# Progress in the Fisheries Improvement Programme, Discovery Bay, Jamaica

ZSOLT SARY[1,2], JEREMY D. WOODLEY[1] and HAZEL A. OXENFORD[2]
[1]*Centre for Marine Sciences*
*University of the West Indies, Mona Campus*
*Kingston, Jamaica*
[2]*MAREMP*
*University of the West Indies, Cave Hill Campus*
*Bridgetown, Barbados*

## ABSTRACT

Fish stocks on the narrow fringing reefs of the north coast of Jamaica are highly over-exploited. Since 1988, the Fisheries Improvement Programme (FIP) of the University of the West Indies has been monitoring the fishery at Discovery Bay and working with local fishers towards better fishery management. Through its community development and education programmes, FIP has encouraged (1) development of a fishers' organization, the Alloa Discovery Bay Fishermen's Association (DBFA) (2) use of a larger mesh size for fishtraps, and (3) creation of a fishery reserve.

The mesh exchange programme initiated in 1991, resulted in the exchange of 250 small mesh fishtraps (1" and 1.25") for larger mesh fishtraps (1.5"). As a consequence, catches of 1.25" fishtraps (per haul), after an initial decline, were significantly higher (23% by weight and 42% by number) in 1994 than in 1990, and catches of 1.5" fishtraps were significantly higher (50% by number) in 1994 than in 1991. Increased catch rates in both 1.25" and 1.5" fishtraps may indicate the beginning of fish population recovery. However, catch rates (as kg per week and number of fish per week) differ markedly between large and small mesh fishtraps, with the 1.5" fishtraps currently catching considerably less than 1.25" fishtraps (1.74 kg or 9 fish per week compared with 2.62 kg or 23 fish per week). It is, therefore, not surprising that fishers currently have mixed attitudes towards the programme and management remains a significant challenge.

Even though local fishers are a diverse, divided group, some have come together and created the DBFA and with the help of FIP, have secured grants for a fishing gear retail outlet, for supplies of large mesh to sell, and for construction of improved facilities. DBFA is now seeking more authority in the management of its fishing area, beginning with the creation of a fishery reserve. At the same time, FIP is extending its fishery education to four neighbouring fishing beaches, assisted this time by fishers from DBFA, and will also offer mesh exchanges there.

## INTRODUCTION

Reef fisheries in Jamaica are very important to coastal communities in social, economic and nutritional terms. The fishery is large and widely dispersed with some 20,000 licensed fishers, using 8,000 registered boats (open canoes powered by engines or oars) operating from over 200 fishing beaches scattered around the coastline (Sandra Grant, pers. comm.1 ).

Like many other open access, little regulated fisheries, the reef fishery in Jamaica has been overexploited, particularly along the narrow north coast shelf (Miller *et al.*, 1991; Picou-Gill *et al.*, 1991; Aiken, 1993; Koslow *et al.*, 1994; Anon., 1994, Sandeman & Woodley, 1994). Furthermore, it is argued that the high level of exploitation on the Jamaican north coast has been a major causative factor in the deterioration of reefs there (Hughes, 1994). There is clearly an urgent need for restorative management in the Jamaican reef fishery. Management tools considered suitable for reducing fishing mortality in reef fisheries include gear restrictions, fish sanctuaries, and limited entry to the fishery (Munro & Williams, 1985; Mahon, 1989).

Unfortunately, the present laws concerning fin-fishing in Jamaica (Fishing Industry Act, 1976) are designed to promote fishing, rather than to regulate it. Although all fishers are required to obtain a license, the charge is minimal and there is no limit on the number of licenses issued. There is only one designated Fish Sanctuary (which lies within the Montego Bay Marine Park) and regulation of fishtrap mesh size has not gone beyond the proposal stage (Aiken & Haughton, 1983).

On the north coast of Jamaica, the fishing communities are several kilometers apart and thus responsible for the majority of fishing on the adjacent part of the narrow shelf. This situation is considered ideal for the development of a community-based management approach. This led to the creation of the Fisheries Improvement Project (FIP) by the Discovery Bay Marine Laboratory, University of the West Indies and Trent University, Ontario Canada, in 1988 with funding from the Canadian International Development Agency (CIDA). A community management approach is considered more appropriate than a "top-down" approach given that the Fisheries Division has few staff and resources to enforce laws, and that management measures are likely to involve a reduction in fishers' incomes, at least in the short term.

FIP had three interconnecting components: a biological data collection programme to monitor reef fish populations and catches; an education programme to stimulate changes in fishing methods that could lead to a more sustainable level of exploitation; and a community development programme to help fishers implement the needed changes (see van Barneveld *et al.*, 1991; Allison, 1992; Woodley,1994; Sandeman & Woodley, 1994).

From 1990 to 1992, FIP began a community development and education programme under the guidance of a full time education officer (see van Barneveld, 1991). In 1991, FIP implemented a mesh exchange programme to remove small mesh fishtraps (1"and 1.25") from the fishery and replace them with larger mesh fishtraps (1.5")(see Sary *et al.*, 1991; Sary *et al.*, 1992). Also in 1991, FIP assisted a small group of Discovery Bay fishers in forming the Alloa Discovery Bay Fishermen's Association (DBFA) (see van Barneveld *et al.*, 1991).

Here, we report on the present status of the Discovery Bay trap fishery, and the effects of the mesh exchange programme on catches and on fishers' attitudes three years after the mesh exchange programme; on the development of DBFA; and on the continuing work and future plans of FIP (renamed the Fisheries Improvement Programme).

## METHODS

### Data Collection

Catch and effort data (catch per fishtrap, species composition of catches, number of fishtraps, soak time, mesh size, and fishing area) for the Discovery Bay trap fishery were variously collected from January 1990 to December 1994. Details of the data collection are given in Picou-Gill *et al.* (1991) and Sary (1991) for the period January 1990 to October 1991, in Sary *et al.* (1992) for the period November 1991 to October 1992, and have been summarized by Sary (1995) for the entire period January 1990 to December 1994.

Information on fishers' perspectives on the mesh exchange programme was collected from all active trap fishers in Discovery Bay by informal interviews during catch and effort data collection and by an interview survey carried out between October and December 1994 (three years after the implementation of the mesh exchange programme) using a standard questionnaire.

### Data Analysis

Data collected between July and December 1994 were used to describe the present status of the fishery. Species composition of catches was examined at the family level using the family groups described by Koslow *et al.* (1988) (except for the families Sciaenidae, Chaetodontidae, and Pomacanthidae, as well as others not included in any fish group by Koslow *et al.*, (1988) were combined in Miscellaneous (MIX)).

Changes in catch per haul (i.e. CPUE as number of fish/trap/haul, and kg/trap/haul) for both 1.25" and 1.5" fishtraps were examined by comparing the mean CPUE of all fishers sampled in each of three separate six-month periods (*i.e.* July to December) in 1990 (ten months before the implementation of the mesh exchange programme), 1991 (immediately after the implementation of the mesh exchange programme) and 1994 (three years after the implementation of the mesh exchange programme).

Changes in fishing effort as a result of the mesh exchange programme were examined by comparing the annual mean number of fishtrap hauls per month between 1990 (the year before the mesh exchange programme was implemented), 1991 (the year the mesh exchange programme was implemented) and 1992 (the year after the mesh exchange programme was implemented).

Changes in soak time of fishtraps (in days) were examined by comparing the mean soak time of fishtraps of all fishers sampled in each of three separate six-month periods (*i.e.* July to December) in the years 1990, 1991 and 1994.

All data were examined for normality. Where data did not follow a normal distribution, differences in mean values between years were first tested with Kruskal-Wallis non-parametric ANOVA; if a significant difference was found, two years were compared at a time using Mann-Whitney U-test, a 2-sample non -parametric ANOVA. For data which did follow a normal distribution, differences in mean values were tested using parametric ANOVA and Tukeys multiple range tests.

## RESULTS

### Present Characteristics of the Trap Fishery

The marine habitats around Discovery Bay have been described by many authors (see Woodley and Robinson, 1977; Liddell *et al.*, 1984; Woodley, 1987 for reviews). The bay itself is 1.3 km across and is an important part of the fishing ground exploited by Discovery Bay fishers, especially during severe weather when the small canoes cannot venture outside the bay. Approximately, 10% of fishtraps are set inside the bay. The bay is protected to seaward by a nearly continuous reef crest, through which a 120m wide and 12m deep ship channel was blasted in 1964; another 10% of traps are set in and around this channel. The majority of fishtraps, 80%, are set on the outside forereef slope, particularly between 20m and 30m depth. The use of spears and gill-nets is also prevalent in all shallow areas of the reef, while the use of hook-and-line is widespread from shore to deep slope.

There are currently about 75 active fishers in Discovery Bay of which 45% (34) are trap fishers and the rest, who also exploit reef fish, use spears, hook and line, or gill nets. Trap fishers operate from Old Folly Beach (42%) and Top Beach (58%) within Discovery Bay (Figure 1). Generally, trap fishing is practiced by older, more established fishers who have enough capital to invest in boats and fishtraps. Of the 34 active trap fishers, 72% are over the age of 50. Nearly all fishers in Discovery Bay are part time, relying on other sources of income as well.

There are approximately 285 fishtraps presently in use in Discovery Bay (mean number of fishtraps is 8.4 per fisher), of which 42% (120) are 1.5" mesh, 54% (155) are 1.25"mesh, and 4% (10) are 1" mesh (Table 1). Most trap fishers (83%) own their boats (N=34) which are open, canoe type; 64% have small (<7m) wooden boats, and 19% have larger (8-9m) fiberglass boats. All of the fiberglass boats, but very few of the wooden boats, are motorized (Table 1). There are another twenty small wooden unmotorized boats, which are used only

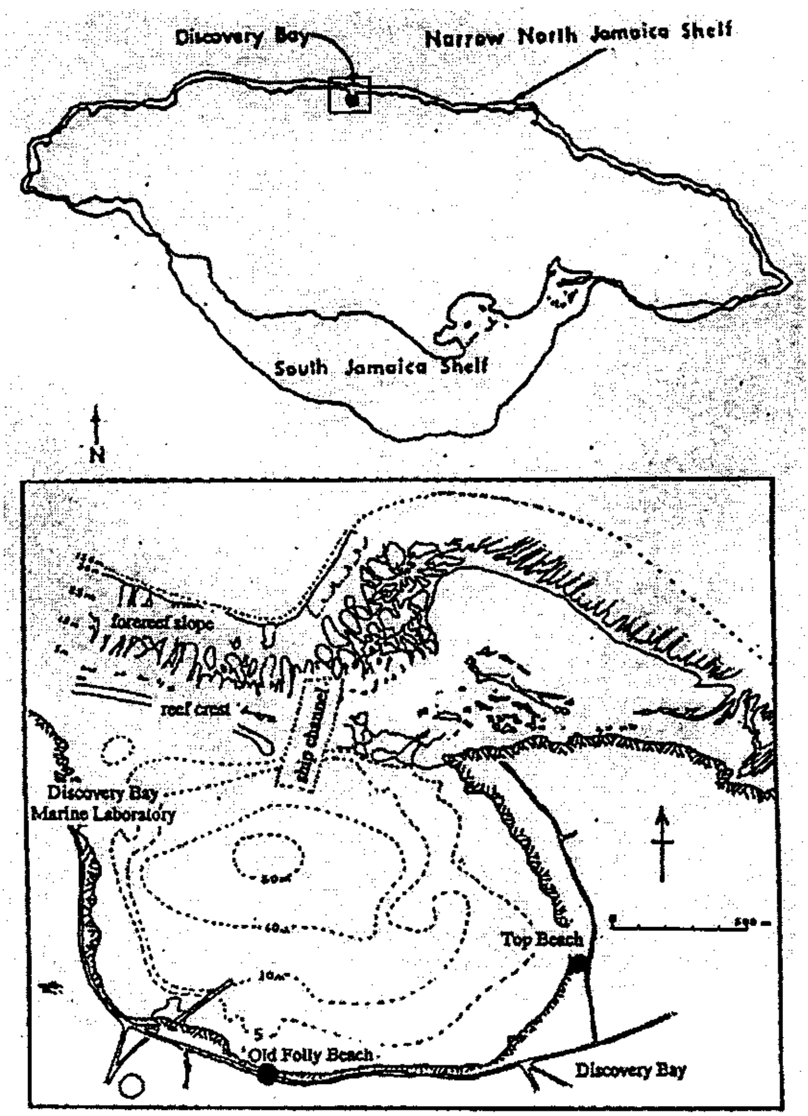


**Figure 1.** Map of Jamaica showing the extent of the island shelf and the location of the study area, Discovery Bay. Inset shows Discovery Bay and the location of trap fishery landing sites (•) and reef outlines (adapted from Woodley, 1987).

**Table 1.** Fishing boats and gear owned by Discovery Bay trap fishers. Information from survey questionnaire conducted in October to December 1994.

| Gear Type | Specifications | Number |
|---|---|---|
| Boat | Small wooden (<7m), unmotorized | 19 |
| | Small wooden, motorized | 2 |
| | Large fiberglass (>8m), motorized | 7 |
| | Does not own boat | 6 |
| All traps | per fisher | 8.4 |
| | in use in fishery | 285 |
| | lost | 73 |
| 1.5" mesh traps | per fisher | 3.5 |
| | in use in fishery | 120 |
| | lost | 26 |
| 1.25" mesh traps | per fisher | 4.6 |
| | in use in fishery | 155 |
| | lost | 36 |
| 1" mesh traps | per fisher | 0.3 |
| | in use in fishery | 10 |
| | lost | 1 |

for hook-and-line. The trap fishers who do not own boats, go to sea either accompanying other fishers, or by renting other fishers' boats. Since boats are predominantly small wooden (plank or dug-out) canoes without engines, most fishers do not venture far from the safety of the bay. However, some of the motorized fiberglass boats may range further afield (10 km east or west along the coast) to set fishtraps.

A total of 811 fishtraps were sampled from July to December 1994, of which 367 were 1.25" mesh fishtraps and 444 were 1.5" mesh fishtraps. The catch composition of the current fishery is summarized by family groups and by fishtrap mesh size in Table 2.

A total of 3,083 fish weighing 358 kg were taken by the 367 1.25" mesh fishtraps (Table 2). The mean catch per haul of 1.25" mesh traps is therefore 0.97 kg/trap or 8.4 fish/trap and the mean size of finfish is 0.12 kg. The family group which dominates in catches of the 1.25" mesh fishtraps is the small parrotfish (SSC), comprising 47% of the total number and 37% of the total weight (Table 2).

A total of 2,656 fish weighing 530 kg were taken by the 444 1.5" mesh fishtraps (Table 2). The mean catch per haul of 1.5" mesh fishtraps is therefore 1.19 kg/trap or 6.0 fish/trap and the mean size of finfish is 0.20 kg. The family group which dominates in catches of the 1.5" mesh fishtraps is the surgeonfish (ACN) comprising 59% of the total number and 37% of the total weight.

A comparison of the current catch performance of the 1.25" and 1.5" mesh fishtraps is summarized in Table 3. Mean catch per haul in weight (as kg/trap/haul), although higher for 1.5" fishtraps, shows no significant difference between the two fishtrap types (Mann-Whitney test: U=5457, N=213, P=0.762). However, mean catch per haul in number is significantly higher for 1.25" mesh fishtraps (8.4 fish/trap/haul) than for 1.5" mesh fishtraps (6.0 fish/trap/haul)(Mann-Whitney test: U=7200, N=213, P ( 0.001). This means that small mesh fishtraps currently catch more fish but the same weight of fish per haul as the larger mesh fishtraps. This difference is amplified by the fact, that the mean soaktime is significantly shorter for 1.25" mesh fishtraps (2.6 days) than for 1.5" mesh fishtraps (4.8 days)(Mann-Whitney test: U=2424, N=194, P<0.001). This means that small mesh fishtraps catch considerably more per week (23 fish weighing 2.62 kg) than large mesh fishtraps (9 fish per week weighing 1.74 kg). However, the mean weight of individual fish is significantly smaller (and therefore less valuable) in 1.25" mesh fishtraps (0.12 kg) than in 1.5" mesh fishtraps (0.20 kg)(Mann-Whitney test: U=163277, N=1687, P(0.001).

**Changes in Catch per Haul with the Mesh Exchange Programme**

Mean catch per haul (as kg/trap/haul) for 1.25" mesh fishtraps within the fishery in 1990, 1991, and 1994 is given in Table 4a. Mean catch per haul showed significant variation between years (Kruskal-Wallis test: H = 13.819, N = 326, P = 0.001). All 2-sample tests also indicated significant differences in catch per haul between years. The catch per haul in 1990 (0.79 kg/trap/haul) was significantly higher than in 1991 (0.60 kg/trap/haul)(Mann-Whitney test: U = 5604.5, N = 208, P = 0.030; Table 4a). The catch per haul in 1994 (0.97 kg/trap/haul; Table 4a) was significantly higher than in both the earlier years (Mann-Whitney tests: for 1990 vs. 1994, U = 7071.5, N = 259, P = 0.038; for 1991 vs. 1994, U = 2692, N = 185, P < 0.001).

Mean catch per haul (as fish/trap/haul) for 1.25" mesh fishtraps within the fishery in 1990, 1991, and 1994 are given in Table 4b. Mean catch per haul showed significant variation between years (Kruskal-Wallis test: H=14.894, N=290, P=0.001). However, 2-sample tests indicated that there was no difference in catch per haul between 1990 and 1991 (Mann-Whitney test: U=3524, N=172, P=0.178), although catch per haul in 1994 was significantly higher (8.4 fish/trap/haul) than in both the earlier years (1990: 5.9 fish/trap/haul, 1991: 5.2 fish/trap/haul; Table 4b) (Mann-Whitney tests: for 1990 vs. 1994, U=5430, N=238, P=0.002; for 1991 vs. 1994, U = 2126, N = 170, P < 0.001).

**Table 2.** Catch composition of fishtraps sampled in Discovery Bay, between July and December 1994, shown by numbers of individuals and by weight (kg), seperately by fish groups for all mesh size fishtraps, 1.25" mesh fishtraps and 1.5" mesh fishtraps. Numbers in parantheses show rank.

| Code | Group | Family | All traps (n=859) | | | |
|---|---|---|---|---|---|---|
| | | | # fish | % of total | W(kg) | % of total |
| SSC | small parrotfish | Scaridae | 1787 | 28.4 (2) | 170.41 | 18.2 (2) |
| LSC | large parrotfish | Scaridae | 252 | 4.0 (6) | 60.05 | 6.4 (5) |
| ACN | surgeonfish | Acanthuridae | 2144 | 34.1 (1) | 247.66 | 26.4 (1) |
| HAM | grunts | Haemulidae | 367 | 5.8 (4) | 127.37 | 13.6 (3) |
| HOL | squirrelfish | Holocentridae | 508 | 8.1 (3) | 48.22 | 5.1 (6) |
| LUT | snappers | Lutjanidae | 272 | 4.3 (5) | 103.54 | 11.0 (4) |
| SSR | small groupers | Serranidae | 232 | 3.7 (9) | 30.41 | 3.2 (9) |
| LSR | large groupers | Serranidae | 4 | 0.1 (13) | 4.61 | 0.5 (13) |
| MUL | goatfish | Mullidae | 243 | 3.9 (7) | 27.96 | 3.0 (10) |
| CAR | jacks | Carangidae | 147 | 2.3 (10) | 38.13 | 4.1 (8) |
| BAL | trigger & filefish | | 54 | 0.9 (11) | 21.79 | 2.3 (11) |
| TET | puffers & boxfish | | 35 | 0.6 (12) | 16.38 | 1.7 (12) |
| MIX | miscellaneous | | 241 | 3.8 (8) | 40.93 | 4.4 (7) |
| | **TOTALS** | | **6286** | | **937.4** | |

| 1.25" traps (n=367) | | | | 1.5" traps (n=444) | | | |
|---|---|---|---|---|---|---|---|
| # fish | % of total | W(kg) | % of total | # fish | % of total | W(kg) | % of total |
| 1445 | 46.9 (1) | 131.74 | 36.8 (1) | 116 | 4.4 (6) | 19.83 | 3.7 (6) |
| 90 | 2.9 (8) | 11.61 | 3.2 (9) | 146 | 5.5 (4) | 46.77 | 8.8 (4) |
| .449 | 14.6 (2) | 39.43 | 11.0 (2) | 1554 | 58.5 (1) | 196.14 | 37.0 (1) |
| 144 | 4.7 (6) | 17.24 | 4.8 (8) | 198 | 7.5 (2) | 108.99 | 20.6 (2) |
| 327 | 10.6 (3) | 28.15 | 7.9 (4) | 122 | 4.6 (5) | 15.31 | 2.9 (7) |
| 78 | 2.5 (9) | 39.34 | 11.0 (3) | 189 | 7.1 (3) | 63.41 | 12.0 (3) |
| 168 | 5.4 (5) | 21.76 | 6.1 (5) | 44 | 1.7 (10) | 6.28 | 1.2 (11) |
| 2 | 0.1 (13) | 0.34 | 0.1 (13) | 2 | 0.1 (13) | 4.27 | 0.8 (13) |
| 189 | 6.1 (4) | 21.67 | 6.1 (6) | 45 | 1.7 (9) | 5.49 | 1.0 (12) |
| 61 | 2.0 (10) | 8.03 | 2.2 (11) | 77 | 2.9 (8) | 29.25 | 5.5 (5) |
| 30 | 1.0 (11) | 9.07 | 2.5 (10) | 23 | 0.9 (12) | 12.53 | 2.4 (9) |
| 8 | 0.3 (12) | 7.94 | 2.2 (12) | 26 | 1.0 (11) | 7.90 | 1.5 (10) |
| 92 | 3.0 (7) | 21.27 | 5.9 (7) | 114 | 4.3 (7) | 13.49 | 2.5 (8) |
| **3083** | | **357.6** | | **2656** | | **529.6** | |

**Table 3.** Comparison of catch performance characteristics of fishtraps in the Discovery Bay trap fishery sampled from July to December 1994 (three years after the implementation of the mesh exchange program).

| Characteristics | 1.25" mesh | 1.5" mesh |
|---|---|---|
| N | 367 | 444 |
| Mean kg/trap/haul | 1.03 | 1.24 |
| Mean number of fish/trap/haul | 8.5 | 6.0 |
| Mean weight of individual fish (kg) | 0.12 | 0.20 |
| Mean soak time (days) | 2.6 | 4.8 |
| Number of finfish species | 67 | 61 |
| Dominant group by weight | SSC | ACN |
| Dominant group by number | SSC | ACN |
| Dominant species by weight | redband parrotfish | blue tang |
| Dominant species by number | redband parrotfish | ocean surgeon |

In summary, the catch per haul of 1.25" fishtraps, after an initial decline, has shown a significant increase (23% by weight and 42% by number) with the implementation of the mesh exchange programme.

Mean catch per haul (as kg/trap/haul) for 1.5" mesh fishtraps within the fishery in 1991, and 1994 is given in Table 4a. Mean catch per haul showed an increase between 1991 and 1994 , but the difference was not significant (Mann-Whitney test: $U = 1818$, $N = 136$, $P = 0.181$).

Mean catch per haul (as fish/trap/haul) for 1.5" mesh fishtraps within the fishery in 1991, and 1994 is given in Table 4b. Mean catch per haul was significantly higher in 1994 (6.0 fish/trap/haul) than in 1991 (4.0 fish/trap/haul) (Mann-Whitney test: $U=1438.5$, $N=131$, $P=0.026$).

In summary, the catch per haul of 1.5" fishtraps has shown a significant increase in the number of fish per haul (50%) with the implementation of the mesh exchange programme. The corresponding increase in catch per haul of the 1.5" fishtraps (43%), however, was not significant.

**Fisher Reaction to the Mesh Exchange Programme**

Fishing effort (as mean number of fishtrap hauls per month and mean soak time of fishtraps) were examined for changes resulting from the introduction of a larger mesh size within the trap fishery. (1990: 107 hauls/month; 1991: 127 hauls/month; 1992: 149 hauls/month). Mean number of fishtrap hauls per month showed no significant variation between years (ANOVA: $F=1.352$, $N=32$,

**Table 4.** Mean catch rates per trap per haul for all mesh size fishtraps, for 1.25" mesh fishtraps and for 1.5" mesh fishtraps in the Discovery Bay trap fishery from July to December in 1990 (ten months before the mesh exchange), 1991 (immediately after the implementation of mesh exchange), and 1994 (three years after the mesh exchange). Catch rates are shown by (a) fish weight in kg, and (b) fish number. N represents number of fishtraps sampled, "=" represents no significant difference between years (Mann-Whitney, $P > 0.05$), "≠" represents significant difference between years (Mann-Whitney test, $P < 0.05$).

(a) kg/trap/haul

| Year | relative abundance of 1.5" mesh fishtraps (%) | all mesh size fishtraps N | all mesh size fishtraps kg | 1.25" mesh fishtraps N | 1.25" mesh fishtraps kg | 1.5" mesh fishtraps N | 1.5" mesh fishtraps kg |
|---|---|---|---|---|---|---|---|
| 1990 | 6 | (787) | 0.77 | (590) | 0.79 | | |
| 1991 | 68 | (868) | 0.72 | (207) | 0.60 | (176) | 0.83 |
| 1994 | 42 | (859) | 1.14 | (367) | 1.03 | (444) | 1.24 |

(b) number of fish/trap/haul

| Year | relative abundance of 1.5" mesh fishtraps (%) | all mesh size fishtraps N | all mesh size fishtraps kg | 1.25" mesh fishtraps N | 1.25" mesh fishtraps kg | 1.5" mesh fishtraps N | 1.5" mesh fishtraps kg |
|---|---|---|---|---|---|---|---|
| 1990 | 6 | (963) | 6.1 | (721) | 5.9 | | |
| 1991 | 68 | (1059) | 5.5 | (234) | 5.2 | (200) | 4.0 |
| 1994 | 42 | (859) | 7.4 | (367) | 8.5 | (444) | 6.0 |

**Table 5.** Mean soak times in days for 1.25" mesh fishtraps and for 1.5" mesh fishtraps in the Discovery Bay trap fishery from July to December in 1990 (ten months before the implementation of the mesh exchange program), 1991 (immediately after the implementation of mesh exchange program), and 1994 (three years after the implementation of the mesh exchange program). N represents number of fishtraps sampled, "=" represents no significant difference between years (Mann-Whitney, $P > 0.05$), "≠" represents significant difference between years (Mann-Whitney test, $P < 0.05$).

| Year | relative abundance of 1.5" mesh fishtraps (%) | all mesh size fishtraps N | all mesh size fishtraps kg | | 1.25" mesh fishtraps N | 1.25" mesh fishtraps kg | | 1.5" mesh fishtraps N | 1.5" mesh fishtraps kg | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | 6 | (1072) | 3.4 | | (835) | 3.1 | | | | |
| 1991 | 68 | (1174) | 3.8 | = | (276) | 3.5 | = | (201) | 6.0 | = |
| 1994 | 42 | (813) | 3.5 | | (360) | 2.6 | | (411) | 4.8 | |

**Table 6.** Perceptions of Discovery Bay trap fishers on the mesh exchange programme three years after its implementation, expressed in response to survey questionnaire conducted in October to December 1994. The number of active fishers in the trap fishery is 34. N represents number of respondents.

| Question | Response | Percent | N |
|---|---|---|---|
| Participated in the mesh exchange programme? | Yes | 76% | 34 |
| | No | 24% | |
| If participated, gained or lost? | Gained | 32% | 25 |
| | Lost | 64% | |
| | No effect | 4% | |
| Changes in the catch due to the large mesh? | No change | 4% | 25 |
| | Bigger fish (better catch) | 12% | |
| | Smaller fish (worse catch) | 68% | |
| | Fewer but bigger fish (even) | 16% | |
| The purpose of the mesh exchange programme? (multiple answers were recorded for some respondents) | To save juvenile fish | 42% | 33 |
| | To save certain fish species | 18% | |
| | To introduce larger mesh | 21% | |
| | To develop fishing industry | 21% | |
| | To harm fishermen | 6% | |
| Mesh exchange programme met its objective? | Yes | 76% | 33 |
| | No | 21% | |
| | Do not know | 3% | |
| If 1" mesh was no longer used in the trap fishery, in the long run.. | Catches would improve | 74% | 33 |
| | Catches would not improve | 24% | |
| | Do not know | 3% | |
| If 1.25" mesh was no longer used in the trap fishery in the long run... | Catches would improve | 53% | 32 |
| | Catches would not improve | 47% | |
| Preferred mesh size for fishtraps? | Large mesh (1.5") only | 22% | 33 |
| | Large mesh but may use both | 16% | |
| | Small mesh but may use both | 40% | |
| | Small mesh (1" or 1.25") only | 22% | |

P=0.274). Mean soak times of 1.25" mesh fishtraps within the fishery in 1990, 1991 and 1994, and of 1.5" mesh fishtraps in 1991 and 1994 are given in Table 5. Mean soak time for either mesh size showed no significant variation between years (Kruskal-Wallis test: for 1.25", H=1.23, N=311, P=0.541; for 1.5", U=1400, N=123, P=0.156).

Fisher responses to questions relating to the mesh exchange programme are given in Table 6. Seventy six percent of currently active fishers (N = 34) participated voluntarily in the mesh exchange programme in 1991. Although, 64% of the fishers who participated said they have lost as a result of the mesh size (change primarily because they thought there were fewer fish in the catch of the larger mesh fishtraps), 53% thought they would eventually catch more fish, if only large mesh was used in the Discovery Bay trap fishery. Furthermore, 74% of the respondents believed that the mesh exchange programme met its objectives. The objectives were seen by fishers as (i) to reduce fishing pressure on certain species of fish, and juveniles of all species (58% of respondents) and (ii) to introduce the large mesh into the fishery, and to improve the fishing industry(42%). Twenty two percent of fishers said that they now only use large mesh fishtraps, 16% said they preferred the large mesh but also used smaller mesh fishtraps, 40% said they preferred the small mesh but already do or would use large mesh fishtraps, and 22% said they did not want to use large mesh fishtraps at all.

**Current Progress of the Discovery Bay Fishermen's Association (DBFA)**

The DBFA has continued to develop with FIP assistance. The group achieved legal recognition in May 1993 when the Jamaica Cooperative Union registered it as a District Branch. This has allowed the DBFA to negotiate contracts on behalf of its members, to access duty-free fishing gear, and to open a gear store. FIP organized two courses for DBFA officers responsible for bookkeeping of gear store accounts and members' share records in Cooperative Management and Accounting. One course was held in 1993 over a six week period in collaboration with the U.S. based Volunteers in Oversees Cooperative Assistance (VOCA), and the other in 1995 in collaboration with the JCU. FIP also assisted DBFA members and other community leaders to attend various training workshops around the island to discuss topics such as Protected Area Management, Oyster and Seamoss Farming, Turtle Conservation, the Volunteer Game Warden System, and Environmental Legislation. With improved organizational capacity and greater environmental awareness, DBFA is now seeking more authority in the management of its fishing area, beginning with the creation of a fishery reserve (see Vieira *et al.*, this volume).

The DBFA is continuing to develop its headquarters at the Old Folly fishing beach. With FIP's assistance, DBFA obtained funding and materials in 1993 to renovate and enlarge their building to house the fishing gear store, and to construct a meeting hall. With a few donated rolls from the Kaiser Jamaica Bauxite Company (KJBC) and FIP, the DBFA was able to begin marketing the 1.5" mesh wire, meaning that it is now, for first time, easily available to north coast fishers.

FIP also assisted DBFA in contacting various funding agencies, and formulating proposals for projects to further upgrade facilities at the Old Folly fishing beach. In 1995 a grant was awarded by the Canada Green Fund to construct a fishers' complex comprising gear lockers, a kitchen, a caretaker's room, showers, toilets, and a much enlarged, secure gear store. Construction began in July 1995. A second grant was awarded by the Environmental Foundation of Jamaica to purchase the initial stock of 1.5" mesh wire.

**Continuing FIP Community Outreach Activities**

From late 1992 until August 1995, a small education programme was maintained with the help of the St. Ann Environment Protection Association (STAEPA), a local environmental non-governmental organization. Information and assistance were provided to the Discovery Bay fishing community in areas such as fishery laws, environmental issues, and the supply of fishing gear. FIP's notice boards were maintained on the fishing beaches and video/slide presentations on marine conservation issues were organized on the beaches as well as in Discovery Bay schools, churches, youth clubs, and summer camps. In addition, FIP organized beach clean-ups and other community events marking international environmental days to further sensitize the wider community to environmental issues.

Since August 1995, FIP extended its fishery education programme (with assistance from the DBFA) and fishery data collection programme (in collaboration with the Fishery Division and the CARICOM Fishery Resource Assessment and Management Programme (CFRAMP)) to four neighbouring fishing beaches. The main objective is to reduce the use of small mesh traps in waters within five kilometre of Discovery Bay (by promoting the use of large mesh), and to establish a minimum mesh size regulation for the fishery. A second objective is to facilitate the development of community-based organizations which could participate in co-management initiatives.

In the near future, FIP will offer mesh exchanges to the four neighbouring fishing beaches, will encourage and assist in the formation of legally registered Associations to facilitate the development of a community-based management approach, such as the establishment of locally managed fishery reserves.

The long term aim of FIP is to assist fishers from these communities to form a Local Fishery Management Council with authority to regulate the reef fishery on the north coast shelf.

## DISCUSSION AND RECOMMENDATIONS

Management of trap fisheries presents a particularly difficult problem given their artisanal nature, use of a relatively non-selective multi-species gear, and a highly complex multi-species resource (Munro and Smith, 1984; Mahon, 1989). One of the most popular management tools for trap fisheries in the Caribbean is minimum mesh size regulation, but there is no general agreement on what minimum mesh size is appropriate or what the outcome of a mesh size regulation on the resource or the resource user would be (Hunte and Mahon, 1994).

This study represents the first attempt to document the effects of introducing a larger mesh size into a small-scale commercial trap fishery. Comparisons of catch per fishtrap haul from before, immediately after, and three years after the implementation of the Fisheries Improvement Project's mesh exchange programme show that the trap fishery in Discovery Bay is beginning to benefit from the introduction of a larger mesh size. Catch per haul has increased in both 1.25" and 1.5" mesh fishtraps over the three year period since the implementation of the mesh exchange programme, despite the fact that fishing effort has remained steady. This indicates the beginning of some population recovery. However, fishers using 1.25" and 1.5" fishtraps have benefited differently because the changes observed in catch per haul are different for the two mesh sizes. For example, although the mean size of individual fish caught and the mean weight of fish per trap haul are greater for 1.5" fishtraps than the 1.25" fishtraps, the mean catch per week (approximately 1.74 kg/trap/week) is still less than for 1.25" fishtraps (approximately 2.62 kg/trap/week) because of the longer soak time. Thus, fishers who continue to operate small mesh fishtraps three years after the implementation of the mesh exchange programme, are benefiting greatly from other fishers moving to the large mesh. Furthermore, those who use 1.5" fishtraps exclusively, still have weekly catch rates (approximately 1.74 kg/trap/week) which are similar to those they would have had when using 1.25" fishtraps before the mesh exchange programme (approximately 1.78 kg/trap/week). These facts may be major obstacles in maintaining the use of the large mesh in the fishery. However, there are some benefits to fishing with 1.5" fishtraps compared with 1.25" fishtraps. For example, fishers who have full time employment outside the fishery will have less time for fishing and are therefore likely to prefer the large mesh fishtraps since they can maximize their returns for each fishing trip. The situation is further complicated by the fact that the value of the catch is also determined by species composition, and this too varies between mesh sizes (Sary, in press).

Since its implementation in 1991, the Fisheries Improvement Project's mesh exchange programme has enjoyed good support from Discovery Bay trap fishers with all but one of the trap fishers using small mesh fishtraps in 1991 entering the mesh exchange programme willingly. Furthermore, fishing effort (as number of fishtrap hauls per month) remained relatively stable after initiation of the mesh exchange programme despite the fact that fishers were given enough large mesh to built two fishtraps in exchange for every small mesh fishtrap they turned in. Therefore, early fears that the mesh exchange programme would lead to an escalation of fishing effort, and therefore contribute to the already severe overexploitation of the fishery, were not realized.

Fishers perceptions are very important to the success of any fishery management strategy, and this is particularly true for the mesh exchange programme in which participation is completely voluntary. According to the majority of trap fishers surveyed, the mesh exchange programme has not created noticeable improvements in the fishtrap catches in Discovery Bay. In fact, two thirds of fishers who participated in the mesh exchange programme reported that they had lost out as a result of the programme, with most citing a decline in the number of fish in the catches as the reason for the loss. Catch analysis confirms that the large mesh fishtraps indeed catch significantly fewer fish than the small mesh ones. However, it is of interest that 38% of those fishers who said they lost as a result of the mesh exchange programme, also said that catches would eventually improve if small mesh fishtraps were eliminated from the fishery, and 67% said they would continue using large mesh fishtraps despite their loss. Furthermore, 76% of all fishers surveyed thought the mesh exchange programme had met its intended objective. Therefore, it seems that the fishers' dissatisfaction with the mesh size change is more a reaction to the continually low catches in this depressed fishery, even though catch per hauls are no longer quite as low as before the mesh exchange, and to the current disparity in catch rates of the 1.5" fishtraps versus the 1.25"fishtraps.

Despite the positive changes observed since the mesh size change, the Discovery Bay fishery remains heavily overexploited, and although the price of fresh fish in Jamaica is very high, fishers' incomes remain small because catches are small.

It is clear therefore that the reef fish population requires further rehabilitation, which should in turn increase yields in the trap fishery. The positive changes detected in the catches, and the trap fishers' sometimes contradictory but overall positive reactions to the mesh exchange programme, suggests that continued attempts to maintain and complete the transition to a larger mesh size in the Discovery Bay trap fishery are worth while.

It is recommended that this initiative in Discovery Bay be accompanied by legislation to completely eliminate the smaller mesh sizes from the fishery. Enforcing the minimum mesh size regulation may best be achieved by established, community-based organizations, such as the DBFA in the Discovery Bay area, who have vested interests in the continued use of the large mesh. It is recommended that the formation and/or strengthening of fisher groups be encouraged in all fishing communities in Jamaica. Further, it is recommended that a legislative framework be developed (similar to the OECS harmonized legislation) to allow for the formation of local management councils which could participate in fishery management by recommending, implementing, enforcing or even enacting regulations within their prescribed area.

It is also recommended that a programme similar to the FIP's mesh exchange programme be attempted elsewhere in another Caribbean state where reef fish resources are exploited, in order to document the process of involving fishers in the implementation of a mesh size increase under different circumstances, and to build on the results of this study.

A modest change in fishtrap mesh size in an otherwise unregulated fishery, however, cannot adequately protect all fish stocks in a fishing area. A minimum mesh size regulation should therefore be accompanied by other management measures to realize the full potential of the fishery, and to protect diversity on the reefs. It is further recommended, therefore, that a major focus of reef fishery management, in Discovery Bay and elsewhere in Jamaica, be on fishery reserves where no disturbance of the reef community is allowed (see Vieira *et al.*, this volume). If successfully implemented, fishery reserves can support higher densities and larger sizes of heavily fished species than are found outside reserves, which may lead to a 'spillover' of individuals across reserve boundaries which could augment local catches (Rowley, 1994). Fishery reserves are also likely to be easier to enforce than most other management options, and they have the potential of reducing conflict between resource users (Roberts and Polunin, 1993; Bohnsack, 1993).

It is also recommended that the potential for an alternative small-scale pelagic fishery on the north coast of Jamaica be investigated, in order to alleviate some of the fishing pressure on overexploited reefs.

## LITERATURE CITED


Aiken, K.A. 1993. Jamaica. In: FAO. 1993. Marine fishery resources of the Antilles: Lesser Antilles, Puerto Rico and Hispaniola, Jamaica, Cuba. FAO Fisheries Technical Paper. No. 326: 159-180.

Aiken, K.A. and Haughton, M.O. 1983. A Management Plan for the Jamaican fisheries. Ministry of Agriculture, Science and Technology, Government of Jamaica. 41 p.

Allison, W.R. 1992. The Discovery Bay Fisheries Improvement Project: A status report. Proc. Gulf Caribb. Fish. Instit. 42: 331-337.

Anonymous, 1994. Draft principal elements of the Jamaica National Environmental Action Plan. Government of Jamaica. 38 p.

Anonymus, 1976. The Fishing Industry Act. Government of Jamaica. 24p.

Bohnsack, J.A. 1993. Marine reserves: They enhance fisheries, reduce conflicts, and protect resources. Oceanus 36(3): 63-71.

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

Hunte, W. and Mahon, R. 1994. Size selection of fish by the mesh of fish traps. Presented to the CARICOM Fisheries Resource Assessment and Management Project. Caricom Fishery Research Document. 28 p.

Koslow, J.A., Hanley, F. and Wicklund, R. 1988. Effects of fishing on reef fish communities at Pedro Bank and Port Royal Cays, Jamaica. Mar. Ecol. Prog. Ser. 43 (3): 201-212.

Koslow, J.A., Aiken, K., Auil, S., Clementson, A. 1994. Catch and effort analysis of the reef fisheries of Jamaica and Belize. Fish. Bull. 92: 737-747.

Liddell, W.D., Ohlhorst, S.L. and Coates, A.G. 1984. Modern and ancient carbonate environments of Jamaica. Sedimenta X, University of Miami.

Liddell, W.D. and Ohlhorst, S.L. 1993. Ten years of disturbance and change on a Jamaican fringing reef. Proc. 7th Int. Coral Reef Symp. 1: 144-150.

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

Miller, M., Z. Sary, J. Woodley, M.Picou-Gill and W. van Barneveld. 1991. Visual assessment of reef fish stocks in the vicinity of Discovery Bay,Jamaica. Presented at the 44th Annual Meeting of the Gulf and Caribbean Fisheries Institute, Nassau, Bahamas, November 1991.

Munro, J.L. and Smith, I.R. 1984. Management strategies for multi-species complexes in artisanal fisheries. Proc. Gulf Caribb. Fish. Instit. 36: 127-140.

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

Picou-Gill, M., Woodley, J., Miller, M., Sary, Z., Van Barneveld, W., Vatcher, S. and Brown, D. 1991. Catch analysis at Discovery Bay, Jamaica: The status of an artisanal reef fishery. Presented at the 44th Annual Meeting of the Gulf and Caribbean Fisheries Institute, Nassau, Bahamas, November 1991.

Roberts, C.M. and Polunin, N.V.C. 1993. Marine reserves: Simple solutions to managing complex fisheries?. Ambio 22(6): 363-368.

Rowley, R.J. 1994. Case studies and reviews: Marine reserves in fisheries management. Aquat. Cons.: Marine and Freshwater Ecosystems. 4: 233-254.

Sandeman, I.M. and Woodley, J.D. 1994. Jamaica North Coast Fisheries Improvement Project - Final Report to the Canadian International Development Agency. C.I.D.A. No. 504/13778. 36 p.

Sary, Z. in press. Responses of an overexploited Caribbean trap fishery to the introduction of a larger mesh size, in Discovery Bay, Jamaica. M.Sc. thesis. University of the West Indies, Cave Hill, Barbados, 112 p.

Sary, Z., Miller, M., Van Barneveld, W., Picou-Gill, M and Woodley, J. 1991.

Facilitating change in artisanal fishery practice: The two-for-one trap exchange programme at Discovery Bay, Jamaica. Presented at the 44th Annual Meeting of the Gulf and Caribbean Fisheries Institute, Nassau, Bahamas, November 1991.

Sary, Z., Picou-Gill, M., Miller, M., Van Barneveld, W., Woodley, J.D. and Sandeman, I.M. 1992. Effects of the increase in trap mesh-size on the Discovery Bay fishery. Presented at the 44th Annual Meeting of the Gulf and Caribbean Fisheries Institute, Merida, Mexico, November 1992.

van Barneveld, W., Sary, Z., Woodley, J., Miller, M. and Picou-Gill, M. 1991. Towards the co-operative management of fishing in Discovery Bay, Jamaica: The role of the Fisheries Improvement Project. Presented at the 44th Annual Meeting of the Gulf and Caribbean Fisheries Institute, Nassau, Bahamas, November 1991.

Vieira, A., Black, K.L., Woodley, J.D. and Sary, Z. The Discovery Bay Fishery Reserve: The development of Jamaica's second marine protected area. Proc. Gulf Caribb. Fish. Inst. 48: this volume.

Woodley, J.D. 1987. The development and management of a marine park system in Jamaica: 3. Discovery Bay. WWF/IUCN Project 1801. 28 p.

Woodley, J.D. 1994. Facilitating changes in artisanal fishery practice at Discovery Bay, Jamaica. In J.L Munro and P.E. Munro (eds.) The management of coral reef ecosystems. ICLARM Conf. Proc. 44. 124 p.

Woodley, J.D. and Robinson, E. 1977. Field guidebook to the modern and ancient reefs of Jamaica. Atlantic Reef Committee, University of Miami. 54p.