Management of Antillean Trap Fisheries — Bermuda's Experience

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INTRODUCTION

Fish traps or pots, as they are often known, are used world-wide for catching crabs, shrimp, lobster, octopus, and fishes and are made in a wide range of sizes and shapes. In Bermuda and throughout much of the Caribbean, the standard pot used is the Antillean trap made from wire, or in some areas from woven bamboo. Pots made from hexagonal mesh "chicken coop wire" are typically chevron (or arrowhead) shaped and are reinforced with sticks of a dense wood or metal reinforcing bars. There are a number of variations on the basic chevron design including chevrons joined together to form "Z" and, when the corners are rounded, "S" pots (Figure 1). Some of the pots are split through the middle to enable them to be stacked when being transported (Munro, 1973). The hexagonal wire mesh used varies in measurement across the shortest dimension of the hexagon from 1.27 cm (0.5 in) to 3.8 cm (1.5 in). The length and width of Antillean traps range from 61 cm (2 ft) to 245 cm (8 ft) and their heights range from 30.5 cm (1 ft) to 122 cm (4 ft). Volume of these traps thus range from 0.37 m^3 (4 ft^3) to 7.25 m^3 (256 ft^3). Fishermen use both baited and unbaited traps for catching finfish and, when fishing for lobsters, they hang fish racks or salted cowhide, or use pieces of broken porcelain as attractants.

Although the Antillean trap is an important gear type for harvesting spiny lobster and tropical reef fishes, relatively little is known about the mechanics of how traps work. Based on research carried out in the late 1960's and early 1970's at the University of the West Indies, Jamaica, Munro (1983) developed a model using mesh size selection by body depth to determine the optimum mesh size for the harvest of the many varied coral reef fish species. This model was much criticized by Hartsuijker and Nicholson (1981) who felt that this model was too simplistic. They questioned its value and suggested that the size at recruitment may be more a function of the behavioural changes that occur as fish mature.

BERMUDA TRAP RESEARCH

The trap research carried out in Bermuda in recent years has been directed towards gaining insights into the mode of operation of this gear type and, in aprticular, to assess the effects of changes in mesh size on the size at recruitment, species composition of the catch, and the fishing power of traps. Luckhurst and Ward (1987) carried out a diving census on an array of traps two to three times daily over a period of four weeks using three different wire mesh sizes and both "straight" and "horseneck" funnels. The straight funnel terminates in an opening directly into the pot in a vertical plane with the jagged edges of the wire mesh serving to discourage escape from the pot. The

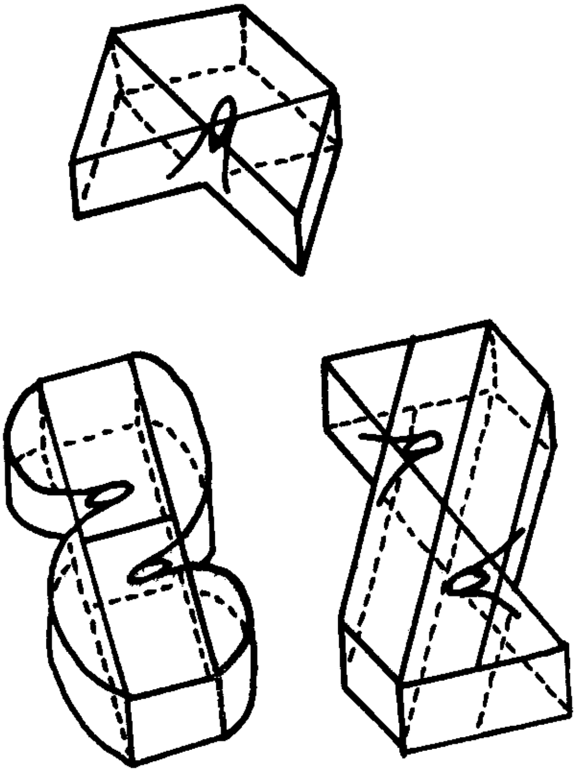

Figure 1. Three basic designs of Antillian fish traps in common use. Clockwise from the top a) arrowhead or chevron trap, b) Z-trap, c) S-trap (after Munro, 1983).

"horeseneck" funnel turns down at the inner end forming an elliptical opening in the horizontal plane (Figure 2). Of the three mesh sizes used, 3.8 cm (1.5 in), 5 cm (2 in) and 8.3 cm (nominally 3 in), only the 8.3 cm mesh showed a significant and dramatically different result. This large mesh caught a much reduced species assemblage and far fewer fish than pots of the smaller mesh sizes. The 8.3 cm mesh also caught far fewer large fish (fish of sufficient size to be physically retained by the mesh) than did both of the smaller meshes. This result and the fact that these large mesh traps present a poor visual image led the authors to suggest that visual impact may be an important factor affecting the fishing power of traps. This study failed to produce sufficient data to separate the efficiencies of the 3.8 cm and 5 cm mesh traps. Significant differences were seen when a more extensive project was carried out in collaboration with a local commercial fisherman (Ward, in press). In this study the effect of mesh size was examined when traps were fished commercially. The effect of mesh size on mean length at first capture (L_c) was examined and Munro's model,

$L_c = dD + v$ (Munro, 1983)

where D = maximum aperture of the mesh, and d and v are constants describing the length to maximum body depth relationship for the species.

was found to give an adequate first estimate although the L_c determined experimentally was consistently greater than that predicted by the model. This is generally in agreement with the findings of Hartsuijker and Nicholson (1981) and Munro (1983), however it is clear that the interpretation of Hartsuijker and Nicholson (1981) that this may be due to size-related behavioural changes in foraging is not the case in this study. Ward (in press) found that the smaller mesh sizes caught fish smaller than the sizes at which selection in the larger mesh was likely to occur. This result, in addition to the fact that the predicted L_c was usually smaller than the smallest specimen caught in the larger mesh, suggests that the underestimation of the parameter L_c is not due to the fish becoming susceptible to traps as they mature. A more likely explanation is the suggestion of Hartsuijker (1982) that fish can "squeeze" and pass through meshes of a smaller size than predicted. The major flaw in the use of Munro's model is that it fails to consider the effects of changes of mesh size on fishing power and the species composition of the catch. Ward (in press) found that the fishing power of traps was affected by mesh size, with the small increase in mesh size from 3.8 cm to 5 cm actually leading to an apparent increase for certain species whilst the larger (8.3 cm) mesh caught few fish of any size. The effect on fishing power was found to depend on the species in question.

It is intersting to note that Bermudian fishermen have been changing from the legal 3.8 cm minimum to 5 cm mesh wire as the new industry standard. Fishermen will rarely voluntarily adopt a measure that will reduce their effective fishing effort suggesting that, as was noted by Ward (1987), the expected reduction in usable catch when this change in mesh size was made did nto materialize. Fishermen report that fewer small, unmarketable fish are caught in the 5 cm mesh pots and that, in addition to saving up to one third on the cost of the wire, the labour invested in the construction of the trap is reduced.

Observations were made of traps with both "straight" and "horseneck" funnels (Luckhurst and Ward, 1987). With both designs, catch was seen to build up over time, however, straight funnels achieved a relatively lower asymptotic level with shorter soak times than did the traps with "horseneck" funnels. The authors attribute this difference to the increase in ingress and escape observed with "straight" funnels.

This corresponds with information from fishermen who indicate that"straight" funnel traps are "quicker" acting and should be fished with short soak times. Some species like the grey snapper (*Lutjanus griseus*) are adept at escapement; they seem to use straight funnel traps as shelter sites, the impression being that they can enter and leave at will. For practical conservation purposes the impact of lost traps would be greatly reduced if the straight funnel design were employed, although the behaviour of some species is poorly adapted to escapement, regardless of what funnel configuration is used.

MANAGEMENT

The trap fishery in Bermuda is managed by such measures as:

1. Minimum legal mesh size of 3.8 cm (1.5 in).
2. A requirement that the door be fastened with untreated (biodegradable) 0.6 cm (0.25 in) sisal twine.
3. Pots may be no smaller than 0.9 m (3 ft) nor larger than 2.4 m (8 ft) in the major dimension.
4. All pots must be marked with the owner's licence number.
5. All pots much have numbered surface floats of an approved type.
6. All pots must be hauled at least once every seven days.
7. The use of pots is restricted to licensed fishermen who are licensed to use a specified number of pot.
8. Only "full-time" fishermen may obtain a license and such licenses to use pots are not transferable.

The pot fishery is a limited entry: fishery and the Bermuda Government has a mandate to reduce numbers in use from 3200 (in 1985) to 1600 by 1990. Currently (1986), 2,600 pots are licensed to be used.

Although many of these pot regulations have been in effect for nearly 15 years, pots continue to be a problem gear type. Generally, pots are ideal for harvesting coral reef resources in that they harvest at all trophic levels taking both herbivores and carnivores. Unfortunately, the use of such a non-selective gear type precludes the possibility of managing the many species in isolation, with the result that some species will be overfished at levels of effort far below that appropriate for the optimal use of others. Consequently, in heavily trapped areas some species can be expected to be selectively removed. The most vulnerable species will probably be the larger, late maturing predators. Another potential problem arises from the fact that traps are selective to the extent that they rarely catch water column foragers, that group of carnivorous fishes which feeds on plankton carried onto the forereef by tides and currents. The diets of these fish consist variously of larval and juvenile fishes and crustaceans. As Hartsuijker and Nicholson (1981) point out the reductions in competition and predation on smaller piscivorous fishes caused by heavy trapping pressure may cause a species shift favouring this group. If trap fisheries tend to promote an increase in the populations of planktivorous fishes and small demersal piscivores, this may result in a decrease in the recruitment of all finfish species.

During the last several years, one of the main objectives of the Bermuda fisheries management programme has been the reduction of fishing pressure exterted by fish traps on the highly stressed reef fish resources. The introduction of a limited entry system, the elimination of part-time fishermen and amateurs from the trap fishery as well as the reduction of the maximum trap allotment to 50 per licensed fisherman are all intended to facilitate this. However, in response to these restrictions, some fishermen have moved towards the use of larger traps to offset their restricted numbers. Large traps are expensive to construct and require larger boats and winches to service them. It is highly unlikely that fishermen would continue to use such traps unless they were effective in increasing their allowable fishing effort. Anecdotal information in addition to the large catches occasionally landed by fishermen specializing in such large traps support this notion. Munro (1974) proposed that escapement is a function of the escaping fish encountering the funnel aperture after essentially random movements within the trap and that trap catches approach an asymptotic level when escapement equals ingress. If this holds true then the use of larger traps with the same number and size of funnel apertures willr esult in reduced escaptement and increased asymptotic catches. Further increasing the effectiveness of large traps is the probable effect of the enhanced visual image of a large trap effecting an increase in attraction potential and the fact that schooling fish can remain active in large traps, thereby creating a dynamic attractant.

We have recently initiated studies aimed at determining the nature of the relationship between catch and trap size with the hope of being able to quantify this effect. Traps of identical design and proportions but of 3 different sizes are being fished with the catch being measured and enumerated. It is anticipated that the highly variable nature of fish trap performance will dictate that an extremely large number of trap hauls will be required to adequately address this question.

Research is continuing to determine if large mesh (8.3 cm or greater) panels can be incorporated into fish pots without reducing the catch of target size fish whilst allowing small fish and lobsters to escape. Research is also continuing on finding ways to deactivate lost traps by incorporating degradable panels as weak links on door fastenings. The problems are not so much to find degradable materials as to learn how these materials can be incorporated into pots in an economical and practical way.

A most humbling discovery has come out of our research on pots and that is: we still do not fully understand how pots really work to catch fish. We therefore continue to manage the use of pots with minimum mesh size regulations that are too small to permit the escapement of juvenile fish and lobsters that we wish to protect and by attempting to cap the total pot fishing effort by limiting the number that can be used.

The range of fishing effort permitted under our present pot management regulations could be refined by reducing the allowable size range of pots. Total effort could also be reduced if pots were withdrawn from the fishery seasonally. It has been suggested that all pots should be removed from the water during three to four months in the summer when reef fishes and lobsters are spawning at Bermuda. Such a regulation would drastically reduce fishing pressure on spawning stocks at a time when many species are particularly vulnerable to the pot fishery and this would correspond with the seasonal closure of the lobster fishery. Such a regulation would give resource managers an opportunity to clean the reefs and channels of lost or abandoned gear and make counts of the gear actually being used by the fishermen. It would also reduce the illegal practice of storing lobsters out of season. Drawbacks to this proposal are that fishermen would spend a fair amount of unproductive effort bringing in their pots and caring for them while they are on shore. Perhaps more importantly, closing the trap fishery for this period might cause an unwanted "spill-over" effect into the line and net fisheries. Such a shift in fishing effort would increase competition and conflicts with net and line fishermen who are not licensed to use pots and who, under our limited entry system do not have an opportunity to obtain a license to use pots. A most important question to be answered about this propsal is whether or not total annual effort by pots will be reduced by removing them from the water for three to four months. With the numbers of variables that affect the fishing effort of each pot, will fishermen be able to effectively exert as much effort in the fishery during the open eight to nine months as they did when fishing with pots all year? If the answer to this question is "yes" or "probably" then a closed potting season may not be a wise management measure to contemplate.

The institution of a permanently closed area to act as a reservoir for the protection of all life history stages of the coral reef assemblage is also being contemplated. It is hoped that this tactic would preserve a breeding source for the repopulation of adjacent areas. Critical to the success of this proposal are:

1. The need for a sufficiently large area such that "chumming out" of fish by fishermen around the perimeter will be minimized.
2. That it be sited so as to include known spawning grounds.
3. That it include all the various habitat types necessary for the different life history stages of all the important species.
4. That it be established in an area where retention of larval production would be likely.

These are very difficult conditions to satisfy without causing undue hardhsip to the fishing community given the limited available shelf area of Bermuda. Further problems come from the facts that such a reservoir would affect fishermen to varying degrees with the fishermen who traditionally work that area being the hardest hit, that protection is restricted to a portion of the platform, and that the movement of traps from the reservoir would likely increase fishing pressure and conflicts in adjacent areas.

The sensibility of instituting these, or other major management schemes, are decisions that challenge fisheries administrators and, indeed, legislators world-wide. A forum to discuss the merits of the various management approaches might facilitate the planning of long-term resource use and fisheries development within the Gulf and Caribbean region.

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