The American Lobster Fishery Management Plan: An Assessment of Its Impact on the New Hampshire Lobster Industry

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THE AMERICAN LOBSTER FISHERY
MANAGEMENT PLAN: AN ASSESSMENT OF ITS
IMPACT ON THE NEW HAMPSHIRE LOBSTER INDUSTRY

BY
JOHN C. BELCHER

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MASTER OF MARINE AFFAIRS

UNIVERSITY OF RHODE ISLAND
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INTRODUCTION

The management by the Federal government of fisheries can be traced back to 1953 when Congress passed the Submerged Lands Act in response to the dispute between the Federal government and coastal States over title to oil and gas found in submerged lands. This Act gave to the States jurisdiction over oil and gas resources out to three nautical miles from the coastline. The Submerged Lands Act also granted to the States "title to and ownership of the natural resources within the three-mile belt, those natural resources being defined to include 'fish, shrimp, oysters, clams, crabs, lobsters, sponges, kelp, and other marine animal and plant life'."¹ "Since the limit of U.S. fishery jurisdiction at the time was three miles, the federal government had no territorial basis for promulgating a fishery management programme for waters seaward of state jurisdiction."²

Exclusive fishery management jurisdiction between three and twelve nautical miles from the coast was granted to the Federal government by Congress in 1966. No federal regulations governing fishery management were ever promulgated, however.³

In 1972 an attempt was made to establish management regulations. Regional councils were formed to
discuss industrial, managerial and scientific problems associated with fisheries within the territorial sea. Their success was limited.

Not until the Fishery Conservation and Management Act of 1976 (Public Law 94-265) was enacted did a sound management structure exist at the federal level for fisheries regulation.

This Act (FCMA) established a fishery conservation zone and an exclusive fishery management authority. The stated purposes of the Act were, in part:

1. to take immediate action to conserve and manage the fishery resources found off the coasts of the United States, ...by establishing (a) a fishery conservation zone within which the United States will assume exclusive fishery management authority over all fish... and (b) exclusive fishery management authority beyond such zone over such anadromous species and Continental Shelf fishery resources;  

2. to promote domestic commercial and recreational fishing under sound conservation and management principles;  

3. to provide for the preparation and implementation, in accordance with national standards, of fishery management plans which will achieve and maintain, on a continuing basis, the optimum yield from each fishery;  

4. to establish Regional Fishery Management Councils to prepare, monitor, and revise such plans under circumstances (a) which will enable the States, the fishing industry, consumer and environmental organizations, and other interested persons to participate in, and advise on, the establishment and administration of such plans, and (b) which take into account the social and economic needs of the States.
The term "conservation and management", as used in this Act, refers to "all the rules, regulations, conditions, methods, and other measures (A) which are required to rebuild, restore, or maintain, and which are useful in rebuilding, restoring, or maintaining, any fishery resource and the marine environment; and (B) which are designed to assure that--

(i) a supply of food and other products may be taken, and that recreational benefits may be obtained, on a continuing basis;

(ii) irreversible or long-term adverse effects on fishery resources and the marine environment are avoided; and

(iii) there will be a multiplicity of options available with respect to future uses of these resources."\(^8\)

The term "fish" refers to finfish, mollusks, and crustaceans. The American lobster (Homarus americanus) is a crustacean and is specifically mentioned in the Act as being a "Continental Shelf fishery resource."\(^9\)

The fishery conservation zone is defined in the Act as being a zone "contiguous to the territorial sea of the United States...the inner boundary of the fishery conservation zone is a line coterminous with the seaward boundary of each of the coastal States,"
and the outer boundary of such zone is a line drawn in such a manner that each point on it is 200 nautical miles from the baseline from which the territorial sea is measured."\(^{10}\)

Title III, the National Fishery Management Program, of the Fishery Conservation and Management Act states that any fishery management plan must be consistent with the following national standards for fishery conservation and management:

1. Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery.

2. Conservation and management measures shall be based upon the best scientific information available.

3. To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

4. Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various United States' fishermen, such allocation shall be (a) fair and equitable to all such fishermen; (b) reasonably calculated to promote conservation; and (c) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.
5. Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

6. Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

7. Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.11

The Fishery Conservation and Management Act applies only to the management of fisheries within the fishery conservation zone. "Nothing in this Act shall be construed as extending or diminishing the jurisdiction or authority of any State within its boundaries."12 But at the same time, "no state may directly or indirectly regulate any fishing which is engaged in by any fishing vessel outside its boundaries, unless such vessel is registered under the laws of such State."13

The American lobster, Homarus americanus, covers a geographical range of about twenty degrees of north latitude, from the thirty-fifth (Cape Hatteras) to
the fifty-second (southern shores of Labrador) parallel. In width, the lobster's habitat extends from the coastal inlets to the continental slope. Because this is the only geographical area where the American lobster is found, it is considered to comprise a single stock, although its habitat does cross the regional boundaries defined by the 1976 Act.

As previously noted, the Fishery Conservation and Management Act established eight Regional Fishery Management Councils. With respect to the question of management of the American lobster, only two of the eight Regional Councils are involved: the New England Council and the Mid-Atlantic Council. The New England Council represents the States of Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut. The Mid-Atlantic Council represents the States of New York, New Jersey, Delaware, Pennsylvania, Maryland and Virginia.

Since 1972, the Northeastern States along the Atlantic seaboard have cooperated under the auspices of the National Marine Fisheries Service's (NMFS) State-Federal Fisheries Management Program to coordinate lobster conservation and management measures among lobster-producing States. A policy group was formed in 1972 and became known as the Northeast Marine
Fisheries Board. Its purpose was to provide overall policy guidance for fishery management programs developed under the State-Federal Program in the Northeast Region of the National Marine Fisheries Service. A plan for the management of the American lobster was completed by this Board in 1978 and submitted to the concerned States for their consideration and implementation under their respective fishery management systems. It was similarly submitted to the New England Regional Fishery Council and the Mid-Atlantic Regional Fishery Council for implementation under the FCMA.

The assistant Administrator for Fisheries, the National Oceanic and Atmospheric Administration (NOAA), had previously designated the New England Regional Fishery Council to prepare a fishery management plan for the American lobster. 17

The FCMA preserves the jurisdiction of States over the fisheries within State waters. The American lobster industry has, until very recently, been almost exclusively a coastal industry. This is particularly true with regard to New Hampshire. As such, "the federal government has no way of insuring that it could successfully implement a single unified policy with regard to lobster management throughout the range of the resource." 18 It was for this reason that the
proposed federal lobster management plan provides regulations in the Fishery Conservation Zone which complement those lobster fishing regulations already existing in the majority of the coastal States. The impact of the proposed federal regulations is therefore minimal for most States. New Hampshire, however, is affected by the regulations. Its lobster fishing regulations differ from the majority of the States with regard to minimum size limitations and escapement vents on traps. Additionally, the offshore lobster industry in New Hampshire has recently entered a new phase of growth. Thus the impact of the proposed lobster management plan may be greater than initially thought. This paper will examine the lobster, the industry, the management plan, and the effect of each on the lobster and on the industry of lobster fishing in New Hampshire.
Lobsters are true products of their environment. Their growth, frequency of molt and each phase of their life cycle are dependent upon many things that vary from place to place and from season to season. Two lobsters may weigh the same, but one taken from the rocky coast of New Brunswick and the other from a wreck off the New Jersey shore will not be the same age. Neither will one living in 15 feet (4.5 meters) of water on a breakwater in Long Island Sound be the same age as one living in water 1,000 feet (300 meters) deep in the canyons on the edge of the continental shelf. Water temperature and food are the two most important factors affecting a lobster's growth and weight gain. But also important are: salinity, availability of shelter, frequency of regeneration and even the kind of seafloor they live on. A simple generality is that in warm water lobsters grow faster.

The American lobster inhabits an area stretching from Cape Hatteras to the southern shores of Labrador. It is found in the inlets, bays and estuaries along the Atlantic Northeast and as far out as the continental slope. Until the late 1950's, the American lobster was thought to be strictly a coastal creature, but
offshore experiments in the late 1950's and early 1960's showed that lobsters did live on the outer continental shelf in sufficient numbers that fishing for them was economically feasible. Their maximum population density has been estimated at 0.001/m$^2$. Within the offshore lobster fishery, the greatest abundance is found at the heads of six submarine canyons along the continental slope: Veatach, Hydrographer, Oceanographer, Gilbert, Lydonia and Corsair. Their depth ranges from 200 meters to 1500 meters. (See Figures 1, 2.)

"In the Gulf of Maine, inshore sandy substrates with overlying flattened rocks support the greatest concentrations and biomass of lobsters, juveniles and adults combined (3.25 lobsters/m$^2$, average carapace length (CL) = 40 mm, total weight = 178 g/m$^2$). Average density and biomass for the sand/rock habitat, which is the prime lobster fishing ground throughout the year, is 1.2 lobsters/m$^2$ or 63 g/m$^2$. Scarratt reported a mean of 12.6 g/m$^2$ on 'good natural lobster grounds.' "

"Mud substrates mixed with solid objects (rocks, stones, man-made objects, etc.) at depths of 5-15 meters in harbors and estuaries on the Maine coast support densities of small juveniles...up to 20/m$^2$. " The carapace is measured from the base of the eye socket.
to the point where the flexible tail joins the hard shell.

The life cycle of lobsters is typical of crustaceans. As a rule, the adult female lays her eggs in August of any given year and carries them until they hatch in June, a period of ten to eleven months later. Spawning occurs every other year.

When the lobster escapes from the egg capsule and has shaken free from its cuticle, it emerges as a free-swimming animal. It is about 7.85 mm in length. For the next one to five days it remains at the surface slowly rising and sinking. The second larval stage lasts two to five days. Its free-swimming continues. During this stage it grows to about 9.3 mm. The third larval stage lasts again two to five days at which time the new lobster has grown to an average length of 11.1 mm. In the fourth larval stage, the lobster seems to undergo a literal metamorphosis to become a new animal. For the first time it truly resembles a diminutive lobster. The duration of this stage is 10-19 days at which time its average length is 12.6 mm. The next three larval stages are uneventful except in the growth of the lobster. The fifth stage lasts 11-18 days and the average length is 14.2 mm. The sixth stage lasts 14 days at which
time the animal is 16.5 mm. And the seventh stage lasts 14-21 days whereupon the lobster is 18.6 mm. The seventh stage marks the end of the lobster's pelagic days. The creature now begins a benthos type existence, moving inshore to rock crevices where it will live until driven to deeper water by the advent of ice. The early planktonic life may be an important means of distributing tiny lobsters over a wide area. It should be noted, however, that this planktonic period is also a period of phenomenal mortality. It has been estimated that close to 99 percent of the eggs hatched never reach the benthic period.

An important aspect in calculating the maximum sustainable yield of a fishery is that species' reproduction cycle. A lobster cannot reproduce until it has matured. The notion of a minimum allowable length being the determinant in legal versus illegal lobster is predicated upon the length of a lobster at maturity.

Water temperature is the most important single element in determining a lobster's life cycle. It may alter the rate of activity and growth, thereby affecting the age of sexual maturity, the frequency of molting or shedding, and the rate of basic body
functions. "The size at which sexual maturity is reached seems to depend largely on water temperature and hence the number of molts. In the warm water regions of the southern Gulf of St. Lawrence, some lobsters mature at a length of 7 inches and a weight of less than one-half pound." In most New England waters, maturity is believed to occur within one year or molt of the lobster attaining legal size (3 3/16 inches). New Hampshire's minimum legal size is 3 1/8 inches (79.31 mm).

In male lobsters, two aspects of maturity must be considered: physiological, when is the male capable of producing mature spermatozoa, and functional where, given a reasonable opportunity, the male is capable of mating with and inseminating a female. Male lobsters of 40-45 mm carapace length (CL) are able to produce mature spermatozoa, but they are well below the smallest sizes of females at first maturity. "Whether these small males are capable of mating with females is a question that has not been properly addressed, but Templeman (1935) conducted mating experiments with American lobsters from the southern Gulf of St. Lawrence and found that males between 60 and 65 mm CL were unable to mate with freshly molted mature females..."
The scientist Anderson developed an idea whereby the relative size of the lobster's cheliped (crusher claw) is related to the onset of maturity. This Anderson-Cheliped Index is:

\[ CPV = \frac{L \times W \times D}{CL} \times 10 \]

where,

- \( CPV \) = Crusher propodite volume index
- \( L \) = Crusher propodite length
- \( W \) = Width across palm of claw
- \( D \) = Maximum thickness of claw
- \( CL \) = Carapace length.

The Anderson-Cheliped Index for male American lobsters suggests the onset of maturity occurs at a carapace length of 78 mm and 93 mm for males from the Gulf of St. Lawrence and the Bay of Fundy, respectively.\(^{38}\)

The largest size at maturity for female American lobsters occurs among the "offshore" lobsters of southern Georges Bank and the "inshore" lobsters of the Bay of Fundy-Grand Manan area. There the smallest ovigerous females are close to 90 mm CL and 50 percent maturity is reached between 110 and 120 mm CL.\(^{39}\) From the Bay of Fundy, the size at the onset of maturity decreases along the coast in both directions. To the south, the minimum size at maturity drops to 83 mm CL in Mainecoastal waters and reaches the smallest size
throughout the range in western Long Island Sound (55-59 mm CL), with 50 percent maturity occurring at approximately 70-74 mm CL. 40

"Several hypothesis have been advanced to explain why American lobsters mature at different sizes in different areas. It has been suggested, for example, that high exploitation rates in commercial fishery combined with legal size limits below mean minimum size at maturity exert genetic pressure for maturation at a smaller size. It has also been suggested that exposure to the continental slope results in larger minimum size at maturity because of the genetic influence from offshore stocks, both through larval drift and directed movement of adults. However, the most plausible explanation appears to be first advanced by Templeman, who contended that high summer temperature favors early maturity in female American lobsters, whereas the very cold water of the Bay of Fundy retards reproductive maturation.41

A lobster's growth occurs only at molting. Egg-carrying lobsters do not molt because molting and spawning both occur in the summer months, and if the "berry" or egg-carrying female were to shed, the eggs too would be discarded. However, mating can only occur just after the female has molted. A lobster which is
at the New Hampshire minimum legal size of 3 1/8 inches is about 7 years old. An increase in carapace length for 90 mm lobsters from the Gulf of Maine ranged from 12 to 13 percent. Growth for males and females was similar. In contrast, offshore lobsters 90 mm in carapace length increased 19 and 17 percent for males and females, respectively. The frequency of shedding for inshore lobsters of a given size is less than that for offshore lobsters. Thus, the rate of growth for inshore males and females is significantly less than for their deep water counterparts. 42

Although many fishermen believe that lobsters migrate with the seasons, going offshore in the fall and inshore in the spring, science disagrees. No coastwise migrations of American lobsters are known to occur, but large numbers of offshore lobsters move to and from deep water in the fall and spring. This benthic migration varies in accordance with the character of the coast and nature of the bottom. It is influenced by the temperature of the ocean, by the abundance of food, and, to some extent, by molting and breeding habits. 43 In numerous tagging experiments, it has been shown that most inshore lobsters are stable,
with few making annual movements of more than two miles. This lack of movement helps to explain existing regional differences in size, coloration and sex ratios among lobster populations.44

The offshore lobster population lives in water as deep as 2400 feet and are generally larger than their inshore relatives. Tagging experiments have shown that offshore lobsters prefer warm water. The optimum temperature of the lobster is about 55°F. When the water temperature is 50-55°F in the spring, large numbers of lobsters begin to crawl shoalward. Similarly, when the temperature begins to drop in the fall, the offshore lobsters migrate back to their submarine canyons, where the water is actually warmer. The tagging of some 6,000 offshore lobsters and recovery of over 400 has indicated a definite shoalward migration in the spring. But this does not necessarily mean there is a mingling of inshore and offshore lobsters during the summer. Most offshore lobsters found in the submarine canyons described earlier migrate toward the shallower and warmer waters of Georges Bank. Of these tagged offshore lobsters recovered, about 20 percent had moved less than 10 miles, while 60 percent had moved 10 to 50 miles and the remaining 20 percent had journeyed over 50 miles.45
Since the 1950's and particularly during the last decade, rising prices and increasing demand for lobsters have resulted in a substantial increase in levels of applied fishing effort throughout the lobster fishery in the United States. Considering the number of traps fished as a rough index of applied effort, the coastal trap fishery has more than tripled over the last 20 years to a level in 1981 of more than two million traps. The offshore fishery, which was identified and began to flourish in the early 1960's, extends over much of the continental shelf and in the offshore canyons, from the Virginia Capes to the northeast peak of Georges Bank and parts of the Gulf of Maine. By definition, the offshore lobster fishery lies beyond 3 nautical miles of the baseline. That lobster fishery lying in the waters under State jurisdiction is defined as inshore or coastal.

Commercial lobster fishing goes back to pre-Revolutionary days, but it expanded rapidly during the late 1800's. In 1880, the total landings in the United States were 9,208 metric tons (MT). By 1900, the State of Maine had become the leader in lobster production. Lobster canneries were an important element
of the fishery during these years, but quickly declined and had virtually disappeared in the early 1890's.

Lobster fishing was done by traps. Although the fishery fluctuated in the first half of the 20th century, the number of traps being fished remained relatively constant from 250,000 to 350,000. However, in the post World War II era, and especially in the period from 1960 to 1980, the lobster fishery expanded rapidly. During that period, the number of traps fished in the traditional coastal fishery grew to a record high of 2.1 million traps in 1978.48

In addition, a new fishery developed offshore. Although offshore trawlers were known to harvest some lobsters in earlier times, the fishery remained essentially a shoal water coastal trap fishery well into the 1950's. Increased demand for lobster and improvement in the technology of mobile gear stimulated rapid development of an otter trawl fishery for lobster, principally around the canyon areas located in deep water along the continental margin off Southern New England. Reported landings on trawl-caught lobsters grew from 128 MT to 2,500 MT between 1950 and 1965.49 The new fishery rapidly expanded to an offshore area ranging from Corsair Canyon to Norfolk Canyon. However, by the mid 1970's, trawl landings had slipped to 600 MT.
Development in the 1960's of the hydraulic trap hauler stimulated the offshore lobster trap fishing industry. The industry expanded rapidly, too rapidly. The early 1970's saw serious economic problems from overcapitalization. Another problem was in gear conflicts, especially with trawlers from foreign fleets. "Annual landings from the offshore lobster trap fishery have fluctuated between 2,000 MT and 3,000 MT."\(^{50}\)

"Landings of American lobster in 1981 were 37.5 million pounds valued at $86.5 million—up 542,000 pounds (1 percent) and $11.3 million (15 percent) compared with 1980. The average exvessel price per pound was $2.31 in 1981 compared with $2.04 in 1980. Landings in Maine, the principal producing State, were 22.3 million pounds, about 1 percent more than the previous year. Massachusetts' landings of 9.8 million pounds increased by only 140,000 pounds from the previous year. Rhode Island landings of 2.2 million pounds decreased by 205,000 pounds compared with 1980."\(^{51}\) New Hampshire, by comparison, landed 802,432 pounds from its inshore fishery.\(^{52}\)

Although the United States in 1981 landed a record 37.5 million pounds of lobster, an additional 40.3 million pounds was imported from Canada.\(^{53}\) It is obvious that an extensive market exists for lobster
in the United States.

The relative contribution of the offshore lobster fishery to the total lobster production can be seen from the following figures: for 1981, within the inshore fishery (0-3 miles), 33 million pounds of lobster were caught; the offshore fishery (3-200 miles) contributed 4.5 million pounds, about 13.6 percent of the total catch.

The total number of persons engaged in lobster fishing has increased substantially since the middle 1960's. Since 1968, the increases have been in the trap fisheries. The vast majority of persons and vessels involved in the lobster fishery are engaged in the coastal trap fishery.

Lobster fishing is largely seasonal. Winter weather increases gear losses and makes trap hauling difficult and dangerous, particularly for small vessels. Also, the lobster becomes less active in the winter months with the onset of colder water temperatures, and generally, therefore, the catch declines. There are three basic categories of lobstermen: those who lobster full-time, those whose lobstering is a regular but seasonal part of a diverse fishing enterprise, and those who are part-time lobstermen with their principal employment elsewhere. Probably less than half lobster
full-time. Lobstering may not require a large initial
cash investment or experience, so there is considerable
participation in the coastal lobster fishery. States
require that licenses be obtained to lobster. It is
one way to manage the fishery. Commercial lobstering
in New Hampshire is defined as setting out greater
than five traps. In 1981, New Hampshire issued 443
lobster fishing licenses and of those, 302 were
commercial. Of the commercial lobstermen, most
lobster only part-time.

In the offshore fishery, because of the magnitude
of the necessary investment, participation is limited
to serious full-time operators. When the value of
traps, lines, buoys and radar reflectors is totaled, a
single string with 20 to 100 traps can be worth up to
$10,000. Offshore vessels cost from $250,000 to $750,000.
Using a typical offshore lobster vessel worth $250,000,
$50,000 for the gear normally carried and disregarding
operating costs, an investment of about $300,000 for
an individual offshore lobster enterprise is not an
unreasonable estimate. The offshore lobster trap
fishery as a whole is estimated to be valued at about
$34 million, not including shore facilities such as
storage tanks, maintenance shops or piers.56

Gross revenues from the fishery can be estimated
by landings value, which in 1981 was $86.5 million. This set a new record, the previous high being 1980 at $75.2 million. The inferred values for expense and accounting items for the 1976 inshore lobster fishery are shown in Table 1.

Most of the prices used in calculating the indexes of exvessel prices are based upon monthly landings and value data. The index for each species is calculated by multiplying the current monthly price by the total quantity caught in 1967 (the base year) to obtain a value for the current month. That value is then divided by the 1967 average monthly value to obtain the final index:

\[
\frac{\text{Current Price} \times \text{1967 Quantity}}{\text{1967 Average Monthly Value}} = \text{Index for each Species}
\]

The indexes for exvessel prices for American lobster from 1976 through 1981 follow (1967=100):

<table>
<thead>
<tr>
<th>Year</th>
<th>Index</th>
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<tr>
<td>1976</td>
<td>216.3</td>
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<tr>
<td>1977</td>
<td>245.1</td>
</tr>
<tr>
<td>1978</td>
<td>264.3</td>
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<td>1979</td>
<td>262.8</td>
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<tr>
<td>1980</td>
<td>278.1</td>
</tr>
<tr>
<td>1981</td>
<td>304.0</td>
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Within the year 1981, by month, the following were the indexes for exvessel prices of American lobster (1967=100):

<table>
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<th>Month</th>
<th>Index</th>
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<td>Jan</td>
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<td>Nov</td>
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From these two sets of figures, one can readily see that exvessel prices for American lobster have been steadily increasing, except for a slight regression in 1979, and that within a given year the highest exvessel price is in the winter and the lowest in late summer.

Different size lobsters command different prices per pound at the market. The smallest legal sized lobsters, known as chickens and weighing about one pound, are the least valuable per pound next to culls (lobsters with only one claw) or damaged lobsters. Prices increase with the size of the lobster until a threshold size, about three pounds, is reached. Above this size, the lobster is too big to serve easily and without waste, and the price per pound decreases somewhat.

Because a major portion of the lobster sold is served by restaurants and other institutions, the retail market and retail price are difficult to evaluate. Institutions and restaurants require stable supplies of lobster, which makes the quantity remaining for retail sale very sensitive to changes in landings. Thus, when
the supply of lobster decreases in the winter months, the retail price increases substantially. The inverse is of course true for the summer.

The distribution chain for American lobster consists of several steps. The lobsterman sells his catch to a dealer or buyer. The dealer then sells the catch to a wholesaler. In smaller ports, dealers often function as wholesalers. The wholesalers then market their lobster to either retail outlets or to restaurants. "Wholesale prices tend to reflect differences in handling and transportation costs between the major markets, but are otherwise equalized." 61 Wholesale prices generally mark up the price of lobster about 40 percent. "Lobstermen are often forced to deal with only one local wholesaler-dealer, and because firms at this level frequently maintain storage of lobsters for speculation, the wholesalers' operation has potential to be very profitable." 62

Within the New England American lobster industry, New Hampshire plays a minor role, contributing about 2 percent of the total annual lobster catch. New Hampshire and Maine have traditionally been coastal lobstering states, with only a couple boats involved in
the offshore lobster industry.

New Hampshire has a very short coastline of 18 miles. Although this is the shortest coastline of any New England seacoast state, it has the highest fishing activity per mile of coastline. Yet despite this intensity, it has the second lowest revenue generated by the industry. 63

A study conducted by the University of New Hampshire Marine Program in 1976 found that the stereotype of the uneducated Yankee fisherman was false.

The vast majority of traditional New Hampshire fishermen have at least a high school education. One-quarter of these fishermen have completed college. First time fishermen, i.e., those who have not inherited fishing from a previous generation, are entering the industry with more years of schooling than their traditional peers. Sixty-six percent of the new fishermen have over 12 years of education, while 25% of the traditional fishermen have education levels above high school. This is significant because the median education level in New Hampshire according to the 1970 U.S. Census was 12.1 years. The median education level for all fishermen combined is 13.0 years. 64

High degrees of competition among the fishermen
have traditionally been absent. This is indicative of their social relations with one another, which can be characterized as social businessmen. When on their boats fishing, they compete as businessmen, but tend to socialize among themselves on the docks.65

Politically, they have traditionally been able to agree on a few issues. The New Hampshire Fishermen's Association was created to unify the lobstermen. It has of late fallen into a silent organization with little influence. The current controversy over a New Hampshire legislative proposal to increase the minimum size to 3 3/16 has caused informal groups on both sides to form. The New Hampshire lobsterman appears vocal on some issues, but remains quiet on most. Their political power is slight.

New Hampshire has four ports: Portsmouth, Rye, Hampton and Seabrook. The majority of the lobster landings occur in Portsmouth. Due to the size of the other harbors and the facilities available at Portsmouth, all New Hampshire offshore lobster vessels tie up in Portsmouth and offload at the marine piers. New Hampshire has seen a general annual increase in its landings from inshore lobster fishing. The greatest increase, however, is in the offshore industry. In 1976, New Hampshire had no vessels involved in that
industry. Currently there are five vessels fishing the offshore lobster from the port of Portsmouth. In 1982 they brought in an estimated 1½ to 2 million pounds of offshore lobster.66

New Hampshire law states that any person using a trap or pot to fish lobster must have a license. That license costs $100 for commercial purposes and $25 for recreational.67 This license applies only to waters under the jurisdiction of the State, that is from the New Hampshire-Massachusetts border northward to the New Hampshire-Maine border and seaward to the line demarking inland and high seas.68 Only residents of five years in the State may be issued licenses.69

The restrictions on what lobsters may not be taken are several:

1. No female lobster carrying spawn may be taken nor may spawn be removed from the female lobster.70

2. No female lobster bearing eggs may be taken.71

3. The minimum carapace length is 3 1/8 inches.72

4. The possession of mutilated lobsters is prohibited. Mutilation is defined as any lobster from which accurate measurement of size is impossible.73
A significant difference between Maine and New Hampshire prohibitions on lobsters which may be taken is legal size. The minimum carapace length in New Hampshire is 3 1/8 inches. The minimum carapace length in Maine is 3 3/16 inches. Furthermore, Maine has a maximum carapace length of 5 inches. New Hampshire has no restriction on maximum size. The 5 inch limitation was adopted in 1935. In all probability, the "maximum size limit has little conservation or management value and has nothing to do with increased production."\(^7\)

Another difference is that when female berried lobsters are caught in Maine state waters, they are V-notched. That is, a notch is cut from the tail's middle fin. Until the notch disappears, which may take up to four molts, that lobster may not be landed. As a means of managing the lobster stock, its success is controversial. "Maine lobstermen widely support the program and are convinced that it provides significant benefits to the resource. The rationale for their support is that a berried female is a proven 'brood stock' lobster that will, if not harvested, continue to contribute to future spawning and ultimately recruitment in the resource... The yield per recruit for V-notched females is higher than for other females harvested at ages comparable to those at which berried females are
V-notched. The problem with V-notching is that it leaves the lobster extremely susceptible to infection.

A third significant difference is in the construction of the lobster traps. Maine, along with several other states, presently requires the incorporation of escapement openings or vents in the construction of lobster traps. Their purpose is to improve the escapement of sublegal lobsters. New Hampshire currently has no requirement for the inclusion of escapement vents in lobster traps. "As the risk of increasing damage associated with fishing is greatest to lobsters in the sublegal size class, the escapement of sublegal lobsters by venting may have an important positive impact on the damage problem. In addition to reducing mortality associated with fishing damage, a reduction in the number of sublegal lobsters with claw damage caused as a result of entrapment may also reduce the future frequency of culls in the legal size class."
NEW HAMPSHIRE - MAINE BOUNDARY DISPUTE

The coastline of New Hampshire is 18 miles long. To the south it meets Massachusetts, to the north Maine. The northern seacoast boundary passes through Portsmouth harbor and out to the Isles of Shoals. Should there be no difference between the two states in their lobster fishing regulations, there would be little conflict. However, there are differences, as previously discussed, and the location of that boundary therefore becomes significant. In question is an area of 3,205 acres. In terms of the total area of state controlled waters, this disputed area certainly is a greater percentage of New Hampshire waters than of Maine waters.

James Sullivan, author of History of the District of Maine in 1795, describes the New Hampshire-Maine boundary as beginning at the Piscataqua River, "which finds the sea in the latitude of 43 degrees 4 minutes North from the Equator, and extends northerly on that river to the source of its main branch..." 77

William D. Williamson's History of the State of Maine states: "the southwesterly extremity of the state is - Kittery Point on the eastern bank of the Piscataqua River, at its mouth, in Latitude 43 degrees 4 minutes." 78  "The divisional line shall pass from
the sea through the entrance of Piscataqua harbor, and up the middle of the rivers...and the Piscataqua harbor shall be divided in the middle by a line extended through the Isles of Shoals - assigning those to New Hampshire and to Maine which lie on their respective sides of that line."  

Later, Jeremy Belknap wrote that the point where the islands of the Isles of Shoals are divided bears "S 29 degrees E from the middle of the harbor's mouth; the variation of the needle being 6 degrees W."  

Lewis W. Brewster wrote that the Isles of Shoals islands "are partly in New Hampshire and partly in Maine. The dividing line is between Star and Appledore and through Cedar Islands. Star, White and Londoner are in New Hampshire, while Appledore, Malaga, Smuttynose and Duck are a part of Kittery, Maine, as the proprietors of Appledore find--to their sorrow--when they receive a heavy tax bill from the collector of that town."  

Both states, in 1982, appointed commissioners to examine the boundary. The commissioners reported to the states that the boundary decreed in 1740 by the King George and Council was the true boundary. On June 30, 1827, the New Hampshire legislature enacted a law recognizing that boundary as the true boundary, provided the State of Maine reciprocated. By resolve
on February 28, 1829, the State of Maine also recognized that boundary as the true boundary.

In 1973, the State of New Hampshire in Chapter 580 of the 1973 Laws of New Hampshire adopted a new boundary: "Beginning at the midpoint of the mouth of the Piscataqua River; thence southeasterly in a straight line to the midpoint of the mouth of Gosport Harbor of the Isles of Shoals; thence following the center of said harbor easterly and southeasterly and crossing the middle of the breakwater between Cedar Island and Star Island on a course perpendicular thereto, and extending on the last-mentioned course to the line of mean low water; thence 102° East (true) to the outward limits of state jurisdiction..."  

In 1974, the State of Maine claimed a new line to be the true boundary. This new line started at the mouth of the Piscataqua harbor (43 degrees 4 minutes North) and running South 2° E, variation 6° W and thence to South 56° E, variation 6° W, based on a claim made by Massachusetts in 1737 at Hampton, New England. At that time, Maine was a part of Massachusetts. In 1737, New Hampshire commissioners had also claimed in Hampton, New England, a boundary of SE, variation 6° W.
The resolution of this dispute fell in April 1974 to Special Master Thomas Clark. The New Hampshire Fishermen's Association filed a brief claiming the traditional and accepted boundary between New Hampshire and Maine was "lights on range" (143° true). The "lights on range" is a straight line connecting Fort Point Light and Whaleback Light and extending from the mouth of the Piscataqua River to Gosport Harbor in the Isles of Shoals. The other line in question, as a proposed boundary, was a Geological Survey line. This line, however, was without much factual or historical background, being, in 1917, merely the "opinion of a cartographer."84

A concern in the resolve of this dispute was that "lights on range" boundary would eliminate Maine's access to Portsmouth harbor. "While it may be that larger boats might have to go through New Hampshire waters to enter the harbor, this creates no problem whatsoever, since under law vessels can navigate freely in waters of either state, regardless of any boundary line... Even for Maine lobster fishermen, no difficulty will arise from their having to pass through New Hampshire waters, since, if they are carrying lobsters which are legal in Maine, they are ipso facto legal in New Hampshire... The only problem created by a boundary
accrues to New Hampshire fishermen. If they have to enter Maine waters, they will risk arrest by carrying lobsters of sizes legal in New Hampshire, but illegal in Maine.\textsuperscript{85} It should be pointed out here that the entire boundary controversy arose out of a dispute over lobster fishing. "Before the original action was filed, efforts to settle the dispute failed, and violence over lobster fishing rights in the area was threatened."\textsuperscript{86}

The Special Master, once both States proposed boundaries and briefs were filed, asked that both States consent to a decree line. Exceptions to this were taken to the U.S. Supreme Court.

Mr. Justice Brennan, in writing the opinion of the Supreme Court in 1976 states, "New Hampshire and Maine are not here adjusting the boundary between them; the boundary was fixed over two centuries ago by the 1740 decree, and the consent decree is directed simply to locating precisely this already existing boundary."\textsuperscript{87} The line currently in effect is one that extends from the middle of the Piscataqua River to a point at Latitude 43\degree-02'-42.5"N, Longitude 70\degree-42'-06"W; thence southwesterly to a point at Latitude 42\degree-58'-55"N, Longitude 70\degree-37'-39.5"W; thence to a point at Latitude 42\degree-58'-45.5"N, Longitude 70\degree-36'-43"W; thence to a point
at Latitude 42°-58'-37.3"N, Longitude 70°-36'-36.4"W; thence on a line of 102° True. This line, although a compromise, is one which is extremely difficult to lobster by. With the different lobster regulations for each state, and the line not following easily navigable marks, it is not uncommon for New Hampshire or Maine lobstermen to be mistakenly fishing in the wrong waters. This new boundary cost New Hampshire 2,466 acres. (See Figures 3 and 4 for disputed and final boundaries.)
In the past few years, the world community has become increasingly aware of the sea and its resources. Many management strategies used to protect these resources from overexploitation have resulted in inefficient use of gear and equipment. "The U.S. American lobster fishery is a classic case of rapid increases in consumer demand impinging upon a limited resource." 89

A general bioeconomic model of how a fishery functions was developed by Fullenbaum, Carlson, and Bell in 1971. "The firm is predefined as a bundle of inputs. Second, the long-run catch rate per vessel per unit of time is beyond the individual firm's control. It is, in effect, determined by stock or technological externalities. Finally, we are assuming that the number of homogeneous vessels is a good proxy for fishing effort. Alternatively, we may employ fishing effort directly in our system by determining the number of units of fishing effort applied to the resource per vessel." 90

One hypothesis regarding the fish catch is that the proportion of the biomass caught is a direct function of the number of vessels (or equivalent fishing effort)
exploiting a given ground. 91

"The system...can be reduced to two steady-state functions. The first, which condenses all relevant biotechnological factors, is the ecological equilibrium equation. It plots the relationship between the biomass and the number of vessels (or fishing effort) needed to harvest the yield such that the biomass is in equilibrium."92 The second function assumes there is no entry to or exit from the fishery. These two functions provide two curves which intersect at two points (X,K) and denotes bioeconomic equilibrium. Figure 5 represents general exploitation. Nonexploitation and extinction are shown in Figures 6 and 7, respectively.

The fishing effort for the American inshore lobster has been gradually, but steadily, increasing. For modest changes in fishing effort, the steady-state assumption will not yield biased estimates. It has been calculated that (assuming a temperature of 46°F) the fishable stock of U.S. inshore American lobsters consistent with maximum sustainable yield is equal to 31 million pounds.93 By examining the variables of numbers of vessels, numbers of traps, seawater temperature, personal income and output per trap, one may develop models which statistically will predict how management strategies will meld effort and maximum
sustainable yield.

The bioeconomic model of Schaeffer-Gordon postulates that the growth, in weight, of a particular fish stock over a certain period of time will depend upon the weight of that stock at the beginning of the period. This relation is an inverted parabola. "Within the range bounded by nought and the environmental carrying capacity (ECC), growth is positive and thus the stock will be increasing. Once ECC is attained, growth declines to zero, and this stock size will be maintained. Growth of the stock is greatest when the stock is half its maximum potential size."\(^{94}\) (See Figure 8.)

If the stock size is given at ECC, and fishing begins, the stock size will decline because growth is zero at ECC. If the fishing effort does not change, a new equilibrium will be established at a point where growth is equal to catch. This point is the sustainable yield. The origin of the sustainable yield curve corresponds to ECC on the biological productivity curve. (See Figure 9.)

The economic aspects of the bioeconomic model involve three important assumptions. First, it is assumed that the fishery represents only a small part of the total world market for the particular species. Price in the fishery is therefore determined by the
world market situation, is independent of local output and is therefore constant. Multiplying the sustainable yield by the price gives a total revenue (TR) curve for the whole fishery. Second, it is assumed that fishermen work only for monetary gains and worker satisfaction is unimportant. Third, it is assumed that fishing effort fluctuates by the entry and exit of vessels rather than by vessels expanding their individual effort. Total cost (TC) is a linear function of the total amount of effort. (See Figure 10.)

Given open access to the fishery, as stated in assumption three above, an equilibrium will exist at an effort level where TC=TR. As fish prices increase over time, the TR curve will shift upwards. As technology improves, the cost of the effort expended should decrease and thereby shift the TC curve to the right. The result is that the open access level of exploitation will increase. (See Figure 11.)

The threat of overfishing a species is often mentioned as a primary reason for establishing fishery management plans. But the definition of overfishing deserves examination.

Biologists have often argued that fisheries should
be exploited so as to yield the maximum catch that can be maintained in the long-run, i.e., maximum sustainable yield (MSY). As Figure 11 illustrates, the tendency is for fisheries to become increasingly heavily exploited through time. Biological overfishing is thus inevitable.

"Economists criticize the above definition of biological overfishing on the grounds that it is purely a physical definition in which no account is taken either of the value of the fish caught or of the cost of catching them." Marginal revenue (MR) is positive although declining up to the point that TR equals MSY because TR is increasing at a decreasing rate. MR is zero at MSY. Marginal cost (MC) will be positive and constant because each succeeding unit of effort adds the same to the linear TC. Economic overfishing therefore occurs when MR is less than MC. The optimum is when they are equal. This point is called maximum economic yield (MEY).  

"TR is an inverted parabola and is therefore of the form TR=aE-bE^2. TC is a linear function TC=cE. Since the open access level of effort (Eoa) is where TR=TC, we must have Eoa=(a-c)/b... MEY occurs when MR=MC and the MEY level of effort (Emey) is therefore Emey=(a-c)/2b." The level of effort corresponding to MEY is half that of open access.
Biologists have tended recently to steer away from the idea of maximum sustainable yield as a definition of overfishing because it assumes a stable fishery. Instead, biologists have chosen optimum sustainable yield (OSY) which is based upon such considerations as environmental, social, economic and biological factors. It is a figure below MSY, and, more often than not, merely some figure based upon the previous year's catch.

The economic explanation of overfishing cited previously is based upon a particular point in time. No account is made for the time span over which the fish stock, catch and costs would adjust if fishing effort were altered. "The dynamic view of overfishing explicitly takes account of the time distribution of net revenue..." The question of how far fishing effort should be cut back from the open-access level depends on the relationship between total discounted future benefits (that is, their present value) and current loss. In theory, fishing should be reduced to the point where the difference between these is maximized. This effort yield is called dynamic maximum economic yield (MEY).

The limits for dynamic MEY are:
(1) it corresponds to static MEY if there is no time preference and (2) it corresponds to open-access if
there is complete time preference. "In practice, society tends to show some degree of time preference, so that the effort level corresponding to dynamic MEY lies somewhere between static MEY and open-access... Economic overfishing, then, may be redefined as beyond the level corresponding to dynamic MEY."101 (See Figures 12, 13.)

For the fisherman, overfishing may mean something entirely different. A variable of importance is catch per unit of effort (CPUE). As fishing effort increases, CPUE can be expected to decline. "Mathematically, this means that the long-run relationship between CPUE and effort must be an inverse linear function... Given that TC increases linearly with effort, it follows that profit per unit of effort (PPUE) will also decline as effort expands toward open-access equilibrium."102 Because both CPUE and PPUE decline with any increase in fishing effort, so far as the individual fisherman is concerned, any increase in fishing effort will be overfishing.

The term overfishing has become increasingly popular and is often used to justify an argument. Yet the definitions of overfishing may be quite different. One must therefore be cautious in accepting conclusions based on accusations of overfishing.

The draft states, "A lobster management program is necessary because the resource is fished very intensively throughout its range, resulting in only a small fraction of American lobsters surviving long enough to reproduce once. Such a condition in the resource increases the risk of recruitment failure and stock collapse, and jeopardizes the continuation of a viable fishery. Although catch has remained relatively constant in the American lobster fishery, catch per unit of effort has been on a steady decline for more than twenty-five years."103

As its objective, this plan is designed to "promote conservation, to reduce the possibility of recruitment failure, and to allow full utilization of the resource by the United States industry. The management program should be sensitive to the need to minimize social, cultural and economic dislocation."104
The first major prohibition cited by the draft American Lobster Fishery Management Plan is that it is unlawful:

"To possess in the FCZ any American lobster with a carapace length smaller than 3 3/16 inches; or to land any American lobster harvested from the FCZ with a carapace length smaller than 3 3/16 inches."\(^{105}\)

Both the purpose and effectiveness of the minimum size limitations imposed on the fishery are complex. Since the smaller lobsters generally bring lower prices, the minimum size limits are effective in providing a product of relatively high unit value. "In view of current rates of exploitation, which may be as high as 90 percent in the inshore areas, the minimum size limits undoubtedly have performed an important conservation function. However, present size limits [3 1/8 and 3 3/16 inches] are well below the size (age) of lobsters providing maximum yield in weight per recruit in all areas."\(^{106}\) Additionally, indications from biologists is that most female lobsters in the highly exploited areas of coastal Maine, New Hampshire and Massachusetts do not reach sexual maturity until their size is greater than those states' minimum size limit. High rates of exploitation of immature lobsters could result in excessive depletion of lobster brood stocks.
Implementation of the 3 3/16 inch size limitation will most likely result in a slight decrease (less than 1 percent) in total landings due to New Hampshire and New Jersey currently have a 3 1/8 inch limitation. This, it is estimated, would result in a wholesale price per pound increase of about 0.1 percent. It seems that gross revenues decline and prices increase as the minimum size specification increases.\(^{107}\) The Northeast Marine Fisheries Board, in presenting its proposed plan, cited Nicholls (1978) who interviewed major lobster dealers and processors and analyzed the price-supply relationships for lobster. He estimated "the increase in cost per lobster would be approximately $.84 at the retail level", and concluded "there would be no substantial adverse social and economic impacts of a 3 1/2 inch minimum size limitation", and that "there are benefits which would accrue to both the producer and the consumer as a result of the minimum size increase."\(^{108}\) The minimum size limitation was recommended by the Northeast Marine Fisheries Board to be increased to 3 1/2 inches (88.83 mm). The Council rejected this proposal due to strong opposition by fishermen throughout the lobster industry.
A second major prohibition contained in the Plan is that it is unlawful to "possess in the FCZ any American lobster parts or shelled meat; or to land any American lobster parts or shelled meat from lobsters harvested from the FCZ." This regulation has little effect on most states as that prohibition generally is already in existence. New Jersey, however, is the exception. A significant part of their offshore catch stems from the landing of parts. This ban on mutilated lobsters "is intended to prevent harvestors from snapping off and marketing claws and tails of undersized lobsters." A third prohibition makes it unlawful to "possess in the FCZ any berried female American lobster or any female American lobster from which eggs have been forcibly removed; or to land any berried female American lobster or any female American lobster from which eggs have been forcibly removed." This regulation also is widely adopted by the northeast states and therefore should have little effect on lobster output.

A fourth prohibition makes it unlawful to fish with traps which do not contain one of the following in
each parlor: "(1) a rectangular escape vent with an unobstructed opening not less than 1 3/4 inches (44.5 mm) by 6 inches (152.5 mm); or (2) two circular escape vents with an unobstructed opening not less than 2 1/4 inches (52.2 mm) in diameter; or (3) such other vent as the Regional Director may find is consistent with the above." The purpose of escapement vents is to allow sublegal size lobsters to escape when the trap is still resting on the sea floor. Lobsters are preyed upon most heavily by codfish. Large cod average 10-25 pounds and cods school in large numbers over the same range as the American lobster. In discussion with several fishermen, they have indicated that it is not uncommon to find lobster in the stomach of cod. Without a means to release sublegal size lobsters at the bottom, the lobstermen must throw them over the side when the trap is opened onboard the vessel. It is estimated that many of these undersized lobsters never make it to the bottom.

The final significant prohibition of the Plan makes is unlawful to "possess a V-notched American lobster in the FCZ north and east of a line beginning at a point 43°06'N, 70°34'W; thence to a point 42°00'N,
60°35' W; thence due east along the 42nd parallel to the outer limit of the FCZ. In the proposed management plan submitted by the Board, there was no mention of retaining V-notching, a practice performed exclusively by Maine. However, due to the strong influence of Maine lobstermen, V-notching was injected into the final draft. (See Figure 14.)

"Without a prohibition on the FMP on take of V-notched lobsters in the FCZ in the designated area, fishermen from other states could harvest great numbers of such lobsters in areas outside Maine's territorial sea and thus effectively negate Maine's longstanding program with risks that are considered significant by Maine and her lobstermen. Because the impacts on lobstermen from other states are likely to be minimal or non-existent and because of the great importance Maine attaches to this program in its own management efforts, the Council has elected to make this provision applicable to a large part of the Gulf of Maine."
The American lobster, Homarus americanus, does live in a rather small area off the Northeastern United States. Since the 1950's, it has become an increasingly popular species. As the demand for it increased, so too did the fishing effort. The total landings in 1960 was 31.17 million pounds; in 1970 it was 34.15 million pounds; in 1980 it was 36.95 million pounds. But to bring about this steady increase in total landings, effort had to increase by almost 300 percent. The Atlantic States Marine Fisheries Commission published a study in 1966 which calculated the relationship of yield to effort to seawater temperature. It found that as seawater temperature dropped, yield dropped, despite a substantial increase in fishing effort. Domestic landings have increased, but other than fishing effort increasing, it is believed that the current higher yield is due to the delayed effects of a seawater warming trend from 1967-1976. It is, however, generally felt that seawater temperature along the Northeastern United States will continue to drop for the next few years. This could result in a significant decline in yield in years to come. Management plans are necessary to prevent a biological overfishing of the stocks during
this upcoming period.

The effect of the proposed lobster management plan on the New Hampshire lobster industry is a hotly debated question among resident lobstermen. There is no doubt that increasing the minimum size of the legal lobster will reduce the total catch. But this will only be in the short-run. It must be kept in mind also, that the Lobster Management Plan applies only to the FCZ and not to waters under state jurisdiction. In 1978, the Northeast Marine Fisheries Board estimated that about 98 percent of New Hampshire's lobster catch came from state territorial waters. It should also be noted that due to seawater temperature and other factors previously cited, the size of the lobsters caught offshore, along the continental shelf, are generally well above the 3 3/16 inch size. The effect on New Hampshire lobsterman would therefore be restricted to those lobsters caught beyond state territorial waters but not as far out as Georges Bank and the continental slope. This take is not more than 30 percent of total landings. Of this 30 percent, it is a small amount that are between 3 1/8 and 3 3/16 inches. The effect of the management plan on New Hampshire with respect to
minimum size criteria will be minimal and short-lived.

The New Hampshire legislature is currently reviewing in committee a proposal for increasing the minimum size of legal lobsters to 3 3/16 inches to comply with the federal minimum size proposal, and to eliminate conflict with the size criteria of its neighbors, Massachusetts and Maine, both of which have 3 3/16 inch regulations. Should such legislation be enacted simultaneously with the federal plan, the effect would be more severe. It is estimated a one-year loss of $430,000 would be incurred. Given, however, the record yield for 1981 and the prediction that this increased yield will continue through 1983 due to the warming trend of 1967-1976, the yield for 1983 under the new size limitation regulations should significantly offset the expected losses.

If size limitations are not raised to coincide with the maturity of lobsters, there can only occur a reduction in the size of the stock. Increasing the minimum size limit to near the size at which the majority of female lobsters are mature will increase the abundance of brood stock and, depending upon the stock recruitment relationship, should increase recruitment.

"Increasing the minimum size limit will not affect an increase in the number of size groups in the exploited..."
phase. The number of size groups present is affected by the fishing mortality rate, given available information on lobster growth and natural mortality rates. So long as the fishery operates essentially on one size group which is subject to natural failure of recruitment, as is presently the case in inshore areas, the stability of the fishery will be threatened. Even with a substantial increase in the minimum size, this aspect of the overfishing problem may continue in the absence of a program to control fishing mortality. The mortality rate of lobster is to be partially controlled in the federal plan through requirements for escapement vents. But more than that is required.

Available information indicates that 20-25 percent of all lobster traps are lost annually. The traps (called ghost pots) continue to fish. While sublegal lobsters can escape through vents and effectively decrease ghost-fishing mortality rates among these smaller lobsters, a problem remains for the larger ones. "The ghost-fishing problem might be resolved by incorporation of a degradable section in the trap construction, which will rot out and liberate all lobsters from lost pots... However, the major portion of damage and mortality among entrapped lobsters occurs during the first 30 days of confinement, and it is important
that the degradable section be short-lived.\textsuperscript{120} Such a plan would certainly improve the mortality rate and thereby serve to increase the stock. Such a plan should be incorporated into any lobster management plan. It is not currently in either the federal plan or state plans.

It is my hope that through this paper one may gain an appreciation for the American lobster, its life cycle and the effect fishing has had on its numbers. But also, it was my purpose to take these numbers as well as other factors and demonstrate the effect a federal management plan would have not only on those numbers but also on the State of New Hampshire and her lobster industry.

It is the purpose of the Federal Fishery Conservation and Management Act to manage fisheries. The Regional Councils propose plans to manage species. The American lobster is considered a single unit. Yet depending upon its particular location and habitat, environmental factors such as seawater temperature cause it to grow and mature at various rates. By establishing a minimum legal size, one is hopefully averaging those environmental factors. To maintain an adequate stock, one
must allow the lobsters to reach maturity. The general consensus is that maturity is achieved when the carapace length is 3 1/2 inches (88.83 mm). Pressure from fishermen seemed to have caused the limit to be placed at 3 3/16 inches (80.90 mm). Whether this is adequate will require close scrutiny. The effect of increasing the minimum length from 3 1/8 to 3 3/16 inches will be minimal and short-lived for New Hampshire lobstermen.

In reviewing the impact of the management plan on New Hampshire, one cannot overlook the boundary controversy with Maine. That conflict grew out of dissatisfied lobstermen. The Supreme Court ruling in 1976 gave a great proportion of the disputed area to Maine. With regard to New Hampshire lobstermen, they are feeling increasing encroachment. First, the State of Maine is awarded fishing area along the boundary which by the traditional "lights on range" had been fished by New Hampshire lobstermen. Second, largely through the efforts of Maine lobstermen, the Regional Council recommended that 3 3/16 inches be established as the minimum legal length. This could, of course, be viewed as a victory for New Hampshire lobstermen because the Board had originally recommended 3 1/2 inches. Third, the requirement that V-notched lobsters not be kept in waters north and east of a particular line was seen as
encroachment. Much of the FCZ fished by New Hampshire lobstermen lies north and east of this line. Maine is the only state which V-notches. Their power as the largest harvester of lobster has overshadowed the New Hampshire lobsterman. And now he sees a proposal in his legislature to increase the minimum size to 3 3/16 inches.

What must be realized by the lobstermen is that the impact of such a new restriction will be relatively small when compared with the long-term benefits that can be gained.

Any management plan must be dynamic, however. The criteria established by the federal proposal are good, but must be continuously reviewed and compared to actual yield figures. Other management methods may be necessary: limiting the number of traps allowed, share certificates and limited access are some examples. The proposed American lobster management plan is a good beginning. Its impact upon the New Hampshire lobster industry will be minimal.
Figure 1: Distribution of the American Lobster

(Source: Doliber, *Lobstering Inshore and Offshore*, p. 4.)
Figure 2: Georges Bank Submarine Canyons

Figure 3: 1974 Boundary Claims by New Hampshire and Maine

(Source: Harrison Workman)
Figure 4: Final Boundary between New Hampshire and Maine

(Source: Harrison Workman)
Figure 5: Exploitation

\[ K = \frac{\alpha}{\beta e} K - \frac{\alpha}{\beta e} K^2 \]

Figure 6: Non-exploitation

\[ K = \frac{1}{e} [\beta - \alpha e] \]

Figure 7: Extinction

\[ K = \frac{\alpha}{\beta e} K - \frac{\alpha}{\beta e} K^2 \]

*(Source: Fullenbaum and Bell, "American Lobster Fishery", Fishery Bulletin, Vol. 72, No. 1, p. 17.)*
Figure 8: The Biological Productivity Curve*

Figure 9: The Sustainable Yield Curve*

*(Source: Cunningham and Whitmarsh, "When is Overfishing Underfishing?", Environmental Management, Sept. 1981, p. 378.)
Figure 10: The Bioeconomic Model

Figure 11: Possible Open-access Equilibrium

*(Source: Cunningham and Whitmarsh, p. 379.)*
Figure 12: Economic Overfishing

(Source: Cunningham and Whitmarsh, p. 380.)
Figure 13: When is Overfishing Underfishing?

(Source: Cunningham and Whitmarsh, p. 382.)
Figure 14: Approximate V-notch Line

(Source: Draft American Lobster Fishery Management Plan, p. 37.)
### TABLE 1

Inferred Values for Expense and Accounting Items for the Inshore Lobster Fisher, 1976*

<table>
<thead>
<tr>
<th></th>
<th>Value ($)</th>
<th>Percent of Total</th>
<th>Average Per Boat ($)</th>
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<tbody>
<tr>
<td><strong>Gross Earnings</strong></td>
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<td>100.00</td>
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<tr>
<td><strong>I. Materials &amp; Supplies</strong></td>
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<tr>
<td>a. Fuel</td>
<td>2,988,120</td>
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<td>b. Bait</td>
<td>5,037,117</td>
<td>11.82</td>
<td>487</td>
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<tr>
<td>c. Other</td>
<td>2,048,996</td>
<td>4.84</td>
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<td><strong>II. Purchased Services</strong></td>
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<td>a. Insurance</td>
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<td>b. Maintenance</td>
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<td>c. Other</td>
<td>145,137</td>
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<td><strong>III. Value Added</strong></td>
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<td>2,725</td>
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<td>a. Payroll</td>
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<tr>
<td>b. Capital Costs</td>
<td>4,465,105</td>
<td>10.46</td>
<td>431</td>
</tr>
<tr>
<td>1. Interest</td>
<td>2,454,527</td>
<td>5.75</td>
<td>237</td>
</tr>
<tr>
<td>2. Depreciation</td>
<td>2,010,578</td>
<td>4.71</td>
<td>194</td>
</tr>
<tr>
<td><strong>IV. Other</strong></td>
<td>294,543</td>
<td>.69</td>
<td>28</td>
</tr>
<tr>
<td><strong>V. Net Profit</strong></td>
<td>5,101,148</td>
<td>11.95</td>
<td>492</td>
</tr>
</tbody>
</table>

*Source: Northeast Marine Fisheries Board's Lobster Management Plan.*
FOOTNOTES


2. Ibid., p. 23.

3. Ibid., p. 23.


5. Ibid., Section 2(b)(3).

6. Ibid., Section 2(b)(4).

7. Ibid., Section 2(b)(5).

8. Ibid., Section 3(2).

9. Ibid., Section 3(4).

10. Ibid., Section 101.

11. Ibid., Section 301(a)

12. Ibid., Section 306(a)

13. Ibid., Section 306(a)


15. FCMA, Section 302.


17. Ibid., p. 2.

18. Ibid., p. 2.

20. Ibid., p. 15.


24. Ibid., p. 113.

25. Ibid., p. 113.


27. Ibid., p. 25.


30. Ibid., p. 27.

31. Ibid., p. 27.

32. Ibid., p. 27.

33. Ibid., p. 27.

34. Doliber, p. 19.

35. Ibid., p. 16.

36. Ibid., p. 17.


38. Ibid., p. 219.

39. Ibid., p. 235.

40. Ibid., p. 235.

41. Ibid., p. 236.

42. Ibid., Vol. II, p. 119.
44. Doliber, p. 20.
45. Ibid., p. 22.
47. Ibid., p. 7.
48. Ibid., p. 7.
49. Ibid., p. 7.
50. Ibid., p. 8.
52. Fish and game figures received from Mr. Brian Doyle, Coordinator, University of New Hampshire Sea Grant Program.
55. Fish and game figures, Doyle.
58. Ibid., p. 78.
59. Ibid., p. 79.
60. Ibid., p. 80.
62. Ibid., p. 57.
64. Ibid., p. 29.
65. Ibid., p. 31.
66. From figures quoted by Mr. Brian Doyle.
67. New Hampshire Fish and Game Regulations-1980, Sec. 211.18.
68. Ibid., Sec. 211.19.
69. Ibid., Sec. 211.23.
70. Ibid., Sec. 211.25.
71. Ibid., Sec. 211.26.
72. Ibid., Sec. 211.27.
73. Ibid., Sec. 211.30.
77. Information provided by Mr. Harrison Workman, Chairman, NH Boundary Commission.
79. Ibid., Vol. 2, p. 197.
80. Ibid., Vol. 2, p. 120.
81. Ibid., Brewster, p. 12.
83. Information provided by Workman.
84. "Supplementary Submissions in Support of House Concurrent Resolution 4", (NH), p. 3.
85. Ibid., p. 5.

87. Ibid., p. 6.


90. Ibid., p. 14.

91. Ibid., p. 15.

92. Ibid., p. 15.

93. Ibid., p. 19.


104. Ibid., p. 1.

105. Ibid., Regulations, Sec. 649.7(a).


109. "Draft...", (August 16, 1982), Regulations, Sec. 649.7(b).


111. "Draft...", (August 16, 1982), Regulations, Sec. 649.7(c).

112. Ibid., Sec. 649.20(d).

113. Taylor, p. 38.
114. "Draft...", Regulations, Sec. 649.7(f).

115. Ibid., p. 38.


118. "Draft...", p. 31.


120. Ibid., p. 93.
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INTERVIEWS

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Mr. Brian Doyle; Coordinator University of New Hampshire Sea Grant Program.

Mr. Wilford LaPage; Seacoast Commissioner of Fish and Game.

Mr. Earl Sanders; wholesaler, retailer and owner of Sanders Lobster Pound, Portsmouth, NH.

Mr. Harrison Workman; Chairman of the NH Boundary Commission.