampling areas.
***Time includes both fishing and searching time.**

Area	*Sum All Fish Caught*	*Sum Goldband Snapper*	*Total Lines/ Area*	**Time (h)*	*CPUE All fish (fish/line/h)*	*CPUE Goldband snapper (fish/line/h)*
1	28	24	118	16.0	0.015	0.013
2	95	24	177	11.91	0.045	0.011
3	No fish					
4	203	148	213	22.50	0.042	0.011
5a	555	384	142	11.92	0.328	0.227
5b	472	420	160	18.59	0.159	0.140
5c	156	93	125	20.33	0.068	0.040
6	465	415	143	14.17	0.230	0.205
7a	246	182	115	12.49	0.171	0.127
7b	109	70	111	16.67	0.059	0.038
8a	256	222	103	9.75	0.255	0.222
8b	369	313	77	10.33	0.464	0.400
8c	63	52	111	15.67	0.036	0.014
9	285	218	113	15.17	0.166	0.127
10	197	114	151	16.33	0.080	0.046

Table 2. CPUE (Number of fish/line/hr) for repeated areas.
***Time includes both fishing and searching time.**

Area	*Month sampled*	*Sum all Fish caught*	*Sum Goldband snapper*	*Total Lines/ Area*	**Time (h)*	*CPUE All fish (fish/line/h)*	*CPUE Goldband snapper (fish/line/h)*
5a	February	555	384	142	11.92	0.328	0.227
5b	March	472	420	160	18.59	0.159	0.140
5c	October	156	93	125	20.33	0.068	0.040
7a	March	246	182	115	12.49	0.171	0.127
7b	October	109	70	111	16.67	0.059	0.038
8a	March	256	222	103	9.75	0.255	0.222
8b	April	369	313	77	10.33	0.464	0.400
8c	October	63	52	111	15.67	0.036	0.014

Full details of position, catch, fishing time, searching time for each station is shown in Appendix I.

Presence of Bait Fish

We used a trammel net and an underwater video camera to investigate whether poor dropline catches were due to absence of fish or fish not biting. Of the 22 shots with the trammel net, we found that on 11 occasions the trammel net caught more fish than the droplines at the same location. Usually this occurred when good marks of fish were seen on the sounder, yet almost nothing was caught on the droplines. In many cases fish caught in the trammel net were gorged with small bait fish. Video footage taken at the same time shows large schools of fish swimming around the baited lines, but not biting. The water also appeared to be quite cloudy compared with video footage shot earlier in the year at the same site. This cloudiness was possibly large amount of bait fish in the water column.

Details of species, size range and position for the trammel net catch is shown in Appendix II.

Hook Size Comparisons

In this study we were interested in determining if there was an optimal hook size for goldband snapper. We looked at both the size range caught and the number of goldband caught with each hook size.

A Kolmogorov-Smirnov test showed no significant difference between the length distributions of goldband snapper caught with hook sizes 10/0 and 13/0, (D=0.01; p>0.05).

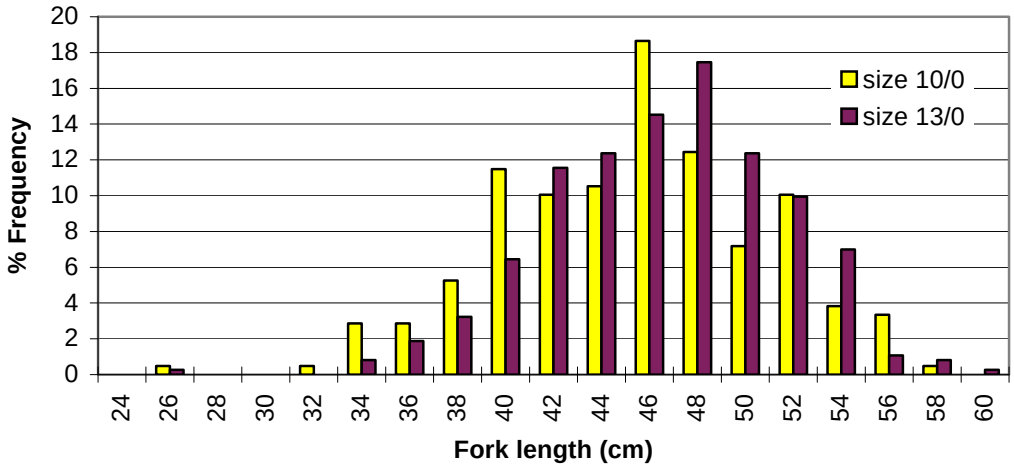


Figure 6. Length frequency distribution for goldband snapper (*Pristipomoide*s spp) for hook sizes 10 (n = 1023) and 13 (n = 1510).

To determine if there was a difference in the number of goldband taken with the two different hook sizes, we analysed the results using an ANOVA with repeated measures. No significant difference was found in the CPUE with respect to hook size ($F = 0.85$, $df = 1,48$, $p > 0.05$). Therefore for future long-term monitoring either hook size could be used

Length Comparisons for Dropline and Trammel Net

For goldband snapper we found that the trammel net caught a larger range of fish than the droplines (Fig. 7) and when we compared dropline and trammel net for all species the results were more pronounced (Fig. 8). A Kolmogorov-Smirnov test showed that statistically there was a significant difference in length frequency distributions between the two sampling methods ($D=0.0165$; $p<0.05$ for goldband snapper, and $D=7.1$;$p<0.05$ for all species).

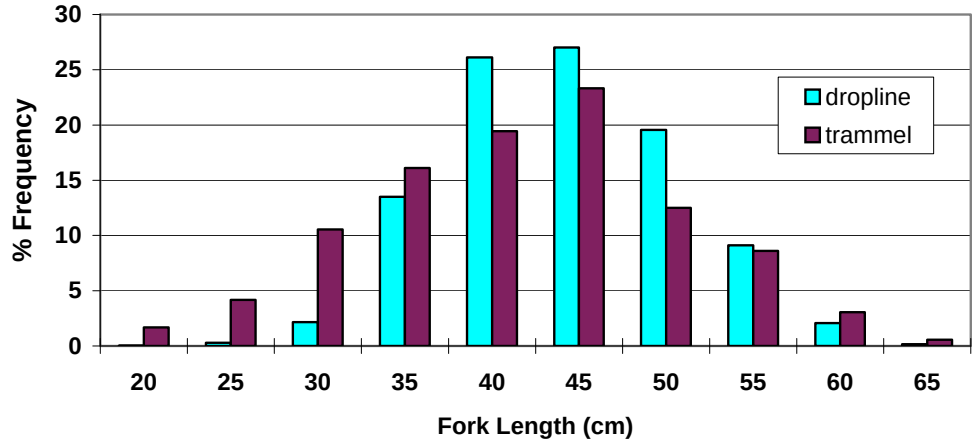


Figure 7. Comparison of length frequency distribution for goldband snapper from trammel net (n = 367) and dropline (n = 2533).

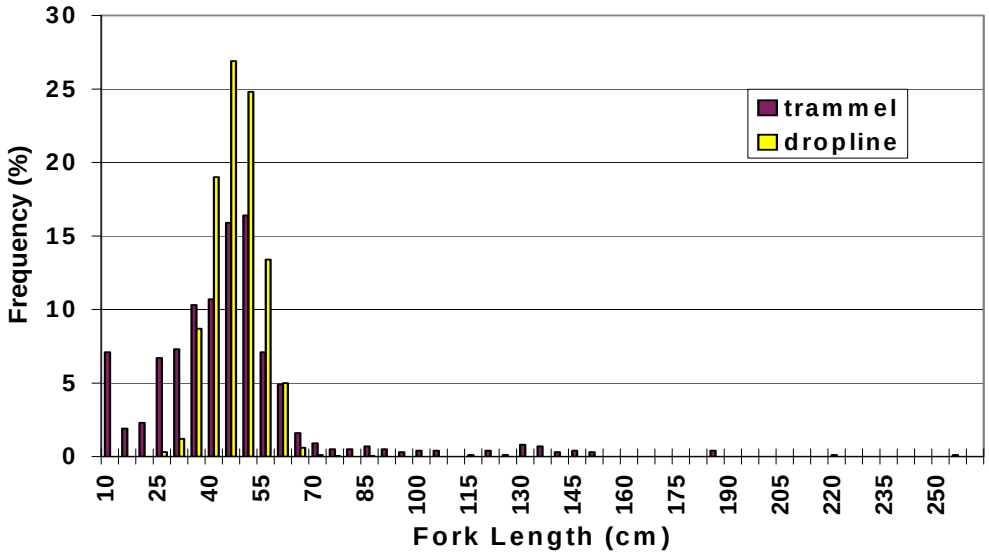


Figure 8. Comparison of length frequency distribution for all species from trammel net (n = 757) and dropline (n = 3,517).

Species Comparisons

Fifty-nine fish species were recorded from the trammel net compared with 27 species from the dropline (Table 3). Of the 59 species caught in the trammel net, there were eight new records for the Northern Territory, and one new record for Australia. These specimens are lodged with the NT Museum and the Australian Museum respectively.

Dropline Catch

From the four sampling trips a total of 3,517 fish were caught on the droplines. The species breakdown in commercial categories is shown in Figure 9. These results closely reflect the species composition we have observed on commercial boats, with nearly 80% of the catch goldband snapper. Therefore we feel that our survey is an accurate reflection of the commercial fishery.

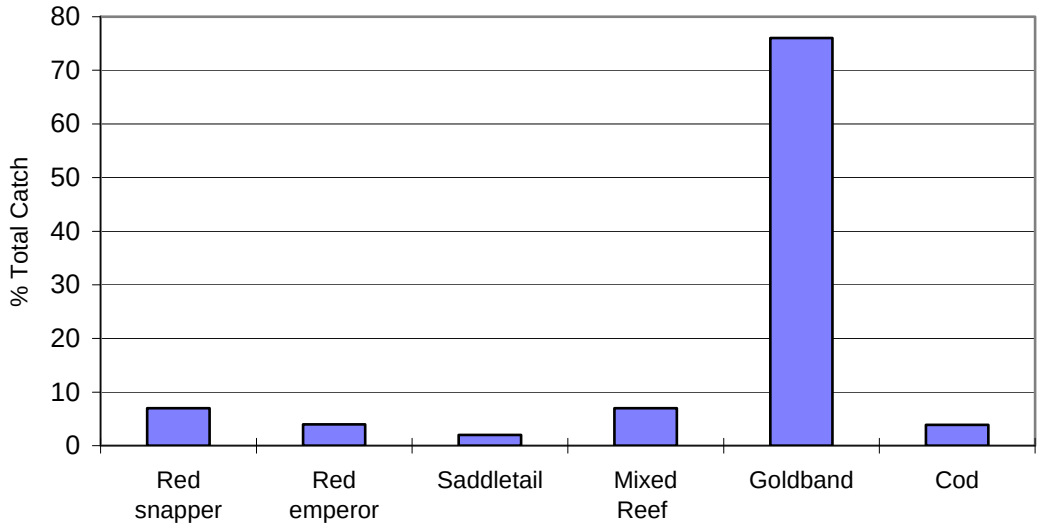


Figure 9. Breakdown of main commercial species caught by droplines during the 4 sampling trips.

Table 3. Comparison of species caught using trammel net and dropline.

DROPLINE ONLY	**DROPLINE AND TRAMMEL NET**	**TRAMMEL NET ONLY**
Argyrops spinifer	*Bodianus perdito*	*Abalistes stellaris*
Caranx bucculentus	*Elegatus bipinnulatus*	*Amblyrhynchos*
Choerodon monostigma	*Epinephelus areolatus*	*Arelomycterus* sp
Epinephelus quoyanus	*Gymnocranius elongatus*	*Arius thalassinus*
Epinephelus radiatus	*Gymnocranius griseus*	**Atelomycterus* sp *A*
Epinephelus rankini	*Gymnocranius robinsoni*	*Balistidae*
Labridae	*Lethrinidae*	*Carangidae*
Seriola dumerilii	*Lethrinus lentjan*	*Carcharhinus* sp
Symphorus nematophorus	*Lutjanus argentimaculatus*	*Carcharhinus altimus*
	Lutjanus erythropterus	*Carcharhinus brevipinna*
	Lutjanus lemniscatus	*Carcharhinus leucas*
	Lutjanus malabaricus	*Carcharhinus sorrah*
	Lutjanus russelli	*Carcharhinus tilstoni*
	Lutjanus sebae	**Choerodon robustus*
	Lutjanus vittus	*Gnathanodon speciosus*
	Pristipomoides multidens	*Hectocephalus* sp
	Pristipomoides typus	*Holocentridae*
	Serranidae	*Lactarius lactarius*
		**Lutjanus boutton*
		Lutjanus lutjanus
		Lutjanus quinquelineatus
		Lutjanus timorensis
		Megalaspis cordyla
		Mullidae
		Nemipteridae
		Nemipterus bathybius
		Orectolobidae
		Parupeneus chrysopleuron
		**Parupeneus multifasciatus*
		***Pinjalo lewisi*
		Pristipomoides filamentosus
		Protonibea diacanthus
		**Sargocentron caudimaculatum*
		**Sargocentron melanospilos*
		Sargocentron rubrum
		**Scolopsis bilineatus*
		Sphyraena barracuda
		Sphyrna lewini
		Sphyrnidae
		**Triaendon obesus*

***New record for NT**
****New record for Australia**

Spatial Distribution

Table 4. Results of sampling at different depth and time of day with different gear types. Large mesh is the original trammel net shown in figure 2.

Gear	*Date*	*Time (h)*	*#Fish*	*Depth (m)*	*Latitude*	*Longitude*	*Comments*
Large mesh	12/06/96	am	29	8	1205.17	13115.17	
Small mesh	"	"	5	"	"	"	
Hand line	"	"	4	"	"	"	
Large mesh	"	mid	none	"	"	"	
Small mesh	"	"	"	"	"	"	
Hand line	"	"	10	"	"	"	
Large mesh	"	pm	none	"	"	"	
Small mesh	"	"	"	"	"	"	
Hand line	"	"	"	"	"	"	
Large mesh	13/06/96	am	32	18	1205.20	13116.22	
Small mesh	"	"	6	"	"	"	
Hand line	"	"	5	"	"	"	
Large mesh	"	mid	75	"	"	"	
Small mesh	"	"	29	"	"	"	
Hand line	"	"	8	"	"	"	
Large mesh	"	pm	14	"	"	"	
Small mesh	"	"	12	"	"	"	
Hand line	"	"	none	"	"	"	
Large mesh	14/06/96	am	33	26	1202	13114	strong current
Small mesh	"	"	12	"	"	"	trouble retrieving net
Hand line	"	"	none	"	"	"	
Large mesh	"	mid	41	"	"	"	
Small mesh	"	"	16	"	"	"	
Hand line	"	"	none	"	"	"	
Large mesh	15/06/96	am	7	35	1200.4	13114.7	net dragged
Small mesh	"	"	5	"	"	"	filled with rocks
Hand line	"	"	none	"	"	"	

Results from spatial distribution investigation are summarised in Table 4. For ease of analysis the total number of fish in each category is presented. A breakdown of the number of fish by species is shown in Appendix III. No snapper, and very few fish of commercial value were caught.

When results were analysed using a 3 factor ANOVA, a significant difference was found between gear types ($F=17.14$, $df=2,4$ $P<0.05$). No significant difference was found in the number of fish caught at different depths ($F=1.20$, $df=1,2$ $P>0.05$) or different times of day ($F= 0.79$, $df=1,2$ $P>0.05$), and these factors did not interact with gear ($F=0.10$, $df=2,4$, $P>0.05$ and $F=1.24$, $df=2,4$, $P>0.05$, for gear x time and gear x depth, respectively). However the current strength varied considerably during the sampling period. Therefore it is possible that any difference due to depth or time of day may be masked by the effect current has on the fishing gear.

Catch comparison of the three gear types is shown in Figure 10. The large mesh trammel net caught the widest size range of fish, 100-1450 mm. The small mesh trammel net caught more fish in the 50-100 mm and 350-500 mm size range. The handlines were most effective in the 150-250 mm size range, but generally performed poorly compared with the trammel nets. We felt that the inner 25 mm panel in the small trammel net was not fishing effectively. Although small fish were meshed in this panel, very few were able to form pockets. This was possibly due to the material in the inner 25 mm panel being too heavy, although this was the lightest material available in Australia at the time. We have recently purchased substantially thinner and lighter material from the Philippines and feel that this experiment should be repeated.

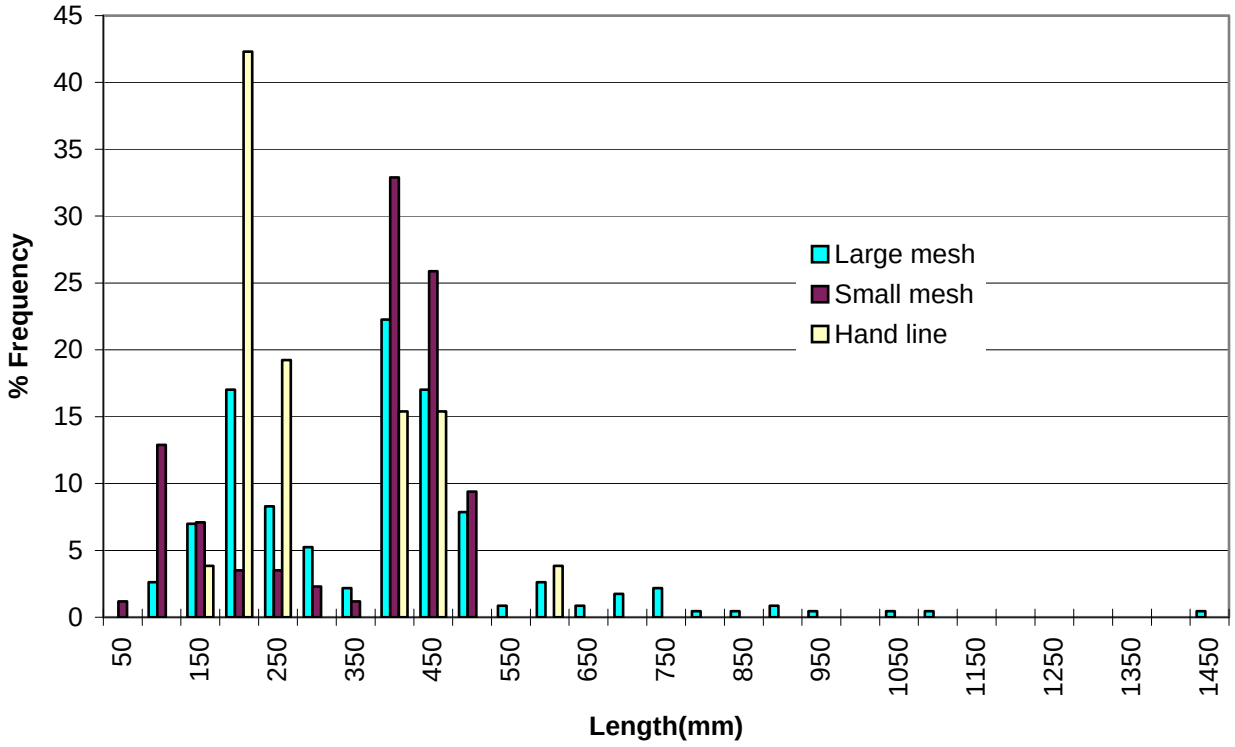


Figure 10. Comparison of the length frequency distribution from large mesh (175 & 65 mm), small mesh (100 & 25 mm), and handlines

SUMMARY AND CONCLUSION

From our study we have identified two areas (5 & 8) which gave repeatable results when sampled in the same season. However, there was a significant difference when these areas were resampled six months later; all showed lower catch rates. These results indicate that there is a seasonal influence, and for long-term monitoring it is important to sample during the same period of the year. There were other areas (all in the western section of the Timor Box) which also gave high catches and may have been suitable for long-term monitoring, but due to time constraints could not be resampled.

The seasonal reduction in CPUE in the resampled areas was probably due to goldband snappers preference for bait fish over the baited lines. This was indicated by the large

fish marks seen on the echo sounder, results from the trammel net and underwater video footage.

Our investigation of optimum hook size showed that there was no significant difference between size 10/0 and size 13/0 tuna circle hooks, for both the number of target species caught and the size distribution of the target species.

The trammel net provided us with a method for sampling when fish were not attracted to the baited lines. It also provided a wider size range of fish than the droplines; 110-2560 mm FL for the trammel net compared with 206-803 mm FL for the droplines. The trammel net also provided a much better indication of species composition than the dropline. Fifty-nine species were recorded from the trammel net compared with 27 species from the dropline. Therefore we feel that the trammel net has provided valuable supplementary information to our study and has complemented the main sampling method in a useful manner. In future long-term monitoring we would continue to use the trammel net as a complementary method.

Unfortunately the spatial sampling could not be carried out as originally planned due to a cyclone alert. A modified sampling trip was undertaken during commercial fishing operations from 12-14 June 1996. Results from this trip show that there was a significant difference in the number of fish caught in relation to the three different gear types. No significant difference was detected in the number of fish caught at different depths and different time of day. However variation in current strength during the sampling period may have affected fishing gear performance which in turn may have masked the effect of depth and time. This component of the project should be repeated before long-term monitoring is undertaken.

In conclusion this study has achieved its objectives by identifying sampling areas and strategies which will be suitable for the Timor Reef fishery, and CPUE obtained in this manner could be used as an independent index of abundance for long-term monitoring of the fishery.

BENEFITS

Although droplining is an effective method for catching goldband snapper there is some bias in this method due to hook selectivity and the need for fish to be attracted to the bait. The trammel net provided us with a sampling method which was not dependant upon fish being attracted to the bait. It gave us a wider size range of fish and better information on species composition. It has proved to be a very useful and comparatively inexpensive way to sample on coral reefs and rough bottom. Some of the advantages are:

- The exact position of the sample is known.
- It is equally representative of fast and slow swimming species.

We feel that this technique may be of benefit to other researchers who need a relatively non-selective method for sampling rough bottom areas with which are not suitable for trawling, or areas where political sensitivity precludes trawling.
The identification of a seasonal effect on CPUE, and the non selectivity of the range of hook sizes used in this study should be of benefit to researchers in other states who are studying similar species.

Many fishers have requested copies of the underwater video footage and have reported that it has assisted in their understanding of fish behaviour to the baited lines.

INTELLECTUAL PROPERTY

No significant intellectual property is expected to be developed.

FURTHER DEVELOPMENT

In this pilot study sampling was confined to commercial fishing grounds, but for long-term monitoring sampling sites outside the main commercial area would also need to be included. Although we identified two areas which gave repeatable results when sampled at the same time of the year, time precluded resampling other areas which may have also been suitable for long-term monitoring. Further work should be carried out to determine the best areas for a long-term monitoring program.

Future research should also be directed towards sampling for juvenile goldband snapper as we obtained very few goldband samples less than 30 cm FL. The small mesh trammel net proved to be the most effective gear type for catching this smaller size range of fish and should be incorporated into future sampling program which target juveniles.

The trammel net has proved to be a useful sampling technique, but there needs to be further development of this gear to maximise its benefit. At present it is quite small and consideration would need to be given as to whether it would be more effective to increase the net size or put more nets in the same area. Optimum soak time also needs to be established. With regard to the small mesh trammel net, the inner 25 mm panel needs to be replaced with a lighter material in order that it may fish more effectively. Results from the pilot study showed that most fished were meshed in this panel, rather than forming pockets.

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FINAL COST

Final financial statement supplied separately.

PUBLICATIONS

Lloyd, J.A. (1995). Goldband snapper research continues into refining stock estimates, *NT Fishing Industry Newsletter, Volume 5 Issue 3.*

Lloyd, J.A. (1995). Joint effort to sustain tropical snapper-a valuable resource, *Infofish International Number 6/95*.

Lloyd, J.A. (1995). Pilot study looks at methods for measuring indices of abundance for tropical snappers in the Timor Sea. *ASFB conference 1995*.

Lloyd, J.A. and Mounsey R.P. Trammel nets provide an alternative method for sampling deep water reefs (in prep).

Mounsey, R.P. (1996). Trammelnets: Multiple walls of death or useful research tools, *Infofish International Number 1/96.*

Lloyd, J.A. (1996). Goldband snapper pilot project in the Timor Sea. *Fishery Report 37*

DISTRIBUTION

Northern Territory Fishing Industry Council
Timor Box Reef Fishermen's Association
Deep Sea Fishermen's Association
Commercial Fishermen's Association
West Australian Fishing Industry Council
Queensland Commercial Fishermen's Organisation
West Australian Fisheries Department
Queensland Department of Primary Industry
Australian Fisheries Management Authority

REFERENCES

Ramm, D.C. (1995). Dynamics of the deepwater snapper (*Pristipomoides*) resource in the Timor Sea. South Pacific Commission and Forum Fisheries Agency Workshop on the Management of South Pacific Inshore Fisheries. Manuscript collection of country statements and background papers-Volume II. South Pacific Commission. *Integrated Coastal Fisheries Management Project Technical Document,* **12,** 23-38.

Van Tjeerd H., and Veevers J.J (1967). Morphology and Sediments of the Timor Sea. Bulletin No.83. Dept. of National Development, Bureau of Mineral resources, Geology and Geophysics, Commonwealth of Australia.

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APPENDIX I

TRIP 1

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station No fish/ line/hr	*Total CPUE/ Station (No.fish/ line/hr)
1	1/2/95	mixed reef	101847	1302740	1	6	0.58	0.250	0.287	0.201
2		goldband	101880	1302770	2	18	1.33	0.833	0.084	0.128
		sharptooth			3					
3		No fish	101890	1302730	0	18	0.50	0.417	0	0
4		mixed reef	102450	1302510	0	18	1.92	1.667	0.261	0.140
		sharptooth			9					
5	2/2/95	cod	102520	1302560	1	14	1.08	0.000	0.397	0.397
		goldband			1					
		mixed reef			1					
		sharptooth			3					
6		goldband	102520	1301700	4	26	2.00	1.750	0.135	0.072
		mixed reef			1					
		sharptooth			2					
7		No fish	102490	1302560	0	18	1.67	2.000	0	0
8	3/2/95	mixed reef	100180	1304800	4	35	2.00	0.000	0.171	0.171
		red emperor			1					
		red snapper			6					
		sharptooth			1					
9		red snapper	100140	1304790	1	11	0.75	0.250	0.121	0.091
10		No fish	100220	1304780	0	12	1.00	0.167	0	0
11		cod	100140	1304790	2	49	1.00	0.250	1.123	0.899
		mixed reef			4					
		red emperor			2					
		red snapper			38					
		sharptooth			6					
		trash			3					
12	4/2/95	cod	100140	1304810	2	22	2.00	0.000	0.205	0.205
		mixed reef			3					
		red snapper			2					
		sharptooth			2					
13		cod	100140	1304760	1	24	2.25	0.167	0.056	0.052
		goldband			1					
		sharptooth			1					
14		goldband	100190	1304680	13	24	1.83	0.250	0.300	0.281
		saddle tail			1					

* Searching time included in CPUE

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station No fish/ line/hr	*Total CPUE/ Station (No.fish/ line/hr)
15	5/2/95	No fish	101070	1295060	0	6	0.50	0.000	0	0
16		goldband	101550	1294320	13	30	3.00	3.000	0.244	0.128
		mixed reef			3					
		red emperor			1					
		saddle tail			1					
		sharptooth			4					
17	6/2/95	goldband	101560	1294330	7	33	2.50	0.000	0.170	0.170
		red emperor			3					
		red snapper			2					
		sharptooth			2					
18		goldband	101520	1294340	9	19	1.50	0.333	0.561	0.460
		mixed reef			0					
		mixed reef			0					
		saddle tail			2					
		sharptooth			5					
19		goldband	101570	1294300	5	25	2.00	0.667	0.260	0.195
		red emperor			4					
		sharptooth			4					
20		cod	101620	1294280	1	22	1.50	0.500	0.485	0.364
		goldband			4					
		mixed reef			2					
		sharptooth			9					
21		cod	101666	1294268	4	34	2.00	0.500	1.520	1.212
		goldband			42					
		mixed reef			9					
		red emperor			3					
		red snapper			11					
		saddle tail			1					
		sharptooth			32					
		trash			1					
22	7/2/95	goldband	101751	1294246	3	18	1.50	0.000	0.259	0.259
		mixed reef			1					
		saddle tail			1					
		sharptooth			2					
23		goldband	101780	1294240	6	20	1.67	0.083	0.359	0.343
		red emperor			1					
		saddle tail			4					
		sharptooth	101780	1294240	1					
24		No fish	101768	1294055	0	6	0.75	0.500	0	0

* Searching time included in CPUE

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Sation	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station (No fish/ line/hr)	*Total CPUE/ Station (No.fish/ line/hr)
25		cod	101746	1293918	3	34	2.00	0.250	1.162	1.033
		goldband			11					
		mixed reef			20					
		red emperor			6					
		sharptooth			37					
		trash			2					
26		cod	101769	1293970	1	25	2.00	0.500	1.20	0.096
		goldband			7					
		mixed reef			4					
		red emperor			1					
		red snapper			2					
		sharptooth			45					
27	8/2/95	cod	101680	1293810	2	26	2.00	0.000	2.135	2.135
		goldband			65					
		mixed reef			7					
		red emperor			3					
		red snapper			9					
		shark			1					
		sharptooth			23					
28		goldband	101620	1293810	66	26	2.00	0.750	1.980	1.440
		mixed reef			5					
		red emperor			1					
		red snapper			5					
		sharptooth			26					
29		cod	101560	1293800	2	31	2.00	0.417	3.274	2.710
		goldband			84					
		mixed reef			33					
		red emperor			15					
		red snapper			33					
		saddle tail			16					
		sharptooth			20					

* Searching time included in CPUE

TRIP 2

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station No fish/ fine/hr	*Total CPUE/ Station No fish/ line/hr
30	15/3/95	cod	101663	1293816	4	26	2.00	0.000	0.789	0.789
		goldband			6					
		mixed reef			9					
		red emperor			2					
		red snapper			5					
		sharptooth			15					
31		cod	101567	1293800	1	24	2.07	0.5833	0.564	0.440
		goldband			17					
		mixed reef			1					
		red emperor			1					
		red snapper			2					
		saddle tail			1					
		sharptooth			5					
32		sharptooth	101744	1294902	3	9	0.77	0.583	0.433	0.247
33		No fish	101743	1293904	0	6	1.00	0.250	0	0
34		goldband	101735	1293912	1	10	1.00	0.250	3.0	2.400
		mixed reef			3					
		red emperor			1					
		red snapper			3					
		sharptooth			22					
35	16/3/95	goldband	101750	1293492	78	22	2.00	0.250	1.796	1.596
		sharptooth			1					
36		goldband	101792	1293490	88	25	2.00	2.000	2.180	1.090
		red emperor			12					
		saddle tail			2					
		sharptooth			7					
37		goldband	101865	1293487	6	11	1.00	0.500	0.546	0.364
38		cod	101898	1293483	1	27	2.00	0.333	3.259	2.762
		goldband			158					
		red emperor			2					
		red snapper			1					
		saddle tail			1					
		sharptooth			13					
39	17/3/95	cod	100745	1293461	1	13	1.50	0.000	1.282	1.282
		goldband			15					
		red emperor			6					
		sharptooth			3					

* Searching time included in CPUE

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station No fish/ fine/hr	*Total CPUE/ Station (No.fish / line/hr)
40		cod	100747	1293442	3	22	2.00	0.250	1.114	0.990
		goldband			28					
		mixed reef			4					
		red emperor			1					
		sharptooth			13					
41		cod	100630	1293509	3	33	2.00	0.417	3.333	2.759
		goldband			162					
		mixed reef			1					
		red emperor			1					
		red emperor			4					
		red snapper			1					
		sharptooth			47					
		trash			1					
42	18/3/95	cod	100531	1293498	1	18	2.00	0.250	0.694	0.617
		goldband			20					
		mixed reef			1					
		red emperor			1					
		red snapper			2					
43		cod	100486	1293458	1	25	2.00	0.000	2.18	2.18
		goldband			95					
		mixed reef			1					
		red emperor			4					
		sharptooth			8					
44		No fish	100490	1293405	0	8	0.50	0.000	0.000	0.00
45		cod	100564	1295525	1	12	1.50	0.500	0.5	0.375
		goldband			4					
		mixed reef			1					
		red emperor			1					
		sharptooth			2					
46		goldband	100683	1293496	14	12	1.00	0.25000	2.333	1.867
		mixed reef			1					
		red emperor			5					
		red snapper			4					
		sharptooth			4					
47	19/3/95	cod	100798	1291941	1	14	1.50	0.00000	0.143	0.143
		goldband			2					
48		No fish	100811	1291947	0	4	0.50	0.25000	0	0
49		cod	100803	1291941	1	7	0.58	0.25000	0.246	0.072
		goldband			1					

* Searching time included in CPUE

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station No fish/ fine/hr	*Total CPUE/ Station (No.fish/ line/h)
50		cod	100703	1291870	3	20	2.00	0.333	1.205	1.033
		goldband			37					
		mixed reef			1					
		red emperor			6					
		red snapper			1					
		sharptooth			5					
51		cod	100684	1291905	11	28	2.00	0.417	1.857	1.537
		goldband			57					
		mixed reef			2					
		red emperor			15					
		red snapper			3					
		saddle tail			1					
		shark			3					
		sharptooth			12					
52	20/3/95	cod	100699	1291964	1	21	2.25	0.000	0.995	0.995
		goldband			41					
		red emperor			1					
		sharptooth			4					
53		cod	100739	1291955	6	21	2.08	0.333	0.847	0.728
		goldband			14					
		mixed reef			3					
		red emperor			5					
		sharptooth			9					
54		cod	95919	1291825	1	23	2.50	0.000	0.957	0.957
		goldband			44					
		mixed reef			3					
		red snapper			2					
		sharptooth			5					
55	21/3/95	cod	95948	1291858	3	26	2.00	0.000	2.385	2.385
		goldband			95					
		mixed reef			2					
		red emperor			4					
		sharptooth			20					
56		cod	95944	1291818	3	16	1.75	0.250	1.286	1.125
		goldband			22					
		mixed reef			2					
		red snapper			2					
		sharptooth			7					
57		cod	95949	1291822	8	38	3.00	0.250	0.360	0.332
		goldband			22					
		mixed reef			4					
		sharptooth			7					

* Searching time included in CPUE

TRIP 3

Station	Date	Species	Latitude	Longitude	Catch (Number fish)	Total Lines/ Station	Fishing Time (hrs	Searching Time (hrs)	CPUE/ Station No fish/ line/hr	*Total CPUE/ Station/ (No fish/ line/hr)
59		goldband			101	19	2.0	0	2.974	2.974
		mixed reef			2					
		red snapper			5					
		sharptooth			5					
60		cod	100924	1294484	1	11	1.00	0.750	0.636	0.364
		goldband			6					
61		cod	100979	1294387	6	20	2.00	0.417	1.00	0.828
		goldband			14					
		mixed reef			2					
		red emperor			5					
		red emperor			2					
		saddle tail			9					
		sharptooth			1					
		trash			1					
62		goldband	100963	1294460	2	8	0.75	0.417	0.333	0.214
63	30/3/95	cod	100850	1294808	1	23	1.92	0.417	1.608	1.362
		goldband			49					
		mixed reef			10					
		red snapper			2					
		shark			9					
64		No fish	100797	1294631	0	6	0.50	0.750	0	0
65		cod	100087	1294189	3	20	2.00	1.250	1.300	0.8
		goldband			40					
		mixed reef			3					
		red snapper			2					
		saddle tail			4					
66		No fish	100830	1294032	0	6	0.58	0.417	0	0
67	31/3/95	mixed reef	95749	1293249	2	21	2.00	0.750	0.0952	0.069
		shark			1					
		sharptooth			1					
68		mixed reef	95748	1293226	5	21	2.00	0.500	0.191	0.152
		saddle tail			1					
		sharptooth			1					
		trash			1					
69		cod	95743	1293178	1	20	2.08	0.250	0.264	0.086
		mixed reef			3					
		red emperor			3					
		red snapper			4					
70		cod	95917	1293246	1	12	1.67	0.417	0.264	1.282
		goldband			21					
		mixed reef			9					
		shark			1					

* Searching time included in CPUE

Station	Date	Species	Latitude	Longitude	Catch ()Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE Station No fish/line/ hr	*otal CPUE/ Station (No fish/line/ hr)
71	1/4/95	cod	95902	1293248	1	19	2.00	0.000	0.763	0.763
		goldband			23					
		shark			1					
		sharptooth			4					
72		cod	95912	1293190	11	20	2.00	0.250	1.275	1.133
		goldband			12					
		mixed reef			22					
		red emperor			1					
		sharptooth			5					
73		cod	95903	1293139	7	20	2.00	0.167	1.200	1.106
		goldband			30					
		red emperor			6					
		sharptooth			5					
74		cod	95837	1293155	2	18	2.00	0.250	0.389	0.346
		goldband			11					
		sharptooth			1					
75	2/4/95	cod	95939	1291840	2	18	2.00	0.000	2.000	2.000
		goldband			63					
		mixed reef			1					
		sharptooth			6					
76		cod	95915	1291818	4	21	2.00	1.333	2.5	1.500
		goldband			50					
		mixed reef			1					
		red emperor			3					
		red snapper			35					
		sharptooth			12					
77		cod	95870	1291836	1	22	2.08	0.833	2.360	1.697
		goldband			83					
		mixed reef			1					
		red emperor			1					
		red snapper			5					
		sharptooth			18					
78	3/4/95	cod	95809	1291811	1	16	2.08	0.000	2.494	2.494
		goldband			58					
		mixed reef			1					
		sharptooth			23					

* Searching time included in CPUE

TRIP 4

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station No fish/ line/hrs	*Total CPUE/ Station (No fish/ lines/hrs
79	29/9/95	goldband	101836	129388	8	18	2.000	0	0.445	0.445
		mixed reef			0					
		red emperor			1					
		sharptooth			7					
80		mixed reef	101795	129391	0	4	0.500	0.250	0.5	0.333
		sharptooth			1					
81		goldband	101740	129391	1	12	1.000	0.167	2.586	2.214
		mixed reef			2					
		red snapper			20					
		sharptooth			8					
82		cod	101645	129381	1	19	1.000	1.580	1.316	0.510
		mixed reef			3					
		red snapper			6					
		sharptooth			15					
83		mixed reef	101917	129329	0	9	1.00	0.500	0.333	0.222
		sharptooth			3					
84		goldband	101835	129329	1	5	0.750	2.417	0.267	0.048
		mixed reef			0					
85	30/9/95	cod	101842	129328	1	16	1.500	0.000	1.292	1.292
		goldband			9					
		mixed reef			5					
		red snapper			5					
		saddle tail			9					
		sharptooth			2					
86		mixed reef	101830	129334	0	3	0.500	0.167	0	0
87		cod	101804	129350	4	18	2.000	0.500	0.861	0.689
		goldband			22					
		mixed reef			0					
		red emperor			2					
		saddle tail			1					
		sharptooth			2					
88		cod	101830	129390	1	10	1.500	1.250	0.513	0.280
		goldband			5					
		mixed reef			1					
		sharptooth			3					
89		goldband	101794	129390	2	11	1.500	0.250	0.424	0.364
		mixed reef			2					
		sharptooth			3					
90	1/10/95	cod	95877	129183	1	4	0.333	0	1.502	1.502
		goldband			1					
		mixed reef			0					

* Searching time included in CPUE

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station No fish/ line/hr	*Total CPUE/ Station (No fish/ line/hr
91		cod	95935	129182	1	17	2.000	0.167	0.206	0.190
		goldband			1					
		mixed reef			1					
		red emperor			2					
		red snapper			2					
92		goldband	95878	129179	1	12	1.000	0.333	0.167	0.125
		mixed reef			1					
93		mixed reef	95850	129181	0	8	1.000	0.583	0	0
94		mixed reef	95910	129183	0	12	1.500	0	0.167	0.167
		red snapper			2					
		sharptooth			1					
95		mixed reef	95860	129182	1	10	0.750	0.500	0.533	0.320
		red snapper			2					
		saddle tail			1					
96		mixed reef			1	10	1.167	0.083	0.343	0.320
		red emperor			1					
		red snapper			2					
97	2/10/95	goldband	95901	129179	1	6	0.500	0	0.333	0.333
		mixed reef			0					
98		goldband	95949	129181	5	14	1.667	0.167	0.214	0.195
		mixed reef			0					
99		mixed reef	95951	129183	1	12	1.250	0.167	0.067	0.059
100		cod	95907	129158	1	6	0.500	2.000	3.667	0.733
		goldband			9					
		mixed reef			1					
101		mixed reef	100682	129183	0	4	0.333	2.00	0	0
102		cod	100792	129194	1	19	2.000	0.750	0.605	0.440
		goldband			16					
		mixed reef			0					
		red emperor			1					
		red snapper			2					
		saddle tail			1					
		sharptooth			2					
103	3/10/95	cod	100759	129202	4	20	2.000	0	0.475	0.475
		goldband			6					
		mixed reef			0					
		red emperor			1					
		red snapper			5					
		sharptooth			3					
104		cod	100712	129197	9	19	2.000	0.583	1.184	0.917
		goldband			5					
		mixed reef			1					
		red emperor			2					
		red snapper			7					
		saddle tail			2					
		sharptooth			19					

* Searching time included in CPUE

Station	Date	Species	Latitude	Longitude	Catch (Number Fish)	Total Lines/ Station	Fishing Time (hrs)	Searching Time (hrs)	CPUE/ Station No fish/ line/hr	*Total CPUE/ Station (No fish/ line/hr
105		goldband	100680	129187	1	10	1.000	0.500	0.300	0.200
		mixed reef			1					
		sharptooth			1					
106		mixed reef	100697	129184	0	7	1.000	0.167	0.143	0.122
		sharptooth			1					
107		mixed reef	100697	129186	0	8	1.000	0	0	0
108	4/10/95	goldband	100863	129197	1	6	0.500	0	0.667	0.667
		mixed reef			1					
109		goldband	100692	129196	1	18	2.000	0.833	0.444	0.314
		goldband			13					
		mixed reef			0					
		red emperor			1					
		sharptooth			1					

* Searching time included in CPUE

APPENDIX II

TRAMMEL NET

TRIP 1

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
1/2/95	10º 24.31, 130º 24.94 Station 4	Night	*Pristipomoides multidens*	1	500
			Lutjanus malabaricus	2	440-465
			Carcharhinus spp	4	
			Arius spp	3	
			Sphyrna spp	2	
			Muraenesox cinereus	5	
			Lethrinus spp	2	
			Gnathanodon speciosus	1	
			Lutjanus timorensus	1	425
			Protonibea diacanthus	1	
2/2/95	10º 02.30 130º 48.56	Night	*Lutjanus sebae*	2	362-365
			Rachycentron canadus	1	
			Sargocentron rubrum	1	
			Elagatis bipinnulata	1	
			Lutjanus. leminiscatus	1	
			Gnathanodon speciosus	1	
			Lethrinus lentjan	1	

TRIP 1 (contd)

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
3/2/95	10º 02 17 130º 47.83	Day	*Pristipomoides multidens*	1	
			Pristipomoides typus	4	
			Carcharhinus spp.	1	
			Lethrinus spp	2	
			Melalaspis cordyla	1	
3/2/95	10º 01.51 130º 48.1	Night	*Lutjanus erythropterus*	4	440-475
			Lutjanus vittus	1	290
			Lutjanus kasmira	1	
6/2/95	10º 15.83 129º 43.07 Station 19	Night	*Pristipomoides multidens*	11	305-580
			Pristipomoides typus	1	280
			Lutjanus malabaricus	1	545
			Lutjanus sebae	3	368-460
			Lutjanus erythrpterus	3	462-500
			Lutjanus vittus	3	214-240
			Lutjanus russeli	5	282-395
			Caranx spp	1	500
			Gymnocranius robinsoni	1	495
			Sphyyrna spp	1	
			Carcharhinus spp.	1	
			Arius spp.	1	

TRIP 1 (contd)

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
7/2/95	10º 16.68 129º 42.69	Day *Baited	*Pristipomoides multidens*	11	336-435
			P. typus	13	225-526
			Gymnocranius griseus	6	126-273
			Lutjanus vittus	2	218-237
			Epinephelus areolatus	7	214-335
			Caranx spp	1	830
			Abalistes stellaris	3	335
			Bodians perdito	3	284-397
			Carcharhinus spp	1	
			Elagatis bipinnulata	1	
7/2/95	10º 17.69 129º 39.70	Night	*Pristipomides multidens*	1	356
			Pristipomoides typus	3	328-474
			Lutjanus erythropterus	30	411-505
			Lutjanus vittus	1	222
			Sargocentron rubrum	1	215
			Epinephelus spp	1	360
			Carcharhinus leucas	1	

TRIP 2

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
15/3/95	10°16.80, 129° 38.12	Day	*Pristipomoides multidens*	4	346-452
			P.typus	7	250-455
			Lutjanus vittus	2	185-245
			Gymnocranius elongatus	2	127-193
			Coradion chrysozonus	1	250
			Shyrna spp	1	1880
			Pleurospilus parupeneus	1	185
15/3/95	10º 16.80, 129° 38.12	Night	*Arus thalassinus*	1	530
			Carcharhinus spp	1	1895
16/3/95	10° 08.74, 129° 33.35	Night	*Trianodon obsesus*	20	640-910
			Carcharhinus spp	7	860-1160
			Carcharhinus amblyrhynchos	8	500-740
			Sarocentron rubrum	1	160
			Scolopsis bilineatus	1	145
			Lethrinus semicinctus	1	235
			Parupenus multifasciatus	1	170
			Myripristis murdjan	1	110
17/3/95	10° 08.72, 129° 33.42	Day	*Gymnocranius griseus*	1	330

TRIP 2 (contd)

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
17/3/95	10° 06.30, 129° 35.13	Night	*Pristipomoides multidens*	21	240-515
			P. typus	2	210-475
			Lutjanus erythropterus	2	400-426
			L. vittus	2	254-255
			L. quinquelineatus	1	240
			Gymnocranius griseus	6	285-380
			Epinephelus areolatus	2	258-340
			Sarocentron spp	2	170
			Choerodon robustus	1	240
			Parupeneus chrysopleuron	1	230
			Sphyra lewini	2	680-1900
			Carcharhinus limbatus	4	1280-1380
			Carcharhinus brachyurus	3	1270-1440
18/3/95	10° 08.01, 129° 19.40	Night	*Pristipomoides multidens*	16	235-572
			P. typus	1	200
			Carcharhinus limbatus	1	1350
			C. brevipinna	1	2240
			Sargocentron rubrum	2	210-220

TRIP 2 (contd)

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
18/3/95	10° 08.01, 129° 19.40	Night	*Lutjanus erythropterus*	1	480
			L. vittus	2	221-225
			Gymnocranius elongatus	1	120
19/3/95	10° 06.92, 129° 18.53	Night	*Pristipomoides multidens*	44	210-558
			P. typus	1	452
			Atelomycenterus sp.A	1	460
			L. vittus	7	205-328
			L.sebae	1	472
			Carcharhinus altimus	1	2560
			Carcharhinus tilstoni	4	1250-1310
			Rachycentron canadus	3	445-645
			Sphyraena barracuda	3	465-586

TRIP 3

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
29/3/95	10° 09.46, 129° 44.46	Night	*Carcharhinus* spp	3	1200-1330
			Nemipterus bathybius	1	110
			Lutjanus sebae	1	420
			Epinephelus areolatus	1	260
30/3/95	09° 57.15, 129° 31.96	Night	*Lutjanus sebae*	1	440
			Arius thalassinus	1	665
			Pristipomoides typus	1	320
			Lutjanus argentimaculatus	1	620
			Paramonacanthus spp	1	330
1/4/95	09° 59.06, 129° 32.52	Night	*Pristipomoides filamentosus*	18	320-650
			Carcharhinus spp	3	780-950
			Sargocentron rubrum	8	115-230
			Chiloscyllium spp	1	520
			Monotaxis grandoculus	22	265-558
			Sargocentron spp	2	154-250
			Nemipterus spp	1	159
			Pristipomoides multidens	3	382-460
			Triaenodon obesus	1	685

TRIP 3 (contd)

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
			Gymnocranius spp	3	370-415
			Lutjanus erythropterus	3	382-418
2/4/95	09° 5.98, 129° 18.04	Night	*Pristipomoides typus*	5	400-560
			P. multidens	1	450
			Lutjanus argentimaculatus	1	565
			Carcharhinus	1	1200
			Arius thalassinus	1	

TRIP 4

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
30/9/95	9º 58.74	Night	*Pristipomoides multidens*	3	405-518
	129º 18.27		*Pristipomoides typus*	32	260-615
			Lutjanus malabaricus	1	552
			Lutjanus erythropterus	4	465-491
			Lutjanus carponotatus	1	305
			Carcharhinus spp	2	840-1140
1/10/95	9º 58.67	Day	*Pristipomoides multidens*	23	378-618
	129º 17.70		*Pristipomoides typus*	13	383-585
			Saurida spp	3	362-378
			Epinephelus aerolatus	2	345-362
			Epinephelus fasciatus	1	260
			Xanthichthys lineopunctatus	1	213
			Nemipterus spp	1	265
			Euthynnus affinis	1	425
			Scolopsis spp	1	255
			Choerodon spp	1	225
1/10/95	9º 58.74	Night	*Pristipomoides multidens*	4	291-345
	129º 18.27		*Pristipomoides typus*	3	234-460
			Lutjanus malabaricus	2	552-573

TRIP 4 (contd)

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
			Lutjanus quinquelineatus	1	224
			Lutjanus vittus	2	205-245
			Lutjanus erythropterus	1	
			Lutjanus spp	1	222
			Sargocentron spp	1	215
			Amampses lennardi	2	265-266
			Parascdopsis eriomma	1	200
			Epinephelus aerolatus	1	342
			Carcharhinus spp	2	440-858
			Chiloscyllium qunctatum	1	495
2/10/95	9º 58.80	Day	*Pristipomoides multidens*	14	256-452
	129º 17.80	*(4 hrs)	*Pristipomoides typus*	6	317-475
			Parascolopsis eriomma	1	260
			Lethrinus spp	1	278
2/10/95	10º 07.81	Night	*Pristipomoides multidens*	10	302-484
	129º 19.91		*Pristipomoides typus*	8	355-528
			Lutjanus erythropterus	18	448-526
			Carcharhinus spp	10	1260-1500
			Lutjanus vittus	1	238
			Chiloscyllium punctatum	2	465-490

TRIP 4 (contd)

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
			Choerodon zamboangae	1	181
			Sphyraena barracuda	2	518-542
			Pterois russelli	1	143
3/10/95	10º 07.58	Day	*Pristipomoides multidens*	3	284-294
	129º 20.18		*Pristipomoides typus*	9	320-530
			Lutjanus vittus	3	200-250
			Epinephelus aerolatus	1	328
			Lutjanus argentimaculatus	1	538
3/10/95	10º 07.58	Night	*Pristipomoides multidens*	19	220-580
	129º 20.18		*Pristipomoides typus*	1	520
			Lutjanus erythropterus	1	421-890
4/10/95	10º 07.61	Day	*Pristipomoides multidens*	3	263-315
	129º 20.20	am *(4 hrs)	*Pristipomoides typus*	6	390-536
			Lutjanus erythropterus	13	421-890
			Sphyraena barracuda	1	427
			Bodianus perditio	1	340
			Epinephelus aerolatus	5	215-366
			Carangoides spp	1	506

TRIP 4 (contd)

DATE SET	POSITION	TIME	SPECIES	CATCH	SIZE RANGE (mm)
		Day	*Pristipomoides multidens*	8	318-428
		pm *(4 hrs)	*Pristipomoides typus*	12	281-429

* Results not used in analysis.

APPENDIX III

LARGE MESH TRAMMEL NET

DATE	POSITION	DEPTH	TIME	SPECIES	CATCH	SIZE RANGE (mm)
12/06/96	12º 05.17	8	0530 - 0730	*Pantolabus radiatus*	5	110-164
	131º 15.17			*Carangidae* spp	9	93-105
				Rhizoprionodon taylori	7	390-455
				Herklotsichthys koningsbergeri	1	124
				Eleutheronema tetradactylum	2	285-295
				Sillaginidae spp	1	188
				Salarias calvus	1	134
				Carcharhinus breuipinna	1	590
				Carcharhinus leucas	2	534-550
13/06/96	12º 05.20	16	0530 - 0730	*Rhizoprionodon actus*	15	327-475
	131º 16.17			*Arius thalassinus*	13	165-204
				Rhizoprionodon taylori	2	394-400
				Carcharhinus leucas	2	499-570
	12º 03.00		1100 - 1300	*Rhizoprionodon taylori*	6	374-471

LARGE MESH TRAMMEL NET (contd)

DATE	POSITION	DEPTH	TIME	SPECIES	CATCH	SIZE RANGE (mm)
	131º 16.00			*Carcharhinus dussumieri*	1	615
				Carcharhinidae spp	1	635
				Harpadon translucens	5	216-254
				Arius thalassinus	7	129-166
				Protonibea diacanthus	1	202
				Rhizoprionodon actus	54	260-705
			1600 - 1800	*Rhizoprionodon actus*	3	280-464
				Carcharhinus fitzroyensis	2	595-712
				Arius thalassinus	4	170-213
				Amphotistius annotatus	1	210
				Eleutheronema tetradactylum	1	215
				Harpadon translucens	1	248
14/06/96	12º 02.00	26	0530 - 0730	*Arius thalassinus*	23	168-254
	131º 14.00			*Rhinoprenes pentahemus*	1	120

LARGE MESH TRAMMEL NET (contd)

DATE	POSITION	DEPTH	TIME	SPECIES	CATCH	SIZE RANGE (mm)
				Carcharhinus leucas	1	1090
				Rhizoprionodon actus	9	375-460
			1100 - 1300	*Rhizoprionodon actus*	25	392-585
				Pomadasys argenteus	2	155-173
				Johnius vogleri	1	169
				Engraulis spp	1	155
				Rhizoprionodon taylori	1	570
				Sphyrna spp	1	1430
				Carcharhinus sorrah	10	680-940

SMALL MESH TRAMMEL NET

DATE	POSITION	DEPTH	TIME	SPECIES	CATCH	SIZE RANGE (mm)
12/06/96	12º51.70	8	0530 - 0730	*Pantolabus radiatus*	4	77-145
	131º 15.17			*Anodontostoma chacunda*	1	135
13/06/96	12º 52.00	16	0530 - 0730	*Rhizoprionodon actus*	4	373-400
	131º 16.00			*Setipinna tenuifilus*	2	80-103
	12º 30.00		1100 - 1300	*Rhizoprionodon actus*	24	356-455
	131º 16.00			*Arius thalassinus*	1	179
	12º 30.00			*Thryssa hamiltoni*	3	80-90
	131º 16.00		1600 - 1800	*Engraulididae* spp	4	94-102
				Rhizoprionodon actus	4	390-430
				Thryssa hamiltoni	3	80-90
				Engraulididae spp	4	94-102
14/06/96	12º 20.00	26	0530 - 0730	*Rhizoprionodon actus*	7	364-460
	131º 14.00			*Arius thalassinus*	5	200-259
			1100 - 1300	*Carcharhinus tilstoni*	2	485-515
				Sciaenidae spp	1	108
				Euristhmus lepturus	1	160
				Rhizoprionodon actus	2	382-460