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# Bulletin of the Fisheries Research Board of Canada

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# The Lobster Fishery of the Maritime Provinces: Economic Effects of Regulations

A Gordon DeWolf



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**THE LOBSTER FISHERY**  
**OF THE MARITIME PROVINCES:**  
**ECONOMIC EFFECTS OF REGULATIONS**

Bulletins are designed to assess and interpret current knowledge in scientific fields pertinent to Canadian fisheries and aquatic environments. Recent numbers in this series are listed at the back of this Bulletin.

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BULLETIN 187

# The Lobster Fishery of the Maritime Provinces: Economic Effects of Regulations

A. Gordon DeWolf

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DEPARTMENT OF THE ENVIRONMENT  
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# CONTENTS

<b>ABSTRACT</b>	<b>viii</b>
<b>RÉSUMÉ</b>	<b>ix</b>
<b>INTRODUCTION</b>	<b>1</b>
<b>DESCRIPTION OF INDUSTRY</b>	<b>4</b>
Primary Sector	
Secondary and Tertiary Sectors	
<b>BIOLOGICAL ASPECTS OF FISHERY</b>	<b>9</b>
Lobster Stocks	
Natural Mortality	
Growth	
Exploitation	
Regulations	
<b>HISTORY OF LOBSTER FISHERY REGULATIONS</b>	<b>15</b>
Conditions Prior to Regulations	
Early Attempts at Regulating the Fishery	
Decreasing Production	
The Interwar Period	
Post World War II Developments	
<b>THEORETICAL ASPECTS</b>	<b>29</b>
Demand	
The Enterprise	
The Fishery	
Management	
<b>ECONOMIC EFFECTS OF REGULATIONS</b>	<b>39</b>
Technology	
Production	
Productivity	
Net Economic Yield	
Income	
Investment	
Employment	
Ownership and Scale of Operations	
Mobility	
Other	
<b>CONCLUSIONS</b>	<b>53</b>
<b>ACKNOWLEDGMENTS</b>	<b>55</b>
<b>REFERENCES</b>	<b>56</b>

## ABSTRACT

DEWOLF, A. G. 1974. The lobster fishery of the Maritime Provinces: economic effects of regulations. Bull. Fish. Res. Board Can. 187: 59 p.

The Maritime Provinces' lobster fishery is one of the oldest continuously managed fisheries in Canada, 1973 marking the 100th anniversary of the first regulation. For most of this period, regulations were formulated that purported to accomplish numerous, often conflicting, objectives. The one objective that was most consistently advanced was the biological concept of conservation. Recently, regulations have been introduced based on economic principles.

Regulations that prohibit the capture of egg-bearing female lobsters, the retention of small lobsters, and permit fishing for only a short time each year, have been and are sometimes upheld as conservation measures. A review of the biological aspects of the lobster fishery reveals that there are some serious doubts as to whether these regulations have achieved their objective.

Conservation, as an end in itself, is not a valid objective for fishery management. Management goals must be related to the users of a resource, whether they be producers or consumers. In this respect, economic analysis can give guidance in formulating objectives for fishery management. Consequently, a chapter on the theoretical economic basis of fishery management has been included and an attempt made to apply these principles to the lobster fishery.

This Bulletin attempts to examine the biological and economic bases of lobster fishery regulations. To give perspective and to analyze the effects of regulations, a chapter on the history of regulations has been included. It becomes obvious from the history that other factors, such as the common property nature of the fishery and economic conditions outside the industry, have probably been more influential than regulations in the evolution of the fishery to its present-day structure.

The crux of the book is the chapter on the economic effects of regulations. In it, using data that do exist, the theoretical model, and such insights as can be gleaned from history, an attempt is made to analyze the effects of regulations. The criterion used is efficiency. The conclusion is that regulations have led to economic inefficiencies but that some of the most recently introduced regulations (trap limits and license limitation) could, if properly implemented and administered, lead to increased benefits through greater efficiency and increased returns to factors of production that have been lost because of the common property nature of the fishery.

This Bulletin is by no means definitive and the frustration of attempting to analyze effects using incomplete and possibly unreliable data is obvious. Scientific economic analysis has been avoided in favor of a more general approach.

## RÉSUMÉ

DEWOLF, A. G. 1974. The lobster fishery of the Maritime Provinces: economic effects of regulations. Bull. Fish. Res. Board Can. 187: 59 p.

La pêche du homard dans les Provinces Maritimes est l'une des plus anciennes pêcheries canadiennes à avoir été l'objet d'une gestion continue, 1973 marquant le 100<sup>e</sup> anniversaire de la première réglementation. Pendant la plus grande partie de cette période, on a fait des règlements, ayant en vue divers objectifs, souvent contradictoires. L'objectif le plus souvent mis de l'avant était relié au concept biologique de la conservation. Récemment, on a introduit des règlements basés sur des principes économiques.

Les règlements qui interdisent la capture des femelles œuvées et la rétention des jeunes homards, et qui permettent la pêche pendant une courte période seulement chaque année ont été, dans le passé, et sont encore parfois considérés comme mesures de conservation. Une revue des aspects biologiques de la pêche du homard nous fait douter sérieusement que ces règlements aient atteint leur but.

La conservation, comme telle, n'est pas un objectif valable dans la gestion d'une pêcherie. Les objectifs de la gestion doivent tenir compte de ceux qui font usage de la ressource, qu'ils soient producteurs ou consommateurs. Sous ce rapport, une analyse économique peut aider à formuler les objectifs de la gestion d'une pêcherie. C'est pourquoi nous consacrons un chapitre aux principes économiques qui sont à la base de la gestion des pêches, principes que nous tentons d'appliquer à la pêche du homard.

Ce Bulletin veut analyser les fondements biologiques et économiques de la réglementation de la pêche du homard. Afin de donner à ce travail une certaine perspective et de mieux faire comprendre les effets de la réglementation, nous consacrons un chapitre à l'historique de la réglementation. On se rend compte, à la suite de cet historique, que d'autres facteurs, tels le caractère de propriété en commun de la pêcherie et les conditions économiques en dehors de l'industrie, ont probablement eu une plus grande influence que la réglementation sur l'évolution de cette pêcherie et ont contribué davantage à lui donner la structure qu'elle a aujourd'hui.

Le point capital de l'étude est le chapitre sur les effets économiques de la réglementation. Dans ce chapitre, utilisant des données disponibles, un modèle théorique et tout indice que peut nous fournir l'histoire, nous tentons d'analyser les effets de la réglementation. Le critère utilisé est l'efficacité. On en vient à la conclusion que la réglementation a engendré l'inefficacité économique, mais que quelques-uns des règlements récemment introduits (limite des casiers et du nombre de permis) pourraient, s'ils sont adéquatement mis en vigueur et administrés, résulter en des bénéfices accrus, par suite d'une plus grande efficacité et en de plus grands bénéfices aux facteurs de production, bénéfices qui ont été perdus à cause du caractère de propriété en commun de la pêcherie.

Ce Bulletin est loin d'être définitif, et on comprend facilement qu'il est plutôt décevant d'essayer d'analyser les effets de la réglementation, lorsqu'on n'a à sa disposition que des données incomplètes et possiblement peu fiables. Nous avons opté pour une méthode d'attaque générale de préférence à une analyse économique scientifique de la question.

## INTRODUCTION

Lobster is the most valuable fishery species landed in the Maritime Provinces. In 1971 the landed value was close to \$29 million, over double that of the next most valuable species (scallops) (Dep. Environ. 1972, table 16). The importance of the lobster fishery varies considerably from one province to another. In 1971 lobsters represented 57% of the total landed value of all species in Prince Edward Island, 30% in New Brunswick, and 31% in Nova Scotia (Dep. Environ. 1972, table 16). During 1970, 88% of all commercial fishermen in Prince Edward Island participated in the lobster fishery, 66% participated in New Brunswick, and 68% in Nova Scotia (Dep. Environ. 1972, table 40, 42). Many inshore fishermen depend almost entirely upon the lobster fishery for their livelihood, and failure of this fishery would have serious economic and social consequences.

The lobster fishery is characterized by low average incomes, a rate of exploitation perhaps unequalled in any other Canadian fishery, more

capital than is needed to produce the annual output, seasonality in both fishing and processing, and a virtually unchanging technology. Many of these characteristics result from the nature of the fishery but some result from the regulations controlling it.

Regulations, under control of the federal government, have evolved over the past century and have been introduced to achieve various objectives — biological, economic, social, political, and administrative. *Lobster Fishery Regulations*, discussed in greater detail in the following chapters, define 10 inshore lobster fishing districts, 1 offshore district, 3 minimum carapace length size limits, and 7 open seasons in the Maritime Provinces. These are shown in Fig. 1 and 2. Figure 3 shows the maximum and minimum number of lobster traps that can be fished from a class "A" vessel. In lobster fishing in the Maritimes only conventional wooden traps can be used. Regulations prohibit the capture of female lobsters carrying eggs and require lobster

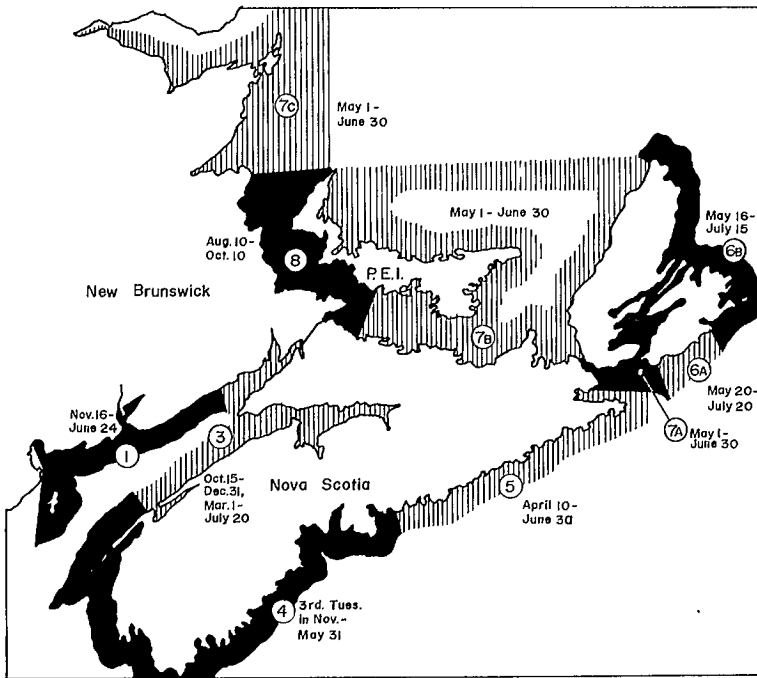


FIG. 1. Lobster fishing districts and open seasons in effect in 1971.

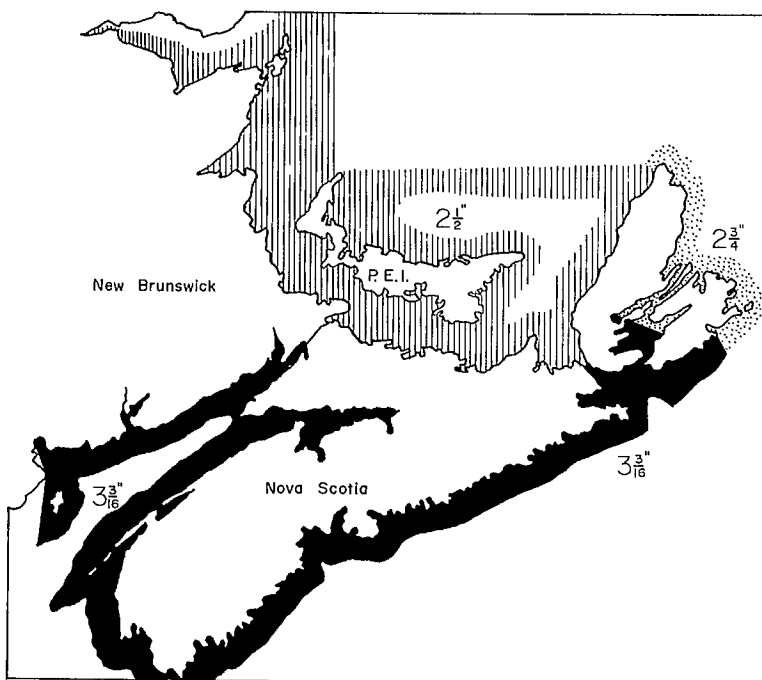


FIG. 2. Minimum carapace length size limits in effect in 1971.

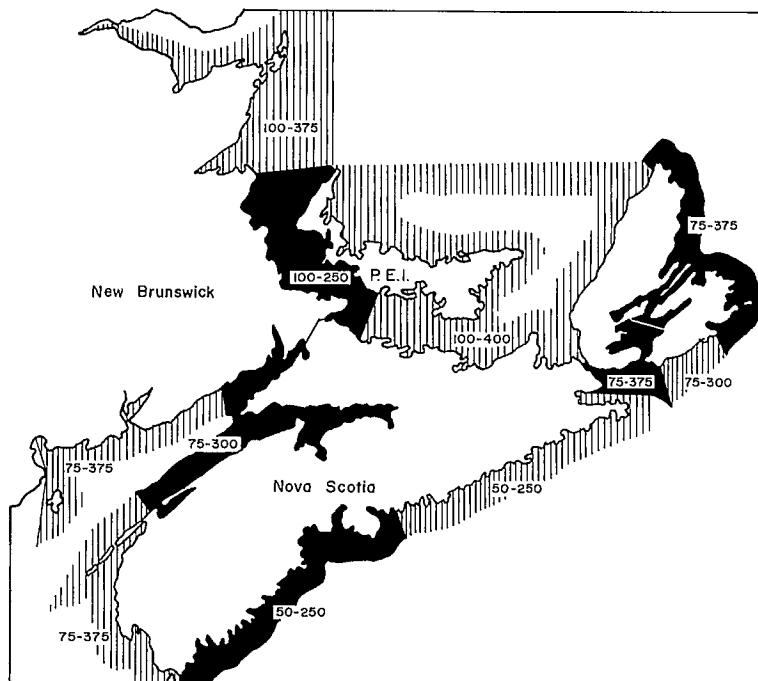


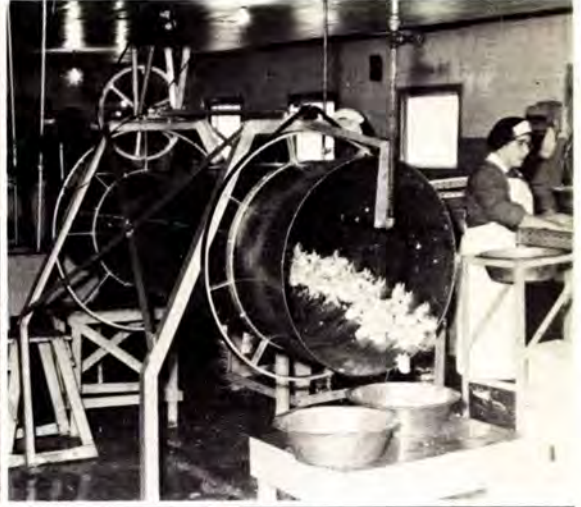
FIG. 3. Minimum and maximum trap limits for "A" class vessels in effect in 1971.

pounds (holding units) to liberate females that extrude their eggs during impoundment. Fishing for lobsters is not permitted on Sundays. A boat operator, and there may be more than one in a boat, must purchase a license (\$2.00) and each boat used in lobster fishing must be registered annually. The registration fee is \$5.00. An operator is not permitted to fish in more than one district in any year nor can a boat used in one district be used in another. The overall effect of these regulations on the present state and structure of the industry is by no means clear. The evolution and development of the lobster fishery has

been influenced perhaps as much by the common property nature of the fishery as by the regulations controlling it.

This Bulletin concentrates on the primary sector of the industry, although some effects on the secondary and tertiary sectors are examined. Geographical limits of the study are the Maritime Provinces, but other areas are included to explain particular aspects of regulations.<sup>1</sup>

<sup>1</sup>This Bulletin is modified from a thesis presented to the Department of Economics at Dalhousie University as partial fulfillment of the requirements for the Master of Arts degree.



A. *Top left*: shucking lobsters, Richibucto, N.B.; *Top right*: mechanical lobster meat washer, Tignish, P.E.I.; *Bottom left*: rollers squeezing meat from legs, Richibucto, N.B.; *Bottom right*: packing lobster meat, Richibucto, N.B.

## DESCRIPTION OF INDUSTRY

Fishermen trap lobsters and normally sell them to buyers who hold them for short periods of time before selling them to larger collecting units, processors, tidal pound operators,<sup>2</sup> or retailers. Processors transform lobsters into several products — frozen or canned meat, and paste and tomalley. Pound operators impound live lobsters when they are abundant and hold them until they are in short supply. Retailers sell either live or processed lobsters. Fishermen constitute the primary sector of the industry and the secondary sector includes buyers, processors, pound operators, and those engaged in transportation. Retailers make up the tertiary sector.

Between and within the secondary and tertiary sectors integration is fairly common. Buyers are often agents for larger concerns that hold, process, transport, or retail lobsters or lobster products. Horizontal integration also exists in these sectors. Both horizontal and vertical integration are less common in the primary sector. Credit operations link fishermen and buyers and obviate the need for formal vertical integration.

### Primary Sector

There are approximately 16,000 commercial lobster fishermen<sup>3</sup> in the Maritime Provinces and about 10,000 lobster fishing enterprises.<sup>4</sup> Table 1 gives the distribution of lobster fishermen in 1968 by lobster fishing districts. The total number of fishermen has not changed very much in recent years although there have been large variations at some ports.

Until the introduction of license limitation in 1967 and 1968, there was a fairly high turnover of lobster fishermen, largely as a result of the lack of effective barriers to entry. The main restriction on entry up to that time was the difficulty of obtaining funds for capital outlays. In 1961-62 the average capital investment per enterprise in the Maritimes was \$2480, of which \$827 was for lobster fishing gear and \$1134 for equipment used jointly in lobster fishing and other fishing (Rutherford et al. 1967, p. 43). An established fisherman who started lobster fishing might require less than \$2480, while a nonfisherman who began lobster fishing could require considerably more. The capital barrier is reduced, how-

ever, by low interest loans, insured by the federal government under the *Fisheries Improvement Loans Act*, for the construction of fishing equipment, vessels, and shore equipment by low interest loans from provincial lending agencies, and by credit extended by buyers.

Necessary equipment for lobster fishing is a boat, traps, rope, and buoys or markers. A fisherman may also own a shed, wharf, salting vats or puncheons for bait, and a truck or trailer. The average value of lobster gear and equipment for Miminegash, P.E.I., in 1968, is given in Table 2. This is higher than the 1961-62 average quoted above because the fishermen interviewed at Miminegash fished relatively large gears and because of price increases in the intervening period.

In economic analysis costs are normally divided into fixed and variable. The division of costs, however, depends upon the time period. In the long run, all costs are variable. In the medium run (say a year or season), outlays for boats, engines, trap haulers, shore equipment, and electronic navigational equipment and echo sounders are fixed but all other costs, including maintenance and repairs, are variable. In the short run, which in the lobster fishery can be considered as 1 day, all costs except expenditures for fuel, bait, and possibly hired help are fixed.

Gross returns depend upon the quantity of lobsters landed and the price received. For any given stock of lobsters, ignoring catchability, an individual fisherman's landings depend to a large extent on the number of traps he hauls during a

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<sup>2</sup>Lobster pounds are large holding units, usually constructed by damming off a natural cove. In Canada they are located only in southwestern New Brunswick and southwestern Nova Scotia where tidal amplitude is sufficient to allow a good exchange of water with each tide.

<sup>3</sup>A commercial lobster fisherman is an "operator" or "helper" who fishes lobsters for part or all of his income. Not included are persons who trap a few lobsters for their own use.

<sup>4</sup>An enterprise is normally comprised of two fishermen, an "operator" and a "helper" or "partner," although small gears are often fished by one man and large gears by three men.



B. Lobster cars, Grand Manan, N.B.



C. Culling lobsters in pound, Yarmouth Bar, N.S.

TABLE 1. Number of commercial lobster fishermen, by lobster fishing districts, 1968. (Source: Dom. Bur. Stat. 1970 b, c, d; table 12)

Lobster fishing district	No. fishermen	Lobster fishing district	No. fishermen
1	616	7A	231
3	295	7B	3,868
4	4645	7C	1,610
5	1138	8	2,500
6A	203		
6B	1314	Total	16,420

TABLE 2. Average beginning of year value of capital equipment, Miminegash, P.E.I., 1968.<sup>a</sup> (Source: Unpublished data, Econ. Branch, Dep. Fish. For., Ottawa)

Item	Value (\$)
Boat and engine	1928
Lobster gear	
Hauler	75
Traps	723
Rope	505
Buoys	61
Nets, trawls, lines for bait	346
Crates	17
Other lobster gear	4
Subtotal lobster gear	1731
Shore equipment	
Sheds	226
Vats or puncheons	62
Car, truck, trailer	117
Subtotal shore equipment	405
Total	4064

<sup>a</sup>Figures are for 20 of 59 fishermen fishing out of that port.

season, his skill, and the efficiency of his gear and equipment. Annual variations in gross returns result mainly from changes in the stock produced by natural factors. Prices, on the other hand, are affected by variations in the commodity and seasons. Lobsters  $2\frac{1}{2}$ – $3\frac{3}{8}$  inches (64–81 mm) carapace length ("canners") bring a lower price than those over  $3\frac{3}{8}$  inches ("markets"). Generally speaking, prices are low in late spring and early summer and high during winter.

Gross returns of a fisherman, therefore, are affected by several factors over which he exerts

little control. Account is taken of some of these factors in Table 3, which gives average gross returns for lobster fishing enterprises in the lobster fishing districts of the Maritime Provinces. There will, of course, be large variations in gross returns among fishermen within a district.

### Secondary and Tertiary Sectors

Buyers may ship lobsters immediately to a firm that will process or distribute them or, alternatively, buyers may hold the lobsters until a large shipment can be made. Some buyers process lobsters and distribute the products on their own behalf. Buyers are of three general types — independents, fisherman cooperatives, and commissioned agents. Prince Edward Island has a large proportion of commissioned agents whereas southwestern Nova Scotia has many independent buyers. In any region, however, all three types are likely to be present.

Most lobster canneries are located in the Gulf of St. Lawrence. According to one royal commission, "a lobster cannery does not represent a very large capital investment; the equipment is essentially a boiler, a can-sealing machine and one or two retorts capable of maintaining the tinned meat at 240 F for the required time. A great deal of meat is sold fresh (chilled, not frozen) and this similarly does not require expensive specialized machinery." (Royal Commission on Price Spread of Food Products 1959, Vol. II, p. 256). A growing number of establishments produce frozen lobster meat that, unlike canning, requires relatively heavy investment for freezing and storage units. Table 4 gives the value of different forms of lobster products for 1968.

Live lobsters are usually shipped by truck from point of landing to large depots (generally within a few hundred miles) where facilities for storing and shipping are better. Here lobsters may be held in crates, floating wooden cars, or land-based tanks supplied with running sea water, or they may be shipped directly to their destination (McLeese and Wilder 1964, p. 36–38). Lobsters from the Maritime Provinces sold live are marketed mainly in New England. Shipments are normally made in trucks carrying up to 100,000 lb. Shipments to widely scattered restaurants, hotels, and retail outlets, however, are often made by railway express, whereas shipments to still more distant points are usually made by air (McLeese and Wilder 1964, p. 55–58; McLeese 1958, p. 5–6). Transportation charges, particularly to distant points, are an important

TABLE 3. Lobster fishing enterprises, landings, landed value, seasons, and type of lobsters, by lobster fishing districts 1972. (Landings are given in thousands of pounds, and landed values in thousands of dollars.)

District	No. fishing enterprises	Landings	Landed value	Landed value/enterprise (\$)	Avg landed value (\$/lb)	Season	Type of lobster
1 (Grand Manan)	134	653	879	6560	1.34	Winter Spring	Markets
1 (Mainland)	300	404	517	1723	1.28	Winter Spring	Markets
3	133	230	310	2331	1.35	Fall Spring	Markets
4 (Digby-Baccaro)	1466	7,497	10,916	7446	1.46	Winter Spring	Markets
4 (Baccaro-Cole Hbr)	1364	1,480	2,104	1543	1.42	Winter Spring	Markets
5	846	948	1,253	1481	1.32	Spring	Markets
6A, 7A	251	293	373	1486	1.27	Spring	Markets
6B	747	1,323	1,378	1845	1.04	Spring	Canners Markets
7B	2057	8,835	7,831	3807	.89	Spring	Canners Markets
7C	764	1,787	1,621	2122	.91	Spring	Canners Markets
8	1378	4,020	3,348	2430	.83	Summer	Canners Markets
Total	9440	27,470	30,530	3234	1.11		

element in the cost of supplying lobsters to consumers.

Another important element of cost is holding in pounds. Owners of lobster pounds try to profit from fluctuating prices. Thus, some pounds are stocked twice during a year, once in May and June, and again in December, when prices are low. Owners try to sell in early August and between late January and March when prices are high. Most lobsters from Canadian pounds are sold in the United States. There are 21 tidal pounds in the Maritimes (16 in Charlotte County, New Brunswick, and 5 in southwestern Nova Scotia) with a combined capacity for storing about 3 million lb live lobsters at one time. Total annual stocking of these pounds has averaged 4 million lb recently with an average mortality rate of about 445,000 lb (11%) (D. W. McLeese personal communication).

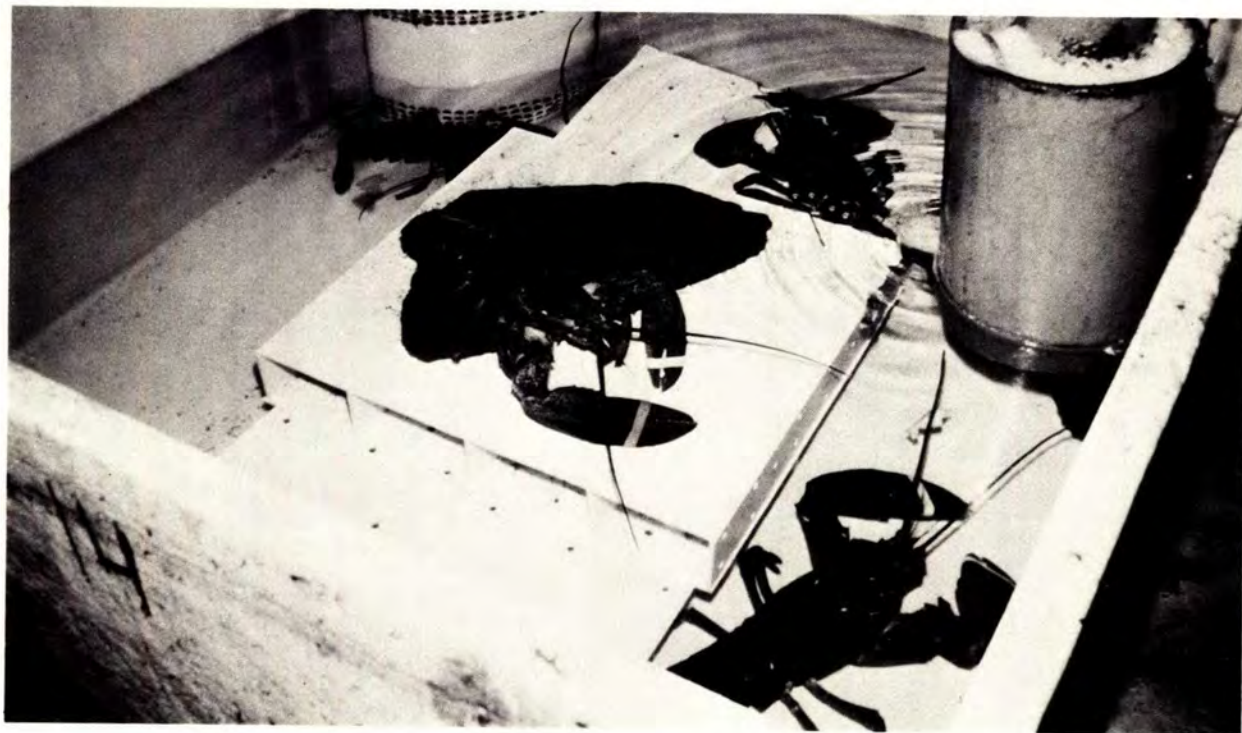
McLeese and Wilder (1964, p. 64) estimated that losses of lobsters intended for the live-lobster market may be as high as 10% annually. There are losses of canner lobsters as well, although these are not so great as lobsters in poor condition may be canned. The probable effect of these losses is to raise the retail price of

lobsters reaching market. Any significant improvement in survival might lead to reduced prices to consumers without seriously affecting the average landed value of lobsters per pound or, conversely, might result in greater returns to primary producers without an increase in consumer prices.

TABLE 4. Market value (in thousands of dollars) of live and processed lobsters, Nova Scotia, New Brunswick, Prince Edward Island, and Atlantic total, 1968. (Source: Dom. Bur. Stat. 1970 a, b, c, d; table 5)

Form	N.S.	N.B.	P.E.I.	Atlantic total <sup>a</sup>
Live, in shell	13,288	10,145	3116	29,095
Meat, fresh or frozen	473	6,268	1071	10,351
Canned meat	-	1,027	1803	4,468

<sup>a</sup>Includes Newfoundland and Quebec. Provincial totals cannot be summed because of interprovincial shipments.



D. Banded lobsters in tank.

## BIOLOGICAL ASPECTS OF FISHERY

### Lobster Stocks

The American lobster (*Homarus americanus*) is found in the waters off the Atlantic coast of North America from Newfoundland to Virginia. Along this coast lobsters are found almost entirely within 10–15 miles of shore in depths of water to about 25 fath (Wilder 1965, p. 21). Areas of greatest yield are Maine, southwestern Nova Scotia, and the southern part of the Gulf of St. Lawrence.

During the past 2 decades lobsters have been captured on the continental slope off the Atlantic coast from Nova Scotia to North Carolina. Vessels are exploiting a virgin population and estimates of sustainable yield, size, and extent of the population are not available.

This fishery was exploited almost entirely by United States vessels until August 1971, when five Canadian (Nova Scotian) vessels entered it. In 1972 six Canadian vessels participated in the offshore lobster fishery. Canadian offshore lobster landings were 223,560 lb valued at \$177,204 in 1971 and 719,233 lb valued at \$785,133 in 1972 (Econ. Branch, Fish. Ser., Dep. Environ.). Until 1971 Canadian vessels were prohibited from fishing for lobsters in offshore waters. So far, the Canadian fishery has been reserved for fishermen displaced from fishing swordfish, which (because of mercury contents above 5 ppm) cannot be sold in the United States or Canada, the major swordfish markets. Gear has been restricted to traps. Until 1968 all United States offshore lobster vessels used trawls but since that time a trap fishery has developed. Of 133 United States offshore vessels fishing in May 1972, approximately 83 used traps (Saila and Pratt 1973, p. 6–40). United States offshore landings accounted for 10% of total United States lobster landings in 1963 (McKenzie 1966, p. 4) and 37% in 1970 (Saila and Pratt 1973, p. 6–40).

The Canadian offshore lobster fishery is becoming more important to the Maritime Provinces' lobster fishery, in particular, to Nova Scotia. In 1972 offshore landings represented slightly over 2% of total Maritime Provinces' quantity and value of catch (Econ. Branch, Fish. Serv., Dep. Environ.). Offshore lobsters, on the average, are much larger than inshore

lobsters with approximately 50% of the catch comprised of individuals of 3–8 lb. Most of the catch is marketed live in the United States. Costs of fishing are high as vessels must be equipped with circulating seawater tanks and gear losses can run as high as \$1000 per week. It is difficult to assess direct effects of the offshore lobster fishery, but it is possible that the price of inshore lobsters may be depressed as a result of buyers purchasing offshore lobsters at less than inshore prices.

Lobsters appear to be nonmigratory. Those recaptured in experiments conducted by the Fisheries Research Board (Templeman 1935, p. 269–278; Wilder 1963a, p. 305–318), on the average, travelled only 2 or 3 miles (straight-line distance) from the point of release in approximately 1 year. Only 6 of 60,000 tagged lobsters recaptured travelled 60 miles or more (Wilder 1963b, p. 4). In the inshore fishery, therefore, the adult lobster population of a particular ground or area can be considered as more or less independent. Where grounds are close together, however, there is likely to be some intermingling.

This independence does not necessarily hold for lobster larvae. Lobster eggs from which larvae develop are usually hatched in summer. In Northumberland Strait, for instance, hatching begins about mid-June, continues at a high rate through July and early August, and then declines to the end of September. Eggs in most cases have been carried by the female since the previous summer (Wilder 1953, p. 373). Larvae emerge from eggs as free-swimming creatures. The newly hatched lobsters molt three times during the first month or two until they reach the fourth stage, when they are easily recognizable as lobsters. During the first three stages and the first half of the fourth stage, larvae generally swim close to the surface of the water. It is likely that they are driven by the wind during this period, and their path probably follows that of the water currents. It is probable, particularly in Northumberland Strait, that eggs hatched in one area become the adult stock of lobsters in another area. In this way, different lobster populations become interdependent. (For details, see Templeman 1937, p. 343–347; Scarratt 1964, p. 661–680.)

Little relation appears to exist, however, between the number of eggs hatched and the

resultant population of adult lobsters. Few eggs survive to become adults. During the period that larvae are swimming close to the surface of the water they are particularly susceptible to predation. Large numbers are eaten by young fish and other creatures that swim near the surface (Wilder 1954, p. 12). Cannibalism also results in the death of some larvae (Scattergood 1960, p. 4). Other natural dangers include unfavorable conditions of light, salinity, food, and oxygen, and the possibility of large numbers of larvae being washed ashore (Templeman 1936, p. 485-497). It was estimated for Northumberland Strait over a 13-year period, 1949-61, that only 1.12% of stage one larvae reached stage four (Scarratt 1964, p. 666). If this is typical, then very few larvae that are hatched become commercial-sized lobsters. No relation between the number of stage four larvae taken in plankton tows and the resulting commercial catch in one region was found (Scarratt 1964, p. 677).

### Natural Mortality

Toward the end of the fourth stage lobster larvae sink to the bottom. These young lobsters are once again subject to predation, particularly by small fish, crabs, and other lobsters. Many small lobsters (4-6 inches total length) are eaten by cod, skate, catfish, and dogfish. The larger, commercial-sized lobsters are probably free from predation by fish and other marine animals (Wilder 1954, p. 12). Their greatest predator is man.

Little seems to be known about competition for food, but it has been suggested that lobsters and crabs, where they inhabit the same ground, probably compete for a common food supply. It is possible that reducing crab stocks might increase the lobster population as a result not only of less competition for food but of less predation on lobsters by crabs (Wilder 1966, p. 2). Too little is known about food supplies and competition, however, to predict the outcome of a given change.

Another factor affecting survival is disease. Lobsters are subject to two known diseases both of which may be fatal, but neither is harmful to humans. One disease that attacks lobsters both in their natural environment and in captivity is caused by bacteria that eat away the shell (Hess 1937, p. 358-362). Although the lobster is rendered unsightly, the disease does not appear to affect greatly the marketability or value of the lobsters infected (Taylor 1948). The other disease, which affects the blood of the lobster,

is caused by bacteria known as *Gaffkya homari*. This disease, called "gaffkemia," appears to be resident in the lobster population, but epidemic outbreaks seem to occur only when lobsters are held in captivity (Stewart et al. 1966, p. 1325-1330). In Maine, in 1946, losses of 25-50% of lobsters held in pounds were reported from this cause (Getschell 1948).

There are, in addition, a few types of parasites, harmless to man, that live in the digestive tract of the lobster (McLeese and Wilder 1964, p. 11). Diseases and parasites do not, on the whole, account for the death of many lobsters. Outbreaks that do occur when lobsters are held in captivity are usually scattered geographically and fairly well contained.

In addition to predation, competition, lack of food, disease, and parasites (all natural factors that increase mortality), "wide seasonal and short-term variations in temperature, sporadic variation in salinity and reduction of dissolved oxygen are known to occur, and either singly or in combination may result in conditions that are unsuitable for lobster survival" (McLeese 1956, p. 248). There are probably other factors that increase the natural mortality rate and so reduce the potential increase of the lobster stock resulting from reproduction and growth.

### Growth

Growth of a lobster depends on the number of times it molts and the increase in size with each molt. Molting generally occurs during the summer months, but this process may vary from one region to another.

Growth rates also vary from one region to another. Most lobsters in the Northumberland Strait molt five to seven times in their first growing season and pass their first winter in the sixth, seventh, or eighth stage (Wilder 1953, p. 395-397). In the second year it is possible they molt three times, but in the third, fourth, and fifth years it is unlikely they molt more than twice annually. Subsequently, it is likely they molt once a year or once every other year. On the other hand, in the Bay of Fundy, where the water is relatively cold in summer and warm in winter, lobsters probably molt fewer times in their first year. Lobsters in the Bay of Fundy, however, may molt during the winter, which is unlikely in the Northumberland Strait. After a lobster matures, it molts less frequently. Lobsters in the Northumberland Strait are smaller than those in the same stage in the Bay of Fundy. In the former area the smallest mature lobsters are about 7

inches (178 mm) total length whereas in the latter area the smallest are about 12 inches (305 mm) (Wilder 1957, p. 8).<sup>5</sup>

More important for assessing the economic effects of size limits is increase in weight (as lobsters are sold by weight). Wilder concluded that lobsters of 6–8 inches (15–20 cm) total length from the southern part of the Gulf of St. Lawrence grow 13–15% in carapace length and 45–53% in weight with each molt. Immature lobsters of 8–10 inches (20–25 cm) total length from southern Nova Scotia and Grand Manan increase 13–15% in carapace length and 43–54% in weight (Wilder 1953, p. 387, 390). As some sublegal-size lobsters (less than 7¼ inches total length in “canner” lobster areas and less than 9¼ inches total length in “market” lobster areas) may molt twice in 1 year, it is possible that they may increase about 100% in weight in 1 year.

If the growth rate of lobsters were the only factor determining the size of the lobster stock, then it might be argued that lobsters should be left to reach a larger size than is required by existing regulations. This change could result in a greater catch measured in terms of weight, and

<sup>5</sup>Total length is approximately 2.9 times carapace length (Rutherford et al. 1967, p. 21).

might also allow more lobsters to mature and thereby increase the number of eggs laid. However, as there does not appear to be a determinate relation between the number of eggs and the subsequent number of adult lobsters, no conclusion can be drawn regarding the effects of a size limit on the lobster population.

Natural mortality is another important factor limiting the increase in lobster populations; this has been estimated to be 10–15% in some areas, whereas in others it may be greater (Wilder 1953, p. 387, 390). One estimate for Maine lobsters placed the natural mortality rate at 28–33% (Dow 1964, p. 22). Although it is impossible to be precise, natural mortality probably has a lower limit of approximately 10% and an upper limit of approximately 50%. Under certain conditions, however, the loss in weight of the lobster stock as a consequence of natural mortality will equal the gain in weight brought about by growth. This balance between natural mortality and growth must have been in effect before fishing began.

### Exploitation

Once lobsters grow larger than the minimum legal size for any district, mortality caused by fishing becomes the most important factor determining the size of the lobster population. From

TABLE 5. Estimated rates of exploitation for selected areas of the Maritime Provinces.<sup>a</sup> (Average yearly landings, landings per square naut. mile, and legal-size lobsters per square naut. mile are given in thousands of pounds.) (Source: Rutherford et al. 1967, p. 19.)

Region	Avg yearly landings 1956–60	Area less than 10 fath (square naut. miles)	Landings per square naut. mile	Estimated rate of exploitation (%)	Legal-size lobsters per square naut. mile
Southern N.B.					
Grand Manan	735	50	14.7	60	24.5
Bay of Fundy	606	240	2.5	25	10.0
Bay of Fundy, N.S.	237	175	1.4	20	7.0
Western N.S.	7,740	490	15.8	55	28.8
South shore, N.S.	1,714	280	6.1	50	12.2
East shore, N.S.					
Hlfx. & Guys. Co.	2,100	390	5.4	50	10.8
Outer coast, C.B.	2,900	300	9.7	60	16.2
Gulf	14,900	1,600	9.3	65	14.3
Strait	8,800	1,050	8.4	65	12.9

<sup>a</sup>In making these estimates it is assumed that there is no migration between areas and that tagged lobsters are caught at the same rate as untagged lobsters. The assumption about migration is probably quite realistic. There is, however, some doubt about the second assumption. Paloheimo (1963, p. 60) argued that the rate of capture of tagged and untagged lobsters may differ because of clustered distributions and the slow rate of mixing of tagged and untagged lobsters.

tagging experiments estimates can be made of fishing mortality and size of population. Table 5 gives the estimated rate of exploitation (fishing mortality) for several areas in the Maritime Provinces. The figures indicate that there are wide variations in the density of lobster populations and the rate of exploitation. In the Bay of Fundy, which has a low rate of exploitation and a low population density, fishing occurs during the late fall, winter, and early spring. In the Gulf of St. Lawrence and Northumberland Strait, respectively, there is a spring and summer open season.

The rate of exploitation depends, among other things, upon the catchability of lobsters. Catchability refers to the likelihood of a lobster entering a trap and is determined by several factors, one of the most important of which is water temperature. As water temperature rises, the activity of lobsters increases, which leads to an increase in catchability. Thus lobsters should be caught most easily in the late spring, summer, and early fall. Another factor affecting catchability is the molting cycle; just before molting lobsters do not trap very easily. Catchability also depends on size of lobsters, density of population, and amount of fishing effort (McLeese and Wilder 1958, p. 1345-1354; Smith 1944, p. 301).

## Regulations

From the preceding discussion it is evident that the main factors affecting the stock of lobsters are growth, recruitment, natural mortality, and fishing mortality. When regulations are considered as a means of sustaining the yield of the fishery, these factors must be taken into account. The desired population level, which takes into consideration the number and size distribution of the stock, must be determined, and regulations must be formulated that attempt to realize this level. Not all regulations, however, are designed as conservation measures. There is considerable overlap among the biological, economic, and administrative bases of regulations. Some regulations—particularly those dealing with size limits, the protection of “berried” females, closed seasons, and lath spacing—are sometimes upheld as being conservation measures. There is some doubt about whether regulations designed for conservation purposes have achieved their objective.

“Minimum size limits are intended to increase the sustained yield either by allowing more lobsters to mature and increase reproduction or to take advantage of the period when growth is

rapid enough to more than offset losses from natural mortality” (Wilder 1965, p. 24).

Lobsters in different areas mature at different sizes and ages. In the southern Gulf of St. Lawrence, to enable all female lobsters to spawn at least once, the size limit should be greater than 9 inches total length (about  $3\frac{1}{4}$  inches carapace length) (Wilder 1954, p. 15). In the Bay of Fundy and southern Nova Scotia the size limit would have to be even larger. Because the size of lobster populations does not appear to be a function of the number of eggs laid, there seems to be little validity in the argument that increasing the size limit would increase the stock of lobsters. Nevertheless, as a means of increasing landings present size limits may be useful, at least for those areas where natural mortality is more than offset by growth of the stock. In one area where size limits were introduced, and another where the size limit was raised, both the quantity and value of landings increased (Wilder 1954, p. 15), but in other areas where the size limit was raised the catch declined (Wilder 1965, p. 25-26). In regions such as the southern Gulf of St. Lawrence, where natural mortality is low and the growth rate of small lobsters is high, minimum size limits probably increase the yield of the fishery. On the other hand, in southern Nova Scotia, where survival of sublegal lobsters released in the spring of the year may be low, there is some doubt about a size limit as a conservation measure. Wilder (1965, p. 26) pointed out that, although there is no proof that size limits have increased the yield of the fishery, there is also no proof that they have decreased it.

TABLE 6. Average monthly landings (lb) of lobsters, Maritimes, by provinces, 1958-67. (Source: Dom. Bur. Stat. 1958-67)

Month	N.S.	N.B.	P.E.I.	Maritimes
Jan.	505,050	41,440	-	546,490
Feb.	156,660	19,650	-	176,310
Mar.	358,310	26,940	-	385,250
Apr.	1,541,860	32,940	-	1,574,800
May	4,557,450	2,616,980	2,710,870	9,885,300
June	4,325,750	1,278,050	3,246,870	8,850,670
July	1,094,420	258,700	854,720	2,207,840
Aug.	183,390	2,775,570	904,400	3,863,360
Sept.	132,780	1,617,660	614,210	2,364,650
Oct.	83,330	648,510	222,760	954,600
Nov.	69,490	474,030	3,900	547,420
Dec.	4,939,990	310,330	7,700	5,258,020

Closed seasons have also been regarded as a conservation measure. Insofar as their aim is to protect lobsters during egg-laying, molting, and hatching, which usually occur during summer months, closed seasons may have some effect. (See Table 6 for average monthly landings, 1958-67.) To the extent that the intention is to maintain or increase the sustained yield by a reduction in fishing effort they are considered to have failed. According to Wilder (1954, p. 13), "... our present system of closed seasons has little, if any, real conservation value."

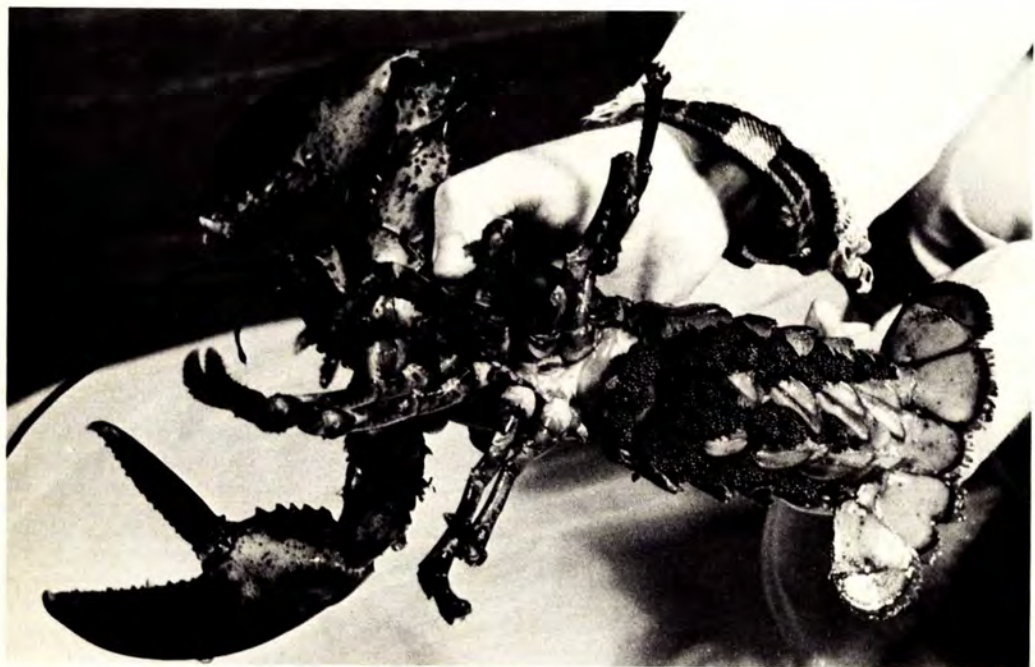
A regulation designed entirely for purposes of conservation is the one that protects "berried" females. It is frequently suggested that large lobsters, both male and female, should be protected because potential egg production of large females is so great — in Maine, lobsters over 5 inches carapace length are protected for this reason. However, as the proportion of such large lobsters is low, there seems to be little justification for protecting them (Saila and Flowers 1965, p. 66-78). Also, "a large, protected population of old, slow-growing lobsters could, through competition and cannibalism, have serious effects on growth and survival of the smaller lobsters" (Wilder 1957, p. 22). Although the regulation protecting "berried" females may be of little value in improving the yield of the fishery, it probably does little harm to the welfare of fishermen, as few lobsters fall into this category and, when released, they can be caught legally after the eggs have hatched (Wilder 1958, p. 14).

One regulation in effect in the Maritimes in the past and that still has some conservation value is lath-spacing of lobster traps. This regulation stipulated the minimum distance between the two lowest side laths of the trap. It was intended to

allow a large proportion of sublegal-size lobsters to escape. There are several strictly conservation reasons for using wide lath spaces. Some small lobsters become weak from exposure to wind and sunlight and die after they are released; many lobsters lose their claws from rough handling and enter the fishery the next year as culls; and some small lobsters when returned to the water are eaten by fish, particularly cod and catfish (Wilder 1948, 1949, 1965). Other reasons in favor of this regulation are that wide-spaced traps, in comparison with narrow-spaced ones, catch fewer crabs, snails, etc.; traps can be overhauled more easily and require fewer laths, less ballast, and are lighter and easier to handle. Lobster fishermen object to regulations on lath-spacing on the grounds that some legal-size lobsters escape from wide-spaced traps, bait is eaten more quickly, and the laths are more easily chewed (Templeman 1958, p. 25). Several experiments have been carried out using wide- and narrow-spaced traps. In these experiments, up to 90% of sublegal lobsters escaped from the wide-spaced compared to the narrow-spaced traps, whereas there was no difference in the catch of legal-size lobsters (Wilder 1948, 1949).

Wilder (1965, p. 28) assessed the general impact of regulations as a means of increasing sustained yield:

"Examination of the available data has failed to provide convincing evidence that the weight of lobsters landed has been affected significantly by regulations defining the fishing season, prohibiting the sale of egg-bearing lobsters and specifying minimum legal sizes. It seems probable that environmental factors such as temperature, type of bottom (cover), food, competition, predation and possibly disease play a much more important role in determining the sustained yield from the various regions."



E. "Berried" female lobster.

## HISTORY OF LOBSTER FISHERY REGULATIONS

### Conditions Prior to Regulations

Only within the last 100 years has the lobster fishery become important commercially. Lobsters were probably first captured by Indians before the arrival of European settlers. The first Europeans in North America known to eat lobster were the French at Port Royal, who captured lobsters by hand (Lescarbot 1609, p. 319-320; Thwaites 1896, p. 69). By the 1700s small local markets for lobsters had developed.<sup>6</sup> The lobster fishery in eastern Canada experienced little change, however, until the middle of the 19th century.

The lobster fishery, as a separate industry, started at the beginning of the 19th century along the coast of Massachusetts in the Cape Cod and Boston regions, spread to Maine by 1840 (Herrick 1911, p. 170), and to eastern Canada during the 1850s and 1860s. The market remained local and prices were low (Cozzens 1877, p. 26; Perley 1852, p. 58 and 128). On the north shore of New Brunswick lobsters were used for fertilizer.<sup>7</sup>

As far as can be determined, the first lobster cannery in Canada was established at Portage Island on the eastern shore of New Brunswick

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<sup>6</sup>One account stated that "lobsters are found on all parts of the sea shore in great abundance and the catching of them is chiefly confined to the Indians, who carry them to market in their small canoes" (Hollingsworth 1787, p. 63).

<sup>7</sup>Perley (1852, p. 20) stated: "Lobsters are found everywhere on the coast, and in the Bay of Chaleur in such extraordinary numbers that they are used by thousands to manure the land. At Shippegan and Caraquet, carts are sometimes driven down to the beaches at low water and readily filled with lobsters left in the shallow pools by the recession of the tide. Every potato field near the places mentioned is strewn with lobster shells, each potato hill being furnished with two, and perhaps three, lobsters."

<sup>8</sup>Most commentators on the history of the lobster industry argue that canning techniques were brought to Canada by Americans in the late 1860s and early 1870s, after the apparent depletion of United States' stocks of lobsters (Found 1912, p. 50; Innis 1954, p. 437; Venning 1909, p. 4 and 14). There were lobster canneries in the Maritimes before 1860, however.

about 1845, where lobster meat was packed in hermetically sealed cans.<sup>8</sup> The first attempt to operate a lobster cannery in Nova Scotia was apparently at Yarmouth some time in the late 1840s. Lobster canning was introduced to Prince Edward Island from New Brunswick about 1870 (Can. Sess. Pap. 1880, p. 226), and to Newfoundland from Nova Scotia about 1873 (Templeman 1941, p. 5). In that same year there were approximately 40 lobster canneries in operation in Nova Scotia and about 24 in operation in New Brunswick (Venning 1909, p. 4). The two main canning areas were the east shore of New Brunswick and the south shore of Nova Scotia.

With the opening of new grounds and rapid development of canning, new methods were found to capture lobsters. At first lobsters were captured by hand. During the 18th century the method changed, and lobsters were gaffed, hooked, and speared. The next innovation was the hoop trap, that was simply a net stretched across a hoop with bait in the center. A fisherman might attach 20 or more hoop nets to a cable suspended at the surface, thereby forming a trawl. By 1867 fishermen in Nova Scotia knew of lobster traps but they were not used extensively as they were considered expensive (Knight 1867, p. 57). Herrick (1911, p. 173), North America's first biologist to undertake an intensive study of lobsters and lobster fishing, described the lobster trap as follows:

"The principle of the modern lobster trap is that of the old fashioned rat trap adapted for taking an aquatic animal with as keen a scent as the rodent, but with far duller wits. The device is undoubtedly of great antiquity, but as modified and applied for the lobster it is apparently not over 200 years old. It was introduced to this country [United States] from Europe, where, . . . it was first applied in this way by the Dutch in 1713, and was adapted from the eelpot then in use."

When stocks became reduced through heavy fishing, capture by hand, spears, and hoop traps became less efficient and was replaced by trapping. In the decade after Confederation, however, the supply of lobsters was abundant and demand limited, consequently prices remained low.



F. Lobster traps on wharf (southwestern Nova Scotia).

### Early Attempts at Regulating the Fishery

Between 1870 and 1886 lobster landings increased rapidly (Fig. 4). Wilder (1965, p. 21) considered this period to be the first of three phases: "The first phase of rapid expansion, when new areas were being discovered and the fleet was growing quickly, was accompanied by a steady increase in landings to a maximum of about 100 million pounds in 1887."

The first areas to develop a commercial fishery, the east shore of New Brunswick and the south shore of Nova Scotia, were those with the most productive grounds and those most accessible in relation to transportation and exploitation from the United States. About 1870 new grounds were opened on the New Brunswick side of the Bay of Fundy. About 3 years later Cape Breton began more intensive exploitation, with Prince Edward Island following close behind. Exploitation in the Northumberland Strait section of Nova Scotia began around 1877. Other sections of the Maritime Provinces, where lobster grounds were not as productive, were not exploited until later.

Early in phase one concern was expressed over exhaustion of the lobster stock. In 1872, W. H. Venning, Inspector of Fisheries for the province of New Brunswick, urged the government to take

measures to protect the fishery (Can. Sess. Pap. 1873, p. 167-168). Venning repeatedly pointed to the decrease in the average size of lobsters captured as a sign of overfishing. On July 7, 1873, an Order in Council prohibited the capture of soft-shelled lobsters, egg-bearing females, and lobsters less than 1½ lb in weight (Can. Sess. Pap. 1893, p. 14-15).

The regulation was a conservation measure insofar as it was intended to protect females carrying eggs and small lobsters. The prohibition on soft-shelled lobsters was an attempt to prevent lobsters in poor condition from being canned and, therefore, was intended to insure quality of the canned product. Both fishermen and cannery operators objected to the regulation (Venning 1909, p. 5; Can. Sess. Pap. 1874, p. 149-154). In response to objections the regulation was modified by an Order in Council of April 23, 1874. The restriction on the capture of "berried" lobsters was retained, a closed season instead of a prohibition of the capture of soft-shelled lobsters was introduced for July and August, and the weight limit was changed to a 9-inch total length limit, on the grounds that it was difficult to enforce the weight limit. Changing the weight limit to a 9-inch total length limit was

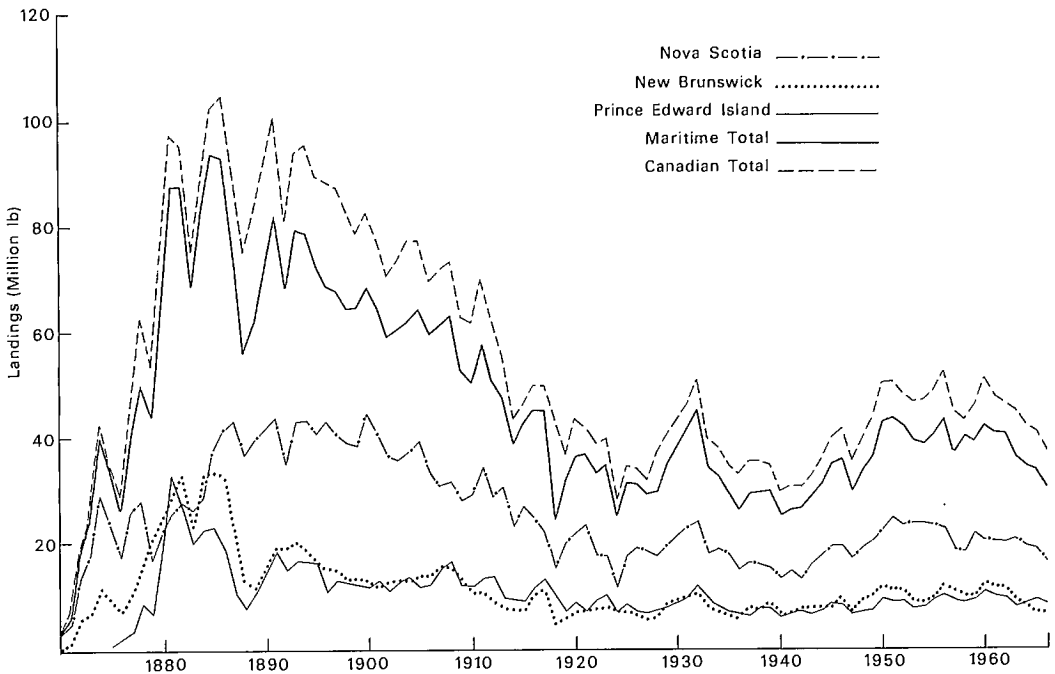


FIG. 4. Maritime Provinces' lobster landings, by provinces and Canadian total, 1870-1966.

also a way of decreasing the size limit, as a 9-inch lobster weighs less than 1 lb.

In April 1876 the closed season was changed from July and August to July 10 – August 20. A month later the closed season was changed to August 10 – September 20. These changes appear to have resulted from pressure by the cannery operators, who wanted a longer season in which to can lobsters (Can. Sess. Pap. 1877, p. 254). As virtually the complete catch of lobsters was canned at that time, the influence of cannery operators in modifying regulations is understandable.

The first sectional closed seasons were introduced in 1877. Nova Scotia, Prince Edward Island, and the Bay of Fundy area of New Brunswick had a closed season in August, and the rest of New Brunswick had a closed season from August 20 to September 15. Closed seasons were primarily a device to prevent lobsters in poor condition from being canned. In 1879, however, there was a serious attempt to use closed seasons as a means of decreasing exploitation. An Order in Council of that year stipulated a closed season from August 1 to April 1 for the Bay of Fundy area of New Brunswick and Nova Scotia, and all the southern and eastern sections of Nova Scotia, including Cape Breton. The rest of Nova Scotia, New Brunswick, and all Prince Edward Island had a closed season from August 20 to April 20. These regulations remained in effect until 1887.

An important effect of the long closed season was to make lobster fishing a part-time activity. There were complaints from fishermen who depended upon sales for their winter supplies (Can. Sess. Pap. 1880–81, p. 140) and from cannery operators because the season was too short (Can. Sess. Pap. 1880–81, App. No. 11, p. 237). Cannery operators also petitioned for the restriction on the capture of egg-carrying lobsters to be modified (Can. Sess. Pap. 1882, App. 2, p. 55, and App. 5, p. 185).

The number of canneries increased rapidly in the 1870s and 1880s. Most had no solid financial backing and decreases in demand sent many into bankruptcy, only to be replaced by other financially weak operations when conditions improved. Quality of the pack was often poor. Canned lobster meat was sold largely to the United Kingdom, although canning operations were promoted by Americans.

For the most part canneries did not comply with regulations, and both egg-carrying and short lobsters were packed. Cannery operators used

the argument that if one cannery did not purchase illegal lobsters then another one would. They also argued that if fishermen did not land such lobsters they would not can them, whereas the fishermen argued that if the canneries would not purchase them they would not land them.

Among cannery operators, disputes often arose regarding property rights. A cannery might control a 2- to 4-mile frontage and, if successful, might attract other canneries to the same region. Established canneries complained of unfair competition and pressed for a leasing system that would give them defined property rights. Fisheries inspectors also pressed for a leasing system to stabilize the industry (Can. Sess. Pap. 1880–81, App. 10, p. 209; App. 11, p. 237–238; 1882, App. 2, p. 55). They argued that canneries would be much more concerned with protecting lobsters if they were guaranteed future property rights. The federal government favored free competition and argued that exclusive fishing rights would create a monopoly and take away bargaining power of fishermen.

There were two systems of ownership of capital in the primary sector during this phase. Under one system a cannery operator supplied a fisherman with boat and gear and, in return, the fisherman agreed to sell his catch to the cannery. A small fee was normally charged for rental of the equipment. Under the other system of ownership a fisherman owned his boat and fishing equipment and chose his buyer. Fishermen were normally paid cash, which was one of the attractive features of the lobster fishery, as in other fisheries fishermen had to wait until the end of the year before they received payment.

Cash sales and relatively high returns attracted more and more people into the fishery so that, between 1877 and 1886, landings in the Maritime Provinces rose steadily, reaching approximately 94 million lb in 1885 and 93 million lb in 1886 (Fig. 4). Market value increased during the decade by over 200% (Can. Sess. Pap. various issues).

One of the most significant developments during this period was the beginning of the live-lobster trade. "A regular export business between Yarmouth and Boston began on a small scale in 1878, but it was not until 1882, with the formation of the Arcadia Lobster Company (Yarmouth County), that a marked development of the live lobster trade was in evidence" (Grant 1934, p. 28).<sup>9</sup> During the next decade the live-lobster trade was conducted almost entirely from southern New Brunswick and western Nova Scotia. Carrying-smacks collected lobsters and brought them

to Shelburne, Yarmouth, Digby, and Saint John for transport to the United States, in particular, Boston. In some instances, smacks were dispatched from Boston to collect lobsters along the coast of southern Nova Scotia and New Brunswick, and to take them directly to Boston. The most important factor in development of the live-lobster trade was proximity to the market.

Development of the live lobster trade had at least two effects. First, it created a price differential between lobsters sold for the live trade ("markets") and those sold to the canning industry ("canners"), with the "markets" bringing a higher price. The other effect was to create a size limit not imposed by Canadian regulations. In Massachusetts, the principal area to which live lobsters were shipped, the minimum legal size was 10 inches total length. As "markets" brought a higher price than "canners," fishermen in areas that supplied the live-lobster market pressed for a large size limit.

By 1886 the first phase of the lobster fishery was over. Early in this phase canneries, financed mainly by American capital, began operations in areas most accessible to the United States and where grounds were most productive (southern Nova Scotia and eastern New Brunswick). This was followed by the extension of canneries into less accessible and productive areas, with the bulk of the canned product being shipped to England. As the live-lobster trade with southern New Brunswick and southern Nova Scotia developed as a result of improved shipping methods, the canneries in these areas began to disappear and move into more remote areas (eastern Nova Scotia, Prince Edward Island, and northeastern New Brunswick). During this phase there was a large influx of capital and labor in response to

<sup>9</sup>The first attempt to ship live lobsters appears to have been made early in the 19th century when "... some loyal Nova Scotians shipped in a sailing vessel several barrels of lobsters to King George III. They reached London safely and alive" (Dep. Mar. Fish. 1899, p. 9). A fairly detailed description of early attempts at shipping live lobsters is contained in Williams (1930, p. 15-18).

<sup>10</sup>The first hatchery was erected at Bay View, Pictou County, N.S., in 1891. According to Knight (1917, p. 5), "What might be fairly described as a mania for the artificial hatching of commercial and game fish spread over the country, and found expression in demands upon the Government for the erection of various kinds of hatcheries."

<sup>11</sup>In 1903 a pound to keep "berried" lobsters until the eggs hatched was established at Fourchu, Cape Breton County, N.S.

quick, substantial returns, even though the high volume of landings between 1870 and 1886 tended to keep prices low. Regulations, neither obeyed nor enforced, had little effect on the development of the fishery. Only the closed season was fairly well observed, and the principal effect was to make lobster fishing a part-time occupation complementing other types of inshore fishing.

### Decreasing Production

After 1886 the lobster fishery entered its second phase.

"During the second phase which lasted to about 1918, the catch declined steadily. The average size of the lobsters also declined appreciably. It now seems apparent that during the latter part of phase one and the early part of phase two, the fishery was removing accumulated stocks considerably faster than the grounds could replace it." (Wilder 1965, p. 21)

The decline in landings that began in 1887 brought about an examination of regulations, and new measures were introduced in an attempt to arrest the decline. No less than eight commissions were appointed to investigate the fishery in the 27-year period from 1887 to 1913. Hatcheries<sup>10</sup> and pounds<sup>11</sup> were established in an attempt to augment the natural supply of lobsters. All efforts to reverse the decline in landings failed.

This phase was a turbulent one for cannery operators. The number of canneries increased steadily until about 1900, when there were 760 in the Maritime Provinces (Table 7). Quarrels over the right to control sections of the coast increased. Bankruptcies were common. Attempts were made early in the 20th century to bring the number of canneries under control by a leasing system, but it was largely ineffective. Canning of egg-bearing and short lobsters continued, with cannery operators blaming fishermen and fishermen blaming cannery operators.

There were major changes in technology during this phase. The first box traps used had an opening at each end, so that when the traps were hauled from one end some lobsters fell out the other. As a remedy, one end was closed and entrances were put on the sides or at the end that faced up when the trap was hauled. A further modification was the introduction of two compartments, one that the lobsters entered initially and another that, if they entered it, prevented their escape.<sup>12</sup> The closed-end trap supposedly

<sup>12</sup>This is often referred to as the parlor trap. The lobster enters the "kitchen" first and then the "parlor" from which escape is virtually impossible if the lobster cannot crawl out between the laths.

TABLE 7. Number of lobster canneries, Maritimes, by provinces, 1873-1947. (Sources: 1873, Venning 1909; 1879-88, Can. Sess. Pap. 1889; 1887, Can. Sess. Pap. 1888; 1896-1917, Dep. Nav. Serv. 1918; 1917-42, Dom. Bur. Stat. 1917-46; 1943-47, Dom. Bur. Stat. 1945-50)

Year	N.S.	N.B.	P.E.I.	Year	N.S.	N.B.	P.E.I.
1873	24	40	- <sup>a</sup>	1915-16	227	151	172
1879	-	-	35	1916-17	216	161	198
1880	-	-	58	1917	171	194	197
1881	-	-	118	1918	148	158	180
1882	-	-	130	1919	134	153	182
1883	-	-	88	1920	152	177	183
1884	-	-	97	1921	141	172	160
1885	-	-	113	1922	157	173	185
1886	-	-	130	1923	163	177	195
1887	170 <sup>b</sup>	168	132	1924	142	142	145
			(112) <sup>c</sup>	1925	133	137	143
1888	-	-	79	1926	133	128	137
				1927	124	124	133
1896	206	198	174	1928	112	99	103
1897	218	201	220	1929	114	96	88
1898	231	199	230	1930	106	98	85
1899	247	216	240	1931	97	103	87
1900	277	237	246	1932	107	108	91
1901	258	221	225	1933	88	99	91
1902	240	198	192	1934	88	96	94
1903	242	199	190	1935	77	86	89
1904	237	206	199	1936	76	80	84
1905	237	198	196	1937	71	78	74
1906	238	197	188	1938	62	73	64
1907	217	184	184	1939	55	67	60
1908	215	187	183	1940	42	46	49
1909-10	217	189	187	1941	33	40	44
1910-11	214	185	187	1942	33	37	43
1911-12	226	200	185	1943	35	42	44
1912-13	210	198	195	1944	38	49	47
1913-14	231	179	197	1945	36	46	48
1914-15	226	167	189	1946	32	45	47
				1947	29	38	49

<sup>a</sup>Indicates number unknown.

<sup>b</sup>Estimated from value of factories for Nova Scotia.

<sup>c</sup>Duvar (Can. Sess. Pap. 1880) gives the number of factories as 112.

captured smaller lobsters than the open-end trap (Found 1912, p. 52).<sup>13</sup> The hoop trap became increasingly less popular, although some fishermen still used it after the turn of the century.

Around 1900 the gasoline-powered motorboat began to replace sailboats and rowboats. This innovation meant that fishermen could reach and travel within lobster fishing grounds much more quickly, the result being an increase in the number

of traps fished. Whereas around 1880 a fisherman probably fished 75-90 traps (Anon. 1879, p. 18),<sup>14</sup> by the end of World War I fishermen in some areas fished 250-300 traps (Knight 1919, p. 22). The decline in landings was also an impetus to the increase in the number of traps fished as fishermen tried to offset a decrease in catch per trap by increasing the number of traps.

In July 1887 the first of several commissions was appointed to study the lobster fishery (Can. Sess. Pap. 1888, Vol. 8). The commissioners argued that the spawning period of lobsters should be excluded from the fishing period, and that the minimum total length of 9 inches should be continued and raised in the future to 10½ inches. Fishermen were to pay the penalty attached to the capture of short and egg-bearing lobsters. The commissioners were divided on the

<sup>13</sup>The apparent capture of smaller lobsters by the closed-end trap may have resulted simply from its general use coinciding with the natural decrease in the size of lobsters, or it may have been a result of the selectivity of this type of trap.

<sup>14</sup>It is assumed that roughly the same number of traps were fished in Canada as in the United States.

question of whether to lease fishing areas to the canneries.

The regulations adopted in December 1887 bore some similarity to the recommendations. The prohibition of egg-bearing lobsters was retained. The regulations stipulated a closed season from July 1 to December 31 for the Bay of Fundy area and southern and eastern Nova Scotia as far as Cape Canso, Guysborough County. For the rest of the Maritimes the closed season was to be from July 15 to December 31. The size limit remained at 9 inches. The regulations adopted in 1887 remained in effect with only slight modifications until 1899.

An Order in Council of September 27, 1898, provided for the appointment of a commission, under the chairmanship of E. E. Prince, Dominion Commissioner of Fisheries, to investigate and make recommendations on the lobster fishery. Recommendations of this commission formed the basis of the modern regulations.

The lobster fishery at the time the Prince Commission was appointed was the most valuable fishery of the Maritime Provinces. It had become the most valuable fishery in Prince Edward Island and New Brunswick during the 1890s and, about 1900, the value of the lobster fishery to Nova Scotia surpassed that of the cod (Innis 1954, p. 437). According to the Prince Commission, "the failure of the mackerel, cod and other fisheries, has had a great deal to do with compelling a large number of fishermen to take up lobster fishing with the result that the fishery has become practically the staple industry along large portions of the coast" (Dep. Mar. Fish. 1899, p. 27). In no area was lobster fishing the only means of support. Other fishing and farming complemented lobster fishing.

The commissioners found wide variations in the price paid for lobsters. "In some localities the fishermen receive 80 cents per hundred lobsters by count, whereas in other localities, as in western Nova Scotia, the fishermen get as high as from \$10 to \$20 per hundred" (Dep. Mar. Fish. 1899, p. 39). The price differential resulted mainly from the market and canner lobster trades and the larger size of lobsters in western Nova Scotia. By 1900 most of Nova Scotia from Guysborough County to the Bay of Fundy, and southern New Brunswick was active in the live-lobster trade. The chief obstacle, according to the Commission, was the danger of a glut resulting from the closed season then in effect (Dep. Mar. Fish. 1899, p. 24).

Like most previous inquiries, the Prince Commission found that regulations had neither been

obeyed nor enforced. If enforced, the canneries would have had to cease operations because of the lack of legal-size lobsters. According to the commissioners, "... the law, especially respecting size, has been a dead letter on most parts of the coast" (Dep. Mar. Fish. 1899, p. 36).

The regulations that went into effect in December 1899 and April 1900 were virtually the same as the recommendations made by the Commission. There were slight changes in the recommended size limits and the boundaries for lobster districts (Fig. 5). There was no restriction on the type of trap that could be used. Fishing was not permitted in less than 2 fath of water or closer than 100 yards to a stationary salmon net. Lath spacing was not included in the regulations. The prohibition of the capture of egg-bearing lobsters continued.

There were few significant changes in the decade after the turn of the century. Landings continued to decline whereas prices rose. By 1910 the value of output exceeded \$3 million (Dep. Nav. Serv. 1918, p. 408-413). Investment in 700 canneries was estimated at over \$500,000 and in traps at \$1.5 million (Found 1912, p. 53). Eleven thousand fishermen were engaged in the primary operations and over 8000 people were employed in canneries (Found 1912, p. 53).

Between 1909 and 1912 three more investigations of the fishery were undertaken. Although seasons and districts were modified somewhat as a result of these investigations, the most important changes were made with respect to size limits. After a Select Standing Committee on Marine and Fisheries, appointed in 1909, was unable to recommend changes in existing regulations because of insufficient evidence, Commander William Wakeham was appointed to undertake an inquiry and to make recommendations (Can. Sess. Pap. 1910). With respect to size limits, Wakeham favored a 10½-inch total length or a 4¾-inch carapace length<sup>15</sup> size limit for all the Bay of Fundy and southern Nova Scotia as far as Halifax harbor. He believed this district should supply the live-lobster market because of its proximity to the United States, and the higher prices received for the larger lobsters should, he argued, compensate for the large size limit. A point on which Wakeham felt strongly was lath spacing in traps as an alternative to a size limit for the rest of the Maritimes. He

<sup>15</sup>The carapace measurement at that time was from the tip of the rostrum to the posterior margin of the carapace, and differed from the carapace measurement used today.

recommended, therefore, that after a period of 2 years all lobster traps be required to have a 1¼-inch space between the laths and a 3-inch mesh in the head. The regulations introduced in 1910, instead of applying a 4¾-inch carapace length size limit to the whole of the area suggested by Wakeham, applied the large size limit to Charlotte and Saint John counties, N.B. Excepting the rest of the Bay of Fundy, which had a 9-inch limit, size limits in all districts were abolished and lath spacing was introduced.

The Dominion Shell-Fish Fishery Commission (1913, p. 62) recommended abolition of lath spacing in traps, as fishermen claimed that wider-spaced traps caught as many if not more lobsters than the narrow-spaced ones. The Commission also recommended that fishermen be licensed. In 1914 the section regarding lath spacing in the *Lobster Fishery Regulations* was rescinded, and by 1918 lobster fishermen were required to obtain a license before they were permitted to fish.

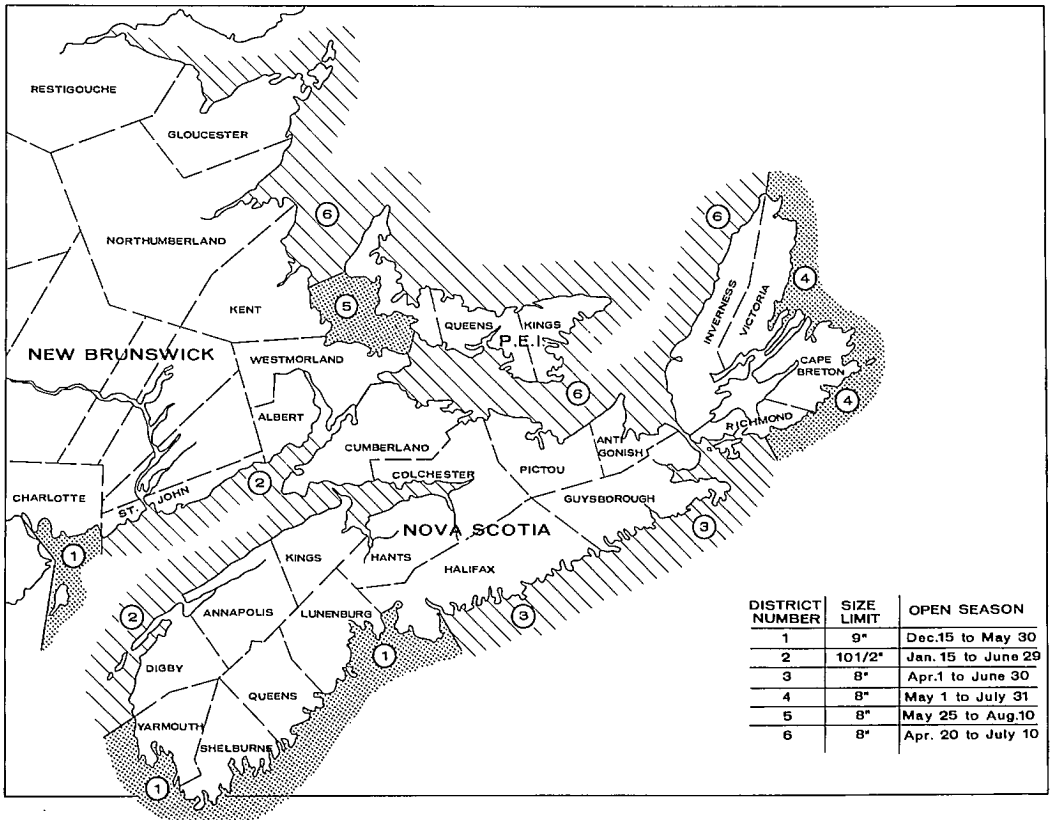
By 1918 lobster production in Canada and the Maritime Provinces was the lowest it had been since 1873 (Fig. 4). Regulations designed to stop the steady decline in landings had failed, and

other methods of halting the decline had also failed. Hatcheries were closed in 1919, largely as a result of the investigations of A. P. Knight, who considered hatcheries, because of their destruction of eggs, together with overfishing, as being the principal factor in the decline in landings (Knight 1918, p. 53-71, 1919, p. 22).

At the end of World War I the lobster fishery was moving toward a position of equilibrium. Most technological changes in the method of fishing had been introduced, although the widespread use of some was still to come. The lobster-producing areas of the Maritime Provinces were divided roughly into two sections, a market section in the south and a canner section in the north. The period of great influx of capital and labor was over. Changes in the industry continued after 1918 but they were neither as dramatic nor as sudden as those of the first two phases.

### The Interwar Period

After 1918 the lobster fishery entered the third phase of its development.



22 FIG. 5. Lobster fishing districts, size limits, and seasons, 1899. Size limits are total length.

TABLE 8. Average landed value of lobsters (¢/lb), Maritimes, by provinces, 1917-72. (Calculated from data supplied by Fish. Intell. Branch, Dep. Environ., Halifax, N.S.)

Year	N.S.	N.B.	P.E.I.	Mari- times	Year	N.S.	N.B.	P.E.I.	Mari- times
1917	8.6	6.1	5.9	7.0	1945	30.8	25.6	18.5	26.8
1918	9.2	6.0	6.0	7.1	1946	33.1	28.3	24.9	30.1
1919	10.8	7.3	8.0	9.6	1947	31.4	22.8	17.4	26.5
1920	12.9	10.6	8.5	11.5	1948	29.9	25.4	21.6	27.2
1921	9.4	7.5	4.0	8.1	1949	31.3	22.8	20.8	27.1
1922	11.3	11.9	7.4	10.4	1950	32.0	23.3	21.6	27.4
1923	13.0	12.5	9.0	11.8	1951	30.8	23.7	20.4	27.1
1924	11.9	11.0	8.6	10.8	1952	34.8	27.2	22.1	30.3
1925	12.5	12.2	8.4	11.4	1953	37.7	32.6	28.5	35.0
1926	13.5	13.4	9.2	12.6	1954	38.3	32.3	26.9	34.9
1927	13.5	14.0	9.8	12.8	1955	39.5	32.4	27.9	35.5
1928	12.8	10.9	8.4	11.5	1956	41.7	32.2	28.1	36.1
1929	11.4	10.4	8.4	10.5	1957	37.5	30.1	28.8	33.4
1930	10.8	7.9	6.7	9.1	1958	41.0	35.1	31.5	37.2
1931	8.3	7.8	5.9	7.6	1959	42.4	35.7	33.9	38.9
1932	7.5	6.2	4.8	6.5	1960	38.3	34.1	31.7	35.6
1933	6.9	6.9	4.3	6.2	1961	44.3	35.7	32.1	39.1
1934	9.9	9.0	6.1	9.0	1962	48.9	41.6	37.0	44.4
1935	10.8	10.8	7.3	10.1	1963	53.1	48.1	43.8	49.8
1936	13.7	12.3	9.2	12.4	1964	62.7	60.0	53.8	60.1
1937	14.5	9.8	9.0	12.2	1965	73.4	61.7	58.6	67.3
1938	11.4	7.3	6.4	9.2	1966	65.3	56.3	50.0	59.5
1939	11.4	8.5	6.6	9.5	1967	74.7	64.5	58.3	67.7
1940	11.1	8.9	6.4	9.5	1968	69.3	66.9	61.0	66.5
1941	11.9	10.8	7.8	10.7	1969	78.4	77.3	65.6	75.1
1942	15.9	14.1	10.8	14.2	1970	90.6	76.8	71.5	82.4
1943	20.1	20.7	17.6	19.8	1971	98.2	81.3	71.5	88.5
1944	24.1	22.4	17.5	22.3	1972	127.9	95.1	86.6	110.7

"Since 1918 (...) landings have been relatively constant, averaging 40 million, and ranging from 30 to 50 million pounds. During this phase the fishery and stock have remained more or less in a state of balance." (Wilder 1965, p. 21)

In the period between the two world wars, prices, total landed values, and market values did not change significantly, although there were fluctuations. Only one commission investigated the lobster fishery during this period, and then only as part of a much larger investigation (MacLean Commission 1928). Few changes were made in the regulations governing the fishery in the 2 decades after the end of World War I.

The regulations introduced in 1918 left the open seasons virtually unchanged. The Bay of Fundy area and southern Nova Scotia still had a winter and spring season, whereas the rest of the Maritimes had a spring season, with the exception of the small district between Prince Edward Island and New Brunswick, which had a summer season. The 4¾-inch carapace length minimum size limit was retained in Charlotte County, N.B., and in the rest of the Bay of Fundy area there was a

9-inch total length limit. For the rest of the Maritimes there was no size limit.

Lobster landings increased from a low of 24.1 million lb in 1918 to a high of 34.4 million lb in 1923 (Fig. 4). The increase in landings was accompanied by an increase in average landed values from 7.1¢/lb in 1918 to 11.8¢/lb in 1923 (Table 8). The short postwar boom ended in 1924. In that year a decrease in landings was accompanied by a decrease in prices, so that total landed value fell by about one third from the previous year (Table 9). The industry recovered quickly, however, and in the next few years landed values remained close to the 1923 level.

In 1927 the MacLean Commission began hearing evidence on the lobster fishery. The Commission made the usual observation regarding regulations, that they were neither obeyed nor enforced (MacLean Commission 1928, p. 12). In some districts the catch of lobsters in the closed season was as high as 60% of the catch in the open season and in one district equalled it. In examining lobster districts and closed seasons, the commissioners argued that districts had been

TABLE 9. Landed value of lobsters, Maritimes, by provinces, 1917-72 (\$ million). (Source: Fish. Intell. Branch, Dep. Environ., Halifax, N.S.)

Year	N.S.	N.B.	P.E.I.	Maritimes	Year	N.S.	N.B.	P.E.I.	Maritimes
1917	1.9	0.6	0.6	3.2	1945	5.8	1.9	1.5	9.3
1918	1.4	0.3	0.3	1.9	1946	6.2	2.6	2.0	10.7
1919	2.1	0.4	0.5	3.0	1947	5.2	1.7	1.1	7.9
1920	2.8	0.7	0.7	4.2	1948	5.5	2.1	1.4	9.0
1921	2.2	0.5	0.3	2.9	1949	6.2	2.1	1.4	9.8
1922	2.0	0.8	0.7	3.4	1950	7.0	2.6	2.0	11.6
1923	2.2	0.9	0.9	4.0	1951	7.5	2.5	1.7	11.7
1924	1.4	0.8	0.6	2.7	1952	8.0	2.8	1.8	12.7
1925	2.1	0.8	0.7	3.6	1953	8.9	2.8	2.0	13.7
1926	2.5	0.8	0.6	3.9	1954	8.9	2.6	2.0	13.5
1927	2.4	0.7	0.6	3.7	1955	9.1	2.9	2.3	14.3
1928	2.2	0.6	0.6	3.4	1956	9.3	3.7	2.7	15.7
1929	2.2	0.9	0.6	3.6	1957	6.8	3.1	2.5	12.4
1930	2.3	0.7	0.5	3.5	1958	7.4	3.4	2.5	13.3
1931	1.8	0.7	0.6	3.1	1959	8.9	3.3	2.8	15.2
1932	1.8	0.6	0.6	2.9	1960	8.2	4.1	3.2	15.5
1933	1.2	0.5	0.4	2.1	1961	8.8	3.9	3.1	15.7
1934	1.8	0.6	0.5	2.9	1962	9.8	3.9	3.2	16.9
1935	1.9	0.6	0.5	3.0	1963	10.7	4.1	3.2	18.0
1936	2.0	0.7	0.5	3.2	1964	12.0	4.4	4.2	20.5
1937	2.3	0.7	0.5	3.5	1965	13.6	3.8	5.2	22.6
1938	1.8	0.5	0.5	2.7	1966	10.5	3.4	3.9	17.8
1939	1.6	0.7	0.5	2.8	1967	10.7	3.3	5.2	19.3
1940	1.5	0.5	0.4	2.4	1968	11.0	4.0	5.3	20.3
1941	1.7	0.6	0.5	2.8	1969	14.9	5.2	5.4	25.5
1942	2.0	1.0	0.7	3.7	1970	14.3	4.7	6.2	25.3
1943	3.1	1.4	1.0	5.5	1971	18.3	4.8	5.9	28.9
1944	4.1	1.6	1.1	6.9	1972	19.3	5.1	6.4	30.8

set up for purposes of administration, and that "the open fishing season in these districts varies and is determined by consideration of ice conditions and by the known or surmised presence of lobsters in these particular waters at non-spawning periods" (MacLean Commission 1928, p. 12).

The Commission recommended that size limits again be introduced — a 9-inch limit for the Bay of Fundy and southwestern Nova Scotia, as far as Cole Harbour, and the small district between Nova Scotia and New Brunswick, and an 8-inch limit for the rest of the Maritimes. The recommended size limits were not introduced until 1934, when the regulations of 1918, with amendments, were revised. In 1934 a  $3\frac{1}{8}$ -inch carapace length limit was applied to all the Bay of Fundy (with the exception of Charlotte County, N.B., which had a  $3\frac{1}{2}$ -inch limit), to southwestern Nova Scotia as far as Cole Harbour, Halifax County, and to District 6A (Fig. 1) in Cape Breton. The rest of the Maritimes had no size limit. The districts introduced at that time were practically the same as they are today, although the seasons remained much the same as

they had been. A regulation prohibiting fishermen from fishing lobsters in more than one district in any one year was introduced at that time.

At the time these regulations were introduced the lobster fishery was just beginning to get over the effects of the depression. In 1933, at the height of the depression, average landed value was less than half that of 1927. With lack of employment during the depression, young men who lost their jobs returned to fishing, and others who would have found employment in other trades turned to fishing (Gordon 1952, p. 15). The influx of fishermen brought about by the depression was probably partly responsible for the increase in landings between 1928 and 1932 (Fig. 4). The increase in landings, however, was insufficient to offset the decrease in prices paid to fishermen so that by 1933 landed values were at a record 14-year low. After 1933 landed values increased, but not significantly, whereas the number of lobster fishermen remained at a high level until the outbreak of World War II. Prices between 1932 and 1940 remained low although landings declined sharply after 1932.

At the outbreak of World War II the lobster fishery was in a depressed state. Both landings and prices were nearly as low as in 1918. Landed value was only 20% above the 1918 value and was considerably below that of 1920. Employment was high (Table 10). The fishery had just passed through a period of stagnation lasting over 20 years. It was, however, to enter a period of relative prosperity.

### Post World War II Developments

World War II marked the beginning of an upward trend in production that culminated about 1960. Average landed values rose steadily from a low of 9.5¢/lb in 1940 to a high of 38.9¢/lb in 1959 (Table 8) in response to a strong, steadily increasing demand resulting from increasing affluence in western nations. Total landed values increased in the same period by over 500% (Table 9).

During the war, with British markets cut off, the value of exports of canned lobsters fell but exports of live lobsters increased, as American markets remained open. When the European markets reopened, exports once again increased, but the value of exports of canned lobsters continued the decline that had been taking place since 1920 (Table 11). The value of exports of live lobsters, on the other hand, increased dramatically in the 2 decades after the war (Table 11).

In 1940 a 6½-inch total length size limit was introduced into the "canner" areas, but in most "market" areas a 3⅞-inch carapace length limit remained in effect. A regulation requiring commercial lobster pound operators to liberate "berried" lobsters was also introduced in 1940. The MacLean Commission had urged the government to take this step, as it had been reported that lobster pounds sold "berried" lobsters (MacLean Commission 1928, p. 16). In 1957 permission was granted to commercial pound operators to hold and sell female lobsters that did not have eggs attached when first impounded, but became "berried" when retained, by purchasing a special permit for a yearly payment of \$1000.

During the 1940s and 1950s attempts were made both to enforce and to raise existing size limits. In the market lobster areas in 1941 the size limit was raised to 3½ inches carapace length, and in the canner areas it was raised to 7 inches total length. The latter limit was changed to 2¾ inches carapace length in 1951 but, because fishermen and packers complained that lobsters as small as 6½ inches total length could be landed, it was raised to 2½ inches in 1952 (Wilder 1954, p. 15).

TABLE 10. Number of persons engaged in lobster fishing, Maritimes, by provinces, 1928-71. (Source: 1928-52, Econ. Branch, Dep. Fish. For., Ottawa, Can.; 1959-71, Stat. Can. 1972a, b, c)

Year	N.S.	N.B.	P.E.I.	Maritimes
1928	8,406	2969	2102	13,477
1929	8,514	2760	1914	13,188
1930	8,547	3130	1989	13,666
1931	8,397	3123	1905	15,425
1932	9,394	3759	2625	15,778
1933	10,210	3975	2588	16,773
1934	10,604	4160	2674	17,438
1935	10,424	4060	2726	17,210
1936	11,112	4202	2697	18,011
1937	11,202	3963	2656	17,824
1938	10,798	4074	2521	17,393
1939	10,764	3926	2491	17,181
1940	9,427	3448	2001	14,876
1941	7,969	2834	1755	12,558
1942	7,563	2641	1648	11,812
1943	7,275	2733	1691	11,699
1944	7,431	3061	1775	12,267
1945	7,578	3258	1939	12,775
1946	8,678	3465	2431	14,574
1947	7,939	3461	2646	14,046
1948	8,234	3722	2462	14,418
1949	8,393	3396	2316	14,105
1950	9,761	3341	2313	15,415
1951	9,314	3051	2255	14,620
1952	9,108	2153	-	-
1953	- <sup>a</sup>	-	-	-
1954	-	-	-	-
1955	-	-	-	-
1956	-	-	-	-
1957	-	-	-	-
1958	-	-	-	-
1959	9,758	4197	2501	16,456
1960	9,802	4095	2280	16,177
1961	9,473	4202	2810	16,485
1962	9,527	4289	2792	16,608
1963	10,031	4144	2798	16,973
1964	10,085	4087	2809	16,981
1965	10,739	4293	3043	18,075
1966	9,468	3881	2898	16,247
1967	9,181	3741	3103	16,025
1968	9,432	3995	2993	16,420
1969	8,131	3482	2654	14,267 <sup>b</sup>
1970	7,464	3356	2470	13,290 <sup>b</sup>
1971	7,247	3247	2353	12,847 <sup>b</sup>
1972	-	-	-	12,543 <sup>b</sup>

<sup>a</sup>Indicates that figures are not available.

<sup>b</sup>Figures are for licensed fishermen. Only "operators" licensed these years, consequently, the total number of lobster fishermen is underestimated.

At the same time the size limit in the market areas was changed to 3 $\frac{3}{8}$  inches.

Changes in size limits for canner lobsters appear to have emanated from the Fisheries Research Board, whereas changes in size limit for market lobsters resulted from changes in Massachusetts legislation. Massachusetts raised its legal size limit in 1951. Because this market for live lobsters was so important, Canadian limits were adjusted to conform with those of Massachusetts. This change clearly demonstrates the effect of United States legislation on size limits regulating the Canadian lobster fishery.

TABLE 11. Value of exports of live and canned lobsters from Canada, 1911-71, 5-year intervals.<sup>a</sup> (Value of live and canned lobsters is given in thousands of dollars.) (Sources: 1911-56, Fish. Intell. Branch, Dep. Environ., Halifax, N.S.; 1961-1971, Stat. Can. 1971-72d)

Year	Live	Canned
1911	567	3081 <sup>b</sup>
1916	1,038	3639 <sup>b</sup>
1921	1,403	3756 <sup>b</sup>
1926	1,350	3607
1931	1,876	3113
1936	2,101	2080
1941	1,463	739
1946	9,572	3781
1951	11,798	2214
1956	16,846	2073
1961	18,781	2064
1966	22,160	2591
1971	23,915	1492

<sup>a</sup>Figures for exports from the Maritime Provinces are not available.

<sup>b</sup>Fiscal year ending March 31, following year.

A measure designed to produce better enforcement of size limits and to reduce mortality was introduced in 1949. Largely as a result of Wilder's lath-spacing experiments, fishermen in the market areas were required to have a 1 $\frac{5}{8}$ -inch space between the two bottom laths of their traps and those in the canner areas a 1 $\frac{1}{4}$ -inch space.

"In some areas the new regulations were adopted with enthusiasm . . . In other areas, particularly those where sub-legal lobsters were abundant and could be sold readily, enforcement proved extremely difficult . . . With fishermen's opposition increasing in some areas and general enforcement difficulties continuing, the regulations were rescinded in February 1955 in New Brunswick, Nova Scotia and Prince Edward Island . . ." (Wilder 1965, p. 27)

In 1945, capital mobility in the lobster fishery was restricted by an Order in Council (P.C. 2528, April 12, 1945) that stated:

"No one shall, during the lobster fishing season of any year, use in lobster fishing, any boat, trap or other lobster fishing equipment that had been used during that year in lobster fishing operations in any other lobster district."

Because of enforcement difficulties, the part of the regulation referring to traps and other equipment was rescinded in 1959.

One of the main concerns of the federal government in the 1960s, with respect to the lobster fishery, was more efficient management in an attempt to increase net incomes of fishermen. As it is generally agreed, and history has proved, that the same total catch of lobsters can be taken with much less total fishing effort, regulations controlling effort were introduced. Effort control is expected to reduce unit fishing costs so that net incomes will be increased providing revenue does not change.

The methods adopted to control fishing effort were trap and license limitations. The first trap limit was introduced in 1966, when a maximum of 250 traps per boat was permitted in District 8. The following year a 500-trap limit was applied to the northern part of Prince Edward Island in District 7B. In 1968, trap limits were introduced into all other districts of the Maritime Provinces (see Fig. 3). License limitation was applied to fishermen in 1967 and changed to boats in 1969.

A significant development of the 1970s was the opening of the offshore lobster fishery to Canadian vessels. The federal government first attempted to open this fishery in 1970 but opposition to the move from inshore fishermen, who feared it might have a detrimental effect on the inshore lobster fishery, was apparently responsible for it not being opened that year. It was, however, opened in 1971 as part of a plan to convert displaced swordfishing vessels to other fisheries.

Lobster landings in the Maritime Provinces declined from 43.5 million lb in 1960 to 27.9 million lb in 1972 although total landed value increased from \$15.5 million to \$30.8 million. With a decrease in the number of lobster fishermen from 16,177 in 1960 to 12,543 in 1972 (Fish. Intell. Branch, Halifax, N.S.), average landed value per fishermen increased during the same period from \$906 to \$4476 (Table 9 and 10) with average landed value per pound increasing from \$0.36 in 1960 to \$1.18 in 1972 (Table 8). Some fishermen from southwestern Nova Scotia have received up to \$2.50/lb (February 1973).



G. Lobster fishing preparations at Lower Woods Harbour, Shelburne Co., N.S.

Despite the decline in landings, the lobster fishery appears to be relatively healthy, compared to fisheries for some other species (haddock, herring, and redfish, to name a few). There is no real cause for alarm over the low level of landings in 1972, as landings of lobsters have been lower in 6 of the 45 years since 1917 and have always recovered. Research on stocks has not progressed to the stage where the direction of a change in landings can be predicted, let alone the magnitude of change.

An interesting phenomenon of the middle 1960s and 1970s is the revival of interest in lobster aquaculture and transplants to other areas. In 1965 approximately 1200 adult lobsters (Ghelardi 1967, p. 36) were transplanted to British Colum-

bia. The following year (1966), an additional 5000 adults were transplanted to the same area (Anon. 1969, p. 9). Although these lobsters are surviving, it cannot be determined at this point whether a commercial operation would be feasible (Wilder 1972, p. 89). Lobsters can be reared under artificial conditions to smaller than currently acceptable market sizes, but the costs involved are so great that lobster culture cannot, at present, be considered a viable alternative to natural rearing (Wilder 1972, p. 87-90). Experiments are being conducted throughout Europe and North America, and it is possible that a breakthrough sometime in the future will enable lobsters to be reared economically under artificial conditions.

## THEORETICAL ASPECTS

### Demand

The biggest demand for lobsters and lobster products produced in Canada comes from the United States. Europe has, however, imported large quantities of canned products. Within North America most live and processed lobsters are sold in the east. Development of good freezing facilities, recirculating seawater tanks, and improved transportation methods has led to greater quantities being shipped inland, and this trend is likely to continue. Table 12 gives Canadian production, exports, imports, and retention of lobsters and lobster products for 1969.

There is probably no close substitute for the American lobster, particularly when sold in the shell (Dep. Fish. and Fish. Res. Board Can. 1957, p. 94; Pontecorvo 1962, p. 271). However, other high-priced fishery products, such as salmon, may act as substitutes for shell lobsters in some instances. Spiny lobster tails may compete with fresh and frozen lobster meat, and canned shellfish, particularly crab, is apparently a good alternative to canned lobster meat.

It has been suggested that lobsters are an item

of "conspicuous consumption"; that is, some people may desire more lobsters at high prices than at low prices. It seems reasonable to assume that most consumers would be willing to purchase more lobsters at low prices than at high prices.

Lobsters are normally considered a luxury food, which means that consumers at high income levels will spend proportionately more on lobsters than will consumers at low income levels.

"Fishery products of the luxury class . . . are not substitutable by similar products, so that on scarcity their prices usually rise disproportionately, yielding to the fishermen more money for less production. On the other hand, the market for such items is definitely limited and excessive production will cause a sharp drop in prices." (Taylor 1951, p. 339)

Recent price-quantity data tend to confirm this observation. Between 1960 and 1972 Canadian lobster landings decreased by 50%. However, the average landed value increased by 228% with the result that total landed value increased by about 100%. The statement quoted above and data suggest that the demand for lobsters is inelastic with respect to price.

TABLE 12. Canadian production, exports, imports, and retention of lobsters and lobster products, 1969. (Figures are given in thousands of pounds.) (Sources: Dom. Bur. Stat. 1970e, 1971; Dep. Fish. For. 1970)

Item	Form		
	Live	Fresh and frozen meat	Canned meat and products
Canadian production <sup>a</sup>	29,557	3156	1177
Imports	1,045	-	-
Total Canadian supply	30,602	3156	1177
Exports to			
United States	16,542	2934	164
Other countries	963	137	325
Total exports	17,505	3071	489
Domestic retention	13,097	85	688
Exports to US as % of total Canadian supply	54%	94%	14%
Domestic retention as % of Canadian supply	43%	3%	59%
North American retention as % of Canadian supply	97%	96%	73%

<sup>a</sup>Adjusted for beginning and end of year holdings.

The relation between quantity landed and price can only be suggested because these variables reflect the demand for lobsters at the primary level, not at the consumer level. Perhaps more important, the effects of increases in the average level of incomes and population, the price of substitutes, and the extension of the market have not been considered. It is quite possible that the combined influence of these factors is more important in determining price than is the supply of lobsters. We can conclude, however, that if the effects of these variables were included, the price elasticity of demand would not be nearly so inelastic as the simple average landed value-landed quantity data would suggest. No attempt has been made to derive a statistical demand function. Waugh (quoted in Nash and Bell 1969, p. 11-13) calculated the following demand function for lobsters (live at the landings level):

$$X_1 = -1.2008 X_2 + 1.11746 X_3$$

(¢/lb)    (lb/100 persons)    (per capita \$)  
 (4.75)                      (14.99)

where  $X_1$  = price,  $X_2$  = quantity, and  $X_3$  = U.S. personal income.

The figures in brackets are *t*-values. The numerical function suggests that the price of lobsters is inelastic with respect to both quantity and income (direct price elasticity =  $1 / -1.20008 = -.83$  and income elasticity =  $.83 \times 1.11746 = .93$ ), but just barely so.

### The Enterprise

A lobster fishing enterprise is a combination of labor, capital, and skill. Each enterprise has a production function that expresses the technical relation between inputs and outputs.<sup>16</sup>

Normally, a firm uses various inputs to produce a product that differs from any of those inputs. In lobster fishing and fishing generally, however, the output is identical to one of the inputs. A lobster fisherman creates value by making lobsters accessible. Another assumption of economic analysis complicating its application to the fishing enterprise is that of factors in unlimited supply. For the lobster fishery this assumption cannot be made with respect to the lobster stock itself for, although lobsters in one sense are free goods that have not been produced but are available for the taking, there is a limit to the available stock in any year or season.

At the beginning of a season on a given ground there is a stock of legal-size lobsters. During the

fishing season the stock will increase as a result of growth, recruitment, and immigration, and will decrease as a result of natural mortality, fishing mortality, and emigration. The most important factor reducing the stock of lobsters available for capture during a fishing season appears to be fishing mortality. Reduction in the stock is reflected in the fishing operation by a decrease in catch per unit of fishing effort (catch per trap haul). This reduction is referred to in the literature as the "population effect" and is illustrated in Fig. 6 with data for one port in Prince Edward Island.

The result of the "population effect" is a change in the production function of an enterprise continually throughout the fishing season. At the beginning of a season a fisherman sets his traps with a certain probability of catching lobsters, and as the season progresses this probability changes, although a general trend may be predictable. Unlike most enterprises, where the amount of output for a given time period can be fixed or at least accurately predicted (other things being equal), in lobster fishing output is unpredictable, depending to a large extent on factors exogenous to the fishing operation.

The production function of an enterprise is affected by external diseconomies. If a small fishing enterprise operated on a large ground, the "population effect" would probably be non-operative, or at least unimportant, but when many enterprises are fishing, their collective actions reduce the lobster population throughout the season and, thus, each vessel imposes an external diseconomy on the others. As well, "beyond the scope of any vessel, but within a fishery, there may be interference with the efficiency of fishing, built up by the number of vessels" (Scott 1957, p. 46). This is evident in the lobster fishery

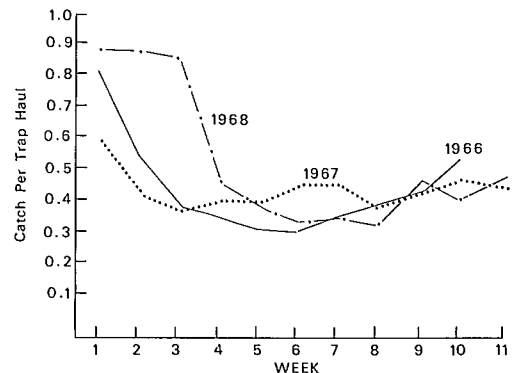


Fig. 6. Catch per trap haul, by week, Miminegash, P.E.I., 1966-68. (Data supplied by Fish. Res. Board Can., St. Andrews, N.B.)

<sup>16</sup>For the derivation of a fisheries production function see Gerhardsen (1952, p. 1-12).

when in congested fishing areas lines of traps are strung across each other or buoy lines are cut unintentionally.

External diseconomies in the above sense are largely a medium-run phenomenon. The medium run can be considered as a lobster fishing season, as only the quantities of some inputs can be varied. At the beginning of a season a fisherman has a boat and other necessary equipment and has made a decision on the number of traps he intends to fish. He can, however, vary the amount of time he fishes and thus vary his inputs of fuel, bait, labor, and so on. In the long run he can vary the quantities of all his inputs but in the short run he can vary the quantities of only one or two inputs.

In the short run (considered as 1 day because decisions on whether to fish are often made daily, especially towards the end of the season) most costs are fixed. Cost of fuel and bait is variable, as is cost of labor for some fishermen. Labor is a variable cost in the short run if it is paid a portion of the value of the catch, and is a fixed cost if it is paid on a daily, weekly, or seasonal basis.

The analysis of a fishing enterprise in the short run is complicated by the effect of the fishing operation on the stock of lobsters. An equal input of all factors other than lobsters will not produce the same output of lobsters at the end of a season as at the beginning because of the "population effect." Consequently, the short-run cost function of an enterprise will change continually throughout the fishing season. Therefore, there is a problem in attempting to apply analysis developed for a private property economy to a common property resource industry, even though the firms in the industry display the characteristics of firms in a perfectly competitive industry. Nevertheless, the reactions of an enterprise to changes in various factors affecting the fishing operations can be described.

The medium run or fishing season can be considered as a series of short runs with fixed costs equally distributed among the fishing days in the season, and with variable costs about equal for each fishing day. Variable costs include an opportunity cost of labor and capital, defined as the yield these factors will obtain in the best available alternative employment. At the first of the fishing season when large catches are being made, var-

iable costs per unit of output will be low and the rate of profit will be high. As the season progresses, with output being produced at a higher cost per unit, the rate of profit decreases. The fall in the rate of profit may be halted by a midseason price increase, or by an increase in the stock resulting from a molt, or it may be accentuated by a decrease in price. A fisherman who attempted to maintain his landings throughout the season by increasing his daily fishing effort would still find his profits reduced as a result of increased costs associated with a more intensive fishing effort. In effect, an individual fisherman is helpless trying to prevent his rate of profit from decreasing as the season progresses, as many of the factors affecting it are not within his control. A rational fisherman will continue to fish as long as he is covering average fixed costs and short-run variable costs. A fisherman whose opportunity costs of capital and labor are very low, or who is efficient in his use of inputs, might, therefore, fish an entire season, whereas a fisherman who has high opportunity costs, or who is inefficient in his use of inputs, might stop lobster fishing before the season closed.

Assuming little annual variation in fixed and operating costs and the opportunity cost of capital, much of the yearly variation in effort (measured in terms of time spent fishing) can be explained by changes in opportunity income. In years when high returns can be earned from other fishing activities or other jobs, fishermen will spend less time lobster fishing and vice versa. Opportunity income, although not the sole determinant of time spent fishing, is nevertheless important.

Gordon (1954, p. 124-142) suggested that the hope of fishermen for a lucky catch and the great occupational immobility of fishermen reduce their actual income below their opportunity income. Scott (1957, p. 43) argued that fishermen have low opportunity incomes because they are geographically and industrially unadaptable. Other reasons given for low opportunity incomes are the participation in fisheries of people who hold regular jobs and who have very little capital invested, and the tendency for fishermen with high opportunity incomes to move out of the fishery, leaving or attracting those with lower opportunity incomes (Sinclair 1960, p. 79-82).

In the long run fishermen who do not cover their costs from one year to the next will leave the fishery. If, however, fishermen have low opportunity incomes they may for long periods of time accept low financial returns from lobster fishing.

## The Fishery

The total catch of lobsters in any year depends largely upon the size of the stock of legal-size lobsters. Annual variations in the stock of legal-size lobsters are a function of growth of survivors from the previous year, recruitment, and natural mortality. From the time a virgin stock is first fished until the fishery becomes developed dynamic changes occur.

“Initially, when there is no fishing the natural losses from the stock are, on the average, just equal to the increments to the stock due to reproduction and growth. With the removal of a part of the stock by fishing, it is reduced to a lower abundance, but at this lower abundance its rate of replacement is larger, so that the removals from fishing are at least partially offset by the ability of the fish at lower population levels to reproduce, survive and grow better. The amount which the population can produce by the annual excess growth and reproduction over losses due to natural causes we may term the natural rate of increase for the given level of population. If, at any level of population, only that amount is caught each year which is capable of being produced each year by this natural rate of increase, the population and the catch would remain stabilized on the average. The catch which can, on the average, be obtained at a given level of population, without resulting in any net change in the size of the population, may be termed the equilibrium catch, because it is the catch which is in equilibrium with the productivity of the population at the given level.

“Now, as the fishery becomes increasingly intense and continues to remove each year a catch in excess of the equilibrium catch, the population falls continuously. The natural rate of increase and the corresponding equilibrium catch, however, rise for a time as the population falls. There is eventually reached a population level at which the equilibrium catch is maximal. Further increase in fishing intensity drives the population down to levels where the natural rate of increase, and the corresponding equilibrium catch, is less than maximum” (Schaefer 1953, p. 54).<sup>17</sup>

The relation between equilibrium catch or sustained yield and fishing intensity or effort is described in Fig. 7. Landings, which equal sustained yield, are measured on the vertical axis and effort on the horizontal axis. Effort in this case is a composite input of capital and labor. At a level of effort of  $Ob$  sustained yield and landings are at a maximum. Higher and lower levels of effort yield lower landings and sustained yields. It is probable that a developed fishery, such as the lobster fishery, will be operating at a level of effort beyond  $Ob$ , say  $Oc$ .

By introducing product prices the landings function can be converted to a total revenue function. If demand is perfectly elastic, i.e.

quantity landed does not affect price, then the total revenue function will have the same shape as the landings function. A unitary elastic demand will make the total revenue function a horizontal straight line while an inelastic demand will give a U-shaped total revenue function.<sup>18</sup> For the sake of simplicity demand will be considered perfectly elastic. By introducing costs the economic optimum level of exploitation of the fishery can be determined. Because the situation depicted here is the long run, all costs are variable, thus, the total cost curve begins at the origin. Aggregate costs are assumed to be a linear function of effort, although they could be assumed to increase more than proportionally to effort. This would occur if increased effort led to increased factor prices. The total cost and revenue functions are depicted in Fig. 8.

The optimum degree of utilization has been defined as “that which maximizes the net economic yield, the difference between total cost, on the one hand, and total receipts (or total value product), on the other” (Gordon 1954, p. 129).

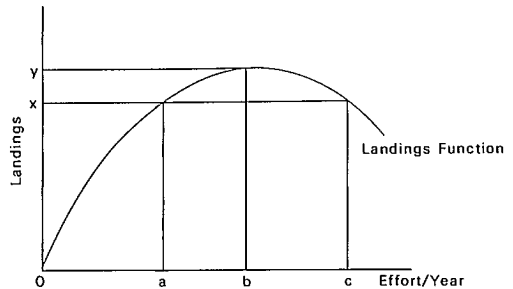


FIG. 7. Landings function.

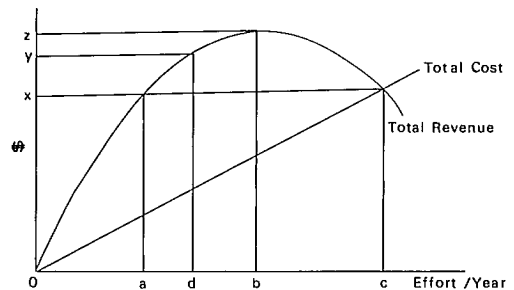


FIG. 8. Total cost and revenue functions of a fishery.

<sup>17</sup>(See also Russell 1931, p. 3-20; Schaefer 1954, p. 27-56, 1957, p. 669-681; Christy and Scott 1965, p. 7-8; Gordon 1954, p. 135-142.)

<sup>18</sup>A good discussion of the effect of various elasticities on the shape of the total revenue function is contained in Hutchings et al. (1967, p. 15-20).



H. Boat bound for fishing grounds (southwestern Nova Scotia).

This occurs at  $Od$  of effort in Fig. 8, where (diminishing returns being in effect) the rate of increase in revenue is equal to the rate of increase in cost. As there is a tendency for fishermen to increase their effort relative to other fishermen (Christy and Scott 1965, p. 7, or Bottemanne 1959, p. 264), and as, the resource being common property, anyone may enter the fishery, the net economic yield, or rent, is dissipated because of excess capital and labor.<sup>19</sup> The fishery will tend to operate at the point where total cost equals total revenue or marginal cost equals average revenue. To maximize net economic yield effort has to be reduced to  $Od$ , at which point marginal cost equals marginal revenue.

At  $Oc$  of effort some fishermen will be making a profit whereas others will be losing. Those fishermen who have superior skills or equipment will receive a quasi-rent, i.e. a return above their opportunity cost of capital and labor. Those who are less skilled or have inferior equipment may not earn enough to cover their opportunity costs. "If total revenue exceeds total cost, resources not in the industry will find it worth while to move into it, while in the reverse case some resources at the margin will be earning less than is required to retain them in the industry, and they will leave it" (Turvey 1964, p. 67). At the level of effort where total cost equals total revenue the fishery is in equilibrium and there is no incentive to move from this position. However, a shift in the cost or revenue functions resulting from, say, a change in factor or product prices will lead to disequilibrium and the fishery will adjust to a new equilibrium where total cost once again equals total revenue, but at a higher or lower level of effort.

The total revenue function is an expression of what consumers are willing to pay in the aggregate for various amounts of product, and total cost represents the cost to society of producing these amounts. Assuming no price effects, if effort were reduced to  $Od$  in Fig. 8, the fishery would receive a net economic yield and society would be better off because the net value product yield (including lobsters) from all factors of production would be increased. In the case of a total revenue function that is eumetric, society would still be better off if the net economic yield were at a maximum because there would be a greater total product at a reduced cost to society. This is

<sup>19</sup>(See Gordon 1953, p. 449-454.) A good discussion of the dissipation of rent in the lobster fishery by overcapitalization and excess effort is contained in Pontecorvo (1962, p. 284-293).

illustrated in Fig. 9. If effort were reduced from  $Ob$  to  $Oa$  then the total value of output in the fishery would be  $Ow$  and total cost would be  $Ox$ . The distance  $xy$  on the vertical axis represents the net value product of displaced factors. The total value of output of the fishery and displaced factors is thus  $Oz$  and total cost is  $Oy$ . Society has a gain in the total value of output of  $zy$  that, of course, is equal to  $wx$  - the net economic yield of the fishery.

Even though maximizing net economic yield appears desirable, it may not be the best move according to the "second best" argument, as making one industry fulfill optimal resource allocation conditions may distort resource allocation even more, if these conditions are not met in the rest of the economy. Maximizing net economic yield is further complicated when time is considered because the social rate of discount must be taken into account (MacKenzie 1959, p. 20; Scott 1955b, p. 122-123).

Maximizing net economic yield over time is the economic rationale of conservation (Scott 1955b, p. 16-22, 58-60). The principal difference between the economist who recommends maximizing net economic yield over time, and the biologist who recommends maximizing sustained yield is that economists consider the costs of fishing that are sometimes disregarded by biologists. Assuming it is desirable to maximize net economic yield for the lobster fishery, there remains the problem of how to manage the fishery to achieve this goal.

## Management

Management normally, but not always, involves some form of regulation. One management method, recommended both by economists and biologists, is a reduction in fishing effort if a

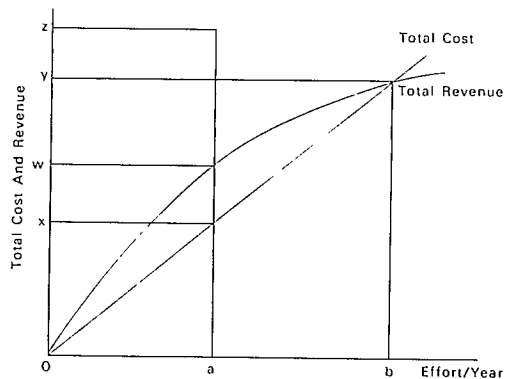


FIG. 9. Total output of a fishery and displaced factors,

fishery is operating beyond its maximum sustainable and net economic yield. Beverton (1953, p. 66-67) pointed out that social and political objectives may make it desirable for effort to be somewhat greater than that called for by economic objectives alone, though this will make a fishery less profitable. If, for instance, there is a large displacement of labor and capital from the industry that could not find alternative employment at comparable returns, then reducing effort sufficiently to maximize net economic yield may involve implicit social costs. It may be necessary to maximize the net economic yield to complementary fisheries. "The fact that the lobster... fishery is complementary to other fisheries or other occupations might justify a somewhat larger entry of fishermen, boats, and gear than would be justified on the basis of the net economic yield in the one fishery alone" (Frick 1957, p. 685).

Even if effort were reduced sufficiently to return some or all of the rent (net economic yield) to the fishery there is a problem of what to do with it. There are basically three alternatives: (1) it could accrue to the government as landlord, either to be put into general revenue or to be designated for research and development of the fishery, (2) it could be returned to the fishermen or, (3) it could be used to compensate those fishermen displaced from the fishery. On ethical grounds, the last alternative would probably be the most desirable (Frick 1957, p. 686).

One method of reducing fishing effort and thus capturing the rent is by limiting entry to the fishery. It has been suggested that limiting the number of fishermen but not the amount of gear would capture some rent that would be distributed among a smaller number of fishermen, that limiting gear but not fishermen would distribute rent among a larger number of fishermen, and that restricting both would give more rent to fewer fishermen (Pontecorvo 1962, p. 287). However, if the number of fishermen were limited, effort might not be reduced if there was an increase in the number of traps, although restricting traps might have no effect on effort if the number of fishermen increased. If effort is to be reduced both fishermen and traps should be limited.

Limiting fishermen can take at least three forms (Scott 1962, p. 50-54). One system gives the right to fish to those who are in the fishery. As fishermen leave their licenses are not renewed. When the number of fishermen is at the desired level new entrants are allowed to replace those

who leave. A second method is a buying-in scheme. Those who are in the fishery have to buy their licenses, and as they leave or die their licenses can be purchased either by another fisherman or by the government. The desired fleet size can be reached by the government buying or selling licenses. The third method is for the number of licenses to be fixed at the start and sold either at a price set by the government or by auction. The rent thus captured would accrue to the government.

The first method, although perhaps most politically acceptable, requires a long time to implement and allows the rent to accrue to those who remain in the fishery and whose position is protected by restrictive legislation. The second alternative suffers the same time defect and, presuming the government has to buy licenses initially, may be more expensive, depending on the revenue from selling licenses. It has the advantage of allowing anyone to enter the fishery. The third method captures the rent immediately but may increase unemployment initially.

Another method of limiting entry is by taxation. It differs from a licensing system in that it attempts to reduce effort by using a levy to eliminate inefficient enterprises. There are basically two types of taxes that could be used, a tax on catch or a lump-sum tax (license fee with no restriction on who may purchase one). A lump-sum tax will not affect the effort of a fisherman because marginal cost will equal marginal revenue at the same level of effort. A tax on catch, on the other hand, will shift the average and marginal cost curves to the left and profits will be maximized at a lower level of effort. In other words, a lump-sum tax can be expected to eliminate the small inefficient enterprises, whereas a tax on catch may simply mean that all fishermen remain but capture fewer lobsters.

Regulating entry alone would not, according to Turvey (1964), lead to an optimum position when the rest of the economy is considered. For this position, referred to in economic jargon as the *optimum optimorum*, to be reached, mesh size (size limits or lath spacing in the lobster fishery) must also be regulated.<sup>20</sup> Thus it is necessary to regulate the fishery, first to place it on the eumetric yield curve (Fig. 10), and then to maximize the net economic return (Fig. 11). Control of entry is a necessary but insufficient condition when the rest of the economy is considered and, if a fishery is not operating along the eumetric yield curve, control of entry may not maximize the net economic yield unless size limits are also adjusted.

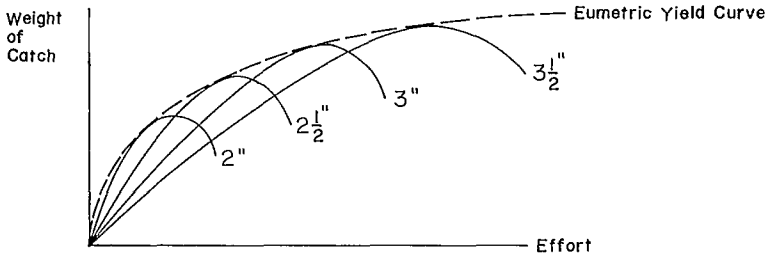


FIG. 10. Eumetric yield curve.

A necessary, but insufficient, condition for maximization is that mesh size be such as to maximize the catch for the actual level of fishing effort. This simply means that fishing must be on the eumetric yield curve that, in the case of the lobster fishery, is derived by plotting the maximum point of yield functions corresponding to various size limits. This is done in Fig. 10. The numbers 2,  $2\frac{1}{2}$ , 3, and  $3\frac{1}{2}$  represent size limits. If a greater weight of lobsters were captured at smaller size limits then the numbers could be reversed. Each yield curve shows diminishing returns resulting from the "population effect." The eumetric yield curve will not diminish, however, and becomes asymptotic. This is likely unrealistic for very large and very small size limits. All that needs to be assumed is that it follows the pattern shown over the relevant range.

The *optimum optimorum* is illustrated in Fig. 11. At  $O$  of effort  $G$  is maximized. In an unregulated eumetric fishery total costs equal total revenue and the total gain ( $G$ ) from the fishery is equal to consumer surplus plus rent of the intramarginal units, i.e.  $S+R$ . This occurs at  $O$  of effort. It is

likely that the lobster fishery is close to this position. (See Pontecorvo 1962, p. 284.)

Two types of regulations frequently considered by resource managers are quotas and seasons (Gordon 1953, p. 455-456; MacKenzie 1958, p. 21-24). With quotas that stipulate the total amount of fish to be caught (when no restrictions are put on the size of fishing enterprises), there is a tendency for each enterprise acting in its own interest to increase in size, so that any net yield that might have resulted disappears as a result of overcapitalization. The annual catch of fish is also landed much more quickly when quotas are established. There are hidden costs as well: boats are forced to diversify and are less efficient than specialized boats, the shortness of the season leads to increased costs of storage and handling, and landings are concentrated in ports nearest the fishing grounds (Crutchfield 1956, p. 294). Seasons have the same defects as quotas. These two types of regulation are clearly less desirable than either effort control or taxes.

Another method of management proposed by Popper (1956) and Scott (1955a) is to turn fishing grounds into sole ownership. In a national fishery such as the lobster fishery where grounds are fairly well demarcated, this could be accomplished

<sup>20</sup>Turvey (1964, p. 70-72) assumed that perfect competition exists in the rest of the economy, that changes in fish prices have no effect on the distribution of real income between consumers of fish and others, that marginal factors are earning socially acceptable incomes, and that the fishery is a small part of the economy. "Under these conditions, the *optimum optimorum* is reached when  $G$  is maximized,  $G$  being the excess of the value of the catch to consumers over the value to them of alternative goods and services sacrificed by devoting resources to fishing." The value of the catch to consumers is what they actually pay plus the consumer surplus (what they would be willing to pay rather than go without). The value of goods and services sacrificed is equal to the total cost of fishing minus the quasi-rents of the intramarginal factors. The *optimum optimorum* is attained by maximizing  $G = (TR+S)-(TC-R)$  where  $TR$  = total revenue,  $S$  = consumer surplus,  $TC$  = total cost, and  $R$  = rent of intramarginal units.

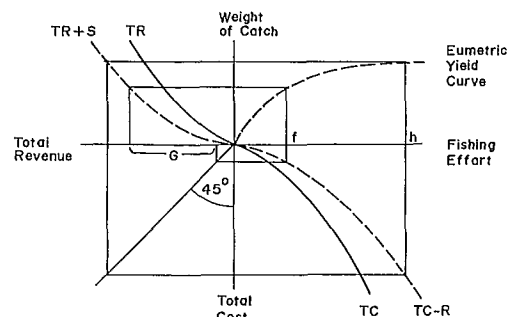


FIG. 11. *Optimum optimorum* of a fishery.



I. Setting traps (southwestern Nova Scotia).

easily. Popper (1956) suggested that the right to fish lobsters on a given ground could be given (or sold) to a company composed of all the fishermen in the area. "Ownership of a particular ground does not necessarily entail monopoly advantages" (Scott 1962, p. 66). This would occur, however, if all grounds were owned by one company and the species, like lobster, had no close substitute.

In the short run the sole owner would operate at the level of output where marginal cost equals price. In the long run, with guaranteed property rights, he would attempt to maximize the present value of the fishery by equating marginal user cost to marginal net revenue.<sup>21</sup> If perfect competition existed in the rest of the economy, output under sole ownership would tend to be closer to the optimum than under common property ownership.

"By equating marginal user cost and marginal net return, we have a situation where the marginal productivity of each factor is the same wherever it is used, and where the allocation of production over time corresponds to the rate of discount determined by the marginal rate of time preference of the community." (Scott 1955a, p. 124)

Copes (1970) argued that, in a fishery not capable of being divided into separate fishing grounds, there is no a priori reason to advocate sole ownership (whether it be by consumers collectively, producers collectively, or by an individual with exclusive user rights) over free entry,

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<sup>21</sup>User costs result from resources being common property. It is the cost to society of the loss of production in the future from too great a fishing effort being applied in the present. If a fisherman abstains from fishing, others will capture his share of the catch and so he does not benefit from conserving the resource. It might, however, from society's viewpoint, be desirable to conserve the resource. The costs of using the resource are therefore borne by society, not the fishermen, and there is a divergence between private costs and user costs. (Scott 1955a, p. 122-123; 1955b, p. 62)

as the net social benefits under sole ownership could be less than the net social benefits under free entry.<sup>22</sup> In the case of a fishery that can be so divided, sole ownership will lead to a social optimum and is superior to free entry. In the former case, i.e. when a fishery is not capable of being demarcated, and assuming optimal techniques and fixed combinations of factors in the rest of the world, ignoring externalities, and neglecting income redistribution effects of factor and product price changes, the socially optimum equilibrium can result from entry control.

We thus have several methods by which to maximize the net economic yield of the lobster fishery. It could be maximized by restricting entry (boats, gear, and fishermen), by taxation, or by converting grounds to sole ownership. Quotas and size limits, by themselves, are not economically sound methods of management, although size limits may be a prerequisite to other types of management. All methods are similar in that output is reduced by some form of control of capital and labor inputs into the fishery. Given our present inadequate knowledge of the behavior of lobster stocks and the costs and returns of fishing enterprises, the most we can hope for is that we are moving in the right direction, i.e. towards the maximum net economic yield. Although control of entry may lead to a suboptimum position when the rest of the economy is taken into consideration, this need not be a deterrent to advocating a policy of maximizing net economic yield of the lobster fishery because perfect competition does not exist in the rest of the economy.

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<sup>22</sup>Copes' paper, in effect, is an extension and refinement of the arguments put forward by Turvey (1964). Both writers analyzed social benefits in terms of consumers' surplus, producers' surplus, and resource rent. However, whereas Turvey focused on the production function and regulatory controls necessary to produce a social optimum, Copes focused on types of resource ownership that would produce a social optimum.

## ECONOMIC EFFECTS OF REGULATIONS

The economic effects of regulations are difficult to determine. Biological and economic factors may combine to produce a result that cannot be attributed largely to either one. Because many regulations now in effect were introduced at an early stage in the fishery's development, information that does exist regarding their effects is often too general or too unreliable to be useful. Most of the available specific information is of a biological nature. Economic effects often take a long time to be resolved and the process of change is not easily discernible. As a result of these and other limitations, discussions of the economic effects of regulations have been mainly theoretical.<sup>23</sup> More work has been done on the biological effects of regulations.<sup>24</sup> Data have recently been collected by the federal Department of the Environment on the effects of gear and license limitation, but the results are not yet available.

The usual method of analyzing each regulation separately has been rejected. Instead, what are considered important economic factors have been selected, and regulations have been analyzed in terms of their effects on these factors. Regulations have been judged in terms of their effects on efficiency. Other criteria, however, have been included where appropriate.

### Technology

According to Scott (1962, p. 45), most gear regulations have been introduced to protect vested interests. This probably applies to the lobster fishery, for the regulation introduced in 1914 limiting technology to the trap stated that "the use of trawls or implements other than traps . . . is prohibited in lobster fishing" (*Lobster Fishery Regulations* [Order in Council, March 25, 1914], sect. 17). An earlier regulation (1910) stated that "the use of trawls for the purpose of catching lobsters is prohibited in the waters of the counties of Gaspé and Bonaventure in the province of Quebec" (*Lobster Fishery Regulations* [Order in Council, Sept. 20, 1910], set. 18). The

trawls referred to are the lines of hoop traps that were still being used in the early 20th century.

Limiting the method of capture to the trap has meant that other technological innovations, such as the introduction of trap haulers, have been developed in relation to this method. Some technological innovations that might be more efficient than trapping may have been prevented because of this regulation.

There are at least two alternative methods of capturing lobsters that might be feasible—dragging and diving. Diving would involve no expense for traps, rope, buoys, and bait, and less expensive boats could probably be used. On the other hand, there would be fairly substantial expenditures for diving equipment. Other operating costs would probably be more or less equal in both cases. The principal deterrent to this method of capture is an institutional one, i.e. fishermen would likely be unwilling to learn the necessary techniques, although a sport fishery is a distinct possibility. Diving for lobsters on a commercial basis is practised in Massachusetts and, in 1969, 40,400 lb valued at \$40,814 were recorded (U.S. Dep. Commer. 1971, p. 114).

United States boats have dragged for lobsters since the mid-1950s on the banks off the north-eastern United States. The boats and crews are larger than in the inshore fishery and they exploit a different stock under different conditions. The United States offshore fleet is switching from a trawl fishery to a trap fishery which indicates that, as a stock is exploited near its maximum sustainable yield (as is the case in the inshore fishery), trapping is more efficient than trawling.

Traps other than the standard type required by the regulations also offer possibilities. In experiments using wooden and metal traps Wilder (1956, p. 34-35) found that, in general, metal traps caught fewer lobsters per haul, retained more short lobsters, were more difficult to set upright, but withstood storms better than wooden traps. He estimated the cost of four-bow metal traps to be approximately twice the cost of comparable wooden traps, excluding labor. There is no clear evidence to suggest that one type is more efficient as total costs, relative catching

<sup>23</sup>The two principal works are Pontecorvo (1962, p. 242-297), and Rutherford et al. (1967, p. 81-92).

<sup>24</sup>Mainly the work done by Wilder (1958, p. 13-16; 1965, p. 21-29).

power, length of life, and amount of loss of each type are not known.

In an experiment conducted in England using scoops (hoop traps) and creels (wooden traps), it was found that scoops were more technically efficient than creels when the population of lobsters was dense, such as in a pound, and that efficiency increased with increasing concentration of lobsters (Thomas 1953, p. 334). Scoops also caught more lobsters over 10½ inches total length and under 8½ inches (Thomas 1953, p. 336–338). This result stems from the selectivity of the ring and lath spaces of the trap (Wilder 1943, p. 22–24). Whether hoop traps would be a feasible method of capture today is unknown. It seems unlikely that they would capture as many lobsters on “normal” grounds. The cost, durability, and effort required with hoop traps are not available.

The regulation that has restricted the method of capture to the standard trap may or may not have reduced efficiency. We do not know whether, in the absence of this regulation, innovations would have resulted. No such regulation exists in Maine, yet commercial lobster fishing there is virtually the same as in the Maritimes. However, diving for lobsters as a sport is fairly widespread in Maine. Scott (1962, p. 45) suggested with regard to regulations respecting technology that “the removal of existing regulations is something that should be tempered with mercy for those who have invested in the belief that the regulations will be permanent.”

## Production

Historically, annual landings (production) have been subject to two trends. There are very long-term trends that have been divided into three phases and can be explained largely by changes in fishing effort and their effect on the stock. Since 1918 there have been short cycles averaging about 5 but varying from 2 to 9 years. These short-term cycles are difficult to explain.

The conclusion reached in the second chapter was that regulations specifying closed seasons, minimum size limits, and the protection of “berried” females have had little, if any, effect on conserving the stock. Originally introduced to prevent lobsters in poor condition from being canned, closed seasons were changed with a view to decreasing exploitation. In the past, the fishery adjusted to shorter seasons by employing more men, boats, and gear with the result that, as a general rule, the rate of exploitation did not

change (Wilder 1965, p. 22). Where minimum size limits have been introduced there does not appear to have been any significant change in landings (Wilder 1965, p. 24–26). In Prince Edward Island, for instance, size limits were introduced in 1940. In the 25 years following their introduction, landings averaged about 7.7 million lb compared to about 7.8 million lb for the 25 years previous to 1940 — a decrease of 1.7%. No relation has been found between the number of egg-bearing females and commercial landings (Wilder 1965, p. 26). We must conclude, therefore, that the protection of “berried” females has little effect on annual landings.

Economic factors also appear to have had little effect. In one study no correlation was found among personal expenditures on consumer goods and services, average prices deflated by the cost of living index, and landings (Gordon 1955, p. 85–92). There is no statistically significant correlation between annual landings and number of traps (Rutherford et al. 1967, p. 9), nor between number of lobster fishermen and annual landings ( $R^2 < .01$ ).

Apparently natural factors such as food supply, predation, competition, and water temperature have a more important effect on stocks and, hence, annual landings than regulations or economic factors. Of these, water temperature may be the most important. In Maine there appears to be a high correlation between seawater temperature and landings for the period 1905–67 (Dow 1969, p. 1060–1063). If this observation can be generalized, then apparently little can be done to increase annual landings.

The pattern of production is greatly influenced by seasonal closures. Seasons prevent Canadian production from coinciding with the peak period of United States production. In Fig. 12 average monthly landings from 1963 to 1967 for the United States and the Maritimes are given. Average landed value per pound for lobsters from Maine (about 80% of United States' landings) and the Maritime Provinces for the same years are illustrated in Fig. 13.

The pattern of exports of live lobsters to the United States is much the same as Canadian production. Figure 14 gives the average monthly quantity and value per pound for the period 1965–68. The data suggest that some benefit might be derived from a greater export of live lobsters in the fall, with a lesser quantity exported in May and June when prices are lowest. This could possibly be accomplished by modifying seasons. If, as a result, the total value of exports increased,

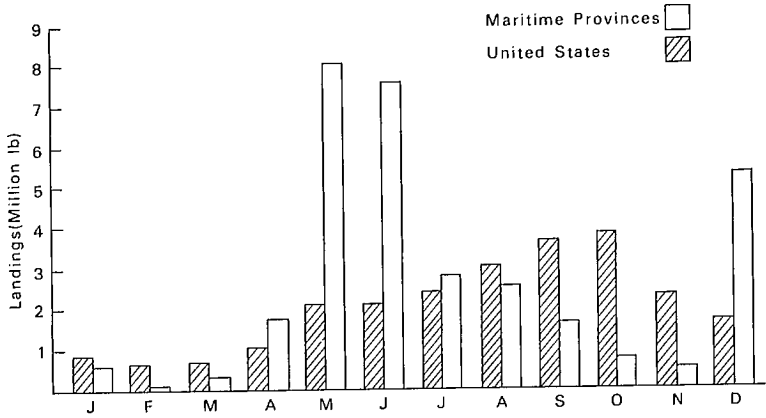


FIG. 12. Average monthly landings of lobsters, United States and Maritime Provinces, 1963-67. (Source: Dom. Bur. Stat. 1963-67; U.S. Dep. Int. 1963-67.)

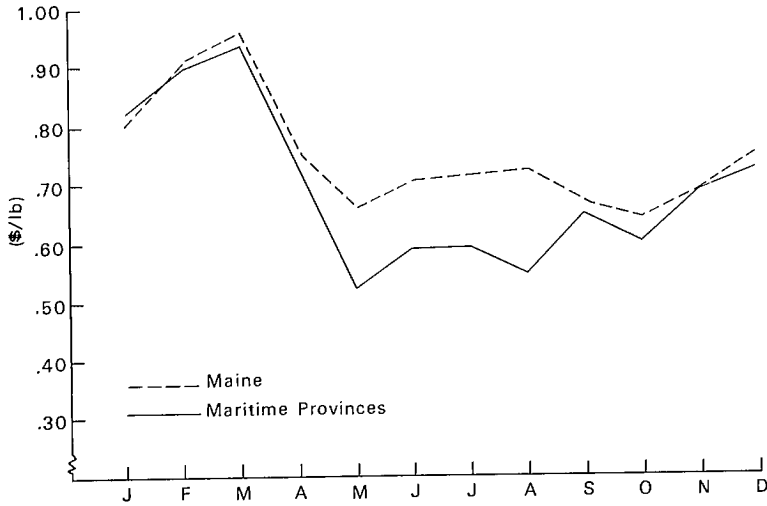


FIG. 13. Average landed value of Maine and Maritime Provinces lobsters, by month, 1963-67. (Source: Dom. Bur. Stat. 1963-67.)

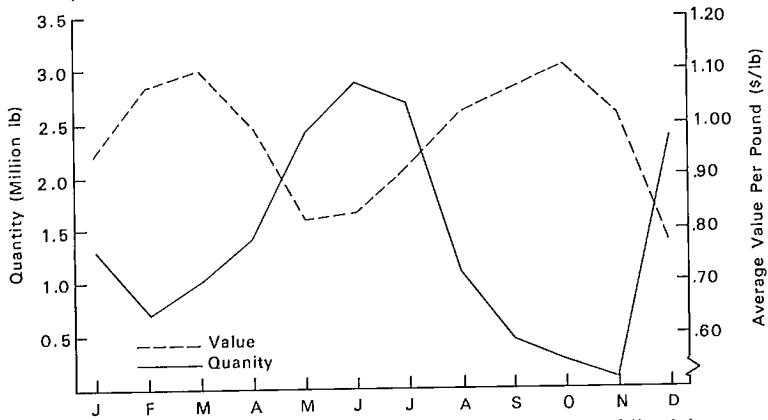


FIG. 14. Average quantity and average unit value of exports of live lobsters to United States, by months, 1965-68. (Source: Dom. Bur. Stat. 1965-68.)

there would be a gain to producers but a loss to consumers. From a Canadian point of view, the gain to Canadian producers would be more important than the loss to American consumers.

Wilder (1958, p. 14) argued that "closed seasons have improved the quality of the lobsters in that less than 20% are caught from July to September when they are soft-shelled and slack meated, difficult to hold and ship and give a poor meat yield." He further argued that thought might be given to a universal open season between October and June as fishermen, taking into account weather, possible catch, and price, would learn how much gear to use and when to fish (Wilder 1954, p. 14). Under such a system of open seasons, however, landings might be concentrated in the early fall, as they are in the United States where there are no seasonal closures (Wilder 1958, p. 15).

The problem of specifying seasons is that several factors must be considered. Ice conditions, particularly in the Gulf of St. Lawrence, rule out winter and early spring fishing. Quality (a determinant of price) considerations support a closed season from July to September. If price is a prime concern, then thought could be given to alleviating the depressing influence on prices of large landings in late spring, particularly since fall landings in the United States do not appear to affect greatly the price of fall landings in the Maritimes. Some gain in total revenue might result if some of the districts that now have a spring season were changed to a fall season. If, as a result, the price of lobsters increased in the spring and was greater in the fall than it was in the spring formerly, then there would be a gain in welfare to those who formerly fished the spring season and those who continued to fish the spring season. There would be a loss in welfare to those who formerly fished the fall season if prices in the fall decreased. This change would appear to be a desirable one if total revenue increased and if the loss in revenue to those formerly fishing the fall season were of no concern, or if these fishermen were compensated for their loss.

### **Productivity**

Productivity can be measured in terms of landings per boat, per trap, per fisherman, or per area. Long-term measurements using published statistics are, however, subject to rather serious shortcomings (Rutherford et al. 1967, p. 7-13). A more difficult to obtain, but perhaps better measure of productivity is catch per trap

haul. In Fig. 15 and 16 catch per trap haul, landings per boat, and average number of traps set together with their linear least square estimates are plotted for two ports in the Maritime Provinces for 1945-68. At each port the catch per boat increased, although the increase was not so great as the decrease in catch per trap haul or increase in the average number of traps set. It appears that fishermen tried to offset a decline in productivity per trap by setting larger numbers of traps, which resulted in a fairly constant productivity per boat. At Port Maitland the number of boats decreased from 38 to 20, while at Miminogash the number decreased from 68 to 42 between 1945 and 1952 and then increased to about 70 in 1965. A decrease in the population of lobsters at Port Maitland was apparent during this period (D. G. Wilder personal communication).

Productivity is probably determined largely by natural factors affecting the lobster stock and economic factors affecting participation in the fishery. If the rate of exploitation of the stock does not change, a trap limit that reduces the total number of traps fished should increase catch per trap haul, provided traps are not hauled more frequently. A decrease in the number of boats through license limitation should lead to an increase in landings per boat, assuming the rate of exploitation does not change.

Productivity per fisherman or per boat may be of particular importance when considering economic development, especially to a province like Prince Edward Island, where the lobster fishery makes a substantial contribution to the provincial product. Economic development can take place through an increase in real output per person. If output per person in the lobster fishery remains constant or declines, then this sector may, under some circumstances, hold back growth in other sectors. The addition of fishermen and capital aggravates the situation because, with a relatively constant total real output, the productivity of capital and labor must decrease. One solution is to decrease the number of fishermen and amount of capital in the lobster fishery, and increase labor and capital in other sectors where productivity is as high as or higher than in lobster fishing.

### **Net Economic Yield**

In the fourth chapter, it was suggested that the net economic yield of the lobster fishery has been dissipated. This probably occurred not because of regulations in effect but rather as a result of

the absence of regulations limiting fishing effort. Trap limits and license limitation are an attempt to restore some of the net economic yield.

There are now two classes of licenses that apply to boats and not to fishermen. Class "B" licenses are issued to all boats from which less than 100, 75, or 50 traps, depending on the district, were fished in 1968 (Fig. 3). Class "A" licenses are issued to all boats and replacements from which more traps than the upper limit for Class "B" were fished in 1968. The maximum limits established in 1968 still apply to these boats. If a fisherman with a class "B" boat stops lobster fishing then the license that goes with his boat is not renewed. If, however, a fisherman with a class "A" boat ceases to fish, he may sell his boat license. The maximum number of traps fished from a class "B" boat is the number fished from

that boat in 1968 but the number of traps fished from a class "A" boat can vary between the minimum and maximum limits for each district established in 1968. These regulations are designed to put an upper limit on the number of boats. As fishermen with class "B" boats leave the fishery, the number of boats will decrease. The new regulations are also an attempt to reserve the lobster fishery for bona fide fishermen, as it is argued that those using class "B" boats are not commercial fishermen.<sup>25</sup> The government has reserved the right to purchase boats if it is

<sup>25</sup>As a matter of fairness, committees have been set up to review the cases of fishermen who feel they have been treated unfairly by the regulations. If the decision of the committee is unfavorable, a fisherman has the right to appeal to the Minister of Fisheries.

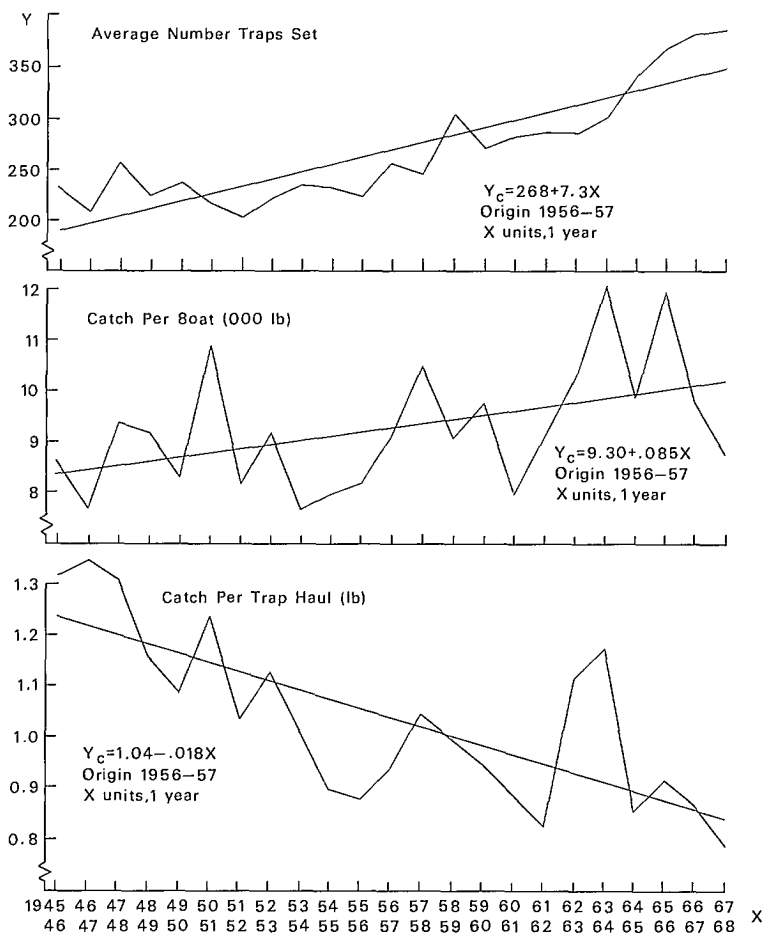


FIG. 15. Average number traps set, catch per boat, and catch per trap haul, Port Maitland, N.S., 1945-46 to 1967-68. (Source: Dep. Environ., Fish. Mar. Ser., Biol. Sta. St. Andrews, N.B.)

felt that such action is necessary to reduce total costs and thus increase net economic yield.

License limitation and trap limits, when introduced to all the Maritime Provinces in 1968, did not have the immediate effect of reducing the total number of traps fished and, in fact, the total number of traps fished apparently increased in some lobster fishing districts. This occurred as a result of (a) partnerships formed in some districts to take advantage of paragraph (2), section 11, of the 1968 amendments to the *Lobster Fishery Regulations*, which permitted partnerships to fish 50% more traps than the maximum set for the district, (b) fishermen, who formerly fished below the maximum allowed, increasing the number of traps fished to the maximum, and (c) an increase in the number of lobster fishermen in some districts. To prevent more partnerships

being formed to take advantage of fishing 50% more traps than the maximum, in 1969 the government prohibited the formation of new partnerships, and stipulated that on termination of previously formed partnerships the privilege of fishing 50% more traps would be revoked.

Table 13 gives information on the number of traps used in lobster fishing since 1968. The number of traps has increased slightly (5.6% between 1968 and 1972), possibly as a result of fishermen slowly increasing to the maximum number of traps permitted in each district. It is impossible to be precise regarding the number of traps fished, as some fishermen apparently apply to fish more traps than they actually do. The data indicate that there has been a substantial reduction in the number of lobster fishing boats, largely in the "B" class, as expected and intended.

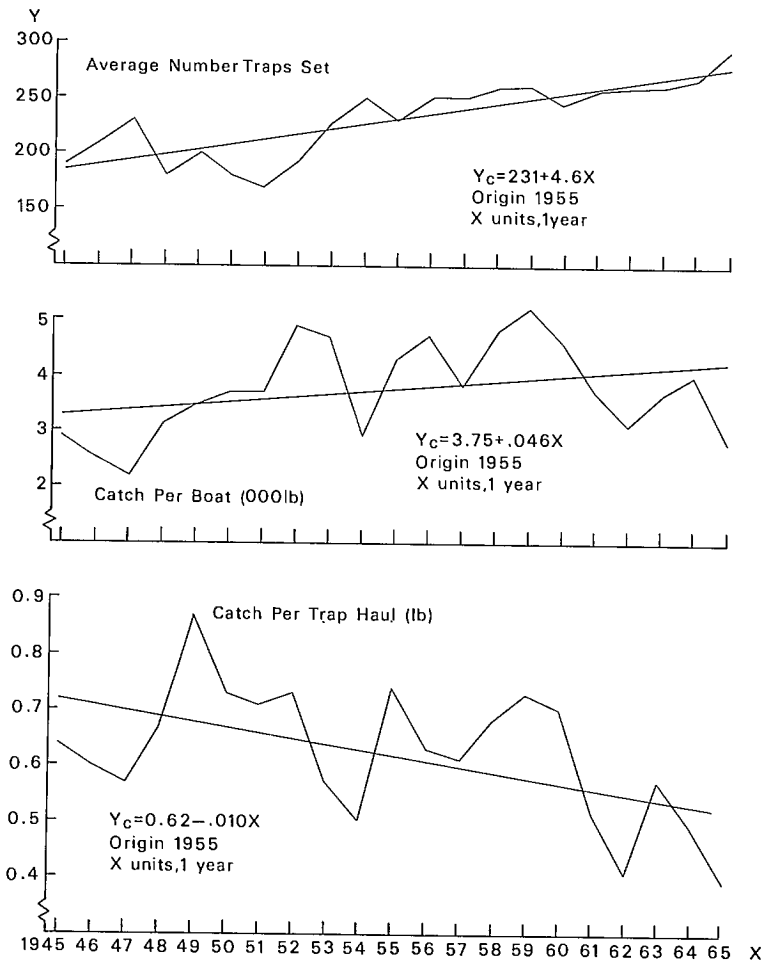


FIG. 16. Average number traps set, catch per boat, and catch per trap haul, Miminegash, P.E.I., 1945-65. (Source: Dep. Environ., Fish. Mar. Ser., Biol. Sta. St. Andrews, N.B.)

TABLE 13. Number of traps and boats used in lobster fishing, Maritime Provinces, 1968-72. (Figures for traps are given in thousands.) (Sources: Econ. Branch, Conserv. Prot. Branch, Fish. Mar. Ser., Dep. Environ., Halifax, N.S.)

Year	Traps	"A" vessels	"B" vessels	Total vessels
1968	2209	N/A	N/A	10,339
1969	2277	8822	1106	9928
1970	2282	8838	914	9752
1971	2379	8798	798	9596
1972	2337	8711	730	9441

In many lobster fishing districts in the Maritimes trap limits were set too high initially to have any impact in reducing the total number of traps. This is evident from the data in Table 14, which gives the number of traps in 1972 and the total number of traps that could be set if all "A" boats fished the maximum possible for each district. Since all partnerships and "B" boats will eventually be eliminated, the data in the last column indicate that approximately 25% more traps could be fished under trap limit by "A" boats than are currently fished by all boats. In other words, if trap limits were intended to reduce the number of traps then, as the limits are presently constituted, they must be considered as having failed to achieve this objective. The notable exception is District 8 where the number of traps fished in 1972 was above the maximum possible for "A" boats. If trap limits and license limitation do not reduce fishing effort, as appears to be the case, then they will have no effect on increasing the net economic yield of the fishery.

### Income

There are no statistical time series on fishing costs, so it is impossible to say whether lobster fishermen's real incomes have been increasing or decreasing. Several regulations, however, affect incomes. Trap limits, because they influence revenue as well as costs, may simply redistribute net income by reducing it for those who previously fished more traps than the maximum although increasing it for those who fished less than the maximum.

Some ports introduced trap limits before required to do so by the regulations. One such port is Lismore, N.S., where traps were limited to 250 per boat in 1942. Originally the number of boats was limited by an agreement among the

fishermen to 16 but this increased to 27 by 1951 and 30 by 1967. This port on the Northumberland Strait has a season from May 1 to June 30. Many of the lobsters landed are "canners" (77% by weight in 1967). Most fishermen have alternative occupations and few participate in other fishing activities.

In 1967 a survey of the fishermen of this port was made to find out what might be expected from trap limits in other areas. Ten of the 30 fishermen gave information on costs and returns. The average net income from lobster fishing was \$2282 for an average of 9.6 weeks work, of which 6 were spent in fishing (the season was delayed 4 weeks because of ice, but was extended 2 weeks). The average weekly net income in lobster fishing is thus about \$238 compared to \$71 for other fishing and other occupations. Profits (including resource rent) have been calculated to be \$1376 per fisherman or about 42% of total value of sales. The relevant information is set out in Tables 15 and 16. It appears that fishermen at this port benefited from the trap limit. However, as information on incomes before the introduction of the trap limit is not available, no definite conclusion can be drawn. It may simply be that the ground is very productive and the trap limit may not have affected net incomes substantially.

TABLE 14. Number of traps fished, 1972, and maximum possible for "A" class vessels, lobster fishing districts, Maritime Provinces. (Figures for traps are given in thousands.) (Source: Unpublished data, Conserv. Prot. Branch, Fish. Mar. Ser., Dep. Environ., Halifax, N.S.)

Lobster district	Traps 1972	Class "A" boats 1972	Trap limit	Maximum no. traps that could be fished by "A" boats
1	95	365	375	137
3	18	107	300	32
4-West	465	1436	375	539
4-East	181	1235	250	309
5	124	775	250	194
6A	10	43	300	13
6B	158	636	375	239
7A	35	146	375	55
7B	728	1983	400	793
7C	184	668	375	251
8	339	1317	250	329
Total	2337	8711		2891

TABLE 15. Average net income of lobster fisherman, Lismore, N.S., 1967.

Item	Amount (\$)
Sale of lobsters <sup>a</sup>	3316
Less operating expenses <sup>b</sup>	-932
Net return lobster fishing	2384
Less depreciation on boat and shore equipment at 7½% straight line	-102
Net income lobster fishing	2282
Sales of gear and equipment not depreciated	37
Net income other fishing	220
Net income other occupations	2255
Total net income all sources	4794

<sup>a</sup>Includes home consumption.

<sup>b</sup>Includes payments for bait, fuel, gear repair, maintenance of boat and engine, wages, and clothes.

The effects of seasons on fixed costs are discussed under "Investment." It is likely that operating costs are reduced and, assuming revenue would be the same with or without seasons, net incomes are increased as a result of seasonal closures. In the canning sector, however, the short season makes overhead costs high, so many canneries pack other species or other products before and after the lobster season to decrease their overhead. Costs are also increased by the uncertainty of supply and the concentration of the catch at the first part of the season (P.E.I. Fisheries Development Committee 1956, p. 8). Some canneries truck lobsters long distances, which adds to operating costs. On the other hand, some canneries reduce costs by purchasing sublegal-size lobsters at reduced prices, although this practice is not as prevalent as in the past. This imposes costs on both the fishermen who do not sell "short" lobsters and on society, assuming that if the lobsters were not taken the gain in weight would be greater than the loss from natural mortality.

The effect of seasons on prices has been discussed. Generally speaking, fishermen in districts 1, 3, and 4 benefit from higher prices associated with periods of low landings. These districts, however, have a long season in difficult fishing weather, and some of the benefits of higher prices are decreased through greater costs. Perhaps equally significant is the price differential that exists between "markets" and "canners."

TABLE 16. Calculation of average profit of lobster fisherman, Lismore, N.S., 1967.

Item	Amount (\$)
Net income lobster fishing	2282
Less interest on total lobster fishing capital at 7%	-215
Return to labor and management	2067
Less opportunity income <sup>a</sup>	-691
Profit	1376

<sup>a</sup>Based on average weekly net income in other occupations and other fishing occupations.

As "canners" generally bring a lower price than "markets," one would expect fishermen in districts 6B, 7B, 7C, and 8 to receive the lowest prices. For an equal total weight of lobsters, fishermen in districts 1, 3, and 4 would have the greatest revenue, and fishermen in districts 7B and 7C would have the least. Lacking accurate data on costs, it is impossible to determine whether net incomes are higher or lower as a result of seasons and size limits in various districts.

On the whole, average gross incomes from lobster fishing are low. In 1971 48% of lobster fishing vessels in the Maritimes had gross returns of less than \$2000 (Fish. Intell. Branch, Halifax, N.S.). Less than 1% grossed over \$15,000, the highest in 1972 being \$34,807 (*The Mail Star*, Halifax, July 21, 1973, p. 3-F) and only 3.6% grossed over \$10,000. In six lobster fishing districts, representing 42% of lobster fishing vessels, no vessels had gross earnings of \$10,000 or more and 60% of the vessels in these districts grossed less than \$2000. The distribution of gross earnings per vessel for each of the lobster fishing districts in the Maritime Provinces is given in Fig. 17.

If resource allocation is optimal, then factors (capital and labor) will receive an income equal to their marginal product. However, this ignores the problem of income distribution. For instance, a person licensed to fish lobsters may receive an income equal to his marginal product, but this may not be socially acceptable. On the other hand, too great a concern for income distribution may lead to resource misallocation. A licensing system such as that now applying to the lobster fishery may, under certain circumstances, prevent some of the more productive factors from participating in the fishery.

## Investment

There is both public and private investment in the lobster fishery. Every year the federal government spends millions of dollars constructing and maintaining wharves and harbor facilities, partly attributable to the lobster fishery. Private investment is also substantial. The average capital investment per enterprise given in the first chapter was \$2480. Assuming price increases have raised this to about \$5000, total private investment in the primary sector is probably in the range of \$50 million. There is also investment in buildings and machines for processing, trucks and boats for transporting, and pounds, cars, and tanks for storing.

License limitation will have at least two effects on investment. The value of licensed boats should increase as payment for the right to fish

is capitalized. On the other hand, old boats that are replaced will be almost valueless as the demand for these boats formerly was mainly for use in lobster fishing.

It is generally agreed that the amount of capital in the primary sector is excessive. According to Wilder (1958, p. 14), "short seasons . . . lead to a keen race among the fishermen, each trying to catch as big a share of the lobsters as possible in the limited time available. To do this they have built such large fleets of traps that in many areas far more traps are fished than are actually needed to harvest the available lobsters." By the same token, there is excessive investment in boats and shore equipment.

It is more difficult to assess whether the amount of capital is excessive in the secondary and tertiary sectors, which include collecting, processing, and distributing the annual output. If one buyer or processor can handle what two or more buyers or processors can handle without increasing the size of his establishment, there is too much capital. This argument could also be applied to pounds and transportation facilities. However, lacking information on the operations of the secondary and tertiary sectors, it is impossible to say whether excess capacity exists. The period of peak landings created by seasons means that capacity in all sectors must be sufficient to handle these landings. If the pattern of landings were more even, capacity in all sectors would not have to be so great.

There can be no doubt that there is idle capacity, i.e. capital used for only part of the year, in all sectors. In pounds that are used for about 6 months of the year idle capacity may not be very great. In the case of lobster gear (traps, buoys, rope) and cars, tanks, and floating crates used for short-term storage, there is a great deal of idle capacity. To the extent that boats, shore equipment, gear, storage facilities, processing establishments, and transportation facilities are used for other purposes, idle capacity is reduced. Idle capacity is a characteristic of fisheries in general, but its extent is increased by seasonal closures.

## Employment

Employment depends in part upon profitability of fishing. In the fourth chapter it was argued that profitability may depend to a large extent upon opportunity income. This explains why, for instance, there was a large entry of fishermen during the depression. In the long run, regulations that affect profitability, i.e. revenue and costs, will also affect employment.

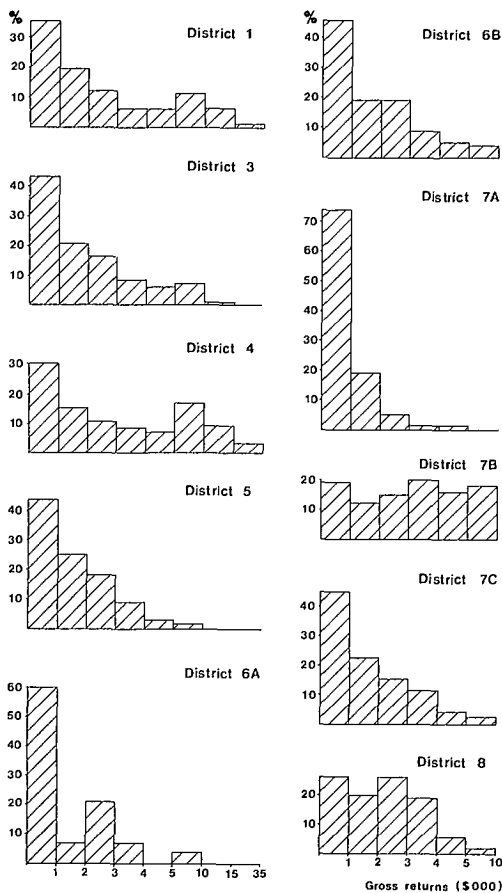


FIG. 17. Distribution of gross returns per vessel, 1971, by lobster fishing districts (Source: Fish. Intell. Branch, Dep. Environ., Halifax, N.S.)

Closed seasons make lobster fishing a part-time activity. Assuming that most fishermen arrange their various occupations to be as fully employed as possible, a change in seasons might lead to conflicts with other periods of gainful employment, in which case a fisherman might experience a loss from having to choose between two or more alternative occupations. Conversely, a change in seasons might lead to greater employment if there is already a conflict. "With short seasons persons who have been gainfully employed elsewhere find it advantageous to engage in the fishery when lobsters are unusually abundant" (Wilder 1958, p. 14). License limitation will eventually eliminate these "moonlighters." The prohibition of Sunday fishing introduced in 1969 will also discourage many.

License limitation restricts the freedom of persons to pursue the occupation of their choice. In the long run this is considered to be uneconomic.

"... if such restrictions become general, they would serve to weaken the effectiveness of one of the most fundamental sources of economic efficiency in a free society — the choice by the individual of the best use for his own talents and skill. On the other side, we must raise the question: if the size of a particular cake is fixed, is it not both proper and just to prevent too many from sharing it?" (Gordon 1952, p. 36)

In other words, if economic conditions in the lobster fishery are to be improved, then the number of fishermen should be limited.

In the processing sector of the industry large numbers of part-time workers are hired when landings are at their peak. Local labor (mainly women because of their availability and manual dexterity in shelling lobsters) is often employed, although it is sometimes necessary to employ workers from outside the area. To the extent that local labor is employed there is a benefit to the community. If the supply of lobsters were more evenly distributed throughout the year, probably fewer people would be employed for a longer period. The choice then becomes whether to have a few people fully employed or a large number of people employed part-time. There is no clear economic argument for one rather than the other. If, however, the necessary labor is difficult to obtain on a short-term basis, as appears to be the case for some of the processing establishments, then it might be desirable to arrange for a more even supply of lobsters.

### Ownership and Scale of Operations

In the primary sector of the industry the operator or manager of the enterprise is usually the

owner. In the 1961–62 survey of the Canadian lobster fishery, of the 506 enterprises included, 82% were operated by a single owner, 17% by a partnership, and the remaining 1% were either operated by a hired manager or were leased (Rutherford et al. 1967, p. 24). A recent regulation (April 1969) will eventually lead to the single ownership of all boats used in the fishery. No person or company was allowed to register more boats in 1969 and thereafter than were registered in 1968, and all new entrants were able to register only a single boat. This regulation was introduced to prevent fishing companies from gaining control of primary operations. The nature of the fishery rather than the regulations has probably been most important in the evolution of the type of ownership that now exists, as a relatively small capital investment is needed, and one man can easily manage an enterprise (although two are usually engaged in the actual fishing operation).

Before trap limits the scale of operations varied from one man using a few traps and a small boat to enterprises with three or more men using one or more boats and up to 1000 traps (Rutherford et al. 1967, p. 24–25). Trap limits and license limitation have changed and will drastically change the scale of operations of fishing enterprises. The greatest number of traps that can now be fished from one boat is 600 (by a partnership in District 7B). Eventually, when all class "B" boats and all partnerships are eliminated, the number of traps fished from a boat will vary from 50 to 400, depending on the district. Enterprises will, of course, still be able to vary their fishing effort by fishing varying amounts of time.

In most industries economies accrue to enterprises, over a certain range, from an increase in some inputs relative to other inputs (mainly fixed factors). In the lobster fishery, for instance, boats and shore equipment are fixed factors. The greater the use of these the lower the per unit cost of output, assuming that operating costs increase proportionally or less than proportionally to output. For instance, if labor is hired by the week, then increasing output by hauling more traps or hauling traps more frequently decreases the cost of labor per unit of output. Other operating costs probably increase proportionally to output, but they also may decrease with increases in output.

In Fig. 18 the total, average, and marginal cost and revenue curves are given for an "average" fishing enterprise at Miminegash, P.E.I., in 1966. This was the first year for a trap limit at that port. Variations in output resulted mainly from variations in the number of times traps were

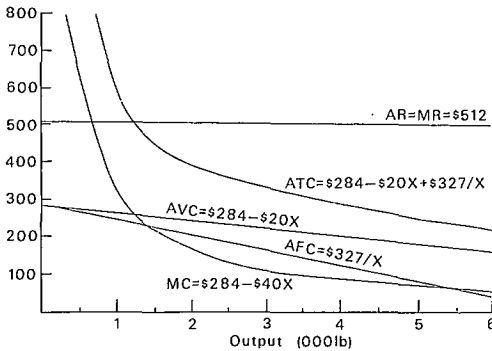
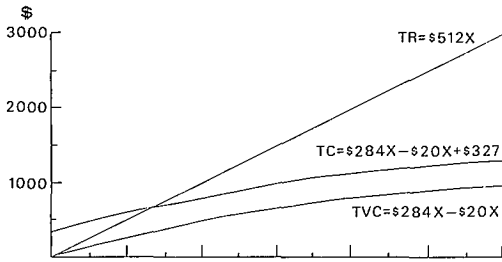


FIG. 18. Total, average, and marginal cost and revenue curves of "average" lobster fishing enterprise, Miminegash, P.E.I., 1966.

hauled, although one boat did fish about half the maximum number allowed. Total revenue increased as a linear function of output. Total variable costs increased less than proportionally to increases in output. The analysis suggests that the most efficient enterprises are those hauling their traps the greatest number of times. There would be a limit to this method of fishing and, beyond a certain point, it is likely that the average and marginal cost curves will rise, but the data suggest that this point has not been reached.

Preliminary work on catch and effort statistics for three ports in the Maritimes revealed that there is a high, statistically significant tendency for landings (revenue) to increase proportionally, or more than proportionally, to increases in trap hauls and traps set. If, on the one hand, revenue per unit of effort (measured in terms of trap hauls or traps set) increases proportionally or more than proportionally to increases in individual fishing effort and, on the other hand, costs per unit of effort decrease as fishing effort increases, then one must conclude that the most economically efficient enterprises are those that are largest in terms of number of traps set or number of times traps are hauled.

As trap limits reduce the amount of fishing effort, it is likely that trap limits will also reduce efficiency. The most efficient enterprises before the introduction of trap limits will probably remain the most efficient, but by fishing more traps these enterprises could make better use of their capital and labor. In other words, if economic efficiency were the sole objective, it might be better to have a small number of boats fishing large gears.

## Mobility

For complete economic efficiency there must be perfect mobility of factors, i.e. capital and labor must flow into their most productive use (ignoring external diseconomies and the "second best" argument). Theoretically, factors receive a payment equal to their marginal product. This is the same thing as saying a factor is in its most productive use where it is paid the most. In practice perfect mobility is impossible, as complete information about all available occupations would be necessary. Nevertheless, it still seems desirable to have as much mobility as possible.

In the lobster fishery those factors that are earning or can earn less than their "opportunity" marginal product will either leave or remain outside the industry, whereas those that can earn or are earning their marginal product will enter or remain in it. Mobility is affected mainly by profitability of fishing, employment conditions outside the industry, and the difficulty of obtaining capital. Table 17 gives the mobility of operators for two ports during the past 10 years. It is obvious that the mobility rate varies substantially from one area to another, largely as a result of economic conditions in the areas and the state of the stock.

License limitation will probably affect mobility. Fishermen already in the fishery, knowing that if they leave they may not be able to return, will likely be inclined to remain, even though they may in some cases be able to earn more at other occupations. There will also be a "locked-in" effect on capital. Mobility will depend to a large extent on the certainty of other occupations. As well, people who may be able to earn more at lobster fishing than in their present occupations may be prevented from doing so if there is no license for sale.

Geographic mobility in the lobster fishery has been curtailed by regulations limiting fishermen and boats to one district in 1 year (Rutherford et al. 1967, p. 86). Fishermen and boats are, however, allowed to fish in different districts in

TABLE 17. Mobility of lobster boat operators, Mimi-  
negash, P.E.I., and Port Maitland, N.S., 1958-69.  
(Source: Dep. Environ., Fish. Mar. Ser., Fish. Res.  
Board Can., Biolog. Sta., St. Andrews, N.B.)

Port and season	No. operators fishing (a)	No. new operators (b)	No. operators dropped out (c)	Mobility rate (%) $\frac{(b+c)}{2}$ $(a)_{t-1}$
Miminegash				
1958	41			
1959	48	11	4	18
1960	52	12	8	21
1961	56	11	7	18
1962	55	7	8	14
1963	48	9	16	23
1964	48	12	12	25
1965	55	15	8	24
1966	61	13	7	18
1967	59	5	7	10
1968	55	6	10	14
Port Maitland				
1958-59	24			
1959-60	24	2	2	9
1960-61	24	2	2	9
1961-62	22	0	2	4
1962-63	22	0	0	0
1963-64	21	2	3	11
1964-65	21	1	1	5
1965-66	22	2	1	7
1966-67	21	1	2	7
1967-68	20	0	1	3
1968-69	18	0	2	5

different years. Fishermen, because of community ties and tradition, move very little from one district to another. The only areas where mobility occurs are those bordering districts with different seasons, where fishermen have the option of fishing in either.

In the case of "operators," the geographic restriction probably makes little difference, although there may be some fishermen who would specialize in lobster fishing and, to the extent that specialized enterprises are more efficient, there is likely some loss in efficiency. In the case of "helpers" the restriction has been probably more serious as, by moving from one district to another, it is possible that some could have been almost fully employed for the whole year. In areas where this type of labor was difficult to obtain, benefits would have accrued to the "operators" from

having access to an efficient, mobile labor force. In the future such a labor force should emerge, as the restriction on the geographic mobility of "helpers" was lifted in 1969.

The mobility restriction on boats brings about a redundancy of capital because in some areas (where seasons do not coincide) the same boat could be used in more than one district. This would lead to greater economic efficiency through decreased costs.

### Other

There are a few regulations that do not fit conveniently under any of the previous headings. One of these prohibits lobster fishing within 100 yards of a stationary salmon trap. The economic effects of this regulation are likely insignificant, although it is possible that a slight loss of production results from it. Another regulation requires owners of pounds and enclosures to pay a \$75.00 fee to hold lobsters during the closed season, and to be issued with a certificate from the fishery officer attesting to the legality of the capture of lobsters during the open season if they are sold (*Fisheries Act*, sect. 17). Yet another regulation requires owners of pounds and enclosures to liberate females that become "berried," unless a yearly payment of \$1000 is made.

This regulation raises a particular problem. Female lobsters, although not "berried" when purchased, may become "berried" during impoundment. If this occurs owners suffer a loss at least equal to the purchase price of these lobsters. If a pound owner buys a license he may "scrub" the "berried" females. He would have to scrub at least \$1000 worth of "berried" females to cover the \$1000 fee. Unlicensed pound operators do, however, try to sell female lobsters before they extrude their eggs, and they are quite successful at doing so.

There is an apparent contradiction in the regulations.<sup>26</sup> If "berried" females are protected for conservation purposes, then it is argued that pounds should, under no conditions, be allowed to scrub them. This argument is not valid. Females when captured, if they are legal size and not carrying eggs, are lost to the fishery as egg-producers. If they were consumed immediately the problem would not arise. The fact that they become "berried" in pounds does not alter the

<sup>26</sup>Interview with lobster pound operator in southwestern Nova Scotia and *The Halifax Chronicle Herald* (April 19, 1968, p. 21).



J. Fishery officers checking lobster fishing license aboard fishing boat.



K. Patrol vessel, Barrington Passage, N.S.

situation. It has been suggested that the government purchase "berried" females from pounds (Footnote 29 and P.E.I. Fisheries Development Committee 1956, App. B-2). This, however, would involve considerable expense for no apparent reason. There is probably no solution to the problem of "berried" females in pounds as long as "berried" females are protected.

The regulation that prevents Sunday fishing will affect mainly "moonlighters," some of whom may stop lobster fishing, as many in the past have fished mainly on Sundays. Commercial fishermen do not normally fish on Sundays, and so the regulation simply enforces a common practice. The catch that would have been taken by the "moonlighters" who stop fishing will be redistributed among the rest of the fishermen and will

thus increase their net incomes (probably not significantly).

Finally, there is the cost of enforcing regulations. For the year 1972, for the Maritime Provinces, this cost has been estimated at approximately \$1.5 million.<sup>27</sup> Some of the cost is offset by license fees, but they amount to only about \$70,000. In the present state of the fishery it would probably be unfair to expect fishermen to pay more. If conditions improve significantly as a result of the restrictive legislation, then it would seem only fair that those who benefit should contribute more to the cost of enforcement than they do at present.

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<sup>27</sup>Conserv. Prot. Branch, Dep. Environ., Halifax, N.S.

## CONCLUSIONS

Until recently regulations were formulated mainly with the intent of preventing the stock from being depleted. Some regulations were introduced, however, with other objectives in mind. For instance, the regulation restricting the method of capture to the trap appears to have been introduced to protect fishermen who used that method from competition, and the restriction of fishermen and boats to one season per year was essentially an attempt to protect the fishery for the resident fishermen of the various districts. Recently, regulations have been introduced principally for economic, social, and administrative reasons. Trap limits, license limitation, restriction of the number of vessels that can be registered by a fisherman or company, and the prohibition of Sunday fishing are an attempt to increase net incomes of bona fide fishermen who remain in the fishery. Operator and boat registration is primarily a method of keeping track of fishermen and boats to facilitate the administration of other regulations.

In this study the economic effects of various regulations have not been tested rigorously, largely because existing data are not adequate. On the basis of the research of others on various aspects of the fishery and using data that do exist, conclusions have been drawn regarding some of the more economically important regulations. The general conclusion is that regulations have had an adverse effect on economic efficiency, although in this respect the common property nature of the fishery may have been more important than regulations. Individually, regulations have had various effects.

It was concluded that some of the depressing effects on prices of large landings occurring at certain periods of the year, that might result from a universal open season, have been alleviated by closed seasons. However, some benefits might result from a change in seasons or district boundaries or both (particularly in the canner areas) to decrease the large production in May and June. Improvements might be limited by such factors as weather and molting and hatching periods.

The effects of size limits on such factors as production and prices are extremely difficult to determine, even under controlled conditions, as

the effects of other factors have to be eliminated. Where size limits have been changed, abolished, or introduced the results have not been such that definite conclusions can be drawn. Size limits have not only reinforced price differentials but have also created an illegal market.

"Berried" lobsters have been protected mainly to ensure reproduction and a continued supply. The conclusion of biologists is that this regulation may not be necessary. The protection of "berried" females has raised a particular problem in the case of those lobsters that become "berried" while impounded, and there appears to be no solution as long as "berried" lobsters are protected.

The effect of the regulation stipulating that only traps may be used to capture lobsters could probably be determined by conducting experimental fishing with other methods of capture such as diving. Data collected from fishermen in Massachusetts who dive for lobsters might also be helpful in determining the effects of this regulation. No conclusion can be drawn regarding the comparative economic efficiency of trap fishing and dragging, as lobsters have not been dragged commercially in inshore waters.

The effects of the restriction on the geographic mobility of fishermen and boats could best be determined by lifting the restriction and following the operations of a random sample of fishermen. Although this regulation has only been in effect for about 20 years, information on the operations of fishermen before its introduction is not adequate for purposes of comparison. The conclusion drawn from the analysis presented in the fourth chapter was that economic efficiency has probably been influenced adversely by this restriction, as specialized boats, crews, and skills lead to more efficient operations.

To determine the effects of trap limits and license limitation it is necessary to follow the operations of fishermen before and after trap limits are introduced. Ideally, the information would include fishing effort, costs, and earnings. The conclusions of this study are that license limitation and trap limits as introduced in the late 1960s will redistribute incomes more equally, will not affect total fishing effort substantially, may lead to an increase in the total number of traps,

may have an adverse effect on economic efficiency, and will increase the value of boats as the right to fish lobsters becomes capitalized.

Regulations considered in combination may have produced an effect different from their individual effects. For instance, closed seasons, size limits, and the protection of "berried" females may, taken individually, appear to have little effect on landings. Taken together, they may be responsible for sustaining the yield of the fishery at the level that has been obtained for the past 50-60 years. The combined effects of regulations, however, have not been treated.

This Bulletin has attempted to trace the development of lobster fishery regulations and to point

out some of the economic effects. It is by no means definitive and, in fact, has only touched upon some of the effects of regulations. It suffers very much from being a qualitative rather than a quantitative study. Certainly much more quantitative research needs to be undertaken on the effects of regulations before any definite conclusions can be drawn. Perhaps more important, economic criteria will have to be developed to enable those persons responsible for management of the fishery to make decisions on the basis of limited information. It is hoped that this Bulletin can serve as a starting point for further evaluations of the economic effects of lobster fishery regulations.

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