Testing a Collapsible Trap Design in the Deep Demersal Trap Fishery of Tobago, Eastern Caribbean

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ABSTRACT

The deep demersal trap fishery of Tobago is an important part of the island's fishing industry. However, there is little recent information on species composition or catch rates in this fishery and no catch and effort data series, constraining even basic management planning. A further concern is that like many other islands in the Caribbean, the traps are deployed and fished from small artisanal boats, and the large size of traps severely constrains the number that can be safely transported at sea on any given trip. This is particularly critical during the hurricane season, when traps must often be brought ashore to prevent loss or damage during storms.

This study collects baseline data on the deep demersal trap fishery and investigates the use of a collapsible trap design in this fishery. The ease of handling the gear, catch rates (as number and weight of fish per haul), proportion of juveniles, mean size of individuals, and taxonomic composition of catches are compared between traditional arrow-head traps and collapsible traps. Traditional traps (constructed from 3.81 cm mesh chicken wire over a rigid wooden stick frame) and collapsible traps (constructed from 3.81 cm soft mesh netting over a folding steel frame) were fished in pairs on traditional fishing grounds off the western end of Tobago from April to June 2001.

A total of 152 trap pairs were hauled, landing 2,909 (952 kg) fish from 17 families. Five species (vermillion, red and lane snappers, cottonwick grunt and saucereye porgy) accounted for 97 % of all commercially important fish caught and 85 % of the total catch (by number). Traditional traps caught on average 16.4 fish (5.10 kg) per haul, of which 14.8 fish (4.4 kg) were commercially valuable species. This is significantly higher than the average catch rates per haul of collapsible traps (all fish: 2.7 fish, 1.13 kg; commercial spp: 2.0 fish, 0.8 kg). Traditional traps also caught a significantly lower proportion of by-catch species (9.6 %) and of juveniles of commercially valuable species (17.6 %) than collapsible traps (by-catch: 28.8 %; juveniles: 52.5 %). In contrast, the collapsible traps caught larger fish (mean size: 0.42 kg, 30.9 cmFL, 8.9 cmBD) than the traditional traps (0.31 kg, 27.6 cmFL, 7.4 cmBD). With regards to gear handling, up to eight collapsible traps could be transported safely together and deployed from the artisanal boats, compared with only two or three traditional traps. Furthermore, the traps were relatively easy to deploy, although they were considered too heavy to haul manually.

Probando un Diseño de Nasa Plegable para la Pesca Artesanal con Nasas de Tobago (Caribe)

La pesqua con nasas representa una parte importante de la industria pesquera de Tobago. Sin embargo, como en muchas otras islas del Caribe, las nasas son desplegadas e izadas mediante pequeñas embarcaciones artesanales, por lo que el gran tamaño de las nasas limita severamente el número de ellas que podrian ser transportadas al mar en un solo viaje. Esto afecta la rapidez y facilidad con que las nasas pueden ser movidas de una zona de pesqua a otra, o entre zonas de pesqua y puertos. Esto es particularmente importante durante la temporada de huracanes, cuando las nasas deben ser llevadas a puerto para prevenir que se dañen o pierdan durante tormentas.

Hemós investigado el uso de un diseño de nasa plegable, y comparado las tasas de captura (número y peso de peces por izada), talla media de los individuos, y composición taxonomica de las capturas de estas nasas plegables con las de nasas tradicionales punta de flecha (arrow-head). Las nasas tradicionales (construidas con malla metalica de 3.8 cm de apertura sobre un marco rígido de madera) y las nasas plegables (construidas con malla de nylon de 4.5 cm de apertura sobre un marco plegable de acero) fueron desplegadas en pares en zonas tradicionales de pesca del suroeste de Tobago de Abril a Junio 2001. Un total de 152 pares de nasas fueron izadas, capturando 2,909 (952.3 kg) peces perteneciendo a 17 familias. La composición taxonomica de familias de valor comercial fué similar en los dos tipos de nasas (las familias más importantes por peso fueron: Lutjanidae, Haemuliade y Spariade). Sin embargo, las nasas tradicionales capturaron más peces por izada (numero medio: 14.8; peso medio: 4.4 kg) que las nasas plegables (numero medio: 2.0; peso medio: 0.8 kg). Por contra, las nasas plegables capturaron peces más grandes (talla media: 0.44 kg) que las nasas tradicionales (0.31 kg). Además, aproximadamente 8 nasas plegables pueden ser transportadas juntas y desplegadas desde una embarcación artesanal, en lugar de sólo 2 o 3 nasas tradicionales.

PALABRAS CLAVES: Nasa plegable, artesanal, Tobago

INTRODUCTION

Fishing is an important economic activity in Tobago (population: 55,000, land area: 300 km^2) providing key support for many coastal communities around the island (Thomas et al. 2001). There are 32 recognised landing beaches, 1,039 registered fishers and almost 700 fishing vessels which are typically small open boats (bumboats and pirogues) 7-9 m long, powered by outboard engines and involved in several types of fishing (Thomas et al. 2001). The two most significant fisheries on the island are for oceanic pelagic species (mainly flyingfish, dolphinfish, wahoo, kingfish) and for deep demersal species (mainly snappers and groupers) the latter being primarily for export.

Despite its recognised importance, there is a dearth of up-to-date information on the deep demersal fishery in Tobago. Only brief mention is made of this fishery in national reports by La Croix (1984), Potts et al. (1988) and Thomas et al. (2001), whilst a more indepth study of the status of the deep demersal fishery in the twin-island republic of Trinidad and Tobago was conducted more than 10 years ago (from 1990-1992: see Manickchand-Heileman and Phillip 1992, 1999a). There are no time-series of catch or effort data for this fishery nor any records of typical catch rates (as catch per haul) or total catch composition, although seasonal patterns in the relative composition of target species in the catch were reported, and yield per recruit analyses for these species suggested that vermillion snapper was overfished and that red snapper and yellowmouth grouper were fully exploited by 1992 (Manickchand-Heilman and Phillip 1992). In 1991 approximately 50 vessels and 143 fishers in Tobago were targetting deep demersal species in a rapidly expanding fishery (Heileman and Phillip 1999a).

In Tobago, deep demersal species are taken primarily by fish traps, although handlines may be deployed in a method of fishing known as "banking" and bottom longlines (palangues) are occasionally used whilst drift fishing for pelagic species. The fishery is conducted year-round, although fishing is more intensive during the low season for pelagics (i.e. July to November). Traditional fishing grounds for Tobagonian boats are on the shelf and shelf edge particularly around the western end of Tobago where the shelf is wider, and traps are set in 40 – 130 m depth. Fishers may have between 10 and 25 traps that they haul (manually or with a mechanical winch) and reset on a daily basis.

A key concern of these fishers, in common with artisanal trap fishers throughout the Caribbean, is the small number of fish traps that can be transported safely at sea by the small open boats. This constrains the speed and ease with which traps can be moved on or between fishing grounds or to and from shore (Munro 1973). This is particularly critical during the hurricane season the peak trap fishing season), when traps must often be brought ashore at short notice to prevent loss or damage during storms (Chakalall 1999). It has been suggested that a collapsible trap design would alleviate these concerns and address the problem of ghost fishing which occurs when traps are lost as a result of being left out in bad weather (Chakallal 1999).

This study reports for the first time on the catch rates (catch per trap), proportion of juveniles and total species composition of catches in the traditional deep demersal trap fishery of Tobago, and investigates the performance of a collapsible trap design in this fishery.

METHODS

Study Site and Duration

Initial fishing trials were conducted from November 23, 2000 to February 2, 2001 on a traditional fishing ground 3 nmi off Scarborough, to test the basic features of the collapsible design. Subsequently a less exposed traditional fishing ground 2 nmi off Buccoo was selected for the study and the experimental fishing took place from April 26 to June 9, 2001.

Fishing Techniques and Schedule

Traps were set, retrieved and marked using ropes and surface buoys. Traps were set in pairs (one collapsible trap and one traditional trap) in 40 - 50 m of water. Their positions were noted by handheld GPS and triangulation landmarks. Traps were baited with skipjack and little tunny and hauled daily, in line with traditional fishing practice. After hauling, all fish were removed and any damage to the trap was repaired before re-baiting and re-setting in approximately the same area.

Trap Design and Construction

Collapsible traps — Collapsible traps had a rectangular base (2.1 x 0.9 m) of steel rod (19.4 mm diameter) strengthened with cross bars (Figure 1). The upper part of the frame comprised four U-shaped folding frames of steel rod (11 mm diameter), hinged at the midway points of the rectangular base. The two outermost frames were slightly taller (0.83 x 0.9 m) than the two innermost frames (0.68 x 0.9 m), such that when erect, a rectangular trap is created, measuring 2.1 x 0.9 x 0.68 m with a volume of 1.29 m^3. The trap was held erect by strapping the two inner frames together in the centre with a synthetic twine, and was collapsed by undoing the twine and folding two frames (one inner and one outer) down on either of the base frame. The folding steel frame was covered with soft 3.81 cm (1½") square mesh netting made of 3-strand synthetic twine (Figure 2) stapled onto the frame, whilst the base frame was covered by plastic hexagonal material (of similar mesh size). The horse-neck funnel made of 3.81 cm (1½") chicken wire was fitted into the trap by stapling it to the mesh on one of the shorter sides of the trap. This funnel was cut horizontally along each side (except for the mesh nearest to the mouth of the trap) and rejoined using galvanised wire rings. This design allowed the funnel to flatten when the trap was folded and reopen when the trap was erected ready for fishing. This feature represents a modification to the original funnels that were used during fishing trials, since the earlier design of funnels got squashed when the traps were in the collapsed state and could not be easily reconfigured when traps were erected.

Traditional traps — Traditional wooden frame traps were made to the same specifications as those most commonly used in Tobago. They comprised galvanized hexagonal mesh wire (3.81 cm [1½"] mesh chicken wire; Figure 2) put together in an arrowhead shape measuring 1.25 x 1.2 x 0.48 m (volume 0.72 m^3) with a horse-neck funnel in the "tail of the arrow". The chicken wire was supported by an external frame of mangrove sticks nailed and tied together with strapping wire. A rectangular door measuring 21.2 x 32.5 cm was also fitted into the left side of the arrowhead to allow removal of captured fish.

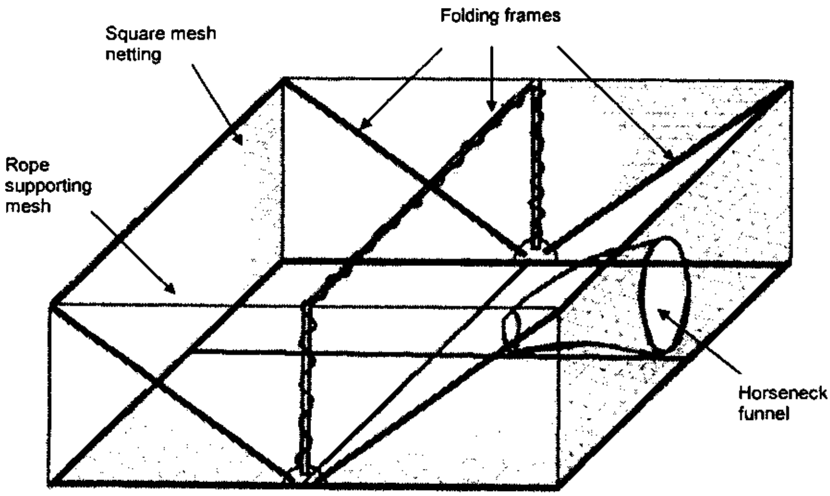


Figure 1. Diagram showing design of collapsible trap used in the deep demersal fishery of Tobago

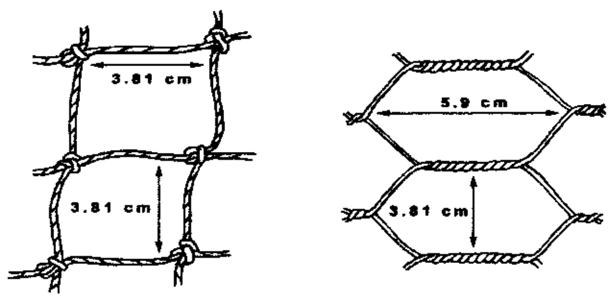


Figure 2. Diagram showing the dimensions of the mesh used in the traps. a – square soft mesh netting used in collapsible traps, b – hexagonal mesh chicken wire used in traditional traps

Sampling Design and Sample Size

Collapsible and traditional traps (five of each design) were fished concurrently, on traditional fishing grounds, in pairs. This paired design approach was taken to allow paired sample testing and therefore avoid the compounding error of variance caused by possible differences in local benthic habitat. Each paired trap haul was taken as a sampling replicate. A total of 15 hauls per trap design were made during fishing trials and a further 152 hauls per trap design were made during the experimental fishing.

Data Collection, Handling and Analysis

For each trap pair hauled, the date, soak time and position were recorded. All fish from each trap were identified to species and measured for total length (TL), fork length (FL) and body depth (BD) to the nearest mm, and weighed to the nearest g. All of the species in six families (snappers, groupers, hogfishes, porgies, grunts and spiny lobster) were categorised as commercially valuable since they were always retained by fishers for sale. All others were designated as by-catch species since they were either thrown back, retained for bait and personal consumption, or given away. Key commercially valuable species were further designated as either juvenile or adult, based on size at maturity data available in the literature (see Table 1), and body shape was defined as either round-bodied or deep-bodied based on the mean aspect ratio (AR = FL/ BD). For deep-bodied fish AR < 2.5, and for round-bodied fish AR > 3. The catch of traditional traps was also adjusted in the database by removing any fish with a body depth of < 7 cm. This represents the size at which fish could be reasonably expected to escape from the flexible square mesh of the collapsible traps.

Statistical analyses were performed using SPSS (Ver. 11). All data sets were tested for normality and homogeneity of variance. Most data sets did not conform and were therefore compared using non-parametric tests. Catch rates were compared between trap types using Wilcoxon paired ranks test, mean sizes were compared using Mann-Whitney test and Student's t-test, and proportions were compared using Pearson chi-square test for independence.

RESULTS

Trap Design and Handling Performance

During fishing trials it became clear that the horse neck funnels of the collapsible traps were being damaged when the traps were collapsed. As a consequence, new funnels with a split construction and less of a down-turn (allowing them to fold without distorting the wire mesh) were designed and subsequently used in this study.

Up to eight collapsible traps could be safely transported at once when folded down, and deployed with relative ease from the artisanal fishing boats, compared with only two or three traditional traps. However, they were found to be too heavy to haul manually and therefore unsuitable for boats without a winch. The collapsible traps were easier to empty and re-bait than traditional traps as they could be opened up completely by undoing the central strapping twine. Furthermore, although the mesh netting was damaged more frequently than the wire mesh of traditional traps, it was very easy to repair onboard before resetting the trap.

Table 1. Size of females at maturity and proportion (% by number) of juveniles in the catch taken by collapsible (coll.) and traditional (trad.) traps for key commercially valuable species. Dimensions are in cm, FLm is fork length at maturity, BDm is body depth at maturity (converted using relationships from this study), a and b are constants in the body depth to fork length linear regression (BD = a + bFL) and r^2 is the coefficient of determination of the regression line, AR is aspect ratio describing body shape calculated as FL/BD.

Species	Common name	FL_m	BD_m	a	b	r2	AR	% juv. (by no.)		Reference for maturity estimate
								coll.	trad.	
Haemulon melanurum	cottonwick grunt	19.0	5.5	0.317	0.304	0.815	3.47	58.6	28.6	Gaut & Munro 1983[1]
Lutjanus synagris	lane snapper	17.6	4.9	0.189	0.299	0.916	3.43	0	0	Thompson & Munro1983[1]
Rhomboplites aurorubens	vermillion snapper	< 13.0	< 3.2	0.826	0.313	0.870	3.57	0	0	Manickchand-Heileman Phillip 1992, 1999b[2]
Lutjanus purpureus	red snapper	35.4	10.7	0.390	0.292	0.831	3.26	98.7	98.7	Manickchand-Heileman & Phillip 1992[2]
Calamus calamus	saucereye porgy	?	?	0.367	0.389	0.880	2.47	?	?	

1 – maturity defined as the smallest size of females at maturity
2 - maturity defined as the size at which 50% females are mature. Values given as TL and converted to FL using the relationships determined in the present study (vermillion snapper: FL = 0.0672 + 0.8936 TL; red snapper: FL = 1.4135 + 0.871 TL)

Catch Composition

A total of 42 fishing trips and 304 trap hauls (152 paired hauls) resulted in the capture of 952.3 kg of fish comprising 38 species from 17 families. The taxonomic composition of catches is summarised in Table 2.

Traditional traps caught 2,492 fish (comprising 17 families and 35 species) with a total weight of 774.7 kg (Table 2). Of these 90.4 % by number and 86.6 % by weight were of commercial value (21 species from 6 families: grunts, groupers, hogfishes, porgies, snappers and spiny lobsters) (Table 3, Figure 3a). Just five species from three families (vermillion, red and lane snappers, cottonwick grunt and saucereye porgy) accounted for 97.6 % of all commercially important fish caught and 88.2 % of the total catch (by number) of traditional traps (Table 2). The 14 by-catch species comprised bigeye, filefishes, goatfishes, nurse shark, pufferfish, sand tilefish, scorpion fish, squirrelfish, triggerfishes, trunkfishes and Spanish slipper lobster, and made up less than 10 % of the catch by number (Table 2). Furthermore only 17.6 % of the catch of four key commercial species (for which size at maturity data were available) comprised juveniles (Table 3). However, of concern is the fact that almost all red snappers taken (98.7%), and close to one third of cottonwick grunts (28.6 %) were juveniles (Table 1).

Collapsible traps caught 417 fish (comprising 20 species from 13 families) with a total weight of 177.5 kg. Of these 71.2 % by number and 67.9 % by weight were of commercial value (12 species) whilst almost 30 % by number were by-catch species (8 species) (Table 2). Like the traditional traps, the same five species made up the majority of the catch (94.9 % of the commercial catch, 67.6 % of the total catch). In contrast with traditional traps however, juveniles made up the majority (52.5 %) of the catch of four key commercial species, but similarly the majority of juveniles captured were red snapper (98.7 %) and cottonwick grunt (59.6 %) (Tables 1 and 3).

In comparison, collapsible traps caught far less fish and fewer species overall, a significantly lower proportion of commercially valuable species, and a significantly higher proportion of juveniles in the catch of four key commercially valuable species, than traditional traps (Table 3). Taxonomic composition of the commercially valuable catch was similar at the family level between trap designs, with snappers, porgies and grunts ranking in the top three for both (Figure 3). However, within the snapper family the relative importance of the species differed between trap designs. Traditional traps caught an overwhelming majority of vermillion snapper (79.7 % of all snappers), whereas collapsible traps caught proportionally more red snapper (51.0 %) (Table 2). By-catch composition differed somewhat even at the family level, with bigeyes and triggerfishes being most important to collapsible traps, whilst triggerfishes and squirrelfishes made up the majority of by-catch in traditional traps (Figure 3).

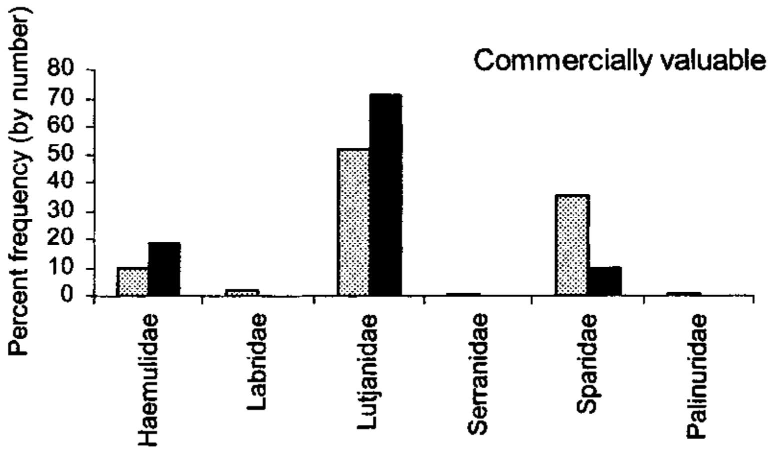
Table 2. Taxonomic composition of the catch taken by collapsible and traditional traps in 152 hauls of each trap type, shown by number and weight of species and separately by commercially valuable and by-catch species.

Family	Species	Common name	No spp	Collapsible traps		Traditional traps	
				No	Wt (g)	No	Wt (g)
COMMERCIALLY VALUABLE							
Haemulidae	*Haemulon bonariense*	black grunt		0	0	2	309
	Haemulon melanurum	cottonwick grunt		29	4373	419	67328
	Haemulon striatum	striped grunt		0	0	1	128
	Haemulon aurolineatum	tomate		0	0	1	145
	Haemulon plumieri	white grunt		0	0	1	268
Sub-total			**5**	**29**	**4373**	**424**	**68178**
Labridae	*Lachnolaimus maximus*	hogfish	1	7	9150	4	3900
Lutjanidae	*Lutjanus buccanella*	blackfin snapper		0	0	1	303
	Lutjanus griseus	gray snapper		0	0	1	513
	Lutjanus synagris	lane snapper		33	12764	58	19036
	Lutjanus mahogoni	mahogany snapper		1	369	15	3618
	Lutjanus analis	mutton snapper		2	2550	13	18990
	Rhomboplites aurorubens	vermillion snapper		39	16134	1279	388683
	Lutjanus purpureus	red snapper		78	28991	233	74897
	Lutjanus vivanus	silk snapper		0	0	4	967
	Ocyurus chrysurus	yellowtail snapper		0	0	1	496
Sub-total			**9**	**153**	**60808**	**1605**	**507503**
Serranidae	*Mycteroperca bonaci*	black grouper		1	5650	2	12000
	Epinephelus fulvus	coney		1	398	0	0
	Epinephelus guttatus	red hind		0	0	1	305
	Mycteroperca interstitialis	yellowmouth grouper		0	0	1	1400
Sub-total			**4**	**2**	**6048**	**4**	**13705**
Sparidae	*Calamus calamus*	saucereye porgy		103	37763	210	75676
	Calamus bajonado	jolthead porgy		1	469	4	1320
Sub-total			**2**	**104**	**38232**	**214**	**76996**
Palinuridae	*Panulirus argus*	spiny lobster	1	2	2000	1	500
Sub-total commercially valuable			**22**	**297**	**120611**	**2252**	**670782**

Table 3. Comparison of catch performance indicators (for finfish) between collapsible and traditional traps over 152 hauls off Buccoo, Tobago a - Traditional trap catches adjusted by removing all fish with body depth < 7 cm. b – cottonwick grunt, lane snapper, vermillion snapper and red snapper.

Catch performance indicator	Collapsible traps	Traditional traps	Statistical test results		
			n	Test statistic	P value
Number of commercial spp. caught	12	21	22	-	-
Number of by-catch spp. caught	8	14	16	-	-
Proportion of commercial spp. in catch (% total no.)	71.2	90.4	2	P^2 = 120.75	< 0.001
Proportion of commercial spp. in catch (% total wt)	67.9	86.6	-	-	-
Proportion of juveniles in key commercial spp[b] (% no.)	52.5	17.6	2	P^2 = 122.94	< 0.001
Individual weight range (g)	91–5,650	61–6,350	2,904	-	-
Mean individual weight of fish in catch (g)	423	311	2,904	U = 322,621	< 0.001
Individual length range (cm FL)	18.8–310.0	14.0–321.0	2,904	-	-
Mean individual length of fish catch (cm FL)	30.9	27.6	2,904	U = 355,285	< 0.001
Individual body depth range (cm)	5.0-19.0	4.0-19.0	2,904	-	-
Mean individual body depth of fish catch (cm)	8.9	7.4	2,904	U = 273,487	< 0.001
Mean body depth of vermillion snapper in catch (cm)	7.8	7	1,318	U = 16,382	< 0.001
Mean body depth of cottonwick grunt in catch (cm)	5.4	5.7	448	U = 4,006	0.002
Mean body depth of saucereye porgy in catch (cm)	9.6	9.6	313	U = 10,209	0.420*
Mean body depth of red snapper in catch (cm)	8.4	7.9	311	U = 6,479	< 0.001
Mean body depth of lane snapper in catch (cm)	8.1	7.6	91	t = 2.536	0.013
Mean catch rate (no./haul)	2.7	16.4	152	Z = 9.50	< 0.001
Mean catch rate (g/haul)	1,126	5,097	152	Z = 9.08	< 0.001
Mean commercial spp. catch rate (no./haul)	2	14.8	152	Z = 9.64	< 0.001
Mean commercial spp. catch rate (g/haul)	794	4,413	152	Z = 9.21	< 0.001
Mean adjusted[a] catch rate (no./haul)	2.7	7	152	Z = 7.59	< 0.001
Mean adjusted[a] catch rate (g/haul)	1,126	3,502	152	Z = 7.86	< 0.001

a



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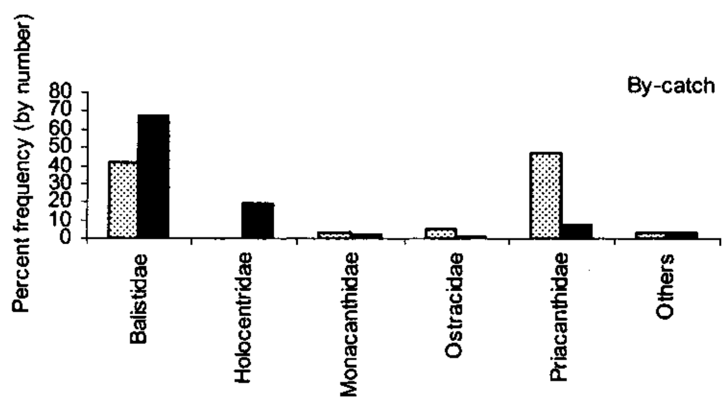


Figure 3. Comparison of catch composition by family between collapsible traps and traditional traps in the deep demersal fishery of Tobago, shown separately by a – commercially valuable and b – by-catch species

Size of Finfish

Individuals in the catch ranged from 61 – 6350 g in weight, 14.0 – 321.0 cm in fork length and 4.0 – 19.0 cm in body depth (Figure 4). These ranges were similar for both trap types, but the mean sizes of fish in the catch were significantly different between trap types. Collapsible traps caught significantly heavier, longer and taller fish on average than traditional traps (Table 3). This was also true for three of the key commercial species (vermillion, red and lane snappers) which are all round-bodied species and had significantly greater mean body depths in collapsible traps than traditional traps. Saucereye porgy (the only deep-bodied species) showed no difference in size between traps, whereas cottonwick grunt had significantly smaller body depths in collapsible traps (Table 3).

Catch Rates

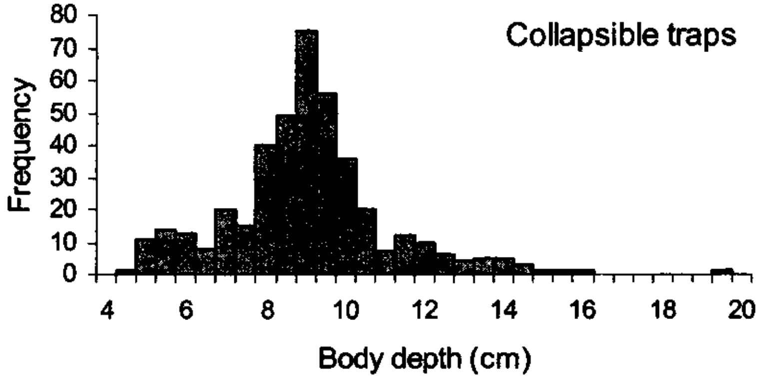
Catch rates as mean number of fish per haul and mean weight of fish per haul are shown for the two trap types in Table 3. Collapsible traps caught significantly less fish per haul (2.7 fish or 1.13 kg per haul) than the traditional traps (16.4 fish or 5.10 kg per haul) (Table 3). This was also the case with catch rates of commercially valuable species, with traditional traps catching on average seven times more (by number) and 5.5 times more (by weight) than collapsible traps (Table 3).

Interestingly catch rates of the traditional traps adjusted for mesh size flexibility by removing all fish small enough to have escaped from the more flexible mesh of the collapsible traps (i.e. all fish < 7 cm BD) were still significantly greater than those of collapsible traps (Table 3). This indicates that mesh flexibility alone does not explain the large difference in catch performance between the two trap types.

DISCUSSION

Performance of the Collapsible Trap Design

The collapsible traps were partially successful in addressing the issue of safety and time efficiency at sea, since more than twice the number of traditional traps could be carried and deployed from the small artisanal pirogues used in the Tobagonian deep demersal fishery. As such, fishers felt that the design had some potential for further development. However, the extra weight of the collapsible traps made them unsuitable for boats without mechanised winches. Furthermore, the vast difference in catch rates between collapsible traps and traditional traps makes them an undesirable gear for fishers, and the higher proportion of by-catch species and higher proportion of juveniles of the key species taken by these traps also makes them undesirable from a fisheries management perspective.



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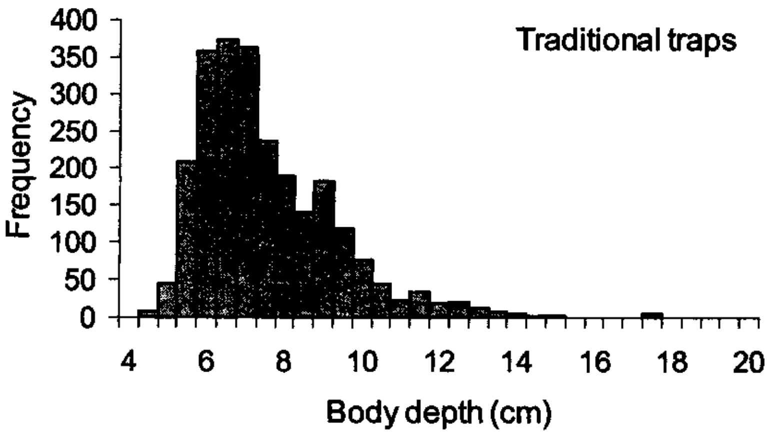

Figure 4. Size frequency of all finfish landed by (a) collapsible and (b) traditional traps in the deep demersal fishery of Tobago, shown as body depth

The reasons for poor performance of the collapsible traps must be addressed if the gear is to be considered in the future. Lower catch rates and larger fish can be partially explained by the fact that the soft mesh netting used in construction of the collapsible traps is more easily distorted and stretched (to a maximum horizontal or vertical aperture of around 7 cm), presumably allowing more and larger fish to escape, than from the galvanised mesh of traditional traps (maximum horizontal aperture of 5.9 cm, maximum vertical aperture of 3.8 cm). Trap catch rates are indeed very sensitive to even small changes in the mesh (see Mahon and Hunte 2001 for a review). However, even when catch rates of traditional traps were artificially adjusted by removal of all fish smaller than 7 cm in body depth, catch rates of collapsible traps were still significantly lower. One possible explanation is that the funnels in the collapsible traps (which had less of a down-turn than the conventional horse-neck funnels of traditional traps, to prevent damage when folded), allowed entrapped fish to escape more easily. Another possibility is that ingress rates were lower for collapsible traps than traditional traps. This could be explained by a difference in the visual impacts of the two trap types resulting from the different materials used in their design such that collapsible traps were less attractive to fishes (e.g. Munro 1974, Robichaud et al. 1999), or from lower conspecific attraction rates in collapsible traps as a result of lower catches (e.g. Munro 1971). One or both of these factors could have meant that collapsible traps were less desirable for fish to enter. Further study is required to investigate the causes and ameliorate the outcomes if collapsible traps are to be used as a management tool.

On the face of it, catching fewer but larger fish would seem to indicate that collapsible traps have potential as a management tool for reducing the mortality on smaller/younger fish and therefore improving potential yield over the long term. However, the fact that they caught a higher proportion of juveniles of commercially valuable species and a higher proportion of by-catch species is both undesirable and hard to explain. The difference in the proportion of juveniles caught is accounted for by a single species (cottonwick grunt), and by the fact that far fewer vermillion snapper (for which no juveniles were caught by either trap type) were landed by the collapsible traps. Why smaller cottonwick grunt (a round-bodied species) were retained by the collapsible traps than by the traditional traps is uncertain.

Catch data for Traditional Traps

Catch per haul data and total catch species composition for traditional traps in the deep demersal fishery are provided in this study for the first time. However, it is recognised that these data represent only a small sample of the total area and months over which this fishery takes place. Manickchand-Heileman and Phillip (1999a) reported differences in catch rates (using a coarser index of monthly average catch per fisher per trip) across months and years and differences in catch composition (for target species only) by area and season. A more comprehensive sampling will therefore be needed if the current data are to be used as a baseline against which to compare future catch rates and species composition. The coarser index and broader scope of the previous study does not allow direct comparison with the current smaller data set.

However, if it is assumed that three fishers haul between 10 – 25 traps a trip then average catch rates for commercially valuable species in the current study of 4.4 kg per trap haul would result in a fisher catch per trip of between 14.7 and 36.7 kg compared with 34 kg per fisher per trip recorded from traditional fishing areas off Tobago in 1990 (Manickchand-Heileman and Phillip 1999a). This may represent a continuation of the decline in catch rates noted by these authors from 1988 – 1990, who were concerned about unmanaged and increasing fishing effort on the deep demersal fish resources of Trinidad and Tobago.

A further possible cause for concern is the apparent decrease in size (modal length) of red snapper taken by traps from 400 mm TL (reported in 1990 by Manickchand-Heileman and Phillip 1999a) to current data showing a bimodal distribution with modes at 240 and 320 mm TL. Vermillion snapper size however seems to have remained stable with a reported modal length of 250 mmTL in 1990 (Manickchand-Heileman and Phillip 1999a) and a current modal length of 260 mm TL. This is despite the fact that this species was deemed overfished 10 years ago. That red snapper may now be showing signs of overfishing would not be surprising given their large size at first maturity, and the high proportion of immature individuals taken by traps. Again however, these comparisons are compounded by differences in the areas and times over which sampling took place and should be treated with caution.

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