Facilitating Change in Artisanal Fishery Practice: The Two-For-One Trap Exchange Program at Discovery Bay, Jamaica

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ABSTRACT

In an overexploited fishery, any management measure that might permit higher sustainable yields in the long term involves reduced fishing effort - and thus reduced catches - in the short term. This presents an economic disincentive for artisanal fishermen. How can it be overcome?

Jamaican fishermen have long been using traps constructed of 3.3 cm (1 inch) and 4.1 cm maximum aperture (1.25 inch) mesh. To encourage progressive change to a larger mesh (as recommended by Munro, 1983), the government subsidizes the price of 4.1 cm (1.25 inch) and 5.5 cm (1.5 inch) mesh. This subsidy is quite small. Unfortunately, the 3.3 cm (1 inch) mesh is still available from ordinary hardware stores.

Trent University/University of the West Indies Fisheries Improvement Project funded by the Canadian International Development Agency (CIDA), budgeted to provide large mesh free of cost to Discovery Bay fishermen. If a fisherman brings us a 3.3 cm or 4.1 cm mesh trap, in working order, we give him sufficient 5.5 cm wire to build two new traps. The old trap is dismantled and the used mesh is made available for other projects in the community.

Initial reaction to our offer was skeptical, but six months later (as of October 31, 1991) the program is coming to a successful conclusion. Only one active fisherman out of forty seven in Discovery Bay refused to participate in the program. One hundred ninety-nine small mesh traps were exchanged by fishermen. The program managed to remove 91% of the 3.3 cm mesh traps, and 58% of the 4.1 cm mesh traps from active use in Discovery Bay, replacing them with 5.5 cm mesh traps. The resulting increase in mean mesh size represents a reduction in fishing effort, but it is hoped that the increased number of traps offsets the economic disincentive for the fishermen.

This program should increase the size at first capture of many reef fish species and increase the catch per unit effort in the future. The success of the program, however, depends on continued use of large mesh by the Discovery Bay fishermen.

KEY WORDS: Trap exchange, mesh size increase, artisanal fishery management.

INTRODUCTION

Despite lack of comprehensive, long-term data for most reef fish populations, indications of reef overfishing are found world-wide (Munro, 1983; Russ, 1985; Bohnsack, 1987; Plan Development Team, 1990). Heavy fishing pressure can decrease stock size, change the size and age structure of the population, and alter community composition. In extreme cases it leads to recruitment failure when not enough reproductive adults remain to produce sufficient offspring. While these changes occur, catch per unit effort decreases, and income from fishing declines.

Overfishing has been identified in Jamaica for many years (Munro, 1983; Aiken and Haughton, 1987) and more recently documented on the North Shore, in Discovery Bay (Picou-Gill *et al.*, this volume). A major contributor to the overfishing problem has been the very small mesh size of the fish traps (known as pots) which are the major gear type used to harvest reef fish in Jamaica. In Discovery Bay in recent years, the two kinds of mesh wire most commonly used have maximum apertures of only 3.3 cm and 4.1 cm (known as the "1 inch" and "1 1/4 inch" mesh). These mesh sizes can capture most of the economically important reef fish species before they reach a mature, reproductive size. This fact, coupled with easy access to a very narrow fishing ground, has led to severe overfishing on the north coast of Jamaica.

Any management strategy designed to rehabilitate the fish stocks must involve a reduction in fishing effort. Reduced fishing effort can be achieved by limiting access to the fishery, creating closed areas, closed seasons, catch quotas, or limiting gear by increasing trap mesh size increases (Aiken and Haughton, 1987). Fishermen resist the introduction of these management strategies not because they do not appreciate the importance of fishery management, but because they are reluctant to bear the economic cost of reduced effort. In Jamaica, where the economy is struggling, unemployment is high and welfare payments do not exist, many fishermen cannot afford to give up part of their daily income without facing severe poverty. Therefore, any management measure introduced must compensate for the expected drop in catches not only by promising a better fishery in the future, but by providing immediate economic incentives in the present.

INCREASING THE MESH SIZE

Beginning in 1988, Canadian International Development Agency (CIDA) funded the Trent University/University of the West Indies Fisheries Improvement Project to study the Discovery Bay fishery since 1988 (Allison, 1989; Vatcher, 1990). The project aims to introduce the fishermen to fishery management practices and to encourage their self regulation. One of the goals is to facilitate a progressive change to a larger mesh size for the fish traps. To achieve this, the project allocated funds to provide Discovery Bay fishermen with larger trap mesh free of charge.

The choice of sizes for the larger mesh was limited. Munro (1983) suggests using mesh with a maximum aperture of 6.6 cm (known as the "2 inch" mesh) as a best compromise between marketing requirements, the utilization of all available species and the protection of the greatest proportion of immature fish. This size mesh, however, is not readily available on the island. The Jamaica Co-operative Union (Fishermen's Co-op), which sells fishing gear at government subsidized prices to fishermen, only carries 4.1 cm and 5.5 cm maximum aperture mesh ("1 1/4 inch" and "1 1/2 inch" mesh, respectively). It would make little sense to introduce a gear type which would not be available to fishermen in the future. Also, the 6.6 cm mesh would introduce such a large increase in mesh size to this heavily exploited fishery that catches would most likely drop to negligible levels. The fishermen would not, and could not afford to accept such a drastic change in mesh size. The 5.5 cm mesh is the only acceptable mesh size to promote to the Discovery Bay fishermen at the present time. It represents a 67% increase in maximum aperture over the 3.3 cm mesh and a 34% increase over the 4.1 cm mesh. Also, it is nearly the same size as the minimum legal limit for fish trap mesh (5.6 cm maximum aperture) in United States, a country with vastly greater fishery resources under management. The acceptance of the 5.5 cm mesh in Discovery Bay would represent a very progressive and highly desirable change in the Jamaican fishery.

We wish to note here that the imperial measurements given are not the equivalent to the maximum mesh aperture but represent aperture between knots. Table 1 describes the relationship between maximum aperture and the distance between knots for the mesh sizes mentioned. The maximum aperture for the 5.5 cm mesh is not the same as the 4.95 cm size quoted by other authors such as Munro (1983) or Aiken (1987). The 5.5 cm size is the actual maximum aperture of the "Bear" brand (Belgium) wire mesh distributed among Discovery Bay fishermen. Only the metric measurements of the maximum aperture quoted in Table 1 will be used for the rest of the discussion.

Table 1. Parameters of various mesh sizes discussed.

MAXIMUM APERTURE	DISTANCE BETWEEN KNOTS
3.3 cm	2.5 cm
1 inch	4.1 cm
3.1 cm	1 1/4 inch
5.5 cm	3.8 cm
1 1/2 inch	6.6 cm
5.1 cm	2 inch

THE TWO-FOR-ONE TRAP EXCHANGE

In order to distribute the larger trap mesh fairly among the fishermen and to remove small mesh traps from the sea as quickly as possible, the project undertook a two-for-one trap exchange program. If a fisherman brings us a 3.3 cm or 4.1 cm mesh trap, in working order, we give him sufficient 5.5 cm mesh to build two new traps. This formula removes small-mesh traps from the fishery, introduces the larger mesh to fishermen, and at the same time, helps to overcome the economic disincentive of the expected smaller catches by doubling the number of traps a fisherman owns. The Project gives out wire mesh, but not fully constructed fish traps, because the fishermen generally prefer to build their own traps.

The exchange program was first announced to the fishermen at a meeting on March 22, 1991. The initial reaction to the offer was one of skepticism. The fishermen were reluctant to surrender their smaller mesh traps which were catching a few small fish, for larger mesh which in their view might catch no fish at all. The program continued to be publicized on the fishing beaches through posters and via personal contact with the fishermen. Finally, the first fish trap was exchanged on April 22, 1991. Slowly, the program gained acceptance among most of the fishermen because they realized the economic benefit of getting new mesh without paying for it. The exchange program has become a great economic incentive at a time of rapidly increasing costs and declining catches for fishermen. Once a few progressive fishermen took up the offer and began building their new 5.5 cm traps on the beaches, word of the exchange program spread quickly through the fishing community. For most of the summer, requests for the larger mesh came faster than we could arrange transport for it from Kingston, 125 km from Discovery Bay. The rate of trap exchange was accelerated even further with the eagerly awaited snapper season in October. Fishermen wanted to build as many of the new traps as possible for the brief snapper run which is one of the major money earning opportunities of the year.

RESULTS

Six months after the first trap was exchanged, we have exhausted our wire mesh budget of $12,250 CAN (approximately J$96,000). We purchased 90 rolls of 5.5 cm mesh wire, which are sold in strips of 45.7 meters (50 yards) by 1.52 meters (5 feet) at the Jamaica Cooperative Union, in Kingston. At the time of writing we have only five rolls of the mesh remaining.

Forty-two of the forty seven active trap fishermen in Discovery Bay exchanged a total of 199 small mesh traps. The old, small mesh traps are dismantled by fishermen hired by the Project, and the old wire mesh is made available for other projects in the community, such the construction of chicken coops. The old mesh wire is distributed mainly to women to prevent it from being made into fish traps again. Recycling of the old wire represents another benefit to the community from the mesh exchange program beyond the benefits to fishery management.

Of the five fishermen who did not exchange any traps, three were already using 5.5 cm mesh exclusively, and one is a part time fishermen who has not yet had an opportunity to exchange his traps. In other words, only one fisherman in Discovery Bay has not participated in the exchange program. Seventeen fishermen in Discovery Bay (36%) now use 5.5 cm mesh traps exclusively, a number which could have been greater had the project a bigger budget for new mesh.

Because Discovery Bay has a small fishery, the exchange program has been able to make a significant impact on the composition of mesh sizes of the fish traps used. In September and October, 1991, more than 80% of the active trap fishermen were interviewed to enumerate their fish traps. The results of this survey are shown in Table 2. Before the exchange program began, 5.5 cm mesh traps made up only 6% of the total number of traps used in Discovery Bay. Six months later, this figure jumped to 68%, and it is likely to increase in the next few months for the following reasons: the mesh exchange program is not completed; not all the 5.5 cm mesh given out has been made into traps yet; the smaller mesh traps remaining in use are older and not likely to last as long as the 5.5 cm traps. Most importantly, 65% of the fishermen interviewed indicated that they will use the 5.5 cm mesh exclusively in the future (see FISHERMEN'S ATTITUDE, pg. 292). Based on fishermen interviews at Discovery Bay landing beaches the proportion of 3.3 cm mesh traps in use has dropped from 21% to about 2% while the 4.1 cm traps have declined from 73% of the traps in use to 30%. The average reported mesh size of traps fished has increased from 3.95 cm in April when the program started to 4.64 cm in October, 1991. This increase in reported mesh size is compared to the same period in 1990 in Figure 1.

Table 2. Summary of the trap exchange program at Discovery Bay.

NUMBER OF TRAPS	MESH SIZE OF TRAPS			TOTALS
	3.3 cm	4.1 cm	5.5 cm	
before the exchange	68	236	20	324
exchanged	62	137	-	199
built since the exchange	-	-	200	200
after the exchange	6	99	220	325
Percent exchanged	91.2	58.1	0	61.4

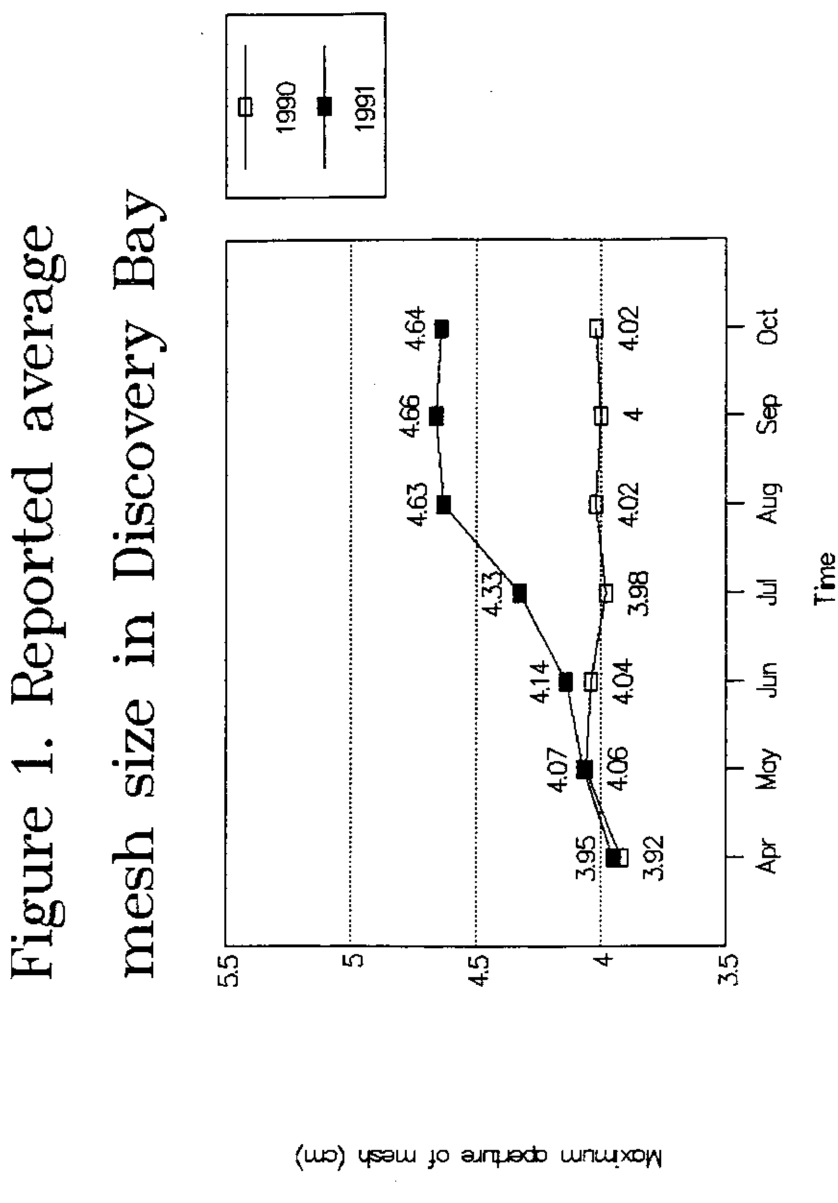

Figure 1. Reported average mesh size in Discovery Bay.

The total number of traps has not changed very much even with the two-for-one exchange. First, because each fisherman can operate only a certain number of traps. Secondly, not all the large mesh traps have been constructed. Thirdly, fishermen tend to build the 5.5 cm mesh traps larger than the small mesh traps. The reason for the larger trap size with larger wire mesh appears to be the longer soak time (from four days to two weeks) needed for the 5.5 cm mesh to successfully catch fish. Furthermore, the larger trap volume enhances the survival of the captured fish while the trap is soaking. Building the 5.5 cm mesh traps larger is a hinderance to older fishermen. Some are in their seventies and they often cannot lift the large traps by themselves. This problem is offset somewhat by the lighter weight per unit area of the larger mesh and its reported ability to resist algal growth for longer periods.

FISHERMEN'S ATTITUDE TOWARDS THE LARGER MESH

The mesh exchange program has provided our project an excellent opportunity to interact with fishermen in a positive manner and to discuss conservation and fishery management issues with them. In addition to the trap information presented above, 50% of the fishermen who participated in the mesh exchange shared their attitudes on the exchange program with us. Eighty percent of those sampled believed that the continued use of the larger mesh would improve fishing in the future. Ninety-five percent of those interviewed believed that fishing would improve if all fishermen used larger mesh. That same percentage said they would not buy 3.3 cm mesh anymore; sixty-five percent said they would buy only 5.5 cm mesh in the future. There were several reasons given for this: the small mesh kills too many juvenile fish; very small fish are difficult to sell; 5.5 cm mesh traps are lighter than smaller mesh traps of the same size; and less algae grows on the larger wire mesh.

THE EFFECTS ON FISH POPULATIONS

Most of the large, commercially valuable fish have all but disappeared from the Discovery Bay fishery, partly because they do not mature until a size much larger than the one retained by fish traps. Presumably, recruitment failures have long caused the collapse of most jack (Carangidae), snapper (Lutjanidae), and grouper (Serranidae) populations on Jamaica's north shore. Most of the fishery now relies on smaller reef species such as parrotfish (*e.g. Sparisoma aurofrenatum*), surgeonfish (*e.g. Acanthurus bahianus*) and the smallest members of the groupers (*e.g., Epinephelus cruentatus*). These species mature at sizes which are near the size retained by small mesh traps and, therefore, overfishing threatens recruitment in these species, as well. Table 3 shows the theoretical lengths retained by the three types of trap mesh used in Discovery Bay for thirteen selected species and their corresponding lengths at maturity (Munro, 1983). Length at maturity falls between the size captured by 4.1 cm

Table 3. Length parameter, based on Munro (1983), for selected, economically important reef fish species in the Discovery Bay fishery.

Species and Formula (FL=Fork Length; TL=Total Length; D=Body Depth)	Minimum retainable length by various mesh sizes 3.3 cm	4.1 cm	5.5 cm	Length at maturity (cm)
Acanthurus bahianus; FL=-8.44+3.64(D)	3.6	6.6	11.6	11
Acanthurus coeruleus; FL=-4.75+2.38(D)	3.1	5.1	8.3	13
Caranx ruber, FL=-1.18+3.61(D)	10.1	13.1	18.0	22.5
Epinephelus cruentatus; TL=0.5+3.47(D)	11.0	14.8	19.6	>16
Epinephelus fulvus; TL=4.2+3.09(D)	14.4	16.9	21.2	>16
Haemulon flavolineatum; FL=1.19+2.82(D)	10.5	12.9	16.7	15.5
Haemulon plumieri; FL=1.37+2.73(D)	10.4	12.6	16.4	20
Holocentrus ascensionis; FL=3.4(D)	11.2	14.0	18.7	14-15
Holocentrus rufus; FL=3.61(D)	11.9	14.9	19.9	13-14
Mulloidichthys martinicus; FL=4.01(D)	13.2	16.2	22.1	18.5
Pseudopeneus maculatus; FL=3.93(D)	13.0	16.2	21.6	17.5
Sparisoma aurofrenatum; FL=2.54+2.78(D)	11.7	13.9	17.7	14.6

Table 4. Parameters of the data used to construct Figures 2, 3 & 4.

Species	Mesh size	Mean size (mm)	Smallest (mm)	Largest (mm)	Sample size
Acanthurus bahianus	3.3 cm	130.97	60	187	39
	4.1 cm	144.93	109	239	268
	5.5 cm	156.07	119	220	13
Sparisoma viride	3.3 cm	177.48	131	269	45
	4.1 cm	187.09	128	377	56
	5.5 cm	259.64	185	400	23
Sparisoma aurofrenatum	3.3 cm	154.70	121	205	254
	4.1 cm	161.45	125	205	351
	5.5 cm	173.50	151	218	28

mesh and the size captured by 5.5 cm mesh for eight of the thirteen species, meaning that a much lower proportion of juveniles of these fish will be caught by the larger mesh. Munro notes the possibility that body length/depth relationships are not linear over the whole range of length groups; nevertheless, these figures provide an indication of the lengths retainable by the various mesh sizes.

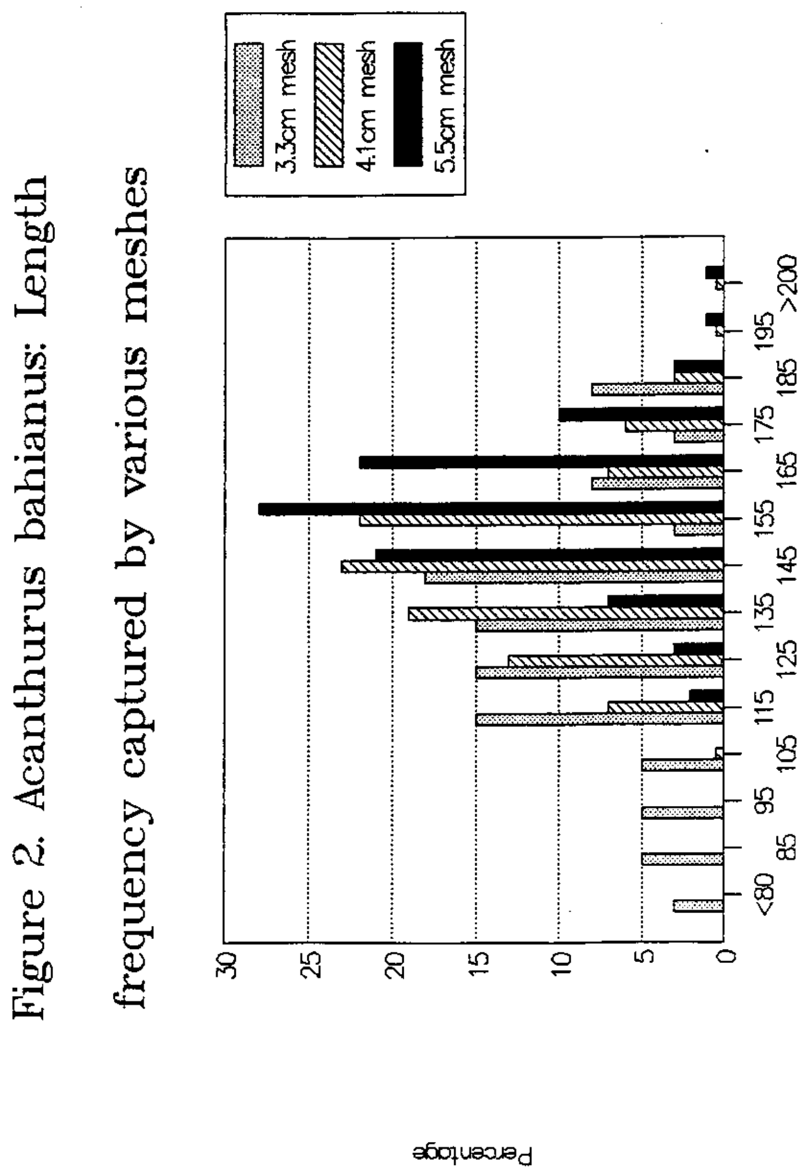

Figure 2. *Acanthurus bahianus*: Length frequency captured by various mesh sizes.

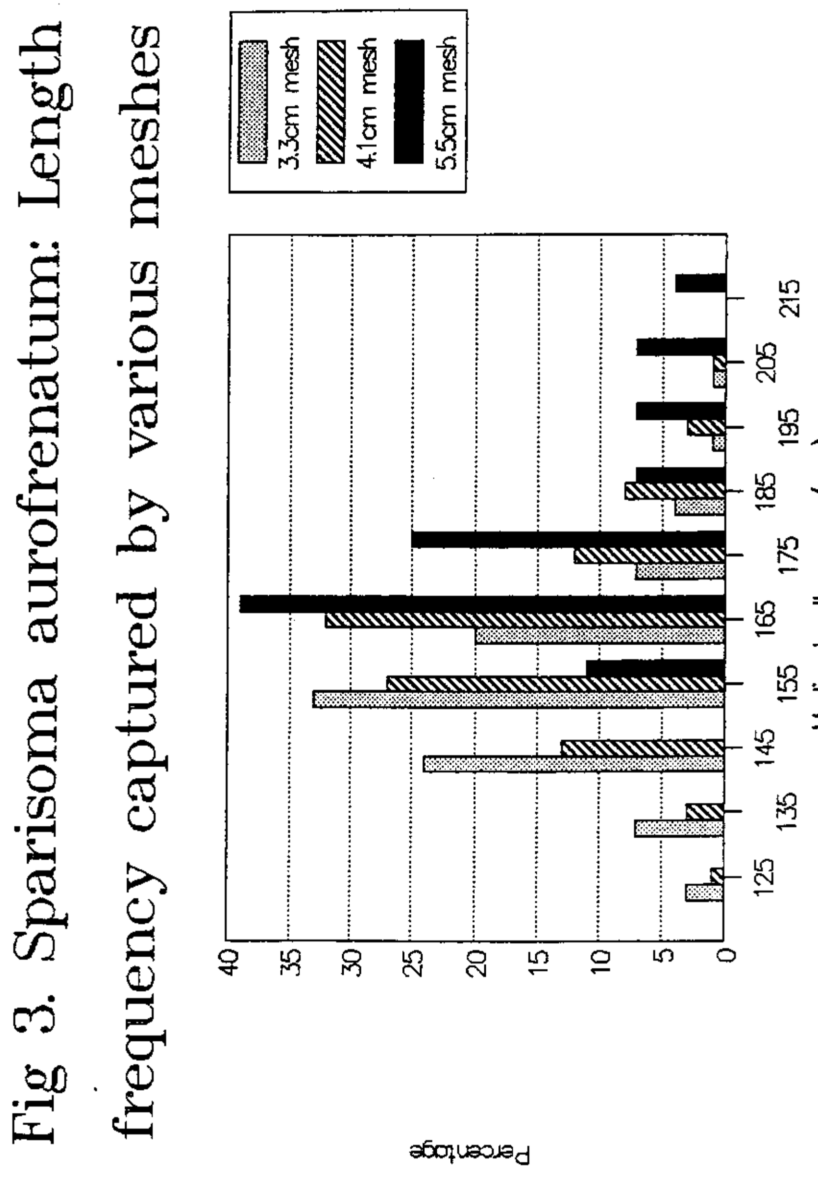

Figure 3. *Sparisoma aurofrenatum*: Length frequency captured by various mesh sizes.

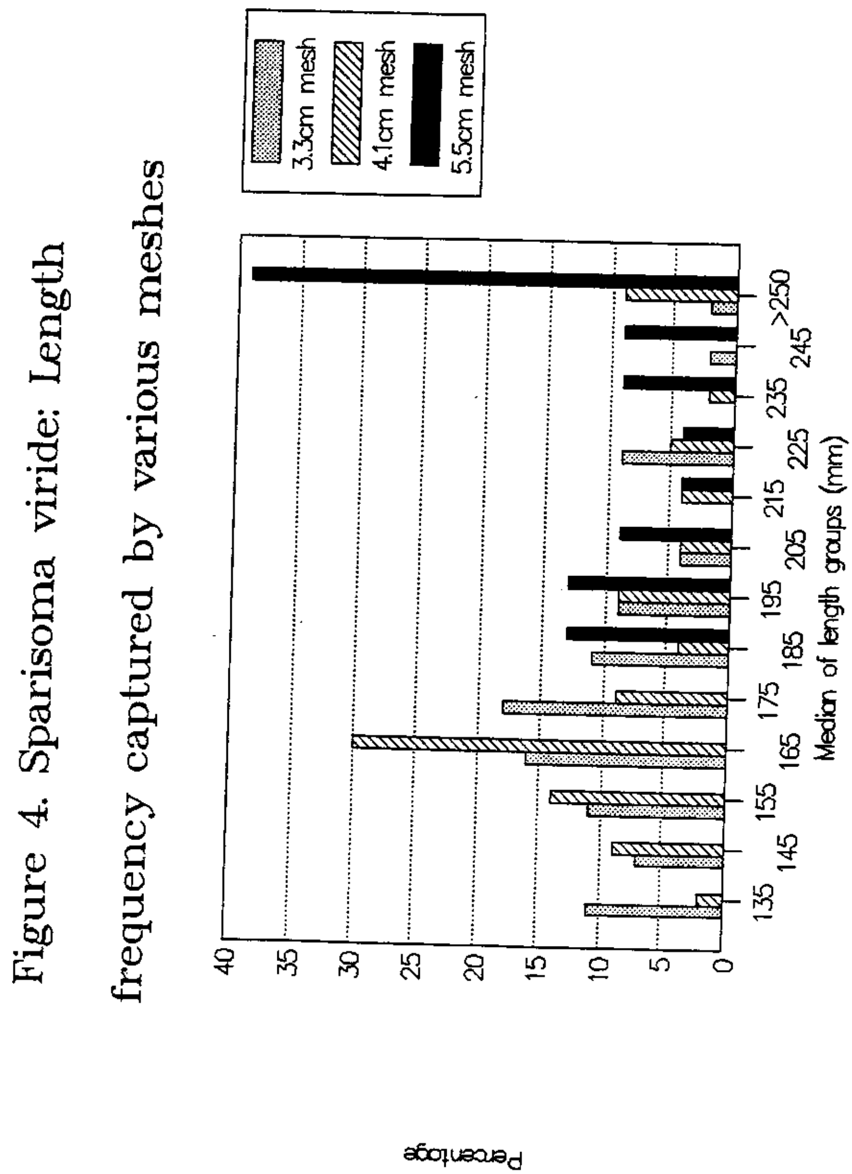

Figure 4. *Sparisoma viride*: Length frequency captured by various mesh sizes

Table 5. Performance of traps constructed of various sized mesh in Discovery Bay, between March 1990 and October 1991.

Maximum aperture of fish trap mesh (cm)	**3.3**	**3.3-4.1**	**4.1**	**4.1-5.5**	**5.5**
Total number of traps in sample	143	528	1602	422	155
Total number of fish captured	1059	2960	8167	1801	603
Mean number of fish per trap	8.47	6.87	6.22	5.34	4.57
Total weight of catch (Kg)	127.66	364.17	1219.46	303.54	159.41
Mean weight of catch per trap (Kg)	0.893	0.703	0.752	0.719	1.030
Mean weight of fish (Kg)	0.113	0.108	0.121	0.134	0.217

Length data collected by the Fisheries Improvement Project in Discovery Bay is not yet substantial enough to determine length at first capture for the 5.5 cm mesh size, although some trends are already evident. For the stoplight parrotfish (*Sparisoma viride*), the smallest fish captured so far in 5.5 cm mesh traps is 185 mm, and the mean size of the 23 individuals measured is 259 mm. These figures are approximately 40% larger than those for the two smaller mesh sizes. The redband parrot (*Sparisoma aurofrenatum*) and the ocean surgeon (*Acanthurus bahianus*) show similar increases for smallest individual captured and the mean length at capture with the 5.5 cm mesh. Table 4 summarizes the length data for the three species mentioned above, captured by various mesh sizes. Figures 2, 3, and 4 graphically show that a much higher percentage of these three species captured by 5.5 cm mesh do, in fact, fall into larger length groups, and none of the fish captured fall below the length at maturity quoted by Munro (1983).

The use of larger mesh will be beneficial even for those commercially important species which mature at sizes smaller than are caught by the 4.1 cm mesh. Hypothetically, if larger individuals survive the fishery, there should be a corresponding increase in egg production and a larger contribution to the genetic variability of the population. Among protogynous hermaphrodites (*i.e.* those which change sex from females to males) such as parrotfish, a reduced fishing mortality can restore the sex ratio so that the numbers of males is no longer limiting to production (Plan Development Team, 1990).

THE EFFECTS ON CATCHES

The data collected so far are promising for the fishermen as well. Table 5 summarizes the performance of the 5.5 cm mesh traps in Discovery Bay in comparison to the smaller mesh traps. While the mean number of fish per trap has declined with the 5.5 cm mesh by 27% from the 4.1 cm mesh, the mean weight of individual fish has increased by 79%. The total catch per trap has actually increased by 37%. This may partly be due to the increase in trap size, or the longer soaking times, but may also be inflated by the high numbers of snappers that were caught during the snapper run in October, 1991. This increasing catch trend is not likely to continue until the species that normally make up the majority of the catch, parrotfishes (Scaridae), surgeonfishes (Acanthuridae), goatfishes (Mullidae) etc., grow to a size where they become retainable by the 5.5 cm mesh. The time to reach retainable size, according to recent otolith aging studies, may be less than one year. For the striped parrotfish (*Scarus croicensis*), the time it takes to grow from a size catchable by the 4.1 cm mesh (approximately 13 cm) and the size catchable by 5.5 cm mesh (approximately 17 cm) ranges from 250-300 days. For the yellow goatfish (*Mulloidichthys martinicus*), the growth period between the sizes catchable by the two meshes (see Table 3) is 300-350 days (Barker, 1991); French grunt (*Haemulon flavolineatum*) is 150-200 days; and for the ocean surgeon (*Acanthurus bahianus*) it is 80-85 days (Brown, 1991). All these periods are less than the life expectancy of the new 5.5 cm mesh of 1 to 1.5 years, meaning that the large mesh should last until catches improve. Unfortunately, there is no way to gauge if the fishermen's patience with the larger mesh traps will last that long.

CONTINUED USE OF THE LARGER MESH

As indicated earlier, the general attitude of the fishermen towards the new mesh is positive. Most believe it will help the fishery in the long run, especially if it is used by all the fishermen. Unfortunately, the majority of the fishermen (more than 60%) buy mesh in the Discovery Bay area where the 5.5 cm mesh is not available. It seems unlikely that they would make the extra trip to Kingston to buy the larger mesh. The local lack of availability may be the major obstacle to the continued use of the 5.5 cm mesh.

The fishermen on one of the beaches, Old Folly, in Discovery Bay are in the process of organizing a cooperative (van Barneveld *et al.*, this volume) in order to supply fishing gear to themselves and to the fishermen in the surrounding area. The success of this cooperative may be instrumental in making the 5.5 cm mesh available in Discovery Bay and in its continued use. A cooperative group could also play a very important role in the self-regulation of the fishery especially by encouraging its members to use the large mesh.

The mesh exchange program can be continued and expanded to neighbouring fishing communities if extra funding is found. The program may be run in partnership with the fishermen's cooperative, by providing a subsidy on the 5.5 cm mesh for those fishermen who do not have any smaller mesh traps to exchange. A 50% rebate on 5.5 cm mesh would effectively continue the "two-for-one" aspect of the program since fishermen could buy two rolls of large mesh for the price of one roll of small mesh. This would also help the cooperative stay in business since mesh sales would be its biggest source of revenue.

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