

Development of a Lobster-Specific Trap in Bermuda and Fisheries Management Considerations for the Re-Establishment of a Commercial Lobster Fishery

JACK A. WARD and BRIAN E. LUCKHURST

*Division of Fisheries
P.O. Box CRS2
Crawl CRBX
Bermuda*

ABSTRACT

The closure of Bermuda's fish trap fishery in April 1990, resulted in the elimination of the commercial lobster fishery which was also based on the use of this gear. As the spiny lobster, *Panulirus argus*, stock is considered to be healthy, this closure created a need for a lobster-specific trap to enable the commercial harvest of lobsters to resume.

In conjunction with commercial lobster fishermen, several different types of traps were fished around the edge of the Bermuda platform over a period of six months. A total of 1,198 trap hauls were made. Statistical analyses showed that catch rates varied significantly between trap designs and within designs fitted with different funnel configurations.

The design accepted for future use is a rectangular trap (122 cm L x 91 cm W x 46 cm H) constructed of 5.1 cm square, ten guage galvanized steel panels. Molded plastic funnels were fitted into the trap in different configurations and two vertical escape gaps for fish were cut in the mesh at each corner of the trap.

Using this trap, catch rates varied from a mean of 1.1 lobsters per trap haul for a single top-mounted funnel to 2.1 for traps with one top and one side-mounted funnel. These results compared favourably with those determined for Antillean fish traps. The by-catch with this new trap design was small with a mean of 0.16 animals (all taxa) per haul.

A three year pilot lobster fishery has been approved using this gear. This restructured fishery will: 1) incorporate limited entry; 2) be based on an estimated Total Allowable Catch; 3) have area/depth restrictions; and, 4) promote control by having fishermen lease traps from the government for an annual fee during the pilot fishery.

KEY WORDS: Spiny lobster, trap, experimental fishing, Bermuda.

INTRODUCTION

The commercial fishery at Bermuda has traditionally been based on the use of wire mesh fish traps. These traps were used both for the harvest of finfish and lobsters. In recent years, the fishery for the spiny lobster, *Panulirus argus*, has been highly regulated. Management measures directed towards the commercial harvest have included: i) a minimum size limit of 92 mm carapace length, ii) a closed breeding season from April 1st through August 31st, iii) protection of gravid females, iv) limited entry into the commercial fishery with attendant gear

limitations, and v) the closure of inshore nursery grounds. The recreational harvest has been limited to: i) the taking of lobsters by licensed divers only, ii) a bag limit of 2 per diver per day, iii) free diving only (no SCUBA), and iv) the use of nooses only to snare lobsters (no spears, etc.). Recreational harvest is also prohibited in inshore waters.

Despite substantial annual fluctuations in landings, under this management regime, the fishery appears to have achieved equilibrium (Figure 1). The healthy status of Bermuda's lobster stock is reflected in the fact that the highest recorded landing of 35, 193 individuals was achieved in 1989.

In stark contrast with the trends in abundance of lobsters, the finfish of Bermuda have shown marked signs of over-exploitation (Luckhurst and Ward, this volume). Concern over the impact of commercial trap fishing on reef fish stocks led to the adoption of the 1990 Management Plan which banned the use of traps (Burnett-Herkes and Barnes, this volume). With this measure, the commercial harvest of spiny lobsters was effectively curtailed. Given the healthy status of the lobster stock along with strong consumer demand and the industry's economic need, the Division of Fisheries was directed to undertake studies aimed at developing a lobster-specific trap fishery.

METHODS

Preliminary Studies

Initially, traps that were in commercial use elsewhere were obtained and fished in inshore waters. Florida wooden slat traps and a basket shaped plastic crustacean trap were tested. Despite varying bait used in locations set, neither of these traps were found to be effective.

After consultation with fishermen, a few key considerations for the design of a new trap were identified: i) the funnel design was considered to be pivotal, with the key aspect being a wide, somewhat rigid inner end, and ii) the use of wire mesh was considered important, being the material upon which a successful local fishery had been based. It was further noted that iii) vertically-oriented, rectangular escape gaps would probably promote escapement of finfish. Limited earlier studies (Division of Fisheries, unpublished) had identified an escape gap of approximately 8.25 cm in width as that size which would allow escapement of sublegal animals (>92 mm CL) whilst retaining legal catch. It was accepted that a smaller escape gap could be incorporated without adversely affecting the catch of legal lobsters.

Several fishermen argued that the incorporation of escape gaps and some method of maintaining a wide open funnel would be effective in making their traditional Antillean arrowhead traps lobster-specific. Despite the logic in this approach, political considerations pre-empted the use of such traps.

The prototype trap was built of heavy gauge, galvanized, 5.1 cm welded square mesh (Figure 2). The dimensions of the trap, nominally 91 cm x 122 cm

(Number of individuals)

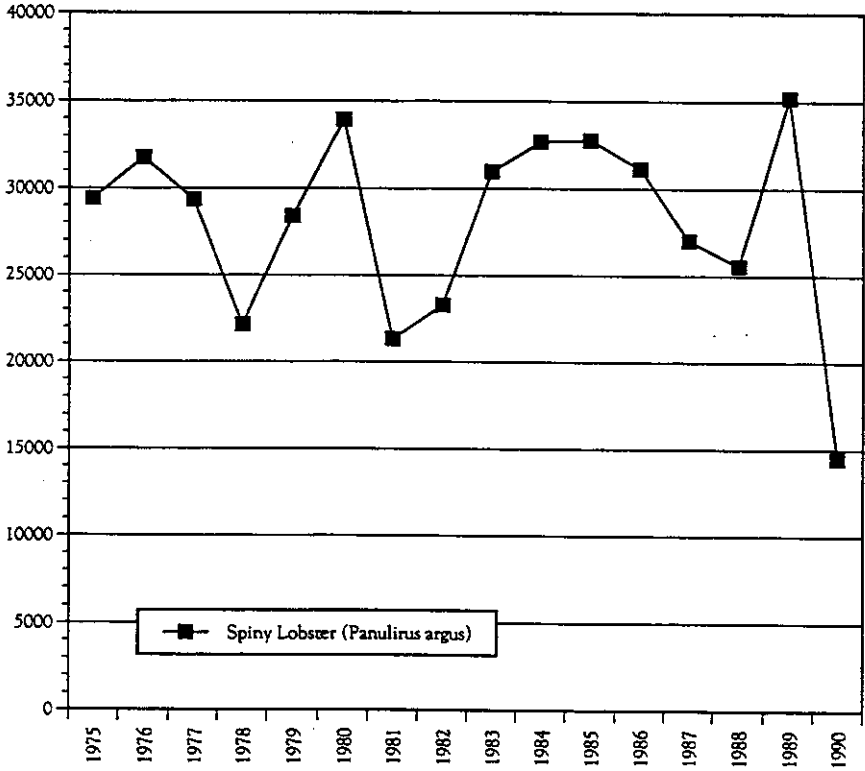
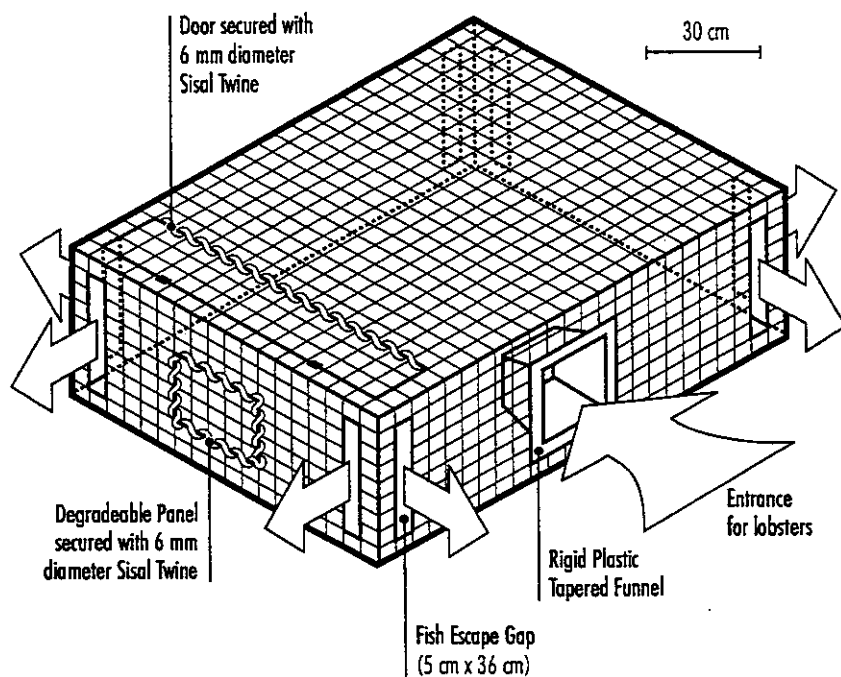


Figure 1. Trends in landings of the spiny lobster, *Panulirus argus*, at Bermuda.

Prototype Lobster-Specific Trap



Constructed of galvanized, 10 gauge, welded, 5.1 cm square mesh

Trap Dimensions

Length: 122 cm

Width: 91 cm

Height: 46 cm

Figure 2. Bermuda Division of Fisheries' prototype lobster-specific trap.

x 46 cm, were dictated by that which could be effectively worked on small vessels, which might win industry acceptance and which provided efficient use of the stock from which they were constructed. The funnel used was a commercially available plastic extrusion scavenged from the Florida slat trap, with a 19 cm square opening tapering over its 19 cm length to an inner, rectangular opening of 18 cm x 11 cm. Funnels were placed either in the middle of the top panel or in the middle of one of the longer side panels. Traps were made both with and without eight vertically-oriented escape gaps of 5.1 cm (1 mesh) x 35.6 cm, two to a side, set back approximately 5 cm from the corners.

These traps were fished in inshore waters in order to test whether: i) they would catch lobsters, ii) the inclusion of escape gaps would minimize finfish bycatch, and iii) whether funnel position would affect fishing power.

Additional Research

Support was secured from Government for the conduct of a limited "commercial" experimental fishery. The limitations placed on this experiment were formulated in the light of several practical constraints. Given the recent compensated closure of the trap fishery along with the fact that widespread abuses of fish trap regulations had promoted this radical measure, it was most important that this experiment be closely controlled.

Historically, control of the fish trap fishery had proven particularly difficult in nearshore waters where traps could easily be set without surface markers. Given this and the knowledge that a significant number of the banned fish traps remained in this area, it was decided that the establishment of a fishery within this area would promote abuses. Additionally, the edge of the Bermuda platform, that zone between 40 and 80 meters depth, had been the most productive area for lobster fishing (Figure 3). As this latter zone is quite limited spatially and impractical to fish with subsurface gear, it is the easiest to patrol. It was agreed that the probability of establishing a controlled lobster fishery was promoted by limiting effort to this zone.

The edge of Bermuda's platform is the site of a dramatic drop-off which demands a substantial measure of experience to effectively fish during the winter lobster season. For this reason the participation of experienced "edge" lobster fishermen was solicited. It was anticipated that there would be general support for the involvement of experienced lobster fishermen in this project. With the fishermen's vested interest in the early establishment of a lobster fishery and their respect for the abilities of the best of their peers, both the credibility of the study and the dissemination of the results would likely be promoted.

The Division of Fisheries undertook to supply the gear whilst the fishermen were required to supply the boat, fuel and bait. The fishermen were given the catch as payment. Fisheries observers were required to be in attendance whenever the gear was hauled to record catch and effort data. Initially the

Bermuda Platform

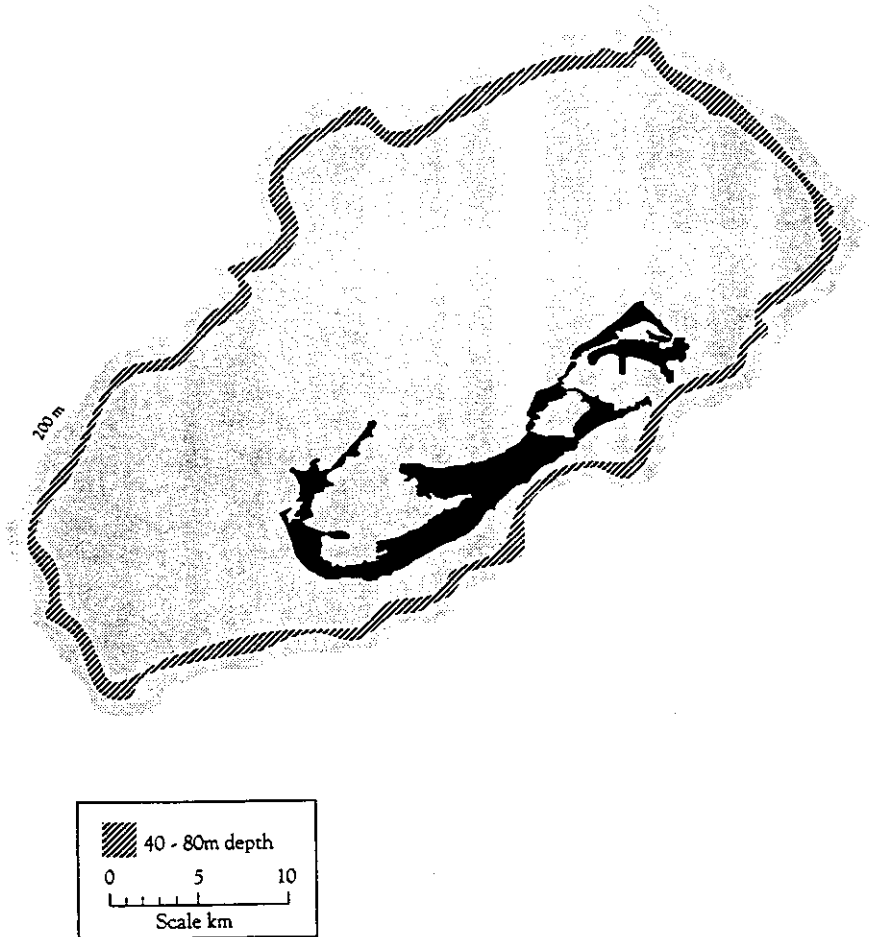


Figure 3. The Bermuda platform to the 200 m bathymetric contour indicating the area designated for the "edge" fishery.

fishermen were supplied with fifteen "standard" top funnel traps and allowed to fish an additional five "experimental" designs of their own. Rather than incur the expense of building their own traps most opted to take an additional five of the "standard" traps and modify them with the insertion of additional funnels. As the study progressed and a data base sufficient to quantify the fishing power of the top funnel trap was created, the "standard" trap evolved to one with a single side funnel. It should be noted that the initial use of the top funnel configuration as the standard was based largely on a widely held preconception, unsupported by the results of the preliminary study, that top funnels would catch fewer finfish.

Fishing began in early October of 1990 and continued through to the end of March 1991. Catches were recorded by trap type and the data stored as a LOTUS 123 spreadsheet. The data were analyzed using Minitab Release 7 statistical software

RESULTS

The results of the preliminary study (Table 1) indicated that the inclusion of escape gaps caused a significant reduction in finfish bycatch without affecting lobster catches. However, this study failed to detect any significant difference in fishing power as a function of funnel placement, a probable result of limited sample size. Although the traps were shown to catch lobsters, the question remained as to whether fishing power was sufficiently great to support the economic viability of this gear. It was accepted that such a determination would be best accomplished through experimental fishing in a commercial setting with the assistance of veteran lobstermen.

A total of 1,198 trap hauls were completed during the experimental commercial fishery, with 3,314 lobsters being caught of which 2,029 exceeded 92 mm CL. The total bycatch was 263 individuals. Fourteen different trap designs were tested, four versions of Fisheries' standard trap and ten more novel designs. Due to the large number of variations many of the designs were not worked sufficiently to adequately quantify their performance. For presentation purposes those traps which were hauled less than 25 times are pooled despite some dramatic differences in the fishing power of some of these designs. Table 2(a) summarizes the catch rate of the various trap designs.

Trap design was found to significantly affect the catch rates of both *P. argus* and of the bycatch. One fisherman's design, LES2, a large (1.5 m x 1.5 m x 0.6 m) trap equipped with two large wire mesh funnels and twelve vertically-oriented escape gaps (approximately 5.7 cm x 22.9 cm) located near the corners consistently outfished all variations of the standard trap. Additionally, the bycatch produced with this trap was extremely low. The distribution of the traps on the fishing grounds was often clumped by design. As *P. argus* is highly gregarious, this distribution compromises gear comparisons.

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Table 1. Summary of catch rates of prototype traps.

Trap	Hauls	Legal Lobster Catch			Bycatch (All Species)		
		Total	Mean	95% C.I.	Total	Mean	95% C.I.
TG	69	15	0.22	0.03-0.41	19	0.28	0.10-0.45
SG	35	15	0.43	0.11-0.74	05	0.14	-0.05-0.33
TN	35	03	0.09	-0.01-0.18	43	1.23	0.54-1.92
SN	35	05	0.14	-0.03-0.31	15	0.43	0.13-0.72
Total	174	38			82		

Key to trap designs:

TG = Single top funnel with escape gaps.

SG = Single side funnel with escape gaps.

TN = Single top funnel without escape gaps.

SN = Single side funnel without escape gaps.

Table 2 (a). Summary of catch rates of various traps.

Trap	Hauls	Legal Lobster Catch			Bycatch (All Species)		
		Total	Mean	95% C.I.	Total	Mean	95% C.I.
T	619	682	1.11	0.95-1.26	149	0.24	0.17-0.31
S	171	249	1.46	1.11-1.81	10	0.06	0.02-0.10
TS	156	325	2.08	1.68-2.52	39	0.25	0.14-0.36
STS	84	124	1.48	0.92-2.04	07	0.08	0.02-0.14
LES2	61	351	5.85	4.64-7.06	03	0.05	-0.01-0.11
Other	107	298	Not Applicable		55	Not Applicable	
Total	1198	2029		263			

Key to trap designs:

T = Standard trap with top funnel only.

S = Standard trap with side funnel only.

TS = Standard trap with two funnels, one top and one side.

STS = Standard trap with three funnels, one top and two sides.

LES2 = Fisherman's design with two wire funnels on one side.

Other = Consists of ten novel designs.

Table 2 (b). Catch rates of selected traps.

Trap	Hauls	Total	Legal Lobster Catch	
			Mean	95% C.I.
T	26	45	1.73	0.83-2.63
TS	128	154	1.20	0.88-1.52
S	95	213	2.24	1.70-2.78

Key to trap designs:

T = Standard trap with top funnel only.

S = Standard trap with side funnel only.

TS = Standard trap with two funnels, one top and one side.

Table 2(b) presents a summary of legal catch rates of selected traps derived from data obtained from two fishermen who alternated rather than clumped gear types. This, more valid comparison, shows that of three variations of the standard trap, the single side funnel version performed best.

Regression analyses of catch rate as a function of soak time revealed no significant interaction. Catch appeared to be independent of soak time, however, it is believed that several factors (e.g. bait quality, predator build-up, etc.) may act to confound any relationships which may exist.

In excess of 90% of the bycatch was made up of the gray triggerfish, *Balistes capriscus*, and the sponge crab, *Dromia erythropus*. Both of these species are hardy and can be returned to the sea without obvious ill effects. Furthermore, at Bermuda, *B. capriscus* is a principle predator of trapped lobsters. It is unlikely that this species attempts to escape from traps containing lobsters except during hauling; indeed, several observations were made of triggerfish leaving traps as they neared the surface.

DISCUSSION

The principle objective of this work was to develop a trap to allow the commercial harvest of spiny lobsters without adversely affecting local reef finfish stocks. The results demonstrate that when fished in "edge" waters, several trap configurations can be used for this purpose.

The traps experimented with in this study exhibited catch rates ranging from 1.11 to 5.85 lobsters per haul. This result raises the question of how this compares with catch rates of traditional arrowhead traps fished in the same depths. In order to attempt to address this question, the statistics of three of the most productive lobster fishermen were examined. All three of these fishermen gave verbal confirmation that they had reported their statistics accurately and that all their efforts had been directed towards fishing the edge for lobsters. It

was determined that, over three years, these fishermen had achieved an average catch rate of between 0.58 and 1.94 with an overall average of 1.20 lobsters per haul. Compared with this result, the new traps were judged to be sufficiently effective.

The conditions under which this study was conducted are likely to have had considerable effects on the resultant catch rates. The lobsters were subjected to greatly reduced fishing pressure and consequently were probably present in increased numbers. This would have biased the results upwards. Compensating for this effect to some unknown degree would be the short time which each fishermen was allowed to use the gear. Several of the participants felt that they could have improved on their performance if they had been allowed sufficient time to track the lobsters. In light of these effects, it is probable that the catch rates that these traps will exhibit in an active fishery may differ substantially from those reported here.

The mean bycatch was judged to be acceptably small, ranging from 0.05 to 0.25 individuals per haul. This is particularly acceptable as the principle concern over bycatch was for reef finfish and the only finfish caught with any regularity, *B. caprisicus*, is locally abundant and apparently increasing in numbers.

It must be noted that fishermen had repeatedly stated that catches of finfish in these waters are predictably low during the lobster season. Bycatch levels determined during this study do not differ significantly from those determined for similar traps worked inshore during the preliminary study. Despite this, a cautious approach to extrapolating from these values to predict catch rates in other areas is encouraged.

Management Application

The closure of Bermuda's trap fishery was largely precipitated by the inability of the Division of Fisheries to adequately enforce fish trap regulations and ensure conformity to limited trap allotments. All of the management measures aimed at limiting fishing effort to forestall the declines in reef fish abundance were compromised by this failure. The Commission of Inquiry (Towle *et al.*, 1991), convened principally to investigate the circumstances surrounding the closure of the trap fishery, outlined three criteria which it felt must be met prior to the reestablishment of any trap fishery:

- a) There must be commitment, both philosophically and financially (boats and wardens) to rigorous enforcement of the regulations.
- b) There should be clear evidence that the traps would be the most efficient and selective approach to harvesting the available yield.
- c) There should be zoning restrictions which would exclude traps from areas which are extensively used by tourist industry."

Armed with the results of this study and guided by these criteria, the Division of Fisheries made a proposal to Government for the establishment of a

three year pilot lobster fishery. The main elements of this proposal were:

i) That the fishery be confined to the edge of the platform in waters of 40 m to 80 m depth.

ii) That the total allotment of traps be set in order to target an estimated Total Allowable Catch (TAC) derived from historical catch and effort data.

iii) That the fishery be based on the use of Fisheries' standard side funnel trap and that the Government lease these traps to the fishermen.

iv) That the fishery be closely monitored in order to obtain accurate information upon which to base a refined TAC target.

v) That the fishery be based on a limited entry system with fishermen to whom lobster fishing had been particularly important being given preferential access in the first year.

Confining the Fishery to the Edge

As was noted earlier, the main rationale for confining this fishery to the edge is to promote enforceability. This zone is spatially limited to a narrow band surrounding the island (Figure 3). Since it is impractical to fish traps without surface buoys in these waters, patrolling this band to ensure conformity to trap allotments, etc., is possible. This spatial limitation does much to offset the Division's limited enforcement capability. In addition to enforcement considerations, this restriction removes the fishery from those areas used heavily by the tourist industry. The edge is also the most productive zone for lobster fishing.

Using an Estimated Total Allowable Catch to Define Allocations

As part of the proposal to open a fishery limited to the edge it was necessary to determine a reasonable total allotment of traps. With the premise that a conservative approach is best, and the assumption that the lobster fishery had been in equilibrium prior to the closure, historical data was used to estimate a sustainable level of harvest for an edge fishery. The most tenuous aspect of this exercise was estimating the proportion of the total lobster catch that had come from the edge fishery. In theory this should have been accessible from Fisheries' database but due to reporting practices and inputting protocol, it was not. From interviews with fishermen and discussions amongst Fisheries officers, it was accepted that 60% was a reasonable first approximation.

Over six years (1984-1989) Bermuda's average reported lobster catch was 30,713. Assuming that 60% of this was derived from the edge fishery, the target TAC was set at 18,400 lobsters. Bermuda's lobster season is approximately 200 days which, assuming an average soak time of four days, allows for 50 hauls/trap/season. Using an average catch rate of 1.75 lobsters/haul for the standard side funnel trap (Tables 2(a) and 2(b)), the expected catch per trap is 87.5/season. These crude calculations result in a total allotment of 210 traps.

Basing the Fishery on Fisheries' Standard Side Funnel Trap

The results of this study demonstrated that several different traps can be used to selectively harvest spiny lobsters with the two key elements apparently being a wide open funnel configuration and escape gaps. Catch rates for lobsters varied significantly between several of the traps with a range in catch rates from 1.11 to 5.85 lobsters/haul. The trap selected for the pilot fishery was not the most effective trap, a design produced by a veteran lobster fisherman, but rather the most efficient of the standard traps. The reasons for this selection are twofold; firstly, with the most efficient trap, the total allotment would have been dramatically reduced, and secondly, the standard trap is much smaller and more appropriate for mass production.

Due to the extremely patchy distribution of lobsters on the fishing ground there is some minimum number of traps needed by a fisherman to find aggregations and to follow their movements. It was felt that, under the terms of the TAC program based on gear restrictions, the use of the most efficient trap would have resulted in either inadequate individual gear allotments or an unacceptably small number of participants.

The condition that Government produce and lease the traps to fishermen was intended to serve two functions: to maintain control over the gear and to limit investment by fishermen. As the proposal was for this fishery to be initially run for three years, to be constantly monitored and for the TAC and hence gear allotments to be refined in light of better information, this condition was considered essential. To better serve this need, a trap that was designed for mass production and which was difficult to copy was desirable.

Preferentially Selecting Veteran Lobster Fishermen

An essential element of the closure of Bermuda's trap fishery was the payment of a Ex-Gratia sum based on participation in the fishery over the previous three years. Fishermen were credited for time at sea, pots hauled and finfish catch landed. These parameters were determined from their statistical submissions. Fishermen were not credited for lobster landings in the formulation of their Ex-Gratia as the Minister had undertaken a commitment to reestablish the lobster fishery as soon as possible. As partial compensation for any shortfall in Ex-Gratia payments, it was proposed that fishermen be ranked according to the importance of lobsters in their landing, and that this ranking be followed when offering places in the first year of this limited fishery.

CONCLUSION

The main elements of this proposal were supported by Government and, with minor modifications, were adopted for implementation. A limited commercial lobster fishery was initiated in October 1991. Acceptance of this new fishery by fishermen has been limited. The main point of contention is the

limitation of this fishery to the edge with the resultant limitations on TAC and participation. At the time of this writing, of the available 25 licenses eleven have been taken up. Thus far, the catch rate of this fishery, derived from the first 608 hauls, is 2.4 lobsters/haul, a value in the upper range of that predicted from the pilot study.

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LITERATURE CITED

- Burnett-Herkes, J.N. and J.A. Barnes. This volume. Banning the use of fish pots and other management methods introduced in Bermuda to manage declining reef fish stocks.
- Luckhurst, B.E. and J.A. Ward. This volume. Analysis of trends in Bermuda's fishery statistical database from 1975 to 1990 with reference to management measures implemented during this period.
- Towle, E.L., R.S. Carney and R.C. Mahon. 1991. Report of the Commission of Inquiry to examine and make recommendations for the future protection of the Marine Environmental in Bermuda. Bermuda Government Information Services, 40pp.