Update on the Mexican Caribbean's Artificial Habitat-Based Spiny Lobster (Panulirus argus) Fishery: The Evaluation of Design, Material and Placement Optimums

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ABSTRACT

Preliminary results are presented of investigations focussing on artificial habitats ("sombras" or "casas Cubanas" - shelters that simulate niches and crevices in rocks and reefs) used by fishermen in the Mexican Caribbean to concentrate spiny lobsters. Organization of the fishery by division of fishing grounds into individually held parcels is discussed and implications for management are assessed. Data are summarized regarding design, material and placement optimums. Long term impacts of the artificial habitats are considered with respect to lobster stocks and their potential impacts on surrounding environs. Guidelines are provided for fishery managers considering the use of similar devices in areas where habitat is limited.

INTRODUCTION

Spiny lobster are, pound for pound, one of the most economically valuable marine species in the Caribbean Basin. Increasing interest is being shown in the use of artificial habitats (shelters that simulate crevices in rocks and reefs) to increase captures. Experiences with enhancement efforts for finfish species suggest that properly engineered and situated structures concentrate stocks, facilitate harvest and increase productivity, the latter being reported by Stone et al. (1979) and in D'Itri (1985).

It seems logical that habitat enhancement ought to increase spiny lobster recruitment (and potentially facilitate capture) where existing habitat is limited. Spiny lobsters do not construct shelters or appear to significantly modify pre-existing shelters available to them (Kanciruk, 1980). Thus, the number of dens in an area is fixed. Shelter availability may be reduced as some are occupied by competitors or predators. Also, den "quality" may vary with respect to degree of protection afforded, access to feeding grounds, and ability to support multiple occupancy. Therefore, the addition of correctly designed and positioned habitats to relatively unproductive

areas would appear to have the potential to increase the amount of productive habitat.

Although habitat enhancement appears to represent a possibility for increasing spiny lobster captures, the long-term impacts of the strategy are uncertain. Enhancement may attract and concentrate lobsters from surrounding areas. Enhancement may also increase productivity of fishing grounds. If gains in productivity do not offset increases in captures associated with concentration of stocks, then the strategy will facilitate overexploitation. We are currently involved in a study of the long-term impacts of artificial habitats used in a spiny lobster fishery located in the Mexican Caribbean (for details see Miller, 1982). In this paper we provide information on new developments, a brief description of our program of research, and some preliminary generalizations regarding optimums with respect to artificial habitat design, material and placement.

NEW DEVELOPMENTS

Fishermen of the Vigia Chico Fishing Cooperative (based at Punta Allen in the Mexican state of Quintana Roo) have used artificial habitats ("casitas" or "sombras") to facilitate lobster captures for more than a dozen years. Currently, the coperative's 110 members utilize more than 10,000 habitats positioned throughout some 160 km^2 of Bahia Ascension (Ascension Bay). The majority of these habitats are positioned in shallow (2-7 meter) back-reef and inner-bay areas. Habitats are currently spaced some 20 meters apart. The fishing grounds are divided into approximately 150 "campos" or individually held capture areas ranging from 0.5 to more than 3 km^2. These divisions were typically arrived at informally, with boundaries being established as fishermen were stopped from expanding in a given direction by the presence of habitats belonging to another. Today, virtually all the areas considered productive are occupied. Fishermen can only harvest from their own campo, and captures are made by diving to the habitat and removing the lobsters with a gaff or herding them into a net.

Contrary to the situation in 1981, fishermen in areas to the north are no longer systematically using casitas. Apparently, their "campo libre" (no individually held campos - anyone has the right to harvest from any casita) system of organization has proved untenable. Discussions with fishermen indicate that the minority who constructed and placed shelters were unable to justify continuing the effort. All fishermen were (legally) reaping benefits of the expense. Fishermen to the south of Ascension Bay (principally in Espiritu Santo Bay) continue to use casitas and the campo system.

Notions about spacing of habitats have changed. In 1980, Punto Allen fishermen were positioning casitas about 30 m apart (Miller, 1982). Today's wisdom suggests that 20 m is optimum. However, some fishermen report that increasing shelter density in their parcels is not justified by increased captures and have adopted a strategy of maintaining rather than increasing the number of habitats per parcel. Fishermen still attempt to

position their habitats over vegetated or rocky bottom.

The distribution of campos has changed. Fishermen have established campos outside the barrier reef in front of the bay. Formerly, all campos were inside the bay, in waters of 2-10 meters depth. Casitas can now be found to depths of 14 m. SCUBA or hookah assisted harvesting is becoming more common.

Campos in some areas have been abandoned. In 1979, fishermen were still actively placing habitats well into the interior of the bay. This is an area of prime juvenile habitat, where we have consistently observed individual shelters concealing large numbers (<30) of under harvest size (< 13 cm tail length) lobsters. Since 1980, we have recorded that some fishermen were abandoning campos in these areas. Two reasons were given. First, the majority of lobsters found in this area are juveniles and under minimum legal harvest size. As they mature they move to deeper water. Second, rates of production were highly variable. The reduced salinity during the rainy season apparently forces lobsters out of the area.

Production has declined considerably in recent years (see Table 1). This is troublesome. If recruitment is predominately local, then decreasing captures may signal that shelters may be concentrating stocks and facilitating capture to such a degree that overharvesting is underway. Also, the failure to maintain habitats in areas primarily inhabited by juveniles may contribute overall to loss of productivity and decreased harvests.

Table 1. Annual Spiny Lobster Landings by the Punto Allen Fishing Cooperative (metric tons, live weight), 1977-1984

Year	Landings
1977	221.4
1978	194.1
1979	188.7
1980	150.0
1981	179.1
1982	147.0
1983	166.0
1984	128.0

Source: De La Torre and Miller, unpubl. data

Although there has been a trend of declining captures, production of some campos has remained relatively high. Fishermen observe that these campos are located along "corridors" of lobster migration. Apparently, a gradient of productivity exists within the bay. The current distribution of campos, and areal variations in shelter density reflect

fishermen's judgments regarding potential for profit. These patterns may provide a reasonably good indicator of spatial variations in productivity.

Elsewhere we have speculated that some measure of productivity may be gained as casitas provide critical refuge to nomadic juveniles (Miller and De la Torre, in press). Also, that the routine harvest of lobster predators (e.g., sharks, groupers and triggerfish) may contribute to a decreased lobster mortality rate (ibid, Miller, 1982). It now appears that this increase may be offset to some degree by dolphins which frequently visit campos, flip casitas over, and feast on the lobsters and other species uncovered. Also, casitas are sometimes damaged when they are overturned. When this occurs, their effectiveness and useful lifetime is diminished. To date, the fishermen are willing to accommodate this competition, since it is widely held that the presence of dolphins keeps sharks out of the area.

RESEARCH CURRENTLY UNDERWAY

We are currently surveying the campos utilizing a Micrologic M-7500 portable LORAN-C position finder. Preliminary work has demonstrated repeatable accuracy to be within 5 to 25 feet (Miller, 1985 unpublished data). This margin of error is acceptable since most parcels are larger than 1.5 km^2. To date, we have surveyed 22 campos of the approximately 150 campos held by members of the cooperative (see Fig. 1). Most campos take about 45 minutes to survey, and 3 to 4 neighboring campos can be surveyed in a day. When we finish the survey, we will divide the area (m^2) within each campo by the number of casitas registered by its owner. This will provide us with each campo's "habitat density statistic" (m^2 per shelter). This procedure will be followed for the years 1980-1985, to establish changes in shelter density over time. Annual production at varying densities will then be calculated.

We anticipate that an analysis of production statistics which takes into account varying shelter densities at the campo level will provide a more accurate measure for establishing production trends. Also regression analysis of production at various densities should reveal optimum densities. Ultimately, a gradient of production will be established, necessary for a planned program of field surveys and sampling to determine the relationship between lobster production in the various areas and the corresponding faunal, floral and physico-chemical characteristics of those areas.

In addition to the LORAN-C survey, we have begun a regular sampling program to establish the size and sex distributions of lobsters found beneath the three different styles of casitas: the all wood ("madera de chit"), the wood and sheet metal ("lamina y chit"), and the wood and reinforced concrete ("ferrocemento y chit"). We have established a network of sampling stations consisting of 45 casitas (15 of each casita style) within each of three zones. Zone I is located in waters averaging 5 m depth near the barrier reef. The substrate is hard (coarse sand or rock), relatively level, and sparsely vegetated.

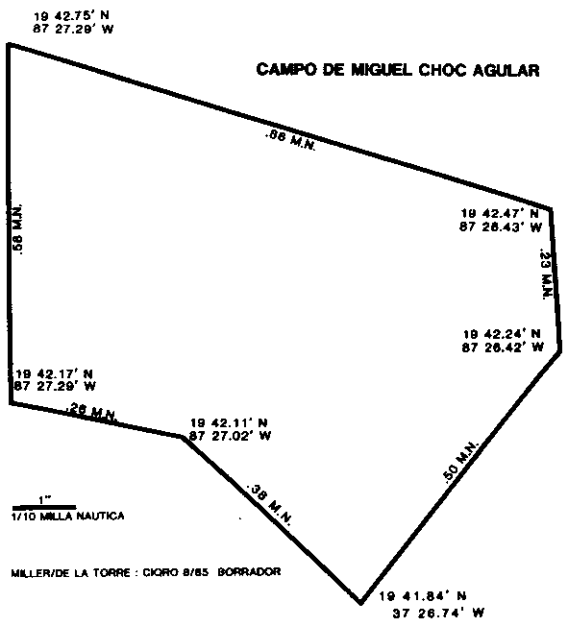

Figure 1. Campo de Miguel Choc Agular.

Occasional patches of coral and areas of irregular rocky bottom are encountered. Zone II is located in waters averaging 3 m depth, and contains vast areas of turtle grass pasture. Sponges (Ircinia sp.), occasional rocky areas and large zones of bare sandy bottom are also present. The majority of casitas are located within this zone. Zone III is in the inner bay, near the shore in waters averaging 1.8 - 2 m deep. The substrate is soft, with some 20 cm of sediment overlying a firmer level (termed "laja"). A variety of algae are present.

PRELIMINARY GENERALIZATIONS REGARDING MATERIAL AND PLACEMENT

Some patterns are beginning to emerge with respect to the distribution of lobster by size and sex, according to zone and casita type. In Zone I (5 m), the majority of legal size (13 cm or larger tail length) specimens are found under the concrete casitas. Juveniles are abundant under the all wood shelters. Males outnumber females 2 to 1.

In Zone II (3 m), a majority of legal size lobsters are again encountered under the concrete habitats; however, some 30% of the lobsters harvested are very close to the minimum legal size. Juveniles are again abundant under the all wood shelters. Males outnumber females 3 to 1.

In Zone III (2 m), some 70% of legal size lobsters are encountered under the sheet metal roofed casitas, while juveniles are abundant under the all wood habitat. Males outnumber females 3 to 1 under the cement casitas and 2 to 1 under the remaining styles.

DISCUSSION

A program of additional sampling and field surveys is necessary to establish the variables which influence casita selection by the lobsters in this bay. To some degree the situation is complicated because the artificial habitats are used as traps. Fishermen report that lobsters frequently abandon a casita after they are disturbed. In the coming year we intend to sample extensively during the closed season. Nevertheless, it appears that lobster preference for shelter style may be associated with life-history stage.

Juvenile lobsters, for example, may experience lower mortality rates while residing on or under the all-wood shelters since the many cracks and spaces between the thatch palm logs offer better refuge. From the standpoint of foraging, the all-wood habitats offer more surface area for the establishment of a fouling community. Also, rates of fouling on this shelter's organic substrate may be more rapid and the composition of its fouling community may differ from that found on the other styles.

Although commercial size lobsters were found to be abundant under concrete casitas in Zone I, and commercial and near-commercial sizes were abundant under the same style casita in Zone II, most of the lobsters eligible for harvest in Zone III were encountered under sheet metal roofed habitats. A variety of factors may be responsible, but we suspect that crawl

space adequate for larger juvenile and adult lobsters may be lost as the heavier all-wood or concrete casitas settle into the soft sediments found in this zone. The sheet metal version is lighter and does not settle into the sediment as rapidly and deeply.

The relative abundance of male lobsters remains to be explained. Do females experience higher rates of natural mortality, are their growth rates different, or are their habitat preferences dissimilar? The latter is suggested by our observation and fishermen's reports that berried females are rarely, if ever, found under casitas. Berried females are found in naturally occurring dens at and beyond the reef in front of the bay. We intend to establish sampling stations in the new campos outside the reef, in order to establish the patterns in deeper water.

SUMMARY

Casitas concentrate stocks, and thus facilitate harvest. They have the potential to facilitate over-exploitation. Some gains in productivity may be achieved, particularly where limited shelter contributes to high mortality. However, concentrations of lobsters may attract natural predators, such as dolphins and loggerhead turtles. A potential exists for conflict between the fishermen and these valued species.

Although much work remains, our preliminary data suggest that lobster preference for a particular style of casita is associated with life cycle stage. However, local conditions such as the substrate character may cause considerable variation. Care is necessary in the placement of artificial habitats for spiny lobsters. The design characteristics and materials chosen must be tailored to specific sites.

The use of casitas would seem appropriate in nursery areas where young juvenile populations are limited by habitat availability. Effort should be directed at developing techniques for determining situations where shelter availability is a limiting resource. Currently, nursery area enhancement represents the earliest opportunity for intervention designed to reduce mortality and improve growth rates. The use of artificial habitats simply to concentrate the stock for harvest - in essence to function as traps - does not appear compatible with efforts to establish sustained yields, at least in the context of this fishery's biological and cultural landscapes.

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