Status Report on a Jamaican Reef Fishery: Current Value and the Costs of Non-management

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ABSTRACT

The reef fishery on the north coast of Jamaica is one of the most intensely overfished in the Caribbean. Discovery Bay lies in the center of the north coast and the reef fishery there is typical of the rest of the fishery on this coast, with a narrow, accessible fishing ground which provides food and employment to large numbers of people, despite its overexploited state.

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 necessary measures. The University of the West Indies has implemented several management measures on a small scale around Discovery Bay but these have not been applied on a wider scale.

This paper provides an updated status report of the reef fishery on a segment of the north coast with a fishing area of about 12 km^2. We estimate current fishing effort to be over 7000 boat trips per year using traps, lines, or nets. In addition, over 5000 spear fishing trips are made per year. The average income is between US$13 and $29 per trip. The total catch in the study area is about 60 tons per year, worth about $300,000. Despite its overexploited state, the productivity of the reef remains high with an estimated yield of 5 tons km^{-2}.

We estimate that the cost to Jamaica over the past 25 years of not managing its fisheries on the north and south coast is around $1.3 billion. Managing small-scale multi-species fisheries is undoubtedly difficult, but the figures here suggest that it is surely worth the effort.

KEY WORDS: Jamaica, small-scale fishery, valuation

Informe sobre el Estado de una Pesquería de Arrecife en Jamaica: Valor Actual y Costa de No-manejo

La pesquería del arrecife en la costa norte de Jamaica es una de la más intensamente explotada del Caribe, un hecho que se ha reconocido durante décadas. Discovery Bay esta ubicado en el centro de la costa norte y la pesquería del arrecife

ICLARM Contribution # 1645

aquí es típica para el resto de la pesquería en esta costa. Los arrecifes se encuetran en una plataforma submarina muy estrecho, accesible. El crecimiento alto de la población humana y las intensas presiones económicas han atraído un gran número de personas en la pesquería, representando una fuente importante de alimento y de empleo, a pesar de su estado de sobre-explotación.

Hace un cuarto de siglo, se sugirieron medidas de manejo para reconstruir los stocks de peces. Sin embargo, el gobierno central no ha sido capaz de introducir tales medidas. La Universidad de las Indias Occidentales ha implementado varios medidas de manejo de pequeña escala alrededor de Discovery Bay, como la introdución de una luz de malla más grande en las trampas pesqueras, y una asistencia en el establecimiento de la reserva pesquera Discovery Bay Fishery Reserve. A pesar de éxitos locales, éstas estrategias de manejo no se han aplicado en una escala más grande.

Este artículo presenta un informe del estado actualizado de la pesquería del arrecife en un segmento de la costa de 20 km adyacente a Discovery Bay. Se evaluó el esfuerzo actuál de la pesca, la captura por unidad de esfuerzo, la composición en especies y el valor global de la pesquería. Se examinan cambios en las capturas durante los últimos cinco años. Se efectuaron estimaciones de la costa a Jamaica por no haber manejado la pesquería en los últimos 25 años.

PALABRAS CLAVES: Jamaica, pesquería, valor actual

INTRODUCTION

The reefs on the north coast of Jamaica are often recognized as one of the most intensively overfished shallow coralline reef areas in the Caribbean. This widespread recognition of the problem is largely due to over 30 years of research on the reefs of Discovery Bay and numerous publications reporting the lack of fish (Munro 1983, Aiken and Haughton 1987, Hughes 1994, Picou-Gill et al. 1996). This paper provides an updated status report on the fishery in the Discovery Bay area and compares current fishing effort and catch rates to historical figures.

Discovery Bay lies in the center of the north coast of Jamaica and the reef fishery there is typical of those along the entire coast. The coral reefs lie on a very narrow, accessible submarine shelf. The coral reef fishery here 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, has drawn large numbers of people into the fishery.

There are a variety of strategies that have been suggested for the management of the Jamaican reef fisheries (Munro 1983), and there are several reviews of these options (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 (UWI), 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. However, little has been done at a national level. Fishers all agree that the fishery is declining but economic factors have led them to intensifying fishing effort over the years (Aiken and Haughton 1987), rather than reducing it.

METHODS

Collection of Catch and Effort Data

Catch and effort data in the Jamaican north coast artisanal reef fishery were 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; Swallow Hole in Runaway Bay; and Salem; Figure 1) three or four times a week, on randomized pre-determined days. To encourage cooperation from fishers, inducements were offered in the form of one ticket in a raffle for every 10 kg of detailed catch data provided, or one ticket for 25 kg of aggregated catch data.

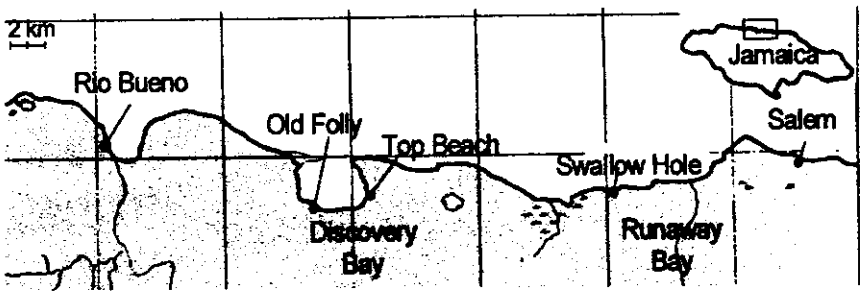

Figure 1. Map of Jamaica, showing study area and the five landing sites.

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.

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) in the catch were recorded separately for all consenting fishers. 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.

A detailed formal survey was 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, number of dependents, primary and secondary gear used, the size of boats and engines used, and the number of fish traps of various mesh sizes and other gears in use in the fishery.

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 >30 m deep, which is too deep to be fished and is not coralline. Full details of the survey and the data collection and analyses are provided by Sary (2001).

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) and Sary et al (1997).

RESULTS

The Fishers, Fishing Gear and Fishing Effort

Key characteristics of the fishing community, the fishing gear used and the effort expended are summarized in Table 1. There are about 130 active fishers in the area, almost 60% of them relying on fishing as their sole income earning activity. On average, each fisher supports another 4 people. The average age of fishers is 49 years.

There are approximately 85 boats (not including derelict boats or boats under repair/construction) that are based at the five landing sites and ten boats that are based at isolated locations along the coastline but operate in the fishing area, in a similar fashion to boats at the main landing sites. Almost two thirds of fishers own a boat. The average boat size is 6.5 m. The majority of the boats are small, usually unmotorized wooden canoes about 3 m in length, while the remaining third of the boats are the standard Jamaican 8 m reinforced fiberglass open canoes, which are powered by outboard engines (usually 35 to 65 hp).

Almost 70% of the fishers use fish traps as their primary or secondary gear. Three mesh sizes are used in wire mesh traps. The most common has 43 mm maximum aperture (32 mm or 1 ¼" between knots), and about 71% of the traps in the fishery are made of this mesh size. Larger 55 mm mesh (38 mm or 1 ½" between knots) are less often used (26% of traps) and 33 mm (25 mm or 1" between knots) are now uncommon (3%).

On an average day there are about 20 boats fishing on the narrow fringing reef along this 26 km shelf, about 12 of them non-motorized. They have approximately

29 people operating from them (captain, share fishers, and crew). In addition, about 15 spear fishers are also fishing in the area each day. This represents over 7000 boat days per year, and over 5000 spearfishing days per year. Many fishers operate more than one gear on each fishing trip.

Trap fishing boats haul 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, over 34,000 trap hauls were made. Nearly 90% of the trap hauls are of 43 mm (1.25") mesh traps and nearly all the rest of the hauls are of 50 mm (1 ½") mesh traps. These figures do not reflect the actual proportion of the various mesh size traps in the fishery simply because the smaller mesh traps are hauled almost twice as often as the larger mesh traps. Trap fishers set their traps 27 m deep on average.

Table 1. Characteristics of the fishers and the fishing fleet at five landing sites (Rio Bueno to Salem) on the north coast of Jamaica, 2000-2001.

		Number	Fishing effort year^{-1}	
Estimated number of active fishers		130		
Average age		49		
Primary gear:	Trap fishers	80	4900	boat days
	Line fishers	19	2400	boat days
	Net fishers	5	340	boat days
	Spear fishers	26	5000	fishing days
Functional boats (sea worthy)		95		
Boats motorized		45		
Average boat length (m)		6.5		
Average motor size (hp)		28		
Traps hauled	1" mesh traps		200	trap hauls
	1.25" mesh traps		30100	trap hauls
	1.5" mesh traps		4000	trap hauls
	TOTAL		34300	trap hauls
Mean soak time	1.25" mesh traps	2.8 days		
	1.5" mesh traps	5.2 days		

About 50% of the fishers use hook and line as their primary or secondary gear. Over 2000 boat trips are spent hook and line fishing, most of them for drop line fishing usually at night (targeting nocturnal reef fish and deep-slope snappers), or in the afternoon (fishing for parrotfish; a small but little known part of the fishery). Very few line fishing trips are for troll fishing. A small number of fishers use gill nets, about 1 boat per day, setting their nets in shallow reef areas. Net and line fishing boats appear to spend nearly twice as much time at sea per trip as trap fishing boats.

About 32 fishers are full- or part-time spear fishers. Their enumeration is difficult because they do not generally operate from boats and will enter and leave the water anywhere along the shore. A limited set of visual surveys along the coast provided the estimates of fishing effort.

Catch Rates

The catch rates in various gears are summarized in Table 2 and incomes from fishing are given in Table 3.

The average catch of a trap fishing boat is 6.1 kg per trip, and the average income is $29 per trip (all figures in US$); this is shared between the boat captain and his crew. The most important fish families in the trap catch are parrotfish and surgeonfish. The more valuable snappers are the third most important family. Other commercially valuable groups, such as groupers, jacks, and grunts are much less common. About 10% of the catch consists of unmarketable trash fish, much of which is nonetheless consumed. The total catch over the entire area by fish traps is about 30 tons per year, with a value of $140,000.

The most lucrative fishing activity appears to be net fishing, with an average income of $34 per boat trip, but the success of this activity may be partly seasonal when jacks are more common in the fishing area. Also, several net fishers are in fact spear fishers using nets and boats. They herd fish into the net and spear any fish too large to be gilled in the net. This activity is very labor intensive. Nonetheless, given the relatively high catch rates per boat, it is not clear why more fishers do not take up net fishing.

Dropline fishing is the least rewarding with fishers making less than $10 per trip, though this type of fishing may still be popular since it is the least gear and labor intensive of all the fishing practices. The estimated catch of all drop line fishers is about 4.7 tons per year, with a value of $25,600. Troll lines yield a total of 1.1 tons valued at $5,600. Net fishing yields 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.

Costs, Catch Values and Incomes

The total catch by all fishing gears in the study area is about 60 tons per year, worth about $300,000. Shared among the approximately 130 active fishers in the area, it represents a yearly income of about $2,300 per year for the average fisher.

The value of the catch is relatively high because of the high demand for fish in Jamaica. Fish are generally sold on north coast fishing beaches directly to the consumers, or occasionally to vendors, in two categories. The "quality" fish are currently sold for $5.90/kg (J$120/lb) and these include groupers, snappers, goatfish, jacks, large grunts and most pelagic predators (Spanish mackerel and wahoo) and lobsters. Almost any large fish is rated as "quality" and small "quality" fish are downgraded to "common". "Common" fish include most of the other reef species, such as parrotfish, surgeonfish, angelfish, small grunt and crabs, which are sold for $4.90/kg (J$100/lb).

Table 2. Estimated catches of traps, lines, nets, spears, and total catch, by fish family, at five landing sites (Rio Bueno to Salem) on the north coast of Jamaica, July 2000 to July 2001.

	Traps		Drop lines		Troll lines		Nets		Spears		All gears
Catch composition	kg/ boat/ day	kg/ yr	kg/ boat/ day	kg/yr	kg/ boat/ day	kg /yr	kg/ boat/ day	kg/yr	kg/ trip/ day	kg/yr	kg/yr
Scaridae	2.34	11500	-	-	-	-	0.56	190	1.38	7050	18740
Sphyraenidae	-	-	0.16	330	3.04	820	0.15	50	1.4	7140	8340
Acanthuridae	0.97	4750	-	-	-	-	0.16	50	0.23	1170	5970
Lutjanidae	0.53	2600	0.36	760	-	-	0.43	150	0.12	610	4120
Serranidae	0.28	1360	0.44	920	-	-	-	-	0.31	1580	3860
Carangidae	0.17	850	0.67	1400	-	-	1.79	610	0.06	300	3160
Haemulidae	0.29	1430	-	-	-	-	0.88	300	0.18	910	2640
Mullidae	0.24	1180	-	-	-	-	-	-	0.23	1180	2360
Holocentridae	0.35	1710	0.2	420	-	-	-	-	0.063	320	2450
lobsters and crabs	0.16	780	-	-	-	-	-	-	0.16	840	1620
Muraenidae	0.23	1110	0.08	180	-	-	-	-	-	-	1290
Balistidae	0.13	620	-	-	-	-	-	-	-	-	620
Scombridae	-	-	0.1	210	0.67	180	-	-	-	-	390
Belonidae	-	-	0.1	210	0.41	110	0.12	40	-	-	360
others families	0.38	1880	0.15	310	0.01	4	2.25	760	0.50	1900	4850
TOTAL CATCH	6.07	29700	2.26	4740	4.07	1110	6.34	2150	4.50	23000	60770

Unmarketable species include moray eels, scorpion fish, filefish and very small fish. These are generally kept by the fisher for home consumption or given away to indigent persons or to people who help pull the boats up on shore.

Table 3. Estimated value of the catch and income per fishing trip, at 5 landing sites (Rio Bueno to Salem) on the north coast of Jamaica, July 2000 to July 2001.

	traps	lines	nets	spears	All gears
fishing trips year^{-1}	4900	2370	340	5100	
	Catch composition by value (kg)				
quality (US$5.90/kg)	5990	2510	1260	10500	20260
common (US$4.90/kg)	21340	3200	870	12310	37720
trash (no value)	2410	130	30	160	2730
	Value of the catch (US$)				
total value year^{-1}	$140,000	$30,000	$11,700	$122,000	$303,700
income trip^{-1}	$29	$13	$34	$24	

The cost of entering and remaining in the fishery is high, except for spear fishing, primarily due to the capital needed to obtain and maintain a boat. The initial costs may range from $800 to $8,000, depending primarily on whether a new or second hand boat and engine are bought (Polunin et al, 2000). Plywood boats are the least expensive at about $400 to $900, while fiberglass boats cost over $4,000 new. Dugout canoes are now rare due to the scarcity of large accessible cottonwood trees. Large fiberglass boats need large engines (35 to 65 hp) that cost up to $3,600 new. Some of the wooden boats are motorized with small engines (e.g. 4 - 10 hp) that cost up to $1,250.

Other costs of fishing depend on the method involved. For trap fishing, the materials needed include 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 build their own traps, but some hire others to build them. With ongoing repairs, fish traps last about a year before they need to be replaced, although many are lost sooner than that because of storms, careless setting near the reef drop-off, or theft. Trap fishers seem to set their traps very deep and often unmarked, perhaps to avoid theft or poaching by spear fishers. These practices tend to increase the number of lost traps. Motorized boats also need to purchase fuel, which of course varies depending on the size of boat and engine, the condition of the engine, the frequency of fishing trips, the number of traps hauled, and the distance the traps are set away from the beach.

Drop line fishers can expect to spend about $50 - $200 for gear per year (fishing line, hooks). Bait is often caught by the fisher himself, or bought at sea from another fisher. Troll fishers may spend money on artificial bait ($5-$10 each) and

a great deal on fuel. For this reason, trolling is not commonly practiced, except when moving between fishing grounds to operate other fishing gear. Net fishers, who usually use gill nets of 50 mm (2") to 100 mm (4") mesh size, would spend from $100 to $200 (about 12 kg of net) on average per year.

DISCUSSION

Catch per Unit Area

Our 2000/01 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, 5,410 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 is therefore 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 surveys of 1968, 1996/97 and 2000/01 (Tables 4 and 6), as well as other published surveys in the area (Picou-Gill et al. 1996, Sary et al. 1997) have provided consistent estimates of catches and there appear to be no reasons for challenging their accuracy.

Changes in Catch Rates Over Time

There are several data sets that warrant comparison with the current results. These are the 1968 and 1981 surveys of the Jamaican fishery (Nembhard 1970, Sahney 1983) and data collected by the UWI/FIP in 1996 and 1997.

In the 1968 survey, catches were reported by parish and the catches at selected beaches were raised by the total number of operational boats, motorized or non-motorized, operating in the parish. Fortunately, the beaches selected to represent St. Ann were Salem and Swallow Hole and it is therefore possible to make a direct comparison between the 1968 and the 2000/01 data. Table 4 shows the landings by all gears, with catches aggregated to conform with the 1968 survey. Catches have fallen 13% by weight and at least 17% by value, using 2001 prices. However, as there are very few large fish of any species in the catches, our estimates of value in 2000/01 are inflated. Perhaps half of all the "quality " fish are too small to fetch the premium price and the decline in value is therefore probably around 20%.

If catches over the whole study area have declined by the same amount as at Salem and Swallow Hole (-13%), the fishery yield in 1968 from these reefs would have been about 5.7 tons/km^2.

The catches reported by Nembhard (1970) for the parish of Trelawney are based on the beaches of Rio Bueno and Charlotte and are therefore not comparable with our data. In any event, the catch rates reported for this area have a number of anomalies, such as large quantities of parrotfish reported to have been taken on hook and line and of tuna caught in traps and are therefore not considered further.

In the 1981 survey (Sahney 1983), catches from the eastern, northern and

western parishes were aggregated and no comparison can be made with the current survey.

Table 5 shows that in 1968, only four motorized craft fished from Salem and Swallow Hole; they seemed to be used irregularly and thus landed very little. The numbers of active motorized craft had risen to about 18 on these two beaches by 2000 - 2001, landing over 1,000 kg per year with a value of $5,366. Non-motorized boats fell from 47 to 21 and the catch/boat/year fell from 596 kg to 287 kg. The corresponding value fell from about $3,300 to less than $1,400.

No spear fishers were recorded in St. Ann in 1968. Since then it has become an increasingly important activity. Spear fishing catches remain difficult to estimate because spear fishers move freely along the coast and most do not use established landing sites.

Table 4. Changes in total catch and value of the catch between 1968 (from Nembhard 1970) and 2000-01, at Swallow Hole, Runaway Bay and Salem fishing beaches, on the north coast of Jamaica.

	Catch		Prices	Value of catch	
	1968	2000/01	2000/01	1968	2000/01
	kg	kg	US$/kg	US$	US$
Kingfish, wahoo	34	260	5.90	202	1534
Tuna, bonito	517	0	4.90	2533	0
Snapper	3648	2778	5.90	21522	16390
Goatfish	1482	776	5.90	8745	4578
Jacks	4719	1704	5.90	27842	10054
Mullet	1196	1	5.90	7058	6
Parrotfish	5563	4340	4.90	27260	21266
Goggle eye	222	471	4.90	1087	2308
Herring, sprat	17	0	4.90	84	0
grouper	3350	1111	5.90	19766	6555
lobster	377	317	5.90	2224	1870
shrimp	90	0	5.90	534	0
Other	6804	12506	4.90	33340	61279
TOTAL	28020	24264		152196	125841
% change		-13.4			-17.3

In addition, we have records of catch rates of 43 mm (1 ¼") mesh fish traps for 12 month periods in 1996 and 1997, from the same fishing beaches covered in 2000 - 2001. Changes in the catch rates, by family (in grams/trap/haul and in number of fish/trap/haul), are shown in Table 6. The catches have been relatively stable over this time period, with the average catch of under 1 kg /haul. Nonetheless, it appears that there has been a very slight increase in the catch rates of fish traps in the fishery,

both in weight and number of fish, over the five-year period, but only the increase in the number of fish between 1996 and 2000-01 is likely to be significant. The increase in the catch appears 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 has actually decreased, especially those of parrotfish, but also other groups such as grunts and groupers.

Table 5. Changes in the catch and the value of the catch of motorized and unmotorized boats between 1968 (from Nembhard 1970) and 2000-2001, at two landing sites (Swallow Hole in Runaway Bay, and Salem), on the north coast of Jamaica.

	1968		2000/01	
	motorized	non-motorized	motorized	non-motorized
Number of boats	4	43	18	21
Catch year^{-1}	kg	kg	kg	kg
traps	1393	24253	16330	2408
lines	-	1393	570	1879
nets	-	985	1503	36
spears	-	-	223	1315
TOTAL CATCH	1393	26627	18626	5638
Catch boat^{-1}	348	619	1035	268
Value year^{-1}	US$	US$	US$	US$
Total value	7870	144327	96590	29250
Earnings boat^{-1}	1968	3356	5366	1393

The value of the catch (in 2001 dollar values) has also increased slightly but it is still only a little more than $4 per trap haul. The total weight of high quality fish has actually decreased since 1996 and there are more lower-valued (common) species in the catch than before. The average fish size in all commercial categories appears to have decreased.

The Costs of Non-Management

Our data show that catches have declined in value since 1968 by 17 - 20% at 2001 prices. However, we have done an evaluation of management strategies since 1975, when Munro (1975) suggested that an increase from the then prevalent 33 mm maximum aperture mesh (25 mm or 1" between knots) to a mesh size of 66 mm maximum aperture (50 mm or 2" between knots) would increase the value of trap catches by about 30%. An increase to 43 mm (1 ¼") mesh would increase harvest

values by 19%. Line catches would also have increased because of the delayed recruitment of all species to the trap fishery. Recruitment rates were also predicted to increase if larger mesh sizes enabled some species to reach maturity before recruitment to the fishery.

Table 6. Changes in trap catches: Comparison of catch rates, catch value, and mean fish size in 1.25" mesh traps, between three 12-month periods (in 1996, 1997, and 200-2001) on the north coast of Jamaica.

	1996	1997	00-01	1996	1997	00-01
catches sampled	(110)	(44)	(278)	-	-	-
traps reported	(672)	(279)	(1832)	-	-	-
Catch composition by family						
	g trap^{-1} haul^{-1}			# of fish trap^{-1} haul^{-1}		
Scaridae	244	349	355	2.0	2.7	3.6
Acanthuridae	153	197	153	1.8	2.4	1.7
Holocentridae	50	73	51	0.6	0.8	0.5
Mullidae	18	26	49	0.1	0.2	0.4
Lutjanidae	80	34	48	0.3	0.1	0.2
Haemulidae	58	40	42	0.4	0.3	0.4
Balistidae	30	3	41	0.1	0.03	0.1
Serranidae	39	35	39	0.2	0.2	0.3
Muraenidae	48	28	36	0.03	0.04	0.1
invertebrate	7	11	16	0.01	0.02	0.03
Carangidae	10	25	14	0.1	0.2	0.1
Pomacentridae	14	5	10	0.2	0.1	0.1
Kyphosidae	6	-	10	0.01	-	0.01
others (18 families)	51	47	39	0.21	0.19	0.20
TOTAL	806	873	903	6.0	7.3	7.6
Catch composition by value						
quality	155	96	140	0.7	0.5	0.7
common	559	691	683	4.8	6.4	6.4
trash	92	86	79	0.5	0.4	0.5
Mean fish size (g)	135	120	119	-	-	-
Catch value	US$ trap^{-1} haul^{-1}					
	$ 3.66	$ 3.96	$ 4.17	-	-	-

Since 1975, the use of 33 mm mesh has declined on the northern coast of Jamaica and, as a result of efforts of the UWI FIP in the Discovery Bay area in the past decade, a substantial proportion of traps have 55 mm (1 ½") mesh. The latter mesh size was calculated by Munro (1975) to produce a very similar relative harvest to the 66 mm mesh, but without the same benefits of delaying recruitment to larger sizes. However, effective fishing intensity has actually increased since 1975, as a result of the increases in numbers of motorized canoes and spear fishers.

Annual catches have declined in value in the survey area by $30,000, mostly as a result of increasing effort, declining recruitment rates and, perhaps, changes in the ecosystem since 1968. If we assume that the decline was linear, the value would have fallen by $6,000 by 1976 (by which time it might have been possible to have management measures in place) instead of increasing by $52,000. If we compound this loss over the next 25 years at 10%/year we arrive at a figure of somewhat over $6.4 million that was lost from this 12 km^2 area of fishing grounds, fished in 1968 by 124 boats. The narrow shelves of the northern, western, and eastern parishes total 699 km^2 (Haughton 1988) and proportionately the compounded total loss would have been about $375 million. If we extend this argument to cover the southern shelf of Jamaica and the proximal oceanic banks (3,471 km^2), all of which are intensively fished with traps, but only assign them half the productivity of the narrow northern shelves, the compounded loss in direct primary production from this shelf and banks is $930 million. Thus, in total, Jamaica has probably lost $1.3 billion over the past 25 years. This figure does not include losses from the vast Pedro Bank and from Morant Bank to the south of Jamaica, that were lightly exploited 25 years ago but which are now reported to have greatly depleted fish stocks.

The foregoing figures might err by a few hundred million dollars. It is undoubtedly difficult to manage small-scale, multi-species, multi-gear fisheries. However, the figures suggest that it is surely worth the effort, and that management would pay economic, social, and political dividends.

ACKNOWLEDGEMENTS

This study was part of the work of the Caribbean Marine Protected Areas Project, funded by the United Kingdom Department for International Development. Nadine Earle and John Samuels collected the vast majority of the data on the fishing beaches, with assistance from several graduate students of the University of the West Indies. Data for 1996 - 1997 were collected by staff of UWI Fisheries Improvement Programme, funded by the Kaiser Jamaica Bauxite Company. We would like to thank the fishers of the area for their assistance in answering all our questions and allowing us to weigh their catches.

LITERATURE CITED

Aiken, K.A. and M.O. Haughton. 1987. Status of the Jamaican reef fishery and proposals for its management. *Proceedings of the Gulf and Caribbean Fisheries Institute* **38**:469-484.

Haughton, M.O. 1988. An analysis of statistical data from the Jamaican inshore fisheries. Pages 443-454 in: S. Venema, J. Moller-Christensen and D. Pauly. (eds.) *Contributions to Tropical Fisheries Biology. FAO Fisheries Report 389.* Rome, Italy.

Hughes, T.P. 1994. Catastrophes, phase-shifts, and large scale degradation of a Caribbean coral reef. *Science* **265**:1547-1552.

Mahon, R. 1989. Fishery management options for the Lesser Antilles. *FAO Field Document (FI:TCP/RLA/6776) Number 4.* 117 pp.

Munro, J.L. 1975. The biology, ecology, exploitation and management of Caribbean reef fishes. Part VI - Assessment of the potential productivity of Jamaican fisheries. *Research Reports of the Biology Department of the University of the West Indies* 3(VI). 55 pp.

Munro, J.L. (ed.) 1983. *Caribbean Coral Reef Fishery Resources.* ICLARM Studies and Reviews Number 7. 258 pp.

Munro, J.L. 1984. Coral reef fisheries and world fish production. *ICLARM Newsletter* 7(4):3-4.

Munro, J.L. and D.M. Williams. 1985. Assessment and management of coral reef fisheries: Biological, environmental and socio-economic aspects. *Proceedings of the 5th International Coral Reef Congress* 4:545-581.

Nembhard, B. 1970. The fishing industry of Jamaica: A report on the 1968 sample survey. Agricultural Planning Unit, Ministry of Agriculture and Fisheries. Kingston, Jamaica.

Picou-Gill, M., J.D. Woodley, M. Miller, Z. Sary, W. Van Barneveld, S. Vatcher, and D. Brown. 1996. Catch analysis at Discovery Bay, Jamaica: The status of an artisanal reef fishery. *Proceedings of the Gulf and Caribbean Fisheries Institute* **44**:686-693.

Polunin, N.V.C., I.D. Williams, J.G. Carrier, and L.F Robinson. [2000]. Ecological and social impacts in planing Caribbean marine reserves. Department of Marine Sciences, University of Newcastle, England. 37 pp. Unpubl. MS.

Sahney, A.K. 1983. Sample survey of the fishing industry of Jamaica – 1981. Pages 255-275 in: *FAO Fisheries Reports.* **278** (Supplement).

Sary, Z. [2001]. The small scale reef fishery on the central north coast of Jamaica in 2000-01: A biological and socio-economic survey. *ICLARM Caribbean/Eastern Pacific Office Technical Report.* In Prep.

Sary, Z., H.A. Oxenford, and J.D. Woodley. 1997. Effects of an increase in trap mesh size on an overexploited coral reef fishery at Discovery Bay, Jamaica. *Marine Ecology Progress Series* **154**:107–120.