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THE SMALL SCALE REEF FISHERY ON THE CENTRAL NORTH COAST OF JAMAICA IN 2000-2001: A BIOLOGICAL AND SOCIO-ECONOMIC SURVEY.

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Caribbean Marine Protected Areas Project
funded by
United Kingdom Department for International Development

CARIBBEAN/ EASTERN PACIFIC OFFICE TECHNICAL REPORT

November 2001

THE SMALL SCALE REEF FISHERY ON THE CENTRAL NORTH COAST OF JAMAICA: A BIOLOGICAL AND SOCIO-ECONOMIC SURVEY FROM RIO BUENO (TRELAWNY) TO SALEM (ST. ANN), 2000-2001.

ABSTRACT

This report provides detailed catch and effort information on the reef fishery on the north coast of Jamaica. The study area covered is from Rio Bueno, Trelawny, to Salem, St. Ann, a 22 km long segment of the central north coast. The reef fishery there is typical of the rest of the fishery on this coast, which is believed to be one of the most overfished in the Caribbean. The resource is easily accessible and it is an important source of food and employment, despite its overexploited state.

The estimated current fishing effort in the 12 km^2 study area was over 7000 boat trips per year using traps, lines, or nets. In addition, over 5000 spear fishing trips were made per year. The average income was between US$13 and $29 per trip. The total catch in the study area was about 60 tons per year, worth about $300,000. Despite its overexploited state, the productivity of the reef fishery has remained high, with an estimated yield of 5 tons km^{-2}.

Changes in fish trap catches were examined between 1996 and 2001. The catches remained under 1 kg per trap haul over this time period. There was a slight increase in trap catches and catch value, which increased to a little more than $4 per trap haul. However, the average fish size in the catch decreased and there were more lower valued (common) species in the catch in 2000/01 than before. The average fish size in all commercial categories appeared to drop.

Management measures that could rebuild fish stocks were suggested a quarter of a century ago. However, the central government has not been able to introduce the measures that are necessary to rebuild the fish populations. The University of the West Indies has attempted to introduce a number of management initiatives on a small scale around Discovery Bay, such as a move to larger mesh sizes for fish traps and the establishment of the Discovery Bay Fishery Reserve. Despite some local successes, these management strategies have not been applied on a wider scale.

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ACKNOWLEDGEMENTS

This study was part of the work of the Caribbean Marine Protected Areas Project, funded by the United Kingdom Department for International Development. Dr. John L. Munro provided the senior technical direction and overview throughout the study. The report also benefited from the valuable comments of Dr. Jeremy D. Woodley of the Centre for Marine Sciences, University of the West Indies (UWI), Jamaica, as well as from Dr. Ivor D. Williams and Robert M. Power of the ICLARM Caribbean/Eastern Pacific Office (CEPO), BVI. Miss Nadine Earle [Fisheries Improvement Programme (FIP), UWI] and Mr. John Samuels (ICLARM CEPO) collected the vast majority of the data on the fishing beaches, with assistance from several UWI graduate students. Data for 1996-97 were collected by staff of UWI FIP, funded by the Kaiser Jamaica Bauxite Company. I would like to thank the fishers of the area for their assistance in answering all of our questions and allowing us to weigh their catches.

INTRODUCTION

When coral reef researchers or fishery managers look for a case study in Caribbean overfishing, they often think of Jamaica. The reefs on the north coast of the island in particular are recognized as one of the most intensely overfished shallow coralline reef areas in the entire region. This widespread recognition of the problem is largely due to 30 years of research on the reefs of Discovery Bay and the numerous publications reporting the lack of fish there (for example Munro 1983, Aiken and Haughton 1987, Picou-Gill *et al* 1991, Hughes 1994). This paper provides a detailed, updated status report on the fishery on the north coast of Jamaica and it expands on the information presented in Sary *et al* (in press).

Several different fishing methods are commonly used in the Jamaican reef fishery: trap, net (both seine and trammel), drop line, trolling line and spearing. Antillean Z trap is the predominant gear type. The majority of fishing boats on the north coast are small, usually unmotorized wooden canoes, but there are a number of the larger, Jamaican type, 27 foot motorized fiberglass open canoes.

The demand for fish and fish products in Jamaica far exceeds the available local supply. High demand causes the price of fresh fish to be high, despite the fact that most of the local catch is comprised of small species, which would be categorized as trash fish in most other countries. The most common species in the catch are small parrots (e.g. *Sparisoma aurofrenatum*) and surgeonfish (e.g. *Acanthurus bahianus*) (Sary *et al* 1997).

A variety of management tools have been suggested for the management of reef fisheries and there are several reviews of these options (e.g. Munro and Williams 1985; Mahon 1989). Some management measures have been implemented locally, with the assistance of the Discovery Bay Marine Laboratory of the University of the West Indies, on a small scale and in the short term. These included introducing a larger mesh size for fish traps and the establishment of a small fishery reserve, but these strategies have not been applied on a wider scale. Fishers themselves have not taken the initiative to improve the situation, though they all agreed that the fishery is deteriorating. Instead, they have intensified their fishing effort over the years, with greater energy put into catching what is left (Aiken & Haughton 1987).

The study area of Rio Bueno to Salem straddled the Trelawny - St. Ann parish border and it covered approximately 22 km of coastline (Figure 1). The area lies in the centre of the north coast of Jamaica and the reef fishery there is probably very typical of those along the entire coast. The coral reefs lie on a very narrow, accessible submarine shelf. The coral reef fishery is an important source of food and employment, despite its overexploited state. Its open access nature, coupled with high human population growth and intense economic pressures have drawn large numbers of people into the fishery.

The aim of this paper was to quantify the economic importance of the fishery to the local communities. Five separate fishing beaches adjacent to or in Discovery Bay were examined, to assess fishing effort, catches, fishers' incomes, as well as other social and economic indicators.

METHODS

Collection Of Catch And Effort Data

Catch and effort data in the Jamaican north coast artisanal reef fishery was collected from 19 July 2000 to 18 July 2001 at five landing sites in and adjacent to Discovery Bay (Rio Bueno; Old Folly and Top Beach in Discovery Bay; Runaway Bay; and Salem; Figure 1) three or four times a week, on randomized pre-determined days. The survey area covered 26 km of shelf edge at a depth of 100 m and a fishing area of approximately 12 km^2. This excluded the central part of Discovery Bay greater than 30 m deep, which is not fished and is not coralline. To encourage cooperation from fishers, inducements were offered in the form of one ticket in a raffle, held at the end of the survey, for every 10 kg of detailed catch data provided, or one ticket for 25 kg of aggregated catch data.

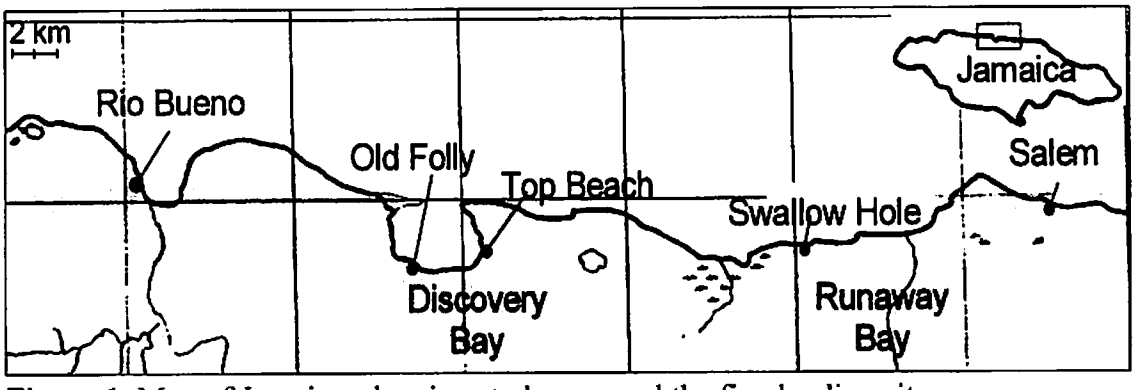


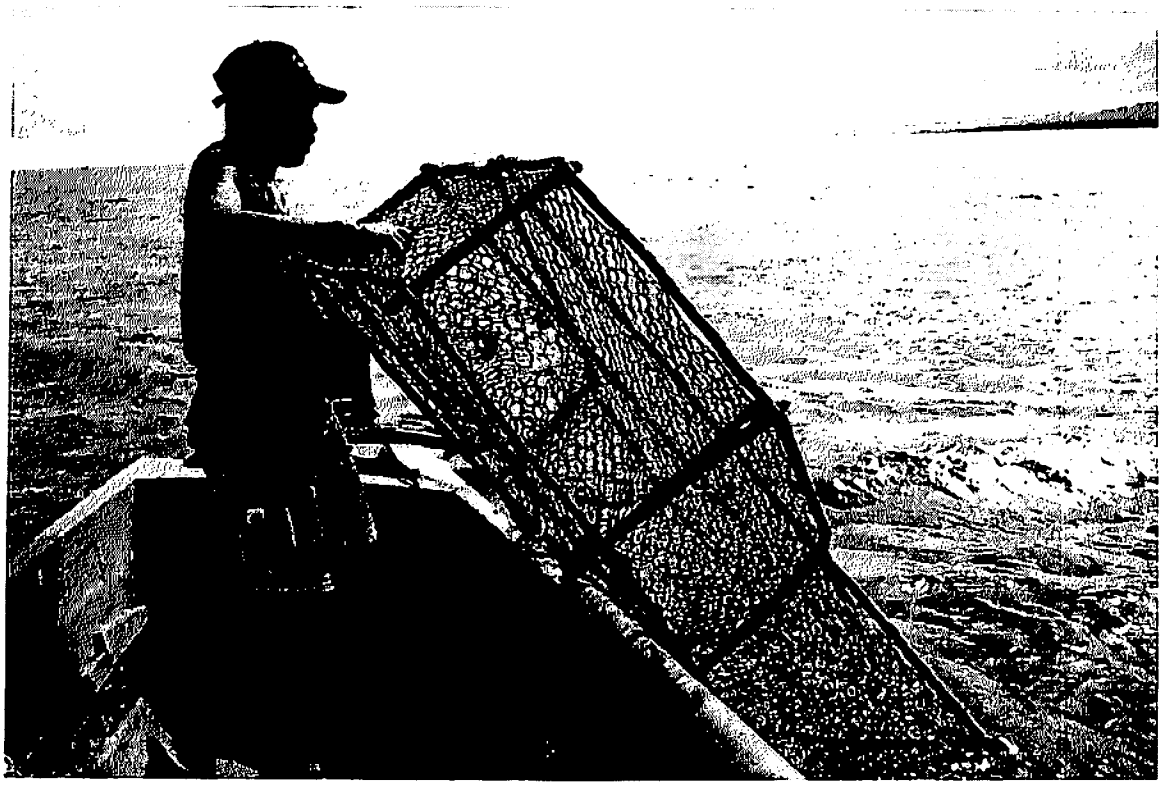
Figure 1. Map of Jamaica, showing study area and the five landing sites.

On each data collection day, the number of active boats (at sea that day), motorized and unmotorized, was enumerated by counting the incoming boats as they were landing on the beach, by counting the empty spaces among the rows of boats and from information from key informants. The number of inactive (seaworthy) boats were also counted at the site. The number of days when fishing was not possible, due to bad weather, was noted.

From the active boats landing at the site, the number of fish and the total weight of each species (to the nearest 0.01 kg) of all catches landed at that site were recorded separately for all consenting fishers (Photograph 1). If sorting of the catch was not possible, an attempt was made to record the total number of fish and total weight of the catch. Fishing effort information (time spent at sea, number of crew members, the number of fish traps hauled, average soak time of gear, mesh size of each fish trap or net, depth fished) was also collected whenever possible. The number of boats missed by the data collectors (due to unusual landing time, too many boats landing at once or uncooperative fishers), was also counted and recorded; the type of fishing gear most likely used by the missed boats was noted.

During the course of the survey, formal interviews were also carried out among the active fishers at the five landing sites using a standard questionnaire to obtain information on the age of the fishers, full/part time status, other occupations of fishers, number of dependents, primary and secondary gear used, the number and size of boats used, number and size of engines used and the number of fish traps of various mesh sizes and other

Photograph 1. Catch and effort data collection at Rio Bueno fishing beach, Trelawny, July 2000. Data collectors are John Samuels, Nadine Earle and Moana Murray, overseen by Dr. John L. Munro.



Photograph 2. Almost 70% of the fishers use Antillean Z-traps as their primary or secondary fishing gear. Salem, St. Ann, November 2000.

gears used in the fishery.

In addition, unpublished catch and effort data, obtained in a similar way to that described above from the same five landing sites, collected by the UWI's Fisheries Improvement Programme (UWI/FIP) from January 1996 to December 1997, was collated and used to examine changes in catch rates in the fishery over the last 5 years. Other sources of data concerning the fishery in the area are the works of Nembhard (1970), Sahney (1983), Munro (1983), Haughton (1988), Picou-Gill et al (1996) Sary et al (1997) and Sary et al (in press).

Data Analysis

Fishing Effort: Fishing effort at each of the five landing sites and overall in the study area, were quantified using the following units of effort: number of active boats (separately for fish trap, net and hook and line fishing), number of share fishers (accompanying the boat captains but keeping their catches separate), number of fish trap hauls (by mesh size) and number of spearfishers (most of them fishing without a boat). In addition, the number of hours spent at sea by each boat (by gear type) and by each spearfisher, as well as the average soak time of traps was also estimated.

The total number of active boats (or boat days) in the fishery per year was estimated for each gear type by calculating the average number of boats that were active on data collection days, multiplied by 365. The total numbers of active share fishers and crew members were estimated in a similar way. Even though fishers may have practiced more than one type of fishing on a fishing trip (e.g. spearfishers often use nets to corral fish; trap fishers often troll a line to and from the fishing grounds), only the primary gear employed on the fishing trip was counted in the effort information.

The total number of trap hauls (separately by mesh size) at each landing site and overall in the study area, was estimated by calculating the average number of trap hauls per active boat in the fishery, multiplied by the total number of boat days within the 12 month period. In addition, the total number of active traps in the fishery was estimated from the fishers' survey.

The total number of active spearfishers (or spear fishing days) was calculated from the number of spearfishers observed in the water from boat cruises within each fishing area multiplied by the estimated proportion of days with fishing activity (with favourable weather).

Boat catch rates: Mean catch rates for fish trap, net and hook and line fishers (in kg boat^{-1} day^{-1}) and for spearfishers (in kg fisher^{-1} day^{-1}) was calculated from sampled catches for the most important species, as well as for each fish family, in the catch. The total catch for the 12 month period, for each landing site (in kg site^{-1} year^{-1}) and for the overall study area (in kg area^{-1} year^{-1}), was estimated by multiplying the mean catch rate per boat (or per spearfisher) by the estimated number of boat days (or spear fishing days) for each species, or fish family, in the catch.

Economic analyses: To estimate the value of the catch in each fishery, fish species were classified into three commercial categories: quality, common and trash, with a corresponding monetary value per unit weight. Based on these three categories, the value of an average catch of each fishing gear was calculated (in US$ fisher^{-1} day^{-1}; rounded to the nearest $1) from the boat catch rates. Then the total value of each fishery at each

landing site (in US$ site^{-1} year^{-1}) and overall in the study area (in US$ area^{-1} year^{-1}; rounded to 3 significant figures) was estimated. This is a somewhat simplified view of the actual situation, where fish are categorized not only by species, but also by size. For example, all snappers were categorized as high quality, although a very small juvenile snapper would be sold as a low quality fish. Therefore, the value of the catch may have been somewhat overestimated if a large proportion of it consisted of small juveniles.

Information on the costs of fishing gears was obtained from the Jamaica Cooperative Union (the main supplier of fishing gear on the island), the Alloa Fishermen's Cooperative (which operates a fishing gear store in Discovery Bay) and from available literature.

Changes in fish trap catch rates: Changes in fish trap catch rates were used as an indicator of changes that may have taken place in the fish stocks that are available to the fishery. The mean catch rates of 1.25" mesh fish traps were calculated (in grams trap^{-1} haul^{-1}; and in number of fish trap^{-1} haul^{-1}) for three 12-month periods (in 1996, 1997 and 2000-2001) in the study area, for each fish family in the catch. Catch rates of only the 1.25" inch mesh fish traps (the most common mesh size in the fishery), were included, in order to provide a consistent basis for comparison between years in this area and between other studies.

To calculate mean catch rates, first the trap catch rates for each individual sampled catch were calculated (catch divided by the number of fish traps hauled, as reported by the fisher); then the mean trap catch rates among all the sampled catches were calculated. This method of calculating the fish trap catch rates relies on information provided by the fisher (number of traps hauled) which is subject to mis-reporting, but nevertheless it is believed to be relatively accurate. The standard error is shown for each calculation to give an indication whether differences between the years are likely to be significant. Finally, the mean fish size (in grams) is derived for all fish families in the catch, by dividing the calculated mean weight of the catch (grams trap^{-1} haul^{-1}) by the calculated number of fish in the catch (number of fish trap^{-1} haul^{-1}).

RESULTS

Data Collection

The data collection effort for this study is summarized in Table 1. The total number of data collection days was 174, or approximately 10% of all beach landing days in the one year period (5 sites x 365 days). Each landing site was sampled on average 35 times, although the larger, busier, sites (Rio Bueno, Top Beach and Salem) were sampled more often than the smaller ones (Old Folly and Runaway Bay). On 21% of days, fishing was not possible due to poor weather conditions.

An average of 3.9 active boats were counted per day, 61% of them non-motorized. Data collectors were able to sample the catches in detail (to species level) of 64% of active boats and another 10% were recorded as total weight only; the other 26% of boats were missed. The majority of sampled boats, about 78%, were trap fishing, while 19% were hook and line fishing and 3% were net fishing. Trap fishers were the easiest group to sample; they tended to go to sea at dawn when the sea was calm and they all returned to shore when the morning wind picked up. However, a few trap fishing boats were

Table 1. Data collection: Summary of data collection during a 12 month period at five landing sites on the central north coast of Jamaica; 19 July 2000 to 18 July 2001.

	Rio Bueno		Discovery Bay				Runaway Bay		Salem		overall	
			Old Folly		Top Beach							
	mean day^{-1}	total site^{-1}	mean day^{-1}	total site^{-1}	mean day^{-1}	total site^{-1}	mean day^{-1}	total site^{-1}	mean day^{-1}	total site^{-1}	mean day^{-1}	total area^{-1}
Data collection days		41		25		42		24		42		174
days with fishing activity		37		18		31		18		33		137
no fishing activity (due to bad weather)		4		7		11		6		9		37
Active boats censused	4.4	182	2.4	60	3.3	140	2.6	62	5.4	226	3.9	670
Non-motorized	2.8	115	2.1	53	2.0	85	1.3	32	3.0	126	2.4	411
Motorized	1.6	67	0.3	7	1.3	55	1.3	30	2.4	100	1.5	259
Boat captain catches												
Recorded in detail	3.2	131	1.8	46	1.9	80	2.0	47	3.0	124	2.5	428
Trap	2.7	111	1.4	36	1.7	70	1.7	40	1.8	77	1.9	334
Hook and line	0.5	20	0.4	10	0.2	8	0.3	7	0.9	36	0.5	81
Net	-	0	-	0	0.05	2	-	0	0.3	11	0.1	13
Total weight recorded only	0.5	20	-	0	0.4	16	0.3	8	0.6	26	0.4	70
Trap	0.5	19	-	0	0.3	14	0.3	8	0.5	19	0.3	60
Hook and line	-	0	-	0	0.02	1	-	0	0.1	5	0.03	6
Net	0.02	1	-	0	0.02	1	-	0	0.05	2	0.02	4
No data recorded	0.8	31	0.6	14	1.0	44	0.3	7	1.8	77	1.0	178
Share fishers catches (in addition to boat captain's catch)												
Recorded in detail	0.1	3	0.1	2	0.2	9	0.1	3	0.3	14	0.2	30
Trap	0.05	2	0.04	1	0.2	9	0.1	2	0.3	14	0.2	28
Hook and line	0.02	1	0.04	1	-	0	0.04	1	-	0	0.02	3
Total weight recorded only (Trap)	0.02	1	-	0	-	0	0.04	1	0.02	1	0.02	3
Spear fishers catches												
Recorded in detail	-	0	-	0	0.1	5	-	0	0.5	20	0.1	25
Total weight only	-	0	-	0	0.1	3	-	0	0.1	3	0.03	6

missed when a large number of boats landed at the same time. The majority of the boats missed were hook and line fishing; these boats often operated at night (targeting nocturnal reef fish and deep-slope snappers), or in the afternoon (fishing for parrotfish; a small, little known part of the fishery). About 10% of the active boat captains refused to provide data when approached by data collectors.

The spear fishers were heavily under-sampled. Of the estimated 15 spear fishers that operated in the area on average each day, data collectors were able to sample less than 1%. Therefore, estimates of the spear fishing catch are based on a very small sample size.

The Fishers, The Fishing Gear and Fishing Effort

Key characteristics of the fishing community and the fishing gear they use are summarized in Table 2. The estimated fishing effort in the fishery, by gear type, is shown in Table 3.

There were approximately 130 active fishers in the area, almost 60% of them relying on fishing as their only income earning activity. On average, each fisher supported another 4 people on their fishing income. The average age of fishers was 49 years.

Almost 70% of the fishers used fish traps as their primary or secondary gear (Photograph 2). Three mesh sizes were used in wire mesh traps. The most common had 43 mm maximum aperture (32 mm or 1 ¼" between knots) and about 71% of the traps in the fishery were made of this mesh size. Traps with larger 55 mm mesh (38 mm or 1 ½" between knots) were less often used (26% of traps) and traps with 33 mm mesh (25 mm or 1" between knots) were uncommon (3%). The average trap fisher owned about 10 traps. Therefore, there were as many as 900 fish traps in the fishery, about 230 of them made of 1.5" mesh size. However, a significant number of these traps were not actively fishing at any one time, as traps were often brought ashore for repairs or storage (Photograph 3).

About 50% of fishers used hook and line. Hook and line fishers targeted both shallow reef fish stocks and very deep snapper stocks. A small number of fishers used gill nets, about 1 boat per day, setting their nets in shallow reef areas. Net and line fishing boats appeared to spend nearly twice as much time at sea per trip as trap fishing boats.

About 32 fishers were full- or part-time spear fishers. Their enumeration was difficult because they did not usually operate from boats. They tended to not use established landing sites and, instead, entered and left the water anywhere along the shore. A limited set of visual surveys along the coast provided the estimates of fishing effort. Their catch was also difficult to estimate because spearfishers sold their catch at various locations in the communities and many were unwilling to cooperate with data collectors.

Almost two thirds of fishers owned a boat. There were approximately 85 boats (not including derelict boats or boats under repair/construction) that were based at the five landing sites. The average boat size was 6.5 m (20 feet). Over 60% of the boats were small, usually unmotorized wooden canoes about 3 m in length (Photograph 4), while the remaining third of the boats were the standard Jamaican 8 m reinforced fiberglass open canoes, which were powered by outboard engines (usually 35 to 65 hp). The actual number of functioning boats at each site fluctuated somewhat, as some fishers move from

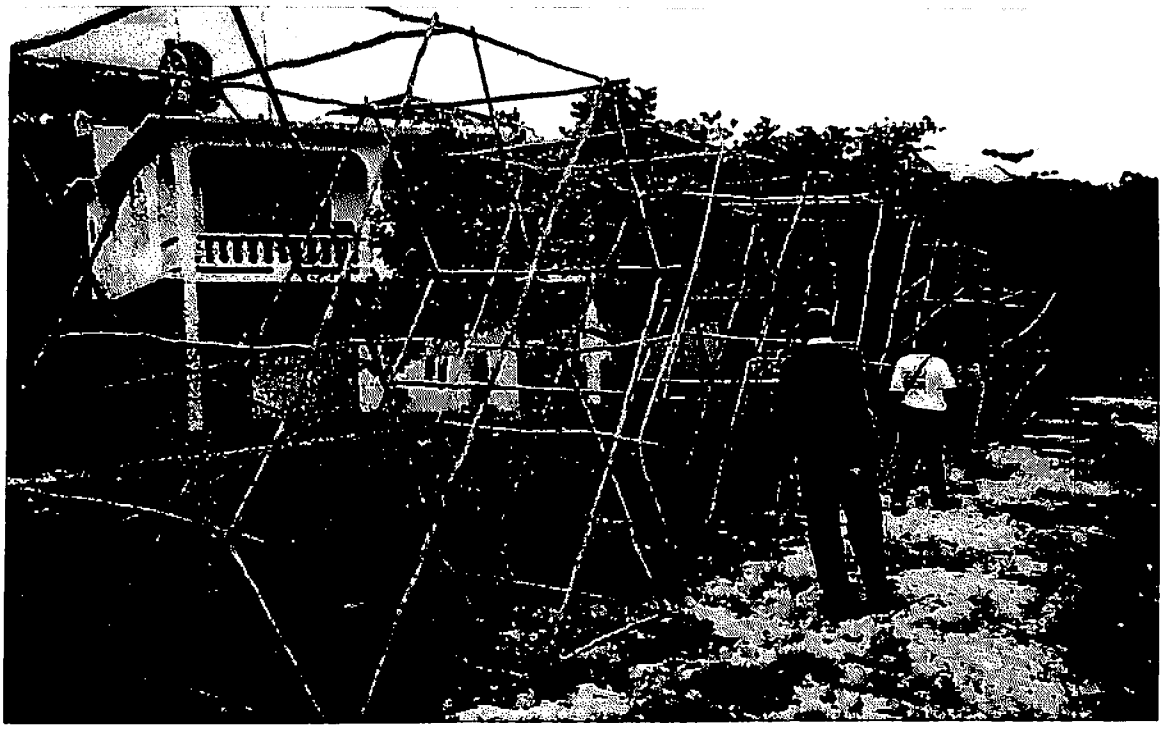
Table 2. The Fishers: Survey of active fishers at five landing sites on the north coast of Jamaica, July 2000 to July 2001.

(Number in survey)	Rio Bueno (19)	Old Folly (13)	Top Beach (24)	Runaway Bay (10)	Salem (33)	Overall (99)
Estimated number of active fishers	30	18	30	15	37	130
Female fishers	1	0	0	1	0	2
Average age	46	52	54	52	45	49
Full time fishers	58%	46%	52%	50%	73%	59%
Boat owners	69%	68%	65%	45%	69%	63%
Average boat length (m)	6.9	5.4	6.4	7.9	6.4	6.5
Boats motorized	36%	36%	33%	80%	61%	47%
Average motor size (hp)	36	8	30	35	29	28
Share fishers (use other fishers' boats)	14%	10%	17%	35%	11%	17%
Does not use boat	17%	22%	18%	20%	20%	19%
Primary fishing gear						
Trap	70%	39%	70%	60%	59%	62%
Line	10%	39%	3%	20%	14%	15%
Net	3%	0%	7%	0%	5%	4%
Spear	17%	22%	20%	20%	22%	20%
Secondary fishing gear						
Trap	5%	8%	8%	20%	3%	7%
Line	42%	15%	42%	40%	33%	35%
Net	0%	15%	4%	0%	9%	6%
Spear	5%	0%	13%	0%	3%	5%
Average number of traps owned by trap fishers	11.9	6.4	7.2	10.9	10.7	9.7
1" mesh traps	0.5	0	0	0	0.5	0.2
1.25" mesh traps	10.9	4.3	4.6	8.6	6.3	7.0
1.5" mesh traps	0.9	2.1	2.6	2.3	3.9	2.5
Estimated total number of active traps in fishery	250	60	170	120	300	900
1" mesh traps	10	0	0	0	20	30
1.25" mesh traps	220	40	110	90	180	640
1.5" mesh traps	20	20	60	30	100	230
Average number of dependent adults per fisher	0.9	1.6	0.7	2.0	1.1	1.1
Average number of dependent children per fisher	2.2	4.3	1.8	3.4	3.6	3.0

Table 3. Fishing effort: Estimated fishing effort at five landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno		Old Folly		Top Beach		Runaway Bay		Salem		overall	
	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total area^{-1} year^{-1}
Functional boats (sea worthy)	15.1		13.7		17.2		13.4		25.7		**95**	
range	*12 - 18*		*9 - 15*		*15 - 18*		*12 - 15*		*22 - 27*		***85-105***	
Active boats (at sea)	4.4	1620	2.4	880	3.3	1220	2.6	940	5.4	1960	**20**	**7300**
upper range	*9*		*5*		*8*		*6*		*14*		***46***	
Active motorized boats	1.6	600	0.3	100	1.3	480	1.3	460	2.4	870	**7.6**	**2800**
Share fishers (catch separate from boat captains)	0.1	40	0.1	30	0.2	70	0.1	50	0.4	130	**0.9**	**300**
Crew (no separate catch)	2.9	1040	0.8	280	0.8	290	1.7	640	1.1	380	**8.0**	**2900**
Trap fishing												
Active boats	3.4	1240	1.6	590	2.3	840	2.1	760	2.7	970	**13**	**4900**
Mean time spent at sea (hours/fisher)	3.7		3.0		2.9		3.5		3.1		**3.3**	
Number of trap hauls	8.1	10,000	4.8	2800	5.4	4600	7.4	5600	8.3	8000	**38**	**34300**
1" mesh traps	0.1	120	0	0	0	0	0	0	0.1	100	**0.2**	**200**
1.25" mesh traps	7.8	9700	3.8	2200	4.7	4000	5.9	4500	7.0	6800	**32**	**30100**
1.5" mesh traps	0.2	250	0.9	500	0.7	600	1.5	1100	1.2	1200	**5.0**	**4000**
Mean soak time (days), 1.25" mesh traps	1.7		3.4		1.9		5.3		2.2		**2.8**	
Mean soak time (days), 1.5" mesh traps	unknown		4.0		6.8		6.2		4.7		**5.2**	
Mean depth (m)	27		20		23		33		27		**27**	
Drop line fishing												
Active boats - drop line fishing	0.9	340	0.8	290	0.8	310	0.5	170	2.1	760	**6**	**2100**
Active boats - trolling*	0.2	55	0.04	15	0.1	25	0.1	30	0.3	120	**0.7**	**270**
Mean time spent at sea (hours/fisher)	5.7		7.4		4.4		5.9		4.1		**5.1**	
Mean depth fished (m) - drop line	129		60		93		104		61		**82**	
Net fishing												
Active boats	0.02	10	0.01	5	0.2	60	0	0	0.6	230	**1**	**340**
Mean time spent at sea (hours/fisher)	unknown		unknown		5.7		0		4.4		**4.5**	
Mean depth fished (m)	unknown		unknown		23		0		14		**15**	
Spear fishing												
Active spearfishers (no boat used)	5.0	1830	1.5	550	2.5	910	2.0	730	3.0	1100	**14**	**5000**
Mean time spent at sea (hours/fisher)	unknown		unknown		2.7		unknown		3.0		**2.9**	
Mean depth fished (m)	unknown		unknown		24		unknown		20		**22**	

* troll line fishing is generally carried out to and from fishing grounds, therefore it is often practiced in addition to other fishing methods.



Photograph 3. Very large "jack" traps are stored on shore awaiting the summer fish season. Rio Bueno fishing beach, Trelawny. June 2001.

Photograph 4. Typical wooden fishing boat, Old Folly fishing beach, Discovery Bay, St. Ann. July 2001.

one site to another, some new boats were brought onto the sites, some old ones were removed, etc. The average number of boats at each site throughout the sampling period, as well as the range, is shown in Table 3.

There were approximately another 10 boats operated in the fishing area but were not based at these landing sites and were based at isolated locations along the coastline. The catches of these boats were not sampled, but they were assumed to operate in a similar fashion as boats at the main landing sites and they were factored in the estimates of total catches.

On an average day, there were about 20 boats fishing on the narrow fringing reef along this 22 km coast line, about 12 of them non-motorized. The 20 boats had approximately 29 people operating from them (captain, share fishers and crew). In addition, about 15 spear fishers were also fishing in the area. This represented over 7000 boat days and over 5000 spear fishing days per year. As mentioned before, many fishers operated more than one gear on each fishing trip.

Trap fishing boats hauled an average of seven traps per fishing trip. Thus, during the estimated 5000 trap fishing trips (or boat days) in the area during the year, nearly 35,000 trap hauls were made. Nearly 90% of the trap hauls were of 1.25" mesh traps and nearly all the rest of the hauls were of 1.5" mesh trap hauls. Small mesh traps were hauled almost twice as often as the larger mesh traps. On average, trap fishers set their traps 27 m deep.

Catch Rates

The catch rates of trap fishing boats are shown in Table 4a and 4b. Table 4a shows the species composition of the boat catches, as well as the value of the catch and Table 4b shows the family composition of the catch.

The average catch of a trap fishing boat (Photograph 5) was 6.1 kg per trip and the average income was $29 a day (all figures in US$; 2001 exchange rate = US$1:J$45); this was shared between the boat captain and his crew. The eastern part of the fishing area appeared to be the most productive, with the largest average catches recorded in Runaway Bay and in Salem. The most important fish species in the catch were *Sparisoma aurofrenatum* and *Acanthurus bahianus,* which together made up 30% of the catch. No other species comprised more than 5% of the catch. A few large groupers, such as *Mycteroperca venenosa*, were still occasionally caught and made up about 1% of the catch (Photograph 6). About 8% of the catch consisted of unmarketable trash fish. The total catch over the entire area by fish traps was just under 30 tons per year, with a value of $140,000.

The catch rates of hook and line fishing is shown in Table 5a and 5b, of net fishing in Table 6a and 6b and of spear fishing in Table 7a and 7b.

The most important species for hook and line fishing was *Selar crumenophthalmus*, which made up 26% of the drop line catches and *Sphyraena barracuda* which comprised 74% of the trolling catches. For net fishing, the top species was *Caranx ruber* (21% of the catch) and for spear fishing it was *Sphyraena barracuda* (31%).

The most lucrative fishing activity appeared to be net fishing, with an average income of $34 per boat trip, but the success of this activity was seasonal when jacks were

Table 4a. Trap fishing: Mean daily catch and estimated total catch (by species), at 5 landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno		Old Folly		Top Beach		Runaway Bay		Sa
	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}
Active boats	3.4	1240	1.6	590	2.3	840	2.1	760	2.7
(Sample size)		(107)		(34)		(69)		(38)	
Catch composition by species	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}
Sparisoma aurofrenatum	1.34	1660	0.75	440	1.18	990	0.93	710	1.06
Acanthurus bahianus	0.81	1000	0.38	220	0.47	400	0.62	470	0.72
Sparisoma chrysopterum	0.32	390	0.39	230	0.18	150	0.53	400	0.36
Ocyurus chrysurus	0.14	180	0.00	0	0.06	50	0.40	300	0.64
Sparisoma rubripinne	0.09	120	0.10	60	0.10	90	0.16	120	0.81
Scarus taeniopterus	0.30	380	0.13	80	0.41	340	0.17	130	0.21
Sparisoma viride	0.10	120	0.17	100	0.18	150	0.25	190	0.41
Acanthurus coeruleus	0.15	190	0.20	120	0.18	150	0.40	300	0.22
Holocentrus rufus	0.22	270	0.07	40	0.14	120	0.24	180	0.26
Haemulon flavolineatum	0.22	270	0.06	30	0.09	80	0.21	160	0.18
Lutjanus apodus	0.11	143	0.03	15	0.05	46	0.13	100	0.23
Gymnothorax moringa	0.11	130	0.09	52	0.03	20	0.25	190	0.27
Caranx ruber	0.11	140	0.05	28	0.03	30	0.49	373	0.10
Balistes vetula	0.08	96	0.00	0	0.03	22	0.20	152	0.16
Mulloidichthys martinicus	0.09	109	0.06	40	0.09	70	0.23	177	0.17
Pseudopeneus maculatus	0.06	80	0.02	10	0.10	86	0.22	160	0.20
Cephalopholis fulva	0.10	130	0.03	20	0.12	104	0.12	90	0.15
Acanthurus chirurgus	0.11	140	0.10	61	0.07	56	0.16	130	0.13
Cephalopholis cruentata	0.10	127	0.03	20	0.07	56	0.16	124	0.15
Scarus iserti	0.06	75	0.07	41	0.12	100	0.16	120	0.12
Lutjanus analis	0.08	96	0.02	10	0.13	112	0.22	170	0.01
Mycteroperca venenosa	0.08	100	0.00	2	0.00	0	0.19	148	0.01
Panulirus argus	0.09	114	0.00	0	0.04	34	0.21	157	0.04
Mithrax spinosissimus	0.00	6	0.08	45	0.01	9	0.23	178	0.00
others (83 species)	0.85	1056	1.04	615	0.49	415	1.88	1428	1.02
TOTAL CATCH	**5.74**	**7100**	**3.86**	**2300**	**4.38**	**3700**	**8.78**	**6700**	**7.62**
Catch composition by value									
quality fish (US$5.90/kg)	0.95	1180	0.55	320	0.66	560	2.80	2130	1.61
common fish (US$4.90/kg)	4.44	5500	2.70	1590	3.55	2980	5.12	3890	5.28
trash fish (no monetary value)	0.35	440	0.61	360	0.17	140	0.86	650	0.73
	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}
TOTAL VALUE (US$)	**$ 27**	**$ 33,900**	**$ 16**	**$ 9,700**	**$ 21**	**$ 17,900**	**$ 42**	**$ 31,600**	**$ 35**

Table 4b. Trap fishing: Mean daily catch and estimated total catch (by fish family), at 5 landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno		Old Folly		Top Beach		Runaway Bay		Salem		OVERALL		
Catch composition by family	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	% of total	kg area^{-1} year^{-1}
Scaridae	2.26	2800	1.60	940	2.18	1830	2.21	1680	2.98	2890	2.34	39%	11500
Acanthuridae	1.07	1330	0.69	410	0.72	600	1.19	900	1.07	1040	0.97	16%	4750
Lutjanidae	0.40	500	0.08	50	0.26	210	0.98	740	0.92	890	0.53	9%	2600
Holocentridae	0.36	450	0.14	80	0.22	180	0.54	410	0.45	430	0.35	6%	1710
Haemulidae	0.31	390	0.21	120	0.17	140	0.49	370	0.31	300	0.29	5%	1430
Serranidae	0.29	360	0.07	40	0.20	170	0.48	370	0.32	310	0.28	5%	1360
Mullidae	0.15	190	0.08	50	0.19	160	0.45	340	0.37	360	0.24	4%	1180
Muraenidae	0.15	190	0.19	110	0.03	20	0.41	310	0.43	420	0.23	4%	1110
Carangidae	0.15	190	0.09	50	0.08	70	0.51	390	0.16	160	0.17	3%	850
invertebrate	0.10	130	0.08	50	0.07	60	0.61	460	0.13	120	0.16	3%	780
Balistidae	0.09	110	0.02	9	0.10	90	0.25	190	0.18	180	0.13	2%	620
Labridae	0.08	100	0.01	7	0.04	30	0.08	63	0.05	50	0.06	0.9%	280
Kyphosidae	0.15	185	0.00	0	0.00	0	0.03	25	0.00	0	0.05	0.9%	260
Diodontidae	0.00	0	0.29	170	0.04	35	0.02	10	0.02	20	0.05	0.8%	220
Pomacentridae	0.03	40	0.07	40	0.01	5	0.11	80	0.06	59	0.045	0.7%	220
Priacanthidae	0.05	60	0.00	3	0.01	5	0.14	110	0.02	20	0.038	0.6%	190
Sparidae	0.01	16	0.00	0	0.02	16	0.04	30	0.05	51	0.026	0.4%	130
Gerridae	0.00	4	0.14	80	0.01	7	0.00	0	0.02	20	0.022	0.4%	110
Monacanthidae	0.01	13	0.00	0	0.01	9	0.05	40	0.03	30	0.019	0.3%	91
Scorpaenidae	0.01	15	0.01	7	0.02	13	0.05	40	0.01	14	0.018	0.3%	87
Ostraciidae	0.01	10	0.01	5	0.01	5	0.03	20	0.02	18	0.013	0.2%	63
Pomacanthidae	0.02	19	0.01	9	0.00	3	0.03	20	0.00	2	0.011	0.2%	53
Grammistidae	0.01	20	0.00	0	0.00	0	0.03	20	0.01	10	0.010	0.2%	47
Sphyraenidae	0.00	0	0.07	42	0.00	0	0.00	0	0.00	0	0.007	0.1%	36
Ephippidae	0.00	0	0.00	0	0.00	0	0.05	40	0.00	0	0.006	0.1%	30
Chaetodontidae	0.00	3	0.01	4	0.00	1	0.00	0	0.01	6	0.003	0.05%	16
Bothidae	0.00	2	0.00	0	0.00	3	0.00	0	0.00	3	0.002	0.03%	10
Aulostomidae	0.01	8	0.00	0	0.00	0	0.00	0	0.00	0	0.002	0.03%	10
Sciaenidae	0.00	0	0.00	2	0.00	2	0.01	8	0.00	0	0.002	0.03%	10
Synodontidae	0.00	5	0.00	2	0.00	0	0.00	0	0.00	0	0.002	0.03%	8
Malacanthidae	0.00	5	0.00	0	0.00	0	0.00	0	0.00	0	0.001	0.02%	7
Mugilidae	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	>0.001	0.01%	2
TOTAL CATCH	5.74	7100	3.86	2300	4.38	3700	8.78	6700	7.62	7400	6.07		29700

Photograph 5. A typical catch from a trap fishing trip. Rio Bueno fishing beach, Trelawny. June 2001.

Photograph 6. A few large groupers, such as these *Mycteroperca venenosa*, are still caught on occasions, and make up 1% of the total trap catch. Swallow Hole fishing beach, Runaway Bay, St. Ann. June 2001.

Table 5a. Hook and line fishing: Mean daily catch and estimated total catch (by species), at 5 landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno		Old Folly		Top Beach		Runaway Bay		Salem		OVERALL		
	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}		total area^{-1} year^{-1}
Active boats - drop line	0.9	340	0.8	290	0.8	310	0.5	170	2.1	760	5.7		2100
(Sample size)		(22)		(12)		(15)		(5)		(29)			(83)
Active boats - troll line	0.15	55	0.04	15	0.07	25	0.08	30	0.33	120	0.74		270
(Sample size)		(6)		(1)		(3)		(2)		(14)			(26)
Catch composition - drop line	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	% of total	kg area^{-1} year^{-1}
Selar crumenophthalmus	0.60	210	0.11	30	0.15	50	0.34	60	1.06	800	0.59	26%	1240
Cephalopholis cruentata	0.32	110	0.14	40	0.23	70	0.55	90	0.38	290	0.31	14%	660
Lutjanus vivanus	0.17	60	0.00	0	0.75	230	0.11	20	0.03	30	0.20	9%	410
Sphyraena barracuda	0.25	90	0.00	0	0.14	40	0.00	0	0.19	140	0.16	7%	330
Holocentrus rufus	0.05	20	0.09	25	0.06	20	0.52	89	0.17	130	0.13	6%	270
Cephalopholis fulva	0.05	18	0.12	30	0.25	78	0.00	0	0.10	80	0.11	5%	240
Tylosurus crocodilus	0.00	0	0.08	20	0.00	0	0.00	0	0.25	191	0.10	4%	210
Etelis oculatus	0.25	80	0.00	0	0.09	29	0.00	0	0.01	7	0.09	4%	180
Sparisoma aurofrenatum	0.01	2	0.53	152	0.00	0	0.00	0	0.00	0	0.08	3%	160
Scomberomorus cavalla	0.23	78	0.00	0	0.00	0	0.00	0	0.00	0	0.06	3%	130
Holocentrus ascensionis	0.01	5	0.05	14	0.01	3	0.00	0	0.12	88	0.05	2%	110
Malacanthus plumieri	0.01	3	0.02	6	0.00	0	0.03	5	0.10	74	0.04	2%	87
Scomberomorus regalis	0.15	53	0.00	0	0.00	0	0.00	0	0.00	0	0.04	2%	86
Caranx lugubris	0.00	0	0.00	0	0.00	0	0.63	107	0.00	0	0.04	2%	80
Haemulon plumieri	0.01	3	0.15	42	0.03	8	0.00	0	0.01	4	0.03	1%	62
others (41 species)	0.16	56	0.63	182	0.17	51	0.39	66	0.12	90	0.23	10%	480
TOTAL drop line catch	**2.28**	**770**	**1.90**	**550**	**1.87**	**580**	**2.57**	**440**	**2.53**	**1920**	**2.26**	**100%**	**4700**
Catch composition - troll line													
Sphyraena barracuda	4.09	220	6.30	90	2.90	70	2.08	60	2.53	300	3.04	74%	820
Scomberomorus cavalla	0.00	0	0.00	0	0.00	0	6.25	190	0.00	0	0.48	12%	130
Tylosurus crocodilus	0.00	0	0.00	0	0.32	10	0.00	0	0.69	80	0.41	10%	110
Thunnus atlanticus	0.00	0	0.00	0	0.00	0	0.00	0	0.29	30	0.16	4%	42
Scomberomorus regalis	0.14	8	0.00	0	0.00	0	0.00	0	0.00	0	0.03	0.8%	9
Cetropomus undecimalis	0.00	0	0.00	0	0.00	0	0.00	0	0.03	3	0.01	0.3%	4
TOTAL trolling catch	**4.23**	**230**	**6.30**	**90**	**3.22**	**80**	**8.33**	**250**	**3.53**	**420**	**4.11**	**100%**	**1110**
TOTAL LINE CATCH (mean)	**2.53**	**1000**	**2.10**	**640**	**1.97**	**660**	**3.45**	**690**	**2.66**	**2340**	**2.45**		**5810**
Catch composition by value													
quality fish (US$5.90/kg)	1.55	612	0.85	258	1.23	412	2.00	400	0.61	534	1.06	43%	2510
common fish (US$4.90/kg)	0.94	371	1.16	352	0.71	238	1.34	268	2.04	1797	1.35	55%	3200
trash fish (no monetary value)	0.04	17	0.10	30	0.03	10	0.11	22	0.05	43	0.05	2%	130
	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}		$ area^{-1} year^{-1}
TOTAL VALUE (US$)	**$ 14**	**$ 5,400**	**$ 11**	**$ 3,200**	**$ 11**	**$ 3,600**	**$ 18**	**$ 3,700**	**$ 14**	**$ 12,000**	**$ 13**		**$ 30,000**

Table 5b. Hook and line fishing: Mean daily catch and estimated total catch (by fish family), at 5 landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno		Old Folly		Top Beach		Runaway Bay		Salem		OVERALL		
Catch composition - drop line	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	**kg boat^{-1} day^{-1}**	**% of total**	**kg area^{-1} year^{-1}**
Carangidae	0.62	210	0.22	60	0.23	70	0.97	160	1.06	800	**0.67**	**30%**	**1400**
Serranidae	0.38	130	0.28	80	0.49	150	0.57	100	0.51	390	**0.44**	**20%**	**920**
Lutjanidae	0.46	160	0.30	90	0.89	280	0.24	40	0.06	40	**0.36**	**16%**	**760**
Holocentridae	0.10	30	0.16	50	0.08	30	0.52	90	0.30	230	**0.20**	**9%**	**420**
Sphyraenidae	0.25	90	0.00	0	0.14	40	0.00	0	0.19	140	**0.16**	**7%**	**330**
Scombridae	0.38	131	0.00	0	0.00	0	0.00	0	0.00	0	**0.10**	**5%**	**210**
Belonidae	0.00	0	0.08	20	0.00	0	0.00	0	0.25	191	**0.10**	**4%**	**210**
Scaridae	0.01	0	0.56	163	0.00	0	0.00	0	0.00	2	**0.08**	**4%**	**180**
Malacanthidae	0.01	3	0.02	6	0.00	0	0.03	5	0.10	70	**0.04**	**2%**	**87**
Haemulidae	0.02	7	0.15	44	0.03	11	0.08	14	0.01	6	**0.04**	**2%**	**87**
Labridae	0.02	5	0.06	16	0.02	5	0.03	4	0.02	12	**0.02**	**1%**	**46**
others (10 families)	0.03	9	0.08	22	0.00	0	0.13	22	0.05	38	**0.04**	**2%**	**91**
total drop line catch	**2.28**	**770**	**1.90**	**550**	**1.87**	**580**	**2.57**	**440**	**2.53**	**1920**	**2.26**	**100%**	**4700**
Catch composition - troll line													
Sphyraenidae	4.09	220	6.30	90	2.90	70	2.08	60	2.53	300	**3.04**	**74%**	**820**
Scombridae	0.14	10	0.00	0	0.00	0	6.25	190	0.29	30	**0.67**	**16%**	**180**
Belonidae	0.00	0	0.00	0	0.32	10	0.00	0	0.69	80	**0.41**	**10%**	**110**
Centropomidae	0.00	0	0.00	0	0.00	0	0.00	0	0.03	0	**0.01**	**0.3%**	**4**
total trolling catch	**4.23**	**230**	**6.30**	**90**	**3.22**	**80**	**8.33**	**250**	**3.53**	**420**	**4.11**	**100%**	**1110**
TOTAL LINE CATCH (mean)	**2.53**	**1000**	**2.10**	**640**	**1.97**	**660**	**3.45**	**690**	**2.66**	**2340**	**2.45**		**5810**

Table 6a. Net fishing: Mean daily catch and estimated total catch (by species), at 5 landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno		Old Folly		Top Beach		Runaway Bay		Salem		OVERALL		
	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}		total area^{-1} year^{-1}
Active boats	0.02	9	0.01	5	0.2	64	0.0	0	0.6	230	**0.9**		**340**
(Sample size)		(0)		(0)		(2)		(0)		(11)			(13)
Catch composition by species	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	% of total	kg area^{-1} year^{-1}
Caranx ruber		(12)		(7)	1.10	71		(0)	1.37	310	**1.32**	**21%**	**450**
Albula vulpes		(6)		(3)	0.00	0		(0)	0.74	170	**0.63**	**10%**	**210**
Haemulon plumieri		(4)		(2)	0.58	37		(0)	0.46	110	**0.48**	**8%**	**160**
Priacanthus cruentatus		(4)		(2)	0.00	0		(0)	0.55	130	**0.46**	**7%**	**160**
Haemulon sciurus		(3)		(2)	0.33	21		(0)	0.30	69	**0.31**	**5%**	**104**
Gerres cinereus		(3)		(1)	0.00	0		(0)	0.34	78	**0.29**	**5%**	**98**
Caranx bartholomei		(3)		(1)	0.00	0		(0)	0.34	77	**0.28**	**4%**	**97**
Sparisoma chrysopterum		(2)		(1)	0.35	23		(0)	0.24	54	**0.25**	**4%**	**86**
Priacanthus arenatus		(2)		(1)	0.00	0		(0)	0.25	58	**0.21**	**3%**	**72**
Scorpaena plumieri		(2)		(1)	0.00	0		(0)	0.24	56	**0.21**	**3%**	**70**
Calamus bajonado		(2)		(1)	0.98	63		(0)	0.03	8	**0.18**	**3%**	**60**
Selar crumenophthalmus		(2)		(1)	0.65	41		(0)	0.09	21	**0.18**	**3%**	**60**
Sphyraena barracuda		(1)		(1)	0.00	0		(0)	0.18	42	**0.15**	**2%**	**52**
Lutjanus mahogoni		(1)		(1)	0.13	8		(0)	0.14	32	**0.14**	**2%**	**47**
Tylosurus crocodilus		(1)		(1)	0.00	0		(0)	0.14	31	**0.12**	**2%**	**39**
Sparisoma rubripinne		(1)		(1)	0.23	14		(0)	0.09	21	**0.11**	**2%**	**38**
Lutjanus synagris		(1)		(1)	0.00	0		(0)	0.13	29	**0.11**	**2%**	**37**
Acanthurus bahianus		(1)		(1)	0.00	0		(0)	0.12	28	**0.10**	**2%**	**35**
Sparisoma viride		(1)		(1)	0.00	0		(0)	0.12	27	**0.10**	**2%**	**34**
Mulloidichthys martinicus		(1)		(0)	0.15	10		(0)	0.07	17	**0.09**	**1%**	**29**
Haemulon parrai		(1)		(0)	0.00	0		(0)	0.09	20	**0.07**	**1%**	**25**
Rypticus saponaceus		(1)		(0)	0.00	0		(0)	0.08	19	**0.07**	**1%**	**24**
Lutjanus apodus		(1)		(0)	0.00	0		(0)	0.09	22	**0.08**	**1%**	**26**
Ocyurus chrysurus		(0)		(0)	0.00	0		(0)	0.08	18	**0.05**	**1%**	**18**
others (17 species)		(3)		(2)	0.38	24		(0)	0.37	84	**0.37**	**6%**	**125**
TOTAL CATCH		**(56)**		**(32)**	**4.85**	**310**		**(0)**	**6.65**	**1530**	**6.34**	**100%**	**2160**
Catch composition by value													
quality fish (US$5.90/kg)		(33)		(19)	2.28	150		(0)	4.02	920	**3.72**	**59%**	**1260**
common fish (US$4.90/kg)		(23)		(13)	2.57	170		(0)	2.54	590	**2.55**	**40%**	**870**
trash fish (no monetary value)		(1)		(0)	0.00	0		(0)	0.09	20	**0.08**	**1%**	**30**
	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat^{-1} day^{-1}	$ site^{-1} year^{-1}	$ boat day^{-1}		$ area^{-1} year^{-1}
TOTAL VALUE (US$)	**$ -**	**$ 310**	**$ -**	**$ 170**	**$ 26**	**$ 1,700**	**$ -**	**$ -**	**$ 36**	**$ 8,300**	**$ 34**		**$ 11,700**

Table 6b. Net fishing: Mean daily catch and estimated total catch (by fish family), at 5 landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno		Old Folly		Top Beach		Runaway Bay		Salem		OVERALL		
Catch composition by family	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	kg site^{-1} year^{-1}	kg boat^{-1} day^{-1}	% of total	kg area^{-1} year^{-1}
Carangidae		(16)		(9)	1.75	110		(0)	1.81	420	**1.79**	**28%**	**610**
Haemulidae		(8)		(4)	0.90	60		(0)	0.88	200	**0.88**	**14%**	**300**
Priacanthidae		(6)		(3)	0.00	0		(0)	0.80	180	**0.68**	**11%**	**230**
Albulidae		(6)		(3)	0.00	0		(0)	0.74	170	**0.63**	**10%**	**210**
Scaridae		(5)		(3)	0.73	50		(0)	0.53	120	**0.56**	**9%**	**190**
Lutjanidae		(4)		(2)	0.13	10		(0)	0.51	120	**0.43**	**7%**	**150**
Gerridae		(3)		(1)	0.00	0		(0)	0.34	80	**0.29**	**5%**	**100**
Scorpaenidae		(2)		(1)	0.00	0		(0)	0.24	60	**0.21**	**3%**	**70**
Sparidae		(2)		(1)	0.98	60		(0)	0.03	10	**0.18**	**3%**	**60**
Acanthuridae		(1)		(1)	0.18	10		(0)	0.16	40	**0.16**	**3%**	**55**
Sphyraenidae		(1)		(1)	0.00	0		(0)	0.18	40	**0.15**	**2%**	**52**
Belonidae		(1)		(1)	0.00	0		(0)	0.14	30	**0.12**	**2%**	**39**
Mullidae		(1)		(0)	0.15	10		(0)	0.08	20	**0.09**	**1%**	**32**
Grammistidae		(1)		(0)	0.00	0		(0)	0.08	20	**0.07**	**1%**	**24**
Serranidae		(1)		(0)	0.00	0		(0)	0.07	20	**0.06**	**1%**	**21**
Scombridae		(0)		(0)	0.00	0		(0)	0.03	10	**0.03**	**0.4%**	**9**
Exocoetidae		(0)		(0)	0.00	0		(0)	0.02	0	**0.01**	**0.2%**	**5**
Holocentridae		(0)		(0)	0.00	0		(0)	0.01	0	**0.01**	**0.2%**	**4**
Pomacanthidae		(0)		(0)	0.05	0		(0)	0.00	0	**0.01**	**0.1%**	**3**
TOTAL CATCH		**(56)**		**(32)**	**4.85**	**300**		**(0)**	**6.65**	**1500**	**6.34**	**100%**	**2160**

Table 7a. Spear fishing: Mean daily catch and estimated total catch (by species), at 5 landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno		Old Folly		Top Beach		Runaway Bay		Salem		OVERALL		
	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}	total site^{-1} year^{-1}	day^{-1}		total area^{-1} year^{-1}
Active fishers	5	1830	1.50	550	2.5	910	2	730	3	1100	**14**		**5100**
(Sample size)		(0)		(0)		(5)		(0)		(19)			(24)
Catch composition by species		kg site^{-1} year^{-1}		kg site^{-1} year^{-1}	kg fisher^{-1} day^{-1}	kg site^{-1} year^{-1}		kg site^{-1} year^{-1}	kg fisher^{-1} day^{-1}	kg site^{-1} year^{-1}	**kg fisher^{-1} day^{-1}**	**% of total**	**kg area^{-1} year^{-1}**
Sphyraena barracuda		(2600)		(770)	0.00	0		(1020)	1.78	1960	**1.40**	**31%**	**7100**
Sparisoma viride		(990)		(300)	0.13	120		(400)	0.65	720	**0.54**	**12%**	**2800**
Sparisoma rubripinne		(630)		(190)	0.38	350		(250)	0.34	370	**0.35**	**8%**	**1800**
Priacanthus cruentatus		(460)		(140)	0.30	270		(180)	0.24	260	**0.25**	**6%**	**1300**
Sparisoma chrysopterum		(370)		(110)	0.43	390		(150)	0.14	160	**0.20**	**5%**	**1040**
Pseudopeneus maculatus		(370)		(110)	0.35	320		(150)	0.16	180	**0.20**	**4%**	**1020**
Cephalopholis cruentata		(360)		(110)	0.30	270		(150)	0.17	190	**0.20**	**4%**	**1020**
Acanthurus coeruleus		(360)		(110)	0.21	190		(140)	0.19	210	**0.19**	**4%**	**990**
Sparisoma aurofrenatum		(300)		(91)	0.20	180		(120)	0.16	170	**0.17**	**4%**	**850**
Panulirus argus		(250)		(74)	0.09	82		(100)	0.15	160	**0.14**	**3%**	**690**
Cephalopholis fulva		(200)		(61)	0.31	280		(81)	0.06	64	**0.11**	**2%**	**570**
Scarus taeniopterus		(190)		(58)	0.51	460		(78)	0.00	0	**0.11**	**2%**	**540**
Haemulon sciurus		(150)		(45)	0.32	290		(59)	0.02	20	**0.08**	**2%**	**410**
Lutjanus apodus		(140)		(43)	0.00	0		(57)	0.10	110	**0.08**	**2%**	**400**
Haemulon carbonarium		(120)		(36)	0.12	110		(48)	0.05	57	**0.07**	**1%**	**340**
Caranx ruber		(110)		(33)	0.00	0		(43)	0.08	83	**0.06**	**1%**	**300**
others (20 species)		(670)		(200)	0.51	470		(270)	0.33	360	**0.37**	**8%**	**1900**
TOTAL CATCH		**(8200)**		**(2500)**	**4.17**	**3800**		**(3300)**	**4.61**	**5100**	**4.50**	**100%**	**23000**
Catch composition by value													
quality fish (US$5.90/kg)		(3770)		(1130)	0.92	840		(1500)	2.37	2610	**2.06**	**46%**	**10500**
common fish (US$4.90/kg)		(4420)		(1330)	3.19	2900		(1760)	2.21	2430	**2.41**	**54%**	**12310**
trash fish (no monetary value)		(60)		(20)	0.06	50		(20)	0.02	20	**0.03**	**1%**	**160**
		$ site^{-1} year^{-1}		$ site^{-1} year^{-1}	$ fisher^{-1} day^{-1}	$ site^{-1} year^{-1}		$ site^{-1} year^{-1}	$ fisher^{-1} day^{-1}	$ site^{-1} year^{-1}	**$ fisher^{-1} day^{-1}**		**$ area^{-1} year^{-1}**
TOTAL VALUE (US$)		**$ 44,000**		**$ 13,000**	**$ 21**	**$ 19,200**		**$ 17,000**	**$ 25**	**$ 27,300**	**$ 24**		**$ 122,000**

Table 7b. Spear fishing: Mean daily catch and estimated total catch (by fish family), at 5 landing sites on the north coast of Jamaica, July 2000 to July 2001.

	Rio Bueno	Old Folly	Top Beach		Runaway Bay	Salem		OVERALL		
Catch composition by family	kg site^{-1} year^{-1}	kg site^{-1} year^{-1}	kg fisher^{-1} day^{-1}	kg site^{-1} year^{-1}	kg site^{-1} year^{-1}	kg fisher^{-1} day^{-1}	kg site^{-1} year^{-1}	**kg fisher^{-1} day^{-1}**	**% of total**	**kg area^{-1} year^{-1}**
Sphyraenidae	(2549)	(765)	0.00	0	(1020)	1.78	1960	**1.40**	**31%**	**7140**
Scaridae	(2516)	(755)	1.65	1510	(1006)	1.31	1440	**1.38**	**31%**	**7050**
Serranidae	(566)	(170)	0.61	560	(226)	0.23	250	**0.31**	**7%**	**1580**
Priacanthidae	(455)	(137)	0.30	270	(182)	0.24	260	**0.25**	**6%**	**1280**
Mullidae	(422)	(127)	0.46	420	(169)	0.17	190	**0.23**	**5%**	**1180**
Acanthuridae	(419)	(126)	0.25	230	(168)	0.22	250	**0.23**	**5%**	**1170**
Haemulidae	(325)	(98)	0.47	430	(130)	0.10	110	**0.18**	**4%**	**910**
invertebrate	(300)	(90)	0.23	210	(120)	0.15	160	**0.16**	**4%**	**840**
Lutjanidae	(217)	(65)	0.00	0	(87)	0.15	170	**0.12**	**3%**	**610**
Holocentridae	(116)	(35)	0.16	150	(46)	0.04	42	**0.06**	**1%**	**320**
Carangidae	(109)	(33)	0.00	0	(43)	0.08	83	**0.06**	**1%**	**300**
Labridae	(65)	(19)	0.00	0	(26)	0.04	49	**0.04**	**0.8%**	**180**
Scorpaenidae	(34)	(10)	0.00	0	(14)	0.02	26	**0.02**	**0.4%**	**96**
Synodontidae	(34)	(10)	0.00	0	(14)	0.02	26	**0.02**	**0.4%**	**96**
Ephippidae	(30)	(9)	0.00	0	(12)	0.02	23	**0.02**	**0.4%**	**85**
Gerridae	(27)	(8)	0.03	27	(11)	0.01	12	**0.01**	**0.3%**	**75**
Monacanthidae	(21)	(6)	0.00	0	(9)	0.01	16	**0.01**	**0.3%**	**60**
Pomacanthidae	(11)	(3)	0.00	0	(5)	0.01	9	**0.01**	**0.1%**	**32**
TOTAL CATCH	**(8200)**	**(2500)**	**4.17**	**3800**	**(3300)**	**4.61**	**5100**	**4.50**	**100%**	**23000**

more common in the fishing area. Also, several net fishers were, in fact, spear fishers using nets and boats; when they operated their nets, they swam around herding fish into it and spearing any fish too large to be gilled in the net (drive netting). This activity was very labour intensive and required physical endurance. Nonetheless, given the relatively high catch rates per boat, it was not clear why more fishers did not take up net fishing.

Line fishing was the least rewarding fishing activity with fishers making less than $15 per trip, though this type of fishing was still popular since it was the least gear- and labour-intensive of all the fishing practices. The estimated catch of all drop line fishers was about 4.7 tons per year, with a value of $25,600. Troll lines yielded a total of 1.1 tons, valued at $5,600. Net fishing yielded 2.2 tons per year, with a value of $11,700. Spear fishers were estimated to land 23 tons, with a value of $122,000.

Economic Analyses

The total catch of all fishing in the study area was about 60 tons per year, worth about $300,000. Shared among the approximately 130 active fishers in the area, it represented a yearly income of less than $2400 per year for the average fisher.

The value of the total catch was relatively high because of the high demand for fish in Jamaica. During the study period, fish were sold on the fishing beaches directly to the consumers and occasionally to vendors, in two categories. The "quality" fish were sold for $5.90/kg (J$120/lb) and usually included groupers, snappers, goatfish, jacks, large grunts, most pelagic predators (such as Spanish mackerel and wahoo) and lobsters. In fact, almost any large fish was rated as "quality" and small "quality" fish were downgraded to "common". "Common" fish included most of the other reef species, such as parrotfish, surgeonfish, angelfish, small grunt and crabs, which were sold for $4.90/kg (J$100/lb). Unmarketable "trash" fish included moray eels, scorpion fish, file fish and very small fish. These were generally kept by the fisher for home consumption or given away to indigent persons or to people who helped pull the boats up on shore.

The cost of entering and remaining in the fishery was high, except for spear fishing, primarily due to the capital needed to obtain and maintain a boat. The initial costs ranged from $800 to $8000, depending on whether a new or second hand boat and engine were bought. Plywood boats were the least expensive at about $400 to $900, while fiberglass boats cost over $4000 new. Dugout canoes were rare due to the scarcity of large accessible cottonwood trees. Large fiberglass boats needed large engines (35 to 65 hp) which cost up to $3600 new. Some of the wooden boats were motorized with small engines (e.g. 4 to 10 hp, cost up to $1250) but most were not.

Other costs of fishing depend on the method involved. For trap fishing, the materials needed are mesh wire, sticks, nails, lacing wire and rope and these materials cost about $30 to $50 per trap, depending on the size of the trap and the type of mesh wire used. Most fishers built their own traps, but some hired others to build them. With ongoing repairs, fish traps could last about a year before they needed to be replaced, though many were lost at sea sooner than that because of storms, careless setting near the reef drop-off, or theft. Trap fishers seemed to set their traps very deep and often unmarked, perhaps to avoid theft or poaching by spear fishers. These practices tended to increase the number of lost traps. Owners of motorized boats also needed to purchase fuel, which of course varied depending on the size of the boat and engine, the condition of the engine, the

frequency of fishing trips, the number of traps hauled and the distance the traps were set away from the beach.

Drop line fishers could expect to spend about $50-$200 for gear per year (fishing line, hooks). Bait was often caught by the fisher himself or bought at sea from another fisher. Troll fishers may have spent money on artificial bait ($5-$10 each) and a great deal on fuel. For this reason, trolling was not commonly practiced, except when moving between fishing grounds to operate other fishing gear. Net fishers, who usually used gill nets of 50 mm (2") to 100 mm (4") mesh size, would spend between $100 to $200 (about 12 kg of net) on average per year.

Changes In Catch Rates Over Time

Changes in the catch rates of 1.25" mesh fish traps between three 12-month periods in 1996, 1997 and 2000/01 are shown in Table 8. The catches were relatively stable over this time period, with the average catch of under 1 kg per trap haul. Mean soak time also remained stable at just under 3 days between hauls for the 1.25" mesh traps.

There did appear to be a very slight increase in fish trap catch rates, both in weight and number of fish, over the five year period, but only the increase in the number of fish between 1996 and 2000-2001 was likely significant. The increase in the catch appeared to be due to an increasing number of small fish in the catch, especially small parrotfish. As a result, the average fish size in the catch actually decreased over the time period, especially those of parrotfish, but also other groups such as grunts and groupers.

The value of the catch (in 2001 dollar values) also increased slightly but it was still only a little more than $4 per trap haul. The total weight of high quality fish actually decreased from 1996 to 2000/01 and there were more lower valued (common) species in the catch than earlier. The average fish size in all commercial categories also decreased.

DISCUSSION

This survey yielded an estimated total catch of demersal and neritic pelagic species of 60,770 kg by the five fishing beaches. This included 29,700 kg landed in traps, 5410 kg on lines, 2160 kg in nets and 23,000 kg taken by spearfishers, all taken from a total shelf area of 12 km^2. The harvest was therefore estimated to be 5 tons/km^2.

These harvests per km^2 are very high by Caribbean standards, but not by those of Pacific coral reef systems (Munro 1984). However, the numerous surveys of the fishery, from 1968, 1990/94, 1996/97 and 2000/01, have provided consistent estimates of catches and there appear to be no reasons for challenging their accuracy.

The Jamaican north coast reefs are known to be one of the most overfished reefs in the Caribbean. This study confirmed that the fishing pressure on these reefs is enormous. Each and every day, on average, over 40 fishers scoured the narrow fringing reef along this 22 kms of coastline; almost 30 people pulling fish traps, nets and fishing lines from boats, another 15 people in the water using spear guns. This amounted to over sixteen thousand fishing trips over the course of the year, all in search of fish within this 12 km^2 fishing area. This figure included only active fishers known to operate regularly in the fishery and did not include an unknown number of recreational fishers who may have cast a line from the rocky shores along the coastline. Jamaica's north coast reefs have been enduring intense fishing pressure like this for decades.

Table 8. Comparison of catch rates, fish sizes and catch values in 1.25" mesh traps in 1996, 1997 and 2000-01 in the study area on the north coast of Jamaica.

	Weight per trap			Number of fish per trap			mean fish size		
	1996	1997	00-01	1996	1997	00-01	1996	1997	00-01
number of catches sampled	(110)	(44)	(278)						
number of traps reported	(672)	(279)	(1832)						
Catch composition by family	grams trap^{-1} haul^{-1}			fish trap^{-1} haul^{-1}			grams		
Scaridae	244	349	355	2.0	2.7	3.6	123	128	99
Acanthuridae	153	197	153	1.8	2.4	1.7	87	82	89
Holocentridae	50	73	51	0.6	0.8	0.5	84	90	94
Mullidae	18	26	49	0.1	0.2	0.4	142	162	127
Lutjanidae	80	34	48	0.3	0.1	0.2	245	352	295
Haemulidae	58	40	42	0.4	0.3	0.4	144	119	116
Balistidae	30	3	41	0.1	0.03	0.1	537	118	627
Serranidae	39	35	39	0.2	0.2	0.3	193	150	137
Muraenidae	48	28	36	0.03	0.04	0.1	1511	635	709
invertebrate	7	11	16	0.01	0.02	0.03	494	655	536
Carangidae	10	25	14	0.1	0.2	0.1	178	146	202
Pomacentridae	14	5	10	0.2	0.1	0.1	69	85	74
Kyphosidae	6	-	10	0.01	-	0.01	460	-	706
Labridae	1	5	8	0.01	0.04	0.1	120	120	123
Diodontidae	9	29	6	0.01	0.03	0.01	728	1087	1060
Scorpaenidae	7	3	5	0.02	0.01	0.01	353	423	529
Priacanthidae	5	2	4	0.04	0.01	0.04	130	130	100
Sparidae	8	-	4	0.01	-	<0.01	850	-	1105
Ostraciidae	3	1	3	0.01	0.01	0.01	239	225	243
Gerridae	7	2	2	0.03	0.01	0.01	240	175	232
Monacanthidae	2	-	2	0.02	-	0.01	155	-	285
Pomacanthidae	5	2	2	0.03	0.02	0.02	157	84	78
Grammistidae	1	-	1	<0.01	-	<0.01	257	-	235
Chaetodontidae	0.5	3	1	0.01	0.1	0.01	49	55	57
Aulostomidae	0.2	-	0.2	<0.01	-	<0.01	250	-	650
Sciaenidae	0.2	-	0.2	<0.01	-	<0.01	80	-	109
Bothidae	-	-	0.1	-	-	<0.01	-	-	225
Synodontidae	1	-	0.1	0.01	-	<0.01	150	-	400
Malacanthidae	-	0.3	0.1	-	<0.01	<0.01	-	100	450
Mugilidae	-	-	<0.1	-	-	<0.01	-	-	110
Dactylopteridae	-	0.4		-	<0.01	-	-	150	-
total	**806**	**873**	**903**	**6.0**	**7.3**	**7.6**	**135**	**120**	**119**
standard error	(96)	(109)	(46)	(0.6)	(0.8)	(0.4)	-	-	-
Catch composition by value									
quality	155	96	140	0.7	0.5	0.7	217	205	197
common	559	691	683	4.8	6.4	6.4	117	108	106
trash	92	86	79	0.5	0.4	0.5	201	201	173
Catch value	US$ trap^{-1} haul^{-1}								
	$ 3.66	**$ 3.96**	**$ 4.17**	-	-	-	-	-	-

Predictably, the rewards for this huge effort are very small. On the north coast in 2000/01, a Jamaican fisher could expect to make on average little more than $200 a month (equals a daily average of $6 including non-fishing days). From this, he had to purchase fishing gear, pay for fuel and support a family of (on average) five people. Most people nonetheless remain in the fishery to either supplement other incomes or simply because they have no other alternative. Fishing is given up or reduced when a person had better opportunities elsewhere and resumed or intensified when times are bad. As a result, the number of fishers using an area can fluctuate substantially over time. Multiple occupations are common in the Caribbean and allow people to increase their economic security (Polunin *et al* 2000).

Although a fisher's net income is low, it is not much lower than the income of those working in other industries, such as tourism. A waiter in a hotel can expect to earn $15 a day and a scuba-diving guide makes $12-20 a day. Day labourers can make about $8-15 a day (Polunin *et al* 2000, P. Gayle *pers comm*). However, other jobs are scarce in the area and, in any case, many fishers do not wish to work in other industries as other jobs do not allow the same independence in working as does fishing.

A number of non-fishers earned money on the fishing beaches, for example, by scaling and cleaning fish (which earned about $0.50 per pound of fish cleaned) and fish vending (purchasing fish on the beach and taking it to markets or buyers' houses to sell at a profit, again about $0.50 per pound). Moreover, at all beaches there were small businesses - shops, bars and restaurants - that relied on the presence of people on the fishing beaches. Most of these businesses bought fish from local fishers and served it to their customers, ensuring a small but steady market for the catch. They also sold other food and drink to fishers and to those people visiting the beaches to purchase fish, or to swim.

Even though Jamaica has an open access fishery, it has been argued that in practice, fishing is not necessarily free for all (Berkes 1987). Fishing beaches are said to act as a kind of territorial system, where fishers must set their traps close to their beach or risk losing them and a person wishing to fish from a beach must first be acceptable to the community of fishers who use it. At the same time, many fishers spent little time on their fishing beach beyond what was necessary to set off for and return from their fishing and hence had little social interaction with other fishers. Social cohesion on the fishing beaches appeared to be weak and there was little evidence of it limiting fishing effort in any substantial way. Because the entire area is heavily fished, there appeared to be little incentive to travel many kilometres from their home beaches.

A much more powerful force limiting fishing effort was the financial costs of entering fishing. These costs were high for all fishing types, except spear fishing, because of the capital needed to obtain a boat, either new or second hand. Most fishers would have liked to own a 27' fiberglass boat because it could last over 20 years and could increase the fisher's status among his peers. However, wooden boats were much more common because they were cheaper to buy and they could be rowed around without the need for an engine. The initial cost of entering the fishery was 40-360% of the annual average income of a fisher.

Owing to the high cost of owning a boat and to locally high unemployment rates, many young men have entered the fishery in recent years as spear fishers. Spear fishing was almost non-existent in the 1960's (Nembhard 1970, J.D. Woodley *pers comm*), yet

by 2000/01, spear fishers landed an estimated 40% of the total catch in the area. The continually increasing number of spear fishers on the fishing grounds and their apparent ability to land a higher proportion of quality fish that other less selective gear types in the fishery, had led to escalating distrust, tension and conflict between spear fishers and the rest of the fishing community.

The Discovery Bay area fishery was the target of numerous management attempts during the 1990's, with the aim of improving fishers' livelihood, restoring the coral reef fish communities and addressing the ecosystem collapse that the reefs experienced on this coast. The University of the West Indies had attempted to address some of these problems, with backing from various local, industrial and international donors (Woodley and Sary in press, Woodley *et al* in press). However, progress had been difficult due to the huge problems facing would-be fishery managers, such as the high levels of distrust and conflict among fishers, widespread illiteracy and unemployment in the communities and lack of a traditional culture of community-based resource management in the country.

Nevertheless, there appeared to be a small increase in the catch rates in the fishery between 1996 and 2000/01. One possible cause of these observed changes may have been the management measures which were implemented in this fishery over the previous years. The Discovery Bay Fishery Reserve was established in 1996 and may have had a positive impact on local catches by delaying the size and age of recruitment to the fishery of certain fish groups that use the Reserve as a nursery area (Munro 2000).

The trap catch rates might have also benefited from the move to larger mesh sizes for the traps, encouraged by UWI with mesh exchange programs in 1991 (in Discovery Bay) and 1996/97 (in Rio Bueno, Runaway Bay and Salem). The proportion of large mesh traps (26%) in 2000/01 was much higher then when the mesh exchange began at Discovery Bay (6%), while the total number of traps in use has not increased and may have declined. The decrease in the number of small mesh fish traps after the mesh change may have reduced fishing mortality on small round bodied species, which would have benefited most from such a change in gear (Sary *et al* 1997). Unfortunately, the fishers gradually moved back to using small mesh traps and in 2000/01 appeared to be harvesting the increased number of small individuals which may have recruited to the fishery.

In any case, it is very difficult to pinpoint causes for changes in the catch rates; the differences over time may not be statistically significant because of the high variability normally observed in trap catches. Also, the fish stocks are exploited by numerous other gear types and the fluctuations in their catch were not examined. There are numerous other biological and human factors that may have impacted the reef ecosystem as well, such as the gradual return of the sea urchin ,*Diadema antillarum*, to the reef and signs of coral recovery in the area (Edmunds and Carpenter 2001, Cho and Woodley in press).

Despite the very high fishing effort, the reefs on this coast have remained surprisingly productive. The estimated total catch of 60 metric tones in the study area represents about 5 tons/km^2 of reef, which was near the high end of production estimates for Caribbean reefs (e.g. Munro 1983). The fishery directly supported at least 600 people and the fish caught continued to provide a valuable food source for a growing population in the area. However, if the fishery were meaningfully managed, i.e. fishing effort were somehow reduced, it could produce a larger and much better quality catch and offer an

improved livelihood to those remaining in it. Escape gaps for traps may offer one feasible management option for overexploited trap fisheries in the Caribbean (Munro *et al* in press). Given the escalating economic and political problems facing Jamaica, however, fishing will likely continue to be the employment of last resort for Jamaica's poor.

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