THE DESIGN AND FIELD TESTING OF A DUAL-SPECIES TRAP TO CAPTURE SPINY AND SCYLLARID LOBSTERS

by

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This material is based on work supported by the National Science Foundation (NSF) under Award Number DAR 7917152. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

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PART I–PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
T. A. Herbert & Associates, Inc. P. O. Box 10129 Tallahassee FL 32302	Geophysical & Environmental Applications	DAR-7917152
	4. Award Period From 10-1-79 To 3-31-80	5. Cumulative Award Amount $24,915

6. Project Title
The Design and Field Testing of a Dual-Species Trap to Capture Spiny and Scyllarid Lobsters

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

Slipper lobster, a name commonly applied to several species believed to be abundant in areas off the coast of South Florida, are not commercially harvested today. The reasons vary but include: lack of gear designed to accomodate these species' unique trap entry requirements and unproven quantities in an area where the ecological distribution of these lobster is beyond the present range of the existing spiny lobster fishery. The design of a trap to take slipper lobster could provide the stimulus to develop a fishery for them. If the trap would capture spiny lobster as well, the existing fishery could be expanded into continental shelf waters where the distribution patterns of spiny lobster are suspected to overlap those of slipper lobster.

Seven modified versions of a conventional spiny lobster trap were compared in pond experiments with a captive population of over 80 lobster. A flattened lath trap, which provided an easy-access end funnel, was covered with black polyethylene sheeting; this trap proved five times more effective in capturing both types of lobster than all other models. Results of the design aspects of the project were supplemented by behavioral observations of the lobsters, including food preferences.

Refinements designed to offer greater utility in removing captured lobster from the prototype den-trap were evaluated in second generation testing. Results from the pond and from limited shallow-water field testing require verification with tests which should be conducted in deep water to determine if the den-trap is effective lobster harvesting gear.

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM: Check (√)	Approx. Date
a. Abstracts of Theses	√				
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c. Data on Scientific Collaborators			√		
d. Information on Inventions	√				
e. Technical Description of Project and Results		√			
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2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
Thomas A. Herbert, Ph.D.	Thomas A. Herbert	3-28-80

NSF Form 98A (5-78) Supersedes All Previous Editions

Form Approved OMB No. 99R0013

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Several species of lobster are found in the South Atlantic Ocean and the Gulf of Mexico, but with existing technology, the capture of only the spiny lobster is commercially profitable. Spiny lobsters are captured regularly in rectangular lath traps designed by Florida lobstermen. The other species, collectively known as "slipper lobster,"* are taken only as a by-product of the spiny lobster and shrimp fisheries.

The irregular harvest of the slipper lobster is attributed to the lack of a directed fishery. Traps have not been designed to take advantage of their particular foraging habits and ecological distribution which differ from the spiny lobster. Slipper lobster are believed to be most abundant in shelf areas beyond the present range of the spiny lobster fishery. The range of the slipper lobster is believed, however, to overlap that of the spiny lobster in some deepwater areas. A dual-species trap of an innovative design could provide the stimulus then to develop a slipper lobster fishery and expand the existing spiny lobstery fishery into continental shelf waters.

From October 1, 1979, to mid-March, 1980, experiments were conducted at Grassy Key, just north of Marathon, Florida, to develop a trap capable of capturing both slipper and spiny lobster. Seven modified versions of the standard spiny lobster trap were tested through two generations and compared with the conventional lath trap. All experiments were conducted with a population of captive lobster in a pond simulating the natural habitat. Results of the design aspects of the project were supplemented by behavioral observations of the lobsters including food preferences.

Conclusions presented here form the basis of an application for funds to conduct a second phase of testing. Phase II will refine the design and test the new, dual-species den-trap 50 to 100 nautical miles offshore on the South Florida continental shelf.

RESEARCH METHODS

Enterprising lobster fishermen often experiment with new trap designs by placing a few modified traps among the traditional models. If the new traps consistently catch more lobsters, the modified design is slowly adopted into the fishery. But such impromptu and individualized experimentation provides an inefficient mechanism for change. There is no experimental control or effective data analysis in such casual experimentation. Only one major change in trap design, a shift from a trapezoid to a rectangle trap, has occurred over the last 20 years.

The approach anticipated for improving this evolutionary process was first to observe the behavior of slipper lobsters while they were kept in 12-foot plastic pools. Next, various trap shapes and entrance combinations were to be tested in a sea-water pond inhabited by a captive

* Other popular names for the slipper lobster are: shovel-nose lobster, bulldozer lobster and Spanish lobster.

population of slipper and spiny lobsters. The effectiveness of these prototype traps was to be evaluated in the adjacent natural environment of Florida Bay, using randomly selected animals from the captive population. Simultaneous attempts to evaluate the influence of various baits (including live decoys and chemical attractants) were planned for the first phase experiments. It became apparent, however, at the beginning of the six-month program that the scope would have to be restricted.

The experimental approach adopted was more straight forward and produced the desired information without introducing additional variables that would have confused interpretation of experimental results. The 12-foot plastic pool observations were eliminated after it was recognized that behavioral observations could be made while the animals were being acclimated to captivity in the pond where initial trap designs were tested. In addition, approximately one-sixth of the test pond provided a natural habitat in the form of rock crevices, solution cavities and gravel-sand bottom, allowing elimination of the original plans for limited field testing in a net-enclosed portion of Florida Bay. Adequacy of the pond's natural habitat was demonstrated during the first generation tests when it was observed that not all of the captive animals entered the traps.

Since the pond provided adequate natural shelter for the captive lobsters, the anticipated population of 250 animals of each species was reduced to ± 85 animals. The total number was determined by the sheltering capacity of the pond. The sizes of these lobsters ranged widely from small to large. Very few spiny lobsters were used in order to simulate the expected dearth of these animals in a habitat favored by the slipper lobsters. The spiny lobsters were used only to determine if they would indeed occupy a trap capable of capturing more slipper lobsters than the conventional model.

Other changes in the methodology included the elimination of competing influences such as food-seeking and the need to avoid directed-predation, both factors which would have been encountered if the traps were tested in Florida Bay. Similarly, baiting techniques were omitted from the trap design phase to avoid introduction of another variable. (Bait selection observations were carried out but not in conjunction with trap preference.)

By consolidating some steps and eliminating others from the design-development phase, the traps' attractiveness became the focus of the reaction solicited from the test animals' behavior. Eight traps were placed in specific positions in the pond and sequentially moved from location to location each time they were pulled and sampled to reduce the bias of any particular location (Figure 1). The traps were pulled about every four days, the catch from each trap recorded, the lobsters returned to the pond and the traps placed in their new positions. Three to four days of undisturbed activity between pulls seemed to provide the proper time for the lobsters to reestablish normal activity patterns.

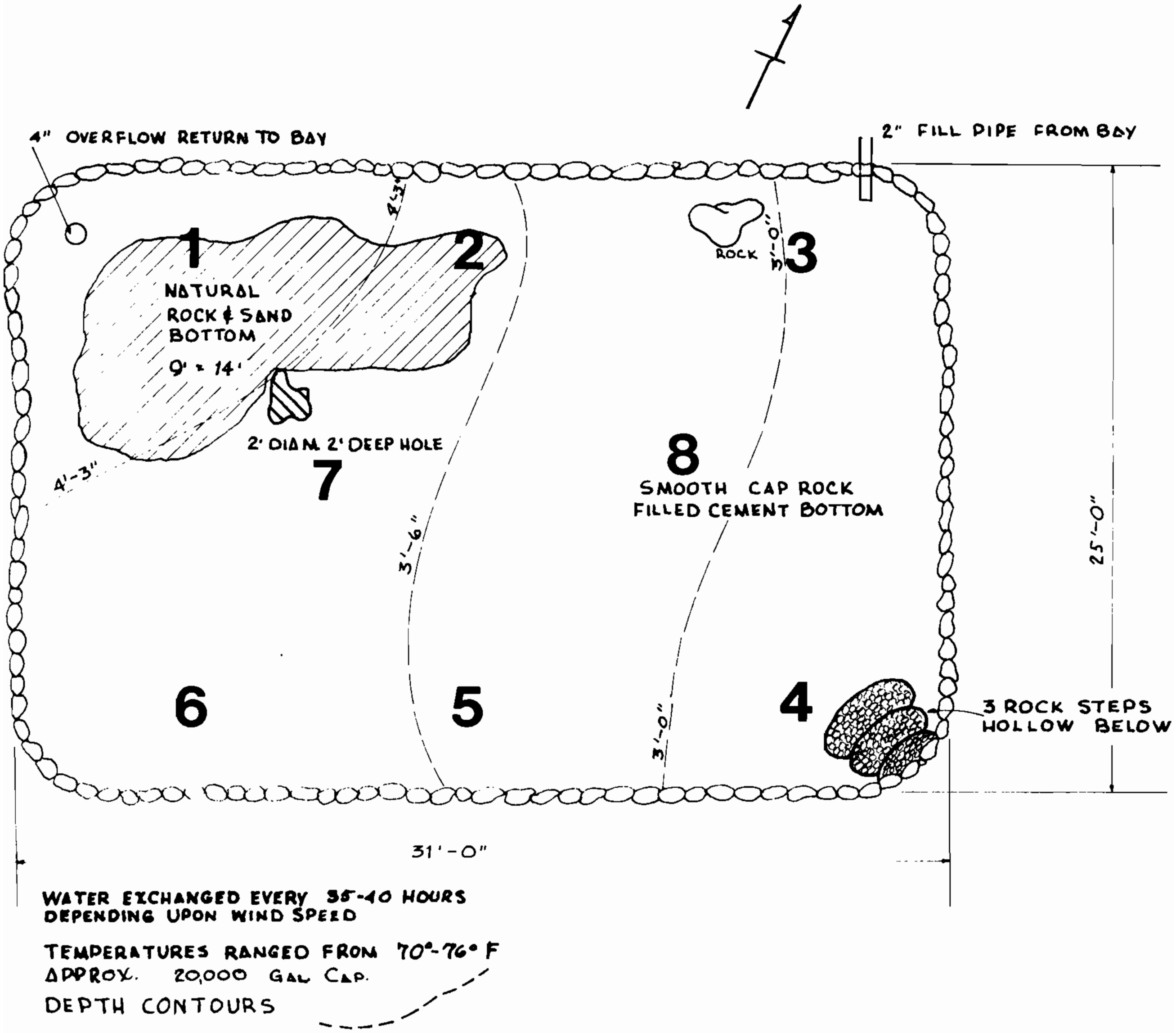

FIGURE 1 - Diagram of Grassy Key test pond.
Trap positions numbered.

The design phase experiments of this study were conducted to learn the influence of shape, size and entrance configuration on the suitability of the trap as alternate shelter. The influence of varying environmental factors and the presence or absence of suitable bait on trap efficiency should be more thoroughly investigated in the next phases of the project.

HABITAT SIMULATION

The pond shown in Figure 1 simulates the natural habitat where slipper lobsters are believed to be abundant. One-sixth of the 3½ to 4-foot deep pond was irregular sandy-rock bottom typical of limestone and coral outcroppings of the southwest Florida shelf. The rest of the pond bottom was concrete-filled cap rock; the sides were cement and stucco. A two-foot diameter, two-foot deep hole (Figure 2) adjacent to the irregular bottom simulated the solution cavities commonly found in the drowned-karst topography of the west Florida shelf.

A windmill pumped sea-water into the pond via a two-inch diameter pipe which extended 200 feet into nearby Florida Bay. A four-inch diameter standpipe was used for the drain. Although wind speed varied the filling rates from 250 to 1,300 gallons per hour, the water was completely exchanged every 35-40 hours. Water temperature ranged from 70° to 76° F. Water depth was maintained at a minimum of three feet in the shallow end, yielding about a 20,000 gallon capacity.

CAPTIVE LOBSTER POPULATION

During October and early November, lobsters were purchased from local fishermen and divers who were asked to keep alive slipper lobsters taken in spiny lobster traps or by hand. Specimens ranged widely in size and consisted predominantly of two species: *Scyllarides nodifer* (A in Figures 3 and 4) from shallow water (1 to 2 fathoms) and *S. aequinoctialis* (B in Figures 3 and 4) from deeper water (up to 25 fathoms). One female *Parribacus antarcticus* and six *Panulirus argus* were also used in the experiment. The sex ratio of the spiny lobster (*P. argus*) was 1:1; the ratio of males to females of the two species of slipper lobster was 1:2. Each of the 78 slipper lobsters comprising the original test population were numbered on the carapace with enamel paint.

A variety of food was used during the experiment and the animals were fed every other day. The principal diet consisted of cut conch meat supplemented by clam meat when available. Several queen conch were kept alive in the pond as a ready supply of fresh food. The lobsters aggressively sought food during each night time feeding; no food remained in the pond the following morning. More than 35 slipper lobster molts were observed during the study, demonstrating the positive response to the maintenance diet.

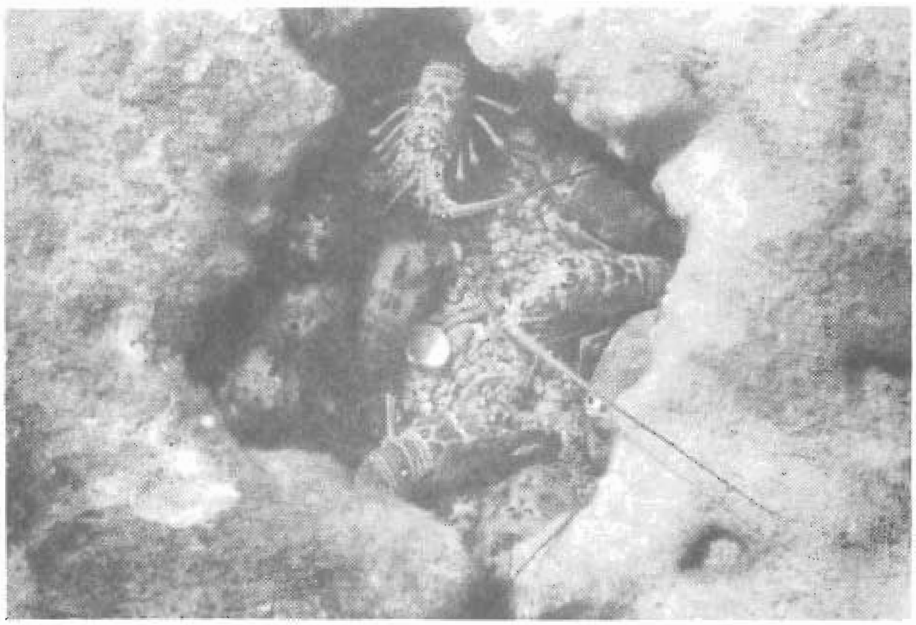

FIGURE 2 - Test pond solution cavity occupied by both spiny and slipper lobster.

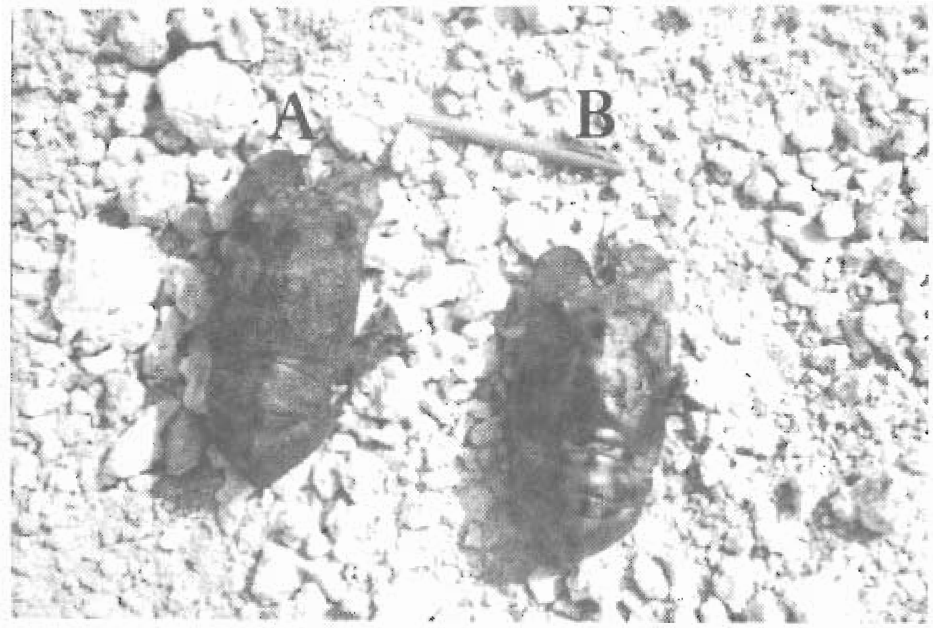

FIGURE 3 - Dorsal view of slipper lobster: A, *Scyllarides nodifer*; B, *S. aequinoctialis*.

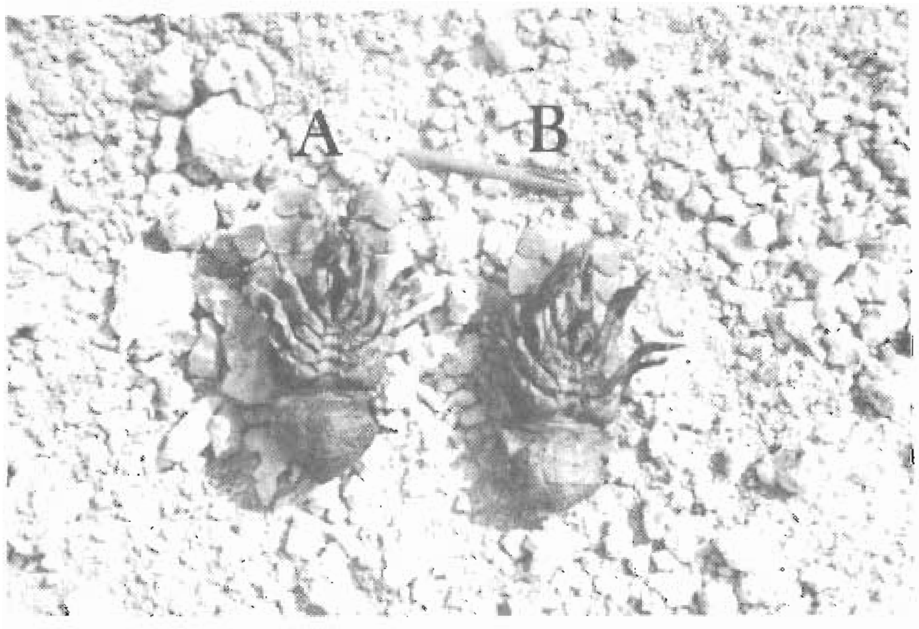

FIGURE 4 - Ventral view of slipper lobster: A, *Scyllarides nodifer*; B, *S. aequinoctialis*.

When experimental traps were placed in the pond on November 25, 1979, the captive population consisted of 84 lobsters. During the experiment, this population experienced a degree of natural variation in numbers when three specimens were added (two male and one female *S. nodifer*) and seven mortalities occurred.

Activity displayed by the experimental population varied widely. The more agile spiny lobsters roamed about the pond both day and night. Slipper lobster did not move about during the day and were only rarely observed via the video monitor to forage throughout the night. The two species of slipper lobster moved about during periods of shorter duration (two to three hours), usually at sunrise and sunset. These nocturnal habits, coupled with divers' reports of finding slipper lobster in the darkest portions of natural reefs during the day, led to the experiments with artificially-darkened traps.

All species of lobsters in the captive population were equally gregarious in the presence of the other species. Often the spiny lobsters were seen climbing over slipper lobsters and they occupied the solution cavity in the bottom of the pond at the same time (Figure 2). In such instances, the spiny lobster were found in the upright position while the slipper lobster were usually clinging to the underside of the rock overhang.

TRAP DESIGNS - FIRST GENERATION

A conventional lath spiny lobster trap (Figure 5) was compared with seven modified traps (Figure 6); all traps were constructed of the same, readily available materials. The object of the experiment was to design a trap that would capture both slipper and spiny lobsters without increasing construction costs for the fishermen. A conventional spiny lobster trap is 32 inches long, 20 inches wide and 16 inches high. It is framed with half-inch cypress lath that is 1½ to 2 inches wide and covered with 3/8 by 1½ inch laths spaced 3/4 to 1 inch apart. A 7¼-inch square entrance or "throat" is located slightly off-center in the top of the trap. Concrete or iron ballast is secured in the bottom and a removable portion of the top serves as an access panel for retrieval of captive lobster. The traps often are not baited when set. But when they are baited, the following are frequently used: cowhide, pig hide, snapper or grouper heads, perforated cans of fish and small, live "decoy" lobsters.

Two trap designs were developed to consider only the limited climbing abilities of the shorter-legged slipper lobster. These two designs represented the least modification of the conventional trap. Figure 7 is a picture of a conventional trap altered by the extension of a wooden slat which forms a ramp from the bottom of the trap to the top entrance. Figure 8 shows a conventional trap modified by inverting it so the entrance was in the bottom; four-inch legs were added to each corner to provide adequate elevation for the animals to enter. The size of this trap was reduced to 20 x 32 x 12 inches.

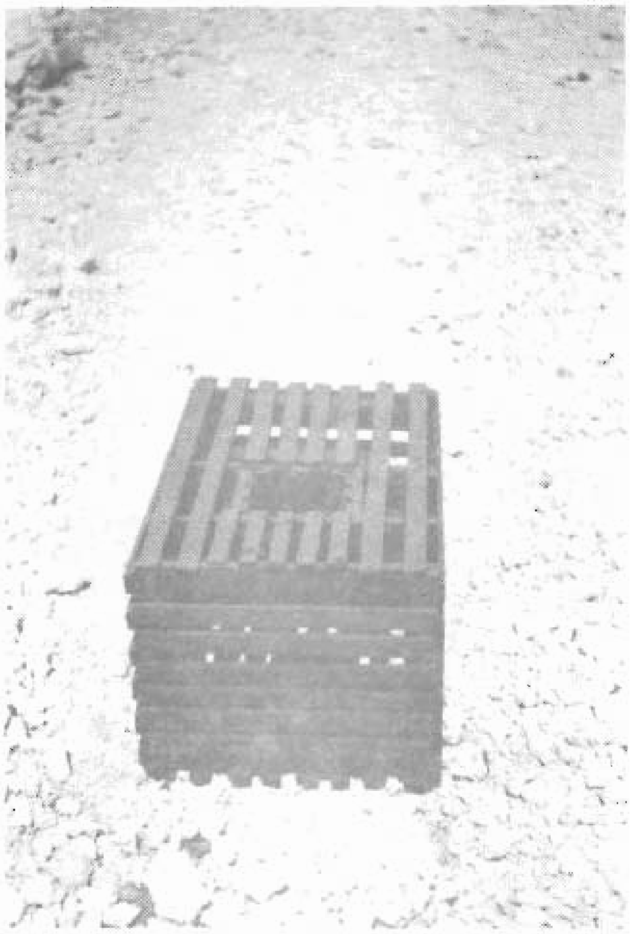

FIGURE 5 - A conventional spiny lobster trap that is used universally in South Florida.

FIGURE 6 - The eight trap designs tested during the first generation experiments.

FIGURE 7 - A conventional spiny lobster trap with the addition of a $1\frac{1}{4}'$ x 3/8" climbing slat extending down to the bottom of the trap along the side of the thraot. The person in the photograph is holding the access panel in his left hand.

FIGURE 8 - A modified conventional trap with four-inch legs to allow entry from beneath. The entry throat was of the conventional design except inverted.

Figures 9 and 10 are pictures of traps modified to allow for the limited climbing abilities and the suspected rooting behavior which may be common to slipper lobsters foraging near natural shelter. Figure 9 shows the conventional trap altered by the removal of one slat to provide a single end entrance near the bottom of the trap. Figure 10 is a picture of a conventional trap with entrances at the bottom of one end and at the bottom of each side.

Figure 11 is a picture of a conventional trap modified by using one bottom end entrance and covering the top half with black polyethylene sheeting.* This design incorporated an additional modification to accomodate the lobsters' suspected desire for shelter. Figure 12 shows a conventional trap modified to include only one bottom entrance; the top as well as all sides of the trap were covered by black sheeting. This model represented the ultimate shelter, similar to a hollowed coral head with limited access.

The trap in Figure 13 was designed to incorporate the double features of shelter and ease of access for a lobster displaying limited climbing ability and rooting behavior. A flattened, slat trap (24 x 48 x 6) was used for this design. The top and sides were covered with black sheeting and one end of the trap had a funnel entrance which offered easier access than the conventional entrance or the entrance created by removal of one slat.

RESULTS - FIRST GENERATION TESTING

The results of the first generation of experiments (Table 1) revealed that the flattened, covered trap (Figure 13) was superior to all other types in producing slipper lobster. This trap was five times more effective than the one modified to simulate the hollowed coral head. Frequently, this trap captured more than 20 lobsters at a time, regardless of its relative position in the pond. It produced over 60 per cent of the lobsters captured during the first seven weeks of the experiment.

At any one sampling, no more than 34 per cent of the total captive population of lobsters were retrieved from all the traps; because of this, the natural setting of the pond was considered to have elicited behavior representative of a wild population. At least 10 per cent of the lobsters captured during the first generation of experiments entered traps set in six of the eight pond positions (Figure 14). The relatively poorer yields depicted in Figure 14 from traps in Positions 5-8 may be attributed to the fact that the most efficient trap occupied those positions only once and all others twice during the experiment. Because of the rotation scheme, it appears that a sufficient probability existed for captive lobsters to encounter each type of trap regardless of its position. Territorial behavior exhibited by individual lobsters could not be determined because the numbered carapaces were shed during an unexpectedly high degree of molting.

*The plastic was a 4 mil, black, cross-laminated polyethylene sheeting manufactured by Sto-Cote Products of Richmond, Illinois.

TABLE 1

First Generation Trap Type Yields (Slipper/Spiny Lobsters)

Sampling Dates	Total	Standard	Throat Slat	Inverted with Legs	One End Opening	Three Bottom Openings	Dark Top with One Opening	Completely Dark with One Opening	Flat, Dark with Funnel End
Nov. 29	10/5	-0-	0/2	-0-	1/0	-0-	-0-	3/0	6/3
Dec. 2	16/2	-0-	-0-	2/0	-0-	-0-	-0-	4/0	10/2
Dec. 6	19/5	0/1	5/2	1/0	-0-	-0-	1/0	1/0	11/2
Dec. 12	26/2	3/0	2/0	-0-	2/0	2/0	-0-	7/0	10/2
Dec. 15	33/5	-0-	3/0	2/0	-0-	-0-	4/0	4/0	20/5
Dec. 19	24/2	0/1	-0-	2/0	-0-	-0-	5/0	4/0	13/1
Dec. 23	19/4	1/0	-0-	3/0	-0-	1/0	4/0	1/0	9/4
Dec. 27	27/5	0/1	1/0	1/0	-0-	2/0	2/0	4/0	17/4
Jan. 1	30/5	1/0	-0-	2/0	-0-	3/0	2/0	4/0	18/5
Jan. 4	26/5	3/0	-0-	1/0	1/0	1/0	1/0	1/0	18/5
Jan. 13	25/5	-0-	0/1	1/0	-0-	1/0	-0-	5/0	18/4
TOTAL									
Slipper	255	8	11	15	4	10	19	38	150
Spiny	45	3	5	0	0	0	0	0	37
Lobsters	300	11	16	15	4	10	19	38	187
% Yield	100	3.7	5.3	5.0	1.3	3.3	6.3	12.7	62.3

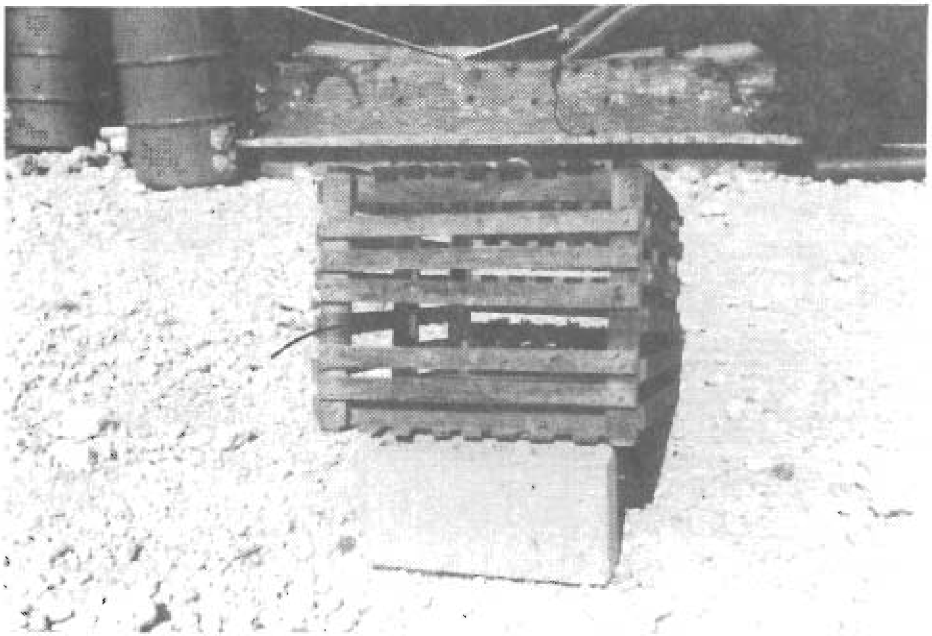

FIGURE 9 - A conventional spiny lobster trap with an end slat removed.

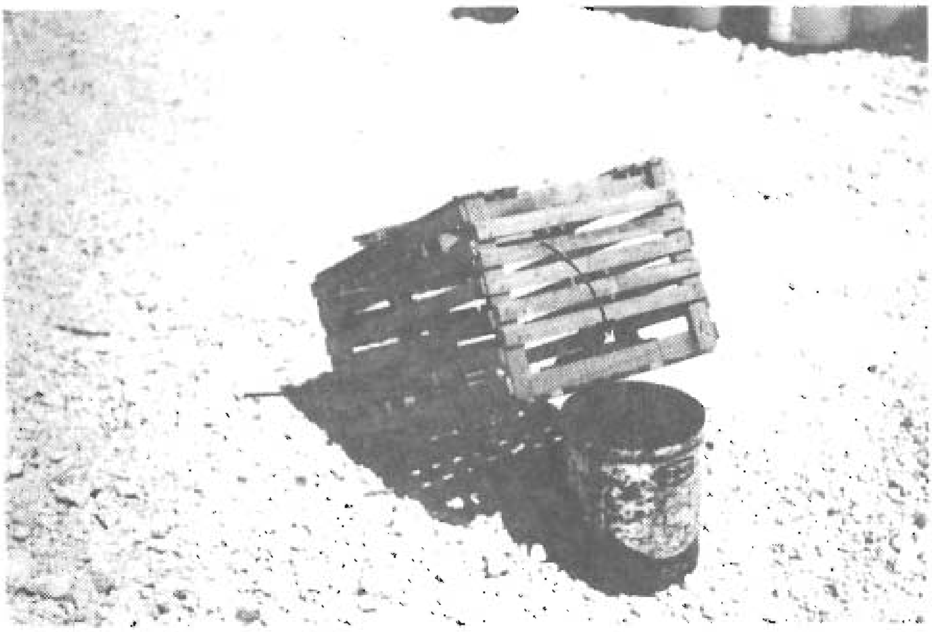

FIGURE 10 - A modified conventional trap with one lath removed from the end and with a small entry-opening on each side.

FIGURE 11 - A modified conventional trap with a single lath removed on one end. There is no entry throat on top and the top one-half of the trap is covered with black polyethylene sheeting.

FIGURE 12 - A modified conventional trap with one lath removed from the end for access. The trap is completely darkened with black polyethylene sheeting to simulate the natural shelter of a hollowed coral head.

FIGURE 13 - Highly modified habitat-trap designed to reduce the need for climbing and to provide dark shelter. The dimensions for this first generation trap are 24" x 48" x 6" with a single access funnel. The habitat-trap is completely covered with black sheeting. The person in the photograph is holding the access panel in his right hand.

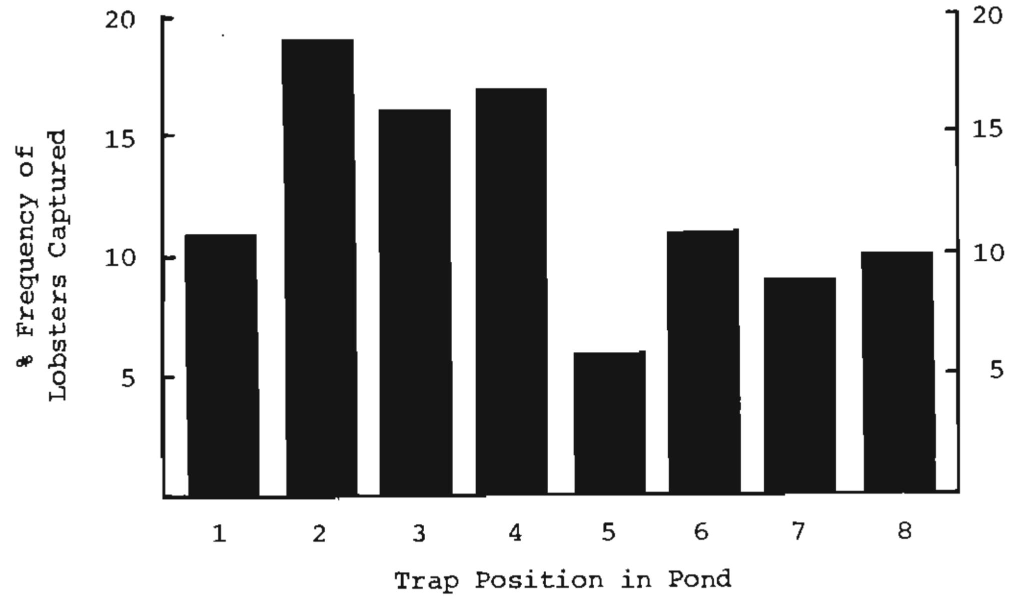

FIGURE 14 - Per cent of lobsters captured at each pond site during first generation testing.

TRAP DESIGNS - SECOND GENERATION

Results of the first generation of trap design experiments indicated the lobsters were seeking shelter; they were using the unbaited traps as dens. The most attractive den appeared to be the covered, flattened model with one, end easy-access funnel. The second generation experiments investigated the relative importance of the darkened shelter and the ease of access offered by further modifications of this den-trap.

The end funnel of this trap was thought to be the source of a potential problem: the lobsters could crawl out as easily as they crawled into the den-trap. The design proved workable, however, because the lobsters attached their walking-legs tightly to the trap lath during retrieval; no loss was experienced. The lobsters' tenacity created as well as solved a problem. The tightly-attached animals (particularly the more-compressed slipper lobster) were difficult to remove from a trap which was only six inches high. The solution was to increase the trap height to eight inches for the second generation of tests (Figure 15).

Eight-inch high den-traps were compared with the prototype six-inch high model from the first experiment, with the second most successful trap (the one simulating a hollowed coral head) and with the standard, unmodified spiny lobster trap. Some new models had a funnel entrance in both ends, some in only one; some were covered and others were not.

Seven traps were placed in the pond on February 10, 1980. Since four were new and unseasoned, sampling was delayed 10 days so that these traps could "soak" long enough to become as acclimated as the old traps. A new eight-inch high, single funnel, darkened den-trap was placed in Pond Position No. 1. Following in the other pond positions were: the standard, unmodified spiny lobster trap; a second eight-inch high double funnel darkened den-trap; the prototype six-inch high single funnel darkened den-trap; a new eight-inch high, double funnel uncovered den-trap and the previously-used conventional spiny lobster trap modified to resemble a hollowed out coral head. These traps were sampled twice and not rotated from their original positions. The results are displayed in Table 2.

RESULTS - SECOND GENERATION TESTING

Individual trap yields rarely exceeded 10 lobsters at any one time and the six-inch high prototype den-trap again produced the largest percentage of both species (Table 2). However, this time no dramatic difference existed in the frequency with which this trap captured lobsters compared with the other traps. Three other models produced more than 15 per cent of the lobster captured during the four-week experiment. The common feature was that all of these traps were covered to some degree. An uncovered, double funnel, eight-inch high den-trap produced only 8 per cent of the total catch.

TABLE 2

Second Generation Trap Type Yields (Slipper/Spiny Lobsters)

Sampling Dates	Total	8-inch Covered Den-Trap 1-Funnel	Standard*	8-inch Covered Den-Trap 1-Funnel	8-inch Covered Den-Trap 2-Funnel	6-inch Covered Den-Trap 1-Funnel*	8-inch Uncovered Den-Trap 2-Funnel	Completely Dark with 1 Opening*
Feb. 21	45/5	8/0	1/0	3/0	13/0	5/5	4/0	11/0
March 7	35/5	9/0	3/2	3/0	3/0	11/3	3/0	3/0
TOTAL								
Slipper	80	17	4	6	16	16	7	14
Spiny	10	0	2	0	0	8	0	0
Lobsters	90	17	6	6	16	24	7	14
% Yields	100	18.9	6.6	6.6	17.8	26.7	7.8	15.6

* "Seasoned" traps from first experiment.

This spread of trapping efficiency is an encouraging indication that the flattened, covered den-trap will be attractive to natural populations of slipper lobsters. Spiny lobsters entered only the conventional (unmodified) trap and the six-inch high prototype den-trap. Both were well "seasoned" from use in the first experiment, a significant point because lobster fishermen recognize that a seasoned, well-soaked trap catches more lobster than a new one.

Field testing should resolve the question of the preference of two funnels instead of one; the second generation of testing failed to indicate a discernable difference in their efficiency. It did show, however, that the uncovered flattened trap was not any more attractive as a habitat for slipper lobster than was the conventional spiny lobster trap.

BAIT PREFERENCE OBSERVATIONS

During Phase I eight varieties of bait (food) were periodically offered to the captive lobster population on a "bait board" at feeding time. This 18 x 36 inch board was a weighted sheet of plywood with six bait selections placed 18 inches apart. The response of the foraging lobsters to each bait was monitored via a video camera floating on the pond surface (Figure 16). A camera positioned directly over the bait board permitted day and night monitoring since the camera was sensitive enough to transmit images to a monitor even under low-light conditions. Supplemental light for night observations was provided by two 10 watt, 12 volt D.C. light bulbs strung above the surface along the long axis of the pond. Observations were not recorded because of the difficulty encountered in quantifying preferences in terms of behavioral response.

In summary, the feeding responses ranged from total consumption to total avoidance. Lobsters were attracted to the following materials in descending order: conch meat, clam meat, fresh herring, mackerel, canned Brunswick herring, cowhide, canned cat food and pig hide. Fresh cut mullet or ballyhoo did not attract lobsters.

FIELD TESTING IN THE NATURAL ENVIRONMENT

The pond is believed to have offered a sufficiently natural environment to elicit behavioral responses from the captive lobster population thought representative of wild stocks. This can only be substantiated by deploying the new den-type traps in field experiments. Effort was made during this first phase of the study to evaluate the attractiveness of 12 second-generation den-traps deployed among 24 conventional spiny lobster traps in 8 to 14 feet of water, 1¼ miles from Grassy Key. When den-traps were placed near rubble piles, spiny lobster appeared to be more readily attracted to these than to the conventional traps. Results were inconclusive as the spiny lobster fishing season neared completion during this time, limiting the relative number of animals available, especially in shallow water. Proper testing of this trap and its ability to simulate shelter should be conducted in both shallow and deep water during the next phase of the study.

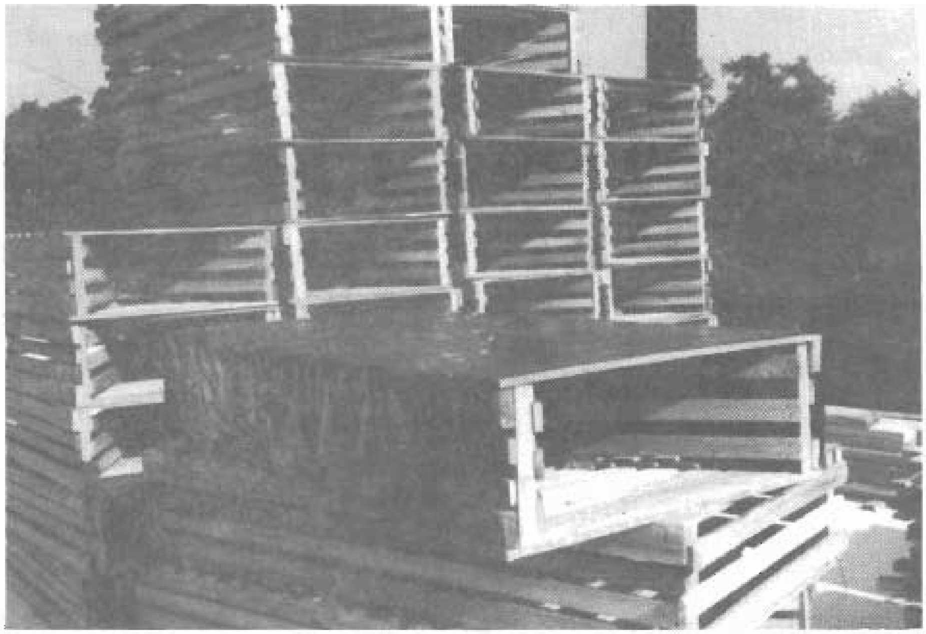

FIGURE 15 - Second generation 24" x 48" x 8" den-trap covered with black sheeting on all but the entrance end(s).

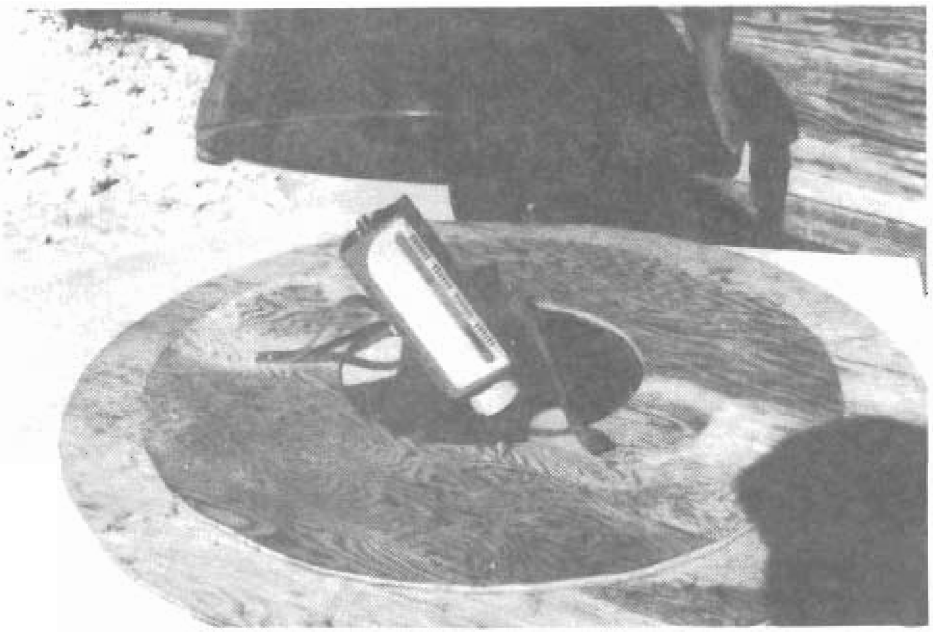

FIGURE 16 - Video camera used to monitor feeding preference.

CONCLUSIONS AND RECOMMENDATIONS

1) In comparison with six other modifications of the conventional spiny lobster trap, a flattened, covered model proved five times more effective in capturing both slipper and spiny lobsters when tested in a simulated natural environment.

2) This den-trap was covered with polyethylene sheeting to darken the interior; the simulated shelter did not have to be baited to catch spiny or slipper lobster.

3) The construction methods and materials are similar to those now used in the industry and material costs and fabrication time are comparable. The extra expense of the polyethylene sheeting was balanced by a reduction in the cost of structural materials because the den-trap is slightly smaller.

4) The den-trap can be stacked on deck in an interlocking manner which increases transport safety and efficiency at sea. This is an important feature when fishing the distant offshore shelf areas believed to harbor unexploited stocks of slipper (and perhaps spiny) lobster.

5) Additional field testing is required to refine trap dimensions and deployment methods in deep water habitats.