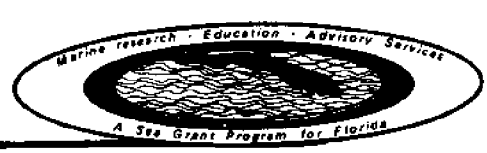
# FLORIDA SEA GRANT PROGRAM

CONFERENCE PROCEEDINGS:

# RESEARCH AND INFORMATION NEEDS OF THE FLORIDA SPINY LOBSTER FISHERY

Edited by
William Seaman, Jr.
and
Donald Y. Aska

SUSF-SG-74-201 (Report Number 1)



# RESEARCH AND INFORMATION NEEDS OF THE FLORIDA SPINY LOBSTER FISHERY

Edited by

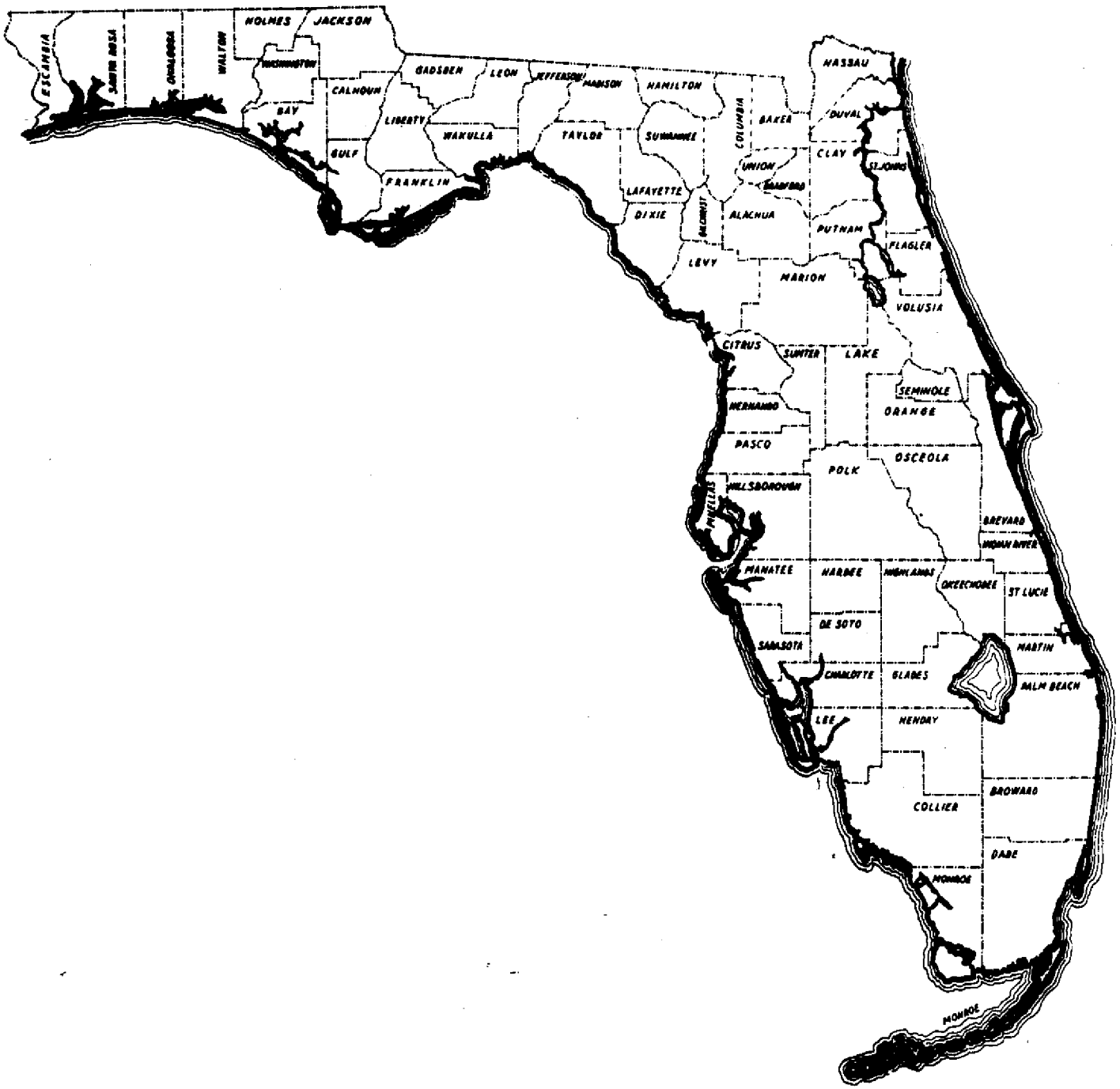
William Seaman, Jr. and Donald Y. Aska

PROCEEDINGS OF A CONFERENCE
HELD MARCH 12, 1974,
IN MIAMI, FLORIDA

Sponsored by
State University System of Florida Sea Grant Program

Copies available from
Marine Advisory Program
G022 McCarty Hall -- UF
Gainesville, Florida 32611

Printed April, 1974


ESCAMBIA
SANTA ROSA
OKALOOSA
WALTON
HOLMES
JACKSON
WASHINGTON
BAY
CALHOUN
GULF
FRANKLIN
GADSDEN
LEON
LIBERTY
WAKULLA
JEFFERSON
MADISON
TAYLOR
HAMILTON
SUWANNEE
COLUMBIA
LAFAYETTE
DIXIE
BRADFORD
UNION
BAKER
NASSAU
DUVAL
CLAY
ST. JOHNS
ALACHUA
PUTNAM
FLAGLER
LEVY
MARION
VOLUSIA
CITRUS
SUMTER
LAKE
SEMINOLE
ORANGE
HERNANDO
PASCO
POLK
OSCEOLA
HILLSBOROUGH
PINELLAS
BREVARD
INDIAN RIVER
MANATEE
HARDEE
HIGHLANDS
OKEECHOBEE
ST LUCIE
DE SOTO
SARASOTA
MARTIN
CHARLOTTE
GLADES
PALM BEACH
LEE
HENDRY
BROWARD
COLLIER
DADE
MONROE
MONROE

CONTENTS


INTRODUCTION.....1
Objectives.....1
Format.....1
SUMMARY.....2
List of Major Problems and Needs.....3
Abstracts of Papers.....3
CONTRIBUTED PAPERS AND AUTHORS
Fishermen's Problems in the Spiny Lobster Fishery...R. C. Wolfferts.....8
Florida Spiny Lobster Industry Problems... R. Felik.....10
Statistical Trends in the Spiny Lobster Fishery...L. E. Johnson.....15
Spiny Lobster Programs at the Marine Research Laboratory, Florida Department of Natural Resources...E. A. Joyce, Jr.....19
Notes on the Status of Spiny Lobsters, *Panulirus argus*, at Dry Tortugas, Florida, 1974...G. E. Davis.....22
*In Situ* Research on the Biology of Spiny Lobster, *Panulirus argus*...W. Herrnkind.....33
Studies on the U.S. Spiny Lobster Fishery in the Bahamas Region...D. C. Simmons.....37
Studies on the Phyllosome Stages of the Spiny Lobster in the Western North Atlantic ...W. J. Richards.....42
Observations on Techniques, Operations, and Harvest of the Spiny Lobster Fishery... A. K. Craig.....43
Economic Research on the Florida Spiny Lobster Industry...F. J. Prochaska.....47
Lobster Data and Bibliography: *MARS VI* and *TRIAL* Multi-Access Retrieval Computer Programs...P. Kanciruk.....50
APPENDICES
Florida Lobster Management Programs.....57
Department of Natural Resources Publications on Lobster.....60
Program.....62
Attendance.....63
Florida Map.....(Inside back cover)

## LIST OF TABLES


1. Spiny Lobster Commercial Landings.....17

2. U.S. Imports of Lobster Tails by Country of Origin, January - June, 1972 and 1973.....18

3. Permits and Traps, Florida Spiny Lobster Fishery.....20

4. Spiny Lobster Landings by Florida County, 1972.....21

5. Incidence of Egg-Bearing Panulirus argus at Dry Tortugas, Florida, by Size Class.....28

6. Percent of Reproductively Inactive Female Panulirus argus in Commercial Harvest at Dry Tortugas, Florida, 1971-73.....29

7. Factors Affecting Success of Trapping and Diving.....39

8. Partial Listing for Entire TRIAL Bibliographic Data Base.....54

9. Partial Listing of TRIAL Key Word in Context Index.....55

10. Partial Listing of TRIAL Author Index.....56


## LIST OF FIGURES


1. 1973 Spiny Lobster Tail Consumption and Wholesale Price.....16

2. Fort Jefferson National Monument.....23

3. Seasonal Movements of P. argus at Dry Tortugas.....25

4. Onset of Egg-Bearing by Panulirus argus at Dry Tortugas, Florida, 1973.....26

5. Comparison of Length Frequency Distributions of Spiny Lobsters from Fort Jefferson National Monument and Dry Tortugas Commercial Fishery.....31

6. Florida Landings and Value of Spiny Lobsters Captured in the Bahamas Region.....40

7. Factors in Successful Lobster Fishery.....45

# RESEARCH AND INFORMATION NEEDS OF THE FLORIDA SPINY LOBSTER FISHERY

Edited by
William Seaman, Jr.[1] and Donald Y. Aska[2]

## INTRODUCTION

In response to a number of fishermen in South Florida, the State University System of Florida Sea Grant Program recently became involved in research on the spiny lobster, Panulirus argus. When additional research needs were expressed, Florida Sea Grant decided to become better informed on the subject, and evaluate its potential for service to the persons dependent on this fishery resource. Hence a meeting of persons and organizations involved in the biology and/or utilization of the spiny lobster fishery in Florida was called.

### Objectives

Within the research and advisory limits of Sea Grant, the objectives of the meeting were:

1. To identify broadly the problems and information needs of persons dependent on the spiny lobster resource.
2. To assess existing sources of information and their possible applications.
3. To identify priorities and actions needed to resolve user problems.

### Format

#### Meeting

Papers on the major aspects of the fishery -- fishing, industry, statistics, history, economic and biological research -- were presented. All papers were heard before discussion occurred. (Program, page 62.)

Following all the presentations, papers were discussed individually. Based on this, a list of major problems and needs was compiled. These items were then reviewed by the group. (Attendance list, page 63.)

#### Proceedings

The contributed papers (pages 8-57) are preceded by a summary section (pages 2-7), in which the major problems and needs of the fishery are listed. Also in the summary are abstracts of the individual papers, in which the main points of information are summarized.

---

[1]Assistant Director, State University System of Florida Sea Grant Program
[2]Coordinator, Florida Sea Grant Marine Advisory Program

## SUMMARY

The spiny lobster (Panulirus argus) is Florida's second most important commercial species, with 1972 landings amounting to 11,400,000 pounds valued at $11,800,000 dockside. Centered in Dade and Monroe Counties, the fishery is intensive, characterized by increasing numbers of fishermen, competition for productive fishing space, and increased entry of casual trap operators and divers. As a result, licensed fishermen are spending more time and effort yet harvesting less on an individual basis.

Furthermore, theft of traps or trapped lobsters is serious. Many feel that prosecution is not dealing strong enough penalties to lawbreakers. Also, transshipment of illegally taken or undersized lobsters is a problem since authorities currently lack authority to stop such practices under existing law.

Limited entry has been suggested by Keys commercial fishermen. The difficult problem of identifying commercial fishermen who would be allowed entry might be solved by examining management precedents established in Alaska and Canada.

Development of information to assist agencies in resolving such management issues was seen to be an immediate need. For example, improved commercial catch data are needed. Sport catch data are nonexistent, yet significant.

Biological questions concern the life history of the species and the ability of populations to sustain fishing pressures. A basic question deals with recruitment, since the source of young lobster -- whether the distant Caribbean or locally -- will influence the relative importance of economic and biological criteria in setting desirable yields. For example, size at sexual maturity is important in legally defining "short size." Questions on the vulnerability of young migrating lobster to fishermen must be answered, as well as vulnerability of all sizes to pollution. Identification and tracking of dispersal of larvae are significant research needs, although costly, and time demanding.

International concerns focus on two areas: (1) National sovereignty and the allocation of the fishery resources of coastal states; (2) biological recruitment of lobsters from waters of another country. Recent enforcement measures by the Bahamian government have affected the activity of Florida-based fishermen.

Several fishermen volunteered to follow-up the session with economic and biological information from their logs and catch records. Small group meetings, for example to set uniform statistical data needs, could be used in formulating specific research and advisory work.

## List of Major Problems and Needs

A. Harvest
   1. Declining catch per unit of effort
   2. Determination of a "maximum sustained yield"
   3. Amount of entry to fishery
      a. Number of fishermen
      b. Seasonality
   4. Definition of short size

B. Biology
   1. Life history
      a. Recruitment
      b. Queues & marches
      c. Age - growth
   2. Larval identification
   3. Effects of pollution
   4. Thermal/hydrographic studies

C. Business
   1. Legal: Enforcement and prosecution
      a. Vandalism
      b. Identifying brushed and clipped lobster
   2. Statistics of commercial and sport fisheries
   3. Economics and budgets of fishermen

D. Workshops on specific problems

## Abstracts

### Fishermen's problems in the spiny lobster fishery

R. C. Wolfferts

Problems include theft and destruction of traps; piracy of lobsters from traps; surveillance not stopping theft. In the Middle and Lower Keys divers contribute to theft problem. Increasing costs will probably go higher.

Conservation efforts must consider international aspects of fishery.

Feeling that species is not endangered, but present catch per effort prompts discussion of moratorium on permits, with future permits denied to those not dependent on commercial fishing for greater part of income.

### Florida spiny lobster industry problems

R. Felik

Increased production is needed by fishermen, processors and distributors. To achieve this, research and federally enforced laws are needed.

Research is required to resolve conflicting information and data gaps about the lobster life cycle and habits. Artificial habitats may be one way to increase production.

Expanded effort and declining catch per unit of effort have been accompanied by taking of undersized lobsters, plus clipping, stripping, and cutting of exposed eggs from the female.

A void between limited state power and lack of federal regulation exists. Shipment of illegal catch (from Florida and non-Florida waters) into Florida is unintentionally encouraged by custom bonding by the federal government.

National and international efforts, including more uniform policies, will solve some of the problems.

Two conservation laws are proposed: (1) To curtail overfishing, restriction of foreign imports into the U.S. during the closed season is proposed. International agreements are required to insure full compliance. (2) To protect egg-bearing females and young, a minimum size limit is required; the "Federal Sponge Act" is suggested as a model.

The international nature of this fishery argues against designating the spiny lobster as a creature of the continental shelf.

## Statistical trends in the spiny lobster fishery

L. E. Johnson

Over 93% of the catch of spiny lobster in the U.S. is landed in Florida.

In the past 10 years, annual Florida landings from Florida waters have increased from around three million to about four and one half million pounds. Florida landings from international waters have increased more rapidly, from one million to around six million pounds.

Landings in Florida are now worth over $10 million at dockside. Price now paid is between two and three times levels of about ten years ago.

U.S. imports of spiny lobster tails in the first half of 1972 and 1973, respectively, were 21.5 and 17.7 million pounds.

The bulk of the catch in Florida is caught and landed in the Keys. Florida's international operations have moved beyond the Bahamas to the Caribbean.

In 1971, 1149 fishermen, 250 boats, and 272 vessels were involved in the spiny lobster fishery in Florida. A 25% increase is forecast for 1973.

The fishery is highly competitive, and may be optimally saturated with men and boats. Catch and landings may be at a peak. A big market for undersized lobster tails creates legal and conservation problems.

## Spiny lobster programs at the Marine Research Laboratory, Florida Department of Natural Resources

E. A. Joyce

The vast majority of Florida spiny lobsters probably originate (i.e., are hatched) in the Caribbean. Currents drift the larvae to Florida. Identification of the larvae at the species level is a problem.

The fate of larvae originating in Florida is another question.

Post larvae have been grown to commercial size in 18 months in the laboratory. Rearing larvae is still a problem.

Lack of data on sport catch is a problem in management. Regulation and enforcement are difficult in the Keys.

Commercial landings center in Dade and Monroe Counties. Permits have steadily risen in the last 20 years.

## Notes on the status of spiny lobsters, Panulirus argus, at Dry Tortugas, Florida, 1974

G. E. Davis

Study of the natural history of, and impact of sport harvest on, an unfished natural population was begun in 1971. *In situ* index den surveys and standardized fishing with baited wooden lath traps were used to sample the lobster population. Seasonal and long term movements of tagged individuals were measured.

A marked seasonal movement was observed between shallow and deep reefs; mature females differed significantly in timing from the rest of the population. The size of first maturity in females observed was substantially larger than previously reported for Florida, but in close agreement with records from Bermuda and Panama in such a way as to suggest a climatic gradient affecting size at first maturity of *P. argus* similar to that reported for *Jasus lalandii*. Exceptionally large (>125mm C.L.) females appeared to be reproductively inactive. No tagged lobster was recaptured more than eight miles from its release site for one year. Very preliminary results showed a 60% reduction in the numbers of lobsters in shallow (>10m) dens as a result of 12 weeks of diver harvest. 17-21% of the total commercial harvest at Dry Tortugas consisted of immature females.

The data presented indicate a fishery-wide investigation is needed to determine (1) size at first maturity and (2) management implications of reproductive senility. Although the population at Dry Tortugas provides insight to an ideal natural system, further investigations must be made of heavily exploited stocks to establish a maximum sustained yield fishery.

## In situ research on the biology of spiny lobster, Panulirus argus
W. Herrnkind

Diving reduces sampling bias and provides for direct observation of lobster activity.

Results of a tagging and survey study of reef-dwelling adult lobsters in the U.S. Virgin Islands indicate non-random distribution and a strong homing behavior. In the Bahamas (Bimini) fall migration of lobster is less abrupt and transient than originally hypothesized.

## Studies on the U.S. spiny lobster fishery in the Bahamas region
D. C. Simmons

To document this fishery, information on (1) the value of the fishery, (2) areas important to U.S. fishermen, and (3) status of Bahama lobster stocks has been sought since 1972.

The fishery has expanded rapidly due to an influx of Cuban fishermen to South Florida, and the high value of lobster.

Standard wood slat traps are used primarily, although trap loss may account for increasing popularity of diving. The methods are compared.

Much of the lobster is landed in states that do not record statistics. Undersized and egg-bearing lobsters are a large part of the catch.

In 1972, 6,300,000 pounds were landed in Florida.

## Studies on the phyllosome stages of the spiny lobster in the western North Atlantic
W. J. Richards

Studies at the Southeast Fisheries Center are underway to determine the origin of recruits of various populations fished by the United States. The distribution of phyllosome larvae is being studied. A computer program of paths of dispersal or recruitment is being developed.

## Observations on techniques, operations, and harvest of the spiny lobster fishery
A. K. Craig

Studies of the Southeast Florida (Palm Beach - Biscayne Bay) techniques and gear were made.

Young adults, when migrating, are very vulnerable to predation by fishermen. Regular heavy pressure on young adults could be disastrous to the fishery.

Silting of habitat downstream from sewage outfall construction (dredging) seemed to reduce catches.

Thirty factors influencing fishermen's success are described in a study of problems of the individual fisherman.

The example of the American lobster is proposed as a model for developing a maximum sustained yield figure for spiny lobster. Comparative trapping in the Dry Tortugas and Keys is proposed.

Economic research on the Florida spiny lobster industry
F. J. Prochaska

Because this species accounts for nearly one-sixth of total fish and shellfish landings, it is an important part of general research describing and analyzing Florida's total fisheries.

Also, three projects specifically concerned with lobster are: demand, including prediction of prices; cost and returns, to provide information on profitable operations; and management, with a view to alternatives.

Lobster data and bibliography: MARS VI and TRIAL multi-access retrieval computer programs
P. Kanciruk

Capabilities and applications of two existing computer programs for information retrieval are presented. Remote telephone utilization is possible. Programs specifically for lobster need to be planned early in the research program.

# FISHERMEN'S PROBLEMS IN THE SPINY LOBSTER FISHERY

Richard C. Wolfferts
Key Largo

Theft and destruction of traps are two very big problems. Also piracy of lobsters from traps has increased drastically during the past five years, especially since hundreds of aliens have entered the industry.

As you gentlemen probably know, each permit holder is required to pay $50 per year, in addition to a regular license fee, to support a State owned and operated aircraft that is supposed to act as surveillance for the crawfishermen. This type of protection from thieves has not proven satisfactory. At the present time our Department of Natural Resources seems more concerned with checking regular crawfishing boats for shorts than with protecting us from thieves. We must have a certain amount of live shorts aboard the vessel, when running the trap line, to use as bait or decoys in the traps set in certain areas.

Like everything else, the cost of material to build traps and the cost of rope and buoys to equip the traps have risen greatly during the past year. Our suppliers tell us that these costs probably will go even higher when they receive their next orders. Each trap that is stolen or willfully destroyed increases our cost of production and reduces the catch.

Divers are a minimal problem in the Upper Keys mainly because of Pennekamp Park rules and regulations and patrol by the Park Rangers. In the Middle and Lower Keys divers are a real problem. Some divers go mainly to remove lobsters from the traps rather than find them themselves.

We feel that spiny lobsters are not an endangered species at the present time. They are a migratory fish, and their migratory habits are a great mystery to both fishermen and scientists alike. Perhaps with further research our scientists may someday solve this mystery. Weather seems to be the main factor in our area. Strong Northeast winds or a hurricane brings good catches over the whole area within a few days; with calmer weather the catches usually drop. Since we had a very mild winter this year the crawfish catches have been very poor. Dark nights and a new moon seem to make the lobsters take the traps better than during high moon nights. This is not necessarily so in the Caribbean Sea. Having fished for five years around the Island of St. Croix in the Virgin Islands we found better lobster fishing over the high moon. This is possibly because of the greater amount of "fire" in the water during the dark moon causing the lobsters to hole up rather than move around.

We have very stringent laws in Florida concerning egg-bearing lobsters even though we are given to understand that eggs dropped and hatched in this area do not grow to maturity here. We must try to gain cooperation from the Caribbean countries to educate their fishermen to better laws of conservation for preservation of the industry in the whole area.

At our last meeting of the Organized Fishermen of Florida in Marathon, Florida, the main topic of discussion was limited entry of crawfish permits in Florida. We do not feel that the species is endangered, but the catch per unit of effort is such that we have proposed requesting a moratorium of permits as of March 31, 1974, (the end of this crawfishing season in Florida).

We realize that every industry needs new blood and young people. This proposed moratorium has been requested in an effort to eliminate future issuance of permits to persons who do not depend on commercial fishing for the greater part of their income.

The commercial fishermen of Monroe County will cooperate in any way they can to assist the newly established branch of the Florida Extension Service in Monroe County with their Spiny Lobster Research Program.

# FLORIDA SPINY LOBSTER INDUSTRY PROBLEMS

Robert Felik
National Fisheries, Inc., Miami

Three sectors need increased production: 1) Industry needs more production that will allow lobster fishermen to make a living and keep up their boat and equipment; 2) Processors need it to cut down cost of operation by having continuous work for equipment and employees; and 3) Distributors need more pounds to bring the price to the consumer down to a level that will allow the once lobster-eating public again to do so.

To achieve this we need both research and federally enforced laws.

Further research must confirm conflicting data that we now have and address unanswered questions. For example, where does the larva (phyllosome) of the Florida Spiny Lobster, when hatched on the Florida coast, drift? Where do the larvae from the Caribbean and South American countries that produce our Florida species (Panulirus argus) go?

Marine biologist Ross Witham hypothesizes that Florida larvae travel north in the gulfstream and go in a complete circle to grow up in Brazil and in the Caribbean, some even making it back to Florida. This world tour is being made possible by low ocean temperatures that delay growth of the larvae as long as eight months. I have the article with me if anyone cares to read it. Dr. Ingle states that they go to Carolina and freeze; maybe 1% of the larvae reach adulthood.

However, another article (by Richard Pothier, July 8, 1971, entitled "Gulfstream Probe Findings Amazing," Miami Herald) quotes a team from the University of Miami School of Marine and Atmospheric Sciences that found up to one-quarter of the huge flow of water through the Florida straits between Miami and Bimini sometimes flows backwards from North to South against the northward flow of the current closer to the surface. That being a fact, then the theory of larvae going North could also be wrong, as they drift on top of the water in the night and go under water in the day time.

Whether we keep our own larvae, and also whether grown lobster can or cannot make it across the Gulfstream between the Bahamas and Florida are open to debate. Those and many other conflicting scientific data need proving, not by floating bottles to prove where a current takes larvae. Through scientific research the entire life cycle and habits of our lobster must be known for our industry to move forward.

We need federal laws to stop practices that any layman knows are detrimental to our lobster industry. In the past five years, the drastic void which exists between the lack of federal regulation and the limited power of the State of Florida has become very apparent in conserving one of our great natural resources, the Spiny Rock Lobster (Panulirus argus).

In the past five years, extreme fishing pressure has been expanded to the harvesting of the Spiny Rock Lobsters, with great disregard of conserva-

tion. Many of the Atlantic shrimp fleets have converted to the fishing of the Spiny Rock Lobsters, allegedly harvesting from our shores and foreign shores with complete disregard for the gender, size and spawning season. Consequently, these fleets operate continually for twelve months a year, stripping the sea's floor of all lobster product. These catches are purchased by fishing run boats and vessels that buy for transport and sell into states other than Florida, namely Georgia, Mississippi, Alabama, Louisiana and South Carolina, or to foreign ports of countries allowing entry for reshipment via air or freighter to Florida. The shipment is then bonded by U.S. Customs and reshipped through Florida to any of the other forty-nine states, or directly to the other forty-nine states without Government Bond, thus circumventing all efforts -- both domestic and foreign -- at protection and perpetuation of the Florida Spiny Rock Lobster.

At present, with the existing Florida laws, we are unable to protect the Spiny Rock Lobster due to the fact that they are being caught in international waters. Without regulation by the federal government the rapid depletion of the Spiny Rock Lobster is inevitable thus robbing ourselves and our children of a commercial entity and a valuable food supply. With one hand we are extending economic aid to neighboring nations, while with the other we are robbing their very livelihood.

Surprisingly enough the federal government has been innocently condoning lobster depletion through the practice of custom bonding of lobster tails landed in Florida from foreign countries. Once the federal government bonds a lobster catch, the state becomes powerless to inspect or prosecute bonded illegal product thus permitting owners to transport to other states for processing and distribution. During the occurrence of this procedure, the Florida wholesale merchants stand idly by watching both their investments and conservation being destroyed with reckless abandon.

Florida by itself cannot remedy these inequities. I beg for federal assistance. Standardization must apply to all fifty states and possessions, and negotiation with foreign governments must result in total international cooperation with countries sharing this great natural resource if it is to be preserved. Of course, I realize that immediate accomplishment of this task is impossible; however, the cleaning of our own house would be a step in the right direction.

Mr. Robert Ingle, now retired from the Florida Department of Natural Resources, stated that the future of our productivity of Spiny Lobsters in the U.S. fishing waters is solely dependent upon the young of the species migrating from the coast of Brazil and other southernmost areas to our shores. In short, each nation supplies the young for other nations and so completes the life cycle. These young are protected by our Florida conservation laws and should not be taken by those desiring personal gain, who are outside the reach of the arm of the law. Failure of the federal government to take initiative in this area will result in the total depletion of the Spiny Rock Lobster and economic havoc for thousands of fishermen, plant workers, distributors, container companies, processing and storage plants, warehouses, boat yards, and many other allied businesses. In short, a half century of labor, investments and conservation is being recklessly destroyed.

According to United States fisheries figures, ten million pounds of lobsters were landed in Florida ports from Florida and adjacent waters by

Florida vessels in 1970. This figure does not include foreign imports; neither does it include the four-month closed season nor the illegal lobsters landed.

At a time in our history when there is so much emphasis on ecology and preservation of our wildlife, a recent uproar was heard over the senseless slaughter of the federally protected eagle of Wyoming. In a world which may someday have to turn to the sea for much of its nourishment, nothing is being done at a federal level, to the best of my knowledge, to protect one of the sea's greatest natural resources.

Through continual contact with the grass-roots lobster fisherman, it has become increasingly apparent that there is a very urgent need for more intense conservation of the Spiny Rock Lobster (Panulirus argus). These fishermen are using twice as many traps as well as twice as many days at sea to harvest half the amount of the product harvested during previous seasons. This continues even though the amount of area fished in international waters has also increased. Due to the clipping, strippings, and cutting of exposed eggs from the female lobster, as well as the taking of undersized lobsters, the apparent course of action warrants effective laws at the federal level to preserve the lobster industry for ourselves and future generations.

I have written thoughts for two very similar laws:

1. To give direction for action necessary to create a law at the federal level to preserve the Spiny Rock Lobster (Panulirus argus) for ourselves and future generations.

(a). To curtail overfishing it is mandatory to create an appropriate closed season using the present Florida laws as a guideline for enforcement at the federal level, and to restrict all foreign imports of the species into the United States and its territorial possessions during the appropriately designated closed season. However, this will serve no purpose unless we have treaties with all countries and islands that could take a vessel's product into port, and process it, and hold the lobster for open season market or stay out on the seas in a freezer mother vessel the duration of the closed season, then coming into port on opening day.

(b). However, in no instance shall female lobsters or lobster tails with exposed eggs, clipped, cut, stripped, or scrubbed or undersized lobsters or lobster tails of the species be allowed into the United States or its territorial possessions.

(c). In accordance with the above, undersized lobsters, lobster tails, and female lobsters and lobster tails with exposed eggs shall be subject to a 3% human error allowance on net weight. However, there shall be in no instance an allowance for lobsters or lobster tails with exposed eggs which have been clipped, stripped, cut or scrubbed.

However, with the above law, fishermen and dealers will land lobsters and lobster tails at foreign ports to store; also they will freeze and store aboard mother ships, and their own fishing boats during the four-month closed season. Therefore, we would only stop the undersized and the egg-bearing female from being sold in the States unless the coast guard could enforce the law at sea. Even then we would have Americans using foreign flagged

ships going into foreign ports while continuing to fish. The above law would be effective if we have treaties with all our concerned neighboring countries and the Coast Guard patrolling the fishing grounds.

2. It is my feeling that the lobster industry can be saved and that the taking and marketing of egg-bearing females and young undersized lobsters can be virtually terminated if a law similar to the following can be enacted at the federal level in this session of Congress.

No person, persons, firm or corporation at sea or loading onto a foreign or domestic airplane, boat, ship or in any state of the United States or its territories may take or have in his possession, regardless of from any area taken, foreign or domestic, any salt water crawfish (crayfish or Spiny Lobster) of the species Panulirus argus with a carapace measurement of less than three inches or a tail measurement of less than five and a half inches, not including any protruding muscle tissue.

The carapace (head, body or front section) measurement shall be determined by beginning at the anterior-most edge (front) of the groove between the horns which protect the eyes; thence proceed along the mid-dorsal line (middle of the back) to the hindmost edge of the carapace. Any tail shall measure no less than five and a half inches measured lengthwise from the point of separation along the center of the entire tail until the rearmost extremity is reached. The tail measurement shall be conducted with the tail in a flat straight position with the tip of the tail closed. Said measurement shall be applicable on board any vessel used for the taking of crawfish or at the dock where such crawfish are in possession of seafood dealers.

Incorporated with the federal law would necessarily be an allowance for honest human error. Three percent of the tails, three percent of the lobsters by weight, and two percent of egg-bearing females with no allowance on tails or whole lobsters for the practice of clippings, cutting, scraping or separating the egg from the tail at any time, would leave reasonable room for honest human error.

Of course, no law can be effective without strict enforcement and a stiff penalty. I might suggest that besides a stiff fine that those found guilty lose their boats for a reasonable period of time.

I have a Federal Sponge Act which I ran across which could conceivably be reworded and passed as a Federal Lobster Act. I have it with me if any one cares to read it. It certainly sets a precedent for this type of Federal law.

An Act recently signed into law has an amendment designating the American Lobster (Homarus americanus) as a creature of the continental shelf. I hope this law does not include the Florida Spiny Lobster or give reason for our neighboring countries to do the same, as our international fishing grounds are other nations' continental shelf. Until about seven years ago both the United States and the Bahamas had a three mile fishing limit; then we changed to twelve miles and the following year the Bahamas followed suit. Our government needs to try again to get the Bahamian government to give back our traditional 3-12 mile fishing rights that have existed with continuity for many years, possibly with each vessel paying a license or fee for the purpose

of both crawfishing and scale fishing. At present, right of innocent passage with or without product are denied U.S. vessels.

To further our production I suggest a study of artificial habitats in the ocean that would be more favorable to growth than areas now found in nature.

My first-hand information from those involved in the industry reveals the feeling that the merchandising and processing aboard vessels on the high seas and in international waters should have some type of official supervision to comply with state side shore installations.

I am an active member of both Southeastern Fisheries Association, Inc. and the Organized Fishermen of Florida. The Association's majority membership concurs that there is a definite lack of conservation at the federal level, pertaining to the Spiny Rock Lobster. Also, the consensus of marine specialists is that, depending on the feeding grounds, it requires from four to six years for lobster eggs to attain legal size. This makes the urgency of action by the Federal Government quite evident.

This great nation of ours harvests and consumes most of the Spiny Rock Lobsters, and also consumes the greater portion of many other species of lobsters from other oceans. Therefore, since this problem is not only a personal one on the part of the lobster industry, but a collective one as a nation concerned with the preservation of a great natural resource, I implore you to do everything in your power to set the wheels of progress within the federal government moving toward the alleviation of our plight.

# STATISTICAL TRENDS IN THE SPINY LOBSTER FISHERY

Lloyd E. Johnson
National Marine Fisheries Service, Miami

Down through the years I have been charged by my many superiors in the N.M.F.S. with the responsibility of gathering, tabulating and publishing all statistical data for the commercial fisheries of Florida. This is a cooperative effort with the Florida Department of Natural Resources. It is a difficult assignment because of (1) the State's large geographical area, (2) the very large numbers of producing dealers, and (3) the great variety and quantity of edible seafoods landed. Generally, Florida ranks number seven in the nation poundage-wise, and fifth nationally as far as value of the catch is concerned. The most valuable fishery in Florida, of course, is the shrimp fishery.

There are, as you know, many important fisheries in Florida such as the Spanish and King mackerel fisheries, the snapper and grouper fisheries and the oyster fishery in the northwest section. There are also important fisheries in Florida that are totally or almost totally unique to Florida alone. I refer you to the sponge fishery; the ballyhoo bait fishery; the sunray Venus clam fishery; the stone crab fishery, and of course, the spiny lobster fishery. In this respect, with the exception of a very small quantity landed in California, Florida produces the balance, or in total over 99% of the catch of spiny lobsters in the United States.

Table 1 shows the commercial catch of spiny lobster for a number of years. Noteworthy is the increased catch during this period as well as the increased price per pound paid for this product. In 1964 we started to gather and tabulate landings data for lobsters caught in the Bahamas area. (Prior to 1964 this type of data was not accumulated.)

In Table 2 can be seen the U.S. import data of spiny lobsters. Figure 1 is a trend graph of consumption as related to wholesale price of the lobster tails during the period of January-June, 1973.

Although some spiny lobsters are caught on the east coast of Florida as far north as Cape Canaveral, the vast majority are caught and landed in the Keys area. To the east and southeast of us is the famed Bahamas area that has gained much notoriety in recent years. Also, in recent years, American flag vessels have extended their operations into parts of the Caribbean area and bring some of their catch back to the United States, landing mostly at Key West and in the Tampa area. However, most of this catch made in the Caribbean enters the U.S. as an import.

During 1971, 1149 fishermen, 250 boats and 272 vessels were involved in the spiny lobster fishery in Florida. For 1973, when the count is tabulated, I dare say that all of the figures will increase by at least 25%.

The State of Florida has a conservation law that essentially regulates the length of the fishing season and bans the taking of small lobsters or the taking of egg-bearing females. This pertains to Florida waters only. In the Bahamas there are no regulations; however, when landed in Florida, these

lobsters must adhere to Florida laws. The Bahamian twelve-mile territorial sea claim has restricted the fishing area to a large extent.

Some observations for your consideration are offered:

1. This is a highly competitive fishery with increasing numbers of boats and men involved. Because the traps are left unattended a great deal of stealing of both traps and lobsters takes place.

2. The high price paid for the product has evidently created a big market for the "undersized" tails. It has been reported that as many as four large "buy boats" operate in this effort. Supposedly their product is landed in other areas. This probably represents a huge money-making endeavor; however, it would appear to me to be rather silly because "you sure can't take or destroy the babies and expect to catch the mamas and papas."

3. The Florida season that opens in August is generally over for many fishermen before the legal closing date of March 31. The catch generally dwindles during the season to the point where the economic return does not justify the effort.

4. Increased competition in Florida and in the Bahamas would seem to indicate that the fishery may have reached its optimum saturation point as far as men and boats are concerned. It is also possible that the catch and landings peak may have been reached. In this respect, should the concept of "limited entry" be considered or should the concept of a "total catch per season" be considered?

These ideas I leave for you because it is a fishery worth over $10 million at dockside. It is a delightful eating product and generally sustains a high market demand. I say this fishery is worth protecting.

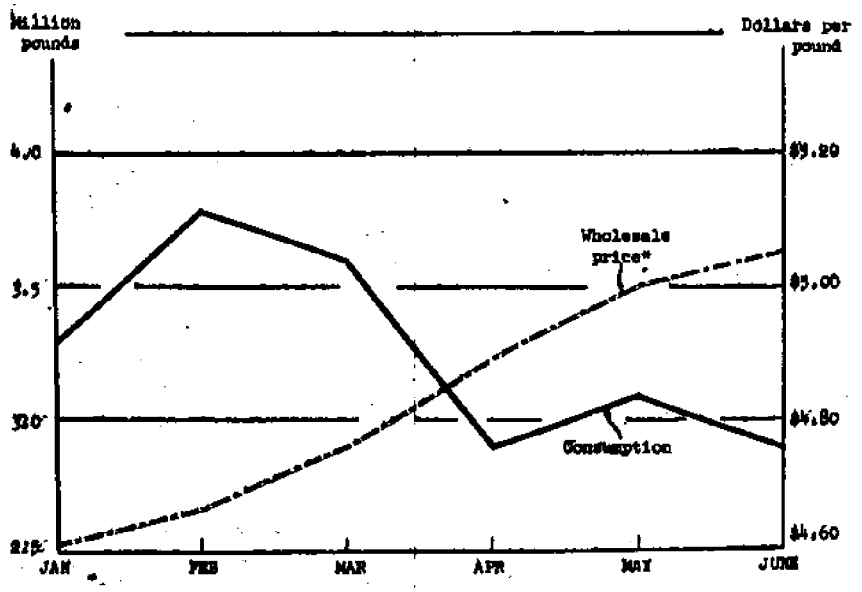



Figure 1. 1973 spiny lobster tail consumption and wholesale price. (Price for 4 - 6 oz. lobster tails.) (Figure courtesy NOAA, NMFS, Mkt. Res. & Svces. Div.)

TABLE 1. Spiny lobster commercial landings

| Calendar Year | Harvest (Pounds) Florida Waters | Other Waters | Total | Average Price Paid (U.S.$) |
|---|---|---|---|---|
| 1960 | 2,849,000 | Not Available | 2,849,000 | .39 |
| 1961 | 2,803,000 | " " | 2,803,000 | .35 |
| 1962 | 3,139,000 | " " | 3,139,000 | .38 |
| 1963 | 3,585,000 | " " | 3,585,000 | .39 |
| 1964 | 2,631,000 | 1,000,000 | 3,631,000 | .43 |
| 1965 | 4,749,000 | 1,000,000 | 5,749,000 | .56 |
| 1966 | 3,150,000 | 2,200,000 | 5,350,00 | .46 |
| 1967 | 1,947,000 | 2,500,000 | 4,414,000 | .62 |
| 1968 | 3,342,000 | 3,800,000 | 7,146,000 | .72 |
| 1969 | 4,405,000 | 3,762,000 | 8,167,000 | .69 |
| 1970 | 6,753,000 | 3,116,000 | 9,869,000 | .60 |
| 1971 | 4,673,000 | 3,533,000 | 8,206,000 | .86 |
| 1972 | 4,790,000 | 6,627,000 | 11,417,000 | 1.03 |
| 1973 | 4,879,000 | 5,785,000 | 10,664,000 | 1.02 ? |

TABLE 2. U.S. imports of lobster tails by country of origin, January-June, 1972 and 1973
(Product weight)

| Country | 1972 | 1973 | 1973 as a percentage of 1972 | Percentage of total imports 1972 | Percentage of total imports 1973 |
|---|---|---|---|---|---|
| | Million pounds | | Percent | | |
| Australia | 7.1 | 6.2 | 87.3 | 33.0 | 35.0 |
| Brazil | 3.6 | 2.9 | 80.6 | 16.7 | 16.4 |
| Rep. S. Africa | 2.7 | 2.6 | 96.3 | 12.6 | 14.7 |
| New Zealand | 2.6 | 2.1 | 80.8 | 12.1 | 11.9 |
| Japan | 1.2 | .4 | 33.3 | 5.6 | 2.3 |
| Bahamas | .3 | .1 | 33.3 | 1.4 | .6 |
| Singapore | .4 | .1 | 25.0 | 1.9 | .6 |
| India | .5 | .6 | 120.0 | 2.3 | 3.4 |
| Thailand | .5 | .1 | 20.0 | 2.3 | .6 |
| Taiwan | .2 | .3 | 150.0 | .9 | 1.7 |
| Mexico | .2 | .1 | 50.0 | .9 | .6 |
| Nicaragua | .2 | .2 | 100.0 | .9 | 1.1 |
| Br. Honduras | .1 | .1 | 100.0 | .5 | .6 |
| Ecuador | .1 | .1 | 100.0 | .5 | .6 |
| Jamaica | .1 | .1 | 100.0 | .5 | .6 |
| Other | 1.7 | 1.7 | 100.0 | 7.9 | 9.6 |
| Total | 21.5 | 17.7 | 82.3 | 100.0 | 100.0 |

# SPINY LOBSTER PROGRAMS AT THE MARINE RESEARCH LABORATORY, FLORIDA DEPARTMENT OF NATURAL RESOURCES*

Edwin A. Joyce, Jr.
Bureau of Marine Science and Technology, Tallahassee

I wish to review our Bureau's work in spiny lobster, which has focused primarily on life history data. In addition to the laboratory in St. Petersburg, work was also conducted from our Key West field lab for about seven years, until its closing a few years ago. Wherever possible we have tried to share data and collaborate with others.

## Biological Studies

### Larva

We are probably most identified with postulating and showing a Caribbean origin of the majority of the spiny lobster population in Florida. In short, it appears that lobsters hatching somewhere in the Caribbean are wafted by currents to Florida during the six to eleven months larval (phyllosome) stage.

Identification, at the species level, of the phyllosome is a continuing problem and has yet to be accomplished. Consequently, larvae hatched in Florida are carried great distances by ocean currents, and we have identified Panulirus collected almost one thousand miles east of New York. Transport by currents in a gyre may provide a mechanism whereby a few individuals hatched in Florida may return eventually to the Caribbean.

Dispersal of turtles -- tagged and released in Florida -- to the Carolinas and Brazil is shedding some light on larval lobster transport.

### Habitat and growth

Our staff has studied the post-larval (puerulus) and first juvenile stages, including laboratory rearing of post-larvae. We were able to get post-larvae to roughly commercial size in about eighteen months. Prior to this work, it was felt that age to maturity was three to five years.

Mariculture of spiny lobster faces serious difficulties because of the problems in rearing the larvae. (To my knowledge Panulirus argus phyllosomes have not been kept alive any longer than four months, and this was done at the University of Miami.)

### Present efforts

Analysis of several years of data on the occurrence of the transparent post-larvae (puerulus) is underway. Information from the Keys, East Coast, and some data from the National Marine Fisheries Service, are being included.

In addition, a behavior study by a student working under Dr. Herrnkind at Florida State University is receiving some support from our offices.

*Ed. note: List of Department's publications on spiny lobster given p. 60

## Fisheries

One of the problems in compiling data on this fishery is that there are no sport catch records. (Although spiny lobster may not fit this description, it is important to realize that for some species, sport catch far exceeds commercial harvest.) Yet this kind of information is vital to those who must consider management strategies. Another management difficulty, especially in the Keys, is enforcement.

When we began issuing crawfish permits in 1954-55, the fisherman was also requested to list the number of his traps. However, it was determined that we could not require this bit of information after 1971 (Table 3). In 1970-71 a $50 fee for permits was initiated. Industry requested and supported this, perhaps to get out of the fishery those persons not dependent on it for a living.

Table 4 is based on Lloyd Johnson's data and it is significant that Dade and Monroe Counties land the bulk of the lobster catch.

Table 3. Permits and traps, Florida spiny lobster fishery

| Year | Number of Permits Issued by Florida Dept. Nat. Resources | Number of Traps |
|---|---|---|
| 1954-55 | 255 | 39,058 |
| 55-56 | 229 | 29,546 |
| 56-57 | 328 | 42,196 |
| 57-58 | 636 | 78,849 |
| 58-59 | 814 | 99,895 |
| 59-60 | 848 | 98,899 |
| 60-61 | 1,073 | 120,327 |
| 61-62 | 1,303 | 149,950 |
| 62-63 | 1,580 | 187,292 |
| 63-64 | 1,853 | 216,646 |
| 64-65 | 1,919 | 227,626 |
| 65-66 | 2,275 | 274,750 |
| 66-67 | 2,639 | 314,542 |
| 67-68 | 2,544 | 298,350 |
| 68-69 | 2,431 | 290,580 |
| 69-70 | 2,719 | 326,780 |
| 70-71* | 961 | 194,253 |
| 71-72** | 1,167 | Not avail. |
| 72-73 | 1,482 | Not avail. |
| 73-74# | 1,565 | Not avail. |

*1970-71 a $50 permit fee was instituted. Previously permits were free
**Trap data no longer required on permit
#As of 8 March 1974

Table 4.

Spiny lobster landings by Florida county, 1972

| County | Pounds | Value (U.S. $) |
|---|---|---|
| Brevard | 196 | 226 |
| Broward | 4,971 | 6,220 |
| Collier | 14,224 | 15,781 |
| Dade | 5,935,317 | 5,921,665 |
| Hillsborough | 56,121 | 56,121 |
| Lee | 35,576 | 39,941 |
| Martin | 23,067 | 24,557 |
| Monroe | 4,814,013 | 5,176,026 |
| Palm Beach | 295,845 | 294,334 |
| Pinellas | 229,368 | 229,368 |
| St. Lucie | 8,086 | 7,186 |
| Total | 11,416,782 | 11,771,425 |

# NOTES ON THE STATUS OF SPINY LOBSTERS, PANULIRUS ARGUS, AT DRY TORTUGAS, FLORIDA, 1974

Gary E. Davis
National Park Service, Homestead

Spiny lobsters support important pan-tropic fisheries of considerable local and export value. Few, if any, species or populations are free from some form of human exploitation. In 1935, an area of 19,000 hectares (47,000 acres), including the Dry Tortugas atoll, was set aside as the world's first underwater preserve. Called Fort Jefferson National Monument, it is located about 110 km (68 miles) west of Key West, Florida, the nearest port of call (Fig. 2). Commercial fishing of all types is prohibited within the administrative boundary of the National Monument.

Until mid-1971, sport harvest of spiny lobsters, primarily Panulirus argus, (with an occasional P. guttatus) was permitted with a two lobster per person per day limit. Few visitors reached the isolated atoll during the first 20 years, with an average of some 1,200 people per year (U.S. NPS, 1942-58). Annual visitation increased to over 21,000 as more and larger private boats came into usage in the late 1960's and early 1970's. (U.S. NPS, 1974). As increased numbers of people began taking lobsters with the nearly open ended limit, concern was expressed for the protection of the quality and quantity of the lobsters found in the area. In the nearby Florida Keys and inshore areas on the east coast of Florida, both the numbers and size of spiny lobsters have been severly limited by intensive sport and commercial fisheries and general degradation of suitable habitat (Voss, 1973). The extent and diversity of spiny lobster habitat at Dry Tortugas, and its isolation from extensive human environmental disruption makes it an ideal site to study a natural, unperturbed spiny lobster population, and assess the impact of a limited harvest on it.

## Objectives

The primary objective of the study was to assess the impact of human harvest on a natural unperturbed lobster population.

## Methods

Two sampling techniques were employed to gather information about the spiny lobster population at Dry Tortugas: 1) direct in situ observations using SCUBA, and 2) fishing with baited wooden lath traps of the traditional Florida top entry design. To insure an undisturbed population, all human harvest was terminated for 29 months, beginning April, 1971, to allow recovery from the low level of sport harvest allowed up to that time. From August, 1973 through March, 1974, sport harvest was once again allowed.

1. In situ observations were quantified in two ways: (1) band transects, 100 m by 20 m, were established at 10 sites representing the five common diurnal lobster habitats in the study area. The number and sex ratio of the lobsters, and the number of potential dens in each transect were recorded. (2) At 17 additional sites, surveys of potential dens were con-

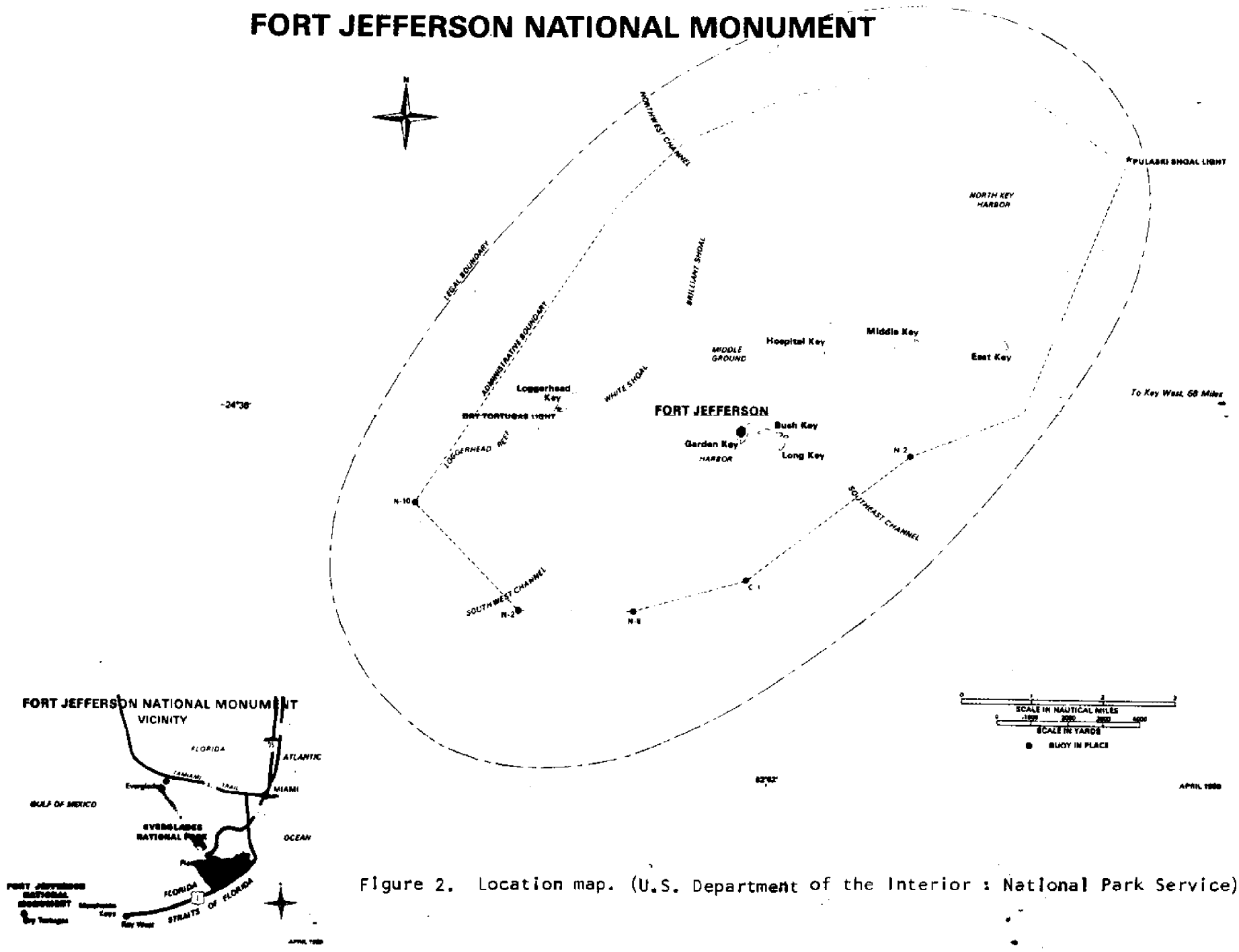



Figure 2. Location map. (U.S. Department of the Interior : National Park Service)

ducted over areas of one or two hectares. The number of potential dens examined, the number of lobsters in each occupied den, and the size and depth of the dens were recorded. Surveys were conducted every 60-90 days from July, 1971 through November, 1973. The relative abundance of lobsters measured in this way is expressed as the number of lobsters per 100 dens at each location.

2. After 24 months of complete protection from harvest, 4,500 trap-nights of fishing effort were conducted at 27 sites at Dry Tortugas. From 1 April to 23 April, 1973, six strings of 20 traps were fished for one to three night soaks rotated through 27 stations, retrapping most stations 12 days after the initial sample was taken. The standard bait consisted of two cowhides (10 cm X 10 cm) and a fish head in a small plastic container. The number of lobsters in each trap, the carapace length, weight, sex, exoskeleton condition and color, and reproductive condition of females were recorded. Each animal was marked with a uniquely numbered shyrion-spaghetti tag, and the depth and location of both capture and release sites were recorded. Tagged individuals were returned to the bottom and released by SCUBA equipped observers within one hour of their removal from the trap.

## Preliminary Results and Discussion

### Seasonal movements

Relative abundance and seasonal movements of the lobsters varied substantially during the study (Fig. 3). Preliminary results indicated a pattern of differential movement by sex between shallow reef flats (less than 10 cm in depth), deeper spur-and-groove reefs (10-25 m), and isolated coral outcrops. During the late summer and early fall a 1:1 sex ratio existed with high concentrations of 290-365 lobsters per 100 dens in the shallow heads and reef flats. In late November or early December both sexes moved to the deeper reefs and scattered, leaving densities of 200-240 per 100 dens in the shallow water. In late January and early February, both sexes began to return to the shallow areas, but by mid-March the females began returning to the deep reefs while the males continued on to the shallow flats. By late June, some 75-80% of the lobsters found above 10 m were males, the remainder were females with carapace lengths less than 75 mm or greater than 130 mm. Through the summer months intermediate sized females returned to the shallow areas, which restored the 1:1 sex ratio and high densities by fall. The absence of medium sized females on the shallow flats in the spring and early summer seemed to be related to their role as egg bearers. Data suggestive of this kind of reproductively based seasonal movement is reported for P. gracilis by Butler and Peace (1965) and for P. argus in the Caribbean by Peacock (1973).

### Reproduction

Although sperm laden (tarred) and egg bearing (berried) female P. argus were found most of the year, there was a marked onset of reproductive activity in late February and March at Dry Tortugas. Data from the adjacent commercial harvest and direct observations indicated that the incidence of tarred females increased from essentially zero to over 60% during March in both 1972 and 1973. During the first two weeks in April, 1973, the percentage of berried females increased steadily from 16 to 81, in a sample of 500 females (Fig. 4).

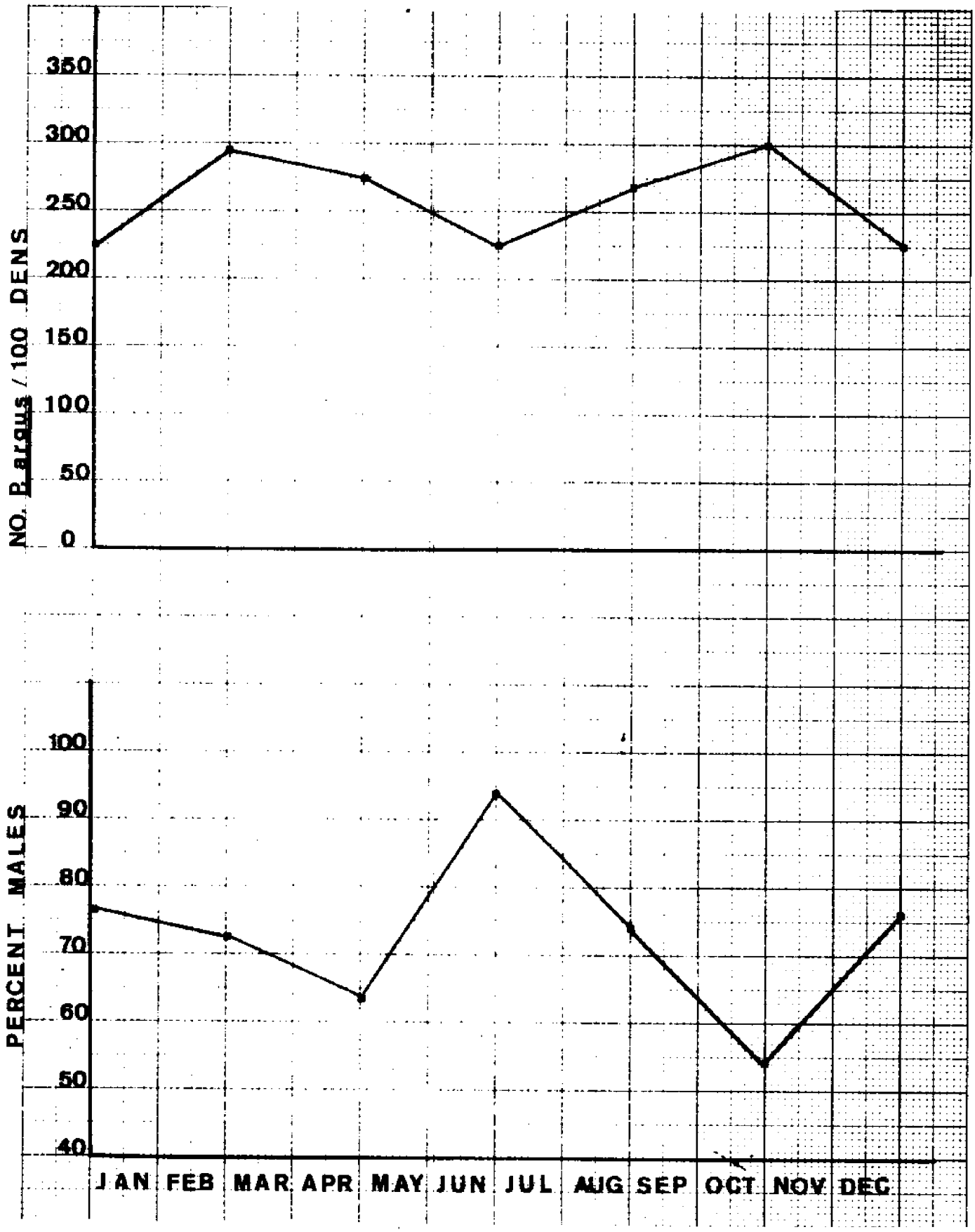



Figure 3. Seasonal movements of P. argus at Dry Tortugas, shallow reef flats. Less than 10 meters in depth

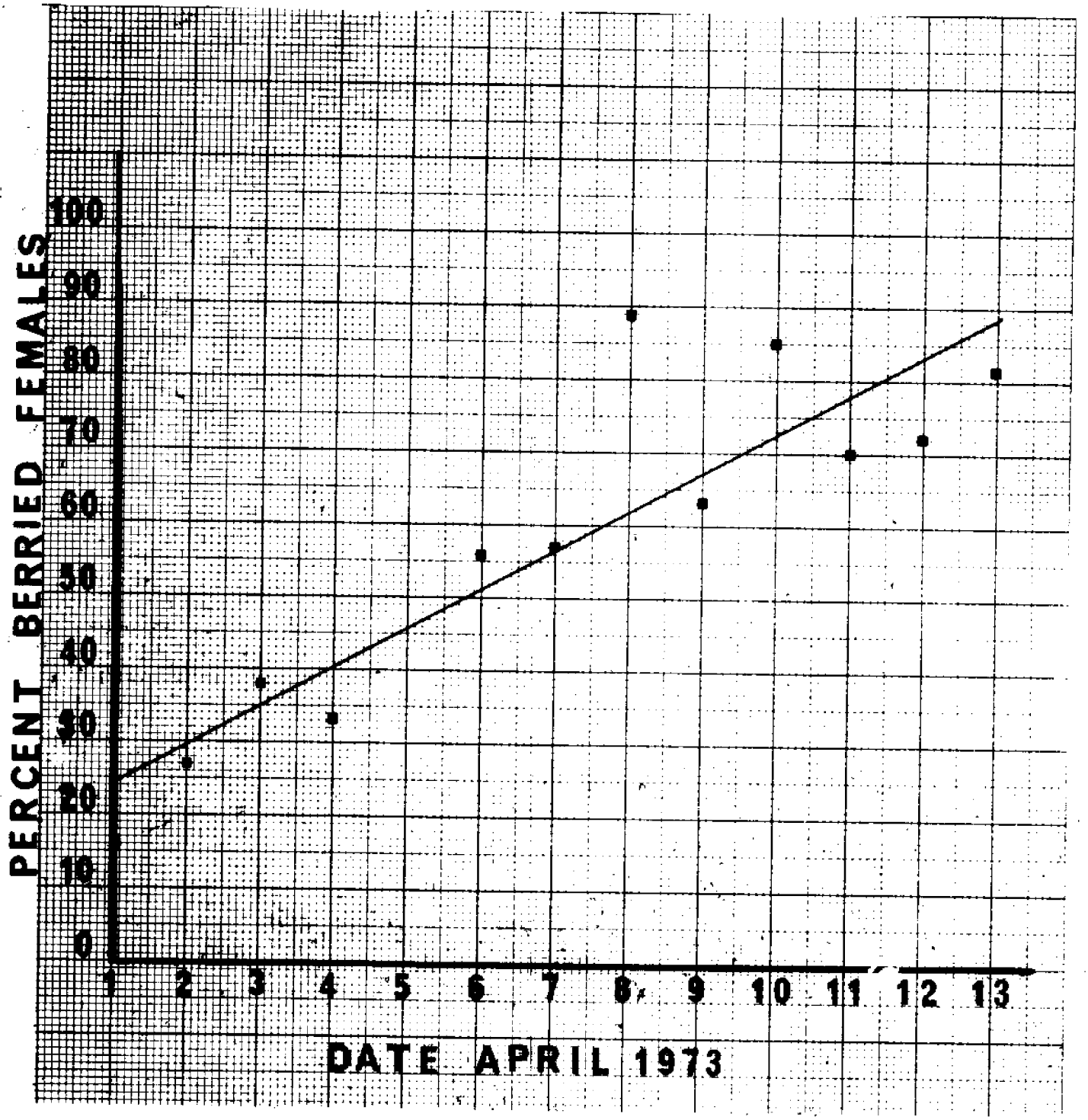



Figure 4. Onset of egg-bearing by Panulirus argus at Dry Tortugas, Florida, 1973.

An examination of the ratio of berried to barren females by size class showed that only intermediate sized individuals were reproductively active (Table 5), presumably indicating immaturity and senility of the small and large females respectively. The smallest females examined with external eggs had carapace lengths of 79 mm. Only 18% of the 76-85 mm (C.L.) females had external eggs, while 52% of the 86-95 mm and 75% of the 106-125 mm groups showed this sign of maturity. The size at first maturity observed at Dry Tortugas (79 mm C.L.) is substantially larger than the 45 mm carapace length previously reported by Smith (1951) for Florida. It is in close agreement with 85-90 mm reported by Sutcliffe (1951) for Bermuda, and the 69 mm reported for Panama by Butler and Pease (1965). Braydstock (1950) reported that, in New Zealand, Jasus lalandii matured at smaller sizes in regions of warmer waters. The observations reported here, placing the size at first maturity from Dry Tortugas in an intermediate position between Panama and Bermuda, suggests a similar pattern for P. argus.

Females larger than 125 mm (C.L.) appear to be reproductively senile as only 32% of the 126-135 mm group, and none of the 11 females examined in the 136-145 mm class were berried. Creaser (1950) reported that large P. argus produced considerably more eggs than smaller individuals, pointing out that one 15 inch (T.L.) female produced more eggs in a season than four 10-inch (T.L.) females. No limit was reported or suggested for this relationship. Peacock (1973) observed that P. argus females in the Caribbean reached maximum reproductive capacity between 100 mm and 130 mm (C.L.) and that individuals larger than 130 mm were senile. The Dry Tortugas data support Peacock's reported reproductive senility of large female P. argus, and size of maximum reproductive capacity.

If Dry Tortugas is representative of other Florida stocks, it is clear that the present legal minimum carapace length is not protecting small immature females. Application of the size class - maturity data presented in Table 1 to an analysis of the carapace length-frequency distribution of 876 P. argus from the Dry Tortugas commercial catch, showed that nearly 24% of the legal harvest were reproductively inactive females, and probably 17-21% were immature females (Table 6 ).

## Tagging program

Nearly 1,200 tagged P. argus were released in April, 1973, at Dry Tortugas. Fewer than 225 were released outside the administrative boundary in the area fished commercially during the open season. To date, 43 tags have been returned by commercial fishermen, all from the Tortugas area. No tagged lobster has been recaptured more than eight km from its release site. Most of the returned tags have been ones that were released outside the administrative boundary. These data suggest a highly resident population, but more conclusive, positive evidence will be sought in April, 1974, when the same 27 stations sampled in 1973 will be retrapped.

## Harvest impact

It is far too early to even speculate about the measurable impact of the sport harvest at Dry Tortugas during the 1973-74 season. However, some notes on the experimental design and a few observations may be of interest. The challenge of obtaining an accurate index of lobster abundance is a major one. The technique that appears to yield the most accurate and precise

Table 5

Incidence of egg-bearing Panulirus argus at Dry Tortugas, Florida by size class

| Size class carapace (mm) | Number of females examined | Number of egg-bearing females | Percent egg-bearing females |
|---|---|---|---|
| 36-45 | 2 | 0 | 0 |
| 46-55 | 2 | 0 | 0 |
| 56-65 | 2 | 0 | 0 |
| 66-75 | 65 | 0 | 0 |
| 76-85 | 72 | 13 | 18 |
| 86-95 | 90 | 47 | 52 |
| 96-105 | 130 | 87 | 67 |
| 106-115 | 83 | 62 | 75 |
| 116-125 | 24 | 18 | 75 |
| 126-135 | 19 | 6 | 32 |
| 136-145 | 11 | 0 | 0 |
| Total | 500 | 233 | 47 |

Table 6

Percent of reproductivity inactive female Panulirus argus in commercial harvest at Dry Tortugas, Florida 1971-73

| Size class carapace (mm) | Percent total catch | Percent female in catch | Percent reproductively inactive | percent total reproductively inactive |
|---|---|---|---|---|
| 36-45 | 0.1 | 0 | 100 | 0.0 |
| 46-55 | 0.2 | 50 | 100 | 0.1 |
| 56-65 | 0.8 | 52 | 100 | 0.4 |
| 66-75 | 14.9 | 51 | 100 | 7.6 |
| 76-85 | 23.1 | 53 | 82 | 10.3 |
| 86-95 | 28.3 | 53 | 48 | 7.0 |
| 96-105 | 19.1 | 52 | 33 | 3.3 |
| 106-115 | 10.0 | 47 | 25 | 1.2 |
| 116-125 | 2.3 | 48 | 25 | 0.3 |
| 126-135 | 1.0 | 24 | 68 | 1.6 |
| 136-145 | 0.1 | 0 | 100 | 0.0 |
| 146-155 | 0.1 | 0 | 100 | 0.0 |
| Total | 100.0 | 51 | --- | 31.8 |

information is that of the index den survey. Observations made with this method on a limited area of shallow coral heads showed a 35% reduction from the expected numbers of lobster after the first six weeks of fishing in August, 1973. After 12 weeks of fishing, the reduction exceeded 60%. This decline was determined by comparing 1971 and 1972 seasonal abundance in these same dens with 1973 abundance, and comparisons with a similar area that remained closed through the open season as a control for variables other than human harvest that would affect lobster abundance. With local redistribution of lobsters during the seasonal movement described above, this impact may be greatly reduced by the end of the season in April, 1974. But it certainly points out the initial vunerability of a virgin population of spiny lobster to divers.

## Trap harvest

Harvest data were collected from two commercial fishermen for the 1971-72 and 1972-73 seasons in addition to project trapping conducted in April, 1973. Carapace length - frequency analyses of the catches from the open and protected areas showed marked differences in the size structures of the two populations. Nearly 45% of the catch from the commercially exploited area were smaller than the minimum legal carapace length of 76 mm, while less than 15% of the catch from the protected area had sub-legal carapace lengths (Fig. 5). Over one-half (56%) of the commercial harvest sampled consisted of animals in the peak of reproductive size classes (95-125 mm C.L.). It appeared that the commercial fishery located on the periphery of the atoll harvested young adult animals that were being recruited from within the protected area. If accurate catch data were available for this entire harvest, it would be possible to quantify the potential long term yield from a relatively well known stable population.

The size structure of the young adult group exported from within the atoll may approximate an ideal, natural sustainable yield from the resident population. From this natural yield, estimates could be made for optimum size and numbers of harvest to maximize the potential yield from similar reproductive stocks.

## Conclusions

Knowledge of the precise size at first maturity and an understanding of the impact of the apparent reproductive senility of large female lobsters are vital to any management program for an international fishery like that of the Caribbean - Florida spiny lobster. While the unique population at Dry Tortugas provides insight to the potential yield for a well managed spiny lobster fishery, only a careful, extensive, international examination of the fishery stocks, from larval production to harvest, and prudent, unbiased application of minimum sizes, closed seasons, or other harvest constraints will produce the elusive maximum sustained yield fishery so avidly sought by all concerned.

## References cited

Braydstock C. A. 1950. A study of the marine spiny crayfish Jasus lalandii (Milne-Edwards). Zool. Pub. Victoria Univ. College No. 7: 1-38.

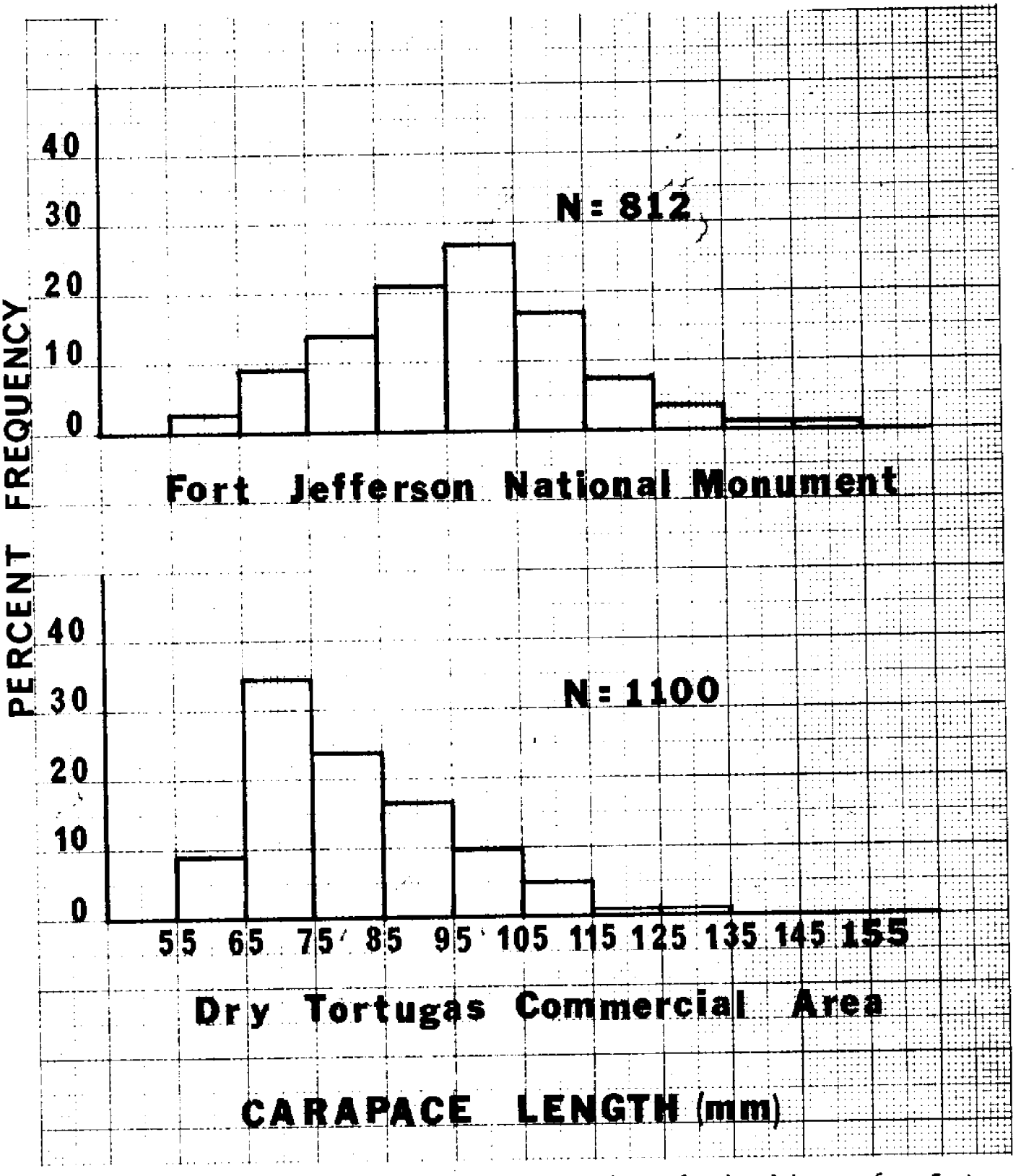



Figure 5. Comparison of length frequency distributions of spiny lobsters from Fort Jefferson National Monument and Dry Tortugas commercial fishery

Butler, J. A. and N. L. Pease. 1965. Spiny lobster explorations in the Pacific and Caribbean waters of the Republic of Panama. U. S. Fish and Wildlife Ser. Spec. Sci. Rep. Fish. No. 505. 26 p.

Creaser, E. P. 1950. Repetition of egg-laying and number of eggs of Bermuda spiny lobsters. Proc. Gulf Carib. Fish. Inst. 2: 30-31.

Peacock, N. A. 1973. A study of the spiny lobster fishery of Antigua and Barbuda. Proc. Gulf Carib. Fish. Inst. 27: (in press).

Smith, F. G. W. 1951. Results of Caribbean crawfish research. Proc. Gulf Carib. Fish. Inst. 3: 128-134.

Sutcliffe, W. H. Jr. 1951. Some observations of the breeding and migration of the Bermuda spiny lobster, Panulirus argus. Proc. Gulf Carib. Fish. Inst. 4: 64-49.

U. S. National Park Service. 1940-73. Monthly public use reports, Fort Jefferson National Monument. Open file reports, Everglades National Park.

Voss, G. L. 1973. Sickness and death in Florida's coral reefs. Nat. Hist. LXXXII: 41-47.

# IN SITU RESEARCH ON THE BIOLOGY OF SPINY LOBSTER, PANILIRUS ARGUS

William Herrnkind
The Florida State University, Tallahassee

## Introduction

Successful operation of an intense fishery depends on an in-depth knowledge of the life history and population dynamics of the fished organism. A search of the literature reveals large gaps in such knowledge of the spiny lobster, Panulirus argus, especially in the Florida Keys and Bahamian waters. Information is particularly scant regarding patterns of habitation, sociality, local movements, feeding, migration and both seasonal and ontogenetic modifications of these various life history components. A coherent research program integrating standard fishery techniques over wide geographic areas, with contemporary in situ approaches to the study of selected sample populations, can provide this crucial knowledge.

In situ study of lobster populations within limited areas is necessary because of the basic limitations of past trap sampling techniques. The latter use the spatio-temporal distribution of catch size, biological condition, size-frequency (and other conditions) to infer the dynamics and behavior of the total population. However, this provides biased data according to the placement and numbers of traps and the effectiveness (or lack thereof) in capturing lobsters of all ages and biological condition. Furthermore, even tag-recapture studies provide little knowledge of the lobsters' activities between captures.

These technique deficiencies are overcome by diver conducted surveys and observation using individually identifiable tags and remote ultrasonic sensing to provide long term, continuous surveillance of a significant population sample. This approach was recently applied to Nephops norvegicus (North Sea; Rice and Chapman, 1971; Chapman and Rice, 1971), Homarus americanus (Northwest Atlantic; Cooper, 1970; Cooper and Uzmann, 1971; Lund, 1971), Jasus lalandii and other palinurids (South Africa; Heydorn, 1969), and Panulirus argus (Bimini and U.S. Virgin I.; Cooper and Herrnkind, 1971; Herrnkind et al., 1973; Herrnkind et al., in press; Tortugas; G. Davis, this volume). Below I outline the methodology and present examples of significant new information obtained through its application.

## Methods

Successful application of the in situ approach centers upon continuously and accurately monitoring the biological character of a significant sample of lobsters in a given region without artifactually modifying their condition. This involves a lengthy initial searching and tagging period followed by frequent, periodic diver surveys. We were interested in day to day habitation and movement patterns of specific individuals comprising a reef population at St. John, U.S.V.I. Thus, divers initially spent several days painstakingly searching the area by day, capturing each lobster by tail-snare (to avoid injury), recording biological data on

each, tagging with a color coded Sphyrion-type tag and replacing each lobster to its original den. Thereafter the surveys were made daily or bi-daily and the location of each resighted, tagged lobster recorded. Each new (untagged) lobster seen was captured, tagged, etc., and each den site marked with a small numbered styrofoam float. This procedure was carried on 96 days over a 6-month period facilitated by operation from the Tektite undersea habitat.

## Results

### Distribution

Analysis of the U.S.V.I. data revealed a number of new, important discoveries regarding reef habitation by adult P. argus (Herrnkind and Olsen, 1971; Herrnkind, et al., in press). The lobsters were non-randomly distributed over the reef area with most individuals (81%) residing in dens with one or more other lobsters (up to 18 in one den). Furthermore, despite the thousands of available crevices, certain dens showed a high positive correlation between number of occupants, consistent multiple occupancy and consistent occupancy. Usually over half the lobsters observed during a given day were found in 10, or fewer, of these major dens out of over 100 identified dens. Thus, the reef dwelling U.S.V.I. lobsters do not randomly distribute themselves among the interstices but demonstrate considerable selectivity.

### Residence

The day to day records of recognized individuals further revealed that a significant number resided for periods of weeks and months in the area. Typically they remained in one or a few specific dens less than 90m apart on the average. Ultrasonic tagging-tracking studies showed that these lobsters emerged from the dens nightly to make nocturnal feeding forays then homed back to them before dawn the following day. Sonic tagged lobsters displaced by divers as far as 250 m from their den, returned to the den area overnight, further demonstrating strong homing behavior (Herrnkind and McLean, 1971). Adult lobsters, rather than being completely transient, represent a more permanent component of the instantaneous reef population.

### Migration

We have also applied in situ techniques to study the phenomenon of mass migration by P. argus in Bimini, Bahamas (Herrnkind et al, 1973). Diving survey and observation allowed us to characterize the lobster habitat of the region and to accurately determine the number, sex, residency pattern and biological condition (reproductive state, molt state, color) of the population. Such surveys were conducted twice per week from September through November in order to observe the course of events preceding, during and following fall mass migration.

We originally hypothesized that the migratory pathway area west of Bimini maintains a small stable population until a cold front storm triggers a mass movement into the area. However, our survey results show that a marked increase in the area lobster number actually begins in early-mid October. Scattered queues of lobsters migrate at night and during crepuscular periods into habitable areas resulting in packing of available crevices. This condition lasts until early-mid November when either a mass

movement occurs, involving diurnal movement of queues in a southerly direction, or the grouped lobsters gradually disperse until mid-late November.

These observations demonstrate that the fall lobster migration is not nearly as abrupt and transient as we originally thought. Rather, there is a significant premigratory increase in the area lobster population over a period of several months even during years no mass migration occurs. Indirect evidence from the U.S.V.I. and published reports from elsewhere, suggest occurrence of a large-scale autumnal redistribution of young, mostly newly mature, lobsters representing a significant fishable population in areas not normally fished.

## Further Research

Future research on fishery-relevant aspects of lobster behavior and ecology can greatly benefit from the type of in situ research reported here. A clear picture of the population dynamics of a large region, such as the Florida Keys, might well derive from a study integrating large scale tagging studies, involving wide area trap returns and diver surveys, with intensive in situ study of selected regions. Such a coherent program should run through a full annual cycle and include concurrent physical environmental monitoring. All stages of the life cycle from the settlement through old-age are subject to in situ examination. Deep water studies are facilitated by judicious application of undersea habitat operations such as HYDROLAB or Tektite and by lock-out submersibles. Use of ultrasonic telemetry is valuable both to tagging-tracking studies and to marking equipment or areas for later return. Hopefully, such a program would provide precise population information including the unfished juveniles and elders (from the concentrated in situ work) relatable to the total region (from the wide-area results).

## Literature Cited

Chapman, C. and A. Rice. 1971. Some direct observations on the ecology and behavior of the Norway lobster Nephrops norvegicus. Mar. Biol. 10: 321-329.

Cooper, R. A. 1970. Retention of marks and their effects on growth, behavior and migrations of the American lobster, Homarus americanus. Trans. Amer. Fish. Soc. 99: 409-417.

Cooper, R. and W. Herrnkind. 1971. Ecology and population dynamics of the spiny lobster, Panulirus argus, of St. John Island, U.S. Virgin Islands. In "Scientists-in-the-Sea" (J. Miller, J. Van derwalker and R. Waller, eds.). U.S. Dept. of Interior, Washington, D.C. pp. VI-34-57.

Cooper, R. and J. Uzmann. 1971. Migrations and growth of deep-sea lobsters, Homarus americanus. Science 171: 288-290.

Herrnkind, W. and R. McLean. 1971. Field studies of homing, mass emigration and orientation in the spiny lobster, Panulirus argus. In "Orientation: Sensory Basis." (H. Adler, ed.). Annals of the New York Academy of Sciences, 188: 359-377.

Herrnkind, W. and D. Olsen. 1971. Ecological study for the development of lobster management techniques. Final report on Sea Grant GH-86. 1-51.

Herrnkind, W., P. Kanciruk, J. Halusky and R. McLean. 1973. Descriptive characterization of mass autumnal migrations of spiny lobster. Panulirus argus. Proceedings of Gulf and Caribbean Fisheries Inst. 25: 79-98.

Heydorn, A. E. F. 1969. The rock lobster of the South African west coast Jasus lalandii (H. Milne-Edwards): 2. Population studies, behavior, reproduction, moulting, growth and migration. Dept. of Industries, Division of Sea Fisheries Investigational Report 71, 1-52.

Lund, W., L. Stewart and H. Weiss. 1971. Investigation on the lobster. Final Report for Commercial Fish Res. Devel. Act. No. 3-44-12: 1-105.

Rice, A. and C. Chapman. 1971. Observations on the burrows and burrowing behavior of two mud-dwelling decapod crustaceans, Nephrops norvegicus and Goneplax rhomboides. Mar. Biol. 10: 330-342.

# STUDIES ON THE U.S. SPINY LOBSTER FISHERY IN THE BAHAMAS REGION

David C. Simmons
National Marine Fisheries Service, Miami

## Objectives

The purpose of this project at the Southeast Fisheries Center is to document the U.S. spiny lobster fishery in the Bahamas region so that we will know (1) the value of the fishery; (2) which areas of the Bahamas are important to U.S. fishermen, and (3) the status of the Bahama lobster stocks. Before describing the project, it is useful to first give some background information about the fishery.

## Background

Two factors are primarily responsible for the rapid expansion of this fishery. The first of these was the influx of Cuban fishermen who fled the Castro government and moved to south Florida, mostly to the Miami area. The local fisheries could not support all of these fishermen, so they looked to the Bahama Banks as a location for their fishing endeavors. Many were already experienced lobster fishermen and some had previously fished the Bahama Banks from Cuba. The second reason for the rapid expansion of this fishery was the lure of high profits due to the high value of lobsters and the apparent abundance of the Bahama stocks.

U.S. commercial fishermen were unimpeded in their fishing efforts in the Bahama area until February, 1969, when the Government of the Bahama Islands established a nine-nautical-mile fishery zone contiguous to its three-mile territorial sea. This zone was not enforced until March, 1971, when four patrol boats were commissioned and several U.S. lobster boats were seized. Periodic seizures of U.S. fishing boats have continued to the present.

### Fishing methods

The primary fishing method used by U.S. fishermen in the Bahamas area is with the standard wood slat trap used in Florida waters. Most fishermen that trap lobsters on the Bahama Banks use cowhide for bait because it remains attractive to lobsters for a relatively long time. This reduces the quantity of bait that is needed on fishing trips to the Bahamas. Cowhide also takes up little space on board the boat and, because it is salted, does not have to be preserved in cold storage. A few fishermen use fish heads for bait because it is reportedly a better lobster attractant than cowhide, but it does not last as long in the trap, has to be preserved in cold storage, and takes up more space.

Diving with "hookah gear" is a method that is becoming more popular as a lobster fishing method on the Bahama Banks. This gear consists of a compressor on board the boat which pumps air through a hose to a regulator held in the

mouth of a diver. The more efficient divers use a long hook to snag the lobster from its den.

The advantages and disadvantages of trapping versus diving for spiny lobsters are compared in Table 7. Of these factors, I attribute the increase in popularity of diving for lobsters primarily to the high increase of trap loss on the Bahamas area fishing grounds.

## Methods

Prior to our studies, which began in September, 1972, no detailed information was available concerning catches, effort, and areas fished. We obtained this information by interviewing fishermen and lobster dealers.

The essential information we record from a fisherman's interview is the boat name, area fished in, date landed, catch in pounds of tails or whole lobsters, dealer catch was sold to, number of days fished, number of traps used, and average number of traps pulled each day. For dive boats, we record the number of hours of diving each day.

The essential information we record from the lobster dealer is the vessel name, date landed, and pounds landed.

We also record pertinent statistics about each vessel in the fishery, such as the vessel name, registration number, size, age, construction, method used to preserve the catch, and fishing method. We obtain this information from the vessel captain and from the U.S. Coast Guard publication Merchant Vessels of the United States.

We have a computer program to summarize the reported production from the Bahamas and catch-per-effort in each 1-degree square and for groups of squares which constitute fishing areas such as Little Bahama Bank, Cay Sal Bank, etc. The catch-per-effort units we are using are catch/trip, catch/day, catch/trap, catch/trap-day; and for dive boats catch/diver-day and catch/diver-hour.

## Results and Discussion

Figure 6 shows the number of pounds and value of lobsters caught in the Bahamas region by U.S. fishermen and landed in Florida. A significant amount of lobsters captured in the Bahamas, including large amounts of undersized and egg-bearing lobsters, are landed in other states. Much of this production is not recorded in the landings statistics of these states. Prior to 1964 landings from the Bahama area were not kept separate from domestic production.

The decrease in 1970 has been attributed to both a poor fishing season and to movement of some fishing operations to the Caribbean Sea. The Bahamian claim to twelve miles probably discouraged new entrants to the fishery during this time. In 1972, a production high of 6.3 million pounds was reached, valued at 6.5 million dollars. Contributing to this increase of 2.8 million pounds over the previous year was an increase in effort due to many new fishermen entering the fishery. These new entrants apparently saw that profits could still be made fishing lobsters, even with the increased Bahamian jurisdiction. Preliminary figures indicate that the 1973 production was about 5.6 million pounds, down about 700,000 pounds from 1972.

Table 7. Factors affecting success of trapping and diving

| Factor | Trap Method | Dive Method |
|---|---|---|
| Weather | Can be used during poor weather conditions. | Can only be used in relatively clear water and calm seas. |
| Depth | Can fish at depths to at least 100 fathoms. | Limited to a depth of about 6 fathoms. |
| Duration | Can stay out for long periods of time, especially if the vessel can be resupplied and the catch transshipped. | Physical endurance of the divers limits the duration of the fishing trip. |
| Lobster Mortality | Lobsters are captured alive, so undersized and egg-bearing lobsters can be returned to the sea. | Lobsters are usually killed by the hooking technique so undersized and egg-bearing lobsters cannot be returned alive. |
| Investment | Relatively high capital investment in traps and bait. | Relatively low capital investment in diving equipment. |
| Gear Loss | Vulnerable to loss of gear. | Gear loss is not a factor. |
| Mobility | Requires hauling and resetting of traps to change fishing areas. | Relatively easy to scout for good fishing grounds. |
| [illegible] | Requires skill in placement of traps. | Requires skill in swimming and compressed air diving. |

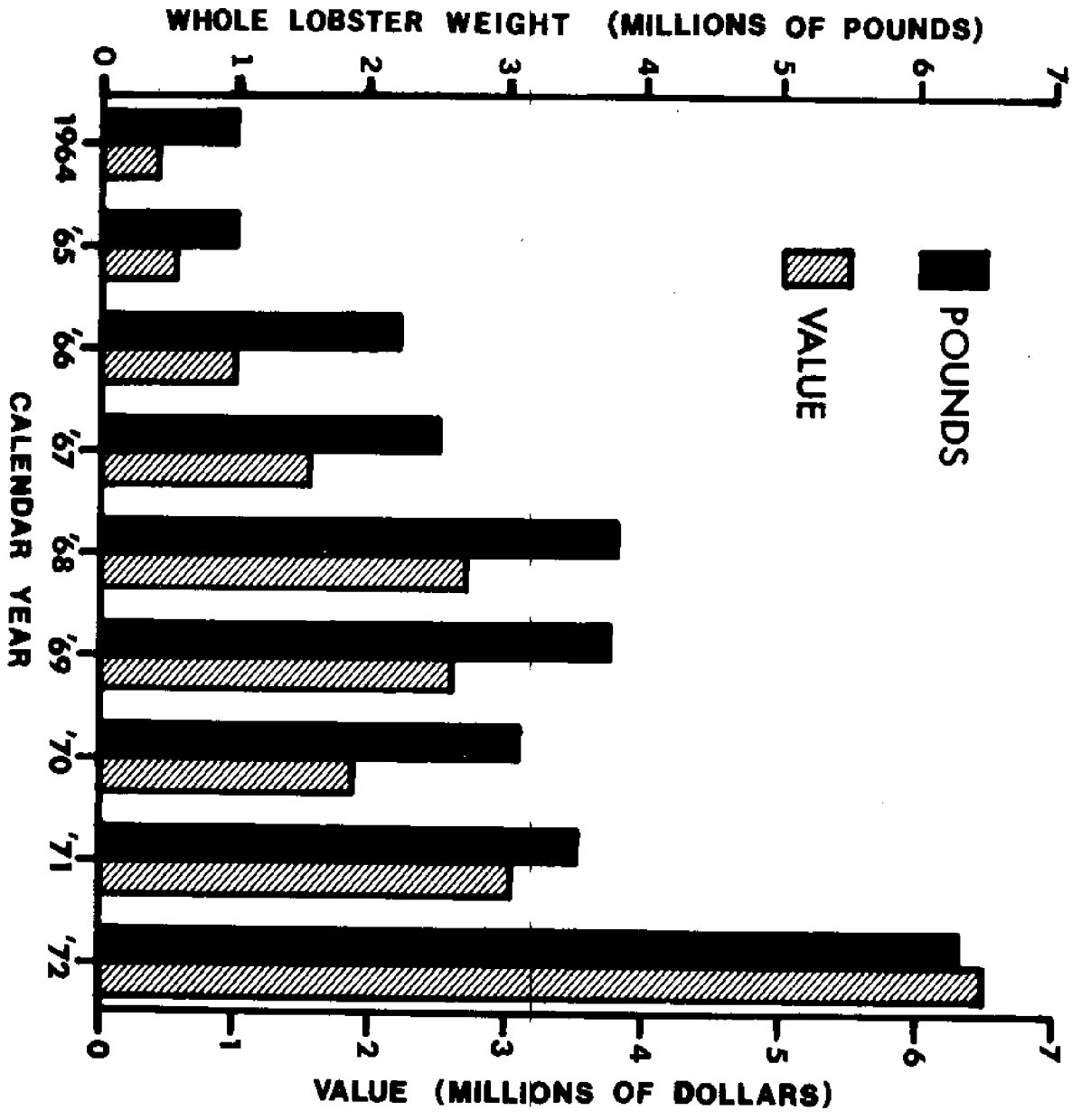



Figure 6. FLORIDA LANDINGS AND VALUE OF SPINY LOBSTERS CAPTURED IN THE BAHAMAS REGION.

## Outlook

In the future we plan to expand our area of coverage to include other major Florida ports. Our area of study is presently from Miami to Key West. To supplement the interview system and to obtain more detailed information on daily catch rates, we intend to distribute log books to cooperative captains. We have passed out a few trial forms and have received satisfactory results. The daily entry in the log includes the area fished, effort, and catch. We also intend to obtain historical records from some dealers and captains to see if we can get an estimation of the catch-per-effort for earlier years.

Another facet of the project which we intend to expand is port sampling of the landings. The information we will record is size, sex, whether hard or soft shell, and presence or absence of spermatophores on the females. Analyses of these data will contribute to knowledge on the basic biology of the Bahamas lobster stocks.

Since spiny lobsters are slow growing and are of such high value it is possible for the stocks to become depleted from overfishing. It is likely, therefore, that the lobster fishery in the Bahamas area will eventually have to be regulated. Before management of these stocks can be effective, each country involved in the fishery (United States, Bahama Islands and Cuba) will have to adopt and enforce uniform regulations.

One of the basic questions that should be answered before the Bahamas lobster stocks can be properly managed is the recruitment question. If recruitment is from distant waters then management should be based on harvesting the optimum economic size. If, however, recruitment is from local stocks, management should be based on maintaining a spawning population.

# STUDIES ON THE PHYLLOSOME STAGES OF THE SPINY LOBSTER IN THE WESTERN NORTH ATLANTIC*

William J. Richards
National Marine Fisheries Service, Miami

## Abstract

Studies underway at the Southeast Fisheries Center on the phyllosome stages of the spiny lobster are designed to determine the origin of recruits of the various populations fished by the United States.

One aspect being studied is the distribution of phyllosomes. Historical samples are being examined for the presence of phyllosomes and to date over 10,000 phyllosomes have been identified, staged and measured. Much of these data have been provided by the Florida Department of Natural Resources.

A second aspect has been the development of a computer program which allows the entry of a location from which probable paths of dispersal or probable paths of recruitment can be calculated based on current direction and speeds derived from historical pilot charts. Preliminary results of this latter aspect are discussed with respect to a film strip.

*Ed. note: The work-up of this information is so preliminary that no additional description or interpretation is appropriate or possible here

# OBSERVATIONS ON TECHNIQUES, OPERATIONS, AND HARVEST OF THE SPINY LOBSTER FISHERY

Alan K. Craig
Florida Atlantic University, Boca Raton

Since an initial study of the British Honduras fishery, including some of its theft problems, I have become involved in verifying Florida fishermen's ideas on techniques and gear. Statistics from this latter study are not yet published although it is worth noting that many of the problems are shared with Florida's fishery. Secondly, I have been involved in studying pollution effects on the Southeast Florida shelf. And recently, I have begun an analysis of fishermen's problems -- business, fishing, equipment -- in South Florida. I wish to review each study briefly and then comment on the biology and harvest of spiny lobster.

## Gear Studies

In attempting to determine if there is a biological basis for local ideas on fishing gear and techniques, I have studied the shelf area from Palm Beach South. The Southeast Florida coast is different from the Keys, Tortugas, and Virgin Islands. Each of these areas has unique problems. Traps are fished in 50 to 120 feet of water here. (In Florida, 20 fathoms is considered deep fishing.)

One thing compared is the success of fishing over rocky areas versus sand bottom, since some area fishermen believe that traps set on rocky areas do not catch as well as traps set on the corridor of sand. Results of this study demonstrated that traps on sand produce lobsters, but only during dark moon phase nights.

One of the most efficient men in the area fishes trawls using a "novie" lobster boat from Nova Scotia. With hydraulic equipment 160 to 180 traps per day can be hauled. To do better, his long day would have to be extended past the present 5:00 A.M. to 2:00 or 3:00 P.M. period. In comparing our results, I conclude that one pound per trap for a five to seven day soak represents an average catch. Exceptionally good hauls reach two to four pounds; one half pound is typical during periods of inactivity.

I have compared efficiencies of single-trapping (in 1972) and multiple trapping with trawls (1973). Cowhide bait of uniform size is used. The standard trap used in this work is what I call a "Cuban design." Probably it was introduced by immigrant Cuban fishermen, some 17,000 having come to Florida over the years. This trap is fairly well known, and resembles one used in the Keys, although there are differences in entry position and construction details. During single trapping, a gasoline powered winch and cantilevering device was used to land traps.

## Pollution

During the work described above, study of a sewage outfall off Boca Raton indicated that siltation from construction (dredging) may have depressed lobster abundance. However, untreated primary sewage discharge did not seem to affect the catch. (It is secondarily treated now.)

This year, however, no significant differences between upcurrent and downcurrent catch records are apparent.

## Fishermen

Figure 7 diagrams three areas that bear on fishing success. Within each of the three areas, individual factors are variably controlled by the fisherman. Whereas some factors (e.g., weather) are beyond our control, maintenance and business items deserve attention. Primarily, these 30 factors are of greatest concern to the small individual fisherman. A few examples are noted:

### Business operations

Economy in buying materials depends on whether an individual or group does it. Recently Mr. Charles Smith of the Organized Fishermen of Florida made excellent insurance available to members.

### Fishing operations

Labor is recognized as an increasing problem. It is difficult to convince people that gear design can be improved, yet it can. During a closed season, what is the most profitable alternative? Catch losses vary from place to place. With good contingency planning, money can still be made while on the water.

### Maintenance and repair

Not only boats, but also vehicles for transporting catch must be kept up. Replacement scheduling is vital or you suddenly miss something crucial to your operation.

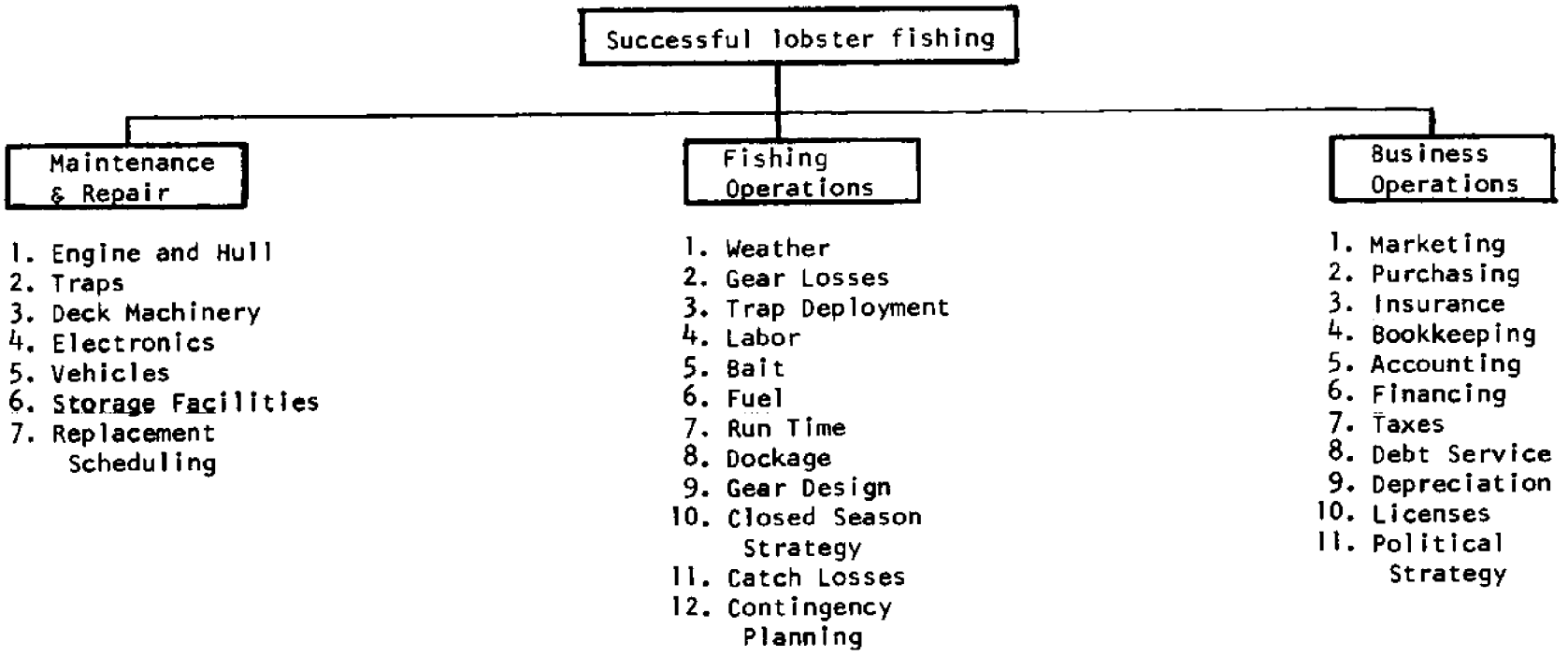
## Biology and Harvest

Because young adults are particularly vulnerable to predation by fishermen during mass migration, I believe that long-term effects of such regular pressure are potentially disastrous. During migration the lobster stock of Florida needs protection.

Secondly, to develop a valid figure for a Maximum Sustainable Yield I propose a program of comparative trapping in the Dry Tortugas and Keys. This research plan would use statistical methods similar to those recently employed in a study of the American lobster.

This procedure is an alternative to attempting to establish the Maximum Sustained Yield on the basis of recruitment, which for the species is a real question biologically. It is proposed that trapping results from 100 stations in the Keys be compared with the level of lobster in the Dry Tortugas. On the basis of this, it should be possible to predict relative stock density yearly, in advance of open season. In time the number of

Figure 7. Factors in successful lobster fishery



stations could be reduced. I believe there would be great benefit in declaring quotas and establishing a Maximum Sustained Yield.

Another important product of trapping surveys is stock density data that can be combined with a locational analysis of where fishermen are concentrating their efforts. Where serious imbalances are detected between fishing pressure and lobster populations, it will become evident and provide a basis for redirecting fishermen from overfished areas to underfished grounds.

# ECONOMIC RESEARCH ON THE FLORIDA SPINY LOBSTER INDUSTRY

Fred J. Prochaska
University of Florida, Gainesville

## Introduction

The Department of Food and Resource Economics at the University of Florida has had an active research program in Marine Economics since 1970, and a marine economics extension program since 1973. Current efforts are mainly restricted to commercial fisheries. A total systems approach is the philosophy of the marine program. Consequently, production, marketing, processing and fisheries management are all receiving emphasis in research and extension programs. Currently, the program is carried out by two full-time faculty, one research and one extension, and four graduate students.

Florida spiny lobsters are receiving considerable attention because of their relative importance and the current needs of the industry. Several research projects are concerned with lobsters indirectly as a part of research intended to describe and analyze Florida's total fisheries. In addition, three projects directly focus on Florida's spiny lobster.

### General fisheries projects

Projects concerned in general with Florida's fisheries are "Florida's Fisheries Management Programs," and an "Economic Survey of Florida's Commercial Fisheries." With respect to lobsters, the first (i.e., fisheries management) project outlines current management programs and traces the historical development of current laws and regulations of concern to the lobster industry. Where secondary information permits, biological and economic characteristics are related to the management programs.

Management programs currently in effect for Florida lobsters consist of permits, a closed season, gear specifications, and size limitations. A permit is required for lobster fishing in Florida, and a closed season prohibits any lobster fishing from March 31st to August 1st. Gear specifications limit the kind of trap that can be used and require a numbering and marking system for traps and boats to facilitate enforcement of fishing laws. A minimum size limit is in effect. The minimum size allowed is a three-inch carapace or a five and one-half inch tail. A special permit is required if the lobster fishing operation involves separation of head and tail of the lobster before landing. Two publications containing this information are: Florida's Fisheries Management Programs: Their Development, Current Status and Administration*, Florida Agricultural Experiment Station Bulletin, by Fred J. Prochaska and James R. Baarda; and Regulatory Management Programs for Florida Marine Fishermen, Florida Agricultural Extension Service Marine Advisory Bulletin (A Sea Grant Publication), by Fred J. Prochaska and James R. Baarda, March, 1974.

*Ed. note: Lobster programs described in appendix, this volume

The economic survey of Florida commercial fisheries is concerned with state, regional and county levels. With respect to lobsters, the studies are concerned with trends since 1952 in landings, total value, prices, location, relative importance, and processed products.

Lobsters currently are the second most important species, accounting for 15.28 percent of total value of fish and shellfish landings in the State. When compared to other major fish and shellfish landings, lobsters have experienced the most significant upward trend in volume of landings.

The volume of landings more than tripled during the decade of the sixties and reached over eleven million pounds in 1972. Dade and Monroe Counties account for over 90 percent of the total lobster landings in the State. In terms of value of processed products, lobsters currently rank third behind shrimp and blue crabs. Several publications containing this and additional information are in various stages of publication. The State survey by Fred J. Prochaska is in the final draft stage and will be submitted for an Agricultural Experiment Station Bulletin. A Marine Advisory Bulletin, Landings, Values and Prices in Commercial Fisheries for the Florida Keys Region, by Fred J. Prochaska and James C. Cato is in press. The same two authors are presently preparing three bulletins covering the remaining areas of Florida, in which lobsters are a component in two of the remaining regions.

The purpose of the above projects is to provide basic background information for the research and extension program. In addition, the information is proving useful to county extension directors, industry and trade associations, government leaders, and to members of the commercial fishing industry.

## Spiny Lobster Projects

The three projects directly focusing on Florida's lobster industry come under three general headings: demand, cost and returns, and fisheries management. The projects are in various stages of development and completion. The first two are somewhat independent but both fit into the third project concerned with management. The following comments are general.

1. The demand project is concerned with identifying those factors which influence dockside prices Florida lobstermen receive for their catch. The primary objective of the demand analysis is to develop a price equation which can be used to predict prices for Florida lobstermen when specified demand parameters change. This project is presently in the development stages of a masters thesis. Several alternative demand models are being investigated and are being evaluated operationally with respect to available data. Factors which theoretically affect price and presently under consideration are the quantity of Florida landings, substitute meat products (including other lobsters, seafoods, beef, etc.), population, income and seasonality.

Availability of adequate data will determine the expansion of the demand analysis to wholesale and retail levels. In addition, departmental

research on marketing margins for Florida seafood products to begin this year will complement the demand analysis for Florida lobster.

2. The cost and returns project concerning the Florida lobster industry is one objective of a Sea Grant project ("Florida Commercial Fishermen: Economics of Production Enterprises and Employment") awarded to our Department to study all major fisheries in Florida. The primary objective of the lobster cost and returns project is to (1) develop a production function for the industry which will specify the effects of given inputs on landings, and (2) develop related cost functions for alternative levels of input use and related output levels (landings). An initial questionnaire has been developed with the cooperation of several members of the industry. Specific input information to be collected includes landings (dollar and pounds), fishermen, vessels, vessel tonnage, traps, days fished, crew size, days at sea, and port landed. Cost information on fuel, ice, bait, food, crew shares, insurance, interest, depreciation, and repairs and maintenance on hull, engine, electrical equipment and fishing gear will be calculated. Florida's lobster industry will be classified into three lobster fisheries, (Florida Keys, Caribbean, and Bahamian) for analysis. The information obtained in these analyses will be used to aid lobstermen in managing their individual operations in a most profitable manner under given demand conditions. In addition this study will be a valuable input into the lobster management study.

3. The final project is concerned with the management for Florida's lobster resource. The management alternatives considered are those which directly affect fishing effort as opposed to those that directly affect the lobster population through biological alternatives. One of the primary objectives is to determine if the biological maximum sustained yield (MSY) is being approached or has been surpassed. In addition the level of fishing effort that is a maximum from the point of view of economic efficiency will be determined.

Alternative formulations of bioeconomic models have been outlined in theory and some have been applied in empirical research. These models are currently under investigation for their theoretical attributes as well as their appropriateness for the Florida lobster industry.

The production functions, cost functions, and demand equations discussed above will be incorporated with the traditional bioeconomic models in order to accomplish specific objectives in addition to the two stated above. That is, the research is intended to not only consider MSY and economic efficient levels of effort and catch, but also to present a model with which alternative management schemes may be analyzed. For example, the effects of limiting entry, vessel size, number of traps, etc., in the lobster fishery will be examined. These effects will be estimated in terms of changes in production costs to fishermen, dockside prices, and income. Also estimated will be employment and indirect income effects on alternative fisheries and support industries.

As mentioned above, parts (demand analysis and costs and returns) of the total management study are currently under way. By the fall of 1974 the separate parts of the analysis will be brought together to achieve the specific objectives of the management study.

# LOBSTER DATA AND BIBLIOGRAPHY: MARS VI AND TRIAL MULTI-ACCESS RETRIEVAL COMPUTER PROGRAMS*

Paul Kanciruk
The Florida State University, Tallahassee

## Introduction

The purpose of this paper is to describe two computer retrieval programs which can be of considerable help in the analysis of data (both field and laboratory), maintenance of a complete and multi-access bibliography, and the coordination of multiple lobster research projects throughout the state of Florida. It is acknowledged that large masses of data are necessary (tagging studies, for example) but such data bases easily can hinder rather than clarify points in question by becoming so unwieldy as to be manually accessible through only a few key parameters. The use of a computer access program can both quickly and economically solve the problems associated with the manipulation of such data and bibliographic bases, but is important that the need for such assistance be acknowledged early in any research program so that any special parameters can be entertained in the planning stages.

Presently there are two retrieval programs being utilized by our group at F.S.U. -- MARS VI (Multi-Access Retrieval System) which will handle our lobster data bases, and TRIAL, which we are using to handle our bibliographic references. Both systems are almost completely interactive with remote terminals, and therefore can be utilized remotely via telephone patch connections. The following descriptions are in no way meant to be complete, but are to act as very general indications of the capabilities of these programs.

## Multi-Access Retrieval System (MARS VI), Version 2.1

### Source

Control Data Corporation (Reference Manual # 17313100).

### System Capabilities

1. Creates, stores, retrieves and modifies data bases.
2. Use of Boolean and relational qualifiers in retrieval.
3. Validity check of data.
4. Handling of both alphabetic and numeric input.
5. The following statistical functions can be performed on the variables in the data base:
   a. count
   b. maximum
   c. minimum
   d. sum
   e. average
6. Transference of subsets of the data base to output files allowing extensive statistical calculations to be performed.

*Ed. note: Not presented at conference

7. Prior knowledge of a computer language or data management techniques are not necessary for retrievals and reports.

For example, let us suppose that the following variables make up our lobster data base. For each lobster captured, our base contains a card with the following data: code number, lobster length, weight, color, sex, carapace condition (soft, hard), type of external parasites, presence of spermatophore or eggs, date and time of capture, location, depth, visibility, type of habitat, water temperature, number per den, tag number, date and area of release, and any recapture data. Once this data base has been entered (we presently have approximately 2000 entries in our base) we can use the command statement to access the data. The command statements are:

1. Recap - lists the number of unique items in each variable.
2. Report - lists the requested information.
3. Count - counts number of occurrences of requested items.
4. Sum - produces sum of numerical variables.
5. Avg - averages the values of numerical variables.
6. Min - prints minimum value.
7. Max - prints maximum.

Types of logical qualifiers are:

1. EQ - equal to
2. NE - not equal
3. LT - less than
4. GT - greater than
5. GE - greater than or equal to
6. Exists
7. Fails

and carry the usual logical meanings.

Examples of possible command statements which might be performed on our data base:

IF DEPT LT 15 AND LENGTH GT 100 REPORT CODE, DATE, AREA, DEPTH, LENGTH, SEX--

would generate a listing of the 6 variables (last six words in the statement) for all lobsters over 100 mm in length and captured in less than 15 feet of water.

IF SEX EQ M AVE SIZE
and
IF SEX EQ F AVE SIZE--

would produce the average size in mm for the subsets male and female. Adding:

IF EGGS EXISTS, AVE SIZE--

would produce an average size for all females carrying eggs in the data base.

A sort clause can be used to generate sorted reports:

IF SEX EQ M REPORT SIZE, WEIGHT, CODE, BY HIGH SIZE BY HIGH WEIGHT--

would result in a listing of all males, in ascending order of size, and within each size grouping, by ascending order of weight as below:

| Size | Weight | Code # |
|---|---|---|
| 65 | 200 | A319 |
| 65 | 207 | A498 |
| 65 | 213 | A1346 |
| 67 | 238 | A45 |
| 67 | 246 | A367 |

etc.

Such sorted listings can be directly used elucidating any size-frequency relationship, and/or generate a length-weight scattergram.

These are only a few of the types of retrievals that can be performed in MARS, but the possibilities are obvious and cost relatively inexpensive.

## TRIAL

Source

Vogelback Computing Center, Northwestern University, originally written in machine language by W. H. Tetzlaff.

System Capabilities

Retrieving, indexing and maintaining files of textural information. Our group at F.S.U. utilizes TRIAL for handling large bibliographic data files.

References are put into the system with cards or interactively on the teletype. Each reference consists of at least 4 levels, and up to 9 levels. Each level contains a different type of reference:

| Level | Information |
|---|---|
| 1 | author(s) |
| 2 | title |
| 3 | journal citation |
| 4 | code words |
| 5 | abstract |
| 6-7 | misc. |

Levels 1,2,3,5 are self-explanatory. Level 4 contains key words not found in the title. Any or all levels can be searched by the search command. Without going into the details of search command statement syntax, a few examples of the types of searches that can be accomplished are: a search for a particular author; a search for papers which contain certain key words (such as a species name); a search for articles having in common the journal of publication; a search for a code word(s) in level 4; or any combination of the above. Logical qualifiers are allowable as in MARS above, so more complicated (and useful) searches are permissible: a search for papers which contain the code words argus, temperature and behavior in level 4 would turn up all papers coded for all three areas.

In TRIAL, indexing is also permissible, (similar to the indexing by key word in context as found in BASIC), as well as alphabetical listing by every author's name, or code word. (See tables for examples of indexes and searches.)

The use of both MARS VI and TRIAL is easily justified in the increased efficiency and accuracy in handling large data bases. The cost is minimal when compared to the vastly increased accessing abilities gained through their use.

```
      CEARA...(TAGGING EXPERIMENTS ON P. ARGUS ALONG CEARA)
      1968.  ARQ ESTAC BIOL MAR UNIV FED CEARA 8(1):19-23
      SLOB DEC CRUS MIG TAG DIST NOV SEA

PARKER T J
      PK        122
      PARKER T J
      NOTE ON THE STRIDULATING ORGAN OF PALINURUS VULGARIS
      1878.  PROC ZOOL SOC LONDON, 1878: 442-444
      AGUS MOR FMOR SLOB PV

PEASE N L
      PK        170
      BUTLER J A              PEASE N L
      SPINY LOBSTER EXPLORATIONS IN THE PACIFIC AND CARIBBEAN
      WATERS OF THE REPUBLIC OF PANAMA—
      1965.  US FISH WILDLF SER, SPEC SCI REP FISH 535: 1-26
      SLOB PA PI DIST ECOL

PERKINS H C
      PK        105
      SKUP B E                PERKINS H C
      SIZE COMPARISON, SEX RATIOS, AND SIZE AT MATURITY OF OFF
      SHORE NORTHERN LOBSTERS
      1969.  US FISH + WILDLF SER SPC SCI REPT 598: 1-10
      REP MOR ECOL  AMLOB

POLLOCK D E
      PK        174
      NEWMAN G G              POLLOCK D E
      BIOLOGY AND MIGRATION OF ROCK LOBSTER JASUS LALANDII AND
      THEIR EFFECT ON AVAILABILITY AT ELANDS BAY, SOUTH AFRICA
      1971.  DIV SEA FISH INVES REPT 94
      ECOL MIG SLOB JL AFR DIST      K 54

      PK        176
      NEWMAN G G              POLLOCK D E
      MIGRATION AND AVAILABILITY OF THE ROCK LOBSTER JASUS
      LALANDII AT ELANDS BAY, SOUTH AFRICA
      1970.  OCEAN IN S AFR 1970. SYMPOS SPON BY S AFR NAT
      CENTER FOR OCEANOGR RES
      MIG SLOB JL DIST AFR

PRESTON F W
      PK        120
      PRESTON F W
      THE MATHEMATICAL REPRESENTATION OF MIGRATION
      1966.  ECOLOGY 47(3)
      MIG STAT
```

**Table 8.** Partial Listing for Entire TRIAL Bibliographic Data Base. (Each author for each paper is included separately. Note last line of each reference is the code line)

| | | | | |
|---|---|---|---|---|
| Y ABOLISHES THE CIRCADIAN RHYTHM OF | MIGRATORY RESTLESSNESS =. | MCMILLAN J P | PK | 29 |
| LOBSTERS EXPOSED TO BLEACHED KRAFT | MILL EFFLUENT =. | NOLESE D W | PK | 129 |
| MERICAN LOBSTER HOMARUS AMERICANUS ( | MILNE-EDWARDS) =. | | PK | 271 |
| ICAN ROCK LOBSTER JASUS LALANDII (H | MILNE-EDWARDS) 1. DEVELOPMENT =. | | PK | 38 |
| FRICAN WEST COAST JASUS LALANDII (H | MILNE-EDWARDS) 2. POPULATION STUDIES. BEHAVIOR; RE | | PK | 66 |
| ICAN ROCK LOBSTER JASUS LALANDII (H | MILNE-EDWARDS) 2. THE REPRODUCTIVE ORGANS, MATING | | PK | 87 |
| KARLSON H G A FEEDBACK | MODEL FOR BIOLOGICAL RHYTHMS. II COMPARASIONS WITH | | PK | 254 |
| LABORATORY AND FIELD TESTS OF | MODIFIED SPHYRION TAGS ON LOBSTERS (HOMARUS AMERIC | | PK | 102 |
| D, ENDOCRINOLOGY AND THE CRUSTACEAN | MOLT CYCLE =. | AIKEN D E | PK | 166 |
| NULIRUS ARGUS LATREILLE, DURING THE | MOLT CYCLE =. | | PK | 250 |
| DEXTER D M | MOLTING AND GROWTH IN LABORATORY REARED PHYLLOSOMA | | PK | 19 |
| STER, PANULIRUS ARGUS LATREILLE. 1. | MOLTING AND GROWTH IN LABORATORY MAINTAINED "CENT | | PK | 179 |
| YGNES GEORGE =. THOMAS L R | MOLTING BEHAVIOR OF THE MALE AUSTRALIAN (JASUS | | PK | 56 |
| TRAVIS D F THE | MOLTING CYCLE OF THE SPINY LOBSTER, PANULIRUS ARGU | | PK | 179 |
| MARSHALL N THE | MOLTING WITHOUT GROWTH OF SPINY LOBSTERS, PANULIRU | | PK | 58 |
| ONGIPES CYCNUS: DENSITY AND NATURAL | MORTALITY OF JUVENILES. =. | | PK | 14 |
| ON STUDIES, BEHAVIOR, REPRODUCTION, | MOULTING, GROWTH AND MIGRATION =. | | PK | 83 |
| LOBSTER JASUS TRISTANI AT VEMA SEA | MOUNT, GOUGH ISLAND AND TRISTAN DA CUNHA =. | | PK | 82 |
| OULINS M FURTHER STUDIES ON | MOUTHPART RECEPTORS IN DECAPOD CRUSTACEAN =. | | PK | 74 |
| T ER PANULIRUS HOMARUS (LINNAEUS) - | MOVEMENT AND GROWTH =. | | PK | 42 |
| BUMPUS H C ON THE | MOVEMENT OF CERTAIN LOBSTERS LIBERATED AT WOODS HO | | PK | 113 |
| HE FACTORS DETERMINING THE VERTICAL | MOVEMENT OF DAPHNIA =. | WIDE | PK | 268 |
| SAULA S B | MOVEMENTS AND BEHAVIOR OF BERRIED FEMALE LOBSTERS | | PK | 8 |
| SALIA S B | MOVEMENTS AND BEHAVIOR OF BERRIED FEMALE LOBSTERS | | PK | 237 |
| DIJKGRAAF S EYE STALK | MOVEMENTS OF PANULIRUS VULGARIS =. | | PK | 250 |
| COMPUTER ANALYSIS OF THE LEAF | MOVEMENTS OF PINTO BEANS =. | | PK | 61 |
| MORRISSEY T D | MOVEMENTS OF TAGGED AMERICAN LOBSTERS, HOMARUS AME | | PK | 183 |
| S, ARTIFICIAL REARING AND MIGRATORY | MOVEMENTS OF THE CAPE CRAYFISH (JASUS LALANDII) " | | PK | 37 |
| S, ARTIFICIAL REARING AND MIGRATORY | MOVEMENTS OF THE CAPE CRAYFISH (JASUS LALANDII) = | | PK | 223 |
| AN INEXPENSIVE ARRANGEMENT OF | MOVIE CAMERA AND ELECTRONIC FLASH AS A TOOL IN THE | | PK | 33 |
| ND FEMALE OF PANULIRUS JAPONICUS IN | NAGASAKI PREFECTURE =. | | PK | 232 |
| RS DISPLACED FROM OFFSHORE AREAS TO | NARRAGANSETT BAY, RHODE ISLAND =. | | PK | 59 |
| RS DISPLACED FROM OFFSHORE AREAS TO | NARRAGANSETT BAY, RHODE ISLAND =. | | PK | 270 |
| ON VULGARUS (FABRICUES) (CRUSTACEA, | NATANTIA) =. | | PK | 42 |
| KIKUTI T | NATURAL HABITAT OF MALE AND FEMALE OF PANULIRUS | | PK | |
| BONDAR H S | | | | |

55

**Table 9.** Partial Listing of TRIAL Key Word in Context Index. (Every word in every title [minus duplications and prepositions, conjunctions, etc.] becomes a key word and the listing becomes a valuable for off-computer access. Note code # at right for each line)

| | | | | |
|---|---|---|---|---|
| AIKEN D E | PK | 180 | COPE C E | PK |
| ALEXANDROWICZ J S | PK | 182 | COSTELLO I J | PK |
| ALLEN B M | PK | 187 | CRAIG A K | PK |
| ALLEN O M | PK | 211 | | PK |
| ALLEN J A | PK | 76 | CRAWFORD D R | PK |
| ANONYMOUS | PK | 25 | | PK |
| | PK | 192 | CREASER E P | PK |
| | PK | 193 | | PK |
| | PK | 194 | CUMMINGS W C | PK |
| ARDELL D J | PK | 118 | | PK |
| ARECHIGA H | PK | 184 | DANDO M R | PK |
| ARIE B | PK | 64 | DAWSON C E | PK |
| ARUDPRAGOSAH K D | PK | 83 | DAWSON D E | PK |
| ATEMA J | PK | 167 | | PK |
| | PK | 190 | DE SMIDT R J J | PK |
| ATKINSON R J A | PK | 173 | DEES L T | PK |
| BACUS J | PK | 196 | DESHMUKH S K | PK |
| BALASUBRAMANYAN R | PK | 197 | DEXTER D M | PK |
| BARNHART P S | PK | 199 | DIJKGRAAF S | PK |
| BERRY P F | PK | 20 | DIMINTRIOU D E | PK |
| | PK | 21 | DINGLE H | PK |
| | PK | 22 | DOUGLES N B | PK |
| | PK | 23 | | PK |
| | PK | 84 | DOW R L | PK |
| BERRY R E | PK | 181 | DUMONT W M | PK |
| BLASS H | PK | 198 | DUNHAM P J | PK |
| BONDE VON C | PK | 116 | ELDRED B | PK |
| BOUBJERG R V | PK | 76 | | PK |
| BOUVIER E L | PK | 200 | ELDRED E A | PK |
| BOWBEER A | PK | 52 | FALEN S T | PK |
| BOWEN B K | PK | 201 | ENGSTROM D G | PK |
| BRADSTOCK C A | PK | 172 | F. A. O. | PK |
| | PK | 202 | FELICIANO C | PK |
| | PK | 203 | FIELDER D E | PK |
| BRADY B D | PK | 166 | FIELDER D R | PK |
| BRADY J | PK | 28 | | PK |
| BRUN M S | PK | 73 | | PK |
| BRUNO M S | PK | 4 | | PK |
| BULLIS H R | PK | 204 | | PK |
| BUMPUS H C | PK | 112 | FINGERMAN M | PK |
| BURTIS J | PK | 205 | FISH J F | PK |
| BUTLER J A | PK | 174 | FLOWERS J M | PK |


**Table 10. Partial Listing of TRIAL Author Index. (Each author of each paper is included, along with the paper's code #)**

## FLORIDA LOBSTER MANAGEMENT PROGRAMS *

In recent years Florida's spiny lobster has become the second most important species landed commercially. The value of lobster landings to Florida fishermen reached nearly $6 million in 1970 (exceeded $11.8 million in 1972--personal communication, FJP, 3/18/74). Most of this growth has taken place since 1964. Between 1964 and 1970 landings increased from 3.6 million pounds to 9.9 million pounds (11.4 million pounds in 1972--pers. comm., FJP). During this same time period (1965-1970) most of Florida's lobster management programs were put into effect.

The goal of Florida's lobster management program is stated in the intent of the legislation providing for the management program.[1] It is the expressed intent of the legislation to maintain the lobster (crawfish) industry for the economy of the State. More specifically, Florida laws regulate the lobster fishing industry for the purposes of insuring and maintaining the highest possible production of lobster, or in other words, the maximum sustained yield. To achieve this goal several types of regulations have been placed on the industry. During the nearly forty years prior to 1965, management was mainly concerned with the protection of the lobster population through controls on minimum size and fishing seasons. These regulations are still of importance in the total management program. Gear regulations were emphasized in the 1965 legislation. Perhaps more important in the 1965 legislation was the emphasis on the need for effective policing policies through the use of marking by permit number, and gear and boat identification for surveillance.

### Lobster Fishing Permits

In order to effectively manage the lobster fishery in Florida, permits are required. A permit is obtained from the State upon the application by the owner of the gear used to catch lobsters. The present cost of the permit is $50 (in 1971, 1,167 permits were issued). It is unlawful for any person or boat to have more that 24 lobsters without a permit, except for possession by a licensed seafood dealer. The permit number is used to mark boats and gear as described later, and the permit is to be carried at all times on the fishing boat, subject to inspection by law enforcement officers. A permit can be suspended or permanently revoked upon the arrest and conviction of a permit holder for violation of any of the lobster fishing laws. The proceeds from the issuance of permits are to be used by the Department of Natural Resources for the enforcement of the laws regulating lobster fishing by aerial and other surveillance.

---

[1] Lobster regulation laws are found in Fla. Stat. secs. 370.14, 370.141 (1971).

* Source: Prochaska, F.J., and J.R. Baarda. In press. Florida's fisheries management programs: their development, administration and current status. Univ. Fla. Agric. Expt. Sta.Bull.

## Gear Restrictions

Florida's lobster management program includes two types of gear regulations. One of these is a requirement for marking the traps, buoys and boats with the permit number and a color coding. The other gear and/or vessels regulation places limits on the physical construction of lobster traps.

Legislation introduced in 1965 requires that permit numbers (in figures at least three inches high) be placed permanently on each trap or other device used to catch lobsters, as well as on the buoy used to mark the traps (57). The permit number is also to be permanently displayed on the boat so as to be easily identified. In addition, the 1965 act requires the traps and buoys to be color coded. In 1970 the color code was also specified for the boat, to permit identification of the boat and traps from the air.

The 1965 act made specific the types of gear that could be used to catch lobster. Wood slat traps can be used, provided that their dimensions do not exceed 3x2x2 feet or the equivalent in cubic feet. The law requires that the constructed traps be of wood slats so that when a trap is lost it will be broken up with time and thus will not continue to catch lobsters which would then be lost both for breeding stock or human consumption. The wood slat traps can be protected on the sides by reinforcement with 16 gauge, one-inch poultry wire, though the bottom and top cannot be so reinforced. Partial wire reinforcing is allowed to protect the trap from the "ravages of turtles". Ice cans, drums and other similar devices are permitted provided that they are not equipped with grains, spears, grabs, hooks or other devices.

Any gear used to capture lobsters must be marked by a buoy. Up to twenty traps can be attached to a trot-line, and the line is marked at each end by the attachment of a flag buoy. Buoys used must be of sufficient strength and buoyancy to remain continuously afloat or a timed floatation device can be used. Any device not conforming to the specifications listed, or not carrying a valid permit number, may be seized and destroyed by enforcement officials. It is unlawful to interfere with anyone's traps or markers without the owner's permission.

## Closed Season

### Present Law

The spawning season in South Florida, where lobsters are caught commercially, is generally from March to July of each year, with the peak in April.[2] The present closed season for lobster is between March 31 and August 1 (which corresponds to the spawning season). Traps may be placed in the water and baited ten days prior to the open season and must be removed within five days after the closing of the season, though no lobsters can be taken during the closed season.

It should be noted that the effects of the closed season on the lobster population is not known with certainty. It is theorized that many (or most) of the lobsters landed in South Florida are attributable to the parent population of lobsters in the Caribbean. Tagging studies suggest the larvae are deposited

[2]The Marine Laboratory has published several papers dealing with lobster in Florida. These include (Dawson, 1951), (Ingle, 1963), (Robinson, 1963) and (Sweat, 1968).

near the Florida coast by the Gulf Stream. In addition, it is suspected that a large number of the larvae produced by the Florida population is carried northward by the ocean currents.

### Historical Development

The 1919 act, the first dealing with lobster fishing in Florida, established a three month closed season of from March 1st to June 1st (58). Excluded from the closed season were lobsters taken for bait purposes. In 1921 the closed season was changed to the period from March 21st to June 21st (59), and in 1929 it was extended to a four month period from March 21st to July 21st (60). In 1953 it was set between April 15th and August 15th (61), and in 1955 the closed season was placed at its present interval of March 31st to August 1st (62). The 1965 act provided for setting traps before the season and removing them after (63).

## Condition of Lobsters

### Present Law

Three types of restrictions on the condition of lobster caught in Florida exist at present. These deal with minimum size, separation of head and tail, and egg-bearing females.

The minimum size allowed is a three inch carapace or a $5\frac{1}{2}$ inch tail, though the tail measurement cannot be applied unless the tail is disconnected from the front part of the lobster for measurement purposes. If head and tail are separated under permit, the tail must have a minimum length of six inches. Minimum size regulations are more feasible than with other fisheries because harvesting techniques require each lobster to be handled individually, therefore measurement is relatively simple. If a lobster is undersized, it can be returned to the sea unharmed.

The 1965 act prohibited the catching of egg-bearing female lobsters, and those found in traps are to be returned alive to the ocean (64). Stripping eggs from them is also prohibited.

That same act required a special permit if the separation of head and tail was to be done before landing the lobster. Some biologists feel that separating head and tail at sea and returning the head to the ocean drives away other lobsters. A permit for such separation may be granted if the operation is so far from land that it is not practical to keep the lobsters alive until landing them.

### Historical Development

In 1929 the first size restriction was enacted, the minimum being one pound (65). In 1953 the minimum was redefined to be a lobster with a tail measuring six inches (66). The 1965 act redefined the minimum size by tail and carapace measurement, with a minimum carapace measurement of three inches and tail measurement of $5\frac{1}{2}$ inches (67). Methods of measurement were also given. Finally, a 1969 act allowed a six inch minimum on tails separated under special permit(68).

### Legal citations, Florida Laws

57, 1965, Ch. 65-53; 58, 1919, Ch. 7909; 59, 1921, Ch. 8591; 60, 1929, Ch. 13618; 61, 1953, Ch. 28145; 62, 1955, Ch. 29896; 63, 1965, Ch. 65-53; 64, 1965, Ch. 65-53; 65, 1929, Ch. 13618; 66, 1953, Ch. 28145; 67, 1965, Ch. 65-53, 1965, Ch. 65-251; 68, 1969, Ch. 69-228

SPINY LOBSTER PUBLICATIONS,
MARINE RESEARCH LABORATORY,
FLORIDA DEPARTMENT OF NATURAL RESOURCES
(Chronological Listing)


Dawson, C.E., Jr. and C.P. Idyll. 1951 Investigations on the Florida spiny lobster, Panulirus argus (Latreille). Fla. State Board Conserv., Tech. Ser. No.2. 39p.

Dawson, C.E. 1954. A bibliography of the lobster and the spiny lobster, families Homaridae and Palinuridae. Fla. State Board Conserv. 86p.

Smith, F.G.W. 1958. The spiny lobster industry of Florida. Fla. State Board Conserv., Educ. Ser. No. 11. 36p.

Ingle, R.M. 1960. Synoptic rationale of existing Florida shrimp regulations. Proc. Gulf Caribb. Fish. Inst. 13: 22-27. (Contrib. 48)

Ingle, R.M., B. Eldred, H.W. Sims and E. A. Eldred. 1963. On the possible Caribbean origin of Florida's spiny lobster populations. Fla. State Board Conserv. Mar. Lab., Tech. Ser. No. 40. 12p. (Contrib. 70)

Robinson, R.K. and D.L. Dimitriou. 1963. The status of the Florida spiny lobster fishery, 1962-63. Fla. State Board Conserv., Tech. Ser. No. 42. 27p.

Sims, H.W., Jr. 1964. Let's call the spiny lobster "spiny lobster." Crustaceana 8(1): 109-110. (Contrib. 80)

Williams, J. 1964. Abdominal section of Panulirus argus. Fla. Board Conserv. Mar. Lab., Leafl. Ser. Vol. 3, No. 1. 3p.

Witham, R., R.M. Ingle and H.W. Sims, Jr. 1964. Notes on postlarvae of Panulirus argus. Q.J.Fla. Acad. Sci. 27(4): 289-297. (Contrib. 83)

Sims, H.W., Jr. 1965. Notes on the occurrence of prenaupliosoma larvae of spiny lobsters in the plankton. Bull. Mar. Sci. 15(1): 223-227. (Contrib. 86)

Sims, H.W., Jr. 1966. An annotated bibliography of the spiny lobsters, families Palinuridae and Scyllaridae. Fla. Board Conserv. Mar. Lab., Tech. Ser. No. 48. 84p. (Contrib. 101)

Sims, H.W., Jr. 1966. The Florida spiny lobster. Fla. Board Conserv. Mar. Lab., Salt Water Fish. Leafl. 7. 5p.

Sims, H.W., Jr. 1966. Notes on spiny lobster larvae in the North Atlantic. Q.J. Fla. Acad. Sci. 29(4): 257-264. (Contrib. 110)

Sims, H.W., Jr. and R.M. Ingle. 1966. Caribbean recruitment of Florida's spiny lobster population. Q.J. Fla. Acad. Sci. 29(3): 207-242. (Contrib. 95)

Ingle, R.M. and R. Witham. 1968. Biological considerations in spiny lobster culture. Proc. Gulf Caribb. Fish. Inst. 21: 158-162. (Contrib. 123)

Sweat, D.E. 1968. Growth and tagging studies on Panulirus argus (Latreille) in the Florida Keys. Fla. Board Conserv. Mar. Res. Lab., Tech. Ser. No. 57. 30p. (Contrib. 124)

Witham, R., R.M. Ingle and E.A. Joyce, Jr. 1968. Physiological and ecological studies of Panulirus argus from the St.Lucie estuary. Fla. Board Conserv. Mar. Lab., Tech. Ser. No. 53. 31p. (Contrib. 116)

Witham, R. 1970. Live shipping of Florida's spiny lobster. Q.J.Fla. Acad. Sci. 33(3): 211-220. (Contrib. 134)

Eldred, B., C.R. Futch and R.M. Ingle. 1972. Studies of juvenile spiny lobsters, Panulirus argus, in Biscayne Bay, Florida. Fla. Dep. Nat. Resour. Mar. Res. Lab., Spec. Sci. Rep. No. 35. 15p. (Contrib.194)

Little, E.J., Jr. 1972. Tagging of spiny lobsters (Panulirus argus) in the Florida Keys, 1967-1969. Fla. Dep. Nat. Resour. Mar. Res. Lab., Spec. Sci. Rep. No. 31. (Contrib. 189)

Witham, R. In press. Preliminary thermal effects studies on Panulirus argus. Q.J. Fla. Acad. Sci.

# SPINY LOBSTER MEETING PROGRAM

Proposal: To convene a small working session of persons and organizations involved in the biology and/or utilization of the spiny lobster fishery in (South) Florida.

Objectives: 1) To identify broadly the problems and information needs of persons dependent on the spiny lobster respurce. 2) To assess existing sources of information and their possible applications. 3) To identify priorities and actions needed to resolve user problems.

Format: Presentations on specific aspects of the fishery, followed by a group workshop to recommend actions appropriate to the status and needs of the fishery. A summary of the session will be prepared and distributed by Florida Sea Grant.

Place: "Jet Room", Airport Hotel, Miami International Airport, Miami, Florida ph: 305/871-4100

Date: 12 March 1974

Time: 8:30 a.m. - 3:30 p.m.

Chairman: H. L. Popenoe

Program:

Presentations...Speakers

I. Present needs and problems of fishery

A. Fishermen's view...R. Wolfferts
B. Industry's view....R. Felik

II. History and overview of fishery

A. Statistical trends...L. Johnson
B. State biological and management programs...E. Joyce

III. Ongoing Studies

A. Biological
   1. Population biology and techniques...W. Hernnkind
   2. Tortugas project...G. Davis
B. Econometric
   1. Alternate economic approaches...F. Prochaska
   2. South Florida industrywide survey...A. Craig
C. Federal programs
   1. U.S. fishery in Bahamas...D. Simmons
   2. Studies of phyllosome larvae...W. Richards

Workshop

IV. Actions to meet needs

A. Summary of problems
B. Priorities
C. Solutions
D. Recommendations
E. Plan of action

## ATTENDANCE

Spiny Lobster Meeting
Florida Sea Grant Program
March 12, 1974 -- Miami, Florida

Barry W. Ache
Dept. Biological Sci.
Fla. Atlantic Univ.
Boca Raton, Fla. 33432
305/395-5100 ext. 2340

Donald Y. Aska
Marine Advisory Program
3002 McCarty Hall
Univ. Fla.
Gainesville, Fla. 32611
904/392-1837

Dick Beales
Bahamas Government
P.O. Box N3028
Nassau, Bahamas

Gary L. Beardsley
U. Miami, R.S.M.A.S.
#10 Rickenbacker Causeway
Miami, Fla. 33149

Jim Cato
Marine Advisory Program
G111 McCarty Hall
Univ. Fla.
Gainesville, Fla. 32611
904/392-1881

Roy J. Champagne
Dade Cooperative Ext. Dept.
2690 N.W. 7th Ave.
Miami, Fla. 33143
305/635-1387

Alan Craig
Fla. Atlantic Univ.
Boca Raton, Fla. 33432
305/395-5100

Johnie H. Crance
NMFS, State-Fed. Relationships
Gandy Blvd., Duval Bldg.
St. Petersburg, Fla.

C. B. Davies
Fla. Dept. Natural Resources
Larson Bldg.
Tallahassee, Fla. 32304

Gary E. Davis
National Park Service
Everglades Nat'l. Park
P.O. Box 279
Homestead, Fla.
305/247-6211

Dean Farrell
Lobster Diver
P.O. Box 1252
Miami, Fla. 33101

Robert Felik
National Fisheries, Inc.
311 N.W. So. River Drive
Miami, Fla.
305/371-4527

William Herrnkind
Fla. State Univ.
Tallahassee, Fla. 32306

Eric S. Holliman
UNDP/FAO Fishery Development
Study, Bahamas
P.O. Box 6345
Nassau, Bahamas 54100

Lloyd E. Johnson
NMFS
75 Virginia Beach Drive
Miami, Fla. 33149

Albert C. Jones
NMFS
75 Virginia Beach Drive
Miami, Fla. 33149

Edwin A. Joyce, Jr.
Fla. Dept. Natural Resources
Larson Bldg.
Tallahassee, Fla. 32304

Louis Lamont
Commercial Fisherman
P.O. Box 38-183
Key Largo, Fla. 33037
305/451-1404

William G. Lyons
Fla. Dept. Nat. Res. Mar. Res. Lab.
100 - 8th Ave., S.E.
St. Petersburg, Fla. 33701

Walter J. McNichols
Heed University
Box 311
Hollywood, Fla.
305/925-1600

Bruce Mounier
Diver's Association
9321 S.W. 80th Terr.
Miami, Fla. 33143
305/361-5761

Hugh L. Popenoe
Florida Sea Grant Program
2001 McCarty Hall
Univ. Fla.
Gainesville, Fla. 32611
904/392-1965

Fred J. Prochaska
Dept. Food & Resource Economics
1099 McCarty Hall
Univ. Fla.
Gainesville, Fla. 32611
904/392-1847

W. J. Richards
NMFS
75 Virginia Beach Dr.
Miami, Fla. 33149
305/361-5761

Willard W. Sands
Keys Lobster, Inc.
P.O. Box 141
Key Largo, Fla.

William Seaman
Florida Sea Grant Program
G025 McCarty Hall
Univ. Fla.
Gainesville, Fla. 32611
904/392-1806

David Simmons
NMFS
75 Virginia Beach Dr.
Miami, Fla. 33149
305/361-5761

Charles Smith
O.F.F.
Box 104
Islamorada, Fla.

Richard E. Warner
UF Coop. Ext. Service
P.O. Box 2545
Key West, Fla.

Richard C. Wolfferts
Commercial Fisherman
Box 309
Key Largo, Fla. 33037

Richard E. Wolfferts
M/V. Diamond Head, Inc.
R & L Lobster, Inc.
P.O. Box 10298
Riviera Beach, Fla.

Ms. Ricky Wolfferts
P.O. Box 309
Key Largo, Fla. 33037
305/451-1691