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## Patterns of Gear Changes in the Maine Fishing Industry

Some Implications for Management

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### Introduction

Many fishermen regularly switch the species they fish. Some fishermen regularly fish for different species with different kinds of gear over the annual cycle; it is a rare fisherman who has not had experience fishing for several different species over the course of his career. Indeed, the difference between financial success and failure in many cases is closely connected with the ability to change species fished as prices or the availability of various fish stocks change. Changing target species is perhaps the most important adaptive strategy used by fishermen. Despite the importance of changing gear and species, the phenomenon is not clearly understood. Fisheries managers think in terms of managing single species, as if the men who are being regulated fish for only one kind of fish. Indeed, the fact that fishermen regularly switch gear and species is obscured by the very language used in describing fishermen. One speaks of 'herring fishermen' or 'lobstermen' or 'scallopers' as if the men exploiting these species have done nothing else throughout their lives. Some men have focused on one species throughout their careers and do, in fact, have operations which would make it difficult to do anything else. The vast majority are not, however, in this position.

For those concerned with the management of marine resources, it is critical to understand the factors promoting or inhibiting changes in fishing gear. After all, the object of regulations is to change fishing patterns, with conservation of over-exploited species in mind. In many cases, this involves promoting a change from one species to another or restrictions on the use of certain kinds of gear. In some cases, management means nothing more than shifting fishing effort from one species to another. In other cases, it means putting people out of business, with all that indicates for social and economic dislocation. In all cases, exactly what will happen depends in large measure on the ability and willingness of fishermen to change gear and species sought. For this reason, an understanding of the factors governing shifting between fisheries is essential for effective and equitable regulations to the promulgated.

In this paper, we will first analyze the patterns of gear changes that have occurred in the fisheries of northern New England between 1973 and 1978 and present quantitative data to identify the factors associated with these patterns of permanent change. Second, data on fishermen's experience, their annual round and career patterns will be presented in an attempt to bring out some of the fun-

damental features — the deep structure so to speak — behind all gear changes. Third, we will analyze the implications for management of the patterns of gear changes observed.

In New England, studies of gear changes are inhibited by the lack of economic information. Fishermen fish for money, and the primary reason they change from one gear to another is to increase profits or avoid losses. Unfortunately, it is impossible to obtain accurate information on revenues, costs, and returns to investment on various kinds of boats and gear configurations at present.<sup>2</sup> However, it was relatively easy to obtain information on the gear changes that were actually made and on the social and cultural characteristics of the fishermen making those changes. From these data we can elucidate not only patterns of gear changes, but also factors explaining those changes. In short, while it was impossible to obtain the cost and revenue figures behind the gear change decisions of individual fishermen, the aggregate patterns are clear enough.

### Methodology

In the summer of 1978, information was gathered from captains of 190 fishing boats in Maine concerning the history of their fishing operations. This sample represents approximately 65 percent of all year-round fin-fishing boats in the area, but only a small percentage of the lobster fishermen. Information was obtained on the personal history of each individual in fishing (age, education, experience, kinsmen in fishing, etc.) and information on changes in fishing operations and fishing equipment between 1973 and 1978 and their plans for the future.<sup>3</sup>

### Permanent Gear Changes in the New England Fishing Fleet

In the 1970's total investment in the fishing fleet of northern New England was expanding. First, there was an increase in the number of boats. In 1974, the Maine Department of Marine Resources listed 104 Commercial Trawlers, Purse Seiners, Gill Netters and Sardine Carriers operating from Maine ports. In 1978, our interviewers found 234 such boats. This increase also occurred in New England as a whole. In 1977 there were 1200 Federal groundfish licenses issued for New England; in 1979, the numbers had grown to 2191 (not all of these boats had home ports in New England, however) (Grice 1980).

Not only were there more boats; they were clearly larger, better-equipped, and had more versatile fishing gear. In 1978 there were 60 fishermen in our sample of 190 who had boats more than six feet longer than the boats they owned in 1973. Only 16 fishermen had boats six feet shorter. The information on boats men planned to build indicated that the strong trend to larger vessels would continue into the early 1980's. In our sample there were 61 fishermen who had ordered larger boats or were planning to do so in the near future. Of these, 43 men had ordered a boat at least six feet longer, while none were planning to build a boat six feet shorter than the one they had at present.

Although versatility is more difficult to measure, there is little question that the fishing fleet in northern New England was becoming more versatile as well. In general, a fishing operation was judged to be more versatile if the data indicated there had been changes in the size of the boat, electronic gear, or fishing gear which would allow the owner to exploit different fishing grounds or more species over the annual round. By these criteria, between 1973 and 1978, 56 percent of the men in our sample had increased the versatility of their fishing operations, while only 8 percent had become more specialized and inflexible. The trend toward increased versatility continued. Sixty-two percent of the fishermen in this sample said they would have fishing operations that would be still more versatile than those owned presently (1978); while only five percent planned less versatile operations (Acheson 1984:Table 5).

The shift to bigger and more versatile boats meant that the fishing fleet of northern New England greatly increased fishing capacity. The critical questions are: 1. Why was there such a strong tendency toward increased capacity? 2. How is that increased fishing capacity going to be used? 3. Were some species slated for a great deal more exploitive effort than they usually receive? Answers to these could be obtained only by looking at the kinds of gear that fishermen were adopting and abandoning since gear is selected with certain target species in mind.

In order to understand the kinds of gear changes that took place, some basic technical knowledge is required. Some gear changes were relatively easily made since the new gear type can be put on the same boat, and used in the same area to fish for the same species. Other gear changes required different sized boats, different skills, and different levels of investment. They mean, in short, a whole change in fishing strategy. The situation is complicated by the fact that the same gear can sometimes be used to catch a variety of different species, and can be used on a whole range of different sized boats involving different levels of investment. Thus, an analysis of changes in fishing gear can only take place against a background knowledge of each gear type, the required level of skill, and the other assets congruent with each gear type.

Fishing success is greatly influenced by several kinds of skills. For our purpose, it is important to know how long it takes a person to learn to use a different type of fishing gear, as opposed to skills in maintenance, crew management, and so on. In assessing the time it takes to use various kinds of fishing gear, we will not assume a person coming from a non-fishing occupation. Rather, we will assume a person has had 5 years experience in lobstering. Most men who enter fishing do enter lobstering first then go on to other things. Men with 5 years experience in lobster fishing have a basic knowledge of navigation, seamanship, maintenance, and related skills. We will describe separately each gear type and the assets (skills, investment) necessary to use it.

*Lobstering.* Lobsters are caught in 3 to 4 foot wooden or wire mesh traps baited with fish remnants. These traps are pulled either by hand or with the aid of a hydraulic trap hauler. Lobster fishing operations vary greatly in size. Many school boys and part-time fishermen go lobstering in the summer with a few

traps which they tend from outboard-powered skiffs. At the other extreme are men who own over 2500 traps which they tend with a large inboard-powered boat over 40 feet long, aided by a three man crew. The average fisherman has between 400 and 500 traps which he tends by himself or with a one man crew in a boat about 34 to 36 feet long. In 1980, such a fisherman might have a total investment of \$60,000 in a boat, traps, pickup truck, and other essential gear. While lobster fishing is not an unskilled occupation, it is relatively easy to enter. Some men have entered lobstering from non-fishing occupations and have done reasonably well in as little as two years.

*Bottom Trawling.* Bottom trawling or dragging is a major technique used in northern New England to catch all species of groundfish (i.e., cod, haddock, hake, pollock, flat fish, etc.). Bottom trawlers operate by dragging a cone-shaped net (otter trawl) through the water, large end first. The mouth of the net, usually 60 to 100 feet wide, is held open by means of heavy 'doors' attached to the sides of the net. Bottom trawling can only be done with relatively large boats ranging from 45 to 110 feet long. In 1978, a medium-sized bottom trawler was about 65 feet long and cost in the range of \$300,000, new and fully-equipped. Dragging is relatively difficult to learn since one has to learn the tows, or smooth places on the bottom where the net can be used without tearing up, along with learning to use a good deal of electronic gear. A man with five years in lobster fishing needs at least two to three years to learn dragging; some men never learn.

*Gillnetting.* Gillnetting is generally done in intermediate-sized boats, between 36 and 60 feet long. The average gillnetter would be about 42 feet long and cost about \$150,000 fully equipped, although many smaller lobster boats are also rigged for gillnetting part of the year. Gillnets are a type of fixed gear. They hang vertically in the water with floats on the top and weights on the bottom. They catch groundfish such as haddock, cod and pollock which swim off the bottom, but not true bottom dwellers such as flat fish. Gillnetting is relatively easy to learn. A man with five years in lobstering can put gillnetting gear on his boat and be reasonably proficient with six months experience.

*Dredging.* Scallops and mussels are caught by dragging a steel dredge along the bottom. The dredge is hauled aboard by steel cable attached to a winch. Dredging is done from a variety of different-sized boats. Many lobstermen rig their boats with boom and winch and go scalloping in the winter inshore with a two man crew. At the other extreme are boats ranging up to 100 feet long carrying 11 to 13 man crews, which take long trips throughout the Gulf of Maine. Such boats can cost more than a million dollars. These large scallop boats are used for off-shore scalloping throughout the year, since scalloping demands permanent changes in the hull (i.e., shucking house), which make it expensive to convert a scallop vessel to any other kind of fishing.

*Weirs.* Weirs are used in eastern and central Maine to catch herring. They are constructed out of poles driven into the ocean floor, between which are strung netting or brush to make the walls. Weirs are set in coves and bays known to be frequented by schools of herring. In 1982 it cost about \$40,000 to construct a weir. The primary skill in weir fishing is knowing where to build the weir. Once

constructed, weirs are relatively easy to learn to use. An experienced lobster fisherman can learn weir fishing in one season — two to six months.

*Stop Seines.* These seines are used to trap schools of herring as they enter coves or bays. After the fish have entered, the stop seine net is drawn across the mouth of the bay, using dories. To enter stop seining, one needs a net between 50 and 300 fathoms long, 'twine dories' to hold the net, and a boat equipped with a hydraulic net hauler. The equipment for an average stop seine operation might be obtained for about \$15,000 to \$25,000. Stop seining is a relatively easy technique to learn. A lobsterman with five years experience can become proficient in two to three months.

*Purse Seines.* A purse seine is a very long, deep net which is set around a school of fish (usually herring) by one or two boats. When the circle is complete, the bottom is drawn up or 'purse' to close the net. Purse seine operations often use small air planes to aid in locating herring schools. In addition, a good deal of electronic gear is increasingly being used to spot fish. The average purse seiner is perhaps 55 feet long and cost in the range of \$350,000 equipped with electronics, net, and seine dory in the early 1980's. Purse seining is one of the most difficult techniques to learn. An experienced lobsterman would require at least two to three years to become reasonably proficient.

*Pair Trawling.* This technique is used to capture adult herring and other schooling species inshore or offshore by having two large boats tow a big net between them. Since two large boats with a lot of electronic gear (e.g. scanning sonar, Loran C plotters, etc.) are involved, pair trawling is one of the most expensive techniques to utilize. In 1978, one set of Maine pair trawlers was valued at over \$1,500,000 for the two vessels. It is also one of the more difficult techniques to learn, since one must coordinate two boats, as well as learn to maneuver a huge net which sometimes catches up to 200,000 lbs. of fish in one tow. A lobsterman would need at least two to three years to become a proficient pair trawler.

*Longlines.* Longlines, as the name suggests, are long ropes from which baited hooks are suspended. They are used in two distinct fisheries. Small longlines, called tub trawls, are set along the bottom to catch groundfish. Such lines are only a few hundred feet long and are generally pulled with a small hydraulic winch and baited by hand. Tub trawling is generally done by lobstermen during the spring. Longlines are also used by three large offshore vessels, which dock part of the year in Maine, to catch swordfish far out in the Gulf of Maine. These boats carry crews of five or six men and range from Newfoundland to Florida. Tub trawling is relatively easy to learn and enter; longlining for swordfish requires at least two years to learn and a boat worth at least \$250,000.

*Harpoons* are used primarily in the summer tuna fishery. Most of the men involved in this fishery go for lobster through most of the year. Thus, it is essentially a small boat, inshore fishery.

*Handlining.* In eastern Maine, there are a number of men who catch groundfish from very small boats and skiffs with lines on which a few baited hooks are attached. This is a summer fishery engaged in by part-time fishermen. Entry into handlining involves only two or three thousand dollars investment. It is very easily learned as well.

**Scottish Seine.** These seines are very long nets placed in a circle around a promising piece of groundfish bottom and slowly winched into the boat. In the early 1980's they were an experimental groundfish gear in Maine; only one was in use. Their use necessitates a boat at least 45 feet long and costing over \$120,000 fully equipped.

**Herring Carriers** are large wooden boats owned by herring processing firms to bring the herring from seines, weirs, etc. to the plant. Some double as purse seiners.

**Midwater Trawls** are used on very large vessels to catch fish in the water column. The nets in use are essentially the same as those used on pair trawlers, save for the fact they are smaller and towed by one boat. Midwater trawlers are a minimum of 65 feet long and cost in excess of \$300,000 fully rigged.

At present, a great deal of gear change is occurring. There were some general patterns in the changes being made, however. These are summarized in Figure 1.

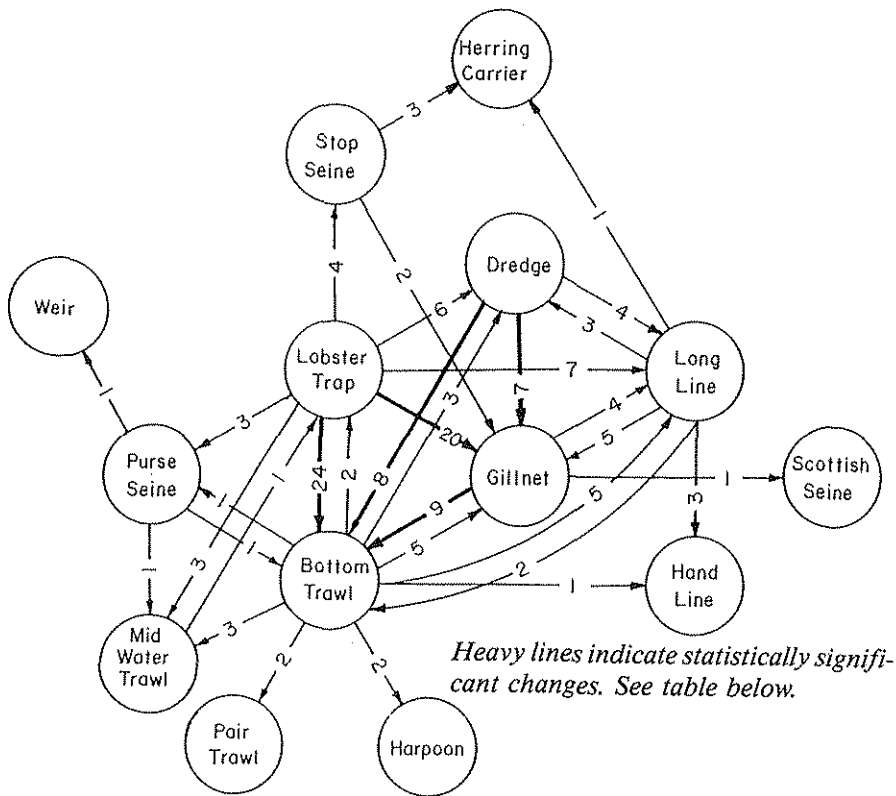


Figure 1. Primary Fishing Gear Changes of 190 Fishermen in Northern New England: 1973-1978

Supplement to Figure 1.

Lobster - - - Bottom Trawl	Bottom Trawls - - - Midwater Trawls
24/2	3/0
.39/.05	.04/-
.00001	
Lobster - - - Gillnets	Bottom Trawls - - - Dredge
20/0	8/3
.30/-	.35/.06
	.01
Lobster - - - Longlines	Bottom Trawls - - - Gillnets
7/0	9/5
.08/-	.30/.08
	.02
Lobster - - - Dredge	Bottom Trawls - - - Longlines
6/0	2/5
.08/-	.10/.08
	.70
Lobster - - - Stop Seine	Dredge - - - Longlines
4/0	3/4
.04/-	.15/.20
	.70
Lobster - - - Purse Seine	Dredge - - - Gillnet
3/0	7/2
.03/-	.35/.01
	.01
Lobster - - - Midwater Trawls	Longline - - - Handline
3/1	3/1
.33/.03	.14/.5
.40	.50

Which of the kinds of changes indicated in Figure 1 are statistically significant, and which might have occurred by accident, given the number of fishing boats represented in our sample? To answer this question, a test of significance was done on the ratio of the people switching between two gear types, and the results are reported in the supplement to Figure 1. In this supplement, three different kinds of figures are listed for every gear change in Figure 1: the numbers of fishing operations which changed between a pair of gear types (in both directions); the proportion of people capable of making the change who actually did so; and the level of significance of these two ratios, indicating the direction of gear change. If we consider, for example, the change from dredge to bottom trawl, there were eight fishing operations in which a change was made from dredges to bottom trawls, and only three cases where men changed from bottom trawls to lobster traps. The figure .35 indicates that 35 percent of all of the men in our sample who could have changed from dredges to bottom trawls did so;

while only 8 percent of those who could have changed the other way actually did so. The level of significance of this ratio (i.e., 8/3) is .01 so that there is only 1 chance in 100 that these results could have occurred by chance alone. These figures indicate that where these two gears are concerned, there is a strong tendency to change from dredges to bottom trawls.

While there are a good many different kinds of changes recorded in Figure 1, most of them involve so few fishing operations that they are statistically insignificant. In these cases, nothing certain can be said about general trends, given our data base.

However, the data do show several different gear change trends. There is unquestionably a shift from lobster fishing to other fisheries. Some 24 men changed from lobstering to bottom trawling, while only two switched the other way. The results are significant at the .00001 level, so that there is only 1 chance in 10,000 that these results could have occurred by accident. There were 20 men who changed from lobster fishing to gillnetting and none who went the other way. Smaller numbers of lobster fishermen went to longlines, dredges, and stop seines; even smaller numbers changed to purse seiners and midwater trawls. While the numbers involved in these gear switches are very small, it should be noted that in every case the shift was out of lobster fishing; none of the longliners, dredge fishermen, seiners, or midwater trawlers switched into lobstering. There was a significant shift from dredge fishing to bottom trawls and gillnets. And there was a shift from gillnets to bottom trawls that was significant at the .02 level.

Three things do not show in these figures which are important. 1. There was no instance in our sample where men switched from a non-fishing job to become captains of boats whose primary gear was a bottom trawl, pair trawl, midwater trawl, or purse seine. Very few men have entered such fisheries from lobstering either. 2. Very little gear is being dropped completely. When fishermen buy new boats and change gear types, the gear they had on their older boat is retained as a secondary or tertiary type of gear. 3. The gear most commonly dropped was lobster traps. There were 54 fishing operations in which one type of fishing gear or another was dropped. In 27, or 50 percent of the cases, lobster traps were being abandoned.

In this whole data set, there are five critical questions:

1. Why haven't men entered pair trawling, purse seining, or bottom trawling from non-fishing occupations? In a similar vein, why have so few men entered such fisheries from lobstering?
2. What factors have caused switch out of lobstering to virtually every other kind of fishing — especially groundfishing?
3. What is the difference between fishermen who have shifted out of lobstering to bottom trawling as opposed to gillnetting?
4. Why is there a general shift from dredging to bottom trawling?
5. Why are groundfishermen shifting from gillnets to bottom trawling?

The answer to the first question is relatively clear and relates to the investment and amount of experience required. To enter fisheries where bottom trawls, pair

trawls, or similar gear are the primary gear requires a boat worth a minimum of \$100,000 and several years of experience. A person usually enters these fisheries by working on a large fin-fishing boat for a period of years and then buying his own boat or by first entering lobster fishing and then gradually entering other large scale fisheries.

The reasons that men were shifting out of lobstering to gillnetting and bottom trawling (questions 2 and 3) deserve careful consideration, since they involved the most fishermen in our sample and the clearest trends in the whole data set.

The reason fishermen were leaving lobstering in large numbers was related to economic conditions in the fishery. Revenue to lobster fishermen as a whole was fairly stable while their costs had increased dramatically. At the same time, net revenues to groundfishermen had increased, making this a far more attractive option.

The lobster catch remained fairly stable between 1976 and 1979. In 1976 the catch was 19.0 million pounds and in 1979 22.1 million pounds. In the 1980's the catch stayed about the same and in the future it will probably remain constant or drop. The biologists most familiar with the lobster industry are relatively certain that all of the lobsters that can be caught are already being caught. In fact, over 90 percent of the lobsters that molt into the legal size are caught within a year (Thomas 1973:47). There are fears that an increase in fishing effort may result in stock failure. In the late 1970's, the prices paid for lobster rose, but relatively slowly.<sup>4</sup> Since *both* catches and prices remained relatively stable during this time, the total value of the lobster catch has increased relatively slowly. In 1974 the total value of Maine lobster landings was 23.2 million dollars; in 1978 the value was 33.8 million dollars, an increase of 45 percent. Despite this increase, costs to fishermen for bait, fuel and boats went up so fast that many fishermen stated they were experiencing real financial difficulties. From the little solid financial data we were able to collect, it appeared that many lobster fishermen had no more purchasing power in 1979 than they had in 1974. Some were experiencing a decline in real income.

At the same time, there was a very large substantial increase in the catch and value of groundfish. In 1974, the total landed value of six common groundfish species was 1.3 million dollars; in 1978, it had increased to 7.2 million dollars, a phenomenal 453 percent rise (Anonymous 1980).<sup>5</sup>

The reason that lobster fishermen are switching to groundfishing in large numbers is relatively apparent. However, the factors impelling some of these men to catch groundfish with gillnetting equipment as opposed to bottom trawl are more difficult to ascertain — particularly since fishermen themselves are not able to give any clear consensus about the factors influencing the choice of groundfishing gear. Two interesting facts did emerge on men moving to groundfishing. The men who adopted bottom trawls were younger than the men who adopted gillnets, and they purchased much larger boats than the men who had moved from lobstering to gillnetting. The men who adopted bottom trawls had a mean age of 32.7 years while those men who adopted gillnets had a mean age of 38.3 years. The men who adopted bottom trawls purchased boats which aver-

aged 10.8 feet longer than the boats they had five years previously. The gillnetters had boats which were far smaller. The results of the t-tests indicate both these differences in means are highly significant statistically.

These facts alone tell very little about the reason men adopted gillnets as opposed to bottom trawls. However, we constructed a very elaborate linear model in which information on the adoption of these two kinds of fishing gear was regressed on a subset of 39 independent variables. The results of these regressions in combination with the descriptive statistics reveal some very interesting patterns concerning the choice of gear type.

The adoption of gillnets after having had lobster traps was positively associated with the age variable, with medium-sized firms, and with having a groundfish dealer in one's home port. It was negatively associated with having groundfish as the primary target species and with the western part of the coast. Bottom trawls, by way of contrast, were linked to intermediate-size firms and membership in a fisherman's political lobbying organization. The adoption of this gear was negatively associated with the intermediate skill variable and with having a large number of kinsmen in fishing in one's home port, which means that men were more likely to adopt bottom trawls if they were less experienced in fishing and have few relatives in fishing (Acheson 1980:477).

There is a pattern in these facts but one that only becomes clear against a knowledge of the ethnography of the fishery. Gillnets are an intermediary gear. They can be used on relatively small boats (in the 35 foot range), and in 1985 a person with such a boat could get into gillnetting with as little as \$14,000 additional investment. Many of the men who adopt them wanted to switch out of the failing lobster industry for part or all of the year, but could not or were not willing to switch completely into other fisheries requiring far more capital and skill. These people were primarily lobster fishermen and did not have groundfish as their major species over the annual cycle. They wanted to keep their lobster boats so they could switch into that fishery in the late summer and fall. Many of these men were older fishermen — in their late 40's or 50's — who were past their prime and who wanted to fish inshore so they could be home every night.

Bottom trawling ordinarily requires a larger investment and a much larger boat than gillnetting. One cannot do bottom trawling for groundfish with a boat that was made essentially for lobstering. It requires a boat at least 45 feet long — some 10 feet longer than a typical lobster boat. Thus bottom trawling involves a much higher investment — a minimum of \$150,000 in 1978 — and a far more serious commitment. The men who switched to bottom trawling from lobstering were apt to be younger men in the prime years of their career. If they had a relatively low level of experience and skill in the industry, they had the drive and ambition to make a major change in fishing technique and assume a much larger financial burden, with all that indicates for having to put in much longer hours and spend much more time away from home.

It should be noted that men picking gillnets or combining gillnets and lobstering are essentially placing a relatively low ceiling on the income they can earn. After all, one can only pull some 25 standard gillnets in a long day, and perhaps

some 250 lobster traps. Since the number of nets and traps that can be pulled is strictly limited, the amount of income that can be earned is limited as well. If bottom trawling gear demands larger boats and longer periods of time spent away from home, such businesses are capable of absorbing much more capital, and generating much more revenue.

In answer to question four, there was also a statistically significant shift from dredges to both bottom trawls and gillnets even though only a few boats were involved. Virtually all of the boats using dredges were owned by men from the eastern part of Maine who used to fish primarily for lobster. These men fished for lobster in the late summer and fall and then for scallops from November to April (the legal scallop season) to augment the income they received from the failing lobster fishery. Scallops, however, proved to be a very unstable source of income for these men. In the late 1970's and early 1980's the price for scallops has been very high, but the scallop beds were being depleted. As a result, these men found themselves shifting between the lobster industry, which was not doing very well, to scallops which were becoming scarcer as well. Thus, these men were changing from scallop dredging to groundfishing as a means of entering a more stable and profitable fishery.

Why did some of these ex-scallop fishermen choose gillnets as opposed to bottom trawls? The evidence suggests that the exact same factors impelling men to shift from lobstering to gillnetting as opposed to bottom trawling was influencing the choice of groundfishing gear for those men who left scallop dredging. In this regard, we note that the average age of the men who switched from scallop dredging to bottom trawling was only 34.7, while the average age of the ex-scalloppers who adopted gillnets was 39.7.<sup>6</sup> Here again, gillnetting, which can easily be combined with inshore lobster fishing, was more appealing to the older men. The younger men preferred to enter dragging (bottom trawling), which clearly is a technique with more potential for a man thinking of getting a much bigger boat and expanding his business. Interesting enough, while the men who entered bottom trawling from scallop dredging all said they planned to purchase much larger boats, there was no statistically significant difference in the length of the boats they purchased as compared with those of men who left scalloping for gillnetting. Both sets of men purchased boats that were between 6 and 6.5 feet longer than the boats they had when scalloping.

The fifth question concerns the men who switched from groundfishing with gillnets to bottom trawls. All nine of the men who made this switch began their careers in lobster fishing and then began to do some gillnetting. By 1973, gillnets had become the major type of gear these men used, although most of them were still involved in lobster fishing at some time in the annual cycle. By 1978, these men had become full-time groundfishermen and had taken on larger boats equipped with bottom trawls. Between 1973 and 1978, when these men changed to bottom trawls, the boats they purchased increased an average of 9.57 feet, and involved much more money invested. Like the men who switched to bottom trawls from other gear types, the men changing to this gear type from gillnetting were relatively young. Their average age was 32.1. Again these are men who want-

ed to increase their incomes from fishing. For them, bottom trawls were the ultimate gear. If they required large boats and an enormous investment, they were capable of catching very large amounts of fish and producing large revenues as well.

### Other Factors Influencing Choice of Gear

Permanent changes in fishing gear are related to three sets of factors. The first are economic factors making one fishery more lucrative than another. As we have seen, at the time our study was done, there was a tendency to switch out of lobster fishing, which was troubled economically, into various kinds of fin-fishing, which were much more lucrative. This set of changes were paralleled by an increase in both the size and versatility of the boats – again for economic reasons.

Second, skill and experience play such a critical role in fishing success (Acheson 1975) that men do not suddenly throw over a gear with which they are familiar to take on one with which they have no experience or familiarity. Virtually all of the men who made changes in primary fishing gear have some experience with that gear. In many cases, changes in primary gear occurred as an outcome of changes in the annual round. That is, men first used a new gear for a few weeks or months at some season of the year, and gradually increased the percentage of time that gear was used until it became the primary gear. In the process they might have dropped their old primary gear completely, or they might have continued to use it for part of the annual cycle as a secondary gear. In studying present, past, and future primary fishing gear of the 190 fin-fishermen in our sample, the role of experience is very obvious. These data are summarized in Table 1. Of captains of fishing boats who switched to a new primary gear, only 7, or 7 percent, of the 99 men on whom we have information had no experience with that gear before using it on their present boat. The other 93 percent did. Much the same pattern could be observed among the men who had ordered or had definite plans to order new primary gear in the near future. Forty three of the 53 men (or 81 percent) on whom we had information had had experience with the new primary gear they planned to add. Only two men, or 4 percent, had ordered a new type of primary gear with which they had had no personal experience. It should be noted in Table 1 that most of these fishermen got their experience with a new primary gear type by using it during some part of the annual cycle on their own boat. This underlines the fact that in the fin-fishery of Maine, gear changes over the annual round are often precursors of permanent changes in fishing gear.

There is still a third factor strongly influencing selection of boats and types of fishing gear – namely one's age and total career pattern. The vast majority of fishermen in Maine begin their fishing careers by going lobster fishing in skiffs as teenagers. In their early 20's most of these boys buy inboard-powered fishing boats and begin to build up large 'gangs' of lobster traps. A few of these men decide to enter various kinds of fin-fishing – usually in their twenties or

Table 1. *Fishing Experience and Primary Gear Type on Past, Present, and Future Boat.*

	Source of Experience	No.	Total
Same Gear on Past and Present Boat	–	80	80
New Primary Gear in Past Five Years	Used gear during part of annual cycle on own boat	58	
	Used gear while working on other man's boat	34	110
	No experience	7	
	No information on source of experience	11	
Planned New Primary Gear	Experience with gear during some part of annual round on own boat	27	
	Experience with gear while working on other boat	16	59*
	No information on experience	6	
	No experience with gear	2	

\* Of the total 190 men in the sample, only 59 definitely planned to switch primary gear types in the near future.

early thirties. (Very few fishermen change from lobster fishing to fin-fishing late in life.) Whether these men choose fin-fishing or lobster fishing, their operation is at its maximum size when they are in their thirties and early forties. By their late forties and early fifties, these fishermen typically begin to reduce their effort and scale of operations. Older lobster fishermen begin to pull fewer traps. Fin-fishermen tend to reduce the number of days they fish; they might also purchase a smaller boat – one which will allow them to go day-tripping and avoid long stays away from home. Late in life, all of these fishermen might have only a small string of lobster traps which they fish from a skiff as they did when they were boys.

We have already noted the effect of age on the decision to enter various types of groundfishing from lobster fishing or dredging. We have noted that older men wishing to enter fin-fishing chose gillnets which would allow them to avoid heavy investments and a lot of time away from home.

Men who decided to switch from lobstering or a combination of lobster fishing and dredging when they were in their twenties or early thirties ordinarily chose to catch groundfish with bottom trawls. It should be noted that virtually all the men in Figure 1 going back to lobstering from various kinds of fin-fishing

were older men who were essentially retiring.

There is a marked gear hierarchy that is apparent in the kinds of changes the men in our sample made. If fishermen are going to change gears, there are certain paths they must take. Some gear types require little investment or skill, e.g. lobstering, stop seining, etc. Others, such as pair trawling and purse seining, require a great many assets to enter. As a result, men tend to first enter lobstering, and many go no further. Some go on to use intermediate gear types, such as gillnets, stop seines, or scallop dredges. In many cases these are combined with lobster fishing at some time during the annual round. A very few men enter fisheries such as pair trawling and purse seining. Most of those who made this type of move have had experience in using some intermediate type of gear or in bottom trawling. These 'ultimate' gear types require very large boats and a large investment. Very little can be said about the characteristics of the men who entered these high investment fisheries, since there are so few cases that statistical reliability is impossible. However, our case study data indicate that these men have relatively high incomes, and a great deal of prestige in the fishing community.

The problems in the lobster fishery such as relatively low prices had to be faced by all the men in that fishery; and the opportunities in groundfishing were again theoretically available to all who entered that fishery. Yet only some lobster fishermen changed to groundfishing. It is one thing to want to respond to a new opportunity; it is entirely another to have the ability to do so. Two other factors influenced the ability of lobster fishermen to enter groundfishing. The first is access to markets. There are only 17 harbors in Maine which had a groundfish dealer at that time, and the lobster fishermen who switched to groundfishing were located in or near those ports. The second is ability to raise the necessary capital. For a lobsterman to enter groundfishing necessitates a larger vessel and sizable amounts of capital. Much of the money for new boats and equipment came from the Farm Credit Service. Many of the lobstermen who wanted to enter groundfishing did not have the kind of business 'track record' required for large loans and were forced to remain in the lobster industry.

The kinds of factors that motivate men to switch fisheries are probably unique to each time, place, and the fisheries involved. As we have seen, in a shift from lobstering to groundfishing in the late 1970's, experience in using groundfishing gear, the age of the fisherman, and related career-cycle factors, ability to get large amounts of capital and access to groundfish markets were all critical in influencing the decision to switch. If the switch had been in the opposite direction, none of these variables would have been of key importance. The typical groundfisherman could sell his dragger or gillnetter, buy a lobster boat and have money left over; there are lobster dealers and cooperatives in every harbor; almost every fisherman has some experience lobstering; and age is no obstacle to entering the lobster fishery. However, the lobster fishery is highly territorial, whereas no territories exist for groundfishermen. That is, people do not go lobster fishing without becoming members of 'harbor gangs' (i.e., groups of men fishing from each harbor) and once one is admitted to such a group, he only goes lobster fishing in the territory of that 'gang' (Acheson 1979:261-63). Anyone seeking to enter

the lobster fishery would have to take this factor into account.

### Management Implications

Fisheries managers attempt to control fishing effort on over-exploited species through regulations controlling fishing effort. Emphasis is placed on controlling the exploitation of single species as if the fishermen exploiting that species can and will do nothing else. This, of course, is not true. Changing fisheries is one of the most common adaptive strategies fishermen employ. This means that regulations to reduce effort on a given species often means nothing more than shifting that effort to other fisheries which can cause problems in those fisheries in the future. In the recent past, managers have come to understand that stocks cannot be managed separately. What has not been fully appreciated is the role of fisheries switching in multi species management. In contemplating restrictions on effort, managers must ask where the displaced boats and fishermen will go. Will they remain in the same industry and accept lower incomes? Will they go out of fishing altogether? Are there other fishing opportunities they are in position to take advantage of? If such opportunities exist, one can expect a substantial number of the men and boats to respond to them. The situation in the Maine fishing industry in the late 1970's points out that even when there are clear economic advantages to be gained by changing fisheries, such a large number of factors is required for successful business, that only a certain percentage of all the fishermen who could benefit from a given switch in fisheries are in a position to make it. The need for capital restricted some lobster fishermen who wanted to switch to groundfishing. Others were not near the 17 groundfish dealers and thus were deprived of markets. Still others did not have the requisite skills. In 1978, only 25 percent of all the fulltime lobster fishermen in Maine switched to some other species over the annual round (Acheson et al. 1980:Table 13); and only 156 of the approximately 2200 full time fishermen had experience with groundfishing over the annual round. Even though groundfishing was a desirable switch for many lobster fishermen, the ground fishery was in no danger of being overwhelmed by lobster fishermen we can see in retrospect.

The number of people in a fishery who can switch gears and species (and thus shift effort from one species to another) can be calculated by figuring out the economically advantageous switches; ascertaining the things one needs to control for a viable business; and then calculating the numbers of fishermen who could possibly make the switch. This might be a very useful exercise for those who wish to manage one fishery and avoid damaging others.

### Notes

1. James Acheson is Professor of Anthropology at the University of Maine, Orono, Maine. The data on which this paper is based was collected as part of a project entitled "University of Rhode Island, University of Maine Study of Social and Cultural Aspects of Fisheries Management in New England Under Extended Jurisdiction." (N.S.F. Project Number: AER77006018.) The author is

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2. From 1973 to 1975, the Internal Revenue Service audited the income tax returns of a very large number of fishermen – particularly in Maine and New Hampshire. Many were fined, and some brought to court on criminal charges. From that time, anyone asking questions on economic matters has been very suspect.

3. The data from this study were coded by the interviewers who collected the information, and keypunched and analyzed at the University of Maine computer center. Several different statistical techniques were used. In studying changes in boat length, versatility, and patterns of changes in gear, simple cross tabulations were used primarily. In order to explain certain relationships between social and economic characteristics and adoption of certain kinds of fishing gear, primary reliance was placed on regression analysis.

4. The reasons the ex-vessel price of lobster has not risen as fast as the general level of prices is clearly due to income elasticity. The income elasticity of demand for lobster is a very high .86 (Acheson and Reidman 1980). What this means is that if real income falls, lobster prices will fall also. Of course, given the general level of inflation in the past few years, real income of most American families has fallen. Under these conditions, it is not surprising that the price of lobster has not kept pace. Exactly what underlies this phenomenon is not completely clear. Many people connected with the lobster industry and restaurant business guess that lobster is treated as a luxury item – one that consumers can do without in periods when they feel their budgets tightening.

5. It is clear in retrospect that these increases in catches were due more to an increase in the stock of fish rather than to increase in total fishing effort. The increase in the supply of fish did not bring a corresponding decline in price. Quite the contrary. The price of fish remained very high throughout this period, due primarily to the fact that prices of beef, pork and other substitutable goods were at an all time high. As a result of good catches and high prices, gross revenues to fishermen were very high as well.

6. These differences in mean ages are highly significant statistically. The value of the t was 4.77, which is significant above the .001 level.

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