New Developments in the Spiny Lobster Fishery of Southeastern Florida

ALAN K. CRAIG
Department of Geography
Florida Atlantic University
Boca Raton, Florida 33432

Recent events have made important changes in the slow pace at which South Florida's lobster fishery has evolved since the definitive descriptions by Crawford and De Smidt (1922) and Smith (1958). Relatively unsophisticated fishing methods prevailed until the advent of: (1) 17,000 displaced Cuban fishermen relocating in the Miami area, (2) widespread use of trawls and hydraulic recovery equipment, (3) reliable electronic depth recording units, and (4) new baiting techniques.

The present study, begun in 1969, was designed to identify relationships between behavior of *Panulirus argus* and the unique offshore habitat of southeastern Florida as revealed by trapping results. Data have been derived from study area conditions as they exist along some 40 miles of coastline between Port Everglades and Palm Beach, but conclusions based on this research have much wider application.

Although some basic biological work has been done in the past (Lewis, 1951; Lewis, et al. 1951; Dawson and Idyll, 1951; Witham, et al. 1964; Witham, et al. 1968 and Sweat, 1968) by concerned academic personnel, there has been comparatively little sponsored research on an animal that now constitutes a multi-million dollar fishery employing hundreds of fishermen. Recent reports by Herrnkind and McLean (1971), Kanciruk and Herrnkind (1972) and especially Herrnkind, et al. (1973), serve to emphasize the great gaps in our knowledge of spiny lobster behavior and the consequent danger of conservation laws based on inadequate information or erroneous assumptions. This paper will point out these discrepancies and recommend changes in legislation.

HABITAT

Figure 1 illustrates in a schematic block diagram the bottom topography and distribution of the reefs present in the study area. Figure 2 is a sonic profile trace of a typical traverse through this zone with corresponding features indicated. Most prominent are three sub-parallel bands of submerged Pleistocene beachrock – calcarenite representing former shoreline water table deposits at intervals of sea level still stand. Margins of these highly indurated, case-hardened rock surfaces occasionally display well-developed spur and groove processes produced by wave action accompanying changing sea levels. Scour has widened the transverse joint sets, producing deep cracks across comparatively flat, gently dipping beachrock outcrops. Epiphytic growth of small corals, sponge,

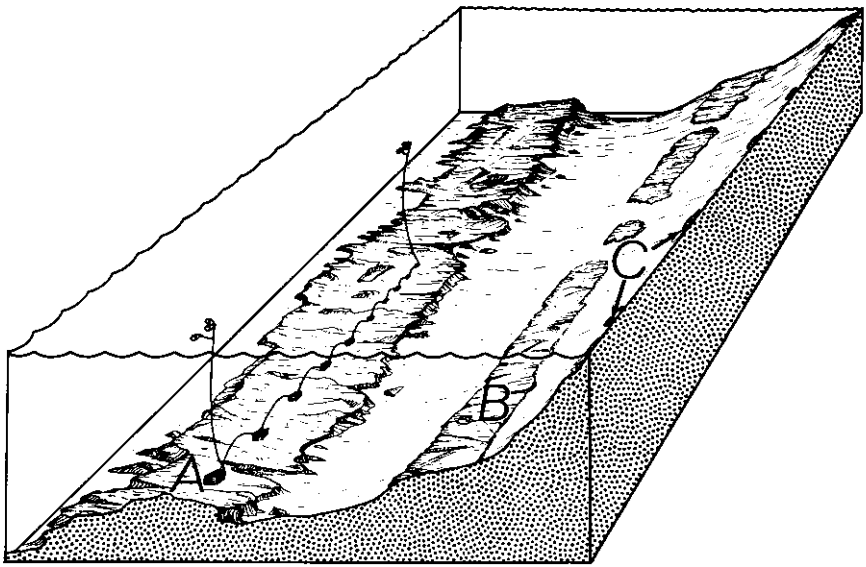

Fig. 1. Schematic block diagram of submerged Pleistocene beachrock reefs – the offshore lobster habitat of southeastern Florida. (A) 3rd reef 8-20 fm., (B) 2nd reef 6-9 fm., (C) 1st reef 2-0 fm. Horizontal distance represented approx. 1.5 miles; vertical exaggeration 26:1.

gorgonians and algae is abundant on surfaces remaining free of shifting sands but many areas are covered on occasion and consequently are comparatively barren.

North of Palm Beach, the outermost band of rock (3rd reef) diverges progressively eastward from the shoreline, extending more than 8 miles out to sea. But over much of the study area these slabby beachrock reefs are restricted to a zone seldom more than 2 miles wide. Here lobster are concentrated in a narrow, current-swept environment. Since lobster detect food by chemoreceptivity rather than visually, strong bottom currents are beneficial in attracting them over long distances to baited traps. In addition to the predominant northerly inshore current (not part of the Florida Current) of 0.5-3.0 kts there are occasional current reversals to the south that attract lobster located up-current from traps.

In spite of the non-coralline nature of this habitat, lobster population densities apparently reach 3,000-5,000/ mi^2 based on conservative extrapolation of average catch data but rapid changes are known to occur. These localized transitory movements between inshore and offshore reefs are known to fishermen and statistically evident but remain virtually unstudied since they were noted by Crawford and De Smidt (1922) and Creaser and Travis (1950).

PREDATOR PRESSURE

Man is unquestionably the most important predator of spiny lobsters but lobstermen's activities are carefully controlled. Totally uncontrolled are the

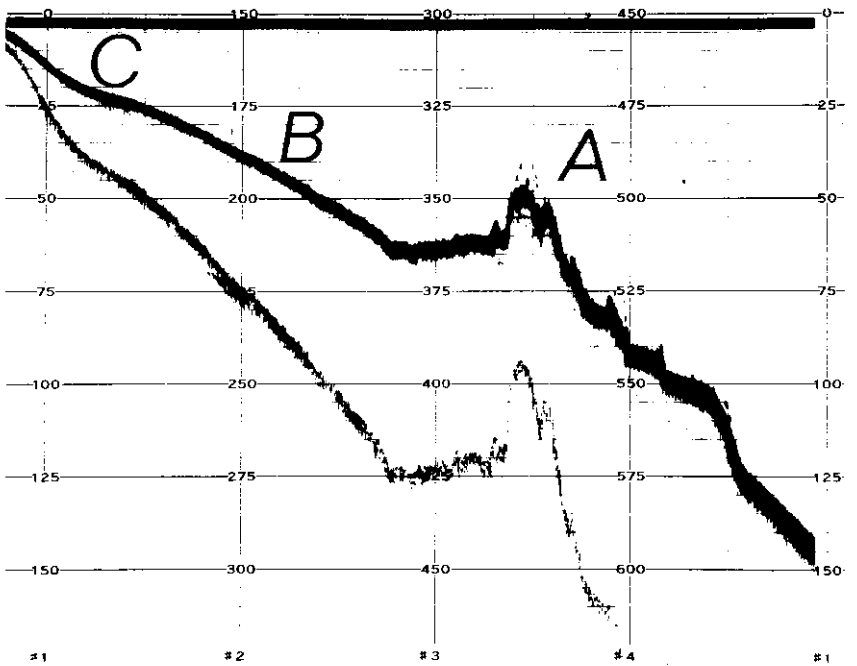

Fig. 2. Sonic profile of typical transect through offshore reefs – letters correspond to reefs shown in Fig. 1. Depths are indicated by peripheral scales in feet. Horizontal distance shown approx. 1.5 miles. Note the abrupt beginning of gently sloping sand bottom at 122 feet.

hundreds of thousands of new residents pouring into southeastern Florida. Their wastes are being discharged at sea (Voss, 1973) by more than 12 municipal sewage systems now pumping nearly 200 million gallons of ground and chlorinated effluent daily. Only one outfall (Boca Raton) presently pumps secondarily treated sewage.

Trapping results up and down plume from this outfall are instructive. Figure 3 indicates definite down-plume avoidance of the reefal habitat by lobsters over a distance of several hundred yards while trap # 5, in close up-current proximity, was noticeably productive.

Divers report that during two years of construction, 1969-71 and 18 months of subsequent primary effluent discharge, habitat degradation is obvious a considerable distance north (down-plume) from the outlet. During this unusually long period dredging operating often created highly turbid water with quantities of sediments entrained into the entire water column from surface to bottom (80-110 feet). Since completion of the project, the contractor has been plagued by repeated loss of the fine sediment designed to cover the outfall pipe. This unstabilized material is likely to have been removed by the prevailing northerly current but transport by wave action is also possible.

Secondarily treated effluent has only been on stream since February, 1973 so that long-term effects on the reefal habitat are not yet evident. Concentrations

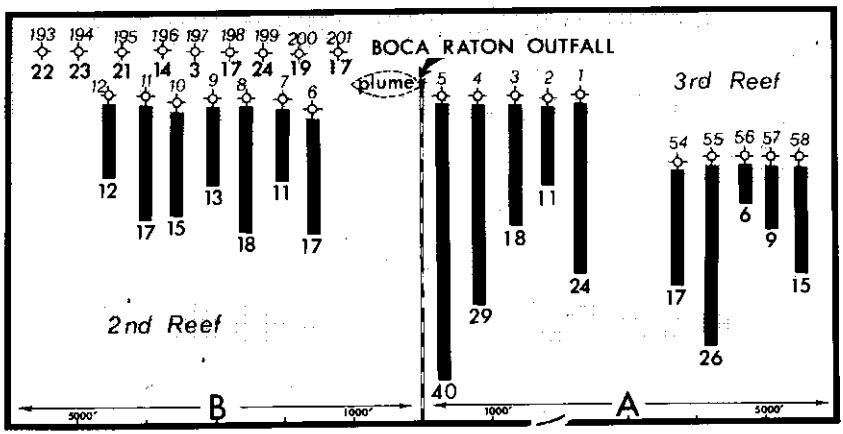

Fig. 3. Five month cumulative catch summary of single traps located up-current (A) and down-current (B) from Boca Raton sewerage outfall. Trap identification numbers are italicized.

of fish, especially small snapper, formerly attracted to this outfall by discharged solids have entirely dispersed now that a clear, odor-free effluent is being produced. However, the threat to the habitat of long-term chemical pollution remains to be studied and cannot long be ignored.

METHODS

Field studies were conducted to determine relative effectiveness of traditional single-trapping techniques compared to multi-trap trawls. In addition, an effort was made to clarify certain biogeographic aspects of lobster behavior patterns, population dynamics and distribution within the habitat. Since initiating this program, observations based on 8,200 trapping entries have been recorded on data sheets. Two seasons were devoted to single-trapping and one to trawls. The first single-trap season was conducted using typical Florida equipment in a small (16 foot 7 inch) boat without a crew. Subsequently a 44-foot trawler (Fig. 4) was the platform used for single-trapping with gasoline engine hauler and cantilevered trap lander (Fig. 5). The next season, this boat was converted to hydraulic hauling and skidways were installed.

Both single traps and trawls were identified by individual numbers to allow detailed efficiency and distribution records to be kept. Additional data from commercial fishermen were used to supplement our own findings.

Of approximately 200 traps maintained, distribution between the two offshore reefs was about equal. The positions for both single traps and trawls being determined electronically either by depth indicator or chart recording sonic profiler. Normal soak times (5-7 days) were allowed although some longer intervals occurred during occasional prolonged periods of rough seas.

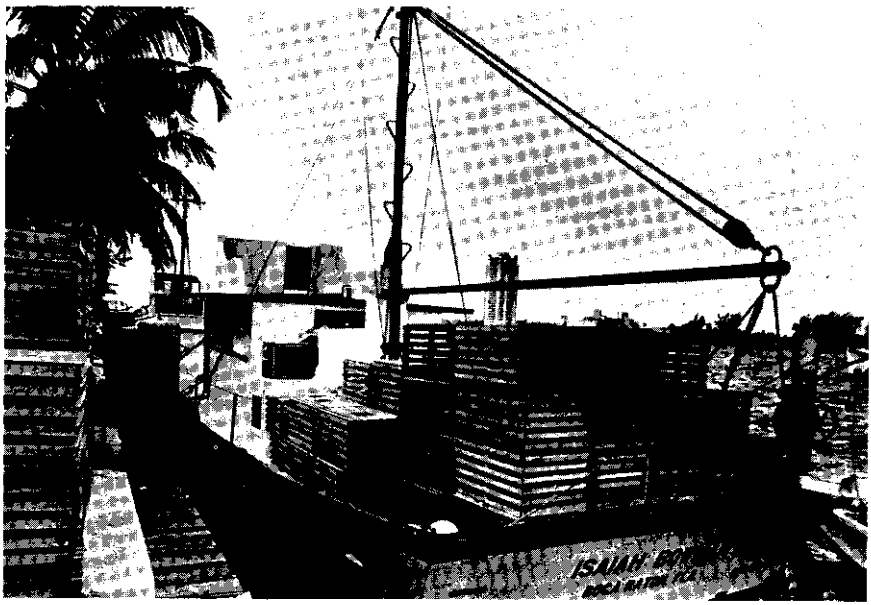

Fig. 4. Standardized Cuban-design traps on board a 44-foot fiberglass research vessel.

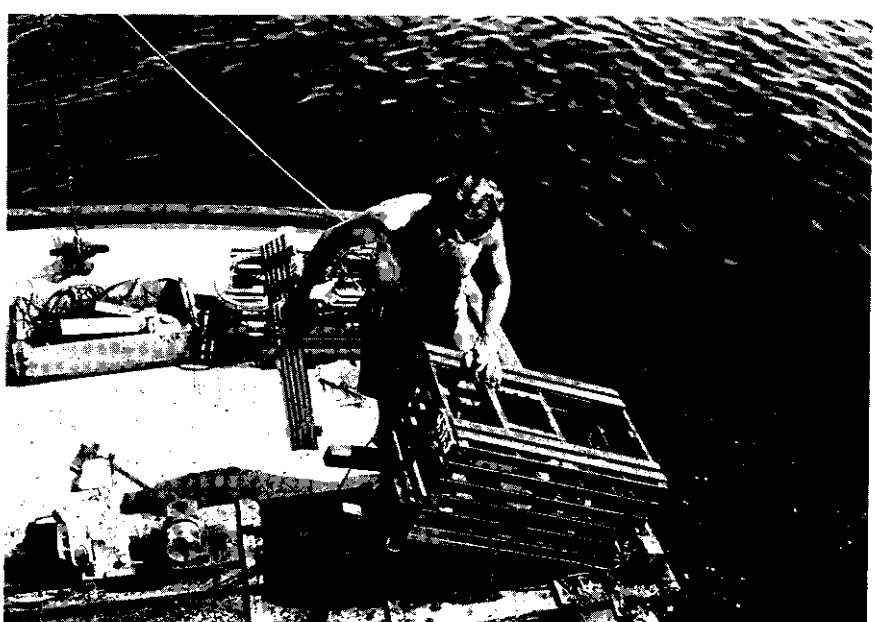

Fig. 5. Detailed view of conventional Florida single-trap winch and cantilevered landing device.

EFFICIENCY FACTORS

A veteran trawl crew can pull and reset at most 180 traps in a 6-hour workday (3 trawls/hr) in moderately deep (15 fm) water. Claims of greater efficiency are exaggerations or involve longer workdays. By comparison, only 90 single traps (15/hr) can be hauled and shot under the same conditions. Most operators do not attain either of these figures because their equipment is inefficient in design and position (Cope, 1959). The highliner for southeast Florida shown in Figure 6 has gradually arrived at a highly effective combination of trawl recovery equipment capable of attaining maximum productivity.

The use of trawls cuts trap loss to about 5%/mo compared to 12%/mo loss among singles but these figures vary greatly depending upon boat traffic and seasonal weather experience. Nevertheless, many fishermen dislike trawls, particularly where fishing grounds have patch reefs surrounded by extensive barren sandy intervals. Neither can trawls be used over an extremely foul coral bottom that will cut ground lines.

A fundamental change in the Florida lobster fishery occurred in 1969 with the widespread use of cowhide which has proven to be a more efficient bait than traditional fish heads. Effectiveness of the latter diminishes rapidly after a 3-4 day soak whereas green hide remains attractive for 2 weeks or more. During prolonged intervals of rough weather durability of cowhide becomes a distinct advantage. Strong tannery demand from Europe has caused much price fluctuation in past seasons (11-55 cents/lb) but there have been corresponding cost

Fig. 6. A trawl of bridged traps being recovered by the study area highliner.

increases in frozen fish heads as well. Prior to the 1969-70 season, bait consumption by the lobster fishery had reached such proportions that some operators were importing heads from Mexico.

PROBLEMS

Trap theft has become the single most serious problem of Florida lobstermen. At the beginning of recent seasons, large scale trap losses have become commonplace. Stolen traps are taken to Bahamian waters by criminals who compound the offense by illegal fishing there. No effective remedy for this type of larceny exists at present. Equally vexatious is pilferage by SCUBA divers who only need follow a trawl line to steal lobster in quantity. In the final analysis, divers know they can rob traps with impunity and do so.

Physical problems in the industry are numerous. Buildup of barnacles (*Balanus*) and algal growth on styrofoam floats and polypropylene lines is accelerated by warm water temperatures (72-89° F) so that buoys become discolored and difficult to see. Floats that accumulate goose barnacles are eventually badly bitten by hungry loggerhead turtles. The fishery needs better buoys adapted to tropical conditions that would provide high visibility, resist ultraviolet radiation and mechanical abrasion, and contain effective anti-fouling ingredients. At present, plastic bleach bottles have most of these characteristics but are susceptible to failure by cracking and punctures.

The traditional problem of trap deterioration from *Teredo* attack is being offset to a considerable extent by increasing use of pressure treated lath and framing. Staining, as indicated elsewhere, does not prolong trap life but does serve another useful purpose.

TRAP DESIGN

Wooden slat traps have predominated in Florida since the fishery first became organized in the 1920s. The trapezoidal or so-called "bridged" design represents New England influence where additional structural strength afforded by this shape allows higher stacking of ballasted traps during the off season. Otherwise, trapezoidal traps have no advantage over the rectangular form. Some combination wooden frame – chickenwire traps are used by Florida based lobstermen, particularly those engaged in offshore Caribbean fishing operations.

Location of the entrance and role of the trap as perceived by lobster are important factors in trap design but neither is well understood by fishermen. If we postulate that lobster seek out traps as potential den sites, then it is evident they will enter more readily where multiple side openings are available than in the case of present designs where they must climb up into an exposed position before encountering the top-opening entrance. The hypothesis that lobster perceive traps as shelter in addition to a feeding opportunity is substantiated by field observations which indicate they uniformly refuse to enter unbaited top-opening traps but will readily do when side-opening traps are employed. Another line of evidence involves the widespread superstition against use of "bleached

out" traps. The implication here is that light-colored wood, rope, or other objects associated with a trap tend to frighten lobster away. Consequently, experienced lobstermen stain traps with a variety of dark, oil-based solutions and avoid bright rigging. Our long-term experiments with stained vs. non-stained new traps do not support this conviction. In general, when traps are kept well-baited there seems to be no significant difference in catch rates between stained and non-stained traps but staining may provide some minor degree of wood preservation.

However, if unbaited side-opening traps are employed then staining appears advisable in order to create a gloomy interior that simulates the rocky ledges, cracks and coral crevices that constitute preferred den sites. Flattened, rusty steel drums formerly much used as traps in Florida waters exactly duplicate this effect as do occasional automobile tires that litter the bottom and are quickly colonized by lobster.

As a general rule then, it is adviseable to keep trap interiors as dark as possible – primarily by using closely spaced, heavily stained lath. Open weave galvanized wire or vinyl-covered wire sides are not recommended in this regard because they admit too much light.

The fact remains that almost any trap design will be a highly effective catching device at queue break-up during autumnal migrations when the lobster resumes their secretive habits (Herrnkind, et al., 1973).

TRAP CONSTRUCTION

Building wooden lath traps is highly labor-intensive under the best of circumstances. The traditional off-season trap building activity of Florida lobstermen is currently being supplanted by large scale contract building by underemployed Cuban refugee fishermen in the Miami area. These people are provided with standardized bundles of pre-cut wood and deliver traps on a piece work basis. Trap components are jigged and the construction is often a family affair.

Cypress is the preferred wood for several reasons; originally it was considered inexpensive, readily available, and has slightly negative buoyancy. Heart wood contains chemicals resistent to attack by teredoes. During the past decade, Florida cypress has become increasingly difficult to obtain as lath. Sawmills prefer to produce lumber consumed by the construction industry to the extent that some fishermen and cooperatives now obtain their wood from outside the State and there have even been attempts to import it from overseas.

Trends in building techniques are moving in the direction of air driven staple-gun fastening although initial investment is considerable for small scale operations. Where construction is by underemployed such time-saving equipment is impractical. Monel nails are another innovation that may be justified when trap longevity increases through better wood preservation techniques.

While conservation legislation has been based on the assumption that lost wooden slat traps will quickly disintegrate and cease to "fish," this is not entirely the case. Cypress traps remain intact for at least 2 years but these old

traps (if top-opening) do not attract lobster. From the fisherman's point of view better wood preservation techniques are welcomed since most traps become more or less "wobbly" after a season's use and must be repaired or replaced. In this respect, field tests of traps completely pressure treated with commercial copper salts preservative are instructive.

During 1972, a sample of 20 standard design cypress traps were "wolmanized" and fished without further staining or treatment. These traps remained substantially free of the usual heavy accumulation of bryozoa, algae and oysters for the entire season. This treatment does, however, allow growth of serpulid worm tests but they are epiphytic and do not structurally weaken the wood.

An alternative to pressure treatment of the completed trap is to build traps from custom-sawed lumber that has itself already been impregnated with preservatives. Traps presently under study have been constructed in this way but it is not yet evident whether this system has any inherent advantages.

TRAP DEPLOYMENT

From the distribution of dens, it would appear most efficient deployment of traps would be along the inner and outer spur and groove zones (Fig. 1, A). But in practice trawls placed in these rugged areas often suffer loss or damage and may be swept over the rims onto barren adjacent sand areas during intervals of rough water. Consequently, the optimum deployment for trawls is along reef margins but somewhat inward where the surface is less jagged.

Nevertheless, many Florida lobstermen argue that sandy areas are preferable to natural habitats of reef and grass flats. They deliberately place traps on these barren spots and enjoy limited success. This happens because during the most active interval (new moon) of the monthly feeding cycle, lobster forage widely across open areas and encounter these traps – occasionally entering them in great numbers when chains break up at the end of autumnal "walks." But during 25-30% of the year (gibbous and full moons) when lobster are den-bound, or nearly so, sand traps are inefficient producers.

Regardless of whether trawls are set or a series of single traps are employed, distribution and spacing are of critical importance, yet neither factor seems well understood by fishermen. Nevertheless, experienced lobstermen usually arrive at efficient approximations through trial and error.

Preliminary evidence from the Tektite II Project seems to indicate that maximum feeding radius of the spiny lobster is approximately 300 feet. This means a feeding circle diameter of perhaps 600 feet with the den at the center. Consequently, assuming generally uniform den distribution over a given habitat, the most efficient trap spacing should not be closer than 600 feet. But this ideal spacing between traps conflicts with rope economy when trawls are placed in more than 8-10 fathoms, therefore 10 traps are commonly placed on a standard 1,200 foot coil of pot warp, leaving about 100 feet of buoy line at either end. If 10 traps were set individually at 8-10 fathoms, from 80 to 110 feet of scope are required and this utilizes more than 1,200 feet of warp at the greater depths. In

other words, deep water trapping dictates the use of trawls where rope economy is the only determinant, but as indicated elsewhere, there are other advantages to the use of trawls.

MIGRATION AND CONSERVATION

Spiny lobster dynamics are especially significant with regard to concepts of conservation and trapping efficiency. Of these, the "zugenruhe" and autumnal migration documented by Herrnkind (1969) are most critical. Even though causes of this phenomenon are not yet understood, the fact that young adult individuals are exclusively involved strongly suggests it has a significant biological function – probably of direct survival value, and possibly involves population distributions. This erratic change in behavioral pattern allows lobster to be easily gathered by hand in the thousands and makes them inordinately vulnerable to human predation for a brief interval of time, apparently on an annual basis.

Migrations are known from September-October in Florida and the Bahamas (Herrnkind, et al., 1973) to as late as February in British Honduras (Craig, 1966) but they are most likely to occur in South Florida during October, concurrent with passage of the first polar front. It is evident lobster should be protected while under the influence of this erratic migratory behavior.

Consequently, I want to propose a radical change in the Florida closed season from its present 31 March-31 July interval to 4 months distributed between 15 July-15 November. The present legislation was designed to provide protection during peak egg-bearing months and to incidently afford stocks a "resting period" free from fishing pressure. Since lobster can be found in berry at all times of the year and must be released alive, there is no rationale from this standpoint alone in maintaining the present closed season.

A shift to the proposed 15 July-15 November season would protect lobster during the period when they are most likely to migrate and have the additional advantages for the fishermen: (1) it would keep traps out of the water during the peak hurricane month of September – obviating some of the spectacular equipment losses that have occurred at these times, (2) result in better early season prices as increasing tourist demand would coincide with opening production, (3) delay algal fouling of rope and buoys until warmer water temperatures were encountered toward the end of the season and (4) reduce the incidence of theft by "fair weather" SCUBA divers.

An alternative schedule consisting of a split closed season comprised of peak egg-bearing and migratory months would be ideal from a resource management standpoint but should not be considered for practical reasons – the setting, soaking, hauling, resetting, and resoaking of hundreds of traps would be a double and intolerable burden on fishermen as well as enforcement personnel.

To reduce the closed season to the months of September and October has merit only if there is statistical evidence that populations are able to maintain sustained yields with this additional fishing pressure – a very doubtful proposition in view of experience in other parts of the Caribbean.

BEHAVIORAL CHARACTERISTICS

Numerous field observations in connection with this study indicate various misconceptions exist both in the literature and minds of fishermen regarding behavior patterns of the spiny lobster.

For example, present conservation legislation involves the concept that lobster having once entered a pot are easily confounded so that lost traps continue to "fish" until they disintegrate. There is abundant and conclusive field evidence to the contrary, overlooked by previous investigators. After an initial 3-4 weeks of immersion at the beginning of each season, a thin coating of algae, diatoms and detritus accumulates on the upper surface of traps, particularly when turbulent sea conditions have placed bottom sediments in suspension. Lobster moving over the lids of these coated traps leave distinctive tracks caused by dactyls and setae. Observations of these "footprints" leading into and out of traps left devoid of bait have been an everyday occurrence during this study. At times of high feeding activity, myriad tracks may cover the top of an otherwise empty trap but lobster will seldom leave a trap that still retains a substantial amount of bait. It has been noted that large lobster, while not noticeably aggressive in confinement, tend to monopolize bait packets when smaller lobster are present, which may account for the appearance that all have been entrapped and cannot find a way out.

As long as entrances are rigid and straight sided – that is, oriented perpendicular to the top, lobster can enter or leave at will and do so. The material from which such a trap is made is of no consequence from a conservation standpoint because lost traps actually serve a very useful purpose by providing shelter from predators for the juvenile, moulting and egg-bearing individuals that enter these surrogate dens.

Feeding habits of trapped lobsters have been observed repeatedly. Berry lobster constitute a substantial percentage of the catch in warmer months, but in cases where only egg-bearing females are present, bait condition indicates that they have not been actively feeding. At other times, traps will contain strangely torpid lobster which likewise have failed to avail themselves of the bait. More unusual are those instances where lobster appear to have carried their own food into a trap. In such cases, large, irregular chunks of sponge and pelecypods (*Glycymeris decussata*) too large to have been introduced through lath spacing were found inside traps occupied by actively feeding lobster.

CONCLUSIONS

Results indicate hydraulically recovered trawls are more efficient than single trapping where environmental conditions are appropriate. Trap deployment is the most important variable for increasing catch and electronic depth recorders greatly improve results. Trap intervals and soak periods should be adjusted to annual patterns of lobster dynamics.

Untreated sewage, dredging and turbidity associated with outfall construction appear to cause down-current avoidance by lobsters, probably because of habitat

degradation. Secondary treatment of sewage creates effluent that seems to have short-term compatibility with the reef habitat.

A change from traditional cypress lath traps to pressure treated pine is occurring. Field studies indicate side or end-opening traps would be more efficient than the traditional top-opening design but the recent shift to cowhide baits makes either style quite effective. Restricted funnel entrances prevent egress and should be proscribed in favor of traps having straight-sided throats.

The present closed season does not correspond to the period of greatest vulnerability from human predation and should be shifted to cover the autumnal migration.

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