FISHERY MANAGEMENT PLAN

FOR THE

SPINY LOBSTER FISHERY

OF THE

GULF OF MEXICO

AND

SOUTH ATLANTIC

GULF OF MEXICO FISHERY MANAGEMENT COUNCIL
LINCOLN CENTER, SUITE 881
5401 W. KENNEDY BOULEVARD
TAMPA, FLORIDA 33609

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL
1 SOUTHPARK CIRCLE, SUITE 306
CHARLESTON, SOUTH CAROLINA 29407

NATIONAL MARINE FISHERIES SERVICE
9450 KOGER BOULEVARD
ST. PETERSBURG, FLORIDA 33702

2.0 SUMMARY

2.1 Fishery

The spiny lobster fishery consists of the spiny lobster, Panulirus argus, and other incidental species of spiny lobster (spotted spiny lobster, Panulirus guttatus; Smooth tail lobster, Panulirus laevicauda; Spanish lobster, Scyllarides aequinoctialis and Scyllarides nodifer) which inhabit or migrate through the coastal waters of and the fishery conservation zone (FCZ) of the Gulf of Mexico and the South Atlantic Fishery Management Council areas and which are pursued by commercial and recreational fishermen.

2.2 Management Unit

The management unit for which federal regulations will be implemented shall be the species Panulirus argus in the FCZ within the jurisdiction of the Gulf of Mexico and South Atlantic Councils.

2.3 Maximum Sustainable Yield

Maximum sustainable yield is estimated as 12.7 million pounds annually for the maximum yield per recruit size of 3.5 inches carapace length.

2.4 Optimum Yield

Optimum yield (OY) is specified to be all lobster more than 3.0 inches carapace length or not less than 5.5 inches tail length that can be harvested by commercial and recreational fishermen given existing technology and prevailing economic conditions.

2.5 Expected Domestic Annual Harvest (EDAH) and Total Allowable Level of Foreign Fishing (TALFF)

Optimum Yield	9.5 million pounds
Expected Domestic Annual Harvest (1982)	9.5 million pounds
TALFF	0 pounds

2.6 Benefits and Costs

The benefits from implementation of this fishery management plan (FMP) include:

1. A first-year increase in annual yield of up to 1.5 million pounds from the present estimated legal catch of 8.0 million pounds (see Sections 5.4.2 and 12.5) to the EDAH of 9.5 million pounds for 1982,

2. an eventual increase in annual yield of 4.0 million pounds from the present 8.0 million pounds to the MSY of 12.0 million pounds with effective enforcement throughout the fishery and the development of alternative attractants for use in traps (see Issue 3 in Section 2.7),

3. a first-year increase in annual revenue to the harvesting sector of up to $3.3 million and a total impact on the national economy of up to $7.3 million (see Section 12.5), and

4. a first-year increase in employment opportunities by 371 man-years.

The costs from implementation of this FMP include first-year statistical reporting costs of $58,798, and in subsequent years a cost of $34,798.

2.7 Issues in the Fishery

1. The number of "shorts" (sublegal lobster) taken and sold illegally appears to be large and may have increased considerably in recent years. Enforcement of size limit regulations will be a major consideration when developing procedures for implementing management measures.

2. There is gear conflict among domestic users of the resource. This consists of a directed otter trawl fishery and pompano drift netters which have caused lobster trap loss.

3. There is controversy over the extent of mortality caused by the fishing practice of using shorts as attractants in traps. (Sections 5.1.5.10, 5.4.2, 5.5, and 8.2.4.1 discuss this issue in detail.)

4. There is an increasing number of traps in the fishery.

5. Harvest in the FCZ during the spawning season is a serious and rapidly growing problem.

2.8 Management Objectives

1. Protect long-run yields and prevent depletion of lobster stocks.

2. Increase yield by weight from the fishery.

3. Reduce user group and gear conflicts in the fishery.

4. Acquire the necessary information to manage the fishery.

5. Promote efficiency in the fishery.

2.9 Proposed Management Measures

A. A minimum harvestable size limit of more than 3.0 inches carapace length or not less than 5.5 inches tail length shall be established.

B. A closed season from April 1 through July 25 shall be established. During this closed season there shall be a five-day "soak period" from July 21-25 and a five-day grace period for removal of traps from April 1-5.

C. All spiny lobster traps shall have a degradable surface of sufficient size so as to allow escapement of lobsters from lost traps.

D. The taking of spiny lobsters in the FCZ with spears, hooks and similar devices or gear containing such devices shall be prohibited. The possession of speared, pierced or punctured lobsters shall be prima facie evidence of the taking with prohibited gear while in the FCZ.

E. No person shall willfully molest a trap or buoy or work a trap belonging to another without permission from the owner.

F. To aid enforcement, traps may be worked during daylight hours only.

G. All spiny lobster taken below the legal size limit shall be immediately returned to the water unharmed except undersized or "short" lobsters which may be carried on the boat/vessel provided they are: for use as lures or attractants in traps and kept in a shaded "bait" box while being transported between traps. No more than three live "shorts" per trap (traps carried on the boat) or 200 live "shorts", whichever is greater, may be carried at any one time.

H. All lobster traps used in the fishery within the FCZ shall be identified by a number and color code issued through the office of the Regional Director of NMFS or his designee to each vessel desiring to use lobster traps in the FCZ. Further, each vessel using such traps must be clearly marked with the same color to allow identification from aerial and water patrol craft.

I. A special two-day recreational nontrap season shall be established.

J. The retention on board boats or vessels or possession on land of "berried" female spiny lobsters taken from the FCZ at any time shall be prohibited. Stripping or otherwise molesting female lobsters to remove the eggs shall be prohibited. "Berried" female lobsters taken in traps or with other gear must be immediately returned to the water alive and unharmed.

K. Use of poisons or explosives to take spiny lobsters shall be prohibited.

L. Statistical Reporting

1. The vessel enumeration information system shall be applied in the spiny lobster fishery and mandatory reporting shall be required.

2. Mandatory trip tickets shall be submitted as necessary by commercial spiny lobster fishermen.

3. A commercial spiny lobster fisherman is one who sells his catch.

2.10 Management Measures Considered but not Proposed

M. Recommend that the Fort Jefferson National Monument, Dry Tortugas be designated as a marine sanctuary for the spiny lobster.

N. Alternative Size Limits:

1. Recommend a minimum harvestable size limit of 2.75 inches carapace length.

2. Recommend a minimum harvestable size limit of 3.125 inches carapace length.

3. Recommend a minimum harvestable size limit of 3.25 inches carapace length.

4. Recommend a minimum harvestable size limit of 3.5 inches carapace length.

O. Recommend areas closed to all commercial and recreational harvest of spiny lobster:

1. Florida Bay extending westward to an imaginary line drawn between Sombrero Light (located south of Marathon on the reef crest) and east of Cape Sable,

2. Biscayne Bay including interior sounds and channels, and

3. The Atlantic side of the Florida Keys and Florida east coast (from Sombrero Light to Miami) out to the southern line of boundary markers for Hawks Channel.

P. Require that traps be limited to: (a) wood slat traps with biodegradable tops or throats (side reinforcement with 16 gauge, one inch poultry wire to prevent turtle damage is acceptable) or (b) ice cans, drums and similar devices.

Q. A buoy must be attached to each trap (or to a set of traps via a trotline with buoys affixed to both ends). Buoys must be of sufficient buoyance to float except when intentionally submerged with a timed float release device.

R. Lobster tails shall not be separated from the carapace while on or below waters of the FCZ. Separated tails shall not be transported or possessed while in the FCZ except that lobster tails separated in waters outside the FCZ may be transported across the FCZ provided that written notification of such transport is received by the appropriate agency at least 24 hours before the separated tails enter the FCZ. Such tails shall measure no less than 5.5 inches measured lengthwise along the center of the tail. The measurement shall be conducted with the tail in a straight, flat position and the tip of the tail closed. This provision should not be construed to prevent the transport of separated tails from foreign countries for lawful import where a valid bill of sale or other evidence of purchase exists.

S. Prohibit any boat without a commercial permit engaged in the spiny lobster fishery from harvesting from the FCZ or possessing while on the waters of the FCZ regardless of where taken, more than 24 spiny lobsters in a single day.

T. Prohibit the importation or possession of spiny lobsters (P. argus only) below three inches carapace length or (when the tail has been separated) below 5.5 inches tail length.

U. Require permitting of recreational and commercial participants in the fishery. As part of this annual permitting program provide for the collection of management information for the fishery.

V. Develop a system to limit access in the fishery.

W. No Action.

2.11 Recommendations

2.11.1 Special Recommendations to the Secretary

The Councils have recommended the following areas of needed information in priority order.

1. Develop new baits or other fishing practices that offer economically viable substitutes for using shorts as attractants in traps.

2. Information needed on unreported landings from all user groups.

3. The need for better estimates of total mortality including natural as well as fishing mortality.

4. To determine larval origins.

5. Information on catch and effort, by area, from all user groups.

6. Encourage the design and implementation of a system that will assist in locating and retrieving of traps and minimize conflicts between users of the resource area.

7. Size selectivity of traps presently in use.

2.11.2 Special Recommendations to the States

The Councils recommend that the states implement the management measures proposed in this plan within their territorial jurisdiction, where applicable. The Councils further encourage the states to assist the Secretary in addressing and supporting the research and other special recommendations.

4.0 INTRODUCTION

The Magnuson Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) gives responsibility to the Regional Fishery Management Councils to prepare and submit fishery management plans for fisheries within their geographical area. The South Atlantic and Gulf of Mexico Fishery Management Councils, in accordance with their legislative mandate, are preparing a joint plan for the spiny lobster fishery.

Following the format for a complete fishery management plan, this report begins with Section 4.0, Introduction, followed by Section 5.0, Description of the Stocks Comprising the Management Unit. The latter section includes discussions of the biological characteristics of the species, the abundance and condition of the stocks, their ecological relationships, and estimates of maximum sustainable yield. Section 6.0 describes the condition of the habitats of the spiny lobster. Section 7.0 presents a discussion of management institutions and laws that are relevant to the species in the management unit. Section 8.0 describes the character of commercial and recreational fishing activities, and is followed in Section 9.0 with an analysis of economic characteristics of the fishery. In Section 10.0 the business and market characteristics, and organizations associated with the fishery are described. Section 11.0 presents a discussion of social and cultural aspects of the commercial and recreational fisheries. Section 12.0 specifies management objectives, optimum yield, and management measures and assesses their impacts. This analysis fulfills the requirements of Executive Order 12291 and thus acts as the Regulatory Impact Review. Also in this section is a discussion of the Paperwork Reduction Act, Regulatory Flexibility Act, and a determination of a major/minor rule. Section 13.0 summarizes management measures required under the plan. Section 14.0 specifies statistical reporting required under the plan. Section 15.0 discusses the relationship of the plan to existing laws and policies. Section 16.0 discusses Council monitoring of the plan. References cited are in Section 17.0.

5.0 DESCRIPTION OF THE STOCK COMPRISING THE MANAGEMENT UNIT

5.1 Description of the Spiny Lobster, Panulirus argus, and Its Distribution

5.1.1 Identity

The valid name of the spiny lobster comprising the management unit is Panulirus argus (Latreille, 1804) Ann. Mus. Nat. Hist. Paris, Vol. 3, p. 393. P. argus is a decapod crustacean of the family Palinuridae.

Artificial keys to "spiny lobsters" found in Florida and the Caribbean have been developed by Smith (1958) and Opresko, et al. (1973). These keys allow one to differentiate P. argus from two other spiny lobsters found in Florida. In addition, most imported spiny lobsters can be identified by the artificial key provided in Chace and Dumont (1949).

The spiny lobster is locally called spiny lobster, Florida lobster, Florida spiny lobster, lobster, crawfish, and crayfish in the United States, Bermuda, Jamaica, the Bahamas, and the British speaking Caribbean; langosta and langosta espinosa del caribe in Central America, South America, Cuba, and the Spanish speaking Caribbean; kreeft in Curacao and Surinam and the Dutch speaking Caribbean; lagosta comun and lagosta vermelha in Brazil; and langouste in Martinique and the French speaking Caribbean.

5.1.2 Morphology

The spiny lobster, P. argus, has two horns projected forward of the eyes. The walking legs are slender, about equal in size and without claws. There is a single transverse groove on each of the second to fifth tail segments which is interrupted in the middle. A pair of large yellow spots, bordered by dark color are found on the second and sixth tail segments. Smaller spots may occur on other segments.

5.1.3 Incidental Species

Two additional species of Panulirus occur in Florida. They are the spotted spiny lobster, P. guttatus, and the smooth-tailed spiny lobster, P. laevicauda. P. guttatus, a smaller animal which often inhabits rocks or interiors of reefs, is rarely landed in the spiny lobster catch. It is similar to P. argus, but differs in having a single continuous groove on tail segments two through five. The grooves are continuous from side to side. Numerous small, light-colored spots occur on the tail and legs. The biology has been summarized by Caillouet, et al. (1971), Beardsley (1973) Chitty (1973) and Marfin (1978). P. laevicauda, which is rare in Florida, differs from P. argus and P. guttatus by lacking grooves on the tail segments. The biology has been reviewed by Paiva and da Costa (1968) and other papers from the University of Ceara, Brazil. Any of the above Panulirus species would be included under the term spiny lobster in the U.S. landing statistics. The vast majority of landings from Florida and the Bahamas are composed of P. argus.

Lobsters of the family Scyllaridae are landed occasionally by trawlers working for shrimp or fish and by traps. Due to the use of common names, these Spanish, sand, shovelnose, or slipper lobsters are sometimes included as "spiny lobsters." They may, indeed, offer an alternate resource to the Palinuridae or spiny lobsters. Landings are a mixture of Scyllarides nodifer and Scyllarides aequinoctialis. At present no Scyllarus are landed as incidental species (W. G. Lyons, personal communication). Scyllarus americanus and Scyllarus chacei are small, but may be used for sustenance and may someday become a fishery resource. The biology of the Scyllaridae is discussed by Lyons (1970) and this work, together with the references cited, contains most of the current knowledge regarding Spanish or slipper lobsters.

On an average, 7,150 pounds per year of slipper lobsters were landed in 1972-1975, with all reported U.S. landings on the Florida west coast. Shrimp trawlers landed about 6,500 pounds per year in Florida during that period, with trap fishermen accounting for the remainder.

Due to the small quantity of landings of these species and the incidental nature of the fishery it is felt that a management program is not warranted at this time. Later inclusion of this group of lobsters in the management unit should be considered if the current status of the fishery changes.

5.1.4 Distribution and Larval Recruitment

Spiny lobster are known from Bermuda, the Bahamas, the Caribbean, and the East Coast of the American continent from North Carolina, U.S.A. to Rio de Janeiro, Brazil.

Larvae known as phyllosoma are found throughout this area. In Florida they are most common in June through August (Lewis, 1951). Many are found in oceanic waters.

The origin of phyllosoma larvae in Florida is unsolved. Menzies and Kerrigan (1979) offer two systems. The first is an "open" system (or a very large transatlantic closed system) of recruitment whereby larvae occurring off southeast Florida were probably spawned in the West Indies or in the Gulf of Mexico (Lewis, 1951; Ingle, et al., 1963; Sims and Ingle, 1967; Austin, 1972). The second is a "closed" system whereby eddies (Lee, 1975; Lee and Mayer, 1977), meanders (Lee and Mooers, 1977), and velocity changes (Niiler and Richardson, 1973) occurring sporadically, when coupled with vertical distribution and migration of phyllosoma larvae (Sims and Ingle, 1967), could retain larvae spawned in Florida. Austin (1972) questions the validity of vertical migration and counter currents as a basis for larval recruitment because phyllosomas do not cross the thermocline; therefore, their recruitment pattern is dependent upon the surface circulation patterns.

Richards and Goulet (1976) used an operational surface drift model to study larval recruitment and dispersal. Their results, while preliminary, tend to support the "open" system.

Menzies, et al. (1977, 1978), and Menzies and Kerrigan (1979) have used antigens of soluble proteins to show some genetic heterogeneity (Belize versus Florida) while also speculating on a westerly flow of larvae to the north of the Greater Antilles.

Postlarvae (= puerull) occur throughout the geographic range. Lewis, et al. (1952) found that postlarval settlement occurred from January through March with peak settlement during January. Year-round postlarval settlement has been documented by Witham, et al. (1964), Witham, et al. (1968), Sweat (1968) and Little (1977). Little (1977) summarized semi-quantitative data on recruitment from 1964-1971 and further substantiated nocturnal recruitment peaks during flooding tides in new and first quarter moon phases. Most postlarvae are found in shallow waters as part of the cryptic fauna.

Adults are present on reefs and among rubble from nearly intertidal areas to depths as great as 450 meters (250 fm) in the Bermudas (Buesa Mas, 1970). Spiny lobsters have been caught at depths of 80-130 fm in the Bahamas (E. Perez, personal communication). There are numerous reports in Cuba of fishing at depths varying between 200 and 228 meters (111-127 fm) (Buesa Mas, 1970). Within their range spiny lobsters are found in all seasons.

5.1.5 Biological Description

5.1.5.1 Sexuality

P. argus have separate sexes with no signs of hermaphrodism. Sexes of juveniles and adults are most easily distinguished by examining the underside of the carapace (head and thorax). Mature female

P. argus have been reported ranging in CL[1] from 38 mm (1.5 inch) to 90 mm (3.6 inches) by Crawford and DeSmidt (1922), Smith (1946), Pearson and Anderson (1946) and Dawson (1949) from Florida; by Smith (1946, 1948, 1951 and 1958) and Waugh (1980) from the Bahamas; by Creasor (1950) and Sutcliffe (1952) from Bermuda; by Butler and Pease (1965) from Panama; by Weber (1968) and Allsopp (FAO, 1968) from Belize, by Mota-Alves and Tome (1965) from Brazil; by Feliciano (1958) from Puerto Rico; by Cobo de Barany, et al. (1972) from Venezuela; and by Buesa Mas and Mota-Alves (1971) from the Caribbean.

It is important to use more recent estimates of size at maturity for P. argus because there appears to have been a reduction in the size at which P. argus matures over the past 30 years that may be related to fishing effort (Davis and Dodrill, 1980).

Sexual maturity by size class provides a better estimate of reproductive activity. Maturity was attained by 50 percent of female P. argus in the 80-89 mm (3.2-3.6 inch) carapace length size class (Aiken, 1977) and 90-99 mm (3.6-4.0 inch) size class (Munro, 1974) in Jamaica. Peacock (1974) reported sexual activity, based on external characteristics of P. argus from Barbuda, as beginning in 80-90 mm size class, reaching a maximum in the 100-130 mm (4.0-5.2 inch) size class and decreasing after 130 mm. A sample of P. argus from Dry Tortugas, Florida, contained no mature females below 78 mm (3.1 inches) CL and maturity was attained by 50 percent of females in the 86-95 mm (3.4-3.8 inch) size class (Davis, 1975). Davis (1975) also found that females with CL over 130 mm (5.2 inches) were not reproductively active. Warner, et al. (1977) found that of lobsters less than, or equal to, 76.1 mm (3.0 inches) CL, 4.2 percent were reproductively active while of those greater than, or equal to, 76.2 mm (3.1 inches) CL 10.7 percent were reproductively active.

An index of reproductive potential by size class was developed by Kanciruk and Herrnkind (1976, 1978):

$$\text{Index} = (ABC)/D$$

where A = number of females in class/total females
B = propensity of size class to carry eggs
C = egg carrying capacity of female size class
D = constant[2] (31.27)

Females with CL less than 76 mm (3.0 inches) represented 14.9 percent of females but only contributed 2.3 percent of total egg production (Kanciruk and Herrnkind, 1976). The most productive (3.9) size class was 96-100 mm (3.8-4.0 inch) CL versus .15 and .52 for the 71-75 mm (2.8-3.0 inch) and 76-80 mm (3.0-3.2 inch) size classes respectively.

5.1.5.2 Mating

The mating season in Florida is principally from February to April (Smith, 1948; Lewis, 1951). Dawson and Idyll (1951) report mating peaks during March to July, with some mating year-round. Mating pairs are of about the same size (Dawson and Idyll, 1951).

Buesa Mas (1965) briefly describes mating of P. argus and it seems to be similar to mating of P. homarus which Berry (1970) described in detail (Munro, 1974).

---

1 CL = carapace length: distance from the interorbital ridge (between the horns) to the posterior edge of the carapace.

2 "The constant, D, was chosen to set the 76-80 mm (3.0-3.2 inch) size class index to 100 as the standard" (See Kanciruk and Herrnkind, 1976).

5.1.5.3 Fertilization

Fertilization and spawning of spiny lobsters occurs when females scratch at the spermatophoric mass or tar releasing sperm which fertilize the eggs as they pass from the female sexual openings at the base of the third pair of legs to the attachment sites on the pleopods located on the underside of the tail (Crawford and DeSmidt, 1922; Sutcliff, 1952; Berry, 1970; and Munro, 1974).

Detailed histological examination of gonads which lie in the postereodorsal part of the carapace have been made by Mota-Alves and Tome (1965).

Buesa Mas and Mota-Alves (1971) have documented the progressive color changes of the ovaries as maturation proceeds and Munro (1974) notes that this may be used for determining stages of the reproductive cycle.

The number of eggs produced appears to be correlated with size and age. Estimates by Crawford and DeSmidt (1922) show a 87.5 mm (3.5 inch) CL female can lay 500,000 eggs while a 100.0 mm (4.0 inch) CL female can lay 700,000 eggs, near the maximum. Dawson (1949) and Smith, (1948) reported that a 76.2 mm (3.1 inch) CL female can lay 500,000 eggs. A female in the 76-80 mm (3.0-3.2 inch) class carries approximately 250,000 eggs (Kanciruk and Herrnkind, 1976). In Bermuda a second spawning in the same season was reported by Creaser (1950) and Sutcliffe (1952). The second spawning produces slightly fewer eggs than the first (Creaser, 1950). Bermuda spiny lobsters seem to lay more eggs than Florida spiny lobsters (Creaser, 1950): 87.5 mm (3.5 inch) CL produced 669,196 eggs, 105.0 mm (4.2 inch) CL produced 1,118,656 and 132.5 mm (5.3 inch) CL produced 2,566,916 eggs.

The number of broods in Florida and Caribbean waters appears to be restricted to one spawning per season (Kanciruk and Herrnkind, 1976). In Jamaica egg production per unit body weight ranged from 670 to 1,210 eggs per gram of total body weight, with an average of 830 eggs per gram (Munro, 1974).

5.1.5.4 Spawning

The seasonal occurrence of berried female *P. argus* has been documented for the Caribbean area (Bahamas and Bermuda included) by a number of investigators (Smith, 1948; Cobo de Barany, et al., 1972; Kanciruk and Herrnkind, 1976; G. T. Waugh, personal communication). Year-round spawning, with and without peaks, has been reported (Mattox, 1952; Feliciano, 1958; Buesa Mas, 1965; Buesa Mas and Mota-Alves, 1971; Munro, 1974; Peacock, 1974). Sutcliffe (1952) reported Bermuda spiny lobsters mating from mid-May onwards and the production of two broods in June and July with no berried females occurring after August.

In Florida the spawning season is from April to July with some reproductive activity continuing into August (Sweat, 1968; Warner, et al., 1977; Lyons, et al., manuscript). Lyons, et al., (manuscript) reported approximately 32 percent spawning in May-June, 15 percent in July and 11 percent in August.

Spawning as related to reproductive potential is discussed in Section 5.2.

5.1.5.5 Larval Phase

The embryology of *P. argus* has not been studied. Crawford and de Smidt (1922) observed some developmental stages of the eggs. The eleven phyllosoma larval stages are described in detail by Lewis (1951) and Baisre (1964). As the phyllosoma develop, legs are added, antennae and antennule segments are added, and abdominal segmentation increases. The phyllosomes are hatched after four weeks and apparently remain in the plankton for about six months (Lewis, 1951) or more.

Larval stages are very difficult to keep alive due to the feathery appendages becoming entangled with one another or clogged with debris (Crawford and de Smidt, 1922; Provenzano, 1969). Postlarvae can be kept more easily but, as Lewis, et al. (1952) indicate, young stages exhibit high mortalities.

5.1.5.6 Postlarval Phase

The final phyllosoma metamorphoses into a small transparent lobster-like puerulus stage. Lewis et al. (1952) described what were thought at the time to be separate postlarval stages; however, there is only one stage (Lyons, 1970; Little, 1977). Metamorphosis occurs in deeper water and the puerull move into shallow water and settle to the benthic environment (Sweat, 1968). Shallow, mangrove-fringed areas provide the optimum habitat for growth and survival (Sweat, 1968; Ingle and Witham, 1969; Peacock, 1974; Little, 1977; Waugh, 1980). It is not known how long puerull can survive if suitable habitat is not encountered after metamorphosis (Munro, 1974).

Shallow habitat does not appear to be essential for completion of the life cycle because P. argus populations occur on isolated oceanic banks such as Rosalind Bank, Jamaica, where the minimum depth is approximately 10 m (33 feet), (Munro, 1974). However, all known major lobster fisheries are located in the vicinity of shallow habitat or nursery areas and such areas appear to be necessary for a productive fishery.

Semi-quantitative data (original research and published data by earlier workers) on recruitment from August 1964 through September 1971 was summarized by Little (1977) who reported that postlarvae were found year-round with peaks between February-June and September-December. Recruitment patterns are slightly different in the lower Florida Keys, where summer peaks have also been reported (Little, 1977). Peacock (1974) reported year-round settlement with two peaks, one in April-June and another in July-September, and speculated that recruitment may ultimately be determined by the arrival of water masses rich in late-stage phyllosomes.

Estimates of growth rate for postlarvae and early juvenile stages are varied. Lewis, et al. (1952) and Sweat (1968) report a growth rate of approximately 12 mm (0.5 inches) in the first year of benthic existence. Much faster growth rates of 2-5 mm (0.1-0.2 inches) per month for the first ten months of the juvenile stage have been reported by Witham et al. (1968), Eldred, et al. (1972), Davis (1978), Waugh (1980) and Lyons, et al. (manuscript).

Post-larval recruitment may have decreased between 1968-69 and 1976-78 in Biscayne Bay (Davis, 1978; Davis and Dodrill, 1980). However, this conclusion was based on mean numbers of juvenile spiny lobsters caught per tow by live bait shrimpers in Biscayne Bay during 1968-69 (Eldred, et al., 1972) and 1976-78 (Davis, 1978) and may not accurately reflect abundance due to possible changes in fishing gear and/or areas.

5.1.5.7 Juvenile and Adult Phases

Lobsters have massive mandibles designed for crushing animals, mollusks in particular (Peacock, 1974). They are active nocturnal predators and will also take carrion as food. During daylight hours adult P. argus occupy dens or crevices in broken bottom with the largest dominant male establishing a "pecking-order" and occupying the safest position deep in a refuge (Strangways-Dixon, 1973).

Juvenile P. argus (26 mm CL; 1.0 inch) are known to use the sea urchin, Diadema antillarum, for shelter during daylight hours and thereby feed on areas which were otherwise devoid of shelter (Davis, 1971).

The sex ratio of P. argus populations generally appears close to unity throughout its range (Creaser, 1952; Buesa Mas, 1965; Munro, 1974).

While the absolute age of individual lobsters and other crustaceans cannot be determined, (during a molt all hard parts are shed with the old exoskeleton) there is information on age composition of P. argus populations (Munro, 1974; Davis, 1978; Lyons, et al., manuscript). Peacock (1974) offers the following estimate of age where X is approximately one year:

CL (mm)	Time From Settlement (Years)
50	X
60	X + 0.3
70	X + 0.6
80	X + 1.0
90	X + 1.5
100	X + 2.0

Herrnkind (1977) describes three types of migratory patterns among the palinurids, as well as a general review of migration: migrations, where lobsters move a considerable distance, usually periodically or with a return movement to the original area; nomadism or wandering; and homing, often daily movements from shelter to a nearby area and return. Mass migrations in which lobsters form very long queues usually moving in a specific direction have been reported from Florida, the Bahamas, Cuba and Belize (Buesa Mas, 1970; Herrnkind, et al., 1973; Herrnkind, 1974, 1977; Kanciruk and Herrnkind, 1978). Herrnkind, et al. (1973) attribute mass migrations from shallow Bahama banks to autumnal cold fronts.

There is also a seasonal movement associated with reproduction (Sutcliffe, 1952; Davis, 1974) and a movement from shallow water nursery areas out to the deep reef habitat (Sutcliffe, 1952; Olsen, et al., 1971; Peacock, 1974; Warner, et al., 1977; Davis, 1978; Waugh, 1980; Lyons, et al., manuscript). Lyons, et al. (manuscript) found a progressively larger mean size of captured lobsters when moving from shallow-water to deep-water areas in the Florida Keys. Inshore movement in the fall and early winter of large, dark-colored P. argus has been documented by Dawson (1949), Buesa Mas (1965), and G. T. Waugh (personal communication).

Fishermen view migration as a movement through the fishing grounds and subsequently out into deeper water where they are effectively lost to the fishery. There are two reasons for this belief: as the season progresses, fishermen must constantly move their traps to keep up with the movement of lobsters and all lobsters that are caught are roughly the same size (56-80 mm CL; 2.2-3.2 inches) implying that these lobsters are part of a group that migrated through the fishing grounds during the season and subsequently move out of the Florida fishery. The fact that lobsters are caught as deep as 80-130 fm, (E. Perez, personal communication), supports their belief that deeper lobsters are lost to the fishery because traps cannot be fished in that depth of water due to the Gulf Stream current.

Scientists believe that current knowledge of P. argus explains these phenomena and that the migration observed by fishermen is a part of the natural migratory behavior as discussed above. Further, the uniform size class is a result of gear selectivity; that is, traps do not retain spiny lobsters with CL <56mm (2.2 inches); high fishing pressure ensures the harvest of virtually all spiny lobsters with a CL $\geq$76.2 mm (3.1 inches).

Since 1917 the idea of culturing spiny lobsters for stocking or food has been considered (Crawford and de Smidt, 1922). Difficulty with larval culture due to the complex and long larval stage (6+ months) has prevented scientists from completing the life cycle in laboratory conditions (Smith, 1948; Ingle and Witham, 1969; Provenzano, 1969; Ting, 1973; Snell, et al., 1978).

5.1.5.8 Growth Patterns

The relative growth patterns of P. argus have been described by a number of authors. Weber (FAO, 1968) noted that females of a given CL have a longer and narrower tail than a male of the same size. Further, that the female's tail is heavier than that of a male of the same CL. This makes the effective legal size by tail length slightly below the minimum CL size of 76.2 mm (3.0 inches) for female P. argus.

Length:weight relationships are described by Dawson and Idyll (1951) for Florida, by Creaser (1952) for Bermuda, by Weber (FAO, 1968) for Belize and by Cobo de Barany, et al. (1972) for Venezuela. In all cases there was a difference in the length:weight relationship for males and females. This has also been confirmed for Florida spiny lobster by Lyons, et al. (manuscript).

Regression equations for the length:weight relationship were given by Buesa Mas (1961) and Buesa Mas, et al. (1968), but there are problems in comparing these with equations of other workers. Olsen, et al. (1971) provided an equation for the U.S. Virgin Islands where no difference between sexes was observed. Munro (1974) used a sample of 50 male and 50 female spiny lobsters in Jamaica to calculate a length:weight relationship that was identical for both sexes. Yang and Obert (1978) provided an equation for south Florida, but did not give methods or address the separation of the sample by sex.

Lyons, et al. (manuscript) noted a significant difference between the sexes in a sample of 570 spiny lobsters in southern Florida. However, for practical purposes the difference is not that large (Lyons, et al., manuscript). The length:weight relationship for sexes combined was:

$$W = 0.00422\ CL^{2.64091}$$

where W = weight in grams
CL = carapace length in millimeters

The relationship between total length (TL) and CL has been given by Peacock (1974) from Barbuda as:

TL = 2.61 CL or CL = 0.383 TL for males
TL = 2.91 CL or CL = 0.344 TL for females

Total weight (W):tail weight (AW) for Brazilian spiny lobsters was estimated to be (Paiva, 1960):

W = 3.36 AW or AW = 0.298 W for males
W = 2.74 AW or AW = 0.365 W for females

Growth rate is the most studied aspect of spiny lobster biology. However, accurate growth estimates are rare due to the difficulty of separating the two growth processes, molting frequency and growth increment per molt (Morgan, 1977). Environmental factors, especially temperature (Chittleborough, 1975; Davis, 1978; Waugh, 1980*), affect growth rates.

An "average" growth rate for P. argus of between 5-8 mm (0.2-0.3 inches) increase in CL per molt and, in general, four molts per year was obtained by examining growth estimates reported in the literature (Crawford and De Smidt, 1922; Dawson, 1949; Dawson and Idyll, 1951; Smith, 1951, 1958; Travis, 1954; Sutcliffe, 1957; Buesa Mas, 1965; Witham, et al., 1968; Little, 1972; Peacock, 1974; Warner, et al., 1977; Davis, 1978; Waugh, 1980).

---

* Portions of this section referenced to Waugh (1980) may be direct quotes. This is with the author's previous knowledge and his consent.

Spiny lobster growth rate is affected by injury. Davis and Dodrill (1980) report growth rates for injured and uninjured juveniles in Biscayne Bay to be 16.1 mm per year and 26.5 mm per year, respectively. In Florida Bay growth was estimated as 38.5 mm per year injured and 40 mm per year for uninjured lobster. Estimates of natural injury rate vary from 13 percent for adults in Dry Tortugas to 30 percent for juveniles in Biscayne Bay (Davis and Dodrill, 1980). Lyons, et al., (manuscript) found an injury rate of 7.7 percent at the end of the closed season. This can be assumed to be the natural injury rate in the Florida population.

Fishing practices, both diving and trapping, increase the injury rate in the population. Total injury rate in the Florida population is estimated as 10.4 percent (Lyons, manuscript). Injury rates increased during the fishing season to a maximum of 25.6 percent for sublegal animals and 18.4 percent for legal size animals immediately following the close of the fishing season.

An estimate of the growth coefficient, K, is needed to calculate size at maximum yield using the Beverton/Holt model of yield per recruit (as applied in section 5.4).

Reported estimates of K vary from 0.10 to 0.44. Olsen, et al. (1971) reports values of K for lobsters in the U.S. Virgin Islands ranging from 37-178 mm (1.5-7.1 inches) CL with a mode of approximately 100 mm (3.9 inches) CL as: 0.436 for males, 0.319 for females and 0.432 for males and females combined. Estimated asymptotic lengths were 153 mm (6.0 inches) for males and 133 mm (5.2 inches) for females. These values are substantially less than actual asymptotic lengths and probably result in an overestimate of K. A K value of 0.215 for combined sexes was reported for lobsters with $50 \leq CL < 120$ mm (2.0-4.8 inches) (Munro, 1974). Waugh (1980) separated growth coefficients by size class and sex and reported values ranging from 0.100 ($76 \leq CL < 86$ mm; 3.0-3.4 inches) to 0.256 ($50 \leq CL < 76$ mm; 2.0-3.0 inches) for the Bahamas. Lobsters between 50 and 76 mm CL represented the fastest growing size class. Yang and Obert (1978) report K = .111 for southern Florida but do not elaborate on methodology. Davis (personal communication) found K ranging from 0.31 to 0.36 for lobsters 37-85 mm CL in south Florida.

The K estimates of Munro (1974), Waugh (1980) and Davis (pers. comm.) overestimate the average value of K for the entire range of growth. They assumed an L_{oo} based on historical maximum recorded size and calculated K based on rapid growth of younger animals. This inherently overestimates K. Of the three, Munro (1974) uses the widest size range and should be the most accurate.

The most likely range of K appears to be 0.20 to 0.30. For the purpose of calculating yield per recruit at different minimum size (see Section 5.4.3), the midpoint of this range, K = 0.25, was accepted as the best estimate.

5.1.5.9 Population Size Distribution

Size distribution decreases as one moves shoreward, from an average of 80.1 mm CL (3.2 inches) on the deep reef (30 m, 100 ft) to 65.6 mm CL (2.6 inches) at shallow (3 m, 10 ft) bay stations (Lyons, et al., manuscript). This is confirmed by Davis (1978) where the mean increased from 60.3 mm (2.4 inches) CL in Biscayne Bay to 64.2 mm (2.6 inches) CL in the tidal creeks and finally to 74.4 mm (3.0 inches) CL on coral reefs within Biscayne National Monument during 1976-77. Warner, et al. (1977) observed a mean CL increase from 73.5 mm (2.9 inches) at Gulf shallows to 81.5 mm (3.3 inches) at Atlantic patch reef stations.

A review of size frequency data indicates that the size of spiny lobsters has decreased since the early 1940's. Dawson and Idyll's (1951) data yield a modal size of 89.7 mm (3.6 inches) CL with a mean of 90.3 mm (3.6 inches) CL (Lyons, et al., manuscript), while that of Robinson and Dimitriou (1963) had a modal size of 82.0 mm (3.3 inches) and a mean of 88.8 mm (3.6 inches) CL; declines of

7.7 mm (0.3 inches) in the modal size and 1.5 mm (0.1 inches) in the mean CL. These data cannot be directly compared to more modern data due to sampling difference and different minimum legal sizes (see Lyons, et al., manuscript, for a complete discussion of these differences).

More recently Warner, et al. (1977) compared the length frequency of the lower Florida Keys data (1975-76) showing a modal size of 65-75 mm (2.6-3.0 inches) CL and a mean of 72.9 mm (2.9 inches) CL to that of Dawson and Idyll (1944-49 data) from the Florida Keys and Davis (1973 data) from Ft. Jefferson. Warner, et al. (1977) illustrated a steady decline in mode and mean from an unfished population in a protected area (mode = 95-100 mm, 3.8-4.0 inches; mean = 101 mm, 4.0 inches; Davis, 1977) to a moderately fished population (mode = 89.7 mm, 3.6 inches; mean = 90.3 mm, 3.6 inches; Dawson and Idyll, 1951) and finally to the present heavily fished population (mode = 65-75 mm, 2.6-3.0 inches; mean = 72.9 mm, 2.9 inches; Warner, et al., 1977). Real decline in population size is less than indicated by Warner because his sample came primarily from inshore areas, while other studies sample offshore populations, which tend to be larger. Lyons, et al. (manuscript) report results similar to those of Warner, et al. (1977) with a mode of 73 mm (2.9 inches) and a mean of 73.2 mm CL for all areas. Lyons, et al. also compared the modal size of their oceanside data (78 mm CL, 3.1 inches) to Dawson and Idyll's (1945-49) data and found a decrease of nearly 12 mm (0.5 inches). This is probably a good estimate of the real decline in size distribution of the lobster population in south Florida.

5.1.5.10 Mortality Rates

Total Mortality

Total mortality estimates for P.argus in areas other than Florida range from Z = 0.41 (Olsen, et al., 1971) to 1.55 (Waugh, 1980). Intermediate values of 0.56 to 0.77 depending on age (Buesa, 1965), 0.65 (Olsen, et al., 1971) and 1.52 (Munro, 1974), have been reported.

Instantaneous total mortality rates (Z) for the Florida lobster population can be obtained by following the methods of Munro (1974), $Z = K (L_{oo} - L_c)/(L_c - L_r)$. Length frequency data presented by Davis (1977), Warner, et al. (1977) and Lyons, et al. (manuscript) were used to obtain measures of size at full recruitment (L_r) and average size of the fully recruited population (L_c). For the coefficient of growth, K, the most likely value was considered, K = 0.20 - 0.30. Asymptotic (terminal) length, L_{oo}, was estimated as 190 mm carapace length. Estimates of Z vary from $1.72 \leq Z \leq 2.73$ for K = 0.20 to $2.59 \leq Z \leq 4.09$ for K = 0.30 (Exhibit 5.2).

The data of Warner et al. (1977) and Lyons, et al. (manuscript) represent the size classes actually fished in southern Florida; therefore, their data were used to calculate values shown in Exhibit 5-3 and estimate maximum yield per recruit, (Section 5.4.3).

Mortality due to harvest practices may be causing significant loss of potential yield. This loss is related to the practice of using sublegal "short", lobster as attractants and to the large participation of recreational divers in the fishery. Large numbers of live shorts are transported aboard commercial vessels in the normal process of fishing. This activity results in some mortality. Recent research indicates that this may be in the range of 20 to 50 percent of all shorts so transported (Hunt, 1981; Kennedy, 1981; Lyons, et al., 1981). Comments from the Advisory Panel indicated that the study was not conducted in accordance with normal practice in the fishery and substantially overestimate mortality. The reported injury rate due to handling was higher than fishermen believed was normal, and the practice of pouring water over the lobsters held on deck is considered to stress the animals and increase the subsequent mortality. At present, the available data are insufficient to accurately estimate actual loss due to harvest practices.

Natural Mortality

Available estimates of natural mortality, M, vary greatly, ranging from M = 0.26 (G. Davis, personal communication) to M = 1.03 (Munro, 1974). Some of this variability may be related to age or habitat. Munro's high estimate was based on an unexploited offshore population of large lobsters (70-159 mm, 2.8-6.4 inches CL) with a modal size of approximately 105 mm CL. If the data of Davis (1974), taken from a similar habitat for a similar size range (modal size 100 mm, 3.9 inches CL), are analyzed by the method of Munro, an almost identical value of M = 1.0 is obtained. Waugh (1980) reported mortality rates of lobster less than 50 mm (2.0 inches) CL found in an inshore nursery area as M = 0.19 for males and M = 0.27 for females. Olsen, et al. (1971) reported values of M = 0.48 for offshore males with size class means between 60 mm (2.4 inches) CL and 77 mm (3.0 inches) CL. The average of reported values for offshore females with size class means between 98 mm and 132 mm (3.9-5.2 inches) CL was M = 0.53. They also reported an estimate for smaller males inshore (size class means between 36.5 mm and 59.0 mm CL) as M = 0.43.

Based on the above estimates, the likely range of M for all size classes appears to be M = 0.30 to 1.00. The best estimate of the average for the exploited population in Florida is M = 0.40 to 0.50. This is on the low end of the estimated range, consistent with the low average size of the Florida population. For the purpose of calculating yield per recruit at larger size limits, (see Section 5.4.3), the best average estimate of M for the entire life span was considered to be 0.60. Based on the available literature, it is reasonable to expect an increase in average natural mortality with increasing average size.

Exhibit 5-2

Populations Parameters of Length, Growth, and Mortality for Different Rates of Exploitation of Spiny Lobster Stocks

	Davis (1977)	Warner et al. (1977)	Lyons et al. (mss.)
L_{oo}	190	190	190
Lr	100	65	73
Lc	115	78	81
K_1	.20	.20	.20
K_2	.30	.30	.30
Z_1	1.00	1.72	2.73
Z_2	1.50	2.59	4.09

$$Z = K\ (L_{oo} - L_c)/(L_c - L_r)$$

Exploitation Ratio

Exploitation ratio, E = F/Z, can be calculated by assuming a reasonable range of M, and calculating instantaneous fishing mortality, F, from the previously estimated values of Z (Exhibit 5-2).

Using the estimated range of natural mortality M = 0.4 to 0.5, and Z values representative of the exploited stock, the estimated values of E vary from 0.71 to 0.96 (Exhibit 5-3). Estimates based on Lyons, et al. (manuscript) varied from 0.82 to 0.90 and are considered more precise. Graphical presentation of data in Warner, et al. (1977) does not allow precise estimation of L_r and L_c. Also the data of Lyons were a better sample of the lobster size range and areas fished by U.S. fishermen.

The best estimate for E is determined to be 0.80 to 0.90.

Exhibit 5-3

	Z	M	F	E
Lyons, et al. (manuscript)	2.73[1]	0.4	2.33	0.85
		0.5	2.23	0.82
	4.09[2]	0.4	3.69	0.90
		0.5	3.59	0.88
Warner, et al. (1977)	1.72[1]	0.4	1.32	0.77
		0.5	1.22	0.71
	2.59[2]	0.4	2.19	0.85
		0.5	2.09	0.81

[1] Represents Z when K = 0.20

[2] Represents Z when K = 0.30

5.2 Abundance and Present Conditions

Catch data in Florida indicate high catches in late summer when the legal season opens and decreasing catches as the season progresses (Warner, et al., 1977). (See Section 8.2.2.1.)

In the past ten years (1970-79) reported commercial landings in Florida (excluding Bahamian catches) have averaged 5.3 million pounds per year. There has been very little fluctuation in landings since 1975. The area fished is approximately 6,475 sq. kilometers (2,500 sq. mi.), giving a yield of about 371 kg per km^2 (2,120 pounds per nm^2) or about 962 kg/nm^2. This density is similar to "reserves" in Cuban waters (Buesa Mas, 1965) and higher than those in Barbuda (Peacock, 1974), in the Bahamas (Waugh, 1980: 189), in Los Roques (Cobo de Barany, et al., 1972), and in Jamaica (Munro, 1974), and less than the total count made by Davis (1977) on the Tortugas.

The true abundance of spiny lobster in Florida, as elsewhere, is unknown. Relative abundance is indicated by catch (c) and catch per unit effort (c/e). Data have been summarized by Smith (1958: 28) for 1925-1958, by Robinson and Dimitriou (1963) for 1953-63, and by Johnson (1974) and Joyce (1974) to 1973. Historical landings in Florida are shown in Exhibit 8-1.

Total Florida landings must be adjusted for catches from the Bahamas and in other foreign waters. In recent years over half of the "Florida" landings came from abroad. The Bahamian concern for their lobster resources reduced effort in their waters in 1975, but illegal fishing, mostly by United States resident alien fishermen who land lobster in Miami, still occurs (see Section 8.2.1.1).

Intensive fishing effort has reduced the size distribution of the population and substantially reduced reproductive capacity. Lyons, et al. (manuscript) estimates that the total number of eggs spawned on reef areas in the Florida Keys has been reduced to 12 percent of the unfished condition. The effect of this reduction depends on the spawner:recruit relationship of the species. For P. argus this relationship is unknown. Normally, species with a very high fecundity, such as spiny lobster, do not show a very close relationship between the number of eggs spawned and the subsequent recruitment.

Limited data on juvenile abundance indicate substantial variation by area and from year to year which may indicate variations in recruitment. In Biscayne Bay, Davis (1978) reports a 67 percent decline in catch rate of juvenile lobster in commercial shrimp trawls between two studies done during 1968-69 and 1976-78. Davis (personal communication) reported an increase of nearly an order of magnitude in juvenile abundance in Florida Bay between 1977 and 1978.

The reported commercial catch for U.S. waters is a good index of recruitment because the fishery takes about all the available recruits every year. The domestic catch has fluctuated very little since 1969, indicating that recruitment has remained relatively stable in spite of very large increases in fishing effort (e.g. Exhibits 5-4 and 5-6) and probable decreases in spawning.

A relation between spawning stock and subsequent recruitment of postlarvae has been shown for Panulirus cygnus, the western rock lobster of Australia (Morgan, 1980). Density dependent growth and mortality effects in the juvenile stage absorb most of the fluctuation in postlarvae recruitment, resulting in relatively stable recruitment of juveniles into the exploited population.

Within the range of stock sizes observed in that fishery, spawning stock reductions are positively correlated with increasing postlarvae recruitment as predicted by Ricker (1975). So far, no reductions in recruitment have occured. At some point, further reductions in spawning stock will result in decreasing recruitment. At this time, it is impossible to predict where that point may be.

This Australian species is significant because of the close similarity with P. argus. The western rock lobster has a very similar life cycle, ecology and size at sexual maturity. The fishery operates with the same three inch size limit, has a very high exploitation rate, and has reduced the spawning stock by an amount similar to that in the U.S. fishery. The Australian experience supports present indications that large reductions in spawning have not adversely affected recruitment in the U.S. fishery. It also indicates that recruitment should be closely watched in the future if spawning continues to decrease.

5.3 Ecological Relationships

Throughout the life of the spiny lobster, it interacts with other species. The larvae are suspected of feeding on small planktonic crustacean larvae and medusae (Provenzano, 1969). Young juveniles were found to feed on molluscs (Peacock, 1974). Large juveniles and adults in the reef habitat contained algae, foraminifera, sponge spicules, polychaetes, sand, bivalve remains, gastropod mollusc remains and crustacean remains in their guts (Peacock, 1974). Allsopp (FAO, 1968) reports P. argus feeding on fish, crustaceans (including other lobsters) and molluscs, particularly the turkey wing clam, Arca zebra.

Juveniles generally live in the shelter of corals, rocks, or other cover. Occasionally they live in association with sea urchins (Davis, 1971) and sponges (Khandker, 1964), which also offer shelter.

Adults serve as attachment sites for barnacles (Balanus eburneus) (Buesa Mas, 1965). The exoskeleton is attacked by a chitinoclastic bacteria yielding a "shell disease" (Iversen and Beardsley, 1976). Sindermann and Rosenfield (1967) mention a microsporidian infection causing a condition similar to "cotton shrimp." Fungi are known from gills of the related P. vulgaris (Sordi, 1958), and a parasitic barnacle, Octolasmis forresti (Stebbing, 1894), has been reported from the gills of P. argus (Pearse, 1954).

No extensive parasite or disease research has been conducted on P. argus or other Florida lobsters.

Interspecific competition with P. guttatus and P. laevicauda is suspected to be minimal due to the scarcity of P. laevicauda thoughout much of the range and scarcity and ecological differences in P. guttatus. No direct studies of interspecific competition have been conducted.

Larvae are preyed upon by a number of pelagic fishes, including tunas, Katsuwonus pelamis and Thunnus atlanticus (Baisre, 1964). Juveniles are presumably subject to predation by numerous fishes while occupying the mangrove and grass flat habitats. Major predators of adults and subadult stages include skates (Dasyatis spp.), sharks (especially Ginglymostoma cirratum), various snappers (Lutjanus), grouper (Mycteroperca spp. and Epinephelus spp.), and octopus (Buesa Mas, 1965). Dolphins (Tursiops) and loggerhead turtles (Caretta caretta) also prey on lobster Munro (1974). Allsopp (1968) reported a small snail, Murex pomum, killed lobsters in traps, and presumably in nature, by boring through the carapace.

Munro (1974) showed a relation between fishing, abundance of predatory fishes and natural mortality of spiny lobster. He assumes natural mortality to be proportional to the biomass of predators on the reef. Since the Jamaican south coast fishery heavily exploits all predators, the effect of fishing reduces predators and improves the survival rate of lobsters.

Witham (1973) has shown early juvenile lobsters will not survive at temperatures below 10°C nor above 35°C. Between 16°C and 32°C growth increased with temperature, but survival was best near 27-30°C. Gradual decreasing salinity from 35 to 20 ppt (parts per thousand) was tolerable, but salinity below 19 ppt or rapid changes proved lethal to postlarval lobsters (Witham, et al., 1968). No scientific studies have been conducted on the reaction of adult lobsters to temperature and salinity.

Welsh (1934) had indicated the presence of a caudal photoreceptor in lobsters and Hess (1938 and 1940) has commented on overall light sensitivity in newly molted animals.

Sound production of P. argus is discussed by Mulligan and Fischer (1977).

5.4 Estimates of Maximum Sustainable Yield

A surplus yield model using only recorded catch and effort data for the commercial trap fishery in the primary fishing areas was used to estimate a sustainable yield of 5.9 million pounds with the present size limit (Section 5.4.1). After considering other unrecorded harvest and optimum size at recruitment, MSY was estimated as 12.7 million pounds (Section 5.4.2). Size at maximum yield per recruit given present fishing effort was estimated to be between 3.7 and 3.9 inches carapace length (94-99 mm). The present 3.0 inch minimum size was estimated to provide between 85 and 91 percent of the maximum yield per recruit at present effort levels (Section 5.4.3).

5.4.1 Surplus Yield Model

Maximum sustainable yield for spiny lobster was computed based on a version of the surplus yield model suggested by Fox (1970). A comparison was made with the surplus yield model of Schaeffer (1954, 1957). Landings of all three species of the genus Panulirus are included in the total used to compute MSY. However, more that 99 percent of the total is P. argus. There is no directed commercial fishery for the other two species.

Catch and effort data which could be used to calculate MSY were available only for Monroe County (Exhibit 5-4). The computed MSY estimate was expanded to reflect the best estimates of other sources of harvest from U.S. waters. Catch and effort from other areas could not be used since a large but unknown amount of the landings and effort in the east coast fishery was directed to foreign waters. The west coast landings, except for Monroe County, are predominantly imported.

Exhibit 5-4

Catch, Traps Fished, and Catch per Trap in Monroe County, Florida, 1952-78

Year	Catch $\times 10^3$ lbs	No. Traps	Catch/ Trap
1952	447	4,500	99
1953	574	6,500	88
1954	722	11,690	62
1955	1,210	12,700	93
1956	2,309	16,775	137
1957	3,384	21,720	154
1958	2,328	23,221	100
1959	2,635	33,612	78
1960	2,126	54,640	39
1961	2,100	38,990	54
1962	2,434	58,250	42
1963	2,770	60,050	46
1964	2,844	73,553	39
1965	4,379	89,700	49
1966	3,650	74,550	49
1967	2,719	91,800	30
1968	3,892	98,500	40
1969	4,621	96,955	48
1970	5,235	150,050	35
1971	4,653	147,037	32
1972	4,640	174,490	27
1973	4,993	171,590	29
1974	5,631	227,250	25
1975	4,472	428,250	10
1976*	4,136	305,000	14
1977*	4,693	408,000	12
1978*	4,675	529,200	9

* Unpublished preliminary figures, include some domestic catches landed in other counties.

Source: National Marine Fisheries Service, Fishery Statistics of the United States (data for 1952 to 1975 modified by Williams, 1976, to exclude foreign catch landed in Monroe County).

Using data compiled by NMFS, corrected by Williams (1976) and summarized here as Exhibit 5-4, regressions were calculated of catch per trap vs. traps, Log_e catch per trap vs. traps.[1] All regressions showed significant decreasing catch per unit effort (c/e) with increased effort (Exhibit 5-5), and produced estimates of MSY (Exhibit 5-6). The variability of these estimates is indicated by the standard deviation of the slope (S_b) in Exhibit 5-5. Yield estimates from different models are presented in Exhibit 5-6. The best estimate of MSY is the Fox model. This model produces the lowest variation around the line relating the Log_e c/e and effort. The number of traps required to harvest the MSY was estimated to be 206,448. This model is presented graphically in Exhibit 5-7 and 5-8.

The Fox model as used here to estimate MSY is based on harvest at a 3.0 inch CL. Yield per recruit analyses indicates that an increase in carapace size would increase yield per recruit and result in a higher yield.

Exhibit 5-5

Regression of Catch/Effort vs Effort for Florida West Coast Lobster Fishery 1952-1975

	X	Y	a	b	S_b	F	R_2
Schaefer	traps	Catch/trap	76	-.00018	.00004	22.12 **	0.47
Fox	traps	Log_e catch/trap	4.3449	-.00000484	.0000004	116.77 **	0.82

Note: The form of the regression equation is $Y = a + bx$ with S_b the standard deviation of the slope, R_2 and the F-statistic measuring significance of the estimate.

** Significant at the 99 percent level.

Exhibit 5-6

Surplus Yield Model Estimates of the Maximum Sustainable Yield Based on Reported Catch and Effort in Monroe County 1952-1975

Model	Unit of Catch/Effort	MSY	Effort	C/E
Schaefer	Catch/trap	7,974,000	208,748 traps	38.2
Fox	Log_e catch/trap	5,854,000	206,448 traps	28.3

---

[1] A second set of effort data was reported by Joyce (1974) based on the number of Florida spiny lobster permits. There are a number of serious problems with this data set. First, no attempt is made to separate from the total permits the portion belonging to divers, shrimpers (who occasionally harvest lobster while trawling), fishermen operating in foreign waters, or fishermen currently not active in the fishery. The great decrease in numbers of permits issued in 1970-71 after a fifty dollar fee was instituted (Section 11.1) illustrates this problem. Second, the number of traps was estimated assuming a constant 118 traps per permit holder, despite evidence that the number of traps per fishermen has risen steadily in recent years (Section 8.2.4.1). Finally, it is impossible to separate east and west coast effort using the Joyce data.

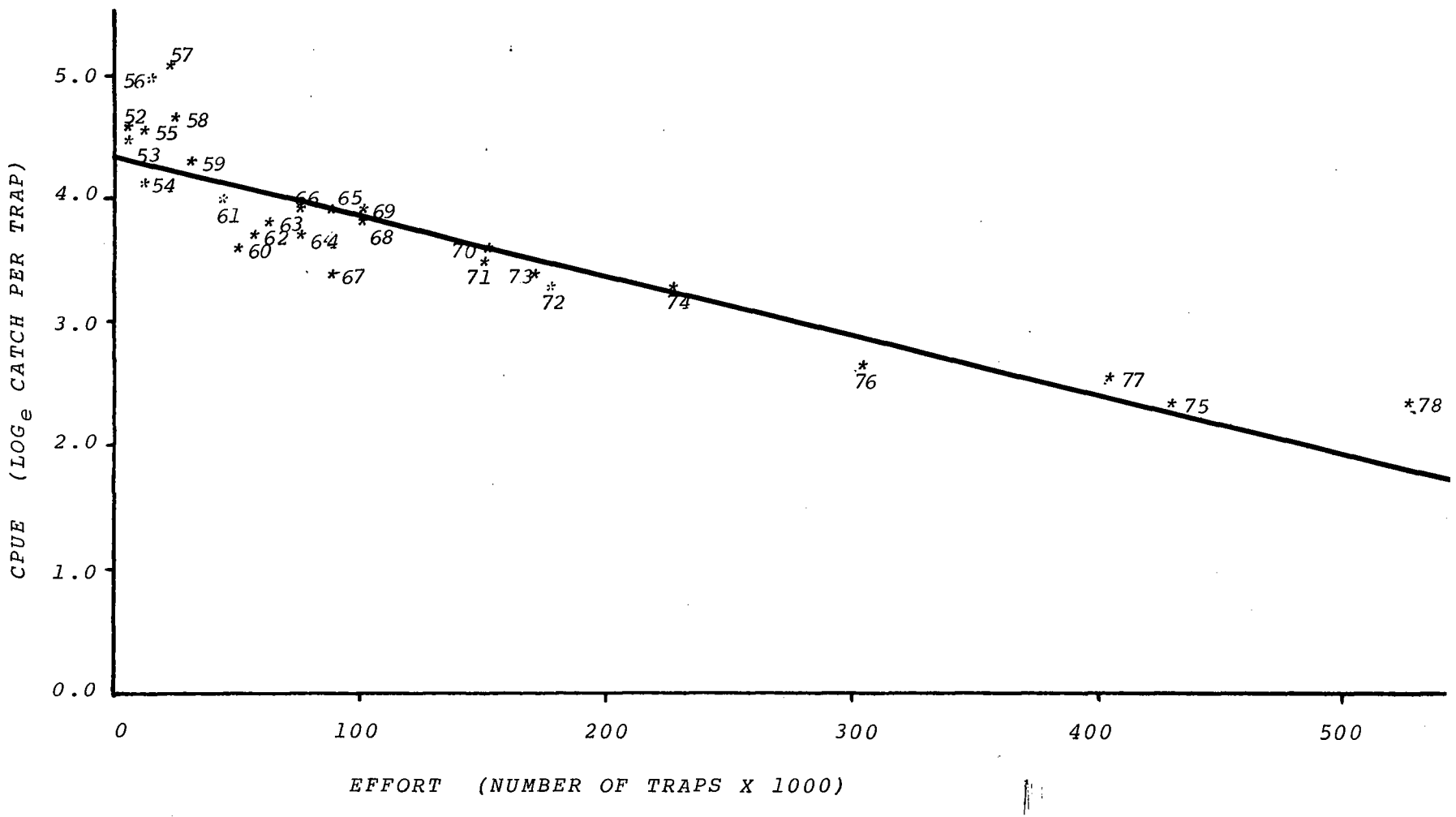


Exhibit 5-7. The relationship of catch per unit effort (CPUE) to fishing effort for spiny lobster in Monroe County for the period 1952-1978.

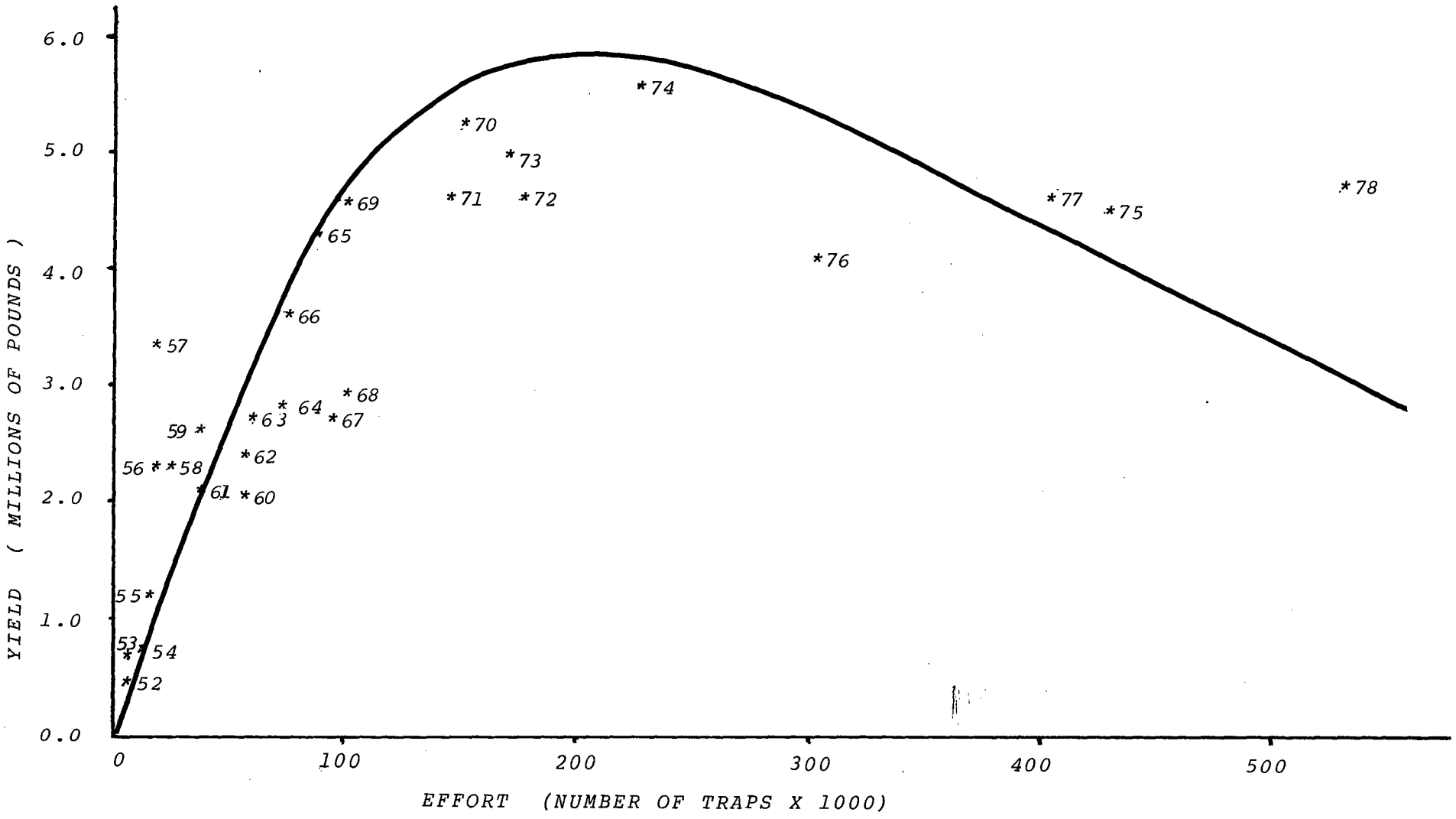


Exhibit 5-8. Relation between fishing effort and yield of spiny lobster in Monroe County for the period 1952-1978

5.4.2 Unrecorded Harvest and Total Estimated MSY

To obtain an estimate of MSY for the entire stock, the estimate using Monroe County data was expanded to account for lobster harvested on the east coast of Florida, recreational catch, unreported landings, both legal and undersize, losses due to present harvest practices, and increased yield at a larger size limit. Sustainable yield at the present three inches limit was estimated as 12.0 million pounds (Exhibit 5-9). Maximum sustainable yield was estimated as 12.7 million pounds given optimum fishing effort and a minimum size of between 3.4 and 3.7 inches CL.

To account for that portion of the stock found on the east coast of Florida, the Fox model estimate was increased, based on most recent reported landings (1978-79) of 200,000 pounds. The amount may not be a precise estimate of equilibrium yield from the east coast, because fishing effort probably exceeds the maximum equilibrium level. However, the amount of potential error in MSY is small due to the small catch.

The Fox model estimate was also increased to account for unrecorded landings or losses due to fishing induced mortality. The best total estimate is 104 percent of the recorded landings (Austin, et al., 1980b). This estimate was based on Monroe County landings from 1970 to 1974, estimated by Austin, et al. (1980b) at 5.5 million pounds. During this period average fishing effort was near the estimated amount of effort for maximum equilibrium yield, therefore it is reasonable to add this percentage amount directly onto the Fox model estimate. The estimated add-on is 5.9 million pounds [(5.5 million pounds plus 0.2 east coast)(1.04) = 5.9]. It should be understood that this is the amount which would have been harvested if all lobster were taken at 3.0 inches CL (76 mm) or larger. The actual amount is less in proportion to the number of lobster taken at less than 3.0 inches. This is due to lower yield per recruit at the smaller size. At present there is no way to accurately divide this 104 percent according to its component categories of:

(1) Unrecorded recreational legal size catch.

(2) Unrecorded commercial legal size catch not sold through fish houses.

(3) Unrecorded recreational harvest of sublegal lobster.

(4) Unrecorded commercial harvest of sublegal lobster.

(5) Unrecorded induced mortality of sublegal lobster from recreational fishing practices.

(6) Unrecorded induced mortality of sublegal lobster from commercial fishing practices.

(7) Loss in yield per recruit due to injury and mortality of shorts due to illegal harvest and fishing practices.

Exhibit 5-9

Total Estimate of MSY

	Millions of Pounds
Fox surplus yield model (Monroe County)	5.9
East Coast	0.2
Total unrecorded harvest	5.9
Sustainable Yield at 3.0 inches CL	12.0
MSY*	12.7

* Maximum possible yield given a larger size limit and optimum fishing effort.

Rough approximations of some components of the unreported catch are available and can be used to set bounds for the total legal harvest and on the likely value of losses due to harvest practices or illegal harvest (Exhibit 5-10).

The estimate of recreational harvest is discussed in Section 8.2.2.2 and summarized in Exhibit 8-8. Estimated unreported commercial legal size harvest was obtained from the spiny lobster questionnaire results of Austin, et al. (1979b, 1980a). Fishermen sold ten to 30 percent of their catch or 0.6 to 1.6 million pounds through channels which were not included in the recorded landings.

Subtracting the total of recreational and commercial legal size harvest implies that from 3.3 to 4.9 million pounds could potentially be attributed to losses from fishing practices and illegal harvest.

At this time it is not possible to differentiate between illegal harvest and harvest practice losses. It is widely accepted by participants in the fishery and many scientists that the illegal harvest is large, (Johnson, 1974; Warner, et al., 1977; E. Felton, pers. comm.) probably in the range of 20 to 50 percent of the legal commercial harvest. The magnitude of losses from harvest practices is dependent on the amount of illegal harvest. If illegal harvest is near the upper end of the above range, then harvest practice losses are small. Conversely, such losses may be large if illegal harvest is less than presently believed.

The sum of the Fox model estimate for Monroe County, east coast landings, and unrecorded harvest or losses is equal to 12.0 million pounds. This amount is the best estimate of maximum yield at optimum effort given a 3.0 inch (76 mm) size limit. Yield per recruit analysis indicate that maximum yield at the estimated optimum effort will be obtained at a size limit larger than 3.0 inches (see Section 5.4.3). Maximum sustainable yield at the predicted optimum effort level is estimated to be six percent greater than the equilibrium yield at 3.0 inches, or 12.7 million pounds (Exhibit 5-9).

Exhibit 5-10

Estimates of Component Parts of the Total Unrecorded Catch

	Millions of Pounds
Total unrecorded catch	5.9
Recreational legal size harvest	0.4 - 1.0
Commercial legal size harvest	0.6 - 1.6
	1.0 - 2.6
Illegal harvest, mortality and yield per recruit loss from fishing practices*	4.9 - 3.3

* These components cannot be separated; see text for discussion.

5.4.3 Maximum Potential Yield from Available Recruitment

Analysis of alternative minimum size limits was conducted utilizing the Beverton and Holt (1957) model of yield per recruit (Y/R). This model incorporates estimates of growth rate and mortality rates to estimate potential yield for any desired combination of fishery effort and minimum size. It estimates yield from the available recruitment and does not consider the effect of variable recruitment. Tables in Beverton and Holt (1966) were used to compute yield per recruit values from ratios of M/K and E = F/Z.

Sizes at maximum yield per recruit are estimated as 3.7 inches if E = 0.80 and 3.9 inches if E = 0.90 (Exhibit 5-11). Estimated yield per recruit at the present 3.0 inch size limit ranged from 85 to 91 percent of the maximum at the present level of effort. An increase in minimum size of 3.0 to 3.5 inches would increase yield per recruit by nine to 14 percent, achieving 97 to 99 percent of the theoretical maximum. Decreasing the minimum size to 2.75 inches CL would decrease present yield (at 3.0 inches) by six to eight percent.

The reliability of this analysis of size and yield is limited by the quality of the parameters. Several parameters are not precisely estimated. This is important because small changes in some parameters can make large changes in the predicted size at maximum yield. This is particularly true for the estimate of natural mortality, which is the least reliable of all the necessary parameters. The analysis is adequate to sustain the conclusion that the present size limit does not result in maximum yield per recruit and that an increase in size limit would increase yield per recruit. However, it is not sufficient to reliably predict the exact size at maximum yield or the exact amount of any increase in yield resulting from an increase in size limit. The point estimates generated by this analysis and projections based on it should be viewed with caution.

Parameters

The best estimate of E is a range of 0.80 to 0.90 (see section 5.1.5.10). The most likely range for K was 0.20 to 0.30 (see Section 5.1.5.8). For the purpose of this analysis, the midpoint of this range was considered the best estimate. The best estimate of M for this analysis was M = 0.60 (see Section 5.1.5.10). The range of M/K ratios is therefore 2.0 to 3.0 and the best estimate is M/K = 2.4.

Exhibit 5-11

Percent of Maximum Yield per Recruit at Different Minimum Size Limits
(E = 0.80 - 0.90 and M/K = 2.4)

	Carapace Length	Percent of Maximum Yield per Recruit
E = 0.80	3.70 inches (94 mm)	100
	3.50 inches (89 mm)	99
	3.25 inches (82 mm)	96
	3.125 inches (79 mm)	94
	3.00 inches (76 mm)	91
	2.75 inches (70 mm)	85
E = 0.90	3.90 inches (99 mm)	100
	3.50 inches (89 mm)	97
	3.25 inches (82 mm)	93
	3.125 inches (79 mm)	88
	3.00 inches (76 mm)	85
	2.75 inches (70 mm)	78

Size at Recruitment for Maximum Yield at Optimum Effort

The Fox model, used as a base to estimate maximum yield, underestimates MSY because the size limit historically imposed on the fishery is less than that required for maximum yield per recruit. A better estimate of MSY can be obtained by estimating the size for maximum yield per recruit at the optimum effort predicted by the Fox model, then increasing the Fox model estimate by the estimated percentage gain in yield per recruit which would result from changing the size limit from 3.0 inches to the size of maximum yield. That model predicts maximum yield at 39 percent of the present level of fishing effort. If the estimate of fishing mortality, F, is reduced in proportion to fishing effort and the present exploitation ratio (E = 0.80-0.90) is recalculated accordingly, the predicted size at recruitment for maximum yield per recruit varies from 3.4 inches (87 mm) to 3.7 inches (95 mm), and the estimated gain in yield per recruit varies from two to ten percent. For the purposes of estimating maximum sustainable yield, the mean value, six percent, was accepted as the best estimate. The estimate of sustainable yield based on the Fox model and associated add-ons for unreported harvest was increased accordingly.

5.5 Probable Future Condition

Models of population dynamics based on surplus production indicate the spiny lobster is a tolerant species which can withstand considerable exploitation without serious biological consequences. Despite an increase from about 100,000 traps in the late 1960's to about 529,000 traps in 1978, catches in Monroe County have remained relatively constant. Dynamic pool models support this conclusion. Our best estimates of growth, mortality and yield per recruit indicate a flat yield curve with only small deviations in yield per recruit being caused by substantial changes in effort, given that minimum size restrictions are maintained.

Despite the large increase in fishing effort and reduction in spawning potential, there is little or no indication that annual recruitment has been affected. However, a relation between spawning stock and recruitment has been demonstrated in Australia for a similar species in a similarly intensive fishery (see Section 5.2). While no adverse impact has yet been demonstrated, the existance of such a relation indicates that further large decreases in spawning could result in decreased recruitment.

Future yield from the stock seems dependent on effective enforcement of an appropriate size limit to optimize yield from the available recruitment and prevent substantial further declines in spawning. Present enforcement is inadequate to prevent a large harvest of undersize animals. The present average size at recruitment appears to be between 2.6 inches (65 mm) CL and 2.9 inches CL (73 mm), less than the present minimum harvest size. This results in a loss of total yield from the available recruitment. Economic factors affecting the fishery will continue to encourage sale of undersize lobster. If effort (number of traps and number of divers) continues to increase in the future as they have in the past, mortality and injury of juveniles due to fishing practices will increase and decrease yield over the long term. The degree of any such decrease in yield cannot be predicted with presently available data.

Implementation of the FMP is expected to result in more effective enforcement of the size limit, reducing sale of undersize lobster, increasing total yield, and preventing further decline in spawning. If a substitute for use of sublegal lobster as attractants can be developed, losses due to harvest practices can be reduced and yield further increased (Sections 12.2, 12.3, and 12.5).

6.0 DESCRIPTION OF HABITAT OF THE STOCK

6.1 Condition of the Habitat

The spiny lobster occupies three major habitats during its life cycle. Larvae occur in the open ocean in the epipelagic zone of the Caribbean Sea, Gulf of Mexico and Straits of Florida. Postlarvae and juveniles occupy shallow coastal waters of bays, lagoons, and reef flats while the adults generally occur at seaward reefs and rubble areas.

The epipelagic open ocean environment of the Caribbean and Straits of Florida is characterized by relatively constant temperature, salinity and constantly low concentrations of nutrients and phytoplankton. For details of the physics and chemistry see Wust (1924), Corcoran and Alexander (1963), Vargo (1968), Wood (1968), and Capurro and Reid (1970).

The shallow near-shore rocks, grass beds and mangroves are suitable habitats for postlarvae (puerulI) and juveniles. PuerulI are generally cryptic members of the subtidal fouling community on rocks, red mangrove prop roots, pilings, seawalls, and boat bottoms. Juveniles take shelter in sponges, natural holes and crevices (Davis, 1978) and among urchins (Davis, 1971). Generally, as the size increases movement toward deeper water occurs.

The reef habitat of Florida curves south and westward from Miami to Key West and the Dry Tortugas. The length is approximately 325 kilometers. The Florida coral reef tract varies from half a meter below mean low water to a depth of about 25 m. Extensive rocky reef areas are found in depths out to 200 fathoms. Spiny lobster are known to occupy such areas out to at least 100 fathoms (E. Perez, personal communication).

The zonation from shore to Straits includes an urchin-encrusting algae zone, a Porites coral zone, an Acropora coral zone, an Alcyonarian soft coral zone, and a massive Montastraea coral zone (see for example Storr, 1964: 56).

Craig (1974) described the bottom topography and distribution of "reef" along the 40 miles of coastline between Port Everglades and Palm Beach. Much of this consists of rocky ledges and hard bottom instead of true coral reefs. In spite of the non-coralline nature of this habitat, lobster population densities apparently reach 3,000-5,000/mi^2 based on conservative extrapolation of average catch data, but rapid changes are known to occur (Craig, 1974). Localized transitory movements between inshore and offshore reefs are known to fishermen and are statistically evident.

6.2 Habitat Areas of Particular Concern

The open ocean epipelagic zone of the phyllosoma larvae is subject to oil and tar pollution of increasing magnitude. International law concerning bilge water and oil spills and continued educational efforts should minimize this impact.

Research on the culture of phyllosomes has shown that water which is heavily laden with sediment is detrimental to the larvae since the silt settles on them and weighs them down, causing death (Crawford and de Smidt, 1922). Open ocean dumping should therefore be controlled to reduce flocculent materials.

The shallow water mangrove and grass flat nursery areas have been subject to past abuses of development, dredge and fill, sewage discharge, modified fresh-water discharge, brine discharge, thermal discharge, etc. Existing laws protecting emergent and subemergent vegetation from dredge and fill and present water quality laws of the Florida Department of Environmental Regulation, and federal

agencies, Environmental Protection Agency and U.S. Corps of Engineers, offer protection to these environments if they are enforced.

There is a correlation between normal high salinity and the occurrence of P. argus. Austin (1972) suggested lobster phyllosomes cannot tolerate the shallow, nearshore waters of the west Florida estuarine system which were less saline than the offshore loop current in the Gulf of Mexico. As a result of Hurricane Alma in June 1966, and the St. Lucie canal discharge, the salinity of the Indian River estuary dropped to 6 o/oo on the surface and interrupted the normal monthly influx of puerull (Witham, et al., 1968). Discharge of fresh water from the flood control structures was discontinued in September 1966, and monthly recruitment resumed in October (Witham, et al., 1968). Hence an increase of fresh-water discharge into the major lobster nurseries along south Florida could affect recruitment. Point sources of fresh-water discharge near major inlets in southern Biscayne Bay, Florida Bay or between various Keys could, if of sufficient magnitude, hinder recruitment and reduce extent of bay habitat for juveniles.

After puerull settlement and after pigmentation is fully developed, rocky shallow-water habitats with mangroves and sea grass (Thalassia testudinum) beds are the most favored environment and serve as nursery areas for pre-adult populations (Munro, 1974). At the tip of south Florida adjacent to the Keys, turtle grass meadows are a principal vegetation type (Moore, 1963). They are common as well south of the Featherbed Bank in Biscayne Bay and Card Sound (Roessler and Beardsley, 1974), and in Florida Bay (Tabb and Manning, 1961), and throughout shallow areas of the Florida Keys (Turney and Perkins, 1972).

Some experimental replanting of areas devoid of marine sea grasses turtle grass (Thalassia testudinum) and halodule (Halodule wrightii) has been undertaken (Kelly, et al., 1971; Thorhaug, 1974).

The economics of replanting (Thorhaug and Austin, 1976) indicate a very high cost. The need to import seeds without a quarantine period also opens the danger of accidental introduction of diseases, parasites or competitors from insular areas. Without more definite proof that the Thalassia detritus food web produces animals of direct benefit to man, the replanting should not be sponsored by the lobster industry.

P. argus is found on most shelf areas which offer adequate shelter in the form of reefs, rocks, or other forms of cover (Munro, 1974). Artificial reefs and other forms of man-made cover provide shelter from natural predators, but the evidence is inconclusive if the effect is one of concentration or if habitat improvement actually increases the standing stock or reduces natural predation. Chittleborough (1970) has shown that the natural mortality of pre-recruit P. longipes cygnus in Western Australian waters is directly related to the density of the pre-recruit populations, and postulated that the amount of shelter on a given reef might be a limiting factor, leading to high mortality amongst individuals which are unable to find a safe refuge by day. However, in coralline areas it seems unlikely that the amount of shelter offered by a reef would ever be a limiting factor, but this might be important in shelf areas which have a sparse coral cover (Munro, 1974). Davis (1976) created a concrete block shelter in south Biscayne Bay but demonstrated no net increase in the lobster population of the area after seven months, despite recruitment of small (35 mm CL, 1.4 inch) lobsters and migration of 90 mm CL (3.6 inch) subadults. The artificial habitat attracted lobsters in larger numbers from adjacent areas, but the overall population per unit area remained constant (Davis, 1976).

While shelter may not be a limiting factor on juvenile spiny lobsters in south Florida (Davis, 1976), during periods of movement from shallow nursery areas to offshore reefs it probably plays an important role as a refuge from predatory pressure.

Man-induced damage has occurred to reef habitats due to dredging, removal of corals and shellfish, and anchor damage in areas of high boater use, such as John Pennekamp Coral Reef State Park. Stirring of sand or mud at the bottom of a lobster den is sometimes used by recreational fishermen to cause the

lobster to vacate a den (Dunaway, 1974). Silting of the spiny lobster habitat downstream from a sewage outfall construction (dredging) seemed to reduce commercial catches with a definite downplume avoidance of the reef habitat by lobsters (Craig, 1974). It is generally thought that the reef tract in the Florida Keys is healthy (stable), though present research is concerned with both natural and man-induced disturbances affecting the total coral reef habitat.

Both dredge and fill and sewage outfall programs are regulated by state (Department of Environmental Regulation) and federal (EPA/Corps of Engineers) permits with public hearings. Adequate consideration of lobster stocks can be assured by active participation by the Gulf of Mexico and South Atlantic Fishery Management Councils.

6.3 Habitat Protection Programs

Mangrove islands, tidal passes, and surrounding shallow water habitats of southern Dade County are protected in Biscayne National Monument. The first 30 miles of coral reefs from Key Largo south are preserved as the John Pennekamp Coral Reef State Park and the Key Largo Coral Reef Marine Sanctuary. Further south, a five square mile coral reef off Big Pine Key will be protected under proposed regulations as the Looe Key Coral Reef National Marine Sanctuary. The Marquesas Keys are a National Wildlife Refuge, while the Dry Tortugas are preserved as a National Monument. In addition, the Everglades National Park preserves a large portion of the mangrove habitat of the state, vast acreages of shallow grass beds and in its southern reaches, protects some lobster habitat.

Section 7 of Article II of the Florida Constitution provides that it shall be the policy of the State to conserve and protect its natural resources and scenic beauty. The Florida code (Ch. 17-4.28 and 4.29) regulates dredge and fill activities, (Ch. 7-4.02) protects submerged lands, (Ch. 17-3, Fla. Admin. Code) provides water quality standards and (Ch. 161 F.S.) protects beaches and shorelines. In addition, the Randall Act (Ch. 253 F.S.) prevents the sale of state-owned lands, except after conservation considerations are met. This Act stopped sale of state-owned submerged lands. By definition, submerged lands in Florida are those lands covered by the categories of water listed in Section 17-4.28(2), Fla. Admin. Code, and having plant dominance as therein listed. Some of the dominant plants are mangroves (black, red and white), as well as the major marine grasses (halodule, manatee, and turtle grass).

In addition Florida has established special use areas, including Aquatic Preserve System, State Wilderness System, the Environmentally Endangered Lands Program, the state park system, and wildlife refuges, with special protection for wildlife and a special Outstanding Florida Waters (OFW) designation.

Other programs, including the Land and Water Management Act of 1972, established special concern for "Areas of Critical State Concern" including the Florida Keys and "Developments of Regional Impact" which may need special regional environmental regulation.

The Federal Coastal Zone Management Act of 1972 (amended and given new authority in 1975) also encouraged Florida to set up programs "to preserve, protect, develop, and where possible, to restore or enhance the resources of the nations coastal zone for this and succeeding generations." Florida is currently developing its Coastal Management Program which will address environmental, economic, and institutional programs within a general resource management framework.

7.0 FISHERY MANAGEMENT JURISDICTION, LAWS, AND POLICIES

Currently the institutions involved in the management of spiny lobster stocks in U.S. waters include the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils, the State of Florida, and the National Park Service. In Florida, the Department of Natural Resources has management authority over marine resources, but the state legislature is also involved in establishing regulations. For example, the legislature has passed statutes containing detailed management regulations for a number of species of fish and shellfish including spiny lobster P. argus. Although the seaward boundaries of Everglades National Park lie within the limits of the state territorial sea, the marine waters within the park are under federal jurisdiction. A large portion of Florida Bay, a major nursery for spiny lobster, is within the park boundary.

Exhibit 7-1 shows the amount of commercial catch of spiny lobsters landed in the South Atlantic and Gulf of Mexico by distance caught off U.S. shores. As can be seen from the exhibit, the lobsters are caught predominantly between three and 200 miles from shore in the waters of the FCZ. (In the Gulf of Mexico, Florida's state jurisdiction extends for nine miles. However, few lobsters are caught between three and nine miles from shore in the Gulf of Mexico because of the Everglades National Park presence and its commercial trapping prohibition. Therefore, the landings shown as 3-200 miles from shore are primarily from the FCZ.) Landings taken off foreign shores have been predominantly from Bahamian waters, despite the closing of the fishery to foreign fishermen by the Bahamian government.

The FCMA requires that stocks be managed throughout their range to the extent practicable. There may be a relationship between the spiny lobster stocks of the Caribbean and the South Atlantic and Gulf regions. Some biologists have theorized that larvae migrate from the Caribbean to South Florida where they mature. However, this link has not been substantiated through biological research (see Section 5.1.4). A separate fishery management plan for spiny lobster has been prepared by the Caribbean Fishery Management Council.

Exhibit 7-1

Commercial Spiny Lobster Landings in the South Atlantic and Gulf of Mexico
by Distance Caught off U.S. Shores (1977-1979)
(1000 pounds)

Year	0-3 Miles		3-200 Miles		International Catch		Total	
	lbs	Percent	lbs	Percent	lbs	Percent	lbs	Percent
1977	1,279	23.3	3,079	56.2	1,125	20.5	5,483	100.0
1978	809	17.5	3,134	67.7	686	14.8	4,629	100.0
1979	1,320	20.9	4,291	68.1	690	10.9	6,301	100.0
3-Year Average	1,136	20.6	3,501	64.0	834	15.4	5,471	100.0

Source: Fisheries of the United States, 1977-79, National Marine Fisheries Service, NOAA, Current Fisheries Statistics 7500, 7800, 8000.

7.1 Management Institutions

Florida is the only state that is involved in a major management effort for spiny lobster in the South Atlantic and Gulf of Mexico. In Florida, the Department of Natural Resources and its Division of Marine Resources are responsible for the preservation, management, and protection of marine fisheries. In meeting its responsibilities the division (through the department) makes recommendations to the legislature, administers management programs, and conducts biological research related to marine fisheries. In addition, the division has the authority to regulate the operations of all fishermen and vessels engaged in taking state fishery resources. Any rules or regulations designed by the Division of Marine Resources and approved by the Department of Natural Resources must also be approved by the governor and his cabinet. Any such rules and regulations must be consistent with existing statutes.

In practice, the Florida legislature is the primary rule setting authority. It has adopted conservation statutes that include special provisions for the management of shrimp, spiny lobster, and oysters. Specific statutory provision have also been enacted for stone crab, blue crab, and shad. In addition to laws passed by the legislature for statewide application, the legislature also passes special laws directed at local areas, usually counties that regulate fishing practices in the designated area.

Everglades National Park is part of the National Park System. It is administered by the National Park Service in the U.S. Department of Interior. The Director of the National Park Service has responsibility for the supervision, management and control of the parks. Through the Secretary of the Interior, the director has authority to develop regulations for management of the parks including the control of fishing activities. All federal regulations developed must be published in the Federal Register. All regulations adopted are contained in Title 36 of the Code of Federal Regulations. With respect to fishing in national parks, unless the federal regulations further restrict fishing activity, fishing laws and regulations of the state are applied. For example, federal regulations for Everglades National Park do not prescribe a closed season for spiny lobster, thus the Florida law for the closed season is enforced. (Federal statutes do however restrict lobstering in the park to recreational fishermen only.)

Through the Secretary of Commerce, the Assistant Administrator for Coastal Zone Management has the authority to develop regulations for the management of marine sanctuaries, including the control of fishing activities. The Assistant Administrator also designs nonregulatory research, education, interpretive and recreational programs. In southern Florida there are two national marine sanctuaries: Key Largo Coral Reef National Marine Sanctuary off Key Largo, Florida, and the proposed Looe Key Coral Reef National Marine Sanctuary off Big Pine Key, Florida.

7.2 International Treaties and Agreements

Foreign fishing is prohibited within the fishery conservation zone or for anadromous species or Continental Shelf fishery resources beyond the fishery conservation zone to the limit of U.S. jurisdiction under the Convention of the Continental Shelf unless (1) it is authorized by an international fishery agreement which existed prior to passage of the FCMA and is still in force and effect or (2) it is authorized by a Governing International Fishery Agreement (GIFA) which has been issued subsequent to the FCMA. There are no pre-FCMA agreements affecting the management unit.

Governing International Fishery Agreements resulting from the FCMA are general bilateral agreements in which participants agree to abide by the fishing laws, and regulations of the other nation when fishing in the other nations' waters. A GIFA is required before a nation can apply for fishing rights pertaining to a particular fishery. There are currently twelve nations that have entered into GIFA's with the United States. Cuba and Mexico are the only foreign countries adjacent to the southeastern

United States that have entered into GIFA's with the United States. If any of these countries wishes to obtain fishing rights for a specific fishery, such as spiny lobster, an application must be submitted to the Secretary of State. No permits can be issued unless a "surplus" (i.e., an amount which will not be harvested by U.S. vessels that is less than the optimum yield) of that fishery exists. No applications for fishing permits have been made for fishing rights applying to the spiny lobster fishery.

Like the United States, the Bahamas, Mexico and Cuba have established economic or conservation zones and have excluded foreign fishermen from fishing local stocks. While Mexico and Cuba have each signed a GIFA with the United States, the Bahamian government as yet has declined to do so. Many U.S. vessels fished for spiny lobster in Bahamian waters before the fishery was closed to foreign exploitation.

7.3 Federal Laws, Regulations, and Policies

The FCMA, under which this plan is being prepared, is the primary federal law that directly affects the management of the spiny lobster fishery in the South Atlantic and Gulf of Mexico. There are several other federal laws and regulations that have some direct or indirect impacts on the fishery. These include the:

- Federal Regulations for Everglades National Park, [36 C.F.R. Sec. 7.45(1978)]
- The Coastal Zone Management Act of 1972 [16 U.S.C. 1456 et seq.].
- Marine Protection, Research and Sanctuaries Act of 1972 [16 U.S.C. 1451 et seq.].
- Endangered Species Act of 1973 [16 U.S.C. 1531 et seq.].
- Lacey Act [18 U.S.C. 43].

The boundaries of Everglades National Park extend into waters of the territorial sea. While the park is located in Florida, it is under the jurisdiction of the federal government. In most of the marine waters of the park, including Florida Bay, exclusive federal jurisdiction is in force, although state fishing laws have been assimilated within the federal regulations. Only the federal enforcement personnel are authorized in this area. In the northwest extension of the park concurrent jurisdiction is in force and both state and federal enforcement officers have authority. The fishing regulations in the park prohibit commercial fishing for spiny lobster. Lobsters may be taken only by hand or with bully nets for personal use. Lobster fishing is also restricted in the Marquesas National Wildlife Refuge and Ft. Jefferson National Monument, Dry Tortugas [36 C.F.R. Sec. 17.27]. All other state laws apply [36 C.F.R. Sec. 7.45(g) (1978)]. For example, during the regular open season no more than 24 lobsters per boat may be taken within a 24-hour period for recreational fishermen. In the special two-day recreational fishing season for spiny lobster, no more than six lobsters per day may be taken on the first day nor more than 12 lobsters during the two-day period.

The Coastal Zone Management Act places responsibility for comprehensive land and water management of the coastal zone upon the coastal states. The Act also requires that federal actions directly affecting the coastal zone of a state be consistent (to the maximum extent possible) with the approved state plans (Coastal Zone Management Act of 1972, [16 U.S.C. Sec. 1456 (1974)].[1]

Florida's coastal zone program is the only such program in the South Atlantic and Gulf of Mexico that is appropriate to the spiny lobster fishery. It is still in the planning stages. The Florida Coastal

---

[1] Plans must meet the approval of the Secretary of Commerce.

Zone Management Act of 1978 authorizes the State Department of Environmental Regulation to develop a program to manage the coastal zone using only existing statutes and regulations. Furthermore, the Act states that both land and water policies should be implemented by local governments to the maximum extent possible.

The Florida Department of Environmental Regulation developed a program document describing the basic policies and proposed process for program implementation. Although the document is being revised in accordance with the newly adopted act, the basic policy pertaining to resource utilization is likely to remain the same. It states that:

> "Consistent with state and national interests it is the policy of Florida to maintain long-term benefits of the coastal zone by giving priority to proper management and protection of renewable resources, benefits and uses of coastal waters, such as production of fish and ... recreation and aesthetic enjoyment over the development of nonrenewable resources."[1]

The Florida Coastal Zone Management Program also proposes to maintain the optimal sustainable yield of its fishery resources while protecting the coastal ecosystem. Both of these policy statements are consistent with the goals and objectives established by the councils for the spiny lobster management plan.

The impact of the coastal zone program on the habitat of spiny lobster in territorial waters will most likely be positive. The program is being designed to protect against degradation of the coastal habitat, while allowing for exploitation of the fishery resources. Thus, productivity of the resource would be maintained. At the same time the program may limit development of onshore facilities that may adversely impact the coastal zone. The growth of facilities for landing or processing fishery products might also be affected. Because the coastal zone program is still in its formative stages, it is not possible to determine its specific effects on the fishery.

Although the Endangered Species Act of 1973 and the Marine Protection, Research and Sanctuaries Act of 1972 do not have a major impact on the spiny lobster fishery, there are several provisions that are worthy of note.

The Endangered Species Act makes it a crime to harm or kill any animal designated as endangered [16 U.S.C. Sec. 668dd(c) (1974)]. Several species of sea turtles that inhabit the geographical area of the spiny lobster fishery have been placed on the endangered list. These include:

- Green turtle (Chelonia mydas)
- Leatherback turtle (Dermochelys coriacea)
- Atlantic Ridley turtle (Lepidochelys kempii)
- Hawksbill turtle (Eretmochelys imbricata)

Under existing regulations the direct or incidental taking of these species is prohibited during commercial fishing operations [50 C.F.R. Sec. 228.71 (1978)]. These turtles do not prey on spiny lobster and are no problem to spiny lobster fishermen. There is no incidental harvest or mortality to these species which results from this fishery.

---

[1] Draft EIS Coastal Zone Management Program, Florida Department of Environmental Regulation, 1978.

Under the Endangered Species Act, the loggerhead turtle (Caretta caretta) which also inhabits southern Florida waters has been placed on the threatened species list. These turtles are carnivorous and do prey on spiny lobsters, often causing considerable loss to commercial fishermen because they damage the lobster traps.

The loss in yield of lobster was estimated to average eight percent of total revenue and 19 percent of net revenue (Higman and Davis, 1978). Some fishermen armor their traps with wire mesh to reduce this type of damage. Expenses for wire can approach $1,000 per year (Higman and Davis, 1978).

The fishery has little direct impact on the loggerhead turtle. An insignificant mortality results when turtles become entangled in the trap or buoy line. This is a rare event (J. C. Davis, personal communication).

Under the Marine Protection, Research and Sanctuaries Act, the Secretary of Commerce may designate marine sanctuaries in ocean waters [16 U.S.C. Sec. 1432(g)(1974)]. Such a sanctuary off of Key Largo has been established and is administered by the federal Office of Coastal Zone Management [15 C.F.R. Sec. 929 (1978)]. It extends an existing state coral reef sanctuary bounded at the three-mile limit another five miles into the FCZ. Hook and line fishing and trap fishing are allowable. Lobster harvest by other means is prohibited. Looe Key is another sanctuary. Regulations now include prohibition of lobster harvest in the fore reef of the area.

The Lacey Act prohibits the possession, sale, delivery, or transportation of wildlife (including spiny lobster) taken in violation of State, national or foreign laws. Florida is the only state with regulations affecting the fishing for spiny lobster. Therefore, in the absence of a FMP, violations of the Lacey Act would be prosecuted only if the spiny lobster were illegally taken in Florida state waters. Even with the Lacey Act, management of spiny lobster in the FCZ would be lacking in the absence of a FMP and with the limited authority and enforcement by the State of Florida.

7.4 State Laws, Regulations and Policies

The State of Florida manages its spiny lobster fishery through detailed regulations contained in the state's statutes. The intent of the spiny lobster[1] regulations are to:

> "Maintain the crawfish industry for the economy of the state and to conserve the stocks supplying this industry... insuring and maintaining the highest possible production of saltwater crawfish" [Fla. Stat. 370.14(1)].

To this end, the Florida Department of Natural Resources (FDNR) is enforcing regulations that include provisions for licensing, gear restrictions, size and reproductive condition restrictions, closed seasons, and reporting of sales and activities. Each of these is discussed below. The brief discussion of Florida's jurisdiction in ocean waters is also presented.

Licenses

Licenses are required for commercial spiny lobster fishermen, for aliens and nonresident commercial fishermen, and for wholesale and retail fish dealers. Applications for licenses have to be filed annually. In addition, special permits are required to import spiny lobster during the closed season.

---

[1] The Florida regulations use the term "crawfish" in reference to spiny lobster, P. argus.

Owners of spiny lobster traps, cans, drums, or similar devices are required to have a valid crawfish license (annual fee $50) [Fla. Stat. 370.14(3)(b)]. This license number must be attached to the fishing gear and buoy and also must be prominently displayed above the topmost portion of the boat. Each boat can be issued only one license number [Fla. Stat. 370.14(3)(c)]. During the open season, it is unlawful for either a fisherman or a number of fishermen on any boat to possess in state waters or to remove from state waters more than 24 crawfish in a 24-hour period without a valid crawfish license [Fla. Stat. 370.14 (3)(g)]. It is unlawful for a fisherman to sell spiny lobster without a valid crawfish license, or for a licensed wholesale dealer to buy from anyone other than a holder of a valid crawfish license [Fla. Stat. 370.14(3)(b)].

There is a separate and additional licensing requirement for all alien and nonresident commercial fishermen. They must purchase a license annually (fee $25) before engaging in harvesting any saltwater fish from state waters, including fish or seafood sold for bait, for other than personal use. This requirement does not apply to employees or crew who take but do not sell saltwater products [Fla. Stat. 370.06(2)].

Wholesale and retail seafood dealers are also required to obtain licenses annually in the State of Florida. Any person, firm or corporation which sells saltwater products to another person, firm, or corporation except to the consumer is considered a wholesale dealer. A retail dealer is defined as any person, firm or corporation selling seafood directly to consumers. No retail license is required of those who sell only salted, cured, canned or smoked seafood. A dealer involved in both wholesale and retail trade must obtain both types of licenses [Fla. Stat. 370.07].

In addition to these seafood dealer licenses, a dealer must obtain a special permit in order to lawfully import, process, or package spiny lobsters or uncooked spiny lobster tails during Florida's closed sea son. There are stringent regulations regarding such importation. First, any lobsters imported during the closed season cannot be sold in the state. Second, the seafood dealer importing spiny lobster under special permit must notify the Florida Department of Natural Resources Division of Law Enforcement as to name of the vessel or airplane, its captain, and point of destination delivering the lobster. Notice must be given twelve hours before the vessel or airplane enters the state. Third, when the imported spiny lobster is delivered to the permit holder's place of business, it is to be weighed in the presence of a marine patrol officer. The dealer must then provide the officer with a receipt showing the quantity in pounds of spiny lobster. Fourth, within 48 hours from the time the receipt is given to the marine patrol officer, the permit holder must submit a sworn report as to the quantity of spiny lobster received which states that all lobsters were taken at least 50 miles from Florida's shoreline. Any vessel or airplane that is not a common carrier must also obtain a special permit in order to lawfully transport spiny lobster for purchase during Florida's closed season [Fla. Stat. 370.14(4)(a)].

Gear Restrictions

Florida regulations make it illegal to possess at any time, fish with, set, or place any trap other than:

- Wood slat traps and traps having biodegradable tops or throats; or
- Ice cans, drums, and similar devices providing that no trapping device has grains, spears, barbs, or hooks.

The sides of a trap may be reinforced with 16 gauge, 1-inch poultry wire to protect them from turtles, but the top and bottom cannot be protected [Fla. Stat. 370.14(3)]. Each trap must have a buoy attached to it. Buoys at both ends of a string of traps must be used if a trotline is utilized. Timed float release mechanisms may be used if desired. The buoy must be of such color, hue, and

brilliancy that it can be easily distinguished. The boat used for setting the traps must also display the color of the buoys in a manner such that it is readily identifiable from the air and water. Additionally, each buoy and trap must have a permanently attached license number [Fla. Stat. 370.14(3)(b)].

There is also a special act pertaining to spiny lobster gear in Monroe County. It requires that wooden traps be used for taking crawfish from salt waters of Monroe County but allows each commercial fishing boat to use one wire trap of size five feet by two feet by two feet [Fla. Special Acts of 1953, Chapter 29299].

Restrictions on Size and Condition of Spiny Lobsters

In protecting the spawning stock of spiny lobster, Florida has adopted the following regulations:

- No person, firm or corporation may lawfully take or have in his possession at any time a spiny lobster (Panulirus argus) unless the carapace length is more than three inches or tail measurement not less than five and a half inches (not including any protruding muscle tissue), regardless of where the lobster was taken[1] [Fla. Stat.370.14(2)(a)].

- Spiny lobster must remain whole while on or below water of the state. The carapace must not be separated from the tail until the lobster is landed, except by special permit [Fla. Stat. 370.14(2)(b)].

- No egg-bearing females may be taken at any time. They must be returned to the water immediately, free, alive and unharmed [Fla. Stat. 370.14(2)(c)].

- The stripping or molesting of egg-bearing females is prohibited. Furthermore, the possession of spiny lobster from which eggs, swimmerettes or pleopods have been removed is prohibited unless the products are imported, cleared through U.S. Customs and accompanied by an invoice [Fla. Stat. 370.14(2)(d)].

Restrictions on Seasons and Fishing Time

Florida has adopted restrictions on harvesting seasons for both commercial and recreational fishermen. Except for a two-day "Sports Fishermen's Crawfish Season" on July 20 and 21 of each year, the state prohibits the taking or possession of spiny lobster regardless of where taken between April 1 and July 25 [Fla. Stat. 370.14(4)].[2] During this two-day recreational season, no person may possess more than six spiny lobsters on July 20 nor more than 12 lobsters for the two-day period [Fla. Stat. 370.14(6)].

With respect to the commercial harvesting season, traps may be placed in the water and baited five calendar days before the opening of the spiny lobster season. Traps must be removed within five days

---

1 Measurement of the carapace is from the anterior most edge of the groove between the horns directly above the eyes to rear edge of the top of the carapace. The tail is measured length-wise along the center to the rear most extremity with the tip of the tail closed.

2 This does not make it illegal to possess reported inventory stocks of spiny lobster.

after the close of the season. Traps may be worked during daylight hours only. The pulling of traps from one hour after official sunset until one hour before official sunrise is prohibited [Fla. Stat. 370.14(3)(a)].

Reporting Requirements

Within three days following the close of the spiny lobster season, each wholesale and retail dealer must submit to the Division of Marine Resources a report detailing the quantity (in pounds) in total and by type (e.g., frozen whole, frozen tails, etc.) that the dealer has in his possession. The report must also state the location of the inventory stock. The dealers may sell this spiny lobster throughout the closed season, but on the first and fifteenth day of each month throughout the duration of the closed season, each dealer must report the number of pounds sold and number of pounds remaining on hand [Fla. Stat. 370.141].

Territorial Waters in Florida

For most coastal states the boundary of the territorial sea is three miles from shore. In Florida, however, the situation is somewhat different. Florida's jurisdiction in the Gulf of Mexico extends to three marine leagues (approximately nine nautical miles) from shore. On the Atlantic side the state's authority extends three nautical miles into the ocean. An agreement was recently signed between the State of Florida and the United States concerning the enforcement of FCMA provisions with respect to foreign fishing in the Gulf of Mexico. According to the agreement, only federal fishery laws will be applied to foreign fishing between three and nine miles off the coast of Florida. Also, state personnel are authorized to enforce federal laws within that geographical area.

There is another Florida law concerning jurisdictional issues which is worthy of noting. Florida, in the absence of federal law, has claimed jurisdiction over the "operations of all fishermen and vessels of this state engaged in the taking of such fishery resources within or without the boundaries of state waters" [Fla. Stat. 370.02 (1)(g)]. Such extended state jurisdiction has been upheld in the courts (Skioriotes -v- Florida, 313 U.S. 69:1941) prior to the federal government's initiation of a management program under the FCMA. However, recent litigation (see Measure W, Section 12.3.2) and budgetary constraints have limited Florida's ability or desire to manage marine resources beyond its territorial sea. The state is authorized under the FCMA to continue regulation of vessels registered in the state until federal regulations implementing an FMP and conflicting with state regulations are implemented.

7.5 Local and Other Applicable Laws, Regulations and Policies

There are no laws passed by local jurisdictions that directly affect the management unit. The power to regulate the taking or possession of saltwater fish as defined in Florida law is expressly reserved by the state [Fla. Stat. 370.102].

According to officials of the Trust Responsibilities and Fishing and Hunting Rights Divisions of the Bureau of Indian Affairs, U.S. Department of Interior, there are no treaties that grant Indians rights to fishery resources of the ocean in the South Atlantic and Gulf of Mexico regions.

Cuban-American fishermen receiving aid in the form of low interest long term loans for vessel conversions and mortgages after being prohibited from fishing in the Bahamas in 1976, agreed not to fish for lobster in Florida as a condition for the loan. This loan was administered by the U.S. Department of Commerce (Economic Development Administration) through the Florida Department of Commerce. Approximately 74 persons and boats are involved in this program.

8.0 DESCRIPTION OF FISHING ACTIVITIES AFFECTING THE STOCK COMPRISING THE MANAGEMENT UNIT

8.1 History of Exploitation

The range of the spiny lobster in the management unit extends from the Florida Keys northward along the east and west coasts of Florida. Commercial and recreational harvest of spiny lobster from U.S. waters is almost exclusively limited to waters off southern Florida. The commercial fishery for the species is quite important, representing the primary target species of lobster boat fleets located in the Miami area and along the Florida Keys. The spiny lobster fishery has in recent years developed into the second most valuable commercial fishery in Florida, behind only the shrimp fishery. In addition, in the past few years recreational diving for spiny lobster has become a popular pastime among Florida residents and visitors, partially due to the widespread popularity of skin diving. There is no known participation by foreign registered vessels in the management unit fishery in the waters of the FCZ.

Commercial spiny lobster catch is recorded in significant quantities in the earliest available statistics. Exhibit 8-1 shows commercial Florida landings, from both domestic and foreign waters, from 1930 through 1979. Between 1930 and the mid-1940's, catch remained relatively stable, ranging between about 300,000 and 450,000 pounds annually. Initially this harvest was mostly consumed locally, due to the high perishability of lobster meat, but Schroeder (1924) reported of the 1919 catch (375,000 pounds) that "40 percent were shipped, 40 percent consumed locally and 20 percent used as bait to catch fish." Large-scale freezing operations and distribution networks began to develop in the early 1950's leading to a considerable increase in the commercial exploitation of the species. Total Florida landings increased spectacularly beginning in the mid-1960's, peaking at 11,417,000 pounds in 1972. Since this peak, landings have dropped considerably to about 5 million pounds annually. Much of this growth in the 1960's was the result of U.S. fishermen extending efforts into foreign waters. The recent decline in landings has been primarily due to the closure of some foreign fishing grounds to the United States. The Florida landings from domestic waters during 1964 to 1979 have averaged about 4.4 million pounds.

Florida's lobster management programs have had a long and varied history, with the first laws specific to the spiny lobster enacted in 1919 legislation. In the period 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. Major 1965 legislation specified regulations on gear, and perhaps more important, placed emphasis on the need for effective policing policies through the use of marking by permit number and identification of gear and boats for surveillance.

The 1919 Act, the first dealing with spiny lobster fishing in Florida, established a three month closed season from March 1st to June 1st(1).[1] Excluded from the closed season were spiny lobsters taken for bait purposes. In 1921 the closed season was changed to the period from March 21st to June 21st(2) and in 1929 it was extended to a four month period from March 21st to July 21st(3). The closed season was set between April 15th and August 15th in 1953(4) and then changed to the period from March 31st to August 1st in 1955(5). The closed season is currently from April 1 to July 25th. The 1965 Act provided for a five-day period before and after the season for placing and removing traps (6).

---

[1] Figures in parentheses refer to the following legal citations (Florida Session Law): (1) 1919, Ch. 7909; (2) 1921, Ch. 8591; (3) 1929, Ch. 13618; (4) 1953, Ch. 28145; (5) 1955, Ch. 29896; (6) 1965, Ch. 65-53; (7) 1929, Ch. 13618; (8) 1953, Ch. 28145; (9) 1965, Ch. 65-53; Ch. 65-251; (10) 1969, Ch. 69-228.

Exhibit 8-1

Historial Florida Spiny Lobster Commercial Landings (1,000 pounds whole weight)

Year	Florida[1] West Coast	Florida[2] East Coast	Florida[2] Total
1930	180	108	288
1931	152	304	456
1932	98	347	456
1934	168	183	351
1936	116	211	327
1937	68	225	292
1938	63	265	328
1939	125	234	359
1940	208	256	464
1945	205	572	777
1949	1,482	NA	NA
1950	628	932	1,560
1951	1,077	2,020	3,097
1952	957	656	1,612
1953	874	1,121	1,995
1954	724	1,223	1,947
1955	1,216	1,079	2,295
1956	2,314	799	3,113
1957	3,388	651	4,039
1958	2,332	623	2,955
1959	2,637	543	3,180
1960	2,129	719	2,848
1961	2,101	702	2,803
1962	2,435	672	3,107
1963	2,771	815	3,586
1964	2,845	786	3,531
1965	4,385	1,329	5,714
1966	3,664	1,686	5,350
1967	2,737	1,677	4,414
1968	3,921	2,234	6,155
1969	4,653	2,929	7,582
1970	6,852	3,018	9,870
1971	4,788	3,418	8,206
1972	5,149	6,268	11,417
1973	5,550	5,622	11,172
1974	6,735	4,147	10,882
1975	5,086	2,319	7,405
1976	4,358	987	5,345
1977	4,843	1,651	6,494
1978	4,711	891	5,602
1979	5,141	821	5,962

Note: Florida west coast includes Monroe County and counties to the north while Florida east coast includes Dade County and counties to the north.

1 Includes some landings from foreign waters and offshore areas of the FCZ.

2 Includes substantial amounts taken in foreign waters from 1964 to 1979.

Source: NMFS.

In 1929 the first size restriction was enacted, the minimum being one pound (7). In 1953 the minimum was redefined to be a spiny lobster with a tail measuring six inches (8). The 1965 Act redefined the minimum size by tail and carapace measurement, with a minimum carapace measurement of three inches and tail measurement of five and one half inches (9). Methods of measurement were also given. Finally, the 1969 act allowed a six-inch minimum on tails separated under special permit (10). Lobster permits were required beginning in the 1954-55 season. Fishermen were also required to list the number of traps in use. In 1971 this trap information was no longer required and a $50 fee for licenses was initiated (Joyce, 1974).

In Florida, commercial fishing is presently done with lobster traps and by divers who catch lobsters by hand. In the early days of the fishery a sizable portion of the catch was taken using throw nets, and as recently as ten years ago ice cans and drums were occasionally used. There have been few major changes in boats or gear in the last several decades. The average boat size has gradually increased and the number of traps per boat has increased as well. Construction of new boats has shifted from predominantly wood to predominantly fiberglass. The traditional wood slat traps continue to be the predominant type of trap employed.

Until recent years, Florida commercial fishermen extended and increased their activities in foreign waters. Fishing activity has been reported primarily in the Bahamas, Honduras and other locations in the Caribbean. The extent to which U.S. fishermen are involved in foreign spiny lobster fisheries is in some cases controversial, and this foreign activity is difficult to substantiate and quantify in light of extended jurisdiction by these countries.

Recreational catch is taken primarily by divers who capture the lobsters by hand. The predominant method is free diving. SCUBA equipment and hookah rigs are also used. Some spiny lobster are taken on shallow flats by recreational fishermen using bully nets, but this represents a small portion of the total recreational catch. (A typical bully net has an 18 inch diameter loop with a mesh bag 20 inches deep using one and a quarter inch mesh and fastened at a right angle to a long pole. Bully nets are frequently used at night with lights to see the spiny lobster.) The use of spears, hooks, and other devices that would puncture or otherwise damage the lobster is not allowed in Florida. Recreational catch has apparently increased sharply during the last several decades but there are no statistics available to quantify this increase. Improvements in recreational gear, such as the popularization of SCUBA equipment and the development of specialized small pleasure boats, have made access to the fishery more available to many people than in the past.

8.2 Domestic Commercial and Recreational Fishing Activities

Spiny lobster is primarily a commercial species within the Gulf and South Atlantic although it does have recreational importance. The high value of spiny lobster gives the fishery major economic importance in southern Florida, where it supports a considerable amount of fishing and fishing related activity. The species is also a primary target for recreational divers, particularly at the beginning of the regular spiny lobster season for all users, and draws vacationers to the Florida Keys during the special two-day recreational season on July 20-21.

While the lobsters taken by recreational divers are for consumption, there is no subsistence fishing for spiny lobster. There are currently no treaties granting special Indian fishing rights for the species in Florida. However, a condition for fishermen participating in the spiny lobster economic adjustment program was an agreement not to fish for lobster in Florida.

8.2.1 Participating User Groups

8.2.1.1 Commercial User Groups

Spiny lobster is the primary target species for lobster boat fleets located in the Miami area and in ports along the Florida Keys. The species is also an important target for gill-net boats that participate in both the king and Spanish mackerel and the spiny lobster fisheries. Exhibit 8-2 shows the proportion of revenue from various species received by fishermen who fish for spiny lobster. Boats under 36 feet in length are active in the spiny lobster fishery for virtually the entire open season and derive an average of between 60 and 94 percent of gross revenues from lobster depending on boat length. Intermediate size boats (24-28 feet) have the greatest dependence on revenues from spiny lobster fishing. Large boats (greater than 40 feet) generally rely on both mackerel and spiny lobster as important target species since the fishing season in the two fisheries are complementary. The time spent in the lobster fishery is less for these larger boats than for smaller boats and over half the gross returns of the larger boats come from finfish.

Commercial divers have recently accounted for one to two percent of total commercial harvest (Section 8.2.4.1). Participants are apt to be part-time fishermen who view their activity both as a source of enjoyment and supplemental income. In the 1977-78 season there were 143 commercial licenses granted to spiny lobster divers. Spiny lobsters are also taken by the shrimp fleet using otter trawls. The amount is generally quite small, ranging from 40 to 80 thousand pounds annually. Landings represent both incidental catch throughout the season and a directed fishery during occasional periods when lobsters are found in high abundance in localized areas. (This high abundance may be related to lobster migratory patterns.) In the 1977-78 season, 44 boats in the shrimp fleet obtained Florida commercial lobster licenses, allowing them to market spiny lobster catches.

Exhibit 8-2

Participation by Boat-Size Class[1]

Boat Size (feet)	Percent of Gross Revenues			Weeks in the Spiny Lobster Fishery[2]
	Spiny Lobster	Crab	Finfish	
16-22	79	17	4	35
24-28	94	4	2	36
31-36	60	31	9	33
40-55	42	0	58	25

[1] Based on a survey of 25 lobster fishermen conducted subsequent to the 1973-74 season.

[2] Due to the closed season April 1 to July 25, 36 weeks represents the maximum length of time that fishing can take place.

Source: Prochaska and Williams, 1976.

The primary commercial user groups for the species are described below.

Miami Lobster Boat Fleet

The most recent NMFS data report 192 boats in east Florida were active in the spiny lobster fishery in 1975, down from a peak of 285 in 1973, (see Exhibit 8-3). Traditional fishing areas have been the Florida east coast and the Bahamas. However, there have been major changes affecting the fishermen in the Miami lobster boat fleet in recent years. At the beginning of the 1975-76 season, the Bahamian government declared spiny lobster a creature of the continental shelf (after the example set by the United States concerning Homarus americanus) and prohibited foreign lobster fishing. This ban caused widespread disruption as fishermen attempted to find other places for their traps. The effect of the ban has apparently led to additional fishing effort not only on the Florida east coast but along the upper Keys as well. At the beginning of the 1978-79 season there were a number of U.S.-based boats still fishing in Bahamian waters. There have been periodic seizures of foreign boats fishing in the Bahamas, with one of the largest occurring in August 1978 when twelve U.S. based lobster boats were seized by the Bahamian government. Periodic seizures have continued through the 1978-1979 season.

Florida Keys Lobster Boat Fleet

Spiny lobster fishermen in the Florida Keys are distributed among a number of the major ports such as Marathon, Key West and Islamorada, on Key Largo. NMFS reports 631 lobster boats active on the Florida west coast during 1975, a considerable increase from the 386 boats in 1973. This increase is likely the combination of boats moving from the Miami area due to increased fishing pressure on the Florida east coast plus new boats entering the fishery due to the high prices being paid for lobster.

King and Spanish Mackerel Gill-net Fleet

Large (greater than 40 feet) mackerel gill-net boats that participate in the spiny lobster fishery are already included in the NMFS statistics showing lobster boats in east and west Florida (Exhibit 8-3). There are an estimated 60 large boats in the Florida Keys in the king and Spanish mackerel fisheries (Austin, et al., 1978) and many of these boats are involved in the spiny lobster fishery.

8.2.1.2 Recreational User Groups

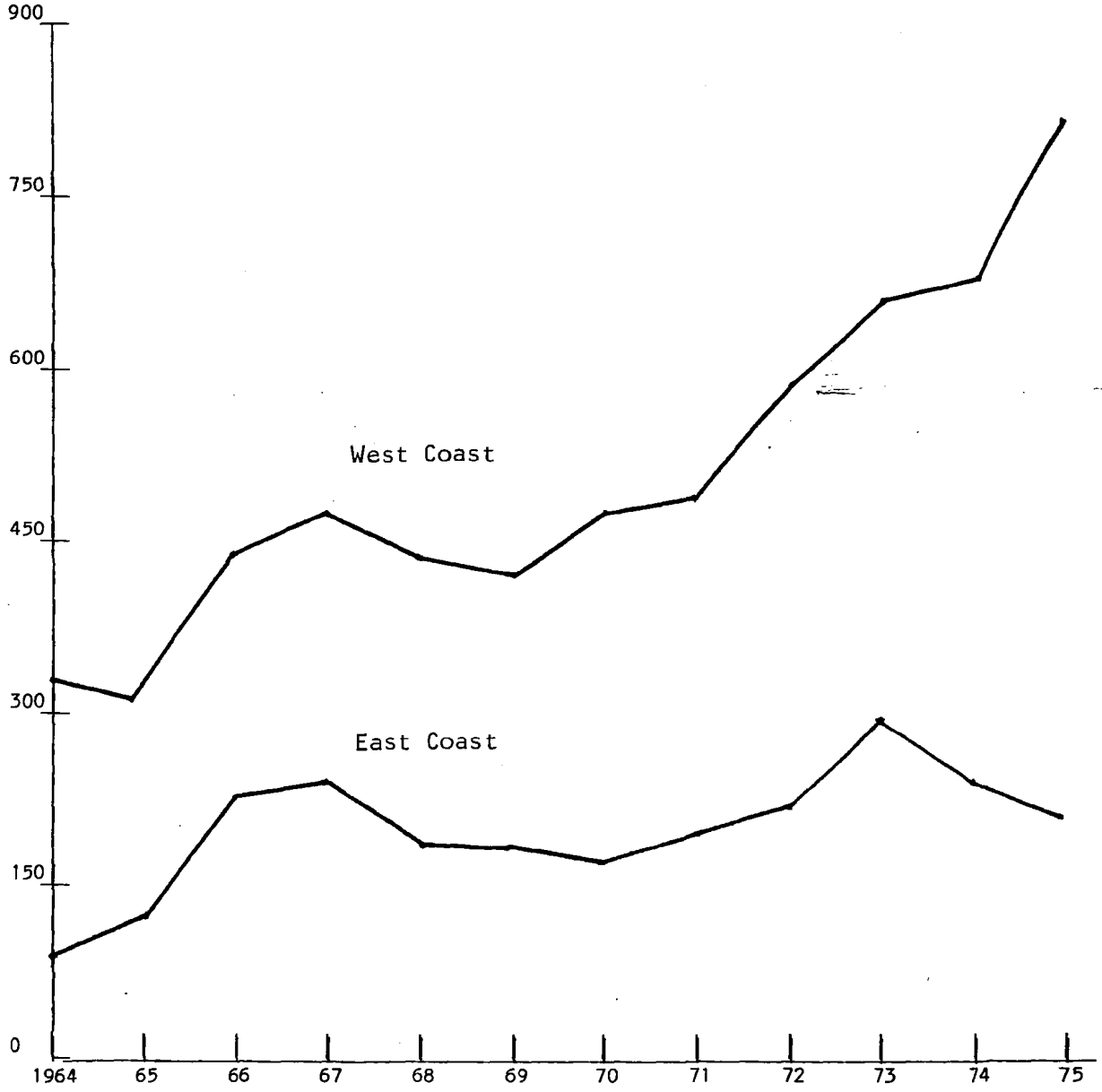
Little research has been undertaken in Florida (or elsewhere) on the recreational aspects of the spiny lobster fishery. The information that has been compiled and presented in this and subsequent sections is based on occasional studies relevant to the fishery, information and insights provided by individual recreationalists and extrapolation based on the available data. The number of people involved in recreational diving for spiny lobster appears quite small in comparison to the involvement in finfishing.[1] However, there does appear to be a considerable degree of "loyalty" among the recreational participants. That is, recreational divers for spiny lobster participate in the fishery year after year and derive considerable satisfaction from their activities.

At the risk of overgeneralization, recreational divers can be divided into three major categories. "Experienced" divers participate frequently. They are likely to catch their limit of 24 lobsters on many outings and freeze their catch for later consumption. The number of these "experienced" divers is likely to be quite small. (There is only a fine line of distinction between these recreational

[1] The number of people engaged in catching lobster with bully nets appears insignificant and has been omitted from the discussion of recreational participants.

Exhibit 8-3

Florida Lobster Boat Fleet



Note: West Coast boats are located principally in the Florida Keys while East Coast boats are located principally in the Miami area.

Source: NMFS, Fishery Statistics of the United States

divers and the commercial divers who account for one to two percent of the commercial catch. Upon paying a $50 fee, a diver becomes "commercial" and is allowed to take spiny lobster without bag limit and is permitted to sell lobster to fish houses.) "Periodic" divers will go diving for spiny lobster only a few times in a season but do so year after year. A common pattern is for a family to schedule an annual vacation in the Florida Keys to coincide with the beginning of the lobster season in late July or August. These "periodic" divers will have varying degrees of success in catching spiny lobster, but most can be expected to catch at least a few. "Periodic" divers most likely represent the largest category of recreational spiny lobster divers. A final category of recreational diver is the "novice" who has had little or no prior experience in diving for spiny lobster. With little experience, these divers are generally less successful in their efforts. For these divers, participation in the fishery is quite incidental to the overall enjoyment of going diving. Exhibit 8-4 presents data on the residence (home) of recreational fishermen surveyed in the Everglades National Park. These data encompass all types of recreational fishing and diving participants and only cover fishing activity within the confines of the Park. Conversations with various people familiar with recreational diving suggest that the residence pattern among recreational divers for spiny lobster is similar to that shown in Exhibit 8-4. (The number of local divers may be overstated by this data since there are areas such as Dry Tortugas and Biscayne National Monument which appear to receive a greater portion of visitors from central Florida and beyond.) Most recreational divers for spiny lobster appear to come from Florida with participation somewhat related to proximity to the fishing area. Out-of-state participation in the fishery is quite small.

Exhibit 8-4

Residence of Sportfishermen in Everglades National Park - 1977-78 Season

	Summer	Fall	Winter	Spring	Total
Number of Fishermen	16,500	22,800	23,900	22,500	85,700
Percent by Residence[1]					
Local	17.4	8.4	5.5	4.5	8.7
South Florida	69.9	78.1	81.3	85.5	79.0
Other Florida	11.7	12.1	4.6	8.3	9.3
Out-of-State	0.9	1.3	8.6	1.6	2.9

[1] Local: Everglades City, Chokoloskee, Homestead, Florida City, Upper Keys.
South Florida: Dade, Monroe and Collier Counties, except local.

Note: Percentages may not sum to 100 due to rounding.

Source: Davis (1979)

Most recreational divers will use their own boats or rent boats from various dealers in the Florida Keys. The figures below, which show the number of pleasure boats registered with the Florida Department of Natural Resources, help provide an indication of the increase in recreation activity that has taken place in recent years. Between 1967-68 season and the 1976-77 season, the number of registered boats in Dade County increased 60 percent, an average annual increase of 5.4 percent while the number in Monroe County increased 146 percent, an average annual increase of 10.5 percent.

Number of registered pleasure boats in Dade and Monroe Counties, 1967-1977

Season	Dade County	Monroe County
1967-68	24,205	3,149
1968-69	26,632	3,460
1969-70	28,253	3,676
1970-71	29,235	4,083
1971-72	31,406	4,820
1972-73	31,999	5,167
1973-74	31,983	4,800
1974-75	36,010	6,690
1975-76	38,220	7,217
1976-77	38,668	7,733

Some divers, generally those from outside of southern Florida, will use charter or party boats. Charter boats are typically hired by diving clubs while party boats operate out of dive shops along the Florida Keys. These boats can hold 30-50 divers and will have commercial lobster licenses.

Estimates of participation in the recreational fishery can be inferred indirectly from the recreational catch data presented in Section 8.2.2.2. The 1977 recreational catch is estimated to fall between 75,800 and 320,000 lobsters. Using yield estimates of 2.25 lobsters per person per day and 7.03 lobsters per boat per day (J. C. Davis, unpublished data) gives the following estimates of participation:

	Low Estimate	Medium Estimate	High Estimate
Days of Diving (1977)	21,900	142,000	213,000
Boat Trips	7,000	46,000	69,000

8.2.2 Landings/Catch

8.2.2.1 Commercial Landings

Exhibit 8-5 presents recent data on the quantity and value of spiny lobster landings in the United States. In recent years, landings in Florida have ranged between about 93 and 98 percent of the total U.S. catch. Occasional landings are reported in South Carolina, Georgia, Alabama and Mississippi, but these landings appear to be from spiny lobster harvested in waters off Florida or in international waters rather than in water adjacent to these states. Some of these landings may be of lobster too small to meet legal size limits in Florida, although there is no documented evidence to support this possibility. None of the other Gulf and South Atlantic states have a minimum size regulation for landing lobsters which Florida does and which is proposed in this FMP. There are small but well developed fisheries in California and Hawaii of the species Panulirus interruptus, and P. penicillatus and P. marginatus, respectively.

A significant portion of the landings reported in Florida between the early 1960's and the mid-1970's were of spiny lobsters harvested outside of Florida waters (see Exhibit 8-1). U.S. fishermen began to exploit foreign fisheries in large numbers beginning in the early 1960s. The Bahamas have traditionally been the major foreign water fishery and in the early 1970s accounted for an estimated 80 percent of the landings from foreign waters.[1] Most of the spiny lobster taken in Bahamian waters were

[1] This is based on information reported in Williams and Prochaska (1976). This estimate is based solely on informed judgement of those familiar with the fishery and should not be regarded as documented fact.

Exhibit 8-5

Commercial Landings of Spiny Lobster[1]
(1,000 pounds and $1,000)

Year	South Carolina		Georgia		Florida		Alabama		Mississippi		California		Hawaii		United States	
	pounds	value	pounds	value	pounds	value	pounds	value	pounds	value	pounds	value	pounds	value	pounds	value
1964	-	-	-	-	3,631	1,563	-	-	-	-	497	309	10	8	4,088	1,880
1965	-	-	35	15	5,714	3,219	-	-	-	-	480	385	8	7	6,237	3,626
1966	-	-	-	-	5,350	2,469	-	-	-	-	489	409	5	4	5,844	2,882
1967	-	-	-	-	4,414	2,733	-	-	-	-	450	388	4	4	4,868	3,125
1968	-	-	1,004	661	6,152	4,408	-	-	-	-	312	293	5	4	7,476	5,336
1969	-	-	882	695	7,582	5,258	-	-	-	-	309	347	8	10	8,781	6,310
1970	33	21	-	-	9,870	5,918	-	-	212	119	225	268	5	6	10,345	6,332
1971	-	-	-	-	8,206	7,056	132	121	373	336	224	309	6	8	8,941	7,830
1972	165	159	-	-	11,417	11,771	39	38	191	191	398	622	5	8	12,215	12,789
1973	-	-	-	-	11,172	11,662	1	1	21	21	233	397	5	8	11,432	12,089
1974	-	-	-	-	10,882	13,382	1	1	-	-	191	365	4	7	11,078	13,766
1975	-	-	-	-	7,408	9,863	-	-	-	-	NA	NA	NA	NA	7,654	9,944
1976	NA	NA	NA	NA	5,345	8,539	NA	NA	NA	NA	NA	NA	NA	NA	4,889	7,491
1977	NA	NA	NA	NA	6,494	10,425	NA	NA	NA	NA	NA	NA	NA	NA	5,483	9,607
1978	NA	NA	NA	NA	5,602	11,944	NA	NA	NA	NA	NA	NA	NA	NA	4,629	9,709
1979	NA	NA	NA	NA	5,962	11,614	NA	NA	NA	NA	NA	NA	NA	NA	6,301	12,765

[1] Based on data in Florida Landings, Fisheries of the United States and unpublished preliminary data. The U.S. totals shown have not been reconciled with data from individual states; U.S. data for 1976-79 are preliminary. Value is at dockside.

NA: Not Available

Source: NMFS, Fishery Statistics of the United States, various years.

landed along the Florida east coast, although data are not available to quantify this relation. Other areas where foreign water harvesting reportedly takes place are off Honduras, Nicaragua, and various countries in the Caribbean.

Two factors were primarily responsible for the rapid expansion of U.S. fishermen's efforts into waters off the Bahamas. 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. Many were already experienced lobster fishermen and some had previously fished the Bahama Banks from Cuba. With domestic waters already heavily fished by U.S. fishermen, the Bahama Banks were a logical location for their fishing endeavors. A second reason for expansion into foreign waters was the large influx of new boats and fishermen in domestic waters, lured by possible high profits due to the high value of spiny lobsters. With domestic waters receiving increased fishing pressure, the apparent abundance of the Bahamian and other foreign stocks made the foreign areas attractive for U.S. fishermen.

At the beginning of the 1975-76 season, the Bahamian government banned foreign lobster fishing in Bahamian waters and has recently begun to enforce the ban by seizing vessels fishing illegally. Landings from foreign waters reported during the 1975-1977 period have averaged less than a third of landings reported before the ban (Exhibit 8-1).

By separating domestic from foreign landings, it can be seen that most of the growth in spiny lobster landings during the 1960 and 1970s was due to growth in foreign water harvests. The trend in landings from domestic waters has been a gradual increase, although considerable year to year variation is evident.[1] Landings from domestic waters are shown in Exhibit 8-6. Reported landings have averaged 5.4 million since 1970, the first year in which the number of traps was sufficient to harvest the available yield.

Substantial amounts of lobster are sold through channels which are not reported in landing statistics. These include retail fish markets, restaurants, and private individuals. Austin, et al. (1980a) estimated these as ten to 30 percent of recorded landings, or 540,000 to 1,620,000 pounds.

It should be noted that the harvest data presented above does not include any "black market" harvesting which is alleged to be a significant portion of the total lobster harvest. Both poachers and fishermen taking lobsters below the legal size limit ("shorts") sell their catch in ways which bypass the fish houses where harvesting statistics are recorded. It has been suggested (E. Felton, personal communication) that the practice of taking shorts has increased significantly in recent years.

It is widely believed that controlling the taking of shorts represents a major difficulty in effectively managing the fishery. By taking shorts, potential yields in the fishery are reduced since shorts are below the point of maximum net species growth (see Section 5.4.2.2). This points out the need for management throughout the fishery both at sea and shoreside.

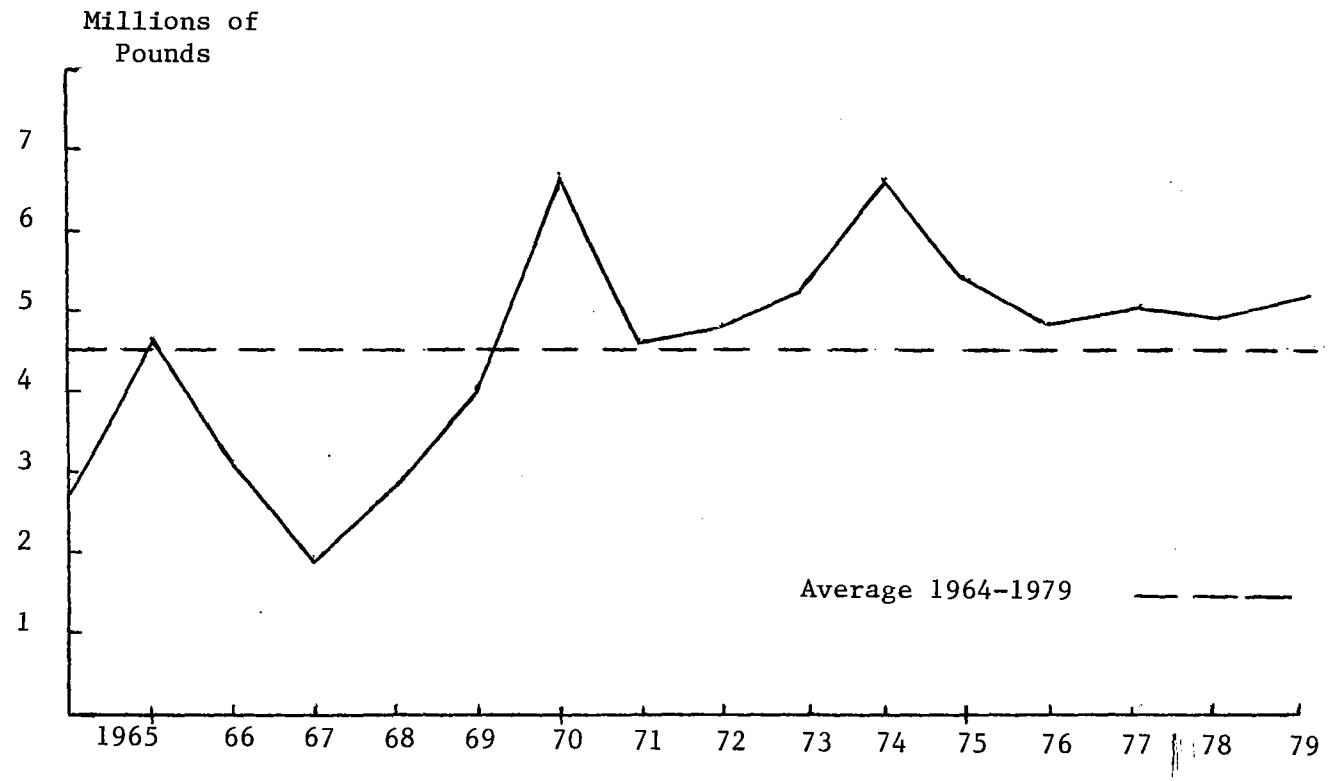
The lobster fishery is quite seasonal as shown in Exhibit 8-7, with the highest volume of catches occurring in August immediately after the closed season (April through July) ends. Landings decline after the season opens to where they are approximately 40 percent as large at the end of the season as at the beginning of the season. Most of the harvest takes place between August and November. Landings during the closed season are of lobsters taken outside of Florida waters. Several explanations have been advanced for the decline in monthly landings following the August peak. Robinson and

---

[1] Economic factors (e.g., exvessel price) do not appear to explain this year to year variation, suggesting that biological factors affecting spiny lobster stock may be a major causative factor. Williams and Prochaska (1977) have developed a bioeconomic model of the spiny lobster fishery which shows water temperatures to be an important explanatory variable for Florida spiny lobster landings.

Exhibit 8-6

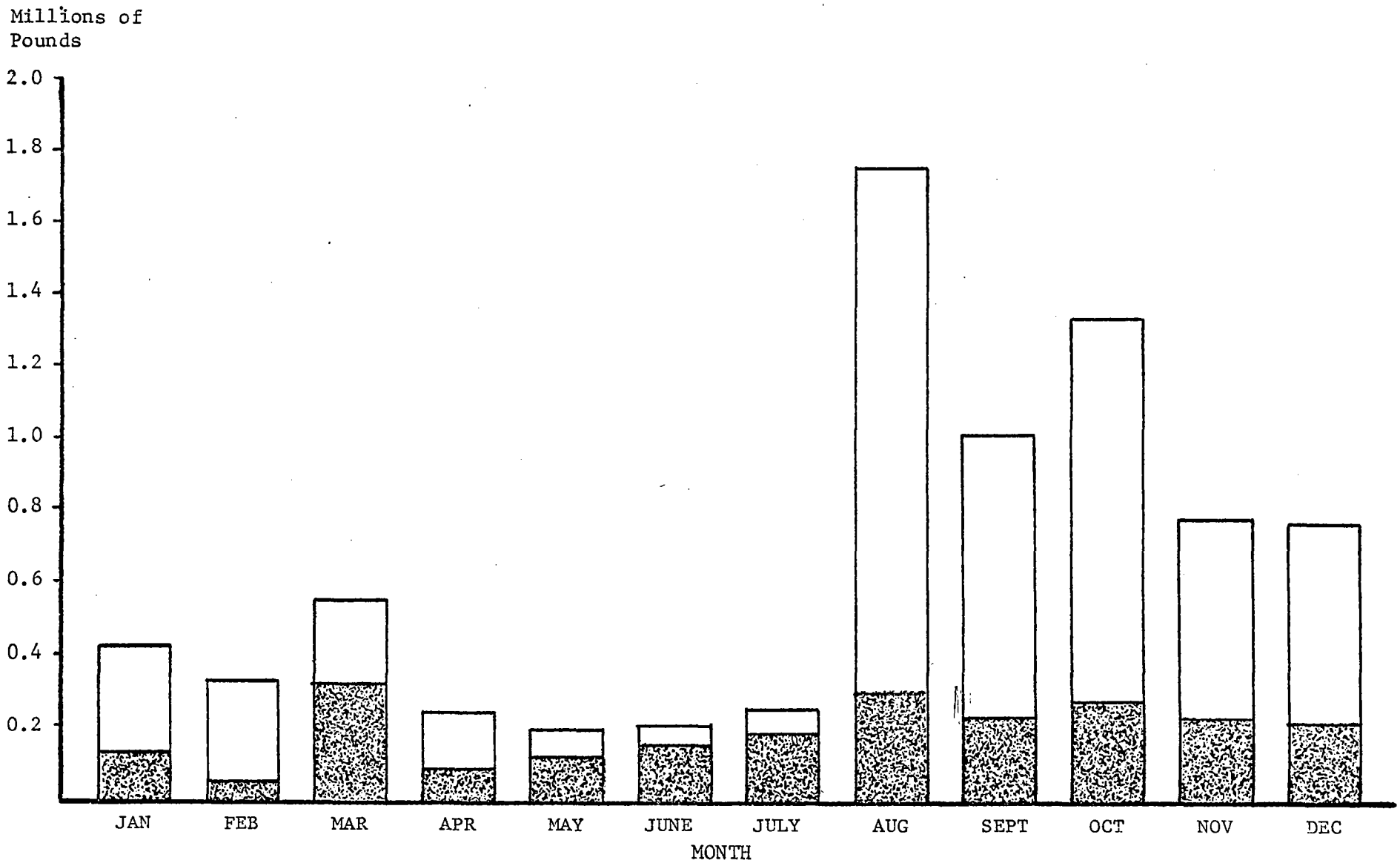
Florida Landings of Spiny Lobster from Domestic Waters



Source: Unpublished data collected by the National Marine Fisheries Service, Statistical Reporting Service, Miami, Florida.

Exhibit 8-7

1974-1976 Average Monthly Florida Spiny Lobster Landings



Source: NMFS Current Fisheries Statistics, Florida Landings, Annual Summary, various years.

Dimitriou (1963) have indicated that changes in catch primarily reflected a higher fishing intensity in the fall when weather permits more frequent hauling of traps by small boats. However, others familiar with the fishery indicate that catch per unit effort declines later in the season as the stock of legal-sized lobsters declines due to fishing effort. As the stocks decline, some fishermen may quit and turn to finfishing where the economic returns are better. Migratory patterns of the spiny lobster may account for the relative peak that occurs in October.

8.2.2.2 Recreational Catch

A number of recent studies have investigated recreational spiny lobster catch in different areas of Florida. During the 1977 season, both recreational and commercial catch were monitored within the Biscayne National Park (J. C. Davis, personal communication). Recreational catch amounted to 11,655 lobsters, which was 5.8 percent of the commercial harvest within the Park of 202,326 lobsters. Recreational effort was concentrated in the special two-day season and dropped off sharply during the regular season. Catch during the two-day recreational season was 6,652 lobsters or 57 percent of the recreational catch for the entire season.

During the special two-day season during 1975, an aerial survey was conducted in lobster fishing areas in Dade County and along the Florida Keys to estimate the number of boats, divers, and landings in the lobster fishery (Austin, 1976). Returning divers were surveyed at various marinas in Dade and Monroe Counties to estimate catch rates. Simultaneously, aerial surveys counted boats in popular diving areas. An estimated 1,289 boats with 4,138 divers harvested 10,712 lobsters in Dade County. An estimated 2,478 boats with 7,607 divers harvested 15,190 lobsters in Monroe County (Austin, 1976). Comparable data are not available for the entire season. However, a rough seasonal estimate can be obtained by assuming this level of activity and harvest continued through November. Adjusting for known weekday versus weekend traffic estimated for all recreational boating activity (Austin et al., 1977) the recreational harvest in Dade County would be 320,000 pounds and the recreational harvest in Monroe County would be 448,000 pounds. The aerial survey data is likely to be downwardly biased for seasonal estimates because there are small islands and shore locations where divers without boats are likely to congregate that are not recorded by the aerial counts. A second difficulty is that the catch of the experienced divers who go out many times during the lobster season (and frequently catch their limit) is likely to be underrepresented during the two day season when a lower bag limit applies and when there are large numbers of inexperienced divers.

There are several important recreational areas which were not covered in the aerial survey, but which have been investigated in separate studies. Recreational catch in the Everglades National Park for the 1977-78 season has been estimated at 3,300 lobsters (Davis, 1979). (Florida Bay is shallow and legal size lobsters are found in relatively small numbers.) In the Fort Jefferson National Monument (Dry Tortugas) which is 65 miles west of Key West an area was opened for recreational diving in 1973, as part of a three year experiment. This area was closed during the 1972 and 1974 seasons and the effects of recreational diving during the 1973 season were investigated. Recreational divers took an estimated 26,500 lobster during the 1973 season indicating a considerable recreational potential. However, this area is currently closed to lobster harvesting (G. Davis, personal communication). These estimates, like the aerial survey, have the unknown biases associated with any form of creel census extrapolation of total catch.

An alternative method for determining the relative proportion of lobster taken commercially and recreationally is through tagging studies. In these studies lobsters are captured, tagged, and released. When recaptured, tags request the fishermen to return the tag to the researcher. If commercial fishermen and recreational divers differ in the rate with which they return tags, the findings of tagging studies could be significantly biased. Indeed, studies that have been completed or are in progress have produced a wide variety of estimates, with tag returns from recreational divers accounting for as much as 50 percent of all tag returns. Recent tagging studies by Lyons, et al., (manuscript) and Davis (1978) estimate the recreational harvest at nine percent of the commercial harvest.

Still another approach has been the expert consensus approach of the Delphi Technique (Zuboy, 1980). This method resulted in a consensus that the recreational catch varies from 520,000 - 1,000,000 pounds, with a mean of 757,000 pounds. Over the course of the Delphi experiment the range of estimates of recreational catch was reduced by a factor of four, resulting in an estimate that compares favorably with estimations by the other methods.

8.2.2.3 Commercial Landings of Incidental Species

The spiny lobster P. argus is the only lobster species in Florida for which there is a directed fishery. There are, however, a variety of other species of lobster which are not commercially exploited except as incidental catch from other fisheries. These lobster are caught infrequently and are not commercial target species due to: (1) rarity; and (2) poor catch rates due to ineffectiveness of current gear.

P. guttatus resembles the spiny lobster and, in Florida, is commonly referred to as the spotted spiny lobster. Due to this close resemblance any P. guttatus captured would likely be included as spiny lobster in the commercial landing statistics. Slipper lobster is the common name for a variety of lobster species with appearance and characterstics very different from the spiny lobster (see Section 5.1.3). Slipper lobsters are found in deeper waters than spiny lobsters and are seldom captured with existing gear. Landing statistics for slipper lobster have been reported since 1972 in Florida and these figures are shown in Exhibit 8-9. There are no reported landings of slipper lobster in any other of the states bordering the Gulf of Mexico.

Exhibit 8-8 summarizes estimates of the recreational catch by the three methods.

Exhibit 8-8

	Estimated Pounds
Aerial Survey and/or Creel Census	
Dade County (1975 aerial survey and creel census)	320,000
Monroe County (1975 aerial survey and creel census)	448,000
Florida Bay-Everglades (1977 creel census)	3,300
	771,000
Tagging Estimates of Percent of Commercial Catch	
Nine percent	486,000
Delphi Technique	
Low estimate	520,000
High estimate	1,000,000

8.2.3 Fishing and Landing Areas

8.2.3.1 Commercial

Commercial fishing activity for spiny lobster in domestic waters is highly localized, occurring principally along the Florida east coast and in waters off islands and reefs in the Florida Keys. Fishing generally occurs from virtually intertidal areas to depths of 200 feet, although most fishing takes place in depths less than 100 feet. As the number of fishermen has increased in recent years, there has been a trend towards fishing in deeper waters. Lobsters are found among coral reefs, coral heads, rock outcroppings, and other locations that provide shelter. At night lobsters move from these lair locations onto nearby flats for foraging. Along the Florida Keys, spiny lobster occur on both the Atlantic and Gulf sides with harvest from the Atlantic side reported to be slightly larger. Lobster are also reported to be more prevalent on the Gulf side early in the season and on the Atlantic side later in the season. Traps are not distributed evenly throughout the Keys. With the considerable increase in lobster traps in the last few years, high trap density has become a problem in some areas. Traps are also set along the Florida east coast as far north as Palm Beach, although the productivity of these waters is apparently less than that along the Keys.

The reef tract, which parallels the Florida Keys (roughly four miles off the coast) is a major habitat area for spiny lobster and is extensively fished. Most of this area is within the FCZ. In recent years (1977 to 1979) roughly 65 percent of the lobsters landed in Florida have come from waters in the FCZ (3 to 200 miles) with much of this harvest attributable to fishing efforts along the reef tract (see Exhibit 7-1). In this same period, landings within three miles have accounted for 20 percent of the lobster harvested. Some landings reported as 3 to 200 miles come from state waters on the Gulf side of the Keys. State jurisdiction extends to nine nautical miles in the Gulf of Mexico. Fort Jefferson National Monument (Dry Tortugas) also supports an active fishery. Despite the relative isolation of Dry Tortugas there are about ten or twelve commercial boats active in the area (Davis, 1977).

Lobster traps are by nature fixed in location although fishermen do move traps during the season to take advantage of relative shifts in the abundance of spiny lobster. There appears to be sufficient mobility between and during seasons that "territorial rights" are not an important issue among fishermen on the open sea but they are important in areas nearby shore.

Exhibit 8-9

Commercial Landings of Slipper Lobster
(pounds and dollars per pounds)

Year	Spiny Lobster Traps		Shrimp Trawls		Total Landed
	Weight	Price	Weight	Price	Weight
1972	1,800	0.97	14,000	0.49	15,800
1973	0	--	5,400	0.69	5,400
1974	700	1.23	1,100	0.77	1,800
1975	200*	0.97	5,400	1.01	5,600

* Captured in crab traps. No landings reported from spiny lobster traps this year.

Note: The only reported landings in the Gulf of Mexico and South Atlantic occurred on the west coast of Florida.

Source: NMFS Fishery Statistics of the United States, various years.

Traditional landing areas for spiny lobster are Dade County in the Miami area and Monroe County along the Florida Keys. Additional landings of a much smaller volume occur in other Florida counties, primarily Collier and Palm Beach. The distribution of landings by county is shown in Exhibit 8-10 for a number of recent years. It should be noted that a fairly large portion of total landings shown for Dade County prior to 1975 were from foreign waters rather than from the domestic fishing areas described above.

Landing areas are scattered throughout the Florida Keys with the most important ports those of Marathon, Key West, and Islamorada on Key Largo. The fishery is local in the sense that catch is generally landed at ports within a few hours travel of where the spiny lobster are caught.

Fishing areas in the Florida Keys are seldom more than 20 miles from a landing area. (The area west of Key West is an exception.) Fishermen in the Miami area frequently travel greater distances. The Bahamian islands where many Miami based fishermen formerly fished are 100 to 150 miles away. Those displaced from the Bahamian banks by the closure of the fishery have in many cases turned efforts to domestic waters and fish along the Florida coast and into the upper Florida Keys, a distance of 20 to 40 miles or more.

8.2.3.2. Recreational

Recreational divers pursue spiny lobster in generally the same areas that are fished commercially. Most recreational diving takes place along the Florida Keys and is widely dispersed in somewhat random fashion. Diving appears to be generally limited to moderately shallow waters. A survey of recreational divers (Austin, et al., 1977) found that 95 percent of those diving without SCUBA gear dove no deeper than 30 feet and 81 percent of those with SCUBA gear descended no deeper than 40 feet. None of the divers included in the sample reported diving below 80 feet. Davis (1977) found that recreational diving in the Dry Tortugas had little effect on lobster stock below 10 meters (about 33 feet) in depth. In contrast to commercial fishing, recreational spiny lobster divers are more frequently found on the Gulf side of the Florida Keys where the water is shallower and the ocean conditions are milder.

Florida Bay within the confines of the Everglades National Park (367 square miles) is reserved for recreational lobster fishermen and commercial spiny lobster fishing is not permitted. Florida Bay is quite shallow (between one and six feet deep over much of the area) and serves as a protected habitat for juvenile spiny lobsters. Recreational catch from Florida Bay is quite small compared to other recreational areas.

Recreational diving also takes place along the Florida east coast where recreational activity is reported to extend well beyond the northern limits of commercial activity. Evidently, towards the northern limit of the spiny lobster habitat stocks are not sufficiently large to justify commercial efforts but are large enough to attract recreational divers. Lobsters caught from these northern areas are reportedly much larger than lobster taken in areas where commercial fishing competes with recreational activity.

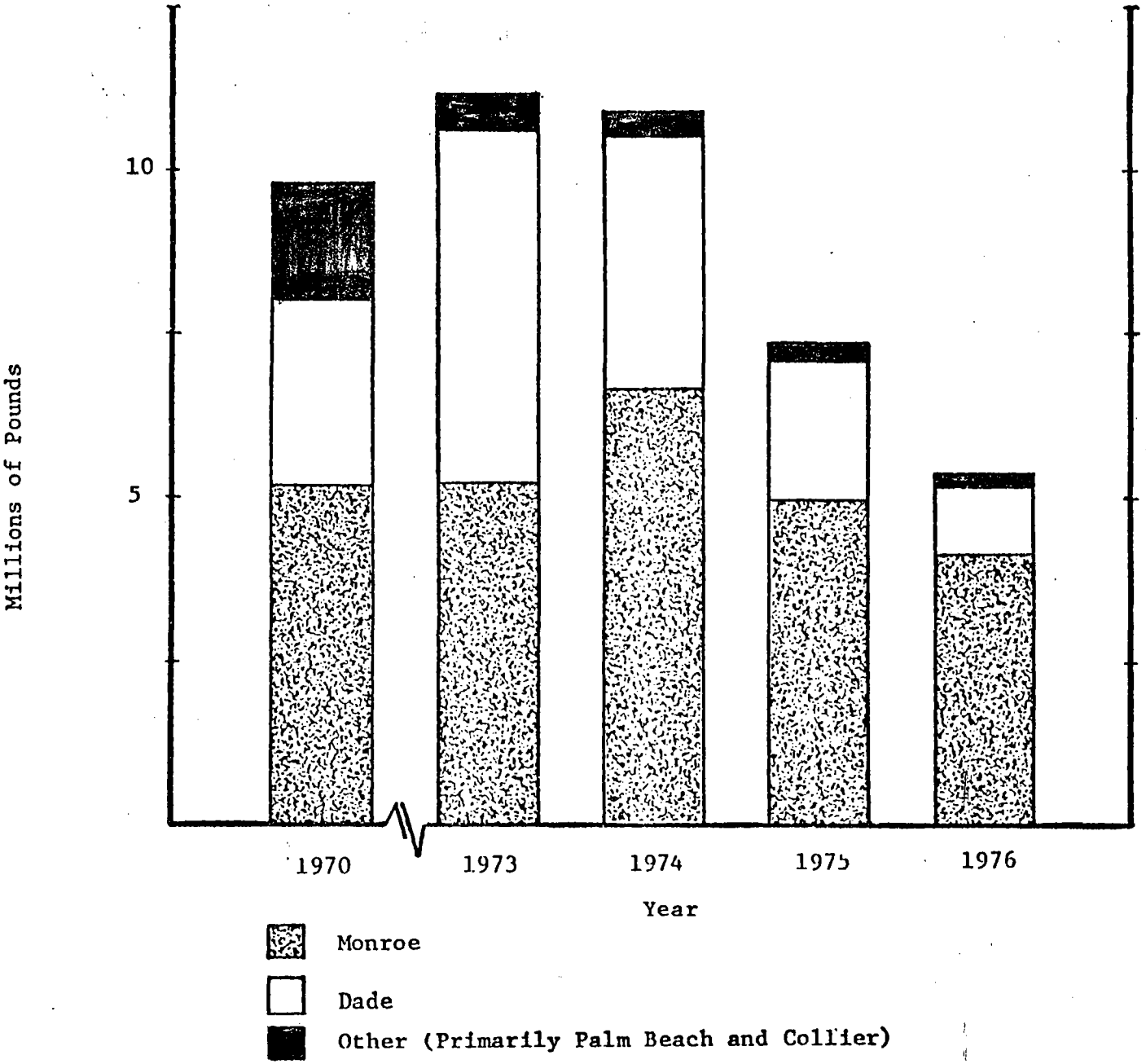
8.2.4 Vessels and Gear

8.2.4.1 Commercial

Roughly 98 to 99 percent of the commercially caught spiny lobster are taken with lobster traps. Drums and ice cans account for the remainder of the commercial catch. The most common type of trap employed is the traditional wood slat design. Wood slats are connected with wire and the trap is weighted with a poured concrete bottom. Slats are routinely placed 1-1/4 inches apart (E. Felton, Spiny Lobster Advisory Panel, personal communication). Estimates of trap costs range from about $8.50 to $25.00,

Exhibit 8-10

Florida Landings by County of Landing



Source: NMFS, Current Fisheries Statistics, Florida Landings, various years.

primarily depending on the depth of the water fished, with a figure of $15.00 about average (based on conversations with a number of fishermen and others connected with the fishery). The cost of a specially designed degradable panel has been estimated at about one dollar per trap (J. Cato, personal communication). Florida's law requires that all traps must be permanently marked with the owner's permit number in three inch letters and have an identified float. Color coding is also mandatory for vessel, float and trap. Traps on a trawl or a string of traps can be used provided the ends of the string are marked with buoys.

In some areas loggerhead turtles present a problem to fishermen by molesting traps to get at spiny lobster. (This species is on the "threatened" list under the Endangered Species Act of 1973.) Side reinforcement of the traps with 16 gauge, one inch mesh poultry wire is used in these areas to protect the traps from turtle damage. (Florida law forbids reinforcement of the top and bottom of the traps which would inhibit disintegration of lost traps.) It is reported that poultry wire is not completely effective and provides only temporary protection until the turtles learn how to get around the wire.

The traditional wood slat trap catches lobster smaller than the legal limit of 76 mm (3.0 inches) carapace length. Studies to determine trap selectivity have not been conducted, but length-frequency data collected by Dawson and Idyll (1951), Davis (1977) and Warner, et al. (1977) indicate an initial capture size of 45 mm CL (1.8 inches) and complete retention of spiny lobsters above 65 mm CL (2.6 inches). Austin (1979a) and Lyons, et al. (manuscript) estimated effective retention size to be 55 mm CL (2.2 inches) which seems to be more accurate than the 45 mm CL estimate of previous workers.

Exhibit 8-11 presents historical catch by type of gear. In addition to traps, lobsters are taken by divers, otter trawls, dip net and by hand. The commercial diving harvest has risen sharply in recent years but remains a small portion of total landings. Divers use both SCUBA and hookah gear. (Hookah gear consists of a compressor located on a boat or floating in the water which pumps air via a hose to the diver below.) The catch reported while using otter trawls is taken by vessels engaged in shrimping operations. Some of the trawl catch is incidental but some results from directed fishing efforts. Occasionally during the season there are "runs" of lobster in a particular area, probably connected with migratory patterns. During these times shrimp boats will trawl for lobsters.

Traps may be set unbaited, baited with cowhide or fish, or baited with several juvenile lobster to serve as attractants for other lobsters. The most common practice, particularly in Florida Bay and other shallow water areas, is use of live sub-adult, "short" lobster as attractants. Cowhide is the next most common bait; other baits include fish scrap, sardines, and catfood.

The use of juvenile spiny lobster varies with their availability. They are most common, and are most commonly used, in the shallow water Florida Bay area. In fact, their use helped develop the fishery in that area since the early 1970's to the point where roughly half the commercial activity takes place there. Use of "shorts" as attractants has also increased gear efficiency in the fishery. Baiting the trap with live lobster apparently encourages other lobsters, including legal-sized adults, to enter the trap. Preliminary research (Lyons, FDNR, personal communication) indicates that one short per trap results in slightly higher catch rates than cowhide (Davis, 1977), while three shorts per trap results in catch rates 3.6 times higher than cowhide. When shorts are not available, some fishermen will bait their traps with legal-sized lobster.

During a fishing trip, a lobsterman will pull his traps and check them for presence of lobsters. Legal-sized lobsters are retained for sale, sublegal-sized lobsters are either kept in the trap for continued use as attractants, or are discarded when there is a great number. Shorts retained for redistribution are usually held in a wooden bait box which is sometimes shaded. Lobstermen prefer to use three to five shorts per trap. The normal "soak time" between pulls for a trap is five to ten days. Soak time typically increases as the season progresses because lobster abundance declines and fishermen may shift to other fisheries.

Exhibit 8-11

Commercial Florida Landings by Type of Gear (1,000 pounds)

Year	Lobster Traps	Commercial Diving	Otter Trawls (Shrimp)	Dip Net
1964	3,585	-	12	24
1965*	5,422	-	205	84
1966	5,271	-	64	15
1967	4,329	3	68	14
1968	6,047	1	84	22
1969	7,463	-	95	22
1970	9,785	7	69	8
1971	8,149	10	46	1
1972	11,370	7	40	-
1973	10,974	154	38	6
1974*	10,433	198	198	53
1975*	7,195	122	47	42

* There were 3,000 pounds caught by hand in 1965, 600 pounds in 1974 and 1,300 pounds pounds in 1975 in addition to the figures shown in the table.

Source: NMFS, Fishery Statistics of the United States

Exhibit 8-12

Spiny Lobster Capital and Labor Inputs (Florida)

Year	Boats (number)	Vessels (number)	Vessels Average Tonnage	Total Firms*	Traps (number)	Traps Per Firm	Regular Fishermen	Part-Time Fishermen	Fisherme Per Firm
1964	294	47	12	341	113,653	333	490	118	1.4
1965	286	46	14	332	138,900	418	575	50	1.7
1966	376	112	14	488	150,970	309	765	36	1.6
1967	388	140	15	528	185,925	352	920	27	1.7
1968	187	265	23	452	168,390	373	978	23	2.2
1969	235	205	23	440	164,655	374	856	29	1.9
1970	266	226	26	492	219,100	445	1,039	20	2.1
1971	250	270	27	520	225,862	434	1,104	45	2.1
1972	275	324	27	599	272,495	455	1,281	41	2.1
1973	269	402	23	671	304,490	454	1,544	31	2.3
1974	312	378	25	690	371,300	538	1,629	60	2.4
1975**	430	393	24	823	520,325	632	1,909	158	2.3
Average Annual Percent Change 1964-1975	3.5%	21.3%	-	8.3%	12.6%	4.9%	13.2%	-	4.4%

* Since most boats and vessels are owner-operated the total firms are taken to be the sum of boats and vessels shown. Boats are defined as less than five tons capacity and vessels five tons or greater.

** Unpublished preliminary data.

Source: NMFS, Fishery Statistics of the United States

The handling of sublegal size lobsters may result in injury or mortality to them. The extent of such damage depends on the frequency of handling, the length of time the animal is out of the water, and the expertise of the fisherman. Fishermen (through the Advisory Panel) argue that there is virtually no loss. Preliminary results of research by FDNR (Lyons, personal communication) in a limited area, indicates that average mortality is approximately 21 percent of the shorts held out of the water for more than a few minutes.

The length of time between successive "pulls" of the trap to check for lobster varies from five days to two weeks. The average is approximately seven days. Traps are usually pulled more frequently early in the season. Operators with very large numbers of traps pull each trap less frequently. Those who fish in the mackerel and finfish fisheries also pull traps less frequently toward the end of the season as they shift to other fisheries.

The major gear improvement in recent years has been the addition of gas and hydraulic pullers which assist in retrieving traps. These devices were introduced in the 1960's and are now in widespread use. With the pullers more traps can be fished in a day and traps can be set in deeper water. There has also been a trend towards larger and faster boats in the spiny lobster fishery.

The number of boats and traps in the spiny lobster fishery have increased considerably in recent years as shown in Exhibit 8-12. The increase in traps in the fishery is evident in Exhibit 5-4. Between 1964 and 1975 the number of "firms" (boats and vessels) more than doubled while the number of traps increased to well over four times the 1964 level.[1]

The average size of boats engaged in the fishery has shown a significant increase in the last decade. In 1964, vessels made up 14 percent of all "firms" versus 48 percent in 1975. The average gross tonnage of vessels in the fleet has also increased. With the greater boat size, the average number of traps fished per firm and the average number of fishermen per firm have increased.

There is considerable variation in operating practices based on boat size. Prochaska and Williams (1976) surveyed the owners of 25 spiny lobster boats during the 1973-74 season. There were seven boats in each of the categories 16-22 feet, 24-28 feet, and 31-36 feet and four boats in the category 40-55 feet. The boats were selected stratified by length so this distribution is representative of the domestic spiny lobster fleet. The average boat length was 30 feet. All boats 16-22 feet and many of the boats 24-28 feet were operated by a single fisherman with no crew. Among larger boats single operators were uncommon and most boats employed one crew member. The average number of trips fished increased with boat length except for the largest boats (40-55 feet) which quit the lobster fishery early to fish for king mackerel or other finfish. Boats 16-22 feet in length averaged 341 traps while boats 31-36 feet averaged 842 traps. Larger boats are able to fish significantly more traps in a single day than small boats. The range is from 139 traps per day for boats 16-22 in length to 272 traps per day for boats 40-55 feet in length. The largest and fastest vessels (50 feet range) with the most efficient gear are capable of fishing 500 traps per day and operating up to 3,000 traps with a seven day soak time.

Many of the larger boats and vessels also have provision for storing lobster tails on ice. If trips are made over more than one day, or over long distances, or in hot weather, fishermen will wring the tail from the body of the lobster and pack it on ice in order to maintain quality until the catch is landed. This is another practice permitted under Florida's fishery regulations which requires a special license. The 5.5 inch tail corresponds to the minimum proposed carapace length and thus facilitates measurement of the live lobster or the tail for enforcement at sea or dockside.

---

[1] Boats and vessels are formally distinguished by tonnage. Throughout this report "boats" is used generally to refer to all craft, both boats and vessels, engaged in the commercial spiny lobster fishery.

8.2.4.2 Recreational

Both free diving and SCUBA gear are common among recreational divers for spiny lobster. Austin, et al. (1977) found that among Dade County divers (fishing for all species of crustaceans and finfish) 28.4 percent were using SCUBA gear, 60.0 percent were free diving and the remaining 11.6 percent were using both techniques. This distribution of effort among diving gear appears somewhat representative of the gear usage among spiny lobster fishermen. Regular fishermen who dive for lobster frequently are more likely to use SCUBA gear and to dive in deeper, offshore areas, than are the occasional divers.

Most boats used in recreational spiny lobster fishing are privately owned. Three or four divers per boat appears typical, at least during the special two-day recreational season. A wide range of types of private boats are used by recreational fishermen to pursue spiny lobster. Boats between 16 and 25 feet in length are the most prevalent length in Dade County (63.0 percent of 1975 registrations with the Florida Department of National Resources) and are common in the spiny lobster fishery. Boats smaller than 16 feet are also common in the fishery. Frequently, recreational visitors will bring in these smaller boats by trailer and launch them from ports in the Keys. During the 1975 two day special recreational season, 44 percent of the boats in Dade County and 60 percent of the boats in Monroe County that were active, were engaged in recreational lobster fishing. Of these, in Dade County only two percent of the boats were not registered in Dade County. In Monroe County, 50 percent of the boats were from outside Monroe County (Austin, 1976).

8.2.5 Employment

8.2.5.1 Employment Associated with the Commercial Harvest

This section describes the estimated employment associated with the commercial harvest of spiny lobster. Data on the number of spiny lobster fishermen are available annually and presented in Exhibit 8-12. It should be recognized that few fishermen are wholly dependent on the spiny lobster fishery as a source of income. Regular fishermen derive 50 percent or more of their income from fishing but may work during the off-season in unrelated occupations or in other fisheries. Casual fishermen have other sources of primary income and only fish for spiny lobster to supplement this income. The 2,067 jobs in the commercial fishery in 1975 are equivalent to roughly 1,300 person-years of employment, based on estimates of the percent of time the various categories of fishermen spend in the spiny lobster fishery. This estimate does not include contributions made by fishermen's wives to build lobster traps and repair gear.

In addition to employment directly in the fishery, there is associated employment in industries providing inputs to fishing activity (e.g., gear manufacture, boat building, bait supplies, gasoline, etc.). The amount of employment in these sectors is estimated at about 156 person years in 1975. Note that the actual number of people involved may be considerably greater than this, but when it is prorated in terms of time actually devoted to producing goods and services needed in the fishery, the above estimate was produced. Also, this estimate is based on a long-run average of new investment in fishing so that in years when particularly large numbers of new boats and gear enter the fishery, associated employment in the fishery may be higher than indicated. Associated employment is estimated by calculating impact ratios from data in Exhibit 9-6 which measure the variable expenses and annualized investment expenses in relation to value of catch. These impact ratios are applied to the total value of landing in 1975. The resulting estimates of variable and investment expenses in the fishery are then applied to the results of a national input/output study of the economic contribution of the U.S. commercial fishing industry (Centaur Management Consultants, 1975) to estimate employment in the direct economic sectors supplying inputs to fish harvesting.

Additional employment is also generated in the wholesale and processing sectors that deal with spiny lobster. Employment in lobster processing plants is estimated at 159 person-years in 1975, using the following method. The processor/wholesaler margin is multiplied times the 1975 quantity of lobster handled by Florida lobster processors (Section 9.2) to estimate revenue net of spiny lobster purchases (gross margin). The fraction of total production costs (including profit and excluding the cost of purchased lobster), which are attributable to employee wages, is estimated from the 1967 National Input-Output Table[1]. This fraction is applied to the revenue figure to give an estimate of total employee compensation paid by lobster processors during 1975. Finally, this figure is divided by the average 1975 wage rate among Florida fish processors to yield an estimate of total employment associated with lobster processing in Florida.

8.2.5.2 Employment Associated with the Recreational Harvest

Recreational divers generate employment in southern Florida and beyond in those sectors of the economy where recreational expenditures are made. The amount of employment attributable to recreational diving for spiny lobster is estimated as follows. The amount and types of expeditures made each day by a typical recreational diver (Exhibit 9-11) are multiplied by the estimated number of days of diving annually to give an estimate of total trip-related expenditures associated with the recreational fishery. These trip related expenditures are then multiplied by the impact ratios (employment per $1,000 of recreational expenditures) given in Exhibit 9-6, yielding an estimate range of 83 to 110 person-years of employment associated with the recreational fishery for 1975. As with employment associated with commercial fishing, the number of people involved in supplying goods and services to recreational divers may be far greater than this estimate, but this is the figure obtained when contributions of the spiny lobster fishery are prorated among the different economic sectors associated with the fishery.

This employment estimate does not include the contributions to employment made by recreational divers purchasing new boats and SCUBA equipment. It is not possible to estimate the employment effects of capital expenditures for the spiny lobster fishery due to limited data on the number and characteristics of the recreational participants. An illustrative calculation is shown below which conveys a notion of the importance of capital investment in creating employment opportunities. In Dade County, where much of the recreational boating activity in southern Florida is centered, expenditures on new boats have averaged $19.7 million dollars.[2] (Based on 1971-1975 data reported by Austin, et al., 1977). Using an impact ratio of 0.03662 person-years of employment per $1,000 of retail sales for recreational boats (Centaur Management Consultants, 1977) and adjusting for inflation gives an estimate of 662 person-years of employment (throughout the U.S.) associated with the manufacture and sale of new boats which are registered in Dade County. Only a small portion of this employment (a few percent) would be attributable to the spiny lobster fishery. Thus, it appears that the employment effects of new boat purchases for the recreational spiny fishery would be similar or smaller in magnitude than employment effects from trip-related recreational expenditures.

The estimated employment associated with the spiny lobster fishery in Florida is summarized in Exhibit 8-14.

---

1 U.S. Department of Commerce, "The Input-Output Structure of the U.S. Economy", in: Survey of Current Business, February 1974.

2 Expenditures on SCUBA gear are small by comparison.

Exhibit 8-13

Estimated Employment Associated with the Spiny Lobster Fishery
(person-years)[1]

	Employment Category	1975 (estimated)
Commercial:	Direct Harvesting Sector	1,309
	Sectors Which Supply Goods and Services to Fishermen	156
	Lobster Processing Plants	159
	Total Commercial	1,624
Recreational:	Trip Related Expenditures	83 - 110
	Boat and Equipment Purchases	( )[2]
	Total Recreational:	83 - 110
	TOTAL EMPLOYMENT:	1,707 - 1,734

[1] Note that the figures shown represent person-years employment. The actual number of people associated with the fishery on a full-time, part-time or prorated basis will be much greater.

[2] Cannot be reliably estimated.

Source: See text, Section 8.2.5.

8.2.6 Conflicts Among Domestic Fishermen

During the 1975-76 season there were a number of conflicts between domestic fishermen over trap placement and entry to the fishery. Many of the fishermen who had fished in the Bahamas prior to 1975 turned to domestic waters after the Bahamian ban on foreign fishing. This caused considerable overcrowding in some of the domestic fishing areas, possibly leading to a conflict situation. Actions taken against another fisherman's traps, such as cutting the buoy line, were the most common type of problem. Over time, the additional effort is being assimilated without violence and many fishermen shift to other fisheries or nonfishing related employment.

Conflicts exist between net fishermen (primarily shrimp trawlers) and lobster fishermen. As nets are hauled through an area containing traps, the traps are snagged, resulting in damage to the nets and destruction of the traps. Problems appear to have intensified in recent years as lobster fishermen have begun fishing further offshore in the Gulf of Mexico in deeper waters. This conflict takes two major forms; trap damage due to a trawl fishery directed at lobster and trap damage by net fisheries directed at other species. In some years, large numbers of lobsters are available on the Gulf Stream side of the Keys in deep water which can be trawled. This was the case during the 1978 season. At such times shrimp trawlers direct their effort at lobster. Because lobster fishermen are also concentrating on the same area, trap losses can be severe.

This type of damage involves several different types of nets which damage traps while fishing for other species. These include shrimp trawls in the areas north and west of Key West, mackerel nets in Hawks Channel south and west of Key West and pompano gillnets in Florida Bay. Reestablishing parts of the Tortugas shrimp nursery area, as proposed in the Shrimp FMP, should greatly reduce damage from trawls. Trap losses from mackerel nets is reported to be small, sporadic and not a serious problem. Losses from pompano gill nets is reported, by members of the Advisory Panel, to be a significant and growing problem.

Traditionally, voluntary agreements among fishermen have controlled the interaction between the two fisheries. However, the effectiveness of these agreements is reported to be declining because of more intensive fishing pressures in these areas brought about by fluctuating revenues and higher costs in all these fisheries. While the reports of damage are large and at times widespread, little documentation is available on the extent of trap losses, individuals involved, or specific areas. Some of the difficulty in documenting losses is due to 1) the open and free access to fishing areas by almost all fishermen, 2) the acceptance of these losses as a normal part of business, 3) the difficulty in determining whether losses are due to trawling, sabotage, or violent weather, and 4) night time shrimping prevents assigning responsibility for trap damage.

A relatively minor "conflict" was described by members of the Special Spiny Lobster Advisory Panel to the Gulf of Mexico Fishery Management Council. The Advisory Panel noted that, based on current Florida law, the special two-day recreational season coincided with the time when commercial fishermen are placing traps. This results in considerable congestion in some areas. The Advisory Panel made the suggestion that the special two-day season be adopted in the FCZ, but that it be moved to the preceding weekend to lessen congestion.

Poaching, while not technically a conflict between different groups of fishermen, has been a significant factor in the fishery. The 1965 Florida spiny lobster legislation which required boats and buoys to be color coded has helped enforcement considerably, but poaching activity is still a major problem. The Marine Patrol (Florida Department of Natural Resources, Division of Law Enforcement) flies a surveillance plane to help identify poachers. If a boat is observed poaching, a Marine Patrol boat is called and the plane circles the area until the poachers have been caught. There is also a private surveillance plane hired by fishermen in Monroe County that patrols for poaching activity along the Florida Keys. This private plane has been in operation for the last several years and reportedly has reduced the incidence of poaching in some areas. The need for effective enforcement is self-evident throughout the fishery in order to combat poaching and other illegal activities, such as the sale of shorts. At sea and dockside enforcement in the main fishing/landing areas would deter these activities, while dockside enforcement in the other Gulf and south Atlantic states would help, too.

8.2.7 Assessment of Domestic Annual Harvesting Capacity (DAHC)

Approximately three to five times the number of traps are fished as are required to harvest the available yield. Therefore, the annual harvest is limited by the available yield, not harvesting capacity. For the purpose of this plan, DAHC is estimated by multiplying the existing number of traps (1977 estimation 408,000) times the catch rate (31.60 pounds per trap) equal to the maximum catch per trap which could be obtained and still harvest all of the available yield. This catch rate is the estimated catch per trap at the optimum level of effort derived from the Fox surplus production model (see Section 5.4.1). The DAHC is estimated to be 12,894,794 pounds.

8.2.8 Assessment and Specification of the Extent to which U.S. Fishermen Will Harvest Optimum Yield

The Councils have specified OY to be all lobster more than 3.0 inches carapace length or not less than 5.5 inches tail length that can be harvested by commercial and recreational fishermen given existing technology and prevailing economic conditions.

For the purpose of determining expected harvest, values for recreational harvest and unreported commercial harvest were assumed to lie at the high end of their estimated ranges. Expected harvest for 1982 is estimated as a total of 9.5 million pounds, consisting of reported commercial landing (5.4 million), unreported recreational (1.0 million) and unreported commercial (1.6 million); the remaining 1.5 million pounds is the best estimate of the immediate benefit which will result from FMP implementation and enforcement of the preferred size limit (see FMP Sections 12.4 and 12.5).

The estimated first-year increase over the present yield results from effective size limit enforcement, effective closed season, and reduction of illegal short harvest. The estimate is based on (1) data available on the magnitude of the illegal harvest, (2) the estimated difference between legal harvest and the amount which could be harvested (see Section 5.4.2), (3) a model developed to estimate short-term effects of different minimum size limits (see Section 12.2), and (4) an effective enforcement effort (see Sections 12.3 and 12.5).

Comment from the Gulf Council Spiny Lobster Advisory Panel, perception of some scientists (Warner, et al., 1977), and a general opinion in the industry indicate that illegal harvest of "shorts" is very large, approximately 20 to 50 percent of the legal commercial harvest. Applying this percentage range to commercial landings statistics gives a range of 1.4 to 3.4 million pounds, with an average of 2.4 million pounds. The model of Austin, et al. (1980) in Section 5.4.2 indicates that 4.0 million pounds of lobster are lost each year to a combination of sublegal harvest and mortality due to harvest practices. The model used to estimate short-term impacts of various size limits (Justen, 1981) indicates that 2.0 million pounds should be available in the first year of FMP implementation with the preferred CL if sublegal harvest and mortality due to harvest practices could be eliminated and the closed season were enforced. On the basis of the information above, the best estimate of potential immediate increase in yield due to reduction of illegal harvest is 1.5 million pounds.

This estimate should not be considered precise. The available data is insufficient to make a precise estimate. Environmental factors may also cause catch to fluctuate. The available data is sufficient to indicate a large potential increase in yield between 1.4 and 3.4 million pounds, given effective enforcement. Enforcement efforts in the FMP represent more effective operations. Coupled with greatly increased penalties for illegal harvest, more effective enforcement effort is expected to result in a high degree of compliance.

The expected harvest is equal to all the legal lobster annually available to the fishery under present conditions. It is substantially less than domestic harvesting capacity. It is, therefore, equal to optimum yield. With improving enforcement and the possible development of an alternative to the use of sublegal lobster as attractants, the expected harvest should increase and approach 12.0 million pounds, the estimated maximum yield at the preferred size limit. Sufficient capacity exists to harvest the probable increase in available yield.

TALFF

Because expected domestic harvest is equal to OY, there is no surplus in this fishery. No TALFF will be declared.

8.2.9 Domestic Annual Processing Capacity

Domestic Annual Processing Capacity (DAPC) is far in excess of the present domestic catch. DAPC is estimated to be at least 11.4 million pounds. This amount is the maximum recorded amount landed and processed in Florida at one time (1972). The amount includes substantial quantities of lobster caught in international waters (Bahamas) which are no longer available. DAPC of at least 11.4 million pounds is feasible because processing requirements are very minimal among all the available seafood processors in the major lobster fishing/landing areas and demand for lobster far exceeds the local supply.

8.2.10 Historical and Projected Transfers from U.S. Harvesters to Foreign Vessels

There are no known historical or projected transfers from U.S. harvesters to foreign vessels.

8.3 Foreign Fishing Activities

No foreign participants are believed to be participating in the spiny lobster fishery within the Fishery Conservation Zone (FCZ). The only known foreign fishermen currently operating within the FCZ off the south Atlantic and the Gulf of Mexico are the Japanese seeking bluefin tuna (a highly migratory species) and there is no known bycatch or gear interaction with the spiny lobster fishery.

There are major spiny lobster fisheries throughout the Caribbean and along the east coast of South America. It has been hypothesized that spiny lobster larvae may be carried considerable distances leading to a "Caribbean origin" for domestic stock of spiny lobster. This would indicate a degree of interaction between the Caribbean and domestic U.S. stocks. This hypothesis has not been proven as yet through research.

8.4 Interactions Between Foreign and Domestic Participants

There are currently no interactions between domestic and foreign participants in the fishery within domestic waters (see Section 8.3). It has been reported that Cuban fishermen, as well as U.S. fishermen, have fished in the Bahamas during recent years. However, there have been no reports of interactions between the U.S. and Cuban fishermen in Bahamian waters.

9.0 DESCRIPTION OF THE ECONOMIC CHARACTERISTICS OF THE FISHERY

9.1 Domestic Harvesting Sector

9.1.1 Commercial Fishing

9.1.1.1 Value of Landings

About 93 to 98 percent of the U.S. commercial landings of spiny lobster are in Florida, primarily in the two southernmost counties, Monroe and Dade. The spiny lobster fishery is very important in the local southern Florida economy because of the high value of the fishery; it currently ranks second in landed value behind the shrimp fishery and the high geographical concentration.

Landings of spiny lobsters are occasionally reported in a number of other Gulf and South Atlantic states. In 1968 and 1969, landings in Georgia accounted for about 10 percent of U.S. landings, but the volume of landings has been insignificant in other years. Small volumes of lobster have also been landed in South Carolina, Mississippi and Alabama. It appears that the lobster landed in these states are harvested in either Florida waters or in foreign lobster fisheries.

The exvessel value of catch has been distributed among the Gulf and South Atlantic states as shown in Exhibit 9-1. Exvessel value is the total amount paid to fishermen for the lobster they sell to fish dealers and represents the direct economic contribution of the spiny lobster fishery. It should be noted that the exvessel values shown do not include any revenues from lobsters sold directly to restaurants or from an alleged "black market" in the sale of poached or illegal-sized lobsters. Most of the legal catch does pass through fish dealers where quantity and value are recorded.

Exhibit 9-1

Exvessel Value of the Spiny Lobster Catch-Gulf and South Atlantic States
(thousands of dollars)

Year	Georgia	South Carolina	Florida (east coast)	Florida (west coast)	Alabama	Mississippi
1965	15	-	752	2,467	-	-
1966	-	-	810	1,659	-	-
1967	-	-	1,058	1,675	-	-
1968	661	-	1,580	2,828	-	-
1969	695	-	1,933	3,325	-	-
1970	-	21	1,830	4,088	-	119
1971	-	-	2,932	4,124	121	336
1972	-	159	6,254	5,517	38	191
1973	-	-	5,748	5,914	1	21
1974	-	-	5,068	8,325	1	-
1975	-	-	3,026	6,837	-*	-
1976	NA	NA	1,734	6,852	NA	NA
1977	NA	NA	2,526	7,899	NA	NA
1978	NA	NA	1,691	10,253	NA	NA
1979	NA	NA	1,743	9,871	NA	NA

NA: Not Available

* Less than $500

Source: NMFS, Fishery Statistics of the United States, Florida Landings, and unpublished data.

The value of the spiny lobster fishery climbed steadily through 1974 as both price and quantity landed increased rapidly. However, much of the growth in value through 1974 resulted from expansion of U.S. fishing efforts into foreign waters. The 1975 closure of Bahamian waters appears to have contributed to a sharp decline in the value of the fishery (despite a continuing increase in exvessel prices), particularly along the Florida east coast. Exhibit 9-2 separates the value of lobster caught in domestic waters from the value of total Florida lobster landings to show the contribution that the domestic fishery makes to the local economy. Exhibit 9-2 also shows the value of lobster landings measured in constant dollars so that the effects of inflation are eliminated. Expressed in constant dollars, the value of the spiny lobster fishery rose 95 percent from 1965 to the peak in 1972, and then declined 42 percent between 1972 and 1979; most of this decline can be attributed to the closure of foreign waters. Real value of landings from domestic waters has slowly but steadily increased.

9.1.1.2 Price and Demand Characteristics

Lobster is a high value product. The only published estimates of demand are NMFS (1974) estimates of price elasticity (-0.65) and income elasticity (1.95). This implies that a one percent increase in landings will decrease exvessel price by 1.54 percent with a net result of decreasing total revenue by 0.54 percent. This would also mean lower prices to the consumer. This situation of a price inelastic demand is common in numerous agricultural markets.

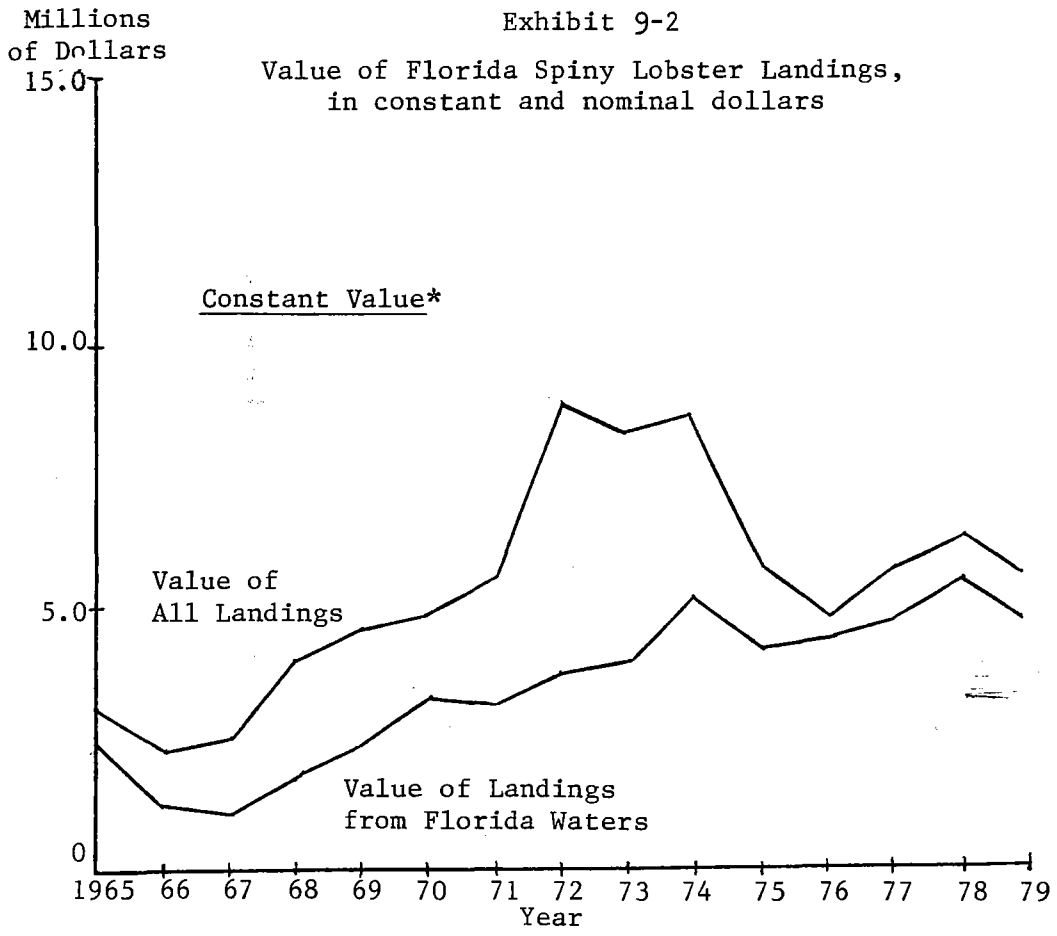
One offsetting condition is the income elasticity of demand (1.95) which indicates that a one percent increase in real disposable income nationally increases the demand for lobster (at a given price) by 1.95 percent. Therefore, as long as per capita national income rises, then the lobster market can absorb present or increased production without decreasing prices. In a recession with decreasing real per capita income, the markets for lobster will be severely limited. Also, in short run situations where income may not increase, price will react to fluctuations in supply.

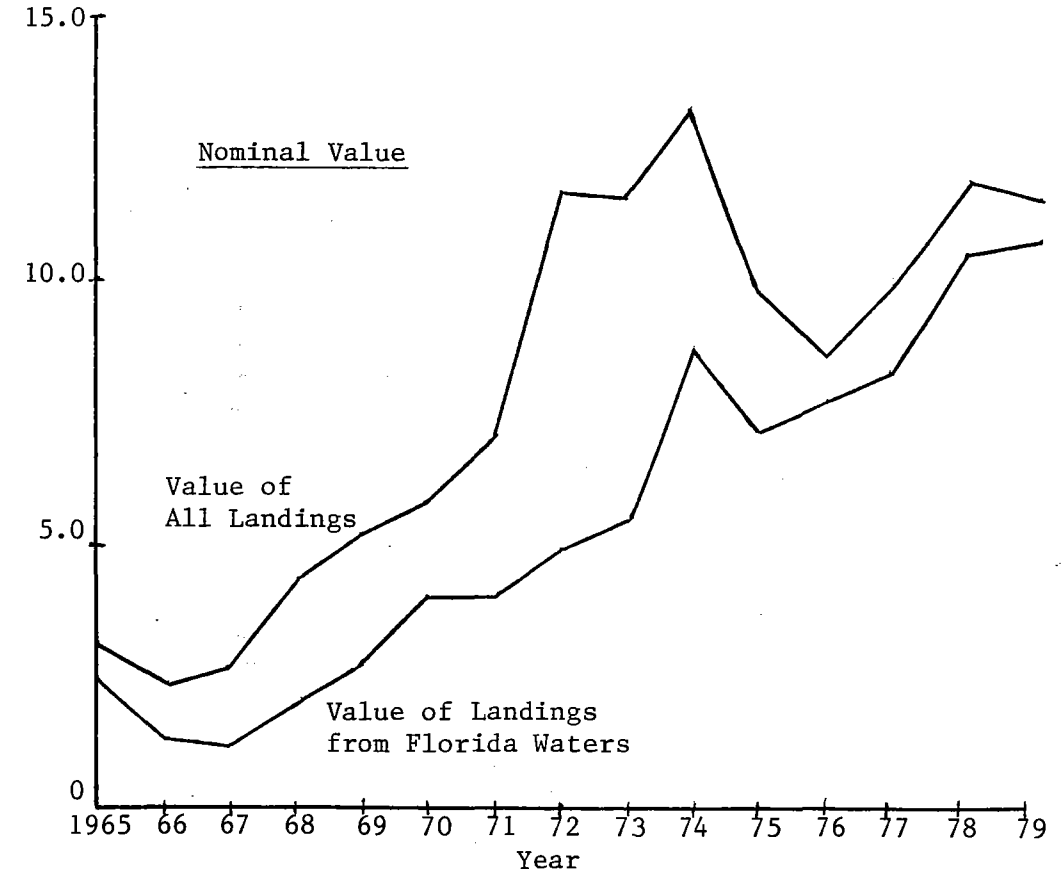
The major weakness with the NMFS estimates is that data on all spiny lobsters (warm and cold water) and American lobster are used. It has not been possible to isolate lobster exvessel demand by species because the prices of the different species are highly correlated. Most recent attempts (Prochaska, personal communication) calculated flexibilities (inverse of elasticities) for Florida spiny lobster during 1952 to 1978. The results differ significantly from the NMFS (1974) values. The results indicate that a one percent increase in landings would only decrease exvessel prices by 0.14 percent. Income elasticity is estimated to be 1.34 which compares favorably with the NMFS value of 1.95. The difference in price elasticities estimated by NMFS and Prochaska are due primarily to Prochaska's inclusion of cross price elasticity that shows that a one percent change in import lobster prices will cause a 0.871 percent change in the domestic exvessel prices. There are sound theoretical, as well as empirical, reasons to believe that the Prochaska estimates are more reliable when discussing only changes in landings in the Florida fishery. The principal reason is Florida's small share of the total U.S. spiny lobster market.

Finally, and an equally important consideration, is that imported and domestic lobster prices are influenced by the size of lobster. Exhibit 9-3 indicates that wholesale prices vary by different sizes of imported tails. This same relationship holds for domestically produced lobster at the wholesale processing level. There is some indication that price by size may vary more when lobster are marketed as tails, as compared to whole lobster. At the exvessel level in the Florida fishery only one price per pound is reflected (Exhibit 9-4). There is very little variation in price by size because fishing practices result predominantly in a 3.0 inch carapace animal or a 5.5 inch tail. This size animal/tail falls mainly into the 5 to 6 ounce and 6 to 8 ounce tail categories. As indicated in Exhibit 9-3, these two size groups are the most valuable groups in terms of wholesale value per pound for warm-water species.

Exhibit 9-2

Value of Florida Spiny Lobster Landings,
in constant and nominal dollars





* Constant Value calculated by adjusting nominal value by Consumer Price Index (1965 = 100) to remove effects of inflation.

Any change in CL would have a two-fold impact on price per pound at the wholesale and exvessel levels. First a change in CL from 3.0 inches to 3.5 inches, as an example, would increase the average tail weight from 7 ounces to 9.8 ounces. This would decrease the price per pound paid for each tail because the average tail has moved into a higher weight class. Specific size distributions are presented below for the present catch (Lyons, et al., manuscript) and projections for the catch at a minimum 3.25 inch CL and 3.5 inch CL based on the formula in Section 5.1.5.8 and assuming a 1:1 sex ratio. Also, the size distribution for a 3.5 inch CL limit was projected by assuming a one-half inch increase in all animals such that the shape of the size-frequency distribution did not change. This assumption is subject to some error due to decreasing growth rate of larger animals, but should not have a serious effect on this projection.

Size Frequency Distribution of Spiny Lobster Catch
at Three Minimum Size Limits

Tail Size (ounces)	3.0 inch CL (present catch)	3.25 inch CL	3.5 inch CL
		Percent	
5 - 6	35.3	0	0
6 - 8	45.3	70.2	15.2
8 - 10	13.0	21.8	48.8
10 - 12	4.2	5.8	22.3
12+	2.1	2.3	13.7

Based on the 1980 prices in Exhibit 9-3, the weighted average wholesale price for the catch would be expected to decrease four percent by changing the CL from 3.0 inches to 3.5 inches. The exvessel price would be expected to decrease as well by four percent because demand is derived from higher marketing (wholesale, retail) levels. This percentage is probably conservative because these prices (Exhibit 9-3) have been established with small quantities of larger-sized tails. If these quantities were to increase substantially relative to the smaller tails, the price decreases would probably be greater. This can be seen in the size frequency distribution above: the most preferred market sizes by wholesale price - 5 to 6 ounce and 6 to 8 ounce tails - decreases from 80 percent of the present catch to 15 percent of the projected 3.5 inch CL catch.

The second impact of changing the CL from 3.0 inches to 3.5 inches, as an example, would be to change the actual price per pound. At the wholesale level, price in each size class would not change appreciably because U.S. landing are a small part of U.S. supplies (Section 9.3). At the exvessel level, price would decrease by approximately four percent from above plus 0.14 (Prochaska, personal communication) times the expected percent increase in landings. Given an average estimate of 11.5 percent increase in landings (see Section 5.4.3), total decrease in exvessel price per pound should be 5.6 percent.

The above analysis of price changes is believed to be representative of the type of price changes which would result from a change in size limit even though not all production goes into frozen tails. A substantial portion of the harvest is sold as whole lobster. In the past, the majority of the harvest was sold in this form. No published data on the price structure of whole lobster are available.

Interviews with the major processors of Florida landings indicate that the price structure for whole lobster is similar to that for tails, although the reduction in price with increasing size is not quite so great. They also reported that the proportion of the total harvest which is processed into frozen tails is large and increasing. At present, frozen tails appear to account for 50 percent or more of the total harvest.

Exhibit 9-3

Wholesale Prices for Imported Spiny Lobster Tails[1]
(dollars per pound, tail weight)

Tail Weight	1975	1976	1977	1978[2]	1980[3]
Cold-Water[4]					
4-6 oz.	$5.54	$7.08	$7.59	$7.47	NA
6-8 oz.	5.52	6.99	7.55	7.46	NA
8-10 oz.	5.60	6.93	7.45	7.39	NA
10-12 oz.	5.64	6.85	7.44	7.29	NA
12-16 oz.	5.71	6.67	7.07	6.78	NA
Warm-Water[4]					
4-6 oz.	4.59	5.89	5.73	6.08	7.72
6-8 oz.	4.62	5.89	5.83	6.17	7.51
8-10 oz.	4.51	5.63	5.60	5.60	7.19
10-12 oz.	4.36	5.38	5.16	5.21	7.04
12-16 oz.	4.41	5.30	5.05	5.02	7.05

1 Annual average computed from monthly price data.

2 Average for January-July 1978.

3 Average for May, August, and December, 1980.

4 There are price differences among spiny lobster sold at wholesale due to differences in quality and size of the lobster. Lobster exported from "cold-water" countries such as South Africa or New Zealand are considered to be tastier and command a higher price than lobsters from "warm-water" countries such as Brazil. The Florida spiny lobster is considered a warm water species.

NA Not available

Source: NMFS, Shellfish Market Review and Outlook. Data based on information supplied by New York importers.

Exvessel spiny lobster prices (Exhibit 9-4) have risen rapidly since 1965, with the U.S. price tripling between 1965 and 1977 (an average annual growth rate of 8.9 percent). During the same period, food prices in the United States doubled (an average annual growth rate of 5.6 percent) so spiny lobster prices have increased substantially in comparision to other food commodities.

Exhibit 9-4

Exvessel Spiny Lobster Prices
(dollars per pound)

Year	South Atlantic	Gulf of Mexico	United States
1965	0.56	0.56	0.58
1966	0.48	0.45	0.49
1967	0.63	0.61	0.64
1968	0.69	0.72	0.72
1969	0.69	0.71	0.72
1970	0.61	0.60	0.61
1971	0.86	0.87	0.88
1972	1.00	1.07	1.05
1973	1.02	1.07	1.06
1974	1.22	1.24	1.24
1975	1.30	1.34	1.30
1976	1.76	1.57	1.53
1977	1.53	1.65	1.75*
1978	1.90	2.18	2.09*
1979	2.12	1.92	2.03*

Note: Price variations between the South Atlantic and Gulf of Mexico may reflect differences in the proportion landings at different times during the season rather than reflecting an actual price difference.

* Preliminary data.

Source: Derived from annual landings and value of landings.

9.1.1.3 Economic Characteristics of the Fleet

Prochaska and Williams (1976) collected costs and returns data from a survey of boats in the spiny lobster fishery during the 1973-74 season. Based on a stratified sample of 25 Florida boats fishing in domestic waters the average gross return was $21,952, with 63 percent of this revenue due to the spiny lobster fishery. The 25 boats participating in the survey harvested 320,700 pounds of lobster worth $346,200 during the season. Since lobster fishing is seasonal, revenues from the lobster fishery are supplemented by fishing for crab or finfish during portions of the year. The average net return to lobster fishing boats was $4,833. Among the largest boats in the sample (greater than 40 feet), gross returns from finfish (primarily the king mackerel fishery) exceed those from the spiny lobster fishery.

Using data from the survey, economic ratios were calculated which related characteristics of the fleet and allow changes in economic performance to be estimated. These ratios, and the resulting estimated economic characteristics of the spiny lobster fleet are shown in Exhibit 9-5. The latest available information on gear and effort in the fishery are for 1975, so this is the year shown. (Figures are adjusted to account for inflation.) Conditions in the spiny lobster fleet have changed appreciably since 1973 (due to a drop in the value of landings and the closure of the Bahamian fishery) and these estimates should be viewed with caution. In particular the recent entry of new boats and gear to the

Exhibit 9-5

Estimated Economic Characteristics of the Florida Spiny Lobster Fleet

Economic Characteristics	Economic Ratio (1973)	1973 Estimates (Million $)	1975[1] Estimates (Million $)
Investment in Boats and Traps (Book Value Less Depreciation)	$18,608/per boat	$12.5	$18.6
Annual Fixed Costs	$ 4,162/per boat	$ 2.8	$ 4.2
Annual Variable Costs (less Crew Wages)	$ 0.260/dollar of landed value	$ 3.0	$ 2.6
Annual Personal Income (Captain and Crew)	$ 0.459/dollar of landed value	$ 5.4	$ 4.5

Note: All figures prorated based on the percentage of gross revenues that boats in the spiny lobster fleet derive from the spiny lobster fishery.

[1] Adjusted for inflation (Wholesale Price Index, 1967 = 100) and increase in number of boats.

Source: See Text.

fishery may cause the investment ratio to understate actual investment in the fishery. (New capital investment will have a higher book value than older investments which are partially depreciated, so the average investment per boat will rise with the new entry.)

In addition to the $4.5 million of personal income which has been estimated to accrue to fishermen in the spiny lobster fishery in 1975, there will be an estimated $2.6 million spent by fishermen on variable expenses such as bait, fuel, and trap repair and replacement. These expenditures in support industries pass through the economy and generate additional expenditures and personal income beyond the direct economic benefits to the fishermen. The $2.6 million of expenditures are divided by type of expenditure (bait, fuel, etc.) using the survey data in Prochaska and Williams (1976). Exhibit 9-6 presents economic impact ratios which related expenditures in fishery related sectors to employment and personal income in those sectors. Multiplying the personal income ratios by the expenditures by type yields an estimate of $1.3 million of personal income attributable to spiny lobster in industries which support fishing efforts. These estimates of personal income are summarized in Exhibit 9-7, along with personal income contributions made by other economic sectors dependent on the spiny lobster fishery.

Exhibit 9-6

Economic Impact Ratios for Commercial and Recreational Fishing Expenditures
(1972 dollars)

Category	Employment Per $1,000 Sales	Wages and Salaries Income Per Dollar Sales
Bait Expense	.01486	.09231
Trap Expense*	.04659	.26401
Boat Repair Expense*	.04218	.48123
Food Expense	.06410	.25002
Lodging Expense	.06062	.28995
Transportation Expense	.02459	.13660
Boat Fuel Expense	.01996	.09400
"Other" Recreational Expense	.02208	.12000
Boat Purchases	.03662	.26316

* Derived from the 1972 Census of Manufacturers (U.S. Department of Commerce). Ratios are estimated using Sector 24491-Wirebound Boxes to represent trap expenses and Sector 37316-Non-military Ship Repair to represent boat repair expenses.

Source: Centaur Management Consultants, Economic Activity Associated with Marine Recreational Fishing, 1977.

Exhibit 9-7

Estimated Personal Income Associated with the Spiny Lobster Fishery
(millions of dollars)

Personal Income Category	1975 (estimated)
Commercial:	
Direct Harvesting Sector	$4.5
Sectors Which Supply Goods And Services to Fishermen	1.3
Lobster Processing Plant	0.9
Total Commercial:	$6.4
Recreational:	
Trip Related Expenditures	$0.5 - $0.6
Boat and Equipment Purchases	( ) [1]
Total Recreational:	$0.5 - $0.6
TOTAL:	$6.9 - $7.0

[1] Cannot be reliably estimated

Source: See Text.

Exhibit 9-8

Net Returns to Ownership among Florida Lobster Fishermen
(1973-1974 season)

Boat Size (feet)	Net Return	Hours Worked	Investment
16-22	$3,034	556	$ 3,875
24-28	5,975	800	14,412
31-36	6,827	888	21,175
40-55	2,493	653	47,238
All Sizes	4,833	733	18,608

Note: All figures prorated based on the percentage of gross revenues that boats in the spiny lobster fleet derive from spiny lobster findings.

Source: Prochaska and Williams, 1976.

Exhibit 9-8 shows the amount of invested time and capital among captains of different sized boats. Using these figures, net return to ownership (profit) for the lobster fishery can be computed. Profit is equal to the net return received by a fisherman for lobster less the value of invested labor and the opportunity cost of invested capital. If the net return to ownership is positive, fishermen will be encouraged to expand efforts in the fishery and new fisherman will be attracted. Based on calculations made by Prochaska and Williams (1976) the net return to ownership among lobster fishermen was negative for the 1973-74 season, among all size classes with the average net return to ownership a negative $1,787.[1] This would suggest a strong incentive for fishermen to leave the fishery when in fact the opposite has occurred. There are several possible explanations. The opportunity costs shown may overstate the range of alternative uses of time and money available to fishermen. Fishermen may have strong traditional ties to their occupation and they may be willing to invest the long poorly-compensated hours of effort required because of the satisfaction they derive from their work. They may also view the investment in their boat as a one-time "sunk-cost" and may not consider depreciation expense when evaluating their participation in the fishery. (With inflation, this may be more realistic than including a derived value of depreciation expense among out-of-pocket fishing costs.) Fishermen may participate in other fisheries during the spiny lobster off-season which may allow a greater portion of fixed costs to be offset against the other fisheries. Finally, at the time the survey was taken, the Internal Revenue Service was engaged in an investigation of income reporting among fishermen and this could possibly bias the data reported.

The closure of Bahamian waters to U.S. based fishermen created economic problems for those fishermen (primarily along the Florida east coast) who had been dependent on these waters for their livelihood. It should be noted that the Economic Development Administration (U.S. Department of Commerce) contributed about $2.3 million in a combination grant-loan for boat mortgage payments, boat conversion costs and living expenses to aid those most affected by the Bahamian fishing ban. Fishermen receiving aid for boat conversions agreed as part of the contractual low interest loan not to fish for spiny lobster in Florida (Austin, et al., 1980b).

[1] Based on $7.00/hour as the value of labor (the average crew wage) and 8.0 percent as the opportunity cost of capital.

9.1.1.4 *Fleet Organization*

Williams and Prochaska (1977) investigated the organization of the domestic spiny lobster fishery using data derived from the survey of 25 lobster boat fishermen described above. Their conclusion was that the fishery in 1973 was not achieving maximum economic yield (highest total profits). The actual and profit maximizing organizations of the domestic fleet (excluding fishing efforts in foreign waters) are shown below.

	Actual (1973)	Profit Maximizing (1973)
Number of Boats	339	213
Traps per Boat	429	795
Total Traps	171,171	169,335
Landings (millions of pounds)	5.4 (est.)	5.8
Cost	$2,725,549	$2,355,407
Returns/Boat	6,667	18,350

At the profit maximizing level overall industry costs would be less, and net return for the remaining firms would rise sharply. The number of traps employed in 1973 would remain virtually the same. Since 1973 the number of traps has more than doubled. Therefore, this profit maximizing organization today would also require reducing the number of traps fished by approximately one-half (Section 5.4.1).

In the case where maximum economic profits and efficiency are not the sole criteria for determining the "optimum" organization of the industry or fishery, economic considerations can be modified such that other goals may be incorporated in the decision framework. The goal may be to maintain employment or the number of fishing firms at some current or desired level. Given the level of desired employment, the optimum economic organization under this constraint may be determined. As an example, Exhibit 9-9 was constructed from models and data provided by Williams and Prochaska (1977) to show economic consequences of maintaining employment at the 1974 level of 399 firms.

Exhibit 9-9

Economic Returns for Various Levels of Traps Per Firm

Traps per firm	Landings	Total Revenue	Total Cost	Total Profits	Profits per firm
	million pounds or dollars				(dollars)
200	1,407,782	1,520,405	1,670,214	- 149,809	- 375
400	5,007,723	5,408,341	2,591,904	2,816,437	7,058
580	6,124,945	6,614,941	3,421,425	3,193,516	8,004
600	6,207,703	6,704,319	3,513,594	3,190,725	7,997
795	6,796,372	7,340,082	4,412,241	2,927,841	7,338
1000	7,167,687	7,741,102	5,356,974	2,384,128	5,975

Note: Based on 399 firms in the industry using data from a survey of lobster fishermen during the 1973-74 season. Dollar figures are based on 1973-74 prices and have not been adjusted to account for inflation.

Source: Williams and Prochaska, 1977.

As each firm increases the number of traps fished from 200 to 1,000 per firm, total industry landings, revenues and costs increase. Net revenues are negative if each firm fishes only 200 traps. Maximum industry revenues and per firm revenues are maximum at 580 traps fished per firm. Several economic trade-offs occur in this situation. Under the constraint of maintaining employment at 399 firms, industry profits are reduced from $3,908,550 with 213 firms to $3,193,516 with the 399 firms each fishing 580 traps. Per firm profits drop from $18,350 under the economic optimum to $8,004 under the constrained optimum with 399 firms. Another trade-off is that the constrained optimum solution calls for 580 traps per firm compared to the 795 traps when only 218 firms would fish. Total industry costs are higher at $3,421,421 compared to $2,355,407 under the optimum solution. However, it should be noted that the constrained optimum is an economically "better" solution to the actual situation in the 1973-74 data base season. Both industry profits and per firm profits are above those in 1973-74. This is because the constrained optimum solution requires 580 traps per firm compared to the 429 which were fished on the average during the 1973-74 season.

An alternative goal for reorganizing the industry may be to fix traps per firm at some level and let the number of firms vary. Calculations in Exhibit 9-10 illustrate economic consequences of this alternative for three selected levels of traps per firm.

If the goal is to allow the existing (1973-74) average number of traps per firm of 429, the constrained economic optimum number of firms would be 271. This would be less than the number existing in 1973-74 but more than the 213 suggested by the overall economic optimum solution. Economic profits to the industry and on a per firm basis would be above existing levels but below those in the overall economic optimum solution. As the number of firms increase above 271 (each fishing 429 traps) profits decrease.

Exhibit 9-10

Economic Returns to the Industry and Per Firm for Varying Number of Firms and Traps per Firm Fishing in the Industry

Traps per Firm	Number of Firms	Landings (million pounds)	Total Revenue (million dollars)	Total Cost (million dollars)	Industry Profits (million dollars)	Profit Per Firm (dollars)
429	271	4,700,416	5,076,449	1,851,201	3,225,248	11,901
429	400	5,253,991	5,674,310	2,732,400	2,941,910	7,355
429	500	5,486,578	5,925,504	3,415,500	2,510,004	5,020
300	307	3,458,368	3,735,037	1,639,689	2,095,348	6,825
300	400	3,810,659	4,115,511	2,136,400	1,979,111	4,948
300	500	4,043,246	4,366,706	2,670,500	1,696,206	3,392
700	225	5,648,964	6,100,881	2,243,475	3,857,406	17,144
700	400	6,550,437	7,077,712	3,984,400	3,093,312	7,734
700	500	6,786,057	7,328,942	4,985,500	2,343,442	4,687

Source: J. Cato and F. Prochaska, unpublished data.

A reduction in number of traps, for example, to 300 per firm may be suggested to allow more employment. With 300 traps per firm, the optimum number of firms would be 307. This is more than the previous optimum number of firms considered with each fishing more traps but less than current levels. However, net profits are below those currently existing in the industry (approximately $2,664,123 in 1973-74 compared to $2,095,348). Under this alternative, too few traps are allowed per firm to be profitable.

As a last consideration, if the number of traps per firm were allowed to expand to an average of 700 to take account of internal economic efficiencies, the constrained optimum number of firms would be reduced to 225 firms. Profits would be increased above those achieved with greater trap limitations, but would be slightly less than that predicted for the overall economic optimum solution. With the required reduction in number of firms for the constrained optimum solution, profits would be above those estimated for the 1973-74 season.

Since 1973 spiny lobster prices have risen sharply and the economic optimum may have shifted to a greater number of traps and traps per boat. The effect of a change in price on the number of traps and firms that enter the fishery can be illustrated using the 1973 models. The economic concept employed is that relating to the additional value generated from placing one more unit (trap or firm) in the fishery.

As the price of lobster begins to increase, each firm will be enticed to fish more traps if the return generated from using the trap is larger than the cost of placing it in service and fishing the trap.

Using the marginal productivity of a trap for the composite firm in 1973 (Williams and Prochaska, 1977) the marginal cost of fishing an additional trap ($11.55) is equal to the marginal value of additional landings at 1,500 traps per firm. That is, a firm operating as described as average in 1973, would continue to add traps until the 1,500th trap were added as long as price were $1.08 per pound (1973 average). The largest and most efficient single vessel operation cannot fish more than 3,000 to 5,000 traps. A 10 percent price increase to $1.19 would cause firms to add traps until 2,242 traps were used. The 10 percent price increase would cause a 49 percent increase in the number of traps per firm. At $2.00 per pound, the optimum number of traps would be 19,133. This implies that prices in the fishery encourage fishermen to fish the maximum number of traps that are physically possible to handle.

Because firms could not respond to these price increases through adding traps per firm the obvious response would be through adding firms. At $1.08 per pound, the optimum number of firms (each fishing 429 traps) would be 271 (Exhibit 9-10). Using this as a base, the ten percent price increase would cause a new level of 285 firms. At $2.00 per pound, 369 firms would be the optimum solution.

Each of the previous two paragraphs must be considered separately. The first analyzes the response of the individual firm through adding traps as the price increases, holding the number of firms constant. The second paragraph analyzes the response of all firms to a price increase, holding the number of traps per firm constant. In the fishery, both the number of firms and traps per firm have increased simultaneously. The analysis does demonstrate that the fishery is very price sensitive and that the large increase in firms and trap numbers up until 1974 has been the result of large price increases.

9.1.2 Recreational Fishing

Recreational participants in the spiny lobster fishery purchase considerable amounts of goods and services in pursuing this part-time. Many participants use their own boats and SCUBA gear, requiring a considerable investment in the fishery. Each time a trip is made to go diving for lobster, there are additional expenses for items such as food, lodging and gasoline. These purchases create and sustain employment and personal income in the production, distribution, and retail sale of the goods and services bought. This employment and personal income is spread throughout the United States particularly for durable goods such as boats and SCUBA gear which may be manufactured in areas distant from Florida.

There are severe practical and conceptual difficulties with identifying the economic effects associated with recreational diving for spiny lobster. From a practical perspective, data on the actual participation and gear employed are incomplete, making the validity of the estimates given somewhat doubtful. It has not been possible to estimate the economic effect of purchase of durable goods (e.g., boats and SCUBA gear) due to lack of data. Conceptually, it must be recognized that divers may derive social benefits from diving such as a chance to "get away from it all", or enjoyment of the natural environment and these social benefits may be quite independent of the actual availability of the spiny lobster. Despite these limitations, the estimates of the economic effects of recreation diving for spiny lobster presented in this section provided a useful measure of importance vis-a-vis other types of recreational fishing.

The approach used to estimate economic effects is as follows. First, the expenditure pattern for a typical spiny lobster diver is determined and expressed as expenditures per diver per day. These expenditures are multiplied by the estimated total days of diving in the fishery to yield an estimate of total direct expenditures associated with spiny lobster diving activity. Finally, these total expenditures are multiplied by economic impact ratio in Exhibit 9-6, which relate expenditures to employment and personal income.

Exhibit 9-11 shows the kind of recreation expenditures made by "typical" divers, a local diver (Monroe, Dade, or Collier County) who periodically makes a one-day diving trip using a private boat and a diver from central Florida (chosen to represent a typical travel distance) who travels to the Florida Keys for a five-day vacation. The relative contribution made by local and non-local divers is weighted using the figures contained in Exhibit 8-4 to derive an estimate of total trip-related recreational expenditures per diver per day. This estimate is multiplied by the total diving activity (middle estimate) shown in Section 8.2.1.2, yielding a range of between $3.1 and 4.2 million for trip-related recreational expenditures (1975). Most of these expenditures will be concentrated in the local Florida economy. Personal income associated with these recreational expenditures is estimated between $0.5 and $0.6 million dollars using the economic impact ratios given in Exhibit 9-6.

By comparison, it has been estimated that in 1975 the expenditures associated with saltwater angling activity in the South Atlantic and Gulf of Mexico regions were $289 million and $64 million respectively (Centaur Management Consultants, 1977).

These personal income estimates do not include the contribution by recreational divers purchasing new boats and SCUBA equipment. It is not possible to estimate these expenditures due to limited data on the number and characterstics of recreational participants. However, expenditures on new boats are expected to be smaller than or similar in magnitude to trip related expenditures (See Section 8.2.5).

9.2 Domestic Processing Sector

In contrast to the American lobster, the spiny lobster is seldom retailed live. Most lobster landed in Florida are trucked from fish dealers ("fish houses") to processing plants in the Miami area, the Tampa area, or the Florida Keys. Processing is heavily concentrated in Miami. NMFS records (1975) list 17 processers in Florida dealing with spiny lobster. Four of these processors (all in Miami) deal exclusively with spiny lobster. These 17 processors appear to account for about 85-90 percent of the lobster processed in Florida. Remaining processing occurs at smaller or incidental processers and is not reported. The distinction between fish dealers and processors is often not clear and there is some overlap with combination dealers/processors, and dealers who also process lobster. There are 29 fish houses listed by NMFS[1] that play a major role in the spiny lobster industry and seven of these fish houses are combination dealer/processors. (The fish house is not necessarily located in the vicinity of the processing facility.)

---

[1] NMFS Wholesaler and Processor Data, unpublished.

Exhibit 9-11

Boating Trip Expenditures
(dollars per person per day)

Expense Category	Visitor from Central Florida	Local Diver
Food	$ 8.60[1]	( )[2]
Lodging	15.00[3]	-
Transportation	7.50[4]	$ 1.80[5]
Miscellaneous	7.30[1]	13.80 - 18.30[6]
Diving Costs	7.10 - 22.00[7]	2.60 - 6.50[8]
TOTAL	45.10 - 60.40	18.20 - 26.60

1 Reported by Gentle (1977) in a study of the Dade County charter boat fishery.

2 Included in miscellaneous

3 Based on typical rates of $17-$30 per night (hotel) and assuming double occupancy.

4 Assumes 500 miles round trip at $0.15 per mile averaged over a five day vacation with two people.

5 Transportation to a local marina: 12 miles (Austin, et al., 1977) at a $0.15 per mile.

6 Based on a range of trip supply expenditures reported in Austin, et al., (1977). The lower bound is for boats less than 16 feet in length while the upper bound is for boats 21-25 feet in length. Reported figures have been divided by two assuming two persons per boat.

7 The lower bound assumes a private boat with costs as follows: 7.4 gallons fuel (Austin et al., 1977) at $.699 a gallon averaged over two people. Cost of $4.50 per person to fill three air tanks. The upper bound assumes a charter boat trip costing $18.50 plus an additional $3.50 for air.

8 Includes only the cost of boat fuel. (Other costs are already incorporated in the "miscellaneous" figure.) A range of 7.4 to 18.6 gallons of fuel use is reported by size of boat (Austin et al., 1977). The figures shown is based on a fuel cost of $.699 per gallon.

City	Processors	
	Total	With Associated Fish House
Miami	11	6
St. Petersburg	2	1
Tampa	1	0
West Palm Beach	1	0
Riviera Beach	1	0
Islamorada (Florida Keys)	1	0
	17	7

Spiny lobster are processed into two major forms. For raw frozen tails, the tail section is separated and frozen. The majority of imports are in this form, due to low shipping weight (about one third the weight of a whole lobster) and consumer acceptance. Cooked whole lobster are boiled and split open before being frozen. Up to half the lobsters processed in Florida are in this form. After freezing, lobsters are stored locally until sold to retailers. Exhibit 9-12 presents data on the quantity and value of lobster processed in Florida.

Exhibit 9-12

Florida Lobster Processing

Year	East Florida Raw Tails (1000 lbs)	East Florida Cooked Whole (1000 lbs)	West Florida Raw Tails (1000 lbs)	West Florida Cooked Whole (1000 lbs)	Florida, Total Quantity (1000 lbs)	Total Value ($1000)
1965	242	1,073	*	*	1,799	1,220
1966	258	2,183	*	*	2,957	1,973
1967	262	1,743	*	*	2,969	1,956
1968	815	1,654	*	*	4,099	3,474
1969	879	2,536	*	*	5,173	4,591
1970	1,000	1,231	-	-	4,231	3,554
1971	1,436	2,019	*	*	6,327	7,522
1972	1,775	4,447	*	469	10,241	14,847
1973	1,339	2,241	796	936	9,582	13,303
1974	1,227	2,559	*	950	7,190	9,372
1975	659	1,636	1,289	1,340	8,820	14,778
1976	483	847	1,294	565	6,743	13,315

Note: Raw tails are shown in actual weight. Total Florida quantity is shown in round weight using a conversion factor of 3.0 for raw tails.

* Not separately reported.

Source: NMFS, Fishery Statistics of the United States and NMFS, Processed Fishery Products, 1975 and 1976.

The primary market for Florida processed spiny lobster is restaurants in Florida and other Southeastern and Midwest states. Lobster are occasionally sold in supermarkets or retail fish markets, but demand is low. Retail prices for spiny lobster are not readily discernible, due to characteristics of the retail market. One discernible trend in restaurants, hotels, and other institutions is to substitute smaller tails in the serving portion. While smaller size tails command a higher price per pound than larger size tails, these retail outlets minimize their total costs for lobster per serving. This is becoming a commonly-used tactic by retail outlets in recent inflationary periods.

Wholesale and exvessel prices of spiny lobster are compared in Exhibit 9-13. Wholesale prices are estimated from the processing data in Exhibit 9-12. Wholesaler margins have recently averaged about $0.35 to $0.40 per pound, which is about 20 to 30 percent of the exvessel price. Wholesale prices reported in the New York area are somewhat higher than those in Florida, apparently due to the higher quality of imported lobster (texture and taste of the Florida lobster is considered inferior to species from cold water countries such as South Africa or New Zealand) and the greater cost of transportation and handling. For example, in 1975 the wholesale price for imported 6 to 8 ounce warm-water tails[1] was $1.54 per pound round weight, compared to $1.30 for Florida processed lobster. It is generally acknowledged that smaller lobster and tails are more tender and sweet which accounts for their higher prices than larger lobster and tails.

[1] Reported in NMFS, Shellfish Market Review and Outlook. Monthly data was averaged and divided by a factor of 3.0 to convert to round weight. Imports are distinguished as cold-water and warm-water and by size. Florida spiny lobster is considered a warm-water species, and 6 to 8 ounce. tail weight is typical of lobsters taken in the fishery.

Exhibit 9-13

Processor/Wholesaler Margin

Year	Florida Wholesale (Price/Pound)[1]	Florida Ex-Vessel (Price/Pound)	Processor Margin[2]	Margin Percentage of Wholesale Price
1965	$0.68	$0.56	$0.16	23.5
1966	0.67	0.46	0.18	26.7
1967	0.66	0.62	0.20	30.3
1968	0.85	0.72	0.22	25.9
1969	0.89	0.69	0.24	27.0
1970	0.84	0.60	0.25	29.7
1971	1.19	0.86	0.27	22.7
1972	1.45	1.03	0.29	20.0
1973	1.39	1.04	0.31	22.3
1974	1.30	1.23	0.33	25.4
1975	1.68	1.33	0.35	20.8
1976	1.97	1.61	0.37	18.8
1977		1.62		
1978		2.13		
1979		1.95		

[1] Price per pound round weight. Tail weight is converted to round (whole) weight using multiplier of 3.0.

[2] Processor/wholesaler margin is the difference between the exvessel price and the whole sale price. (Most processors will also wholesale their processed lobsters.)

Source: Calculated from data in Exhibits 8-5 and 9-12

Economic characteristics of spiny lobster processors are difficult to separately identify, since data is most frequently combined with finfish, stone crab, and other species. Wage and salary compensation tends to be low in the processing industry with average annual salary on $5,699 (County Business Patterns, 1975; average for Florida SIC Code 2092-Food Processing, Fresh and Frozen Seafood). In 1975 there were 3,047 workers employed in processing establishments in Florida with 494 of these workers in Dade County. This compares with an estimated 159 processing workers associated with the spiny lobster fishery (See Section 8.2.5.1). Based on the average Florida salary, these 159 workers receive a total of $0.9 million dollars of personal income, annually.

In 1972 when spiny lobster landings reached an all-time high, processing firms were able to meet the demands on their facilities. Given the current trend in landings, processing capacity appears more than sufficient to process future supplies of spiny lobster.

9.3 International Trade

Over 90 percent of the spiny lobster consumed in the United States is imported, as shown in Exhibit 9-14. The volume of imported lobster has remained relatively constant during the last decade, ranging from a low of 117 million pounds in 1966 to a high of 168 million pounds in 1976. Future imports are not expected to increase significantly because world stocks of lobster are already heavily fished, there is little capacity for increased harvest, and demand in other countries is as strong as in the United States. In fact, U.S. imports as a percentage of world production has been declining since 1947 (NMFS, 1974).

Estimated MSY for the world (all lobster species) is 424 million pounds and the 1972 world consumption of 375 million pounds is 88 percent of world MSY.[1]

Most imported lobster are in frozen tail form. There is a small market for imported canned lobster and a small market for imported live lobster from the Caribbean. (Presumably the live imports are processed in Florida before subsequent distribution.)

New York is the predominant port-of-entry for spiny lobster destined for eastern markets while San Francisco and Los Angeles are the ports-of-entry for the western markets. To a lesser extent, the ports of Miami and Tampa-St. Petersburg also serve as a port-of-entry for imports to Florida and southeastern markets.

Australia, Brazil and South Africa are the major countries exporting spiny lobster to the United States, as shown in Exhibit 9-15. Imports from Australia, New Zealand and South Africa are considered as "cold-water" lobster and distinguished from other imports which are considered "warm-water" lobster. Several trends are evident in the import data. Most significant is the increase in imports from "other" countries. This reflects the development of fisheries in new areas, as rising prices have spurred development of the lobster industry in previously underutilized fisheries. The decline in imports from South Africa was due to conservation restrictions imposed in the late 1960's to protect the lobster fishery. In Brazil, a closed season was instituted in 1975-76 (NMFS, Shellfish Market Review and Outlook), but this does not seem to have had a major effect on imports from Brazil. In Australia, imports to the United States have risen slightly since imposition of a limited entry and biological monitoring system in January 1975 (Beardsley, et al., 1975).

Imports into customs districts in Florida are shown in Exhibit 9-16. The vast majority of imports are from nearby countries bordering on the Gulf of Mexico and the Caribbean Sea. About 40 percent of the spiny lobster imports from the Caribbean area (most of which are *P. argus*) enter the United States through Florida.

There are no tariff restrictions on lobster imports and all lobster products are admitted to the United States duty free. There is no export market for domestic spiny lobster except for a small volume sold to Canada through Midwest distributors.

---

[1] These estimates are reported in NMFS (1974) and attributed to Bell (1970) and the FAO (1972), respectively.

Exhibit 9-14

U.S. Spiny Lobster Supply (Landings and Imports)*
(thousands of pounds, live weight)**

Year	U.S. Landings	Imports			Total U.S. Supply	U.S. Landings as a Percent of Total Supply
		Live	Canned	Frozen/Other		
1965	6,237	591	560	120,174	127,562	4.9
1966	5,844	322	683	119,613	126,462	4.6
1967	4,868	301	647	115,562	121,378	4.0
1968	7,476	259	925	137,861	146,521	5.1
1969	8,781	309	1,311	143,966	154,367	5.7
1970	10,345	149	442	119,605	130,541	7.9
1971	8,941	348	458	133,627	143,374	6.2
1972	12,215	370	413	139,431	152,429	8.0
1973	11,432	373	583	122,846	135,234	8.5
1974	11,078	327	414	131,831	143,650	7.7
1975	7,654	265	486	142,015	150,420	5.1
1976	4,889	352	3,127	164,506	172,874	2.8
1977	5,483	297	1,466	148,858	156,104	3.5
1978	4,629	NA	544	129,102	134,275	3.4
1979	6,301	NA	583	133,251	140,135	4.5
Average 1965-1979	7,745	328	843	133,483	142,355	5.5

* Does not include recreational catch. Supply may differ from domestic consumption because of net inventory change and losses due to spoilage.

** Imports were converted to equivalent live (round) weight using factors of 3.00 for tails and 4.35 for canned and other.

Sources: U.S. Department of Commerce, National Marine Fisheries Service, Fishery Statistics of the United States, various years.

Exhibit 9-15

Imports of Spiny and Rock Lobster by Country or Area of Origin
(thousands of pounds, live weight)

	1965	1970	1975	1976	1977
Total Imports for Consumption	121,326	120,196	142,766	167,985	150,621
Imports by Country or Area (Percent of Total):					
Australia	23.8	22.3	19.9	17.7	19.3
Brazil	6.7	15.1	11.4	9.5	10.5
Chile	5.3	3.7	6.8	13.3	9.3
New Zealand	7.7	12.3	6.4	5.7	5.7
South Africa	30.5	14.9	11.7	10.8	7.8
Caribbean/Latin America	13.1	15.7	18.9	19.4	21.6
Other	12.9	16.0	24.9	23.6	25.8

Source: U.S. Department of Commerce, U.S. Imports for Consumption, Series FT-246 1965 through 1977.

Exhibit 9-16

Spiny Lobster Imports to Florida
(1977)

	Miami Customs District	Tampa/St. Petersburg Customs District
Total Imports (thousands of pounds, live weight)	10,801	3,276
Imports by Country (percent of total)		
Caribbean	31.5	4.5
Latin America	65.1	86.8
South America	1.6	0.0
Other	1.9	8.7

Source: U.S. Department of Commerce, unpublished data.

10.0 DESCRIPTION OF THE BUSINESS, MARKETS, AND ORGANIZATIONS ASSOCIATED WITH THE FISHERY

10.1 Relationship Among Harvesting, Brokering, and Processing Sectors

Consumer acceptance for spiny lobster in frozen form (both raw tails and cooked whole) is high and as a consequence virtually all spiny lobsters landed in Florida are processed and frozen before entering retail markets. Few restaurants purchase live spiny lobster due to its high perishability. (The American lobster is predominantly retailed in live form and the spiny lobster offers restaurants a convenient alternative.) Commercial fishermen sell their catch to local fish dealers ("fish houses") who in turn sell the spiny lobster to fish processors. Processors store the frozen spiny lobsters until they can be sold to a secondary wholesaler or a restaurant. Vertical integration is quite prevalent in the industry with many of the fish dealers operating processing facilities, storage freezers, and functioning as secondary wholesalers by selling directly to restaurants in addition to running fish houses. Brokerage firms are reported to be relatively unimportant in the marketing structure for domestic spiny lobster because recent high prices have tended to reduce the number of "middlemen" involved in selling spiny lobster. Direct selling, from dock to retail level, may eliminate some marketing channels.

Brokerage firms are more heavily involved in the marketing structure for imported spiny lobster, although a number of fish dealers who handle domestic spiny lobster are also heavily involved in the import market. In 1977, imports of spiny lobster into Florida customs districts totaled 14.1 million pounds (round weight), almost three times the volume of the domestic harvest.

10.1.1 Industry Structure

Historically, spiny lobster fishermen have maintained a rather close relationship with the local fish dealers (fish houses) to whom their catch is sold. The fish dealers provide a guaranteed market for the catch and provide boat services such as ice, fuel and equipment for a fee, and docking facilities. They may also help in arranging financing for new boats. Fishermen feel an allegiance to the fish dealers and generally market their catch exclusively at a single fish house. This relationship is similar to that in other Florida fisheries. It should be noted that Florida law prohibits recreational fishermen (those without a commercial license) from selling their catch to fish houses. There are, however, a number of quasi-recreational divers who have obtained commercial licenses and fish both for the enjoyment and the supplemental income. Spiny lobsters caught by these divers are generally sold to fish houses. In 1975, NMFS statistics recorded that landings by commercial divers accounted for about two percent of total commercial landings. It should be noted that some fishermen will sell lobsters directly to restaurants rather than selling through a fish house. There is little information available on which to estimate the volume of these direct sales and a figure of 10 percent of the reported commercial harvest has been used earlier (Section 5.4.1) as a rough estimate of the importance of these direct restaurant sales.

According to an unpublished listing by NMFS (1975, see Section 9.2), there are 29 fish houses in Florida dealing in spiny lobster on a regular basis. Nine of the firms are located in the Miami area. The remaining 20 are located along the Florida Keys, primarily in Key West (seven firms), Marathon (five firms) and Key Largo (three firms). In addition to these 29 firms, there are a number of fish houses in other areas which occasionally deal with spiny lobster on a small volume or incidental basis.

Fish dealers in the Florida Keys often truck lobster to Miami or Tampa/St. Petersburg for processing and subsequent freezer storage. In Miami, fish houses frequently have processing facilities located on premises so no transfer is required. Owing to the high value and rapid perishability of spiny loster, the relationship between the fish houses and the processors is quite close. Seven of the 29 fish houses dealing in spiny lobster are owned by firms which also own processing facilities. The domestic processing sector has been described in Section 9.2.

10.1.2 Market Structure

Processors play a primary role in the spiny lobster marketing structure, often serving as secondary wholesalers (brokers) and selling directly to restaurants or wholesalers located in out-of-state market areas. Spiny lobster is a high demand item and finding buyers seldom presents difficulties. Processors generally have freezer capacity to store lobsters until sales can be arranged. Some processors are also heavily involved in the importation of spiny lobsters.

Many of the domestically produced and imported spiny lobsters are consumed in Florida although shipments throughout the United States and into Canada are reported by some dealers. Information on out-of-state shipments is not compiled and the actual volume of lobsters shipped from Florida is not known. Marketing practices vary considerably from processor to processor, with some selling primarily in Florida and others selling considerable volumes out-of-state.

With prices rising rapidly, there has been an apparent tendency for restaurants to lower costs by dealing directly with processors rather than through a "middleman". Few sales of domestic lobsters are reported to be arranged by brokers and it appears that brokerage activity is generally limited to out-of-state sales.

10.2 Fishery Cooperatives or Associations

There are some fishery cooperatives located along the Florida Keys which are involved primarily with the spiny lobster fishery. The number of fishermen involved is reported to be small, but includes some of the larger operators in the fishery. In general, rising exvessel lobster prices and the tight vertical integration of the industry have acted to discourage the formation of cooperative marketing organizations.

Commercial lobster fishermen are served by a number of different fishing associations in Florida. Local chapters of these organizations in southern Florida have large numbers of lobster fishermen as members and have been actively supporting fishermen's interests in the lobster fishery. Other associations have also been involved in serving various constituency groups within the spiny lobster industry (e.g., processors or fish dealers).

Several years ago a number of fishermen in the Keys banded together to combat problems with poaching from their traps. The group hired a surveillance plane which overflies members' traps. Enforcement is handled by contacting the Florida Marine Patrol when poachers are observed.

There are a large number of diving clubs and other recreational organizations in Florida with an obvious interest in the various Florida fisheries. There are 43 local diving clubs in Florida affiliated with the Florida Skindivers' Association at a local level. Diving clubs bring together people with a common interest in skin-diving and some clubs periodically organize outings to the Florida Keys to dive for lobster. In general, however, lobsters probably receive less attention from the diving clubs than do various popular species of finfish which are hunted with spearguns.

10.3 Labor Organization

There are no known labor organizations in the harvesting or processing sectors that are involved in the fishery.

10.4 Foreign Investment

There is no known foreign investment in the domestic sectors of the fishery.

11.0 SOCIAL AND CULTURAL FRAMEWORK OF DOMESTIC FISHERMEN

11.1 Ethnic Character, Family Structure and Community Organization

In Miami, where a considerable population of Cuban-Americans has settled in recent years, there are many Cuban-American fishermen in the lobster fleet. In Key West there is a concentration of people with Spanish surnames both among local fishermen and in the community at large. In other areas of Florida the concentration of ethnic minorities among spiny lobster fishermen is relatively small.

Exhibit 11-1 shows the number of spiny lobster licenses held by people with Spanish surnames by area. This information was derived from a list of those holding spiny lobster licenses kept by the Florida Department of Natural Resources. There are 1,701 individuals with spiny lobster licenses for the 1977-78 season shown on the list (corporations holding licenses were not included in the analysis) and 24.1 percent of these license holders have Spanish surnames. In the 1965-66 season only 8.2 percent of the individuals holding licenses were people with Spanish surnames. Ethnic characteristics of selected communities in southern Florida from data in the 1970 Census of Population are shown below for comparison.

Selected South Florida Population Characteristics, 1970

	Percent Spanish[1] Speaking	Percent Non-Caucasian
Monroe County	14.9	8.1
Key Largo	N/A	9.7
Marathon	N/A	8.4
Key West	24.2	13.2
Dade County	23.6	15.5
Miami	45.4	23.4

The predominant portion of the fishermen reside in those coastal communities surrounding the ports from which they operate. The greatest numbers of spiny lobster fishermen are found in the Miami area, Key West and Marathon. Together, these communities account for 54 percent of the spiny lobster licenses (non-corporate) during the 1977-78 season (Exhibit 11-1).

The boat captains in the fishery are predominantly owner/operator entrepreneurs, although there are a few cases of company-owned boats or vessels or of a captain owning more than one boat or vessel. Among the smaller boats (16 to 25 feet in length) the owner/operator typically fishes alone. Among larger boats it is common to have one or more paid crew members. It is common for the captain to work with the same crew year after year. In some cases these larger boats are operated as partnerships or as a father-son combination. Husband/wife combinations are also listed in a number of the spiny lobster licenses.

---

1 Since many people of Spanish heritage have adopted English as a native language the category "Spanish speaking" is more selective than "Spanish surname."

Exhibit 11-1

Geographic and Ethnic Distribution of Spiny
Lobster Licensees - 1977-78 Season

Area	No. of of Spanish Surname	Total Licensees	Percent of Spanish Surname
Atlantic Coast:			
Jacksonville-Daytona Area	0	11	0.0
Titusville to Vero Beach	3	55	5.5
Ft. Pierce to Pt. St. Lucie	1	32	3.1
Stuart to Hobe Sound	0	12	0.0
West Palm Beach	3	89	3.4
Boca Raton to Pompano Beach	2	30	6.7
Lauderdale Lakes to Ft. Lauderdale	3	49	6.1
Hollywood Area	4	40	10.0
Miami Area	233	446	52.2
Homestead Area	5	38	13.2
Total Atlantic Coast	254	802	31.7
Florida Keys:			
Key Largo	5	56	8.9
Tavernier	3	25	12.0
Islamorada	12	51	23.5
Lower Matacumbe to Key Colony Beach	0	22	0.0
Marathon/Marathon Shores	27.5*	222	12.4
Big Pine Key	5	74	6.8
Summerland Key	1	44	2.3
Key West-Sugarloaf Key Area	97	256	37.9
Total Florida Keys	150.5	750	20.1
Gulf Coast:			
Chokoloskee to Bonita Springs	0	18	0.0
Ft. Myers Beach to Sarasota	0	30	0.0
Tampa Bay Area	5	58	8.6
Homosassa Springs to Panama City	0	7	0.0
Total Gulf Coast	5	113	4.4
Other:			
Other Florida	1	26	3.8
Out-of-State	0	5	0.0
Address not listed	0	5	0.0
Total Other	1	36	2.8
Total Licensees:	410.5	1,710	24.1

* Partnership with one Spanish surname member.

Note: Licenses held by corporate enterprises (e.g., XYZ Fish House) are not included in the totals. Some double counting may occur as fishermen sometimes hold more than one commercial license number. Identification of ethnicity by surname is a reliable technique but should not be regarded as completely accurate.

Source: Derived from a list of license holders provided by the Florida Department of Natural Resources. (This is a preliminary list and the number of licensees on the list differs by about five percent from the number of licensees indicated in summary statistics from the department.)

There has been a rapid increase in the number of people involved in the fishery in recent years and total licenses (corporate and noncorporate) have risen from 961 during the 1970-71 season[1] to 1,849 during the 1977-78 season, an increase of 92 percent (Exhibit 11-2). Approximately 78 percent of the 1977-78 permit holders had permits in 1976-77, and 49 percent of these same permit holders also held 1975-76 permits (three continuous years in the fishery) (Austin, et al., 1980a and b).

A sample of fishermen (247, roughly ten percent of the total 1965-66 licensees) were drawn from the 1965-66 licenses and compared with licensees in the 1975-76 season. Only 6.9 percent of the spiny lobster fishermen in 1965-66 were still active in the fishery ten years later. Stability of the fishermen in the fishery was greatest among residents of the middle Keys where communities are highly dependent on fishing and where fishing is very much a traditional way of life. None of the Spanish-surnamed fishermen in 1965-66 were active in 1975-76, suggesting less stability among these fishermen. (Due to the small sample size this finding is not statistically significant. It should also be realized that the characteristics of the Spanish surname fishermen in 1965 may be considerably different from those who recently immigrated to the United States from Cuba and entered the fishery.) Results from the sample of fishermen are summarized below.

	Fishermen Still Active in 1975-76 from the 1965-66 Season	
	Number	Percent
Total Sample (n = 247)	17	6.9
By Area:		
Florida East Coast (n=122)	5	4.1
Miami (n=82)	2	2.4
Florida Keys/West Coast (n=108)	11	10.2
Key West (n=40)	3	7.5
Middle Keys/Other (n=68)	8	11.8
Not Listed (n=18)	1	5.6
By Ethnicity:		
Spanish Surname (n=20)	0	0.0
All Other (n=227)	17	7.5

Selected social characteristics of people residing in the counties where spiny lobster fishermen are concentrated are shown in Exhibit 11-3. Average income is higher in Dade County, while a slightly higher percentage of the population in Monroe County has a high school education.

11.2 Age, Education and Experience of Commercial Fishermen

Data on the age, education, and years of experience in fishing are not available specifically for spiny lobster fishermen. A recent survey taken among all Florida commercial fishermen (Prochaska and Cato, 1977) may help convey some idea of the background of spiny lobster fishermen although this survey should be regarded with caution since the characteristics of spiny lobster fishermen may differ from those in other fisheries due to recent high levels of entry. Results of this survey are shown in Exhibit 11-4.

---

[1] Prior to the 1970-71 season there was no fee to obtain a license and the number of licensees was much greater.

Exhibit 11-2

Number of Commercial Spiny Lobster Licenses

Season	Licenses Issued
1964-65	1,919
1965-66	2,275
1966-67	2,639
1967-68	2,544
1968-69	2,431
1969-70	2,719
1970-71*	961
1971-72	1,167
1972-73	1,482
1973-74	1,570
1974-75	1,707
1975-76	1,822
1976-77	1,815
1977-78	1,849

* Beginning with the 1970-71 season a fee of $50 was charged for issuance of a spiny lobster license.

Source: Florida Department of Natural Resources.

The majority of commercial fishermen in the survey are middle-aged, with few younger fishermen. The average age was 48 years. Among spiny lobster fishermen there may be greater numbers of younger fishermen because there has been a considerable increase in participation in recent years. It should also be noted that the fishermen in the survey were boat captains and the distributions in Exhibit 11-4 may thus be skewed towards the older, more experienced fishermen.

Among the fishermen in the survey the average fishing experience in Florida was 16 years. Among spiny lobster fishermen the majority have been involved with the fishery less than ten years (see Section 11.1) due to the large number of recent entrants to the fishery. (However, those who recently entered the spiny lobster fishery may have had experience in other Florida fisheries.)

Finally, Exhibit 11-4 shows the educational attainment of commercial fishermen in the survey by age. The average level of education (11.3 years) corresponds to slightly less than a high-school diploma. Younger fishermen are somewhat better educated than their older peers.

11.3 Employment Opportunities and Unemployment Rates

Economic characterstics of Dade and Monroe counties, the two counties where most commercial spiny lobster fishing is concentrated, are vastly different. Dade County is a major urban center (Miami) with a large population and a well-developed economy. The 552 commercial fishermmen in Dade County in 1975 represented a small portion of total county employment of 676,577 (Exhibit 11-5). In contrast, Monroe County has a small, semi-rural population and a lesser-developed economic base. The economy in Monroe County is highly dependent on commercial fishing. In 1975, there were 3,096 commercial fishermen, representing 13.6 percent of total county employment of 22,699. Commercial fishermen help provide employment opportunities in food processing firms, retail establishments, etc., so the total contribution to county employment will be considerably greater than the direct contribution of 13.6 percent.

Exhibit 11-3

Selected Social Characteristics in
Southern Florida Counties - 1970

	Dade County	Monroe County
Family Income:		
Number of Families	329,695	13,565
Percent by Income Level:		
0 - 1,999	6.2	8.6
2,000 - 4,999	15.8	20.5
5,000 - 6,999	13.0	18.4
7,000 - 9,999	19.5	20.6
10,000 - 14,999	23.9	19.5
15,000 - 24,999	15.1	9.3
25,000 - 49,999	5.1	2.4
50,000 or more	1.3	0.6
Educational Attainment (25 years and older)		
Percent by School Completed:		
None	2.4	1.2
1 - 7 years	16.8	12.5
8 years	11.5	9.7
9 - 11 years	17.4	20.5
12 years	29.5	36.0
13 - 15 years	11.7	10.8
16 years or more	10.8	9.1

Source: 1970 U.S. Census of Population

Both Dade and Monroe counties were hardhit by the 1974-75 recession, as shown by the unemployment data in Exhibit 11-6. Prior to the 1974-75 recession unemployment rates in Dade and Monroe counties ranged between three and five percent, similar to or below the state averages. The local economies have been slow to recover and unemployment rates in 1977 are still higher than those for the state. Effects of the recession are particularly pronounced in Monroe County where the 1977 unemployment rate is more than three times the 1971 rate. No directly comparable unemployment data are available to indicate the extent of unemployment among those who are traditionally fishermen, since information on last previous employment among the unemployed is not regularly collected. However, among lobster fishermen the rapidly rising exvessel prices have tended to keep the employment opportunity within the industry at high levels.

No major seasonal unemployment trends are evident from the data in Exhibit 11-6. In Monroe County unemployment is lower in the third quarter when the spiny lobster season begins, but this decline in the unemployment rate is relatively insignificant to the local economy.

Exhibit 11-4

Age, Experience and Education
Profiles of Florida Commercial Fishermen

	Age					
	16 - 21	21 - 30	31 - 40	41 - 50	51 - 60	61 & over
Age, Percent	4	7	18	24	28	19

	Years Fished in Florida					
	1 - 3	4 - 6	7 - 15	16 - 30	31 - 50	51 & over
Years Fished, Percent	12	18	31	29	8	2

	Education By Age Group					
	21 & under	21 - 30	31 - 40	41 - 50	51 - 60	60 & over
Years of School Completed	12.7	12.5	11.8	11.2	11.6	8.7

Source: Prochaska and Cato (1977).

In Dade County overall employment opportunity (all industries) has risen since the early 1970's, but not fast enough to meet the needs of a growing population. In Monroe County, employment opportunity and population have both fallen since the early 1970's. Employment opportunities in fishing have shown much more favorable trends. In Dade County the number of fishermen rose from 531 in 1971 to 885 in 1973 before declining to 552 in 1975, presumably as a result of the closure of Bahamian waters to U.S. fishermen in 1975. The 552 Dade County fishermen in 1975 represent a 4.0 percent increase over 1971 employment. Monroe County experienced greater employment growth in fishing than Dade County in the early 1970's. Employment rose from 2,060 in 1971 to 3,096 in 1975, an increase of 50.3 percent. The greater growth in Monroe County may partially result from a shift in gear and effort out of Dade County as a result of the closure of Bahamian waters. The overall employment growth in fishing has helped Monroe County offset declining employment opportunities in other sectors of its economy.

Comparable data are not available to identify the employment growth in the spiny lobster fishery by county, although it appears that growth of employment opportunity in the spiny lobster fishery is an important component of the overall growth cited above for Monroe County. Between 1971 and 1975 the number of spiny lobster fishermen in Florida (most of whom are located in Dade and Monroe Counties) rose from 1,149 to 2,067, an increase of 80 percent (Exhibit 8-13). In Monroe County spiny lobster fishermen tend to be congregated among a few relatively small communities where their numbers may be large in comparison to the entire population. These communities along the Keys may thus be even more dependent on the spiny lobster fishery than indicated in county-wide statistics.

The 1974-75 recession apparently resulted in an increase in participation in the spiny lobster fishery, despite the effects of the closure of Bahamian waters. Between 1971 and 1975 the number of vessels in the fishery declined slightly from 402 to 393 (Exhibit 8-12), consistent with a decline in economic returns fromm the fishery. (Both the recession, which tends to reduce demand and the Bahamian ban, which reduced landings, caused less total revenue.) The number of boats jumped sharply from 269 to 430 between 1971 and 1975, an increase of 59.5 percent. A possible interpretation of this increase is that as employment opportunities declined in other sectors of the economy, some people

Exhibit 11-5

Population and Employment Characteristics in Selected Florida Counties

	Dade County			Monroe County		
	1971	1973	1975	1971	1973	1975
I. Population[1]	1,301,700	1,371,400	1,438,600	52,300	53,900	51,400
II. Employment (total)[1]	625,813	714,957	676,577	23,530	24,138	22,699
Proprietors	45,106	46,811	46,983	2,437	2,531	2,542
Farm	762	741	699	6	6	6
Non-Farm	44,344	46,070	46,284	2,431	2,525	2,536
Wage and Salary	580,707	668,146	629,594	21,093	21,607	20,127
Farm	4,490	4,616	3,425	5	5	4
Non-Farm	576,217	663,530	626,169	21,088	21,602	20,123
Government	75,549	83,787	96,643	10,603	9,242	8,142
Private	500,668	579,743	529,526	10,485	12,360	11,981
III. Commercial Fishermen[2]	531	885	552	2,060	2,904	3,096
Regular[3]	106	99	65	448	599	796
Casual[3]	39	45	18	114	338	544
Crew	386	741	469	1,498	1,967	1,756

1 Obtained from U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.

2 Obtained from U.S. Department of Commerce, National Marine Fisheries Service, unpublished data.

3 Regular fishermen are defined as those earning 50 percent or more of their income from fishing while casual fishermen earn less than 50 percent of their income from fishing.

Exhibit 11-6

Unemployment Rates
(percent of labor force)

Area / Year	Quarter First	Second	Third	Fourth	Annual Average
Dade County					
1971					5.2
1973					4.1
1975	11.5	13.5	12.9	12.2	12.6
1977	10.0	9.4	8.1	8.1	8.9
Monroe County					
1971					2.8
1973					3.8
1975	10.4	10.6	9.5	10.4	10.2
1977	11.0	8.7	7.3	8.4	8.9
Florida					
1971					4.9
1973					5.3
1975	10.2	11.2	10.9	10.4	10.7
1977	9.4	8.9	7.6	7.4	8.2

Source: State of Florida, Division of Employment Security

turned to the spiny lobster fishery as a source of income. If this interpretation of the available data is accurate, then the spiny lobster fishery tends to serve a supplemental income function during times when employment opportunities are not available elsewhere. (Part of the increase in boats will of course be attributable to the perceived profitability of the fishery, vis-a-vis other employment.)

The spiny lobster fishery is seasonal with landings taking place primarily in the months of August through November. This complements the king mackerel fishery which takes place primarily in December through February and the stone crab fishery which starts in October. Most participants in the spiny lobster fishery depend on one of these fisheries for additional income and to justify their investment in the fishing industry. (There are evidently local differences in which species are fished during the spiny lobster offseason.) Fishermen also reportedly seek grouper or other finfish. The target species depends on its availability in specific areas.

11.4 Recreational Fishing

The motivations and cultural characteristics of recreational divers in the spiny lobster fishery are diverse. Many seek the excitement of the sport, the chance to relax and socialize with their friends, or the opportunity to be in a natural environment. Very little is known about the characteristics of recreational spiny lobster divers and the discussion of the recreational participants which follows draws primarily on studies of recreational fishermen in general.

11.4.1 Demographic Characteristics of Recreational Fishermen

The 1970 National Survey of Hunting, Fishing and Wildlife Related Recreation (U.S. Fish and Wildlife Service, 1972) found that saltwater recreational anglers in Florida were generally young (56 percent under 35 years olds) mostly male (73 percent), and generally middle income (43 percent between $7,500 and $15,000). Among spiny lobster divers there may be an even greater percentage of younger participants due to the greater physical stamina required for diving.

11.4.2 Social Benefits of Recreational Fishing

Recreational fishing yields significant benefits over and above those measured by the value of expenditures presented in Section 9.0. Researchers have found that participants pursue fishing activities for multiple reasons. Among the benefits are the fulfillment of a desire for solitude; to be outdoors in a natural environment; to have companionship; to explore and have an adventurous experience; for the scenery; to get away from it all and reduce tension; or for the opportunity to "think things through." These, of course, are in addition to the satisfaction gained from the feeling of sporting accomplishment in successfully catching fish (Bryan, 1976, p. 85). For example, a study of sport fishermen in Rhode Island showed that "catching the fish" ranked second behind "experiencing tension and/or relaxation" among the six categories of values of recreational fishing expressed (Spaulding, 1970). It is generally agreed that those who dive for spiny lobster have at least the expectation of being successful.

In efforts to estimate how fishermen value these benefits of recreational fishing, researchers have devised methodologies for expressing them in monetary terms. For example, a 1971 study of the Southeast indicated that saltwater fishermen received benefits valued at $59.80 for each day of fishing (Hovarth, 1974, p. F-48). The valuation procedure used by Hovarth is not necessarily precise because of its subjective nature, but the results of such a methodology provide a benchmark of the value of the social benefits associated with recreational fishing. In the spiny lobster fishery the resource may be valued even more highly because lobsters are a prime "catch" and because of the uniqueness of the fishery. Since many divers combine their diving trip with a vacation and spend a number of days in the fishery, it is conceptually difficult to separate the implicit value of the diving activity from the overall value of the vacation.

11.5 Economic Dependence on Fishing and Related Activities

Recent research on commercial fishermen in Florida provides a picture of the importance of fishing as a source of income (Prochaska and Cato, 1977). In 1974, 48 percent of Florida commercial fishermen surveyed fished fulltime; the remainder reported that some of their income was earned from employment outside of fishing. Approximately 30 percent of the fishermen earn over 50 percent of their income from nonfishing employment. On the average all fishermen (excluding shrimping operations) earned about 38 percent of their income from outside sources. These figures may be somewhat different in the spiny lobster fishery where fewer opportunities for part-time employment exist. In particular those fishermen with large boats who also fish for mackerel have a much greater dependency on fishing income than these average values indicate.

Many fishermen are not fully dependent on fishing for employment and instead rely on fishing income to supplement that from other industries. A recent survey of Florida fishermen (all types of fishing) showed that those with income from nonfishing activities had widely varied employment. Based on those who specificially reported type of employment, eight percent were in residential or commercial construction; seventeen percent were employed in marine related jobs such as tug boat captains, marina operators, and boat builders; ten percent were involved in agriculture; nine percent were employed in security type jobs; seven percent held jobs as mechanics and repairmen; twenty-two percent had other occupations such as teachers, chemists, optometrists, broadcasters, and flight instructors. Only 21 percent of the respondents said that their nonfishing employment was seasonal (Prochaska and Cato, 1977).

Employees in tourism related occupations such as dive shops are likely the most dependent on non-fishing sources of income during the spiny lobster off-season. There are also a significant number of "casual" fishermen; persons who fish to supplement the income of their essentially full-time jobs, although the current $50 commercial spiny lobster license has reduced the number of such fishermen.

Depending on boat size, average revenues from the spiny lobster fishery during the 1973-74 season ranged from 42 to 94 percent of total fishing revenues, with the primary other revenues from stone crabs and king mackerel (Prochaska and Williams, 1976). Intermediate sized boats (24 to 28 feet in length) were most dependent on the spiny lobster revenues with six percent of revenues from stone crab.

The largest boats (greater than 40 feet) were least dependent, with more than half of revenues from king mackerel or other finfish. This latter fact is somewhat misleading however. These large boats are expensive and for many fishermen the investment required could not be justified without revenue from both the spiny lobster and king mackerel fishery. While fishing is often not a full-time occupation, it does represent a substantial source of income for those who are directly employed in commercial harvesting.

Very little is known about the economic dependence of those employed in the processing, distribution, and retail sale of fishery products and of those involved in producing and selling recreational fishing goods and services. It is reasonable to assume that where there is little diversification away from products or services specific to the spiny lobster fishery some employment will be dependent. The processing sector may be most dependent on the spiny lobster fishery. This will be particularly true in the Miami area where there are at least four processors that deal exclusively in spiny lobster (see Section 9.2). There are perhaps a dozen people in the Florida Keys who work full-time assembling lobster traps who are also dependent on the fishery. Employment among suppliers of bait gear and recreational goods which serve a wider variety of fishing activity is likely to be less dependent on the spiny lobster fishery.

11.6 Distribution of Income Within Fishing Communities

The distribution of personal income in Dade and Monroe counties is shown in Exhibit 11-7. The exhibit provides an economic backdrop within which the relative importance of fishing to the local economy can be viewed. Fishing (harvesting) is included in the "Other" sector along with agricultural services, forestry and rest-of-the-world income.[1]

In Dade County, on Florida's east coast, the private industry sectors that contribute the most to total personal income are wholesale-retail trade, services, TCU (transportation, communications and public utilities) and manufacturing. Personal income of $4,942 in 1975 placed the county somewhat lower than other nearby counties. The fisheries, forestry, and agriculture sector accounts for only about 0.3 percent of the personal income in Dade County.

Monroe County, the southernmost county of Florida, has a somewhat different economic base. While personal income derived from government is significant in all the southern Florida counties, in Monroe County it is the leading income source. This is largely because of the federal government installations in Key West. Retail and wholesale trade and services are the next largest sectors contributing to personal income. In 1975 Monroe County had a population of 51,400 and the per capita income was $5,478. The county has virtually no agriculture or forestry, so that the personal income estimates for

---

[1] Rest-of-the-world is the term applied to income of United States residents from international organizations (such as the United Nations) and from foreign governments.

Exhibit 11-7

Personal Income by Major Sources
(thousands of dollars)

	Dade County			Monroe County		
	1971	1973	1975	1971	1973	1975
Type:						
Wage and Salary Disbursements	4,326,584	5,688,500	6,220,418	134,543	160,311	165,718
Other Labor Income	230,874	322,955	395,070	3,569	5,118	6,454
Proprietors' Income	406,446	495,561	493,891	10,432	13,266	13,150
Farm	37,782	40,409	37,559	111	152	182
Nonfarm	368,664	457,152	456,332	10,321	13,114	12,968
By Industry:						
Farm	50,716	55,673	54,778	125	169	201
Nonfarm	4,913,188	6,453,343	7,054,601	148,419	178,526	185,121
Private	4,245,426	5,596,169	5,937,577	67,679	94,179	99,482
Manufacturing	567,744	775,336	812,162	(D)	(D)	5,773
Mining	14,989	25,645	30,623	(D)	(D)	(L)
Contract Construction	394,026	591,037	413,388	7,803	16,607	9,177
Wholesale and Retail Trade	1,013,386	1,306,572	1,452,621	21,844	27,340	32,385
Fin., Ins. and Real Estate	385,118	514,815	551,567	4,867	5,583	7,
Trans., Comm. and Pub. Utilities	726,717	912,678	1,007,188	6,162	7,073	8,743
Services	1,130,407	1,449,715	1,648,874	20,986	27,617	31,304
Other	13,039	20,371	21,154	1,702	4,476	5,056
Government	667,762	857,174	1,117,024	80,650	84,347	85,639
Federal Civilian	151,710	178,479	217,901	15,913	16,040	18,201
Federal Military	80,503	92,377	106,006	49,808	48,279	41,774
State and Local	435,549	586,318	793,117	14,929	20,029	26,664
Total	4,963,904	6,509,016	7,109,379	148,544	178,695	185,322

1. (D) Not shown to avoid disclosure of confidential information. (L) Less than $50,000.

2. Includes fisheries harvesting sector.

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

"Other" in Exhibit 11-7 represents the contribution of fisheries to local personal income. It amounts to about five percent, or $5 million, of the income derived from private industry. Note that this does not include income related to processing and retail sale of fishery products which are included in the wholesale and retail trade sector. By comparison, the fishing industry represents 21 percent of private employment. The larger percentage may reflect the part-time nature of the fishing industry and the relatively low wages received relative to other private industry.[1]

Thus the fisheries (harvesting) sector constitutes a significant element of the local economy of Monroe County. While a contribution of five percent of personal income may not seem large at first glance, in terms of dollars of income each percentage point represents a substantial amount of money earned. Unfortunately, available data do not show all fishery-related (e.g., processing, retail sale) personal income. Such data would illustrate more clearly the even larger contribution that fisheries make to the local economy.

Recreational fishing also makes an important contribution to the local economies of communities in southern Florida. There are numerous shops and services in the Miami and Key West areas which depend on tourism and recreational fishing for their livelihood. Unfortunately, the available data are too aggregated to show the income contribution that recreational fishing makes. Studies of economic impacts of marine recreational fishing show that in general recreational fishing can add substantially to a local economy. As an example, in Dade County charter fishermen spent an estimated $4.1 million in the 1976-77 season (Gentle, 1977).

---

[1] However, BEA employment and personal income data are compiled from different sources and use different estimation techniques to account for proprietors and other unreported economic activity. The figure of 21 percent and five percent are thus not fully comparable.

12.0 DETERMINATION OF OPTIMUM YIELD

Optimum yield (OY) from a fishery is the amount of fish which will provide the greatest overall benefit to the nation with particular reference to food production and recreational opportunities, and which is prescribed as such on the basis of the maximum sustainable yield from that fishery, as modified by any relevant economic, social, or ecological factor [P.L. 94-265]. This section contains a discussion of the important factors which affect the selection of OY and the management measures to achieve OY in the spiny lobster fishery.

Definition of the Fishery:

The spiny lobster fishery consists of the spiny lobster, Panulirus argus, and other incidental species of spiny lobster (spotted spiny lobster, Panulirus guttatus; smooth tail lobster, Panulirus laevicauda; Spanish lobster, Scyllarides aequinoctialis and Scyllarides nodifer) which inhabit or migrate through the coastal waters of and the FCZ of the Gulf of Mexico and the South Atlantic Fishery Management Council areas and which are pursued by commercial and recreational fishermen.

Management Unit

The management unit for which federal regulations will be implemented shall be the species Panulirus argus in the FCZ within the jurisdiction of the Gulf of Mexico and South Atlantic Councils.

The management unit extends beyond the main fishing/landing areas of south Florida because of the need to enforce regulations, particularly the minimum harvest size. Both Councils envision effective enforcement at sea and shoreside in south Florida and primarily shoreside throughout the remainder of the Gulf and south Atlantic. In addition, the Councils will encourage states to adopt consistent regulations in order to facilitate enforcement of regulations.

Issues in the Fishery

1. The number of "shorts" (sublegal lobster) taken and sold illegally appears to be large and may have increased considerably in recent years. Enforcement of size limit regulations will be a major consideration when developing procedures for implementing management measures.

2. There is gear conflict among domestic users of the resource. This consists of a directed otter trawl fishery and pompano drift netters which have caused lobster trap loss.

3. There is controversy over the extent of mortality caused by the fishing practice of using shorts as attractants in traps. (Sections 5.1.5.10, 5.4.2, 5.5, and 8.2.4.1 discuss this issue in detail.)

4. There is an increasing number of traps in the fishery.

5. Harvest in the FCZ during the spawning season is a serious and rapidly growing problem.

Both Councils identified these issues in the development of this FMP. The proposed management measures (Section 12.4.1) and the management objectives (Section 12.1.1) below address these issues. Issues one and three are related in that the "short" harvest and "short" mortality estimates cannot be separated from an aggregate when estimating specific quantities (Section 5.4.2 and Exhibit 5-10) and the estimates themselves have a large variation due to inadequate measurement techniques and insufficient data. Adequate enforcement will help to reduce the short harvest, while short mortality may be reduced in the future through use of economically viable, alternative baits. Issues one and five are the most serious with regard to conservation of the resource.

The illegal harvest of "shorts" and of lobsters of all sizes during the closed season are major resource conservation dangers. Landings of such spiny lobster illustrate the conflict between private monetary gain for individual fishermen and the dangers they pose to the existence of the fishery both biologically and economically. While these illicit landings ultimately generate economic activity, they may result in recruitment overfishing and loss of most if not all the value of the fishery (see Section 5.4.2). Therefore, what appears to be a benefit from illegal harvest is actually a loss to the legal fishery of not only that amount, but also the commercial revenue and recreational harvest foregone from the anticipated growth to a legal size, as well as the risk to the future well-being of the whole fishery. Hence, all references to estimated increases in yield in this FMP relate to increases in yield of legal-sized lobsters. By definition, no benefits are assigned to the harvesting, landing, and sale of illegal-sized lobsters (see Section 12.5 for more discussion).

12.1 Objectives

12.1.1 Specific Management Objectives

The management objectives for the FMP are presented below. These specific management objectives reflect consideration of the biological, economic, social and ecological factors important to the spiny lobster fishery.

1. Protect long-run yields and prevent depletion of lobster stocks.

2. Increase yield by weight from the fishery.

3. Reduce user group and gear conflicts in the fishery.

4. Acquire the necessary information to manage the fishery.

5. Promote efficiency in the fishery.

12.1.2 Alternative Objectives

The following alternatives were considered and rejected for the reasons given.

A. Develop methods for effectively enforcing provisions of the management program. In particular, these regulations should contribute to the enforcement of size limit restrictions.

Rationale

This alternative was considered a function of enforcement rather than an objective and applied in general to any plan.

B. Develop regulations that conform, to the extent practical, with (1) existing state laws by which the fishery is now regulated, (2) practices and laws of other countries within the Caribbean and (3) current methods and practices in the fishery.

Rationale

This alternative was considered more of a consideration in developing a management measure, rather than an objective itself. This subject is discussed in FMP Section 15.

C. Maximize gross revenue.

This objective was a suggestion of the Scientific and Statistical Committee. This statement is defined as the total pounds of lobster sold times the price per pound giving the maximum exvessel total dollar value of the fishery.

D. Maximize employment giving consideration to the part-time and full-time nature of the fishery.

E. Maximize recreational entry opportunity.

F. Maximize revenues from the recreational fishery.

Rationale

Alternatives C, D, E, and F were rejected as inappropriate and overly limiting. The issues addressed by these statements are addressed either within accepted objectives or in management measures.

G. Maximize net revenue by (a) holding the number of participants in the fishery constant at the current level, or (b) by reducing the number of participants to the point of optimum economic efficiency.

Rationale

This objective would be the basis for developing a limited entry system. It was rejected because limited entry was not considered necessary in this fishery. The alternative of limited entry is discussed in FMP Section 12.4.2.

12.2 Description of Alternative Optimum Yields

This section contains a discussion of the important factors which affect both the selection of OY and the management measures to achieve OY in the spiny lobster fishery.

This section does not address which level or levels of government can most effectively manage the fishery. Optimum yield (as defined) and the type of management measures which will lead to OY are determined by the biological, social, and economic characteristics of the fishery. In concept, OY and the management measures will be essentially the same, no matter who is responsible for management. Section 12.3 discusses which level or levels of government can most effectively manage the fishery.

In the spiny lobster fishery the species is taken individually and can, if necessary, be examined and returned to the water unharmed. This characteristic has particular importance in developing a management program for the species. A minimum size limit that protects recruitment to the stock and assures a high yield from the fishery is an effective management tool which can prevent overfishing of the stocks despite the current high level of effort.

The alternative Optimum Yields presented in this section have thus been developed with a size limit as the primary management tool. Similarly, OY in the fishery is specified in terms of a size limit rather than in terms of a total landed weight of the species. Thus, with a size limit of 3.0 inch CL (for example), OY would be equivalent to the stock of harvestable lobsters greater than this size plus the stock that will grow to this size during the year. Actual abundance of lobsters may vary from year to year (reasons for this variation are not fully understood) so that in a given year the actual allowable catch may be (based on a size limit) greater than or less than the long-run average yield.

Another factor affecting the selection of OY, in terms of a specific CL, is the need for a closed fishing season which reduces the fishing mortality rate and allows the stock an uninterrupted period for reproductive activity. The need for a closed season is absolutely essential for size limits close to the 3.0 inches CL, and of decreasing importance as animals approach the maximum yield per recruit size of 3.5 inches CL (see Measure B, Section 12.4.1).

Economic and sociological factors also affect the selection of OY and the proposed management measures. The characteristics of demand for lobster (Section 9.1.1.2) indicate preferences for the smaller-sized animals; in fact, market forces would endanger spiny lobster stocks because the greatest preference in the New York wholesale market (Exhibit 9-3) is for animals less than 3.0 inches CL, sizes at which reproduction has not yet occurred. (All of these smaller-sized lobster are imported.) The economics of harvesting technologies also favor continued use of juvenile lobsters as attractants in traps. Any changes from the present minimum CL (more than three inches) and use of "shorts" would substantially affect the sociological characteristics of the fishery, affecting fishermen's residences, employment, and alternate fishing activities (see Measures A and G, Section 12.4.1).

Five specific OY options were considered for the fishery. These options are listed below along with a brief discussion of the beneficial and adverse impacts of each option. (A fuller description of benefits and adverse impacts is given in Section 12.4 under the specific management measures to achieve the selected OY.)

Analysis of the effect on long-term yield from selected CL's is based on the surplus yield model and discussion in Sections 5.4.1 to 5.4.3. Short-term yields, i.e., one fishing season or less, are estimated from previous works (Warner, et al., 1976; Davis, 1978) and by a model simulating (1) spiny lobster growth and natural mortality by size class, and (2) fishing mortality beginning at various minimum CL's (M. Justen, 1981).

The main purpose of this simulation model is to provide short-term comparisons of yield between the alternative CL's. The model is considered to be accurate in comparing relative differences between size limits but is not very reliable for estimating actual weight yield from different size limits. Estimates of yield in weight are greatly affected by changes in the magnitude of biological parameters such as growth and mortality rate, and assumptions about area distribution of lobsters by size and enforcement. None of these can be precisely determined. These factors, especially growth and mortality, vary from year to year and within season from several causes, including environmental. The level of enforcement is also difficult to specify or estimate. However, variations in these factors affect all size limit alternatives more or less equally. Therefore, percentage differences between yield at different size limits will be essentially unaffected by any variation in the above parameters, although total weight estimates may vary greatly.

The simulation estimates the impact of each alternative size limit with a one equation model. The model estimates monthly catches under each minimum (size) CL. The equation used to estimate monthly catches, given the existing season, is

$$M_{ij} = WN^{\circ}_{Ij}\, S_{Ij}$$

where: M, is an array of the mass in terms of weight of the lobsters in the ith size category which grow to maturity at specified j time periods,

W, is an array of the weights of an average lobster with a 0.9, 1.25, 1.75, 2.25, 2.75, 3.0, 3.125, 3.25, and 3.5-inch carapace length,

$N°_{ij}$, is an array of the number of lobsters initially in the ith size category which grow for j time periods until reaching 3.0, 3.125, 3.25, and 3.5-inch CL's,

S_{ij}, is an array of the survival rate of lobsters in the ith size category which grow to the 3.0, 3.125, 3.25, and 3.5-inch CL's in j time periods.

Growth and size in each time period is based on data presented in Section 5.1.5.8. A mortality rate of 0.92 was used to estimate survival. This is approximately double the best estimate of mortality from natural causes and should compensate, to some degree, for mortality due to harvest practices. The monthly distribution of animals by size category at selected sites in the fishery is from Lyons, et al., (1981). The number of animals in each size category is projected by the above distribution from the reported legal commercial catch (5.7 million pounds in 1978/1979 fishing season) and the estimated recreational catch (700,000 pounds in 1978/1979 fishing season; Zuboy, 1980).

Estimated monthly landings at various minimum CL's are compared with the historical monthly landings to assess the short-term impact of various CL's in percentage terms. The model assumes that practically all lobster are harvested upon reaching the minimum legal CL, a reasonable assumption given the level of current effort. Harvest therefore corresponds to the weight in the ith and larger size category of the variable M in the above equation.

In this analysis, results of the model are presented as percentage differences from a base harvest (Exhibit 12-1). The base level was set at the (more than) 3-inch CL because that is the current state legal size and the preferred CL. This does not imply that the base level is equal to present landings. It is used only as a basis to compare the relative effect of alternative size limits in the first year of implementation. The best information available indicates that implementation of a FMP will result in a substantial increase in landing of legal size lobster. Again, this will not greatly affect the relative differences between size limits.

Optimum Yield: Alternative I - The entire available stock of spiny lobsters greater than 2.75 inches carapace length.

This alternative would allow a short-term (one season) increase in landed weight of the species (approximately 20 percent) and catch per unit effort since current law in Florida (where most of the lobsters are landed) specifies more than 3.0 inches CL as a size limit. Price per pound for whole lobster would be slightly higher than present because of market preference for smaller lobster (four to six ounce tails, Exhibit 9-3). Also, the fishery would be more concentrated inshore which might reduce harvesting costs temporarily, but would lead to congestion and possible conflict in the long run.

Based on the yield models presented in Section 5.4.2 it appears that a 2.75 inch CL would reduce long-term yield by approximately six to eight percent.

A more important concern is the degree to which a lowered size limit would reduce spawning, perhaps reducing recruitment and total yield.

Under present conditions, essentially all lobsters are harvested during the first year after reaching legal size. Few, if any, lobsters are sexually mature at 2.75 inches. Such a size limit would almost eliminate reproduction. This would greatly increase the risk of recruitment overfishing if eggs spawned by lobsters in U.S. waters contribute to recruitment into the same stock. With the present size limit of 3.0 inches the fishery has reduced the spawning potential of the stock by approximately 88 percent. While this does not appear to have affected recruitment, a further decrease in the minimum size limit could be a substantial risk.

More discussion of this alternative is presented in Section 12.4.2, Measure N.1.

Optimum Yield: Alternative II - OY is specified to be all lobster more than 3.0 inches carapace length or not less than 5.5 inches tail length that can be harvested by commercial and recreational fishermen given existing technology and prevailing economic conditions. (This is the alternative proposed in the FMP.)

Based on current experience in the spiny lobster fishery, a size limit of greater than 3.0 inches CL appears adequate to protect recruitment. In addition, 1.5 million pounds of increased yield is expected with FMP implementation (see Sections 8.2.8, 12.3 Option III, and 12.5). The short term model indicates that this size limit results in a substantially larger first-year yield than do larger size limits and less yield than smaller size limits. The yield per recruit model shows that this alternative will result in slightly lower yield in the long term than larger size limits.

This alternative conforms to present state management and conditions in the fishery. Its adoption would result in the least confusion and disruption of the fishermen and be the least difficult and costly to enforce. Management in both state waters and the FCZ would be conducted most efficiently with existing state and federal resources with very little duplication of efforts.

A size limit of 3.0 inches would maintain the important commercial and recreational employment opportunities provided by the fishery and would result in harvested lobster which generally are in the most valuable (wholesale price per pound) size categories for retail consumption (four to eight ounce tails).

See Section 12.4.1, Management Measure A for further discussion.

Optimum Yield: Alternative III - Specify OY as the entire stock of lobsters greater than 3.125 inches CL.

This alternative would result in a marginal increase in reproductive potential for the spiny lobster stock; the actual level of recruitment realized by this minimum CL may not be any greater than the (more than) 3.0-inch CL. Given present levels of effort, this alternative would result in an increase in long-term yield from the available recruits of approximately three to four percent (see Section 5.4.3) over the present yield.

Within the first fishing season, implementation of this size limit would result in an 11 percent decrease in landings during the first three months compared to the (more than) 3.0-inch CL; during the whole year, landings would be 25 percent less than the preferred CL (Exhibit 12-1). Over a third of annual landings occurs in the first three months (Exhibit 8-7) when climatic conditions are most favorable for fishing.

Socioeconomic impacts from this higher CL would be negative. The industry would experience losses in revenue in the short term. Minimum harvest sizes larger than 3.125 inches CL would force fishing operations from the Gulf side of the Florida Keys to the Atlantic side because of the distribution of animals by size. This relocation would increase operating costs and possibly investment by industry to fish farther offshore. Therefore, the marginal increases in long-term revenue would probably be nullified by increased costs. If the State of Florida did not adopt this CL, enforcement costs incurred by the federal government would be higher than under the (more than) 3.0-inch CL because of the difficulty in enforcing two size limits in the same fishery.

See Section 12.4.2, Management Measure N.2, for further discussion.

Optimum Yield: Alternative VI - Specify OY as the entire stock of lobsters greater than 3.25 inches CL.

This alternative would result in an increase in reproductive potential for the spiny lobster stock; the actual level of recruitment realized by this minimum CL may not be any greater than the (more than)

Exhibit 12-1

Impacts on Present Harvest Yields for Selected Time Periods with Various Minimum Carapace Lengths, Compared to the Present Three-Inch Minimum Carapace Length

Minimum Carapace Length	First Three Months of Fishing Season[1, 2]	First Year[3]	Long-term[4]
	(Percent)		
2.75 inches	N.A.	12 - 28%	-(6 - 8%)
3.0 inches (preferred alternative)	Base[5]	Base[5]	Base[5]
3.125 inches	-11.0%	-25.0%	3 - 4%
3.25 inches	-37.7%	-33.0%	6 - 9%
3.5 inches	-86.7%	-50.0%	9 - 14%

N.A. Not available

1 August, September, October.

2 Estimates from M. Justen (1981).

3 Estimates for the 2.75-inch CL from Warner, et al. (1977) and Davis (1978); estimates for the other sizes from M. Justen (1981).

4 Estimates from yield per recruit model, Sections 5.4.2 and 5.4.3.

5 Yield at the 3.0-inch CL alternative was used as a "base yield". Yield at other size limit alternatives is expressed in a percentage difference from base yield. This does not imply that base yield is equal to present landings.

3.0-inch CL. Given present levels of effort, this alternative would result in an increase in long-term yield from the available recruits of approximately six to nine percent (see Section 5.4.3) over the present yield.

Within the first fishing season, implementation of this size limit would result in a 38 percent decrease in landings during the first three months compared to the (more than) 3.0-inch CL. For the entire year, landings would be 33 percent less than the preferred CL (Exhibit 12-1).

Socioeconomic impacts from this higher CL would be negative. In the long term fishermen would be forced to fish in smaller geographical areas, and far deeper waters than present, where larger lobster may be found. This would result in unprofitability because of inevitable congestion, decreased CPUE, and higher investments. The harvesting industry and firms serving recreational fishermen would experience losses in revenue in the short term exceeding $3.7 million. This minimum carapace length would force a major portion of fishing operations from the Gulf side of the Florida Keys to the Atlantic side because of the distribution of animals by size. This relocation would increase operating costs and possibly investment by the harvesting industry to fish farther offshore. The marginal increase in long-term revenue over the status quo may be nullified by increased costs. In addition, the product weight of the lobster (tail) would yield a lower price per pound at the wholesale level. If the State of Florida did not adopt this CL, enforcement costs incurred by the federal government would be higher than under the (more than) 3.0-inch CL because of the difficulty in enforcing two size limits in the fishery.

See Section 12.4.2, Management Measure N.3, for further discussion.

Optimum Yield: Alternative V - Specify OY as the entire stock of lobsters greater than 3.5 inches CL.

This alternative would assure survival of sufficient spawning stock to provide adequate recruitment if eggs spawned in U.S. waters do contribute to recruitment. Given present levels of effort, this alternative would result in an increase in long-term yield from the available recruits of approximately nine to 14 percent (see Section 5.4.2) over the present regime (greater than 3.0-inch CL). In the first year of FMP implementation, yield would be 50 percent less than the preferred CL.

Increasing the average size would decrease the exvessel and wholesale price per pound in Florida by approximately 5.6 and four percent, respectively, assuming no change in either lobster imports or national income (Section 9.1.1.2). It would also force a reorganization of the geographical distribution of fishing effort. The adverse economic impact of the redistribution (higher fishing costs) would not be evenly distributed among different home ports and type fishermen.

Increasing a greater than 3.0-inch CL size limit (current practice under Florida law) to a greater than 3.5-inch CL size limit could cause a substantial shortrun disruption in the industry. These shortrun economic and social disruptions would be severe and would include losing the greater part of one fishing season while allowing increased growth. They could be partially mitigated by gradually increasing the size limit over a period of years. Adoption of this alternative would create confusion and problems with enforcement unless similar measures were adopted by the State of Florida.

For a more detailed discussion, see the discussion of Management Measure A and N.4 in Section 12.4.

12.3 Alternative Approaches to Achieving Optimum Yield

This section examines the potential avenues for achieving the best use of the lobster resource and maximum return to the nation. Achievement of the goals of a management plan does not necessarily require federal action or an FMP. Some fisheries do not require management; others are adequately managed by the states. In the case of lobster, management approaches can be condensed into four

alternatives. These are: (1) no additional action by state or federal authority; (2) modification of state law with no FMP; (3) cooperative state/federal management through an FMP; and (4) predominantly federal enforcement of an FMP. Option 3 is the most cost effective and, in reality, the only viable alternative which will protect the resource. The analysis supporting this conclusion follows.

Option 1. No Action

This alternative represents the status quo. No FMP would be implemented and state management would remain unchanged. It was rejected because it does not adequately protect the resource and will result in substantially less net benefit to the nation than other alternatives.

Present efforts by the State of Florida to enforce its lobster regulations have become ineffective due to legal problems caused by passage of MFCMA, various interpretations of how MFCMA affects state jurisdiction, and low penalties for violation of state regulations. A recent court decision (Allen v. Tingley, 16th Judicial Circuit Court, Monroe County, Florida, May, 1980) has greatly inhibited the state's ability to control out of season harvest. In the Allen v. Tingley case the court held that the portion of a state statute (section 370.15(2)) which prohibited shrimping in areas of the Tortugas shrimp beds beyond the territorial sea was unconstitutional, and the state was enjoined from enforcing the statute. This decision was affirmed by Florida's 3rd District Court of Appeals which held that "... section 370.15(2) is unconstitutional to the extent that it attempts to exercise state authority over the area of the Tortugas shrimp beds which is beyond state boundaries." Passage of MFCMA was interpreted by the State court as preempting the state's authority to manage its citizens in the FCZ. This decision seriously limits the authority of Florida over its citizens outside state waters, as established by the landmark Skiriotes decision (Skiriotes v. Florida, 313 U.S. 69). The Tingley v. Allen ruling cannot be appealed, because the allotted time period for appeals has expired. It is recognized that this decision may be legally arguable. Nevertheless, until another case establishes a different precedent, it will remain effective in Florida.

Passage of MFCMA and the resulting legal interpretations described above have effectively eliminated Florida's ability to enforce its closed season in the FCZ. The MFCMA eliminates state authority over vessels in the FCZ which are not state registered vessels. Those fishermen operating illegally during the closed season in the FCZ do not mark their traps with Florida permit numbers. Unless a Marine Patrol officer observes a Florida vessel pulling traps, there is no way to know if those traps belong to Florida vessels and/or residents. It is the position of the State of Florida that a MP officer may be personally liable for destruction of property should he destroy traps in the FCZ during the closed season and those traps turn out to be owned by nonresidents. Marine Patrol officers could be prosecuted under the United States Code 18 U.S.C. 661. Because of the Allen v. Tingley case there is even substantial doubt over the legality of seizing or destroying traps belonging to Florida citizens. Marine Patrol supervisors will not subject their personnel to the possibility of personal liability or prosecution, no matter how small the risk (Colonel J. Brown, Chief, Florida Marine Patrol, and Major Ed Little, FMP, personal communication, 1981). In addition, state officials fear that FCZ enforcement will result in more court challanges which, if lost, would further reduce the state's legal authority over its citizens outside of state waters (Colonel J. Brown, FMP, personal communication, 1981).

The decrease in the state's ability to control fishing in the FCZ has created a loophole in a Florida law which allowed importation of lobster during the closed season. This law was primarily designed to allow distant water fleets to operate in the Bahamas and Caribbean. Prior to passage of MFCMA, there was little abuse of this permit. More recently large scale abuse of this law has developed. Members of the Southeastern Fisheries Association, Organized Fishermen of Florida, FDNR, and Florida Marine Patrol officers report that many fishermen take advantage of the limited enforcement in the FCZ and the importation permit by fishing outside of state waters and claiming the lobsters were caught in foreign waters. At this time, operators who have obtained a permit can fish with unmarked traps in the FCZ within sight of Key West during the closed season with little or no risk.

The state's weakened legal position has resulted in a major and rapid increase in illegal activity. Prior to MFCMA, out of season harvest was negligible. It began to increase about 1979. During the 1981 closed season, the Florida Marine Patrol estimated that approximately 50,000 traps were being fished in the FCZ (Major Ed Little, personal communication, 1981). A further large increase is expected in 1982, without active management in the FCZ.

Theft of lobster from traps in the FCZ is also increasing, apparently as a result of Florida's decreased ability to enforce its law. At least some of this appears to be related to an influx in Cuban exiles from the recent "boat lift." Theft of lobster from traps has occurred in the past to a fluctuating degree. In the past, FDNR authority and resources were sufficient to control it, however, this no longer appears to be true.

Harvest of sublegal lobster has continued at a high level and is believed to be increasing as a result of the state's weak legal position. Although the immediate and major problem with out of season harvest has overshadowed sublegal harvest, it is still a major problem in the fishery.

The present legal penalties of the state are insufficient to serve as an effective deterrent given the state's weak legal position and the large profits available in the illegal fishery. Maximum state penalties for most lobster violations are $1,000 and 60-days in jail for repeat offenders, half that for a first offense. Increasing violations have led judges to increase fines but they very seldom use the available jail terms. At one time a $50 fine was common. More recently, fines for repeat offenders are often near the maximum. However, even maximum fines are small in relation to the potential profits and low risk of capture, particularly for violations in the FCZ. A typical daily catch of 250 to 500 pounds of sublegal or out of season lobster is worth approximately $500 to $1,000, near the maximum penalty.

The No Action alternative will almost certainly lead to a decline in yield from this fishery. Increasing illegal harvest in the FCZ is a direct and immediate threat to reproductive capacity of the stock. The 50,000 traps estimated to be fished in the FCZ during the closed season can easily harvest 800,000 pounds (see Section 12.4.1). This is about ten percent of the total present yield. Approximately one-half are females, most of which are spawning during the closed season. This represents a very large reduction in spawning in a stock where legal fishing activity has already reduced spawning potential by a substantial fraction. As explained in the rationale for the three-inch limit, a closed season is required if the three-inch limit is to allow sufficient spawning. Out of season fishing of the magnitude seen today effectively eliminates the benefit of the closed season. Recruitment overfishing becomes a strong possibility.

Increasing out of season and sublegal harvest also reduces yield per recruit, decreasing total yield from the available recruitment.

The present legal situation is conducive to the return of buy boats. These are vessels whose operators would purchase lobster from local fishermen for transport to other states. Such vessels would not be registered in Florida or enter Florida waters. Passage of MFCMA has greatly reduced, probably eliminated state jurisdiction over vessels not registered in the state. Therefore, legal barriers to buy boats have been removed. The weakened legal position of the state has resulted in a great increase in out of season harvest in the FCZ, creating a ready clientele and source of supply for buy boats. The price of lobster has risen faster than general inflation, providing a profit incentive.

It should be realized that the No Action alternative actually began in 1976 with passage of MFCMA. Its effect on the fishery did not begin until legal decisions demonstrated the new constraints on state authority and individual fishermen began to realize the weak position of the state. As that realization spread, so did illegal, particularly out of season, harvest. The Allen v. Tingley decision was rendered in May of 1980, the middle of the closed season. During the following closed season (1981) there was a large increase in out of season fishing activity.

In 1980, responsible fishermen who were already aware of the state's weak legal position began demanding immediate action from the state and Councils. They had two concerns. First, illegal harvest threatens the resource. Second, lack of effective management is rapidly forcing many legal fishermen into illegal activity. The legal fisherman is at a substantial economic disadvantage to his illegal competitor. Because the lobster fishery is so highly competitive, this can mean the difference between survival and failure. As illegal activity grows, many legal fishermen feel they must also fish illegally if they are to survive in this fishery. This creates a vicious circle which further threatens the resource.

In response to these increasing problems, emergency action on the closed season was requested by the Council at the time this FMP was originally submitted for formal Secretarial review. This would have resulted in an effective closure during part of the 1981 closed season. The Councils, the state and various industry organizations of fishermen, dealers and processors, recognized and strongly supported the need for fast action (see EIS Appendix C). Because no action was taken, out of season harvest increased to a biologically dangerous level (see Proposed Management Measure B). If no action continues, a further large increase in illegal harvest is expected during the 1982 closed season (Colonel Joe Brown, Major Ed Little, FMP, numerous fishermen, personal communication, 1981.)

Self regulation through free market forces was considered and rejected by the Councils as inappropriate for this fishery. In this fishery, effort and competition are intense and there is a ready market for all sizes of lobster. Allowing the free market to regulate the fishery will result in harvest far below the proposed three-inch limit, reduced yield per recruit and the elimination of virtually all spawning, threatening the stock with collapse due to recruitment overfishing.

Conclusion

The No Action alternative is rejected as inferior to the other alternatives considered. Its cost to the fishery and the nation, both in terms of loss of yield per recruit and potential for recruitment overfishing, are higher than options 3 and 4. Costs to the government are not substantially different from the preferred alternative. The only difference is a small increase in expenditure for data collection. The benefits of this option are effectively zero.

The purpose of this section is to examine the best route to achieving the best use for the nation and, therefore, OY, whether or not an FMP is implemented. In that context, the No Action alternative does not comply with the intent of MFCMA and National Standard one because it allows continuation of an activity which could easily result in recruitment overfishing.

Option 2. All State Action

This alternative assumes that the state can and will modify its laws and increase its legal penalties to become, as nearly as possible, equivalent to federal regulations, and that no FMP would be implemented. This alternative was rejected because it is equivalent to the No Action alternative for at least the next several years, is based on untenable assumptions, and is less effective and more costly than the preferred alternative, even if the state can successfully take the assumed action.

To be as effective as cooperative state/federal management, Florida would have to extend its authority to all U.S. citizens and all vessels in the FCZ. MFCMA specifically preclude state management of vessels not registered in the state. This allows a loophole which appears impossible to close, especially in the case of buy boats and of connecting traps in the FCZ to Florida vessels or citizens. In addition, a generally accepted legal definition of "vessel registered in the state" does not yet exist. It is a complex issue which is, for the most part, untested in court. The outcome of eventual litigation will be highly dependent on facts of particular cases and cannot be predicted at this time. At this point, any legislation written by Florida to extend its enforcement ability in the FCZ runs a

significant risk of successful legal challenge simply because litigation has not established the legal principles in sufficient detail.

Other legislative action would be required, including elimination of the out of season permit and increasing the penalties for lobster violations. In the case of penalties, an increase to the federal level represents a huge increase, far in excess of other state fishing penalties. Politically, this would be difficult. Even if passed, judges must still be persuaded to use the increased penalties. This is by no means certain, in light of past cases.

Legislative action by other states would be required to address the buy boat problem by prohibiting out of season and sublegal landings. Considering that, historically, there has been little similar cooperation among southeastern states, that other states have little interest in lobster and that such action would adversely affect state residents involved in transporting and processing such lobster, it is unlikely that they would act. Even if they did, it is probable that enforcement agencies in other states would not expend significant effort to enforce such a law.

This alternative inherently assumes that the state has primary responsibility for fishery management in the FCZ. This assumption is highly questionable. Congress created the FCZ and established federal authority over it. In so doing, Congress created substantial legal barriers to effective state regulation. The rights of the state to regulate U.S. citizens other than those aboard state registered vessels was greatly limited, probably eliminated. The Councils believe that Congress intended for management in the FCZ to be primarily a federal responsibility, even though the states have substantial interest and are expected to share responsibility for management in some cases.

This alternative is less effective and more costly than cooperative state/ federal management even assuming that Florida and other states could and would make the necessary legal changes. With no FMP, there is no effective avenue for cooperation between existing federal and state enforcement agencies. The advantages which would result from such cooperation are described under Option 3.

Additional state resources would be required to duplicate existing Coast Guard offshore capability. At least one additional vessel of roughly 50 feet in length would be required. State operating costs for this type of vessel are $100,000 per year, including crew (Major Ed Little, personal communication, 1981). Construction costs exceed $300,000 (Colonel Joe Brown, personal communication, 1981). This item alone represents more cost than the preferred option.

The state's legal ability to confiscate or destroy traps found in the FCZ during the closed season would still be impaired (see Section 12.3, Option 1). At present, this is the major factor preventing enforcement of the closed season.

Statistical data collection costs would be higher than the preferred option because state collection efforts would duplicate part of existing federal programs, would be disruptive to the present cooperative Florida/NMFS data collection program, would be a greater burden on fishermen and processors, and would be confusing to the fishermen.

The length of time required for state actions is a major disadvantage of this option. Effective state legislative change will be very slow. For the foreseeable future this alternative is equal to the No Action alternative. At present, there is no legislation planned and there is no possibility of state action before the 1982 closed season. In all probability, there will be no effective action for a minimum of five years. Lead time for budgeting and construction of vessels and acquisition of personnel is at least three years. Limited state budgets would probably extend that considerably. State legislation, even on less complex issues, is often successfully challenged in court. Numerous successful challenges of state lobster and shrimp legislation have occurred in the past. There is no reason to assume that this would not also occur for any new state legislation. Legally defendable

state fishery law is often the result of a series of court challenges and legislative amendments. For controversial or complex issues, this often takes five to ten years. This would be expected in the case of spiny lobster. In the interim, state management in the FCZ would be weak or nonexistant, essentially the same as the No Action alternative, with its risk of recruitment overfishing. Also, there is no assurance that the state will ever be able to surmount the legal problems and loopholes created by passage of MFCMA, conflicting interpretations of the impact of MFCMA on state authority, and other federal law.

State management is even slower than federal management through a FMP. If, in the future, a need arises to change the size limit or address mortality caused by present harvest practices, this would be much slower by state legislation than by FMP amendment. Also, state regulation does not provide the numerous public safeguards that are inherent in the FMP process, e.g., preparation of detailed EIS, RIR, and extensive public hearings.

Conclusion

This alternative was rejected because it is not significantly different from the No Action alternative. As such, it represents a threat to the reproductive viability of the stock and could result in recruitment overfishing. In the context of this analysis, it is contrary to the intent of MFCMA and National Standard 1. It is far too dependent on legal and political factors which cannot be predicted at this time. Even if feasible, the costs of this alternative are higher than the preferred alternative. State costs would be much higher than under cooperative management. Federal costs may be slightly less. It is unlikely that all state enforcement by itself would ever be as effective as cooperative enforcement because of legal loopholes created by enactment of MFCMA and varying interpretations thereof, and because cooperation with existing Coast Guard resources would be difficult if not impossible.

Option 3. Cooperative State/Federal Management

This is the preferred option. Primary enforcement effort will be by state personnel. Federal personnel and vessels will participate as available. No increase in enforcement costs is required by either state or federal agencies. If increased funding becomes available, benefits to the fishery should increase. However, increased enforcement funding is not necessary to protect the longterm yield or to achieve the primary goals of the FMP. Implementation of the Federal regulations, in and of itself, increases effectiveness of existing state enforcement. Cooperative management results in more effective use of existing enforcement resources, both state and federal. Areas of federal strength complement areas of state weakness and vice versa. At minimum, implementation of federal regulations increases state effectiveness.

Understanding the advantages of cooperative management is aided by examples of the types of possible action. After implementation of the FMP, the cooperative state/federal enforcement agreement allows state officers to dispose of traps in the FCZ during the closed season in exactly the same manner as a federal agent, with none of the present legal problems or jurisdiction or personal liability. This provides the basis to essentially eliminate out of season harvest. It is one of the few cases where at-sea enforcement is cost effective. A relatively small effort can result in disposal of a great many traps. For the illegal fisherman, the risk of losing perhaps $10,000 worth of traps is a powerful deterrent to fishing during the closed season.

During the closed season, buy boats in the FCZ off Florida can be cited by Florida officers for violation of MFCMA and subjected to MFCMA penalties. Marine Patrol officers often know the identity and description of vessels illegally fishing far offshore, although they are out of range of most marine patrol operations. This information can be relayed to the Coast Guard. During routine offshore Coast Guard patrols some of these vessels will be intercepted and violations documented. In this case,

neither agency would be effective without the other. As another example, routine Coast Guard patrols may locate traps in the FCZ during the closed season; Marine Patrol officers can then go out and dispose of the traps. This eliminates state costs incurred in searching for traps, increases the ability of state officials to deploy their resources, and increases their effectivess.

Pulse enforcement is a necessity today for most agencies enforcing fishery laws. It has been highly effective in FMP enforcement, notably the Texas option of the Gulf Shrimp FMP. This enforcement strategy is most effective when it is a massive effort and covers the entire range of the fishery. The combination of state and federal agencies can achieve a higher short term level of effort than either can alone. This can be accomplished by reallocation of existing resources with no net increase in budgets. State officers would operate inshore and Coast Guard/NMFS offshore where each is most effective.

Use of federal penalties is expected to increase compliance. The maximum state fine is $1,000 while the maximum federal civil penalty is $25,000. Repeat offenders of federal regulations normally receive severe fines. The extremely good compliance with the Texas shrimp season closure is an example of how effective a credible and well publicized threat of federal penalties can be. Industry representatives report that the low rate of reported violations does reflect good compliance and not lack of enforcement presence.

Cooperation with the state will allow much more effective use of these penalties. Because Florida officials are crossdeputized, they can document any federal violation they observe. State surveillance may detect violations in the FCZ near state waters. State vessels can intercept such violators returning to land and subject them to MFCMA sanctions. Dockside enforcement of federal violations by state officers will be possible in some cases. For example, a vessel is found at the dock with a large load of sublegal or out of season lobster. Local state officers with intimate knowledge of local waters and local fishermen will, in some cases, be able to document that the vessel operator did not have any traps in state waters from which to harvest those lobster. A federal penalty could then be imposed.

Other types of cooperation include exchanges of violation records. For example, the state can supply federal agents with records of repeat violators of state regulations. This can be a factor in determining an appropriate (higher) fine. It also aids in establishing a list of habitual offenders who can be subjected to selective surveillance. The same is true for federal violation records supplied to state judges.

Implementation of a FMP acts as a catalyst speeding changes in state law. This can result in higher state penalties and more enforceable regulations, improving compliance and increasing yield from the fishery. Such an improvement can lead to a long-term decrease in the level of federal involvement needed in many fisheries.

Recommendations from the Councils are often quickly adopted by the states. This contrasts sharply with past efforts by the Gulf States Fishery Commission or individual states to achieve changes in adjoining states' law. There are several examples of recent state action resulting from FMP implementation and FMP recommendations. The Stone Crab FMP established a line to separate shrimp and stone crab fishermen. Part of this line in state waters was immediately adopted by the state. In addition, the state contributed significant resources to enforcing the line, both within and without state waters. The Shrimp FMP recommended that states remove "count laws" from offshore shrimp to prevent waste of the resource. Count laws have been a controversial political subject for many years. There have been many unsuccessful attempts to eliminate them from state law. Given the approval of the FMP to protect the resource in the FCZ, Florida and Texas immediately removed their count laws for offshore shrimp. Texas also greatly increased its penalty for violation of the season closure. The new penalties approach the federal fine amounts.

Conclusion

This is the preferred option. It will protect the long-term yield from the resource and increase present yield. It can virtually eliminate out of season harvest, removing a major and immediate threat to the viability of the stock. It can greatly reduce if not eliminate sublegal harvest. It is the lowest cost option which will protect the resource in the immediate future. A small increase in federal expenditures will be required for improved data collection. Improved data is a requirement of any options which will protect the resource. Federal data collection will be more cost effective than state efforts (see Section 12.3, Option II). No additional federal or state enforcement resources will be required for substantial achievement of the goals of the plan.

If additional resources become available to either state or federal enforcement agencies, compliance and benefits can be expected to increase. In the long-term, improving state law will probably increase compliance and reduce the level of federal involvement needed.

Option 4. Substantial Federal Enforcement of an FMP

This alternative assumes that enforcement activity in the FCZ will be carried out using federal resources at a level sufficient to enforce the FMP. It assumes an increase in federal enforcement resources. State action or cooperation would not be required but would still be useful. This alternative was rejected because of high cost relative to Alternative 3 and because present budgetary realities indicate that obtaining additional enforcement funding is very unlikely.

This option retains most of the advantages of the preferred option. Cooperative state/federal action is still possible and would be expected, although cooperation may not be as extensive. This alternative should result in benefits to the fishery in terms of increased yield and long-term protection of the resource. These benefits would at least be equal to and probably greater than the preferred option. A greater reduction in sublegal harvest could be expected. Either option can effectively eliminate out of season harvest.

The disadvantages are all related to costs. Federal enforcement costs are high. An estimate of enforcement costs for this alternative was made as $328,500 (see Section 12.5). Under this option all of this would be federal expenditure. This would necessitate an increase in enforcement resources.

Federal personnel will not be as effective as state officers on a man to man basis. Florida Marine Patrol officers are stationed in one area for extended periods, often they are long-time local residents. They have personal and intimate knowledge of the participants, fishing areas, and techniques. The State of Florida has 180 Marine Patrol field officers who are required to spend 50 percent of their time on the water. Each officer is equipped with an automobile, trailer, boat, radio and other equipment. NMFS or Coast Guard personnel cannot be expected to match this kind of local knowledge or deployment capability. In addition, there is a rapid turnover of Coast Guard personnel. Effective federal enforcement will require a continuous training program, adding to the cost of this alternative.

At present, there is a very strong effort to limit and decrease federal spending. It is very unlikely that there will be any increase at this time in the federal enforcement budget for enforcement of a spiny lobster FMP.

Conclusion

This option was rejected as impractical. Although benefits to the fishery may be higher than the preferred option, political reality dictates that the necessary additional funds will not be available. Therefore, this option effectively becomes Option 3, cooperative management using existing resources.

12.4 Analysis of Beneficial and Adverse Impacts of Potential Management Options

This section and Section 12.5 evaluates economic, social, environmental, and biological impacts of the proposed and alternative management measures listed below and relates the Councils' rationale for proposing certain measures and not proposing the alternatives. The sections (including the discussion in 12.3) fulfill the requirements of Executive Order 12291. The procedure used in estimating the impacts includes a systematic discussion of both adopted and rejected management measures. The analysis is based on the best available information in all instances.

Executive Order 12291 "Federal Regulation" established guidelines for promulgating new regulations and reviewing existing regulations. Under these guidelines each agency, to the extent permitted by law, is expected to comply with the following requirements: (1) administrative decisions shall be based on adequate information concerning the need for and consequences of proposed government action; (2) regulatory action shall not be undertaken unless the potential benefit to society for the regulation outweighs the potential costs to society; (3) regulatory objectives shall be chosen to maximize the net benefits to society; (4) among alternative approaches to any given regulatory objectives, the alternative involving the least net cost to society shall be chosen; and (5) agencies shall set regularly priorities with the aim of maximizing the aggregate net benefit to society, taking into account the condition of the particular industries affected by regulations, the condition of the national economy, and other regulatory actions contemplated for the future.

In compliance with Executive Order 12291, the Department of Commerce (DOC) and the National Oceanic and Atmospheric Administration (NOAA) require the preparation of a Regulatory Impact Review (RIR) for all regulatory actions which either implement a new fishery management plan or significantly amend an existing plan, or may be significant in that they affect important DOC/NOAA policy concerns and are the object of public interest.

The RIR is part of the process of developing and reviewing fishery management plans and is prepared by the Regional Fishery Management Councils with the assistance of the National Marine Fisheries Service (NMFS), as necessary. The RIR provides a comprehensive review of the level and incidence of impact associated with the proposed or final regulatory actions. The analysis also provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve problems. The purpose of the analysis is to ensure that the regulatory agency or Council systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost effective way.

The RIR also will serve as the basis for determining whether the proposed regulations implementing the fishery management plan or amendment are major/non-major under Executive Order 12291, and whether or not the proposed regulations will have a significant economic impact on a substantial number of small entities under the Regulatory Flexibility Act (5 U.S.C. 601 et seq.).

12.4.1 Measures Proposed for Adoption

The following management measures pertaining to the spiny lobster management unit have been recommended for adoption by both the Gulf of Mexico and South Atlantic Fishery Management Councils. The measures comprise a management regime wherein no one measure is capable of achieving its objectives without the other measures.

A. A minimum harvestable size limit of more than 3.0-inch CL or not less than 5.5 inches tail length shall be established.

Impact and Rationale

The recommended size limit, in conjunction with the recommended season (Measure B) and protection of berried females (Measure K), is believed to assure adequate recruitment in the fishery by allowing a sufficient fraction of the female lobsters to spawn at least once before being harvested.

As described in Sections 12.2 and 5.4.2 above, the present minimum harvest size does not appear to have affected recruitment, even though it has reduced substantially the species' spawning potential. Historical landings indicate that recruitment to the U.S. stock has been stable under historical and existing fishing practices. This can be attested to by the stable domestic catch since 1969 (Exhibit 8-6).

The minimum size limit will provide close to the maximum potential yield from the stock. Yield per recruit analysis (Section 5.4.1) indicates that a three-inch limit will provide 85 to 91 percent of the maximum yield per recruit. Therefore, based on spawning/recruitment and yield per recruit considerations, adoption of this measure will help to achieve Objective 1.

Adoption of this measure will establish a consistent management regime for the resource with respect to a minimum size limit. Effective enforcement of this measure, envisioned to be primarily dockside in south Florida, should help reduce the illegal harvest and sale of "shorts". The sublegal-sized lobsters would have an opportunity to grow at least to a legal size and thus Objective 2 will be achieved as well.

A short-term analysis of this CL indicates that with FMP implementation 1.5 million pounds can be expected in increased annual yields (Sections 12.2, 12.3, and 12.5). In the long-term with FMP implementation, yield should increase to 12.0 million pounds with the development of alternative attractants for use in traps and elimination of illegal harvests.

A minimum CL of greater than three inches is compatible with the methods and practices in the fishery. Since current Florida law specifies a minimum size limit of more than three inches CL, existing Coast Guard and NMFS enforcement personnel can aid state personnel. Adoption of this size limit by other states, as recommended in the plan, will make it more difficult to market undersized lobsters taken from U.S. waters. (It will not interfere with the importation of lobster.) Enforcement at dockside in the other Gulf and South Atlantic states should be sufficient for enforcement of the measure. Adoption of this measure would address Issue 1.

The recommended size limit will result in a high dollar value in the commercial fishery, and in harvesting efficiency for both commercial and recreational user groups. This will help achieve Objective 5.

The first-year increase in legal landings of 1.5 million pounds (18.7 percent over present legal catch) will decrease exvessel price by 2.6 percent; summing these two percentages, revenue to fishermen will increase by 16.1 percent annually, or $3.3 million annually using the 1980 exvessel price of $2.23 per pound. (A portion of the 1.5 million pound increase may be caught by recreational fishermen; this will decrease additional commercial revenue. However, larger recreational catches may increase participation and associated expenditures.) Revenue to processors and wholesalers will increase from the additional 1.5 million pounds; wholesale and retail prices will not decrease except in localized markets because the additional catch is a negligible part of U.S. total supply.

The higher (wholesale) price per pound for smaller lobsters (Exhibit 9-3) indicates a greater demand for lobster in smaller size ranges. The minimum size limit would provide the market with the largest possible number of lobster tails (or whole lobster) in the most desirable size categories without endangering future harvests (see Section 9.1.1.2 for dockside price effects).

The minimum size limit promotes commercial and recreational harvesting efficiency because lobsters of this size are widely distributed at inshore locations accessible to all types of fishermen. A larger CL would concentrate the effort offshore in deeper waters in which lobster are less prone to capture; gear losses would be higher and larger, more expensive vessels would be required. A smaller CL would concentrate the effort inshore, increase gear conflicts, and may endanger long-run productivity because of further reductions in spawning potential.

B. A closed season from April 1 through July 25 shall be established. During this closed season harvesting of spiny lobsters will not be permitted. Within the closed season there will be a five-day "soak period" from July 21-25 and a five-day grace period for removal of traps from April 1-5.

Impact and Rationale

The recommended closed season prohibits all harvesting during the peak of the mating and spawning season when this harvesting would interfere with reproductive activity. Spawning takes place between March and August in waters off Florida (Section 5.1.5) and a seasonal closure between April 1 and July 25 would protect spawning females for a great majority of the reproductive season.

This measure complements the recommended size limit. If the recommended size limit were adopted without a complementary seasonal closure, few lobsters of legal size would survive long enough to spawn. Fishing effort would continue through the summer and harvest almost all lobster very shortly after they reach legal size. The spawning stock would be limited to animals less than three inches CL. This would greatly reduce the available spawners and could affect recruitment. By protecting the spawning stock, this measure contributes to Management Objective 1.

The importance of an effective closed season throughout the fishery is critical as economic pressures encourage more effort in general and illegal harvesting during the closed season in particular. During the 1981 closed season several thousand traps were discovered in Florida Bay (territorial sea) by state enforcement personnel and an industry group; approximately 50,000 traps are estimated to be in the FCZ during the closed season. These traps were actively being fished; they were not abandoned or lost (Major Ed Little, Florida Department of Natural Resources, personal communication). Without a FMP, state enforcement agencies cannot confiscate traps in the FCZ during the closed season if the traps cannot be clearly identified as belonging to Florida residents (see Section 12.3).

For the 50,000 traps cited a catch rate of one pound per week during the 16-week closed season (based on data from Lyons, et al., 1981) would generate at least 800,000 pounds of illegal landings. While these illegal landings undoubtedly enter the market and generate economic activity, their continuation and potential increase threaten the whole fishery because it results in a substantial reduction in spawning. This illegal activity would surely increase in the future as a result of economic pressures and without an effective closed season throughout the fishery.

In this fishery, at-sea enforcement can efficiently enforce the closed season. Traps are highly visible and easily located. An enforcement vessel can seize, destroy, or otherwise dispose of a large number of illegal or abandoned traps in a short time. The replacement cost of those traps is probably greater than the illegal catch a fisherman could expect. Therefore, a relatively low level of at-sea enforcement can seize or destroy enough traps to maintain a credible threat of a larger financial loss to the fisherman. Few fishermen will take that risk. This type of enforcement worked well for the Florida Marine Patrol prior to enactment of MFCMA and the attendant legal and jurisdictional problems. Measure B will remove those problems and result in much more effective enforcement.

The seasonal closure provides economic benefits to the fishery. During the closed season, the standing stock of legal size lobster greatly increases. This results in improved catch per unit effort during the following open season. By limiting the available fishing season, the total amount

of effort is controlled while still leaving sufficient time to harvest the available resource. This limits total costs of fishing and improves economic efficiency, thus contributing to Objective 5.

Florida law specifies a closed season between April 1 and July 25 with a five-day soak period and grace period. The recommended management measure is thus compatible with the current methods and practices in the fishery. Enforcement of the two closures would be complementary, reducing costs and improving effectiveness.

The suggested closure recognizes and supports present fishing patterns. The area supports a multispecies fishery, with the same fishermen seeking different species during different seasons. The main complementary fisheries are those for stone crabs (opens October 15), mackerel (abundance is high beginning in December/January), snapper-grouper (most effort in spring and early summer), and the pompano and mullet fisheries (fall and winter).

The recommended closed season was preferred over other periods because it covers the majority of the spawning season, implementation would cause no disruption within the fishery, and it would be most easily and effectively enforced. The availability of these complementary fisheries provides a source of employment and use of boats which would otherwise be idle during the spiny lobster closed season. Likewise, changing the season would reduce harvest of other species.

The five day pre-season soak time (July 21-25) has an economic and social rationale. The speed with which fishermen can deploy their traps varies substantially according to the number of traps, size and speed of the vessel. Also traps must be conditioned or "soaked" before they are attractive to lobsters. The five-day period allows sufficient time for all fishermen to deploy and soak their traps. Therefore, all fishermen begin on an equal basis on day one of the season when catch rates are highest.

C. All spiny lobster traps shall have a degradable surface of sufficient size so as to allow escapement of lobsters from lost traps.

Impact and Rationale

The requirement that all spiny lobster traps contain a degradable panel prevents traps from continuing to capture lobster years after they have been lost due to vandalism, boat damage to buoys, strong currents, etc. One estimate indicated that 37 percent of all traps are lost annually. With total effort in the fishery over 500,000 traps (1975 estimate), degradable panels prevent at least 185,000 traps yearly from remaining functional after they are lost.

The additional (incremental) cost of this measure would be minimal as Florida law currently requires traps with degradable tops or throats. In addition, virtually all traps currently used in the fishery are constructed of wood. Abandoned or lost wood traps may remain intact for one year; however, most are destroyed by turtles, fish, or wave action within a few weeks or months. Mortality of lobster in lost wooden traps is believed to be small. Therefore, the wooden traps used currently will require no alterations.

If traps made of plastic or other nondegradable material were introduced, a degradable panel sufficiently large for escapement would have to be incorporated. Otherwise, lost traps would remain active for years, perhaps permanently. The panel material should be of wood or other material which would degrade in a time period equal to or less than wood.

It should be noted that degradable panels on nonwood traps would add about $1.00 to the total cost of each trap (J. C. Cato, University of Florida, personal communication). If nonwooden traps are introduced in the fishery, this measure would slightly increase the required level of investment.

The Councils do not wish to inhibit any technologies in trap design or materials with regard to wood or other materials for construction. However, by allowing use of nondegradable material the plan creates a situation which could result in long term losses to the fishery. Requiring a degradable surface equivalent to wood prevent this problem from occurring.

D. The taking of spiny lobsters in the FCZ with spears, hooks and similar devices or gear containing such devices shall be prohibited. The possession of speared, pierced or punctured lobsters shall be prima facie evidence of the taking with prohibited gear while in the FCZ.

Impact and Rationale

Hook and spear fishing by divers does not allow measurement of the lobster before it is punctured and (frequently) mortally wounded. The majority of diving effort is in areas where sublegal-sized lobster are common. Few divers are sufficiently skilled to accurately judge the size of a lobster while underwater, especially if the animal is near legal size. Divers would presumably return undersized lobsters to the waters where they die from their injury. The practice of spearing or hooking lobsters is thus completely incompatible with Measure A and Objective 1.

No additional (incremental) impact is expected as a result of this recommended measure since Florida law prohibits the taking of lobsters with hooks or spears and this prohibition is the recognized practice throughout the fishery.

Spearing lobster is not presently allowed in Florida waters, so there is no data available with which to estimate potential losses if the practice was allowed in the FCZ. Because most divers cannot easily determine the size of lobster before capture many sublegal animals would be damaged. The provision that possession of punctured lobster will be considered evidence of violation is required to make the measure enforceable. The activity takes place underwater, invisible to any observer, except another diver. Thus, enforcement at the time of the violation is essentially impossible.

This provision is not expected to cause any problems for legitimate users. Marks left by spearing or similar methods of taking lobster leave characteristic marks, easily identified by personnel who presently enforce the state provision. Injuries from other sources are easily distinguished from spear or hook punctures.

E. No person shall willfully molest a trap or buoy or work a trap belonging to another without permission from the owner.

Impact and Rationale

This measure is necessary for the orderly conduct of the fishery and aids enforcement efforts in a fishery where poaching is viewed as a problem (see Section 8.2.6 and 10.2). It is consistent with present custom and regulations within the fishery and addresses Issue 1. It does not interfere with normal practice in the fishery and will improve enforcement of other measures. It has no incremental impact and is consistent with present practices. Adoption of this measure will help to achieve Objectives 1 to 3, and 5.

F. To aid enforcement, traps may be worked during daylight hours only.

Impact and Rationale

This measure is principally intended to improve the enforceability of the recommended measures. A variety of activities not permitted under the recommended measures (e.g., the harvest of undersized lobsters and poaching) could otherwise take place under cover of darkness with little risk of detection. This measure would likely improve the cost effectiveness of the enforcement program for the

management plan. It is consistent with present custom and regulation within the fishery and addresses issues 1, 2, and 5. Adoption of this measure will help to achieve Objectives 1 to 3, and 5. No other impacts are expected. Costs for this measure and the other proposed measure are given in Section 12.5.

G. All spiny lobster taken below the legal size limit shall be immediately returned to the water unharmed except live undersize or "short" lobsters which may be carried on the boat/vessel, provided they are: for use as lures or attractants in traps and kept in a shaded "bait" box while being transported between traps. No more than three live "shorts" per trap (traps carried on the boat) or 200 live "shorts", whichever is greater, may be carried at any one time.

Impact and Rationale

This measure recognizes a traditional and very widespread practice within the fishery. It is allowed in state waters within certain conditions under current regulations in Florida. The Councils' advisory panel strongly recommended that this practice be allowed to continue. This practice has both positive and negative aspects. Traps that retain shorts (sublegal size lobster) and the practice of using shorts as attractants in traps greatly increases trapping efficiency but also results in some fishing induced mortality (see Sections 5.4.1, 5.1.5.10, and 8.2.4.1). The Councils' decision to allow this practice is based on the following considerations:

First, preliminary research by FDNR (Lyons, personal communication) has shown that using shorts as attractants results in catch rates more than three times higher than cowhide, which is a commonly-used alternative bait. Without the use of shorts as attractants fishermen argue that catch rates would be so low that much of the shallow water/inshore fishery would not be economically feasible. The resulting dislocations would most adversely affect smaller boats. More importantly, it would concentrate fishing effort further offshore and in a much smaller geographical area resulting in more gear conflicts and a decline in CPUE for the entire fishery. The central Keys, primarily Marathon, would be most severely affected. Allowance of this practice contributes to Objective 5.

Second, the total amount of loss due to this practice is unknown (see Section 5.4.2). Existing analyses indicate that illegal short harvest may be the major fraction of a total loss estimate which includes loss resulting from use of shorts as attractants. If the present loss from this practice is relatively small in comparison to illegal harvest, a substantial decrease in efficiency caused by prohibiting the practice could result in a decrease in total landings and revenue for the industry.

Without a reliable estimate of the total loss or a viable alternative bait, the Councils were unwilling to prohibit a practice which is considered essential by participants in the fishery, and which may reduce CPUE to less than one-third of current CPUE.

Third, a ban on use or transport of small numbers of shorts would be completely unenforceable given the present trap design and intense competition between fishermen. It is an economic necessity that, if any fisherman is using shorts, then all other fishermen in the area must use them to remain competitive. The only effective, enforceable way to discourage the use of shorts is to require use of a trap which will not retain shorts. At present, such a trap does not exist in the U.S. fishery. Traps with escape gaps have been developed in the Australian rock spiny lobster fishery. Research concerning size selectivity of traps is recommended by the Councils (see Section 14.4).

In summary, the limitations of the three live "shorts" per trap or 200 live "shorts", whichever is greater, is a reasonable restriction based upon historical and current fishing practices. The larger vessels engaged in this fishery may employ a crew of four and, by using two hydraulic "trap pullers," can pull 700 traps per day. To fish this many traps, the fisherman must have a sufficient number of "shorts" available to replace those lost during the soak period, and thereby maintain the rate of three shorts per trap which provides the maximum catch efficiency. Also, traps that are lost must be

replaced, necessitating an additional need for three shorts per trap. During the routine pulling of traps, the actual number of traps carried on the boat may be relatively small; however, the number of shorts required to properly service the trap line may be substantial (e.g., near 200) depending on the degree of trap and short loss during the soak period. The allowance of 200 "shorts" is necessary to accommodate this situation, since the limit of three "shorts" per trap carried on the boat would be obviously insufficient and would seriously reduce efficiency.

Conversely, the provision allowing three shorts per trap is necessary when fishermen are transporting larger numbers of traps in an attempt to follow the lobster population as it migrates to deeper water. Larger craft may routinely carry in excess of 100 traps on board during these moves, and the 200 short limit, by itself, would be inadequate. The Council felt that the combined limit of 200 shorts or three per trap, whichever is greater, represented a reasonable restriction which would limit the illegal short harvest; place an upper limit on mortality due to fishing practices; and still allow for the efficient prosecution of the fishery.

The Councils recognize the traditional nature of the practice, its positive affect on efficiency, and the disruption which would result if it were not allowed. The unavoidable ~~loss~~ was considered of lesser value than the benefits of allowing this activity. The recommended measure allows this practice within limitations designed to reduce injury and loss of undersize animals to the minimum possible.

A special recommendation will be made with regard to this issue (Section 14.4). The highest research funding priority should be placed on finding baits or other fishing practices that are as economically efficient as using shorts. If and when this occurs, regulations should follow that prevent shorts from being retained by traps. Successful application of this research will help achieve Objectives 1 and 2.

H. All lobster traps used in the fishery within the FCZ shall be identified by a number and color code issued through the Office of the Regional Director of NMFS or his designee to each vessel desiring to use lobster traps in the FCZ. Further, each vessel using such traps must be clearly marked with the same color code to allow identification from aerial and water patrol craft.

Discussion:

It is the intent of the Councils that: (a) all traps must be marked with the vessel license number; (b) that all buoys be color coded and marked with the vessel license number, and (c) it is not necessary that every trap be buoyed or that buoys must always be floating at the surface.

Impact and Rationale

Trap and buoy identification is essential to aid enforcement of other proposed measures and to protect gear from poaching and theft. Marking vessels and buoys with colors visible from the air allows aerial patrol of the fishery which has distinct advantages over a water-based patrol craft. This measure directly supports collection of better data (Management Objective 4) and aids enforcement of the seasonal closure, contributing to Objective 1 as discussed in Section 12.3.

The Councils recognize the contradiction between not requiring that every trap be buoyed or that buoys always be floating at the surface, and the requirements for such provisions in order to facilitate enforcement of items (a) and (b) of the management measure. However, there is a very limited number of traps not buoyed at all or where buoys are below the surface. These situations arise from deployment of traps in 1) shallow-water areas with heavy boat traffic which would result in buoys and trap losses, and 2) deep-water areas where currents are so strong that traps would be carried away when tied to conventionally-buoyed lines. In such cases fishermen would use timed-release pop-up

devices on individual traps or one large buoy on several traps, or would retrieve traps through navigational siting methods. The Councils concluded that the small increase in enforcement effectiveness was not justified by prohibiting these limited practices.

It is expected that the identification program developed through the office of the Regional Director of NMFS will utilize the gear identification information and procedures of the Florida Department of Natural Resources (FDNR). Lobster fishermen registered with FDNR to fish in state waters may fish for lobster in the FCZ with the same FDNR license number and identifying color patterns. Their license information would be on file with the Regional Office. Federal expenditures and unnecessary duplication would, therefore, be at an absolute minimum. This would minimize any burden placed on fishermen and would allow traps to be moved between the waters of the FCZ and state waters without identification problems. The Regional Director can issue identifying license and color patterns to lobster fishermen operating in the FCZ only, or may designate the Florida Department of Natural Resources, with its approval, as his designee to issue licenses and color patterns. The cost of these licenses to fishermen is expected to be zero as in the Reef Fish FMP, and of minimal cost ($10 each) to the government. Since all existing fishermen currently possess Florida licenses, the additional cost to the federal government will be zero in the short-term.

I. A special two-day recreational nontrap season shall be established during the weekend preceeding the trap soak period. Catch shall be limited to six per person per day or 24 per boat per day.

Impact and Rationale

This measure specifically provides for a special recreational opportunity in the fishery. It establishes a "two-day window" season for recreationists before the start of the general season on July 26 (Measure B). Economic and social benefits occur as a result of increased participation in the fishery, but there is insufficient information available on the recreational fishing sector to quantify these benefits over the existing state regulation. Moving the two-day recreational season to the first full weekend preceding the trap soak period (instead of at the beginning of the trap soak period, which is the current state practice) is designed to reduce the heavy congestion that occurs when recreationalists are diving during the period when commercial fishermen are setting traps (see Section 8.2.6). More than 50 percent of the recreational divers in Monroe County during the two-day season are not local residents. Recreational activity will be encouraged because the opening will always be on a weekend. This measure differs from state regulations by establishing a different time and different bag limit. Adoption of this measure would address issue 2 and help achieve Objective 3. The FMP recommends that states adopt similar regulations where applicable (Section 12.7.2).

J. The retention on board boats or vessels or possession on land of "berried" female lobsters taken from the FCZ at any time shall be prohibited. Stripping or otherwise molesting female lobsters to remove the eggs shall be prohibited. "Berried" female lobsters taken in traps or with other gear must be immediately returned to the water alive and unharmed.

Discussion:

It is the intent of the Councils that "berried" females are not to be included under the measure allowing transport of undersize lobsters for bait. However "berried" females, if found in a trap, may be retained or replaced in that trap so long as it is immediately returned to the water.

Impact and Rationale

This measure is designed to provide additional protection to the spawning stock and contribute to future recruitment. It is complementary to the recommended measures for size and season limits

(Measures A and B) and contributes to Management Objective 1. Some very small loss to harvest yield from lobster already recruited to the fishery is expected to continue by delaying harvest of egg-bearing females.

Under present management of the fishery and under the proposed regulations, the fishery is almost entirely dependent on a single year class. Most individual lobsters have, at most, one opportunity to spawn before being taken. The closed season protects the stock during the majority of the spawning season. However, some individuals are still carrying eggs at the beginning of the fishing season. The number is unknown but may be substantial in some areas and in some years.

This measure protects those individuals until the eggs are released. It provides a buffer against any unexpected shifts in the spawning season.

The Councils recognize that the presently available spawning stock has been considerably reduced from the original, unfished condition. Failure to adopt this measure would result in a further reduction. Existence of a spawner/recruit relation has not yet been established for this species but has been for a very similar species (Morgan, 1980). Until better information is available, the Councils have made the assumption that further reductions in the spawning stock may be detrimental to recruitment.

This measure will result in a minimal loss in potential yield from lobsters already recruited into the population. This loss results from natural mortality during the period of protection. The time when a lobster would be protected is brief. Females carry external eggs for only a short time, estimated at four weeks. Because most individuals still berried will be near the end of that period when the season opens, the average time berried lobster would be unavailable for harvest would be less, approximately one to two weeks. Only a very small loss to natural mortality would occur during that period. The practice of retaining berried females in the trap if found there limits further loss. These animals release their eggs and may be taken when the fisherman again pulls the trap. Thus, no loss in present yield would occur. While State of Florida regulations specify that berried lobster be released "free and unharmed," this measure allows the protection of such animals in the trap instead of releasing them at the top of the water column.

The Councils have judged that the potential benefits to future recruitment provided by this measure are more valuable than the small amount of potential yield which would continue to be lost.

K. The use of poisons or explosives to take spiny lobster is prohibited.

Impact and Rationale

This measure addresses Management Objectives 1 and 2. The use of poisons and explosives would have a detrimental impact on the coral ecosystem, decreasing its ability to support future lobster populations. The use of chlorine bleach to take lobster in the Bahamas is reported to be extremely damaging to living corals.

No adverse impacts are expected from this measure. At present, these methods are not used in U.S. waters. Enforcement costs for all the proposed measures are given in Section 12.5.

L. Statistical Reporting

1. The vessel enumeration information system be applied in the spiny lobster fishery and that mandatory reporting be applied.

2. Require mandatory trip tickets to be submitted as necessary by commercial spiny lobster fishermen.

2. Require mandatory trip tickets to be submitted as necessary by commercial spiny lobster fishermen.

3. A commercial spiny lobster fisherman is one who sells his catch.

Impact and Rationale

These measures directly support Management Objective 4 and indirectly support Objectives 1 and 2. They are expected to provide the Councils and Secretary with adequate information for management with the least cost to the government and imposition to the fishermen.

Measure L.1 extends data reporting to the recreational spiny lobster fishery. This increasingly important component is being included in other plans being developed by the two Councils concerned. Sampling methods will serve to obtain needed data on catch and effort by recreational participants in the fishery. State boat/vessel registration files may be used to obtain a sampling frame for a survey(s) to determine the actual number of participants in the fishery, catch, and other pertinent data.

A vessel enumeration system for locating the subgroup of recreational spiny lobster fishermen from the larger group of recreational boat owners would be valuable, if accurate and reliable information can be obtained. This component of Measure L.1 is not anticipated to have any significant economic impact as it will only consist of two additional questions on the existing state vessel registration forms.

Once recreational spiny lobster fishermen have been identified, participation rates, and landings data will most likely be collected through mail questionnaires and/or telephone surveys. The total data collection expense will depend on the number of recreational users, the sample size selected, the frequency of the survey, and cost per respondent. The number of recreational participants in the spiny lobster fishery is not known. The number of boat trips in 1977 was estimated at between 7,000 and 69,000 (Section 8.2.1.2 of the plan). Because many of these participants will go diving more than once during the season, it will be assumed that the actual number of vessels participating is half this number or 3,500 to 34,500. A sample size on the order of ten percent can be expected. On the maximum estimated size of the recreational fleet and a ten percent sample size, 3,450 responses will be required. The recreational catch/effort survey in the Gulf of Mexico (D. Deuel, NMFS) is collecting catch data at an average cost per response of $8.75 and it is likely that a data collection effort for the FMP will have a similar cost per response. The total cost of a triennial survey can be anticipated at $30,188 (3,450 x $8.75) or $10,063 per year. The time burden on each respondent should be approximately 30 minutes per year, or 1,725 hours per year for the sample.

Measure L.1 is needed in order to estimate recreational catch and effort for management purposes. At present, recreational catch is very poorly known, but is believed to be significant. Data on this activity is needed for the long-term biological benefit to the stock.

The measure is recommended rather than other alternatives (Measure U) because it is expected to yield the necessary data at the least cost to the federal government and least reporting burden to the fishermen.

Measure L.2 proposes a reporting system based on trip tickets for selected spiny lobster dealers and fishermen. Fishermen selling their catch through commercial fish houses, or dealers, will report information on area fished, hours fished, gear type and quantity and other pertinent data as determined by the Councils and NMFS on receipts at the time of sale. Fish houses or dealers will record landings and value information on the same form. Completed forms will be submitted to NMFS for processing. Commercial spiny lobster fishermen not selling their catch through dealers or fish houses will, when selected, be required to provide information on catch, area and hours fished, gear type, etc.

Daily trip tickets will be maintained by all selected commercial lobster dealers and will be mailed periodically to to NMFS or collected by NMFS agents during the nine-month season. During the 1977-1978 season, there were 1,849 commercial fishermen license holders registered with the Florida Department of Natural Resources. In 1975-1976, 824 (45 percent) of 1,822 license holders were active in the fishery. The following cost estimates are based upon an estimated 1,000 fishermen who will provide information through dealers or fish houses and 1,000 fishermen who will be sampled to determine the catch reported through sales receipts. In 1975 the 824 boats active in the fishery averaged about 80 trips per year. Using this average number, a maximum of 80,000 sales receipts would be required per year. One thousand individuals could be sampled in order to estimate the extent of landings not reported through dealers and fish houses.

It is proposed that a complete census be taken for all data processed through dealers and/or fish houses, the first year of FMP implementation, and a 25 percent sample of the above trips for subsequent years (J. Zweifel, NMFS, Miami). Also, it is proposed that a 25 percent sample be selected from those fishermen not reporting their catch to dealers or fish houses be contacted on the telephone twice monthly.

Statistical reporting costs for the commercial sector during the 1982 fiscal year (first year of FMP implementation) $48,735. In the second and all subsequent years, commercial statistical reporting costs are $24,735 (see schedule below). Therefore, recreational and commercial reporting costs to the federal government are $58,798 the first year and $34,798 every year thereafter.

Reporting cost for fishermen selling through dealers or fish houses include printing costs, mailing costs, data processing costs and the cost of interviews or logbooks if required, and the cost of edits, verification and project management. Interview costs will require the augmentation of the existing NMFS staff of port agents. Logbooks could be used on a sampling basis to determine effort, area of catch, etc. Reporting costs for commercial license holders not selling through dealers or fish houses and recreational fishermen will include costs of mail or telephone surveys and data processing costs.

Estimated costs for the commercial reporting segment are contained in the schedule below. The column entitled "80,000 Census" refers to the first-year cost of the census of fish dealers/houses and the telephone interview of fishermen. The column entitled "20,000 Sample" refers to the cost in subsequent years with a 25 percent sample of fish dealers/houses and the telephone interview of fishermen. The reporting burden on the commercial sector is estimated to be 225 hours per year in the first year for dealers (30 minutes per month per dealer); and 333 hours for fishermen each year with 250 fishermen reporting one minute for each trip (B. Slater, NMFS, Miami).

This system is designed to improve current statistics on commercial spiny lobster landings, which are compiled based on data obtained through fish houses. These statistics understate actual landings since the information collected fails to account for that portion of the catch which is sold directly by fishermen and thus bypasses the fish houses. Currently, effort data are collected by point of landing and do not identify areas fished. Since a significant portion of effort is applied in foreign water fisheries, it is difficult to accurately estimate catch per unit effort for the U.S. fishery which in turn makes it difficult to accurately calculate MSY for the U.S. fishery. Trip ticket reporting would improve the level of detail of the catch/effort data.

Recordkeeping and Reporting

Statistical sampling procedures will be used to select all or a portion of commercial and recreational fishermen, dealers and processors harvesting or handling spiny lobsters. The number of individuals selected, the reporting interval and the duration for reporting will be determined by NMFS according to data requirements for specific management needs.

Estimated Cost for Collecting Spiny Lobster Data

	80,000 Trips Census	20,000 Trips Sample
Printing Cost (Sales Receipt & Log Books)		
Log Books (estimated 350) Dealer Books (estimated 200)	$2,890.00	$2,890.00
Mail Contact		
Contract for mailing to approximately 2,000 license holders	330.00	330.00
Postage for mail and return assuming half will respond @ $.18	540.00	540.00
Postage for mailing logbooks and dealer book @ estimated $1.20 per book	600.00	600.00
Data Processing Cost		
Data Entry and Processing @ $.15 per record	12,000.00	3,000.00
Telephone Interview 25 percent sample		
Twice Monthly @ $2.75 per 15 minutes	12,375.00	12,375.00
Overhead		
Project Management, Edit, and Verification	20,000.00	5,000.00
TOTAL	$48,735.00	$24,735.00

Source: James Zweifel, NMFS, Miami.

When notified of his/her selection for reporting, the owner or operator of a commercial spiny lobster vessel shall provide the information requested on a form available from the dealer or processor at the time of sale. The information may include any of the following items:

(1) Vessel identification, including license number.
(2) Date landed.
(3) Hours fished.
(4) Area and depth of catch.
(5) Fishing time by area and depth.
(6) Gear type, number, and quantity.
(7) Kinds and quantities of incidental catch and discards.

Dealers handling lobsters shall provide the following information on individual fishing trips for commercial vessels on forms provided by NMFS:

(1) Dealer or plant identification number.
(2) Permit number.
(3) Date landed.
(4) Lobsters landed in pounds and value.

Lobster processors shall provide the following information on forms provided by NMFS:

(1) Processor identification.
(2) Type of products.
(3) Lobsters processed (quantity and value by product).

Reports from fishermen, dealers, and processors shall be recorded on a form provided by NMFS or as otherwise described below:

(1) Owner/operators of fishing vessels/boats - required information shall be recorded at the time of the sale on a form provided by NMFS.

(2) Dealers - copies of forms required to be submitted containing the required information shall be forwarded to NMFS within three days of the close of a business week.

(3) Processors - required information shall be submitted on a form and at times specified by NMFS.

Reporting by recreational spiny lobster harvesters will be in accordance with valid statistical sampling methodologies.

When selected, individuals shall provide any or all of the following information:

(1) Date landed.
(2) Area and depth of catch.
(3) Fishing time by area and depth.
(4) Gear type, number, and quantity.
(5) Spiny lobsters landed.

Reporting by nondirected commercial harvesters (shrimp trawlers) will be in accordance with the record-keeping and reporting requirements for bycatch of the Shrimp FMP for the Gulf of Mexico.

Measure L.3 defines a commercial fisherman solely for statistical purposes. It is necessary to implement measure L.2.

12.4.2 Management Measures Not Recommended for Adoption

The following management measure alternatives were not recommended for adoption of the spiny lobster fishery. Included in these alternative measures are four different minimum CL's.

M. Recommend that the Dry Tortugas (Fort Jefferson National Monument) be designated as a marine sanctuary for the spiny lobster.

Impact and Rationale

The intent of this measure is to provide an area where lobster stocks are not subjected to harvest pressures so that scientific studies of the species in a natural state would be possible. This measure was rejected when it was determined that the subject area is entirely within waters of the State of Florida. It should be noted that the National Park Service has jurisdiction in the Fort Jefferson National Monument and is considering a ban on lobster harvesting within the confines of the monument.

N. Alternative Size Limits

In discussing alternative size limits some reviewers have raised questions as to why one size is recommended in the Caribbean Spiny Lobster FMP (3.5 inches CL) whereas a smaller size is recommended in this FMP. There are several reasons why different size limits in the two plans are appropriate.

First, the temperature regimes differ between the two areas. In the Caribbean, it is warmer, resulting in faster growth and greater benefits from large size limits. Also, spawning is spread throughout the year with little of the seasonality evident in Florida. Market demand is quite different. In the continental U.S. there is a large demand for small lobster, resulting in a higher price for small animals and the need for a relatively small size limit. This does not seem to be the case in the Caribbean. Therefore, a larger size limit which maximizes yield per recruit is more logical in that area.

The characteristics of the Florida fishery allow adequate biological management with a relatively small size limit. The Florida fishery is highly specialized and competitive. Traps used are specific to lobster and catch little else. The combination of intense fishing effort and small size limit create a biological need for a closed spawning season. This closure is also economically beneficial because it limits total effort and increases catch per unit effort.

The converse is true in the Caribbean. That fishery is primarily nondirected. Lobster is a bycatch of fish traps which harvest a great many species. A closed season would be a substantial economic disadvantage in that area as well as difficult to enforce. Because the Caribbean has already opted for a large size limit, there is no biological need for a closed season.

1. Recommend a minimum harvestable size limit of 2.75 inches CL.

Impact and Rationale

This measure was not proposed because it would contravene Objectives 1 and 2. While this alternative recognizes the probable abuses of Florida's existing three-inch size limit, the effect of this measure would be to reduce long-term yield an average of seven percent (Sections 12.2 and 5.4.3) from present; to reduce the yield per recruit; and to significantly increase the risk of recruitment overfishing by

reducing the population of mature females to near zero. These factors may imperil the long-run existence of the fishery both biologically and economically.

A temporary increase in landings would be expected in the short-run (one fishing season) from this measure. This short-term increase would result from that portion of the lobster population between 70 and 76.2 mm CL becoming available for commercial harvest. Estimates of the number of lobster from this sublegal size group range from about twelve percent (R.E. Warner, C.L. Combs, and D.R. Gregory, 1976) to 28 percent (G.E. Davis, 1978), for an average of 20 percent. These estimates may vary significantly from one season to the next, among different areas, and with different levels of harvesting effort. Exvessel price will remain unchanged because the increase in price due to a smaller averaged-sized lobster (2.8 percent using 4 to 6 ounce and 6 to 8 ounce categories in Exhibit 9-3) will be negated by the change in price from increased landings (20 percent times -0.14 flexibility). Therefore, commercial revenues may increase an average 20 percent in the short-run. The legal recreational harvest may increase in the short-run as well. In the long-run commercial revenues would be expected to decrease 3.2 percent from present due to reduced yields. The reduction in revenue comes from a seven percent decrease in yield, minus a 3.8 percent increase in exvessel price (2.8 percent increase from a smaller size plus one percent increase from reduced yield). Decreases in commercial revenue may be much greater if future yields are reduced more than the above estimates from recruitment overfishing. Recreational participation and expenditures in the fishery may decline if lobster abundance decreases.

If this measure were adopted it would lead to increased effort inshore, reduced harvesting efficiency, and the possibility for conflict. Enforcement problems would arise from two different size limits (Florida's and this measure) and issue 1 would not be resolved. The enforcement cost for this measure, $328,500, is discussed in Section 12.5.

2. Recommend a minimum harvestable size limit of 3.125 inches CL.

Impact and Rationale

This measure was not proposed because the adverse economic and social impacts would nullify the projected biological gains.

Analysis of this minimum CL on yield (Section 12.2) indicates that in the short-term yield would decline 11 percent during the first three months of the season compared to the status quo; during the first year of FMP implementation, yield would decline 25 percent compared to the yield from the (more than) 3.0-inch CL.

Long-term yield is projected to increase three to four percent over the current legal yield (8.0 million pounds). In addition, with FMP implementation a portion of the 4 million pound difference between current legal yield and MSY would be available for harvest through elimination of "short" harvest. However, not all of the gain should be expected if the State of Florida does not adopt a similar CL.

Economic impacts from this CL would be negative in the short and long-term. Revenue losses would be approximately ten percent during the first three months of the season (11 percent decline in landings minus 1.5 percent increase in price) when most fishing activity occurs. During the first year of implementation revenue would decline by 21.5 percent after subtracting the 3.5 percent increase in price from reduced landings (25 percent times -0.14 flexibility) from the 25 percent reduction in landings. Long-term revenue would increase three to four percent under this CL compared to the 3.0-inch CL. Costs to industry would increase under this CL because fishermen must relocate to deeper more distant waters where there are commercial concentrations of animals greater than this CL. The extent of this relocation cannot be quantified at this time because of limited data on distribution of animals by size. The relocation in the short-term would be to different fishing grounds while in the long-term it would

also involve fishermen and their families relocating place of residence with attendant sociological impacts. In addition, fishing effort would be concentrated in a smaller geographical area adversely affecting all fishermen by lowering CPUE as well as creating conflicts through the reduction of area to set traps.

The central portion of the Florida Keys would be most affected by any CL larger than present (see Measure N.4 for more discussion). Operating costs and investment would increase which would probably nullify increased long-term revenue. Enforcement costs to the federal government for this measure are at least $328,500 (see Section 12.5).

3. Recommend a minimum harvestable size limit of 3.25 inches CL.

Impact and Rationale

This measure was not proposed because the adverse economic and social impacts would exceed the projected biological gains.

Analysis of this minimum CL on yield (Section 12.2) indicates that in the short-term yield would decline 38 percent during the first three months of the season compared to the status quo; during the first year of FMP implementation, yield would only be 67 percent of the yield expected from the proposed (more than) 3.0-inch CL.

Long-term yield is projected to increase six to nine percent over the current legal yield (8.0 million pounds). In addition, with FMP implementation a portion of the 4 million pound difference between current legal yield and MSY would be available for harvest through elimination of "short" harvest. However, not all of the gain should be expected if the State of Florida does not adopt a similar CL.

Economic impacts from this CL would be largely negative in the short and long-term. Revenue losses would be approximately 34 percent during the first three months of the season (38 percent decline in catch plus one percent decline in price due to larger product size, minus five percent increase in price due to less catch) when most fishing activity occurs. Revenue for the first year of FMP implementation declines approximately 29.4 percent (33 percent decline in landings plus one percent decline in price due to larger product size, minus 4.6 percent increase in price due to less catch) compared to the status quo, or a loss of $3.7 million even under the preferred management regime. Part of the decline in yield should be attributed to the recreational sector; the value of this decline is estimated using exvessel price in the absence of other data. Long-term revenue would increase six to nine percent (exvessel price does not vary because decreased landings and increased product size negate each other) under this CL compared to the status quo.

Costs to industry would increase under this CL because fishermen must relocate both their fishing grounds and probably family residences. The magnitude of this relocation would be more extensive and costly than the 3.125-inch CL alternative as discussed above because the animals must be larger to be legally harvested. Operating costs and investment would increase which would probably exceed increased long-term revenue. Relocation costs to fishermen, their families, and society may be increased as well under this CL; no precise estimate can be given at this time (see Measure N.4 below). Enforcement costs to the federal government for this measure are at least $328,500 (see Section 12.5).

4. Recommend a minimum harvestable size limit of 3.5 inches CL.

Impact and Rationale

This alternative measure is not proposed because the adverse economic and social impacts would greatly exceed the projected biological gains.

Based on the yield model presented in Section 5.4.3, a minimum size limit of 3.5 inches CL would increase long-term yield by approximately nine to 14 percent given present fishing effort (see Section 5.4.3). Many fishermen believe that the projected biological gains would not be realized by either commercial or recreational fishermen because lobsters larger than 3.5 inches CL migrate into deeper water beyond the range of the present fishery.

A size limit of 3.5 inches CL would allow most lobsters to reach sexual maturity and spawn prior to being harvested. While a 3.5-inch CL would increase spawning, the spawning level allowed by the existing 3.0-inch CL does not appear to have affected recruitment.

This measure would cause a short-term reduction in biological yield. It would reduce yield an average of 50 percent from present if it were implemented for the next fishing season (Exhibit 12-1). This reduction in yield would result from not harvesting lobsters between 76.2 mm and 88.9 mm (3.0 and 3.5 inches CL). Other estimates of the number of lobster in this size group range from 25 percent (R.E. Warner, C.L. Combs, and D.R. Gregory, 1976) to 45 percent (G.E. Davis, 1977); these estimates vary significantly from one season to the next, among different areas, and with different levels of harvesting effort. The major part of a normal fishing season would be lost because the animals would need an additional six months at the start of the season to grow the incremental half-inch (Exhibit 8-7). This short-term reduction in landings could be minimized, but not eliminated, by increasing the CL over two or more years in smaller increments.

Increasing the minimum harvest size may reduce the projected long-term gain of nine to 14 percent if trap design remains the same. Some loss in yield may occur from injury or short mortality because the time during which a sublegal animal occupies a trap and is handled by fishermen will increase. At present, a trap which will effectively select for larger sizes only has not been developed in this fishery.

The economic and social impacts from this measure are expected to be substantial and generally negative to the fishery and local economy in the short and long-term.

This measure would cause some short run economic loss due to the short run decline in biological yield. If the measure were to be implemented for the next fishing season, commercial revenue would decline an average of 47 percent (50 percent yield decline minus seven percent increase in exvessel price per pound from decreased landings plus four percent decline in exvessel price per pound from a larger average-sized tail) in the short-term (one fishing season). It would take several years to recoup this loss ($6.9 million for the 4.0 million pounds at $2.14 per pound, see Exhibit 12-2) from the fishery itself. Fishermen dependent on lobstering for at least half their income (Section 11.5) would be particularly affected. Local communities in Monroe County where fishing contributes to the local economy (Section 11.6) would be affected. It is uncertain if recreational participation and expenditures would change in the short run with most lobster in shallow waters being sublegal. These short run economic impacts would be reduced, but not eliminated, if the 3.5-inch CL were implemented over two or more years.

The longer-term socioeconomic impacts of this measure would involve 1) restructuring the scope of the fishery, 2) incurring higher costs of operation, 3) possible population shifts of lobstermen and their families among communities in south Florida, 4) a slight increase in commercial revenues, and 5) harvest of a less desirable product.

A larger CL would reduce and possibly eliminate much of the inshore fishery, particularly in Florida Bay because animals larger than 3.5 inches CL are uncommon inshore. This area is roughly half of the fishing area and accounts for a large but unknown fraction of total fishing effort. Thus, the effective fishing area would be substantially reduced.

A larger CL would concentrate effort further offshore. This would exacerbate already crowded offshore conditions and increase fishing costs by forcing the inshore fleet to fish further offshore. The capital investment for larger, more powerful craft, more traps, and other equipment may thus increase.

Sociological impacts would be severe in some fishing communities, such as Marathon, which are heavily dependent on the Florida Bay area. Sociological impacts may include lobstermen and their families moving to communities closer to offshore fishing areas; the need for supplemental income while the fishermen adjust to new regulations; and possible exit from the fishery and perhaps the community with associated stresses on family members.

In the longer term, commercial revenues to fishermen would increase an average of 5.9 percent (11.5 percent increase in landings minus 5.6 percent decline in exvessel price per pound, see Section 9.1.1.2). The exvessel price decline assumes no increase in real national income; if real national income were to increase then commercial revenues would be increased accordingly. A large part of the decline of exvessel price is that the 3.5-inch CL lobster shifts into a less desirable product group (tail or whole lobster) as reflected through wholesale prices.

Recreational participation and expenditures would be adversely affected in the long term because many divers do not have the physical ability to effectively harvest lobster in deeper water.

Increasing the minimum harvest size without a similar regulation by the State of Florida would create enforcement problems for both state and federal agencies. This would not resolve Issue 1. Enforcement cost for this measure is an estimated $328,500 (Section 12.5).

O. Recommend closure of the following areas to all commercial and recreational harvest of spiny lobster:

   1. Florida Bay extending westward to an imaginary line drawn between Sombrero Light (located south of Marathon on the reef crest) and east of Cape Sable,

   2. Biscayne Bay including interior sounds and channels, and

   3. The Atlantic side of the Florida Keys and Florida east coast (from Sombrero Light to Miami) out to the southern line of boundary markers for Hawks Channel.

Impact and Rationale

The purpose of these measures is to increase total yield by reducing injury and disturbance to juvenile lobsters where they are most abundant. They were rejected because the economic and social disruptions which would result were considered more severe than the small potential gain in total biological yield. In addition, most of the above areas are within the jurisdiction of the State of Florida or the National Park Service.

The positive impact of closing these areas would be to reduce the damage which sometimes occurs to small lobsters when they are handled by commercial or recreational fishermen. Area closures would also reduce the opportunity for fishermen to illegally harvest undersized lobsters. This would be most beneficial in the first two areas which have the largest percentage concentration of juvenile lobster. The percentage of legal size lobster in the third area is much higher.

Negative impacts of this measure are social and economic. There is substantial but not well documented fishing effort for the available legal animals in these areas. A crude estimate based on NMFS landing statistics showed 0.66 million pounds caught in that area. The advisory panel estimated that 1.8 million pounds are taken annually from Florida Bay, much of which is included in the first area above.

Commercial fishermen who now harvest in these areas would be substantially disrupted and would need to find new locations offshore for their traps. Fishermen presently operating offshore would be adversely affected by the influx. Some fishermen may be forced out of the fishery. Negative effects will tend to be localized and might be significant in some towns along the Florida Keys, particularly Marathon. Fishing effort would likely increase in the available areas and fishing would be much more intensive along the reef crest, increasing gear conflicts and competition for space. Catch per unit effort may decline, contravening Objective 5.

Recreational divers would be substantially affected since Florida Bay and Biscayne Bay are both popular recreational diving areas. These closures encompass the majority of the present area most used by recreational fishermen.

Areas remaining open and readily accessible to divers (Florida's east coast, various keys between Marathon and Dry Tortugas and shallower areas along the Atlantic side of the Keys) would receive additional diving pressure. Communities and businesses which rely on recreational divers' expenditures would be adversely affected by the shift in diving effort away from Florida Bay and Biscayne Bay. Enforcement costs for this measure are discussed in Section 12.5.

P. Require that traps be limited to (a) wood slat traps with biodegradable tops or throats (side reinforcement with 16 gauge, one-inch poultry wire to prevent turtle damage is acceptable) or (b) ice cans, drums, and similar devices.

Impact and Rationale

Measure C has been recommended in lieu of this measure. Both measures would provide for degradable surfaces on traps, but Measure C would not restrict technological innovations such as traps with plastic slats. No immediate benefits or costs are attributable to this measure.

Q. A buoy must be attached to each trap (or to a set of traps via a trotline with buoys affixed to both ends). Buoys must be of sufficient buoyance to float except when intentionally submerged with a timed float release device.

Impact and Rationale

This measure was not recommended. There is not enough information available to now develop methods for trap location and retrieval that minimizes problems of user conflict, unintentionally damaged traps and lost traps. A recommendation which would encourage the design and implementation of a system to assist in locating and retrieving of traps is discussed in Section 14.2.

R. Lobster tails shall not be separated from the carapace while on or below waters of the FCZ. Separated tails shall not be transported or possessed while in the FCZ except that lobster tails separated in waters outside the FCZ may be transported across the FCZ provided that written notification of such transport is received by the appropriate agency at least 24 hours before the separated tails enter the FCZ. Such tails shall measure no less than 5.5 inches measured lengthwise along the center of the tail. The measurement shall be conducted with the tail in a straight flat position and the tip of the tail closed. This provision should not be construed to prevent the transport of separated tails from foreign countries for lawful import where a valid bill of sale or other evidence of purchase exists.

Impact and Rationale

This measure is similar to Florida law which prohibits the separation of tails except by special permit.

This measure responds to the belief of inshore fishermen that disposal of lobster heads overboard scares away other lobster and to the needs of offshore fishermen. Recent studies in Australia also indicate that at least one species of spiny lobster may avoid areas where lobster bodies have been discarded. There is no scientific evidence that this is true for P. argus or that, if true, it would affect total yield from this fishery.

This measure was considered as unnecessary regulation. Inshore fishermen who make one-day trips (the vast majority) normally land their catch alive. Offshore fishermen who stay out more than two days must clean and ice the catch to maintain a high quality product. This measure would improve enforceability of some proposed measures. However, this was not considered sufficient reason to recommend adoption of the measure.

S. Prohibit any boat without a commercial permit engaged in the spiny lobster fishery from harvesting from the FCZ or possessing while on the waters of the FCZ regardless of where taken, more than 24 spiny lobsters in a single day.

Impact and Rationale

This measure would affect only the recreational fishery. With recreational diving effort increasing, a daily bag limit offers a method of absorbing increasing levels of participation without a large increase in the recreational harvest. Available statistics indicate that in one popular area divers caught an average of 2.25 lobsters per day or an average of 7.03 lobsters per boat (see Section 8.2.2.2). Thus a bag limit of 24 lobsters per day would be an actual constraint on very few recreational divers.

This measure is felt to be discriminatory against recreational fishermen. Although few recreational divers would be able to achieve catches greater than this proposed limit, the measure in principle places a restriction on recreational participants and not on the commercial sector of the fishery. There is no documentation that recreational effort should be restricted.

T. Prohibit the importation or possession of spiny lobsters (P. argus only) below 3.0 inches carapace length or (when the tail has been separated) below 5.5 inches tail length.

Impact and Rationale

Imposing restrictions on the importation of undersized lobsters would make it easier to enforce minimum legal size requirements for lobsters harvested in the FCZ since wholesalers throughout the United States would be prevented from marketing undersized lobsters. (The illegal marketing of undersized lobsters harvested in the FCZ could be more easily traced.) However, this measure could substantially affect the import market which supplies about 90 percent (see Section 9.3) of the lobsters consumed in the U.S. Import restrictions would reduce the supply of 4 to 6 ounce tails and increase the supply of 6 to 8 ounce tails, affecting price-size relationships. The magnitude of this change on the retail market cannot be estimated.

This proposed regulation would indirectly impose a size limit on Caribbean countries that rely on the U.S. market to sell their lobster harvest. This would raise important issues regarding relationships with these countries. The United States through the Lacey Act (18 U.S.C. 43) has already agreed not to accept products illegal in other countries, such as sublegal lobster.

U. Require permitting of recreational and commercial participants in the fishery. As part of this annual permitting program provide for the collection of management information for the fishery.

Impact and Rationale

The collection of information through a permitting system would improve the ability to manage the fishery by providing a data base from which management decisions could be made and would improve enforcement and control of the fishery.

Permit requirements would impose some additional burdens on fishermen due to the time required for obtaining forms and providing the required information. The concept of a permit for recreational boats and extensive mandatory reporting for commercial fishermen is new among Gulf of Mexico and South Atlantic states.

Measure U was rejected in lieu of a vessel enumeration system and survey reporting system for recreational users, and trip ticket system for all commercial fishermen registered with FDNR and the Regional Director. It was believed that these systems would provide adequate data for both management and enforcement activities and could be more efficiently collected. A permit system would cost the federal government approximately $10 per permit for administrative costs (Gulf of Mexico Reef Fish FMP), or $19,500 to $50,500 for the 1,600 commercial craft in the fishery (Section 8.0) and 350 to 3,450 recreational vessels (Measure L.1, Section 12.4.1).

V. Develop a system to limit access in the fishery.

Impact and Rationale

Limited access appears to be the only effective method to control fishing effort. This can be done by limiting the number of traps, the number of fishermen, or traps per fisherman. The purpose of this would be to increase biological productivity and/or economic efficiency.

The fishery is technically overcapitalized in that more traps are fished than physically required to harvest the available yield. A reduction in the number of traps fished would increase the economic efficiency and profitability of the industry. Fewer traps also could reduce fishing-induced mortality and illegal harvest of shorts that occurs because of current fishing practices. This offers some biological rationale for limited entry. However, in order to increase harvesting efficiency and profitability of the industry, and perhaps reduce all forms of "short" loss , there would have to be a considerable reduction in the number of traps and of participants. A simple cap or moratorium on fishermen (or traps) at the present level would not be sufficient. It would take several years of attrition to reduce the number of fishermen (or traps).

As detailed in other sections of this plan however, spiny lobster stocks are not jeopardized by current levels of effort, e.g., the domestic spiny lobster catch has been stable since 1969 when effort approached equilibrium levels. Therefore, any limited entry scheme would be based primarily on social and economic considerations, although it could have some biological benefits as well.

The major drawback to instituting a limited entry regime in the spiny lobster fishery is the impacts it would have on other fisheries. Spiny lobster fishermen are involved in the harvesting of many other species. Many fish for pompano with trammel nets throughout the year depending on the relative availabilities of lobster and pompano. Many fish for Spanish and king mackerel from October through April. Lobster fishermen also fish for stone crabs. They also harvest reef fish with hook and lines and/or traps. Currently some are harvesting tilefish in deeper waters - particulary in the Florida Keys and off the east coast of Florida.

In summation, the geographical area where spiny lobsters are harvested (primarily the Florida Keys) contain a great variety of other commercial species that also are harvested. Imposing a limited entry scheme in the spiny lobster fishery would have dramatic impact on these other fisheries. Some of these impacts would be favorable while many others would adversely affect fisheries and fishermen.

Because of the complex nature of the multispecies fisheries, limited entry measures for the spiny lobster fishery have been carefully considered but rejected in favor of the proposed management measures contained in this plan.

A limited access scheme in the FCZ only without a consistent regulation by Florida would have the effect of shifting fishing effort into state waters. Since these waters are generally shallower than the FCZ, yield may be reduced since smaller lobsters would be caught. Shifting effort inshore would also lead to crowded conditions and reduced harvesting efficiency. Enforcement would also be difficult without consistent State regulations and also costly in any event (see Sections 12.5 and 13.9 for enforcement costs).

W. No Action.

Impact and Rationale

The No Action alternative was rejected because it results in a substantial risk of recruitment overfishing which could lead to collapse of the fishery.

Passage of MFCMA and recent litigation (Allen, et al. v. Tingle, 16 Judicial Court, Monroe County Florida) have inhibited Florida's ability and desire to enforce its regulations beyond the territorial sea. As a result, harvest in the FCZ during the spawning season (illegal under Florida law and this FMP) has greatly increased. This activity is expected to continue increasing at a rapid rate if no further action is taken. It substantially reduces spawning and creates a risk of recruitment overfishing.

Changes in state law and increases in Florida enforcement efforts might be partially effective in reducing sublegal and out of season harvest. However, there is no guarantee that such state efforts could be effective given the difficulties created by passage of MFCMA. Perhaps more important, changes in state law and enforcement capability will be slow, requiring at least five years or more to become effective. In the interim, the fishery could collapse due to recruitment overfishing.

For more discussion of the No Action alternative, refer back to Section 12.3.

12.5 Benefits and Costs of the Alternatives

Basically, four management regimes are considered in evaluating regulatory impacts. The four management regimes are 1) No Action, i.e., the status quo; 2) all federal management and enforcement of the FCZ without any change in state activities; 3) all state management and enforcement of the fishery throughout its range with appropriate changes in state regulations; and 4) state/federal cooperative management via a FMP and existing enforcement personnel. Below is a discussion of the benefits and costs of each alternative.

Comments received on previous drafts of this FMP indicated confusion and a short-term approach regarding monetary values derived from a common property resource. Specifically, it was suggested that the value of illegal harvests (juveniles and out-of-season harvest) should be subtracted from the benefits derived from implementation of this FMP. Implicit in this suggestion was that the elimination of this economic activity (illegal harvesting) is another cost of implementing the FMP. The Councils believe that legitimizing this economic activity in a simplistic accounting procedure would defeat the purposes of sound marine resource management.

In analyzing the economic impacts of proposed regulations, it is necessary to distinguish between gains and losses for private industry and those for society. This distinction is especially important in open access, common property fisheries with resource conservation concerns and with a high level of demand for the product. This is the case in the Gulf and south Atlantic spiny lobster fishery.

Demand is so intense that there is a large and growing practice of harvesting and selling sublegal, juvenile lobsters and lobsters of all sizes during the reproductive season (closed by Florida regulation). These illegal practices result in short-term economic gains to individual fishermen and associated monetary benefits generated in the economy; however, such illegal practices are a cost to society because they can result in recruitment overfishing which threatens the future well-being of both the resource and industry.

The objectives of the FMP (Section 12.1.1) will be achieved by enforcement of the minimum harvest size and the closed season, among other measures. Consequently, these illegal practices will decline as will the value and economic activity associated with them. The issue of whether to include loss of this value as a cost of implementing the FMP appears to be not only a specious argument but is dangerous in its implications. The Council totally rejects the idea of attaching positive values to illegal activities. Members of the Councils' Scientific and Statistical Committee (Drs. K. Roberts (Chairman), J. Cato (Vice Chairman), F. Prochaska, all marine economists, and E. Houde (marine biologist), personal communication) consider this argument as contrary to the resource conservation principles embodied in the Magnuson Act and to the theory of management of common property resources.

The Council did consider the value of the illegal harvest and how to count it. They concluded that monetary values for sublegal harvest were not comparable to the legal value, could not be estimated with any degree of accuracy or confidence, and, most important, any benefit from illegal landings was more than cancelled out by its negative aspects. The value of the sublegal lobster is not comparable to legal value for several reasons, including a lower yield per recruit, and lower return to the nation as no taxes are paid. None of these can be accurately estimated.

Sublegal harvest and particularly the growing out of season harvest are threats to the long-term viability of the resource. Almost all of the sublegal lobsters landed are juveniles which could lead to recruitment overfishing. Uncontrolled fishing during the closed season can come close to eliminating the remaining spawning activity in this stock. Illegal harvest rewards the outlaw and penalizes the legal fisherman. Large scale violation of the size limit and closed season forces more fishermen to become outlaws, further increasing illegal harvest. This has already become a vicious circle which can result in destruction of the fishery.

What is claimed to be a benefit from illegal harvest is actually a loss to the legal fishery of not only that amount, but also the commercial revenue and sport harvest foregone from the anticipated growth to a legal size, as well as the future well-being of the fishery. Therefore, assigning a value to these practices would contradict and negate the objectives of the FMP and hence is not done in this analysis.

Comparison of the Impacts of the Alternate Management Regimes and Measures

The direct economic impact from the proposed management regime on the fishery is highly beneficial. The FMP defines OY with a size limitation (greater than 3.0-inch CL) consistent with the current legal practice in the fishery. Minimal restrictions are placed on those participating in the fishery by the proposed management regime. No prohibitively large expenditures are required by the federal government or user groups under the proposed management regime.

No Action Benefits and Costs. The No Action management regime represents the status quo. Under this alternative, no additional benefits would accrue to industry, recreational fishermen, or society. Long-term cost under this alternative is the risk of the fishery collapsing through recruitment overfishing. While adherence to a minimum harvest size of more than 3.0 inches CL, a closed season, and protection of berried females could maintain the fishery (Section 5.4.2), the resource appears to be under an unacceptable biological risk if illegal harvest of juvenile lobsters and of all sizes during the closed season continues and grows.

The data is inadequate to determine what degree illegal harvesting would result in the inability of the stock to replenish itself and over what time period. Experiences in other fisheries where recruitment overfishing occurred (Atlantic mackerel, California anchovy) indicate long-term declines in yield of substantially greater than 50 percent. A conservative estimate of 50 percent is used here for illustration. Such a decline in this fishery would mean annual reductions in landings of four million pounds or more, in dockside value of at least $9 million, in employment of several hundred fishermen, and in additional value to the national economy of at least $9 million. If out-of-season harvest continues to increase and recruitment of animals to the fishery comes entirely from Florida, then within five years landings and value will decline by at least 50 percent.

Since recruitment overfishing will result from No Action, this alternative is not in the best interest of resource conservation. While no additional short-term costs to government have been identified under this alternative, industry and society would incur short-term incremental costs from the increasing risk of recruitment overfishing and collapse of the fishery (Exhibit 12-2).

For additional discussion of the No Action alternative, refer to Section 12.3.

All Federal FCZ Management Benefits and Costs. This alternative, described above in Section 12.3, would result in a substantial increase in federal government expenditures, particularly enforcement resources, with a corresponding increase in yield and value to the fishery and economy. Enforcement efforts by the federal government amount to an additional $328,500 annually (see government costs below). This level of enforcement, along with cooperative agreements and activities with state enforcement agencies, is a substantial increase in total enforcement throughout the fishery. It does not represent a maximum effort, however, according to cost estimates prepared by NMFS (C. Fuss, Law Enforcement Division; see government costs below). In addition to this amount, there is a net increase in statistical reporting costs of $58,798 the first year and $34,798 annually thereafter, for a total of $387,298 in the first year and $363,298 annually thereafter.

Benefits will vary according to the level and effectiveness of enforcement activities of fishery regulations, in this case a FMP. Benefits include increase in legal harvest, curtailment of illegal harvest, and maintenance of recruitment to the fishery. The Councils considered the level of increased benefits to be commensurate with the level of enforcement and effectiveness below:

	Level of Enforcement/Effectiveness		
	Low	Medium	High
	---------- Increased Landings in Pounds ----------		
Benefits	800,000 reduced overfishing risk and increased yield per recruit	2.0 million	3.3 million

At a high level of enforcement and effectiveness, the Councils' best estimate of benefits commensurate with this effort is 3.3 million pounds of additional legal-sized landings. The 3.3 million pounds is the low value of a range between 3.3 to 4.9 million pounds estimated by Austin, et al. (1980a) to be losses from fishing practices and illegal harvests (Exhibit 5-10 and Section 5.4.2). The difference between present landings (8.0 million pounds) and MSY at a 3.0-inch CL (12.0 million pounds) is made up of illegal harvests and "short" mortality. A high level of enforcement/effectiveness would substantially curtail illegal harvests and abuse in the use of "shorts". At a medium level of enforcement/effectiveness, the Councils' best estimate of benefits is 2.0 million

Exhibit 12-2

Comparison of Benefits/Costs in the First Year of FMP Implementation under Various Management Regimes and Carapace Length Alternatives, with the No Action alternative.
Benefits in numerator (top), costs in denominator (bottom)

Carapace Length[1]	Management Regime[2]			
	No Action	All-State	All-Federal	State/Federal Cooperative (preferred)
(inches)			(current dollars)[3]	
2.75	N.A.	N.A.	5,271,720 risk + 387,298	4,014,000 risk + 58,798
3.0 (preferred)	0 high risk	0 high risk	4,303,900 387,298	3,255,000 58,798
3.125	N.A.	N.A.	-1,115,000 387,298	-1,951,250 58,798
3.25	N.A.	N.A.	-2,943,601 387,298	-3,683,325 58,798
3.5	N.A.	N.A.	-6,420,000 387,298	-6,957,600 58,798

N.A. - Not applicable

[1] Assumes identical state and federal CL.

[2] All benefits/costs are comparable to the No Action alternative. To compare benefits within a management regime, subtract benefits from each other, depending on carapace lengths, e.g., difference between 3.0-inch CL and 3.5-inch CL under all-federal management is $10,723,900.

[3] Benefits for fishermen and costs to government.

Source: Sections 12.4 to 12.5, Exhibit 12-1.

pounds of additional legal-sized landings. The 2.0 million pounds is a point estimate from several sources (Johnson, 1974; Warner, et al., 1977; Justen, 1981; Gulf of Mexico Spiny Lobster Advisory Panel) indicating a range of 1.4 to 3.4 million pounds of illegal harvest. Finally, at a low level of enforcement/effectiveness, the Councils' best estimate of benefits is 800,000 pounds of additional legal-sized landings, the reduced risk of overfishing, and increased yield per recruit. These gains would come from enforcement of the minimum CL and/or enforcement of the closed season. The 800,000 pounds is cited above in Sections 12.3 and 12.4.

All-federal FCZ management, according to the level of enforcement resources anticipated, can be characterized as providing for a medium level of enforcement and effectiveness. Therefore, the corresponding benefits under this alternative are approximately two million pounds annually in increased yield. This represents a 25 percent increase over the present catch, which would decrease the market price ($2.23 per pound) by 3.5 percent (-0.14 percent price flexibility) to $2.15 per pound. This increase in landings results in an additional $4.3 million to fishermen (Exhibit 12-2). In the short run without any additional firms or capital in the industry, fishermen would realize 40 percent of this additional revenue, or $1.7 million, as profit (Prochaska and Landrum, 1981). (The increased catch includes recreationally-caught fish which is conservatively valued the same as commercial catch in the absence of more data.) An additional $3.9 million is generated throughout the south Florida economy through the transportation, processing, wholesaling, retailing, and fishing supply industries (U.S. Water Resources Council, 1977). Additional employment associated with the $3.9 million is 487 man-years (Cato and Prochaska, 1980).

All State Fishery Management Benefits and Costs. This alternative, described above in Section 12.3, would result in a substantial increase in state government expenditures, specifically for enforcement, with a corresponding increase in yield and value to the fishery and economy. The discussion of this alternative above points out not only the uncertainty and lack of timeliness of increased state action and expenditures, but also the legal questions surrounding all-state management.

In reality, the all-state management regime in the first year is exactly the No Action alternative for the reasons cited above in Section 12.3 (Exhibit 12-2). These reasons include the necessary time for legislative consideration of changes in management, possible legal challenges to any new state legislation, delays in acquisition of necessary patrol vessels. In addition to these factors, the main agenda item during the 1981/1982 legislative session for the State of Florida is the subject of reapportionment. For the purposes of analysis, the FMP adopts the most optimistic view of the speed at which Florida assumes management of the fishery, i.e., beginning in year two. A more realistic opinion of the state's ability to manage should reduce all the benefits associated with this management regime in the accompanying exhibits (12-2 and 12-3).

Additional state government expenditures would amount to $305,274 annually. These costs consist of those for enforcement and statistical reporting to achieve fishery management goals. Enforcement needs for the Florida Marine Patrol would require at least one and as many as three fifty-foot patrol boats (Major Ed Little, Florida Marine Patrol, personal communication). Assuming two vessels at an initial purchase cost of $300,000, a 20-year life and ten percent capital recovery factor, the annual ownership cost is $70,238. Operation costs for two vessels would amount to $200,000 annually; this sum consists of $120,000 for fuel, maintenance, etc., and $80,000 in salaries for a total of four crewmen. Statistical reporting costs would amount to $34,798 annually for a data collection system patterned after the one described in Measure L (Section 12.4.1) with sampling of commercial and recreational fishermen.

Due to the uncertainty about the legality and timeliness of all-state management, this alternative appears to have a level of enforcement and effectiveness between low and medium. The Councils' best estimate of benefits with this enforcement level is an additional one million pounds in catch annually. This represents a 12.5 percent increase over the present catch, which would decrease

the market price ($2.23 per pound) by 1.7 percent to $2.19 per pound. This increase in landings results in an additional $2.2 million to fishermen. In the short-term without any additional firms or capital in the industry, fishermen would realize 40 percent of this additional revenue, or $880,000, as profit. (The assumption regarding recreationally-caught fish made above applies here, too.) An additional $2.0 million is generated throughout the south Florida economy. Additional employment associated with the $2.0 million is 243 man-years.

State/Federal Cooperative Management Benefits and Costs. This alternative, described above in Section 12.3, works on the principle of shared management responsibility and the combination of both agencies maximizes both their strengths and minimizes total government costs. In addition to allowing total government costs to remain at a relatively low level, there is no long-term cost associated with this alternative from the risk of recruitment overfishing and collapse of the fishery as there is with No Action or all-state management. The required incremental cost to government (federal) under this alternative is $58,798 the first year and $34,798 annually thereafter. This sum is for data collection from recreational fishermen which is not done continuously or consistently by any entity. Other statistical reporting costs for commercial fishermen and processors are already included in the budget for the Southeast Fisheries Center. Enforcement responsibilities will be performed with existing manpower and equipment of the federal government and states.

Due to the advantages of this alternative, the level of enforcement and effectiveness appears slightly below medium, or between all-state and all-federal alternatives. The Councils' best estimate of benefits in this situation is approximately 1.5 million pounds in additional catch annually. This represents a 18.7 percent increase over the present catch, which would decrease the market price ($2.23 per pound) by 2.6 percent to $2.17 per pound. This increase in landings results in an additional $3,255,000 to fishermen (Exhibit 12-2). In the short term without any additional firms and/or capital in the industry, fishermen would realize 40 percent of this additional revenue, or $1.3 million, as profit. (The assumption regarding recreationally caught fish made above applies here, too.) An additional $3.0 million is generated throughout the south Florida economy. Additional employment associated with the $3.0 million is 371 man-years. If more monetary resources for enforcement become available to the federal government, then benefits will correspondingly increase to the medium level and very possibly increase towards the high level.

Government costs - Costs to government (state and federal) to implement the various alternative regimes in this FMP are made up of statistical reporting costs and law enforcement costs. Statistical reporting under the proposed measures (Measure L, Section 12.3.1) would cost $58,798 the first year of FMP implementation, and $34,798 annually thereafter. Under the alternative measures, a permit system (Measure U, Section 12.3.2) would cost $19,500 to $50,500 annually in order to obtain a population to sample. The cost of the statistical reporting using a permit system first would be similar to the costs cited above.

Enforcement costs for the various management regimes and for the alternate measures were estimated by the Law Enforcement Division of the NMFS Southeast Regional Office and the Florida Marine Patrol. Enforcement costs for state/federal cooperative management via a FMP would remain within existing budgets for both state and federal entities. The U.S. government deploys through the U.S. Coast Guard several cutters, fixed wing aircraft, and helicopters operating daily on a multi-mission basis; and through NMFS one patrol boat and several field agents experienced in enforcing the Shrimp and Stone Crab FMPs. Enforcement costs for the all-state management alternative was estimated by the Florida Marine Patrol (Major Ed Little, Atlantic Division). Currently, Florida deploys 26 officers, 26 boats, one airplane, and one helicopter in south Florida.

Enforcement costs for each alternative CL with the all-federal management alternative, is estimated to be $328,500 annually. This cost assumes a 50:50 ratio of dockside:at-sea enforcement by

NFMS and Coast Guard personnel and at least one contact with each commercial vessel per year. Increases from the existing (and proposed) CL would certainly result in additional expenditures by the federal and state governments. The reasons for this are 1) market forces which prefer a smaller animal and 2) industry resistance to any change. Industry resistance would increase (linearly or exponentially) as the minimum CL would increase. If the state and federal government did not act in concert in setting CL's, enforcement would not only be costly for both entities but nearly impossible to be effective. A maximum of $1,159,800 in annual enforcement costs for all the alternate measures (with any CL) was estimated (C. Fuss, NMFS) because they would close areas to commercial and recreational users, limit the number of fishermen and/or traps, impose bag limits, restrict imports, and require permits for all fishermen.

Summary. Of four management regimes proposed and discussed, the state/federal cooperative system results in the most amount of benefits per dollar of government expenditures, does not result in long-term costs to the fishery and the nation, and fulfills the resource conservation goals found in the Magnuson Act. In the first year of plan implementation, industry revenue would increase by $3.3 million, recreational participation would increase and total additional cost to government (federal) increases by $58,798 (Exhibit 12-2). Additional monetary benefits to the economy amount to $3.0 million through stimulation of several sectors of the economy which also creates additional employment. All the other management regimes, and measures, result in either industry losses and higher government costs, or unacceptable risks to the future well-being of the resource.

In the long-term, defined here as five years in which the fishery theoretically stabilizes at different CL's, the state/federal cooperative system remains the best management regime with the most amount of benefits per dollar of government expenditures and the least cost to industry and the nation (Exhibit 12-3). All the other management regimes result in fewer benefits, higher costs to government, and higher costs to industry and the nation through the risk of overfishing.

The long-term analysis makes the following assumptions:

1) within five years of FMP implementation the long-term effects of increased CL lengths (greater than three inches, described in Section 5.4.2) will be realized;

2) between years two to five the increased yield per recruit gains expected at CL's greater than the preferred CL will be realized in four equal steps until year five in the absence of information about the timing of yield gains, and considering any industry resistance to change;

3) the yield per recruit gains for CL's greater than the preferred are also applied to the benefits from each management regime at the preferred CL, e.g., 1.0 million pounds all-state management, 1.5 million pounds state/federal cooperative management, and 2.0 million pounds all-federal management; these gains, and the absolute amount of gains from a management regime, will be realized in four equal steps in the absence of information about the timing of yield gains and industry resistance to change;

4) all-state management does not begin to take effect until year two; assumptions 1-3 are carried into this management regime, but delayed one year;

5) under the No Action alternative, if harvests during the spawning season continue to increase, as does "short" harvest, the fishery will experience a decline in landings of at least 50 percent by year five; this decline will be experienced in four equal increments (see the No Action discussion above); landings under each CL and management regime are indicated in Exhibit 12-4 within the period they stabilize;

6) exvessel price varies only by changes in landings, using price flexibility, and by changes in product size (see Sections 9.1.1.2 and 12.4); real national income, the level of imports, and

Exhibit 12-3

Comparison of Discounted (Present Value) and Cumulative Benefits/Costs in a Five-Year Period of FMP Implementation under Various Management Regimes and Carapace Length Alternatives. Benefits in numerator (top), costs in denominator (bottom)

Carapace Length[1]	Management Regime[2]			
	No Action	All-State	All-Federal	State/Federal Cooperative (preferred)
(inches)	----------	(current dollars)[3]		----------
2.75	N.A.	- 368,127	1,161,536	18,154
		risk +1,157,230	risk +1,399,004	risk + 153,730
3.0	-6,426,000	6,310,913	16,315,167	12,339,012
(preferred)	high risk	1,157,230	1,399,004	153,730
3.125	N.A.	2,114,052	7,895,576	5,113,616
		1,157,230	1,399,004	153,730
3.25	N.A.	115,994	7,401,321	4,819,141
		1,157,230	1,399,004	153,730
3.5	N.A.	-2,036,807	5,020,297	2,639,789
		1,157,230	1,399,004	153,730

N.A. - Not applicable

1 Assumes identical state and federal CL.

2 All benefits and costs are comparable to the No Action alternative. To compare benefits within a management regime, subtract benefits from each other, depending on carapace lengths selected.

3 Benefits to fishermen and costs to government discounted over five years and a ten percent rate using 1980 exvessel market price of $2.23 per pound.

Source: Section 12.5

the prices of substitute goods remain constant; deflated prices, not used here, simply scale absolute amounts down and do not change relative positions of various benefits;

7) a discount rate of ten percent, which appears a likely compromise between a low rate preferred by government agencies to give value to projects in future years, and a high value preferred by industry to give value only to the immediate future; discount rates deviating from ten percent will simply scale the benefits/costs of the alternatives up or down in the same direction and the same magnitude (absolute amount and/or percentage);

8) present value analysis is the analysis of choice because of its widespread use by U.S. government agencies for public projects.

The results of the long-term analysis indicate the preferred management regime and preferred CL yield five-year cumulative, discounted benefits to fishermen of $12,339,012 and costs of $153,730 to the federal government. Additional monetary benefits generated in the economy amount to $11.3 million over a five-year period to all various sectors handling the increased flow of product. Whichever management regime is selected, development costs for this FMP have already occurred. These costs ($402,988) on an annual basis are $47,335 assuming a 20-year project life for the FMP management framework and a ten percent capital recovery factor.

The analysis indicates the long payback period under any management regime when deviations (increases) are made from the preferred CL. While total landings from CL's greater than the preferred would theoretically be greater in the long run, the industry may not survive revenue losses in the short-run in order to benefit from long-term gains. Benefits of the CL's of 3.125 inches and greater are gross amounts because they do not account for increased industry costs from decreased CPUE, larger investments for boats and traps, and higher fuels costs as described in Section 12.4.2. Even extending the present value analysis to ten years does not alter the superiority of the preferred CL whichever management regime is instituted (excluding No Action).

The procedure used to estimate economic impacts of both the proposed and alternative management measures (and regimes) includes a systematic evaluation based on the following criteria:

1. Changes in price (exvessel, wholesale, retail); price flexibilities will be used where appropriate; no increase in real income is assumed.

2. Changes in supply, effects on production, marketing costs, and product type in the market.

3. Changes in employment.

4. Harvesting revenues; changes in gross revenue to fishermen.

5. Productivity/industry costs; related to production aspects and affecting gross revenue, total costs, or labor time for a reporting burden.

6. International impact; effects on foreign fishing in U.S. waters, imports/exports of product, effect on foreign fishery management.

7. Market structure, changes or restrictions in size, number or location of firms.

8. Government costs; incremental or additional annual costs to state or federal government - a special discussion is above.

9. Recreational participation; number of fishermen, degree of fishing success, economic impact on firms serving this sector.

Exhibit 12-4

Projected Landings over Present Legal Landings

under Various Management Regimes and Alternative

Carapace Lengths

Management Regime	YEAR 1	2	3	4	5	6 [1]
Carapace Length [2]	- - - - - - - - - - - - POUNDS - - - - - - - - - - - - - - - - - -					
No Action						
2.75	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
3.0 [3]	0	-1,000,000	-2,000,000	-3,000,000	-4,000,000	>-4,000,000
3.125	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
3.25	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
3.5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
All-State Management						
2.75	N.A.	1,200,000	- 560,000	- 560,000	- 560,000	560,000
3.0	0	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
3.125	N.A.	-1,250,000	328,750	657,500	986,250	1,315,000
3.25	N.A.	-2,000,000	437,500	875,000	1,312,500	1,750,000
3.5	N.A.	-3,500,000	508,750	1,017,500	1,526,250	2,035,000
All-Federal Management						
2.75	2,400,000	- 560,000	- 560,000	- 560,000	- 560,000	- 560,000
3.0	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
3.125	- 500,000	587,500	1,175,000	1,762,500	2,350,000	2,350,000
3.25	- 1,333,334	687,500	1,375,000	2,062,500	2,750,000	2,750,000
3.5	- 3,000,000	787,500	1,575,000	2,362,500	3,150,000	3,150,000
State/Federal Cooperative						
2.75	1,800,000	- 560,000	- 560,000	- 560,000	- 560,000	- 560,000
3.0	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000
3.125	- 875,000	458,125	916,250	1,374,375	1,832,500	1,832,500
3.25	- 1,666,663	553,125	1,106,250	1,659,375	2,212,500	2,212,500
3.5	- 3,250,000	648,125	1,296,250	1,944,375	2,592,500	2,592,500

N.A. - Not Applicable

Source: Yield per recruit model, Section 5.4.2; Exhibit 12-1; assumptions made in summary section of Section 12.5.

[1] Stability achieved for all management regimes (excluding No Action) in year 6, for all-federal and state/federal cooperative in year 5.

[2] Minimum harvest sizes in inches, measured "greater than."

[3] If the No Action regime continues, probable collapse of the fishery will occur sometime soon after year 5.

Below is a comparison of economic impacts from implementation of the proposed and alternative management measures. The impacts are summarized (from above and Section 12.4) in Exhibit 12-5 for the proposed measures and in Exhibit 12-6 for the alternate measures.

Paperwork Reduction Act (44 U.S.C. 350 et seq.)

The proposed management measures will not increase the reporting burden for commercial and recreational fishermen and processors over present amounts. The major change will be a shift from a voluntary to a mandatory reporting system. Data will be collected on a random sampling basis which minimizes the reporting burden on the fishermen and costs to the federal government. Actual costs and reporting burdens are indicated in Measure L, Section 12.4.1. The proposed licenses, color-coded buoys, and trap and vessel identification are presently required under Florida regulation; the information from this system will be on file with the Regional Director.

Regulatory Flexibility Act (5 U.S.C. 601 et seq.)

The proposed management measures provide significantly positive economic impacts to the small businesses associated with the spiny lobster fishery. Virtually all of the entities associated with the spiny lobster fishery are classified as small business, and will consequently receive practically all of the economic gains resulting from the proposed measures described above, in Section 12.4.1 and in Exhibit 12-4.

Determination of Major/Minor Rule

This FMP is a minor rule under the interim guidelines established on June 17, 1981, by the Office of the Assistant Administrator for Fisheries. This determination of a minor rule for this FMP is based on the insignificant impacts as a result of this FMP on the following criteria:

1) increase in the total cost or price of goods of $5 million per year;
2) increase in cost or prices of ten percent or more;
3) adverse impact on competition;
4) adverse impact on employment;
5) adverse impact on investment;
6) adverse impact on productivity;
7) adverse impact on exports.

12.6 Specification of Optimum Yield

Optimum yield (defined as a minimum size) was obtained by trading off increasing biological yield from a larger carapace length and enforcement of no short retention and use, against the socioeconomic advantages of the preferred carapace length (more than 3.0 inches) and fishery practices (trap retention and using shorts as attractants). The preferred carapace length is expected to prevent recruitment overfishing and the economic factors justify deviating from maximum biological yield to arrive at the optimum yield.

Optimum yield (OY) is specified to be all lobster more than 3.0 inches carapace length or not less than 5.5 inches tail length that can be harvested by commercial and recreational fishermen given existing technology and prevailing economic conditions.

The optimum yield is estimated to be 9.5 million pounds in 1982. Eight million pounds are presently harvested (approximately 5.4 million recorded and 2.6 million unrecorded legal landings). OY could increase and approach a maximum of 12.0 million pounds with a high level of enforcement that prevents illegal harvests and with improved fishing practices. The difference between the current yield of 8.0 million pounds and the potential 12.0 million pounds is primarily illegal harvest and mortality of

Exhibit 12-5 Summary of Impacts of Proposed Management Measures

Management Measure	Exvessel Price	Supply	Employment	Harvesting Revenues	Productivity	International Impact	Market Structure	Government Cost	Recreational Participation
A	exvessel price declines 4 percent	+1.5 mil. pounds first year	371 man-years first year	$3.3 mil. first year	long-term increase with enforcement	encourages pan-American management	0	-[1]	increases
B	0	800,000 lbs. incl. above	maintain	0	maintain	encourages foreign management	0	-[1]	0
C	0	0	0	slight increase in investment if new trap type is adopted in future	maintain	0	0	-[1]	0
D	0	0	0	0	maintain	0	0	-[1]	0
E	0	0	0	0	maintain	0	0	-[1]	0
F	0	0	0	0	0	0	0	minimize[1]	0
G	0	0	0	0	maintain	0	0	-[1]	0
H	0	0	0	0	0	0	0	minimize[1]	0
I	0	0	0	0	0	0	0	-[1]	potential increase

Exhibit 12-5 (continued) Summary of Impacts of Proposed Management Measures

Management Measure	Exvessel Price	Supply	Employment	Harvesting Revenues	Productivity	International Impact	Market Structure	Government Cost	Recreational Participation
J	0	0	0	0	maintain	0	0	-[1]	0
K	0	0	0	0	maintain	0	0	-[1]	0
L 1.	0	0	0	0	1,725 hours reporting	0	0	$10,063 annually	0
L 2.	0	0	0	0	225 hours processors, 333 hours fishermen for reporting	0	0	$48,375 first year, $24,735 thereafter; no net increase over existing resources	0

[1] Total Enforcement

[1] Source: Charles Fuss, Enforcement Division, NMFS, St. Petersburg, Florida.

Exhibit 12-6

Summary of Impacts of Alternative Management Measures Considered but Not Proposed

Alternative Management	Exvessel Price	Supply	Employment	Harvesting Revenues	Industry Costs/ Productivity	International Impact	Market Structure	Goverment Cost	Recreational Participation
M	0	0	0	0	0	0	0	0	0
N.1	no change short-term; 4 percent increase long-term	+1.8 mil. lbs. first year; decrease 560,000 lbs. thereafter	increase short-term; decrease long-term	+$4.0 mil. short-term; -$1.3 mil. long-term	congested conditions; per unit cost higher	slight increase imports	may reduce number of firms	$328,500 +	probable decrease
N.2	3.5 percent decline short-term; 0-3 percent decrease long-term	-875,000 lbs. first year; +1.8 mil. lbs long-term	increase in long-term	-$1.9 mil. short-term; +$3.9 mil. long-term	fishing moved further offshore; residential relocation	decrease in imports	uncertain	$328,500 +	would reduce
N.3	4 percent increase short-term; 4 percent decrease long-term	-1.6 mil. lbs. first year; +2.2 mil. lbs. long-term	increase in long-term	-$3.7 mil. short-term; +$4.7 mil. long-term	fishing moved further offshore; residential relocation	decrease in imports	uncertain	$328,500 +	would reduce
N.4	3 percent increase short-term; 5.6 percent decrease long-term	-3.3 mil. lbs. first year; +2.6 mil. lbs. long-term	increase in long-term	-$6.9 mil. short-term; +$5.3 mil.	fishing moved further offshore; residential relocation long-term	decrease in imports	uncertain	$328,500 +	would reduce

Note: Impacts of alternate Measures N are made under the preferred management regime.

Exhibit 12-6 (continued) Summary of Impacts of Alternative Management Measures Considered but Not Proposed

Alternative Management	Exvessel Price	Supply	Employment	Harvesting Revenues	Industry Costs/ Productivity	International Impact	Market Structure	Goverment Cost	Recreational Participation
O	exvessel price up 1.3 percent	permanently reduced by up to 660,000/lbs.	some commercially related jobs may be lost/jobs be lost/ due to reduced recreational activity	permanently reduced by up to $1,471,800/ recreational expenditures reduced	uncertain	0	likely to become more concentrated as more small operators are forced out of fishery	-[1]	recreational participation reduced
P	0	0	0	0	potential to restrict future productivity if new trap design is introduced	0	0	-[1]	0
Q	0	0	0	0	potential to restrict future productivity if new buoy design is introduced	0	0	-[1]	0
R	0	0	0	0	potential to slightly restrict productivity in fishery	0	0	-[1]	0
S	0	0	0	0	0	0	0	-1	0

Exhibit 12-6 (continued) Summary of Impacts of Alternative Management Measures Considered but Not Proposed

Alternative Management	Exvessel Price	Supply	Employment	Harvesting Revenues	Industry Costs/ Productivity	International Impact	Market Structure	Goverment Cost	Recreational Participation
T	increase price of all sizes	0	0	0	0	potential impact on U.S. relations with Caribbean nations	0	possible increase in enforcement costs	0
U	0	0	0	0	time costs to apply for permit	0	0	$19,500 - $50,000 permit records	Time costs to apply for permit
V	uncertain	uncertain	potential to be reduced or restricted from future growth	potential to reduce aggregate expenses of fleet, thereby increasing profits	potential to be increased now or at future date	0	potential to concentrate or restrict participation in the commercial harvesting sector	substantially higher[1]	0
W	0	0	0	0	0	0	0	0	0
[1] Total Enforcement								$328,500 - $1,159,800	

[1] Source: Charles Fuss, Enforcement Division, NMFS, St. Petersburg, Florida.

juvenile lobsters used as attractants in traps. Implementation and effective state/federal cooperative enforcement of regulations from this FMP (and state regulations) will increase yield approximately 1.5 million pounds due to decreased illegal harvest (see Section 12.5).

12.7 Special Recommendations

12.7.1 Special Recommendations to the Secretary

The Councils have recommended the following areas of needed information in priority order (see Section 14.4).

1. Develop new baits or other fishing practices that offer economically viable substitutes for using shorts as attractants in traps.
2. Information needed on unreported landings from all user groups.
3. The need for better estimates of total mortality including natural as well as fishing mortality.
4. To determine larval origins.
5. Information on catch and effort, by area, from all user groups.
6. Encourage the design and implementation of a system that will assist in locating and retrieving traps and minimize conflicts between users of the resource area.
7. Size selectivity of traps presently in use.

12.7.2 Special Recommendations to the States

The Councils recommend that the states implement the management measures proposed in this plan within their territorial jurisdiction, where applicable. The Councils further encourage the states to assist the Secretary in addressing and supporting the research and other special recommendations.

The Councils recommend that the Florida Department of Natural Resources put a high priority on development of an alternative bait which would be as efficient as the present use of sublegal lobster.

13.0 MEASURES, REQUIREMENTS, CONDITIONS, OR RESTRICTIONS SPECIFIED TO OBTAIN MANAGEMENT OBJECTIVES

The following section summarizes the management measures which were specified for the spiny lobster fishery. Specific details and impacts of individual management measures are presented in Section 12.4.

13.1 Permits and Fees

No permits or fees will be required for vessels fishing in the spiny lobster fishery. The color code and associated number for each operator is not considered a permit. This is described in Section 12.4.1, Measure H.

13.2 Time and Area Restrictions

A closed season will be established from April 1 through July 25, with provisions for a five-day "soak period" from July 21-25 and a five-day grace period for removal of traps from April 1-5 (see Section 12.4.1, Measure B). A special two-day nontrap season was specified in the FCZ primarily to provide fishing opportunities for recreationalists at a time when conflicts with commercial fishermen would be minimized (see Section 12.4.1, Measure I). To aid in enforcement of other provisions of the management plan, traps may be worked during daylight hours only (Section 12.4.1, Measure F).

No area restrictions have been adopted.

13.3 Catch Limitations

13.3.1 Total Allowable Level of Foreign Fishing

The total allowable level of foreign fishing (TALFF) is specified as zero for the spiny lobster fishery. U.S. fishing vessels have the capacity, intent, and are expected to harvest the OY in the fishery (see Section 5.4.2.2 and 8.2.7). There is also enough domestic processing and freezer capacity to readily handle the anticipated domestic catch, and the market exists to absorb the output of the domestic industry (see Sections 9.2 and 9.3).

13.3.2 Types of Catch Limitation

Catch limitations proposed in this plan are a minimum size limit (see Section 12.4.1, Measure A) and prohibition on harvest of egg bearing lobsters (see Section 12.4.1, Measure J).

13.4 Types of Vessels, Gear and Enforcement Devices

Measures have been specified to restrict or specify vessels, gear, and enforcement devices. Two of the measures prevent gear that are harmful to the stock of lobsters and which, if used, could reduce yield in the fishery. Other measures propose trap and vessel identification to aid in enforcement and minimize conflicts. There are no limitations placed on the types of vessels that may participate in the fishery.

All spiny lobster traps must have a degradable surface of sufficient size so as to allow escapement of lobsters from lost traps. This provision prevents traps from continuing to "fish" after being lost and thus protects lobsters that would otherwise be trapped.

The taking of spiny lobsters in the FCZ with spears, hooks, and similar devices which would puncture, impale, or otherwise damage lobsters is prohibited. If this provision were not adopted, speared lobster below the legal size would be returned to the water and would likely die, reducing yield from the fishery. Thus, this provision prevents a possible reduction in yield from the fishery.

All lobster traps used in the fishery within the FCZ must be identified by a number and color code, issued through the Office of the Regional Director of NMFS or his designee to each vessel desiring to use lobster traps in the FCZ. Each vessel fishing lobster traps must be clearly marked with the same color code to allow identification from aerial and water patrol craft. This provision aids enforcement of various provisions of the FMP.

Working or molesting a trap or buoy belonging to another is prohibited without permission from the owner. The design and implementation of a system to assist in locating and retrieving traps and minimizing conflicts is encouraged.

13.5 State, Local, and Other Laws and Policies

Florida is the only state in the management area which has fishery conservation laws specifically for the spiny lobster. The Florida statutes deal extensively with the spiny lobster fishery and include, among other things, provisions for permitting, seasonal and size restriction, gear limitations, and enforcement. These are discussed in detail in Section 7.0. Many of the measures adopted by the Council is are similar or identical to provisions in the Florida statutes.

13.6 Limited Access System

Limited entry is not recommended for this fishery (see Section 9.1.1 and Section 12.4.2, Measure V).

13.7 Habitat Preservation, Protection, and Restoration

Critical habitat areas for spiny lobsters during the puerulus (subjuvenile) and juvenile stages are shallow near-shore areas such as grass beds and mangroves. Juvenile and mature lobsters take shelter in natural crevices and in reef areas. Current environmental protection laws in the areas impacting the management unit greatly restrict indiscriminate uses of these critical habitat areas and specific protection measures are not considered necessary at this time.

13.8 Development of Fishery Resources

The spiny lobster fishery is fully utilized by U.S. fishermen and no resource development is necessary.

13.9 Management Costs and Revenues

No sources of revenue, other than fines from violators, have been identified in this plan. Permits are not required from any user group. The mechanics of enforcement of the measures in this plan have not been finalized at this point; some description is provided in Section 12.3. Federal enforcement efforts will be conducted in conjunction with state enforcement efforts. Such cooperation will be much more cost effective than independent efforts. Enforcement agreements with the various states should be sought for cost effectiveness.

Enforcement costs for the proposed management regime, and measures, represent no increases over present federal and state expenditures.

Alternative management regime enforcement costs has been estimated by assuming independent enforcement without state cooperation. In such a case, total enforcement costs including sea and air patrols, shore inspections, investigation and support are estimated as $328,500 annually.

Implementation of a color-coded identification system for vessels and lobster traps will be realized at a negligible cost by adopting and cross-filing the identification system presently implemented by the Florida Department of Natural Resources and extending it to the FCZ.

Some incremental costs would be associated with establishment of a vessel enumeration information system for recreational fishermen, coupled with a system of mandatory trip ticket reporting for commercial fishermen (i.e., any fisherman who sells his catch). Establishment of a vessel enumeration information system requires that State vessel registration applications be modified to include an indication of the fisheries in which the applicant intends to engage. The number of applicants indicating an intent to fish for spiny lobster thus provides the sampling frame for a follow-up survey to determine recreational participation and catch in the spiny lobster fishery. Approximate costs of such a survey would be $30,189. Annual costs ($10,063) would be less because such surveys would not be needed every year.

An indication of the potential costs of implementing a mandatory system of trip ticket reporting for commercial spiny lobster fishermen can be developed based on similar calculations developed for the Gulf of Mexico Stone Crab Plan and from consultation with NMFS staff. Estimated cost of this system is $48,735 the first year and $24,735 thereafter.

Enforcement costs for the alternative management measures has been estimated at $328,500 to $1,159,800 assuming it would be independent of state efforts. This cost is much higher than the proposed management regime because of restrictions on fishing areas and practices, a higher CL, limited access to the fishery, and limitations on imports. Government costs for permits ($19,500 to $50,500) would involve all users prior to data collection.

14.0 SPECIFICATION AND SOURCE OF PERTINENT FISHERY DATA

14.1 General

Certain data specific to the spiny lobster fishery are already collected by state and federal agencies including landings, value of landings, number of boats and gear units, employment, production of processed products, and product prices. In addition, there have been a considerable number of studies directed towards particular management needs, such as cost and returns data, migration, size distribution, growth rates, etc.

Other areas in which additional data would improve the effectiveness of fishery management are indicated in the paragraphs below. The required data have been carefully considered so as to include only those for which there is a critical need. In addition to statistical data collection, areas of needed research have been specified to encourage efforts that would improve the information base for effectively managing the fishery.

14.2 Domestic and Foreign Harvesters

Reporting requirements for domestic fishermen are described in Section 12.4.1, Measure L.

There are no foreign fishermen participating in the fishery and no TALFF will be declared.

14.3 Processors

Currently processors provide to NMFS information on the volume and value of lobster processed. The fraction of lobsters landed in Florida which are accounted for in the processing statistics varies from year to year, and the reasons for this variation are not well understood. While no additional mandatory data reporting requirements appear to be needed, the methods now used to collect data should be studied to see if a better understanding of the disposition of the total annual harvest can be obtained.

In particular, a baseline study should be undertaken to obtain a complete enumeration of all fish processors handling spiny lobsters. The results of this study can then be used to improve the sampling frame from which processing data are obtained. As part of the same study, data should be collected on processing and freezer capacity and the extent to which lobsters compete with other fish products for freezer space.

14.4 Areas of Research Needed to Improve the Management Information Base

The Councils have recommended the following areas of needed information in priority order:

1. Develop new baits or other fishing practices that offer economically viable substitutes for using shorts as attractants in traps.

2. Information needed on unreported landings from all user groups.

Unreported catches are a serious problem which must be overcome in order to intellegently manage the resource. Unreported catch has three components, illegal take of undersize lobsters, legal harvest which is sold but not reported, and recreational catch which is not sold.

3. The need for better estimates of total mortality including natural and fishing mortality, as well as fishing induced natural mortality.

Information on the size distribution of lobsters drawn from traps (both legal and sublegal size), combined with improved data on effort by area fished (see above), can help to improve the estimates of total mortality and natural mortality given in Section 5.4.2.1. The current estimates are based on a relatively small number of observations and have an associated high degree of uncertainty. This information is used to assess the effect of various size limits on yield from the fishery. The associated uncertainty concerning an appropriate size limit reduces the effectiveness with which the fishery may be managed.

Size distribution information would best be collected by having an observer move from port to port accompanying selected fishermen on trips and making size measurements. This information would be needed periodically to monitor changes in mortality over time.

4. To determine larval origins.

The extent to which U.S. stocks of mature lobster contribute to recruitment in the FCZ and Florida waters is unknown. Some suggest that lobsters recruited off Florida are from larvae produced in the Caribbean and carried to the U.S. by ocean currents while others suggest a local origin. Better information on larval origins is needed to place management of the fishery in a proper regional context. The contribution of foreign larval stocks to the U.S. fishery is now being studied in ongoing research and additional research needs should be evaluated after the current research is completed.

5. Information on catch and effort, by area, from all user groups.

In addition to data on recreational catch and the efforts described under item 2, a better understanding of the general role of the recreational sector for spiny lobster is needed.

Data on catch and effort by area with a more refined measure of effort than is currently available would provide more precise estimates of MSY. These can be obtained in conjunction with trip ticket reporting described in Section 14.1.

6. Encourage the design and implementation of a system that will assist in locating and retrieving traps and minimize conflicts between users of the resource area.

The present system of buoys used to mark traps results in extensive conflicts with other activities in the same areas. It is the intent of the Council to encourage development of a better system.

A buoy demarcation system must achieve three primary objectives. First, it must allow those participating in the fishery to easily locate and identify their respective lobster pots. Second, the buoy system should easily provide the exact location of traps and lines to prevent unintentional damage to traps and buoys by boaters and other fishermen. (Trawl fishermen reportedly represent a particular problem in this regard as described in Section 8.2.6). Third, any buoy demarcation system should facilitate the efficient enforcement of measures to prevent poaching. At this time no specific recommendations have been made by the Councils and research will be encouraged that would ensure that future demarcation regulations efficiently meet the above requirements.

7. Size selectivity of traps presently in use.

Traps currently capture lobsters considerably below the size limit. Traps with wider slat spacing might offer improved size selectivity, but this possibility has not been comprehensively researched. A small study should be undertaken that relates trap slat spacing to size selectivity.

15.0 RELATIONSHIP OF THE RECOMMENDED MEASURES TO EXISTING APPLICABLE LAWS AND POLICIES

15.1 Fishery Management Plans

15.1.1 Spiny Lobster FMP, Caribbean Council

A fishery management plan has been developed for the spiny lobster resource in the Caribbean (Puerto Rico and the U.S. Virgin Islands). Many of the management measures proposed in that plan are similar to those presented in Section 12.0 for the Gulf of Mexico and South Atlantic FCZ, as shown in Exhibit 15-1. It differs by not recommending a closed season and proposing a larger minimum size which is required to protect recruitment if no closed season is proposed.

15.1.2 Management Plans for Other Fisheries

No measures in this plan affect other plans. The Coral FMP is the only other FMP at present which affects this plan by prohibiting traps in habitat areas of particular concern, such as Looe Key.

15.2 Treaties or International Agreements

There are no treaties or international agreements pertaining specifically to the stocks of spiny lobsters in the management unit.

15.3 Federal Laws and Policies

Governance of the spiny lobster fishery is subject to existing federal regulations in the Everglades National Park, Biscayne National Park, Fort Jefferson National Monument (Dry Tortugas), the Marquesas National Wildlife Refuge, and Looe Key Marine Sanctuary. Implementation of the recommended management regulations in these waters will necessitate separate regulations promulgated by the Secretary of the Interior. There are also regulations for the national marine sanctuaries which generally complements the objectives of the FMP.

Consultation with the U.S. Fish and Wildlife Service found no impact from the FMP on the endangered species, brown pelican and manatee.

A Section 7 consultation of the Endangered Species Act of 1973 has been conducted with NMFS. Based on the results of the threshold examination, the FMP is not likely to jeopardize the continued existence of threatened or endangered sea turtle or marine mammal species or result in the destruction or adverse modification of habitat that may be critical to those species (Appendix A of the EIS).

15.4 State, Local and Other Applicable Laws and Policies

The State of Florida is the only state in the Management area with conservation laws directed towards the spiny lobster. In cases where proposed management options correspond to regulations adopted in Florida, implementation of regulations in the FCZ will be made simpler. In some cases where differences exist between Florida waters and the FCZ, implementation may be made more difficult. Exhibit 15-1 shows the relationship of the proposed management measures to current Florida regulations.

There are three instances where an activity legal in the FCZ could result in prosecution if the fisherman returned to state waters. These arise from the Florida prohibition on separating lobster tails, state bag limits, and difference in timing of the special recreational season. The Council will recommend that state law be modified to follow the FMP.

Exhibit 15-1

Relationship of Proposed Management Options
to Existing Laws and Policies

Proposed Management Measures	Proposed for the Gulf and South Atlantic	Caribbean Spiny Lobster FMP[1]	Florida Regulations[2]
1. Size Limit	3 inches	3 - 1/2 inches	3 inches
2. Season Restrictions	During Spawning	None	During Spawning
3. Area Restrictions	None	Nursery Areas	None
4. Gear Regulations			
*(1) Specification of trap design	None		Specified
(2) Biodegradable Surface	Required	Required	Required
(3) Use of Hooks, etc.	Prohibited	Prohibited	Prohibited
(4) Molesting Traps	Prohibited	No Regulation	Prohibited
*(5) Separating Tails at sea	No Regulations	Only by Permit	Prohibited
(6) Use of Undersized Lobsters as attractants	Allowed	Allowed	Allowed under permit
*5. Special Recreational Season	Weekend before "Soak Period"	None	July 20 - 21
*6. Recreational Bag Limit			
a. Special Season	24 per boat per day	None	6 per person per day
b. Regular Season	None	None	24 per boat per day
7. Protect Berried Females	Required	Required	Required
8. Import Restrictions on Undersized Lobsters	None	Yes	None
9. Permit Requirements	Number/color code for boats and traps	Commercial Boats	Number/color code for boats and traps

[1] Based on the Draft Fishery Management Plan for the Spiny Lobster of the Caribbean Fishery Management Council, published February 1, 1978.

[2] Based on the Florida statutes for Saltwater Fisheries and Conservation codefied as Chapter 370, Section 14 of the Florida Statutes.

* Cases where FMP and Florida regulations conflict.

16.0 COUNCIL REVIEW AND MONITORING OF THE PLAN

16.1 General Approach

The Gulf of Mexico and South Atlantic Fishery Management Councils will, after approval and implementation of this plan by the Secretary, maintain a continuing review of the fishery managed under this plan by the following methods:

A) Maintain close liaison with the management and enforcement agencies involved to assess the condition of the stocks and the effectiveness of the management measures and regulations and compliance by the fishermen with the regulations. The Florida Department of Natural Resources, NMFS, the National Park Service and the U.S. Coast Guard are the primary agencies with which especially close liaison will be established for plan monitoring.

B) Maintain close liaison with the members of the Spiny Lobster Subpanel of the Council's Fishery Advisory Panel to assess the effectiveness of the management measures (and regulations) and the need for implementation of other measures or revisions of existing measures.

C) Promote research to increase the knowledge of the fishery and resources by the following methods:

   a. Identify the research required for better management of the fishery resource.

   b. Request the NMFS to consider these research needs and identify those which they can immediately address and those which will require efforts by other agencies or groups.

   c. Request state and university participation in research under their own programs to fill these data needs.

   d. Provide Council funding for research that cannot be addressed by NMFS, state and university entities.

   e. Assess the effectiveness of the statistical reporting system and recommend changes to NMFS or fund specific one-time surveys for data collection where data gaps exist.

D) Conduct public hearings at appropriate times and locations in the areas where the fishing effort is concentrated to hear testimony on the effectiveness of all aspects of the plan and the changes needed in the plan.

E) Consider all information gained from the first four activities listed above, and if necessary, prepare amendments to the plan. Hold public hearings on the amendments prior to sending them to the Secretary.

16.2 Specific Monitoring Considerations

16.2.1 Status or Condition of the Stocks

Additional catch and effort data becomes available each year, they will be incorporated in the data base used to estimate MSY. As the statistical reporting system is improved and other needed research is completed, these data will be reviewed to determine if changes in the management regime are required.

16.2.2 Gear or User Group Conflicts

The appropriate Council will investigate the causes and extent of conflicts which arise, potential solutions to these conflicts, the economic and social impacts of any proposed limitations on any user

group, and other factors as appropriate. Public hearings will be held as appropriate to hear testimony concerning significant conflicts. The Council will review efforts to design and implement a system that will assist in locating and retrieving traps which minimizes conflicts between users.

16.2.3 Size Limit

As better data become available the Council will reassess the size limit needed to obtain the OY from the fishery.

16.2.4 Harvesting Practices

Harvesting practices proposed under the plan will be evaluated for their effectiveness and for any needed additions, deletions or modifications.

16.2.5 Standardization of Management Measures

The Councils will work with the State of Florida and any other affected states, to attempt to standardize regulations for the fishery in the FCZ and state territorial waters, where such standardization will serve a useful purpose.

17.0 REFERENCES

Allsopp, W.H.L. 1968. Report to the Government of British Honduras (Belize) on investigations into marine fishery management, research and development policy for spiny lobster fisheries. FAO/TA Mar. Fish. Biol. Rep. FAO/UNDP (TA) 2481: 1-95.

Aiken, K.A. 1977. Jamaica spiny lobster investigations. pp. 11-22 In: Symposium on progress in marine research in the Caribbean and adjacent regions. FAO Fish. Rep. No. 200. 547 pp. Caracas.

Austin, C.B. 1976. Recreational boating in Biscayne Bay. pp. 247-253 In A. Thorhaug and A. Volker (editor and coordinating editor) Biscayne Bay Symposium, 1976.

1978. Simple and inexpensive ways to monitor diving for spiny lobster in the Florida Keys. pp. 36-43 In: R.E. Warner, ed. Spiny lobster research review; proceedings of a conference held December 16, 1976, in Key West, Florida. Florida Sea Grant, Tech. Pap. No. 4.

Austin, C.B., R.D. Bruger, J.C. Davis and L. Siefert. 1977. Recreational boating in Dade County 1975-76. Florida Sea Grant Progam, Special Report No. 9. March, 1977.

1978. Mackerel Workshop Report: University of Miami Sea Grant, Coral Gables, Florida. Special Report No. 14.

Austin, C.B., G.T. Waugh and S.K. Chan. 1979a. A model to estimate the unrecorded catch based on recorded landings. Presented at the Fifth Annual meeting of the Coastal Society, Newport, Rhode Island, November 6-8, 1979.

1979b. Ford Foundation spiny lobster data base. Report to the Ford Foundation. Manuscript. 163 pp.

1980a. Limited entry and management opinions of Florida spiny lobster fishermen. Report to the Ford Foundation. In: Final report, Ford Foundation program in policy analysis for State Environmental Management. Manuscript.

1980b. Bio-economic and legal analysis for alternative policies for limited entry into the Florida spiny lobster fishery. Final report to the Ford Foundation Progam in policy analysis for State Environmental Management. Manuscript 133 pp.

Austin, H.M. 1972. Notes on the distribution of phyllosoma of the spiny lobster, Panulirus spp. in the Gulf of Mexico. Proc. Nat. Shellfish Assoc. 62: 25-30.

Balsre, J.A. 1964. Sobre los estudios larvales de la langosta comun, Panulirus argus. Contr. Inst. Nat. Pesca Cuba 19: 1-37.

Beardsley, G.L. 1973. Studies of the tropical Atlantic spiny lobster Panulirus guttatus (Latreille). 1. Notes on distribution, size, sex ratios and commercial potential along the southeast coast of Florida. Univ. Miami Sea Grant Program. Manuscript.

Beardsley, G.L., T.J. Costello, G.E. Davis, A.C. Jones, and D.C. Simmons. 1975. The Florida spiny lobster fishery: a white paper. Florida Sci. 38(3): 144-149.

Bell, F.W. 1970. The future of the world's fishery resources: forecasts of demand, supply and prices to the year 2000 with a discussion of implications for public policy. (File Manuscript.) U.S. Department of Commerce, National Marine Fisheries Service.

Berry, P.F. 1970. Mating behavior, oviposition and fertilization in the spiny lobster, Panulirus homarus (Linnaeus). Invest. Rep. Oceanogr. Res. Inst. 24: 1-16.

Beverton, R.J.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Min. Agric. Fish. Invest. Ser. 11 19: 1-533.

1966. Manual of methods for fish stock assessment. Part II. Tables of Yield Functions. FAO Fish. Tech. Pap. FRs/T38 (Rev.1): 1-67.

Bryan, H. 1976. The sociology of fishing: a review and critique. In: Stroud, R. and H. Clepper, Marine Recreational Fisheries. Sport Fishing Institute. Washington, D.C.

Buesa Mas, R.J. 1961. Segunda pesca exploratoria y datos biologicos de la langosta Panulirus argus en Cuba. Contrib. Centro Invest. Pesq., Bauta, Cuba 12: 70 p.

1965. Biology and fishing of spiny lobster Panulirus argus (Latreille). In: Soviet-Cuban fishery research (A.S. Bogdanov, ed.). Translated from Russian by Israel program for scientific translations, Jerusalem 1969 (TT 69-59016): 62-77.

1970. Migraciones de la langosta (Panulirus argus). (Migrations of the lobster, Panulirus argus.) Mar y Pesca 60: 22-27. Translated from Spanish by P. Aukland, Nat. Mar. Fish. Serv., Foreign Fish. Transl. 11403, 10 p.

Buesa Mas, R.J., M.P. Paiva, and R.S. Costa. 1968. Comportamiento biologico de la langosta Panulirus argus (Latreille) en el Brasil y en Cuba. Rio, Rev. Brasil Biol. 28(1): 61-70.

Buesa Mas, R.J. and M.I. Mota-Alves. 1971. Escala de colores para el estudio del ciclo reproductor de la langosta Panulirus argus (Latreille) en el area del mar Caribe. FAO Fish. Rep. 71: 9-12.

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 Wildl. Ser., Spec. Sci. Rep. Fish. 505: 1-26.

Caillouet, C.W., Jr., G.L. Beardsley and N. Chitty. 1971. Notes on size, sex ratio, and spawning of the spiny lobster, Panulirus guttatus (Latreille), near Miami Beach, Florida. Bull. Mar. Sci. 21(4): 944-951.

Capurro, L.R.A. and J.L. Reid (eds). 1970. Contributions on the physical oceanography of the Gulf of Mexico. Texas A&M University Oceanogr. Stu. 2: Gulf Publ. Co., Houston, Texas. 288 pp.

Cato, J.C. and F.J. Prochaska. 1980. Economic impact estimates for Florida's commercial fisheries: 1978. University of Florida. Inst. of Food and Agric. Sciences. 44 pp.

Centaur Management Consultants. 1975. Economic impacts of the U.S. commercial fishing industry. National Marine Fisheries Service. January, 1975.

1977. Economic activity associated with marine recreational fishing. National Marine Fisheries Service. June, 1977.

Chace, F.A. and W.H. Dumont. 1949. Spiny lobsters identification, world distribution and U.S. trade. Comm. Fish. Rev. 11(5): 1-12.

Chittleborough, R.G. 1970. Studies on recruitment in the West Australian rock lobster Panulirus longipes cygnus George: density and natural mortality of juveniles. Aust. J. Mar. Freshw. Res. 21: 131-148.

1975. Environmental factors affecting growth and survival of juvenile western rock lobsters, Panulirus longipes (Milne-Edwards). Aust. J. Mar. Freshw. Res. 26(2): 177-196.

Chitty, N. 1973. Aspects of the reproductive biology of the spiny lobster, Panulirus guttatus Latreille. M.S. Thesis, Univ. Miami, Coral Gables, Florida. ix + 60 pp.

Cobo de Barany, T., J. Ewald and E. Cadima. 1972. La pesca de la langosta en el archipelago de Los Roques, Venezuela. Informe Technico Proy. Invest. Desarollo Pesquero Venezuela 43: 34 pp.

Corcoran, E.F. and J.E. Alexander. 1963. Nutrient, chlorophyll and primary productivity studies in the Florida current. Bull. Mar. Sci. 13(4): 527-541.

Craig, A.K. 1974. New developments in the S.E. Florida spiny lobster fishery. Gulf and Carib. Fish. Inst. 26: 131-143.

Crawford, D.R. and W.J.J. de Smidt. 1922. The spiny lobster, Panulirus argus, of southern Florida, its natural history and utilization. Fish. Bull., U.S. 38: 281-310.

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

1952. Sexual dimorphism in weight and length relationships of the Bermuda Spiny Lobster. Proc. Gulf and Carib. Fish. Inst. 4: 59-63.

Davis, G.E. 1971. Aggregations of spiny sea urchins, Diadema antillarum, as shelter for young spiny lobsters, Panulirus argus. Trans. Amer. Fish. Soc. 100(3): 586-587.

1974. Notes on status of spiny lobsters, Panulirus argus, at Dry Tortugas, Florida, 1974. Pp. 5 [abstract], 22-32 In: W. Seaman, Jr., and D.Y. Aska, eds. Conference proceedings: research and information needs of the Florida spiny lobster fishery. State Univ. Syst. Florida Sea Grant, Rpt. SUSF-SG-74-201. Gainesville, Fl. 64 pp.

1975. Minimum size of mature spiny lobster, Panulirus argus, at Dry Tortugas, Florida. Trans. Amer. Fish. Soc. 104(4): 675-676.

1976. National Park Service spiny lobster fishery research in Florida. Proc. Spiny Lobster Research Review Conf., 16 December, 1976, Key West: 6 pp. (mimeo.)

1977. Effects of recreational harvest on a spiny lobster Panulirus argus population. Bull. Mar. Sci. 27(2): 223-236.

1978. Management recommendations for juvenile spiny lobsters, Panulirus argus in Biscayne National Monument, Florida. U. S. National Park Service, South Florida Research Center Management Rep. M-530. 32 pp.

1979. An assessment of fishery management options in Everglades National Park. U. S. National Park Service, South Florida Research Center Tech. Rep. T-523. 112 pp.

Davis, G.E. and J.W. Dodrill. 1980. Marine parks and sanctuaries for spiny lobster fisheries management. Proc. Gulf Carib. Fish. Inst. 32.

Dawson, C.E. 1949. Florida crawfish research. Proc. Gulf and Carib. Fish. Inst. 1: 21-28.

Dawson, C.E. and C.P. Idyll. 1951. Investigations on the Florida spiny lobster, Panulirus argus (Latreille). Fla. St. Bd. Conserv. Tech. Ser. 2: 1-39.

Dunaway, V. 1974. Its lobster for fun and feast. Fla. Sportsman Magazine 5(6): 50-52, 54.

Eldred, B., C.R. Futch and R.M. Ingle. 1972. Studies of juvenile spiny lobster, Panulirus argus, in Biscayne Bay, Florida. Spec. Sci. Rep. Fla. Dept. Nat. Res. 35: 1-16.

Feliciano, C. 1958. The lobster fishery of Puerto Rico. Proc. Gulf and Carib. Fish. Inst. 10: 147-156.

Food and Agricultural Organization. 1972. Fishery statistics. Food and agriculture organization of the United Nations.

Fox, W.W., Jr. 1970. An exponential surplus-yield model for optimizing exploited fish populations. Trans. Amer. Fish. Soc. 99(1): 80-88.

Gentle, E.C., III. 1977. The charterboat sport fishery of Dade County, Florida, March, 1976 to February, 1977. Masters Thesis. University of Miami, Miami, Florida.

Herrnkind, W.F. 1974. In situ research on the biology of spiny lobster, Panulirus argus. In: Conf. Proc. Research and information needs of the Florida spiny lobster fishery. W. Seaman and D.Y. Aska (eds.) SUSF-SG-74-201 pp. 33-36.

1977. Mass migration of Panulirus argus: casual stimuli, behavioral specializations, and evolutionary significance. P. 31 In: B.F. Phillips and J.S. Cobb (eds.) Workshop on lobster and rock lobster ecology and physiology. CSIRO, Melbourne, Div. Fish. Oceanogr., Circ. 7: 300 p. [abstract].

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

Hess, W.N. 1938. Reactions to light and photoreceptors in the spiny lobster Panulirus argus. Rep. Tortugas Lab. Carnegie Instit. Yearbook 37: 1-91.

1940. Regional photosensitivity and photoreceptors of Crangon armillatus and the spiny lobster Panulirus argus. Publ. Carnegie Inst. 517 Pap. Tortugas Lab. 32: 153-161.

Higman, J. B. and J. C. Davis. 1978. Damage to spiny lobster gear by sea turtles and other predators. Univ. of Miami, RSMAS Contract Report to NMFS. Contract No. 03-7-042-35136, 34 pp.

Horvath, J.C. 1974. Southeastern economic survey of wildlife and recreation, detailed analysis. Georgia State Univ., Atlanta, Georgia.

Hunt, J. 1981. Effect of using short lobsters, Panulirus argus, as bait on the spiny lobster population in the Florida Keys. Proc. of Fla. Dept. Nat. Res. Spiny Lobster Workshop, St. Petersburg, Florida, August 13 - 14.

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. Bd. Conserv., Tech. Ser. No. 40, 12 pp.

Ingle, R.M. and R. Witham. 1969. Biological considerations on spiny lobster culture. Proc. Gulf and Carib. Fish. Inst. 21.

Iverson, E.S. and G.L. Beardsley. 1976. Shell disease in crustaceans indigenous to south Florida. Prog. Fish-Cult. 38(4): 195-196.

Johnson, L.E. 1974. Statistical trends in the spiny lobster fishery. In: W. Seaman and D.Y. Aska (eds.), conference proceedings: research and information needs of the Florida spiny lobster fishery. pp 15-18. Florida Sea Grant Program, SUSF-SG-74-201: 64 pp.

Joyce, E.A., Jr. 1974. Spiny lobster programs at the Marine Research Laboratory, Florida Department of Natural Resources. pp. 19-21 In: Seaman, W. and D.Y. Aska (eds) Research and information needs of the Florida spiny lobster fishery. Fla. Sea Grant Programs, SUSF-SG-74-201: 64 pp.

Justen, M. 1981. Predictive model for spiny lobster (Panulirus argus) landings at various minimum carapace lengths in southern Florida. Proc. of Fla. Dept. Nat. Res. Spiny Lobster Workshop, St. Petersburg, Florida, August 13 - 14.

Kanciruk, P. and W.F. Herrnkind. 1976. Autumnal reproduction in Panulirus argus at Bimini, Bahamas. Bull. Mar. Sci. 26(4): 417-432.

1978. Mass migration of spiny lobster, Panulirus argus (Crustacea: Palinuridae): behavior and environmental correlates. Bull. Mar. Sci. 28(4): 601-623.

Kelly, J.A., C.M. Fuss and J.R. Hall. 1971. The transplanting and survival of turtle grass, Thalassia testudinum in Boca Ciega Bay, Florida. Fish. Bull., U.S. 69(2): 273-280.

Kennedy, F.S. Jr. 1981. Catch rates of lobster traps baited with shorts, with notes on effects of confinement. Proc. of Fla. Dept. Nat. Res. Spiny Lobster Workshop, St. Petersburg, Florida, August 13 - 14.

Khandker, N.A. 1964. Sponges as shelter for young spiny lobsters. Trans. Amer. Fish. Soc. 93(2): 204.

Latreille, P.A. 1804. Des langoustes du Museum National d'Histoire Naturelle. Ann. Mus. Nat. Hist. Vol. 3: 388-395.

1817. Languste, Palinurus, Fab., Noveau Dictionnaire d'Histoire Naturelle, 17: 291-295.

Lee, T.N. 1975. Florida current spin-off eddies. Deep-Sea Res. 22: 753-765.

Lee, T.N. and D.A. Mayer. 1977. Low-frequency current variability and spin-off eddies along the shelf off Southeast Florida. J. Mar. Res. 35: 193-220.

Lee, T.N. and C.N.K. Mooers. 1977. Near-bottom temperature and current variability over the Miami slope and terrace. Bull. Mar. Sci. 27(4): 758-775.

Lewis, J.B. 1951. The phyllosoma larvae of the spiny lobster, Panulirus argus. Bull. Mar. Sci. 1(2): 89-103.

Lewis, J.B., H.B. Moore and W. Babis. 1952. The postlarval stages of the spiny lobster Panulirus argus. Bull. Mar. Sci. 2(1): 324-337.

Little, E.J. 1972. Tagging of the spiny lobsters (Panulirus argus) in the Florida Keys, 1967-1969. Spec. Sci. Rep. Fla. Dept. Nat. Res. 31: 1-23.

1977. Observations on recruitment of postlarval spiny lobsters, Panulirus argus, to the south Florida coast. Fla. Mar. Res. Publ. No. 29. 35 pp.

Lyons, W.G. 1970. Scyllarid lobsters (Crustacea, Decapoda). Mem. Hourglass Cruises, Vol. 1, Pt. 4: 1-74.

1980. Effects of present fishery techniques on sublegal spiny lobsters and on subsequent fishery yield. Manuscript.

Lyons, W.G., D.G. Barber, S.M. Foster, F.S. Kennedy, Jr., and G.R. Milano. 1981. The spiny lobster, Panulirus argus, in the middle and upper Florida Keys: population structure, seasonal dynamics, and reproduction. Fla. Mar. Res. Publ. No. 138.

Marfin, J.P. 1978. Biologie et Peche de la langouste, Panulirus guttatus, en Martinique. Science et Peche, Bull. Inst. Peches Marit. No. 278: 1-10.

Mattox, N.T. 1952. A preliminary report on the biology and economics of the spiny lobster in Puerto Rico. Proc. Gulf and Carib. Fish. Inst. 4: 69-70.

Menzies, R.A., and J.M. Kerrigan. 1979. Implications of spiny lobster recruitment patterns of the Caribbean - A biochemical genetic approach. Proc. Gulf and Carib. Fish. Inst. 31: 164-178.

Menzies, R.A., J.M. Kerrigan and P. Kanciruk. 1977. A biochemical-genetic approach to the larval recruitment problem of the spiny lobster Panulirus argus. In: Phillips and Cobb (eds) Workshop on lobster and rock lobster ecology and physiology. Div. Fish. Oceanogr. Circ. No. 7:38. CSIRO. 300 pp.

Menzies, R.A., J.M. Kerrigan and P. Kanciruk. 1978. Biochemical systematics and problems of larval recruitment in the spiny lobster, Panulirus argus. pp. 22-30 in: R.E. Warner, ed. Spiny lobster research review; proceedings of a conference held December 16, 1976, in Key West, Florida. Florida Sea Grant, Tech. Pap. No. 4. 56 pp.

Moore, D.R. 1963. Distribution of the sea grass Thalassia testudinum in the United States. Bull. Mar. Sci. 13(2): 329-343.

Morgan, G.R. 1977. Adult ecology and population dynamics of the Palinuridae - A review. In: Workshop on lobster and rock lobster ecology and physiology. B.F. Phillips and J.S. Cobb eds. Div. Fish. Oceanog. Circ. No. 7: 245-258. CSIRO. 300 pp.

1980. Population dynamics and management of the western rock lobster fishery. Marine Policy, January, pp. 52-60.

Mota-Alves, M.I. and G.S. Tome. 1965. On the histological structure of the gonads of Panulirus argus (Latreille). Arq. Est. Mar. Univ. Ceara 5(1): 15-26.

Mulligan, B.E., and R.B. Fischer. 1977. Sounds and behavior of the spiny lobster, Panulirus argus, (Latreille, 1804) (Decapoda, Palinuridae). Crustaceana 32(2): 185-199.

Munro, J.L. 1974. The biology, ecology, exploitation and management of Caribbean reef fishes. Pt V.I. The biology, ecology and bionomics of Caribbean reef fishes: crustaceans (spiny lobsters and crabs). Res. Dep. Univ. West Indies Zool. Dept., Kingston, Jamaica, 3: 1-57.

National Marine Fisheries Service. 1974. Basic economic indicators: American and spiny lobsters 1947-73. U.S. Department of Commerce, National Marine Fisheries Service.

Niller, P.P. and W.S. Richardson. 1973. Seasonal variability of the Florida Current. J. Mar. Res. 31(3): 144-167.

Olsen, D.A., W.F. Herrnkind and I.G. Koblick. 1971. Ecological study for the development of lobster management techniques. Puerto Rico Int. Undersea Lab. Spec. Rep. (PRINUL) 1: 1-51.

Opresko, L., D. Opresko, R. Thomas, and G. Voss. 1973. Guide to the lobsters and lobster-like animals of Florida, the Gulf of Mexico and the Caribbean region. Univ. Miami Sea Grant, Sea Grant Field Guide Series 1: 44 pp.

Paiva, M. 1960. Dimorfismo sexual observado em pelacues de pesa e comprimento da langusta Panulirus argus (Latr.) Rev. Brazil Biol. 20(1): 51-62.

Paiva, M. and R.S. da Costa. 1968. Comportamento biologico da lagosta, Panulirus laevicauda (Latreille). Arq. Est. Biol. Mar. Univ. Fed. Ceara 8(1): 1-6.

Peacock, N.A. 1974. A study of the spiny lobster fishery of Antigua and Barbuda. Proc. Gulf and Carib. Fish. Inst. 26: 117-130.

Pearse, A.S. 1954. Parasitic crustacea from Bimini. Proc. U.S. Nat. Mus. 101(3280): 341-372.

Pearson, J.C. and W.W. Anderson. 1946. Spiny lobster. U.S. Fish Wildl. Serv., Fish. Leafl. 142: 1-4.

Prochaska, F.J. and J.C. Cato. 1977. An economic profile of Florida commercial fishing firms. State University of Florida, Sea Grant Report.

Prochaska, F.J. and J.S. Williams. 1976. Economic analysis of costs and returns in the spiny lobster fishery by boat and vessel size. Florida Sea Grant Program, July, 1976.

Prochaska, F.J. and P.D. Landrum. 1981. Spiny lobster, stone crab, and secondary fishery costs and revenues in the Florida Keys, 1978-1979 season. Florida Sea Grant College Report No. 42. 35 pp.

Provenzano, A.J. 1969. Recent experiments on the laboratory rearing of tropical lobster larvae. Proc. Gulf and Carib. Fish. Inst. 21: 152-157.

Richards, W.J. and J.R. Goulet, Jr. 1976. An operational surface drift model used for studying larval lobster recruitment and dispersal. pp. 363-374. In: Stewart, H.B. Jr., (ed.) Cooperative investigations of the Caribbean and adjacent regions. II. Symposium on progress in marine research in the Caribbean and adjacent regions, Caracas, Venezuela, 12-16 July, 1976. Papers on fisheries, aquaculture and marine biology. FAO Fish. Rep. (200). 547 pp.

Robinson, R.K. and D. Dimitriou. 1963. The status of the Florida spiny lobster fishery, 1962-1963. Tech. Ser. Fla. St. Bd. Conserv. 42: 1-27.

Roessler, M.A. and G.L. Beardsley. 1974. Biscayne Bay: Its environment and problems. Fla. Acad. Sci. 37(4): 186-204.

Schaefer, M.B. 1954. Fisheries dynamics and the concept of maximum equilibrium catch. Proc. Gulf and Carib. Fish. Inst. 6: 53-63.

1957. A study of the dynamics of the yellowfin tuna in the eastern tropical Pacific Ocean. Bull. Int. Trop. Tuna Comm. 2(6): 247-285.

Schroeder, W.C. 1924. Fisheries of Key West and the clam industry of southern Florida. Rep. U.S. Comm. Fish. for 1923. Doc. 962: 1-74.

Sims, H.W. and R.M. Ingle. 1967. Caribbean recruitment of Florida's spiny lobster populations. Q. J. Fla. Acad. Sci. 29(3): 207-242.

Sinderman, C.J. and A. Rosenfield. 1967. Principal diseases of commercially important marine bivalve mollusca and crustacea. Fish. Bull., U.S. 66(2): 335-385.

Smith, F.G.W. 1946. Final report on the Bahamas crawfish survey, June 1946. Agricultural and Marine Products Board, Nassau, Bahamas (manuscript).

1948. The spiny lobster industry of the Caribbean and Florida. Carib. Res. Counc. Fish. Ser. 3: 1-49.

1951. Caribbean spiny lobster investigations. Proc. Gulf and Carib. Fish. Inst. 3: 128-134.

1958. The spiny lobster industry of Florida. Fla. St. Bd. Cons., Ed. Ser. 11: 1-36.

Snell, E.W., W. McNeil, R.A. Neal, W. Shaw and R.O. Smitherman. 1978. Production systems. pp. 9-38 in: Aquaculture in the United States: constraints and opportunities. Nat. Res. Council, NAS. 123 pp.

Sordi, M. 1958. Micosi del crostacei decapodi marini. Riv. Parasitol. 19: 131-137.

Spaulding, I.A. 1970. Selected Rhode Island fishermen and their fishing activity. AEA Bulletin 403. Kingston, R.I.

Stebbing, T.R.R. 1894. A new Pedunculate cirripede. Ann. Mag. Nat. Hist. Ser. 6(13): 443-446.

Storr, J.E. 1964. Ecology and oceanography of the coral reef tract, Abaco Island, Bahamas. Spec. Pap. Geol. Soc. Amer. 79: 1-98.

Strangways-Dixon, J. 1973. Behavioral studies on the spiny lobster Panulirus argus. Proc. Assoc. Island Mar. Lab. Carib. 8: 11 pp.

Sutcliffe, W.H. 1952. Some observations of the breeding and migration of the Bermuda spiny lobster, Panulirus argus. Proc. Gulf and Carib. Fish. Inst. 4: 64-68.

1957. Observations on the growth rate of the immature Bermuda spiny lobster, Panulirus argus. Ecology 38(3): 526-529.

Sweat, D.E. 1968. Growth and tagging studies on Panulirus argus (Latreille) in the Florida Keys. Fla. St. Bd. Conser. Tech. Ser. 57: 1-30.

Tabb, D.C. and R.B. Manning. 1961. A checklist of the flora and fauna of northern Florida Bay and adjacent brackish waters of the Florida mainland collected during the period July 1957 through September 1960. Bull. Mar. Sci. 11(4): 552-649.

Thorhaug, A. 1974. Transplantation of the seagrass Thalassia testudinum Konig. Aquaculture 4: 177-183.

Thorhaug, A.T. and C.B. Austin. 1976. Restoration of seagrasses with economic analysis. Environ. Conser. 3(4): 259-266.

Ting, R.Y. 1973. Investigation of the resource potential of the spiny lobster in Puerto Rico. NOAA Rep. #73050307, NTIS Com. 73 10809, 62 pp.

Travis, D.F. 1954. The molting cycle of the spiny lobster, Panulirus argus Latreille. I. Molting and growth in laboratory-maintained individuals. Biol. Bull. 107: 433-450.

Turney, W.J. and B.F. Perkins. 1972. Molluscan distribution in Florida Bay. Sedimenta III: 37 pp. Comp. Sediment. Lab., Univ. Miami, Florida.

U.S. Bureau of Census. 1972. 1970 Census of Population. U.S. Department of Commerce, Bureau of the Census.

1977. U.S. Imports for Consumption. Series FT-246. (1977 and various earlier years.)

U.S. Fish and Wildlife Service. 1972. 1970 National Survey of Hunting, Fishing and Wildlife-Associated Recreation. U.S. Department of the Interior, Fish and Wildlife Service.

U.S. Water Resources Council. 1977. Regional multipliers: Guideline 5. Wash., D.C. 135 pp.

Vargo, G. 1968. Studies of phytoplankton ecology in tropical and subtropical environments of the Atlantic Ocean. Part 2. Quantitative studies of phytoplankton distribution in the Straits of Florida and its relation to physical factors. Bull. Mar. Sci. 18(1); 5-60.

Warner, R.E., C.L. Combs and D.R. Gregory, Jr. 1977. Biological studies of the spiny lobster Panulirus argus (Decapoda, Palinuridae) in South Florida. Proc. Gulf and Carib. Fish. Inst. 29: 166-183.

Waugh, G.T. 1980. Population dynamics of juvenile spiny lobster, Panulirus argus, near Grand Bahama Island. M.S. Thesis, Univ. Miami, Coral Gables, Florida. xi+195 pp.

Weber, D. 1968. Report to the Government of British Honduras (Belize) on investigations into marine fisheries, particularly spiny lobsters and shrimp resources. Rep. FAO/UNDP (TA) 2541: 28 pp.

Welsh, J.H. 1934. The caudal photoreceptor and responses of the crayfish to light. J. Cell. Comp. Physiol. 4(3): 379-388.

Williams, J.S. 1976. An economic analysis of alternative management strategies for the spiny lobster industry. Ph.D. Dissertation Univ. Florida, Gainesville, FL, 164 pp.

Williams, J.S. and F.J. Prochaska. 1976. The Florida spiny lobster fishery: landing, prices and resource productivity. Fla. Sea Grant Program Rep. 12: 1-50.

1977. Maximum economic yield and resource allocation in the spiny lobster industry. Southern Journal of Agricultural Economics. July, 1977.

Witham, R. 1973. Preliminary thermal studies on young Panulirus argus. Fla. Sci. 36(2-4): 154-158.

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

Witham, R., R.M. Ingle and A. Joyce. 1968. Physiological and ecological studies of Panulirus argus from the St. Lucie estuary. Fla. St. Bd. Cons. Tech. Ser. 53: 1-31.

Wood, E.J.F. 1968. Studies of phytoplankton ecology in the tropical and subtropical environments of the Atlantic Ocean Part 1. Introduction to the series. Bull. Mar. Sci. 18(1): 1-4.

Wust, G. 1924. Florida and Antillenstrom. Veriff. Inst. Meeresk. Univ. Berl. 12: 1-48.

Yang, M.C.K., and B. Obert. 1978. Selected statistical analyses of Key West spiny lobster data. pp. 4-7 In: R.E Warner, ed. Spiny lobster research review; proceedings of a conference held December 16, 1976, in Key West, Florida. Florida Sea Grant Tech. Pap. No. 4. 56 pp.

Zuboy, J.R. 1980. The Delphi technique: a potential methodology for evaluating recreational fisheries. NOAA Tech. Memo. NMFS-SEFC-19. 25 pp.