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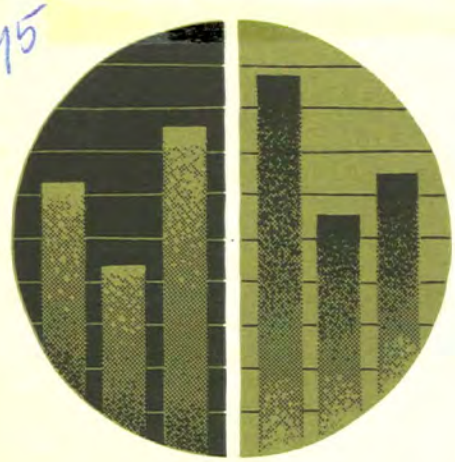

An Economic Study of the Oyster Fishery of the Maritime Provinces

N. H. Morse

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Ottawa 1971

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of the Maritime Provinces

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An Economic Study of the Oyster Fishery of the Maritime Provinces

By

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FISHERIES RESEARCH BOARD OF CANADA
Ottawa 1971

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Contents

PREFACE

This study of the oyster fishery of the Maritime Provinces of Canada, requested in 1966 by the Resource Development Branch and the Economic Services Branch of the Department of Fisheries of Canada, is a combination of two reports presented to the Department for review and limited circulation. The first consisted of a history of the fishery from the third quarter of last century, a description of its current condition, and some references to its prospects. The second contained some recommendations. This study traces the history of the fishery and analyzes some problems now confronting the industry. No further reference will be made to the earlier reports.

Chapter 1 is an introduction to the nature of the fishery, including the manner in which it is prosecuted in the Maritimes and the regulations and institutions that have evolved in connection with it.

Chapter 2 contains a statement of the problem. The nature of the interaction of different forces within, and upon, the industry is indicated.

Chapter 3 contains a brief description of the oyster *Crassostrea virginica,* which inhabits the coastal waters of a large part of the Maritime Provinces, and a discussion of certain of its characteristics, an understanding of which is helpful in both interpreting the history and analyzing contemporary problems of the fishery.

Chapter 4 contains a discussion of the theoretical framework in terms of which the history is interpreted, but, owing to lack of sufficient quantitative data, analysis in terms of micro-economic theory is not made. Instead, a variant of the staple thesis is employed. In this study the staple thesis is interpreted to mean that the nature of the commodity is important and has affected the industry that has evolved in the Maritimes.

Chapter 5 presents the history of the industry in three parts, which mark three periods that can be distinguished from one another according to shifts in the jurisdictional control over the fishery between federal and provincial governments. An attempt is made to show how political, economic, biological, and environmental factors have affected the industry for at least three-quarters of a century.

Chapter 6 elaborates on the current condition of the fishery and position of the industry. Data based on a survey of oystermen in 1966, some analysis of supply and demand, and some tentative projections are included.

Chapter 7 consists of a summary and conclusions.

The writer is indebted to many persons who offered encouragement and assisted in many ways. To name each individually would result in a rather extended list. Officials in the Department of Fisheries of Canada, especially in Resource Development Services, Resource Management Service (Economic Services), Conservation and Protection Services, and the Fisheries Research Board of Canada, including officers in the field, together with Provincial officials concerned with the oyster fishery have been most helpful. Oystermen in the Maritimes were extremely willing to provide information and to present their points of view. Special thanks are extended to interviewers and oystermen interviewed in 1966, to officers in the Dominion Bureau of Statistics who assisted in planning the exercise, and to the staff of the Computer Center, Dalhousie University, who processed the data. Assistance was obtained also in the United States through the Bureau of Commercial Fisheries, Resources for the Future, Inc., Washington, D.C., and officials concerned with the oyster fisheries of the states of New York and Massachusetts. Authors of several reports on the oyster fishery of the United States have assisted greatly in the collection of bibliographical material.

To the many persons who aided in some aspect of the study, as well as to those interviewed, the writer expresses his thanks. Also he wishes to acknowledge the assistance of Mrs A. Love and Mr B. J. McGaughey, who are associated with him in the Fisheries Research Project, and of colleagues in the Department of Economics, Dalhousie University, who have given generously of their time and have offered advice and helpful criticism. At the same time, he must assume responsibility for the study and for any weaknesses it contains.

Dalhousie University
Halifax, Nova Scotia
May 30, 1969

N. H. Morse

ABSTRACT

The American oyster, *Crassostrea virginica*, plentiful in the coastal waters of the United States from Texas to Maine, also inhabits various sheltered bays and estuaries in the Maritime Provinces of Canada, mainly along the southern and western parts of the Gulf of St. Lawrence and Northumberland Strait and in Bras d'Or Lake and a few other locations in Cape Breton Island. In the 1960's high and markedly rising oyster prices were not met by a warranted production response on the part of the industry. The problem was interpreted as a shortage of seed oysters, young oysters for spreading or planting on leases that had been established to facilitate and encourage oyster culture. The Department of Fisheries and Forestry, which is responsible both for research and development of the oyster fishery and also for its regulation, sought to improve the situation by rearing seed oysters in certain reserved locations, and, when severe difficulties were encountered in the pursuit of this policy, by developing a hatchery. The prospect of success in this latter venture raised questions concerning how the hatchery process or its products could best be made available to the industry. There was also a desire to know what the demand for seed oysters would be. If price, mortality, and growth rates could be determined, the quantity of seed oysters would be governed by the size the industry could profitably reach. Current levels of output, ranging from 3.5 to 4 million lb of oysters in the shell, worth from $500,000 to $560,000, were presumed to be far below the economic potential for the region.

Lack of adequate quantitative data has made it impossible to arrive at answers to many relevant questions. The industry will have to become more sophisticated to make quantitative analysis meaningful. There is, e.g., insufficient evidence on which to base estimates of either an industry production function or a product demand function. The leasehold part of the fishery, located almost entirely on ground devoid of natural beds of oysters, has generated little evidence about the economics of oyster production or oyster culture even though some leases date back more than half a century. Harvesting of natural beds as a public fishery has likewise generated inadequate information about their potential productiveness and profitableness under, e.g., a system of user rights or their equivalent. Analysis of demand is not only impossible but also irrelevant at this time, as the level of output is far below what could be sold at profitable prices. The critical problems are those of supply.

Relations that exist between the commodity (the oyster) and the activities that have grown up around it (the oyster fishery or the oyster industry) are discussed. The oyster, except during a relatively short free-floating larval stage in its life cycle, is an immobile species and a system of leases that establishes user rights to the oysters on a lease is sensible, i.e., workable. Leases form an integral part of the institutional arrangements comprising the fishery. The history of the fishery involves consideration of the effects of jurisdictional disputes between the Dominion and the provinces, the implications of the ravages of disease at different times on different parts of the oyster stock, and the responses to these catastrophes. One aim was to probe into the various dimensions of the fishery and to reveal interconnections among its various aspects such as the biological, economic, and institutional.

The study describes and analyzes the evolution of the oyster fishery during the last three-quarters of a century and concludes that a range of policy options are open. It is concluded that government may provide central direction and leadership to the industry during the early stages of economic change but that decisions will be made within the industry as soon as possible. Policy can be expected to lie between strong support of numerous small oyster producers and

opening oyster areas to the highest bidders who probably would develop the largest and strongest industry with the minimum of public assistance. It is desirable that the industry move towards more effective utilization of the resource.

Development of the hatchery process, or some alternative, to provide a supply of seed oysters especially to oystermen practicing oyster culture on their leases and perhaps also for planting on the public beds is mentioned. However, the economics of rearing oysters to market size under wholly controlled conditions distinct from the natural environment have not been explored. Nor have the economics of the depuration of oysters under controlled conditions been considered. The first of these two innovations could alter drastically the locational advantages of the entire region, whereas the second could alter the significance of contaminated areas within the region.

Chapter 1

INTRODUCTION

The oyster fishery of the Maritime Provinces operates under the control of a network of institutional arrangements and regulations that set forth terms under which oystermen may participate in the fishery. A broad distinction exists between the two areas of activity — the leasehold and the public fisheries.

Leases consist of areas of ground, generally devoid of natural beds of oysters yet deemed suitable for oyster culture, which are held by individuals or companies on payment of an annual rental now set at $1.00 per acre per year. A leaseholder has property rights over the oysters on his lease, which requires him to cultivate his lease to build an oyster population on it as a commercial venture.

Generally, ground not under lease is public ground; Malpeque Bay is an exception. When oysters on public ground are sufficiently plentiful to make fishing worthwhile they are a common-property resource, and such areas comprise the public fishery. In order to engage in the public fishery, an oysterman must have a licence issued by the Department of Fisheries and Forestry of Canada. A leaseholder may obtain a licence to engage in the public fishery. On the other hand, many licensees are not lessees. They may be part-time oystermen, as are leaseholders also, who fish for oysters during the harvesting season. However, licence holders as well as leaseholders may be involved in the oyster fishery in a number of ways besides the harvesting of market oysters.

A licensee may be employed by a lessee, and it is possible for any person to care for or control the lease of a lessee by arrangement. More important statistically, however, are the opportunities for both licensees and lessees to gather oysters for planting on leases and to fish for oysters in contaminated water for relaying to clean water. These two activities are allowed under permit. To take most advantage of the opportunities, an oysterman should have a lease on which to plant oysters or to place relayed oysters: however, as many permitholders are not lessees, the oysters they gather for planting and for relaying are sold to leaseholders.

The number of leases exceeds the number of licences. There were 1800 leases comprising 4948.96 acres in the Maritimes in 1966 and 992 licences in 1965 (data from Department of Fisheries, Ottawa, Ont., 1966a). The average size of lease is below 3 acres. For the most part, each lease is held in the name of a different individual or company, but a leasehold enterprise may include several leases, perhaps held by husband, wife, children, or neighbors. The extent of these arrangements is not wholly known, but enough information is available to determine the prevalence of these interconnections and the nature of oyster enterprises.

A rather complicated set of regulations governs the activities of lessees, and permit holders. The purposes are to conserve the fishery, to afford equal treatment to those wishing to engage in it, and to afford some protection to consumers. The

following conditions pertained in 1966 in Prince Edward Island; some differences existed in Nova Scotia and New Brunswick. From May 1 to July 15, oystermen could fish under permit for market oysters for relaying from contaminated areas to leaseholds in clean water. From June 1 to September 24, public picking of oysters was allowed under permit for stocking one's own lease or for sale to other leaseholders. From July 15, the public picking of oysters for planting was restricted to noncontaminated areas. Thus from May 1 to July 15, larger oysters could be taken from contaminated areas for purifying in clean water, and after June 1 smaller oysters for planting could be picked also. Movement of oysters from contaminated areas was prohibited after July 15.

From August 16 to April 30, lessees could fish their leases for market oysters. Lessees could employ oystermen or could work their own leases. Leases were closed to harvesting from May 1 to August 15 while oysters were being moved from contaminated water. A month elapsed between the end of relaying from contaminated water and the beginning of harvesting from leases in clean water. The public fishery for market oysters from noncontaminated water was open from October 1 to November 26 in Prince Edward Island, to November 30 in Nova Scotia, and to the end of December in New Brunswick. A winter public fishery also existed in parts of New Brunswick.

In Prince Edward Island, a nonleaseholder could fish for oysters for relaying from contaminated areas from May 1 to July 15, pick oysters in contaminated areas from June 1 to July 15 and in noncontaminated areas from July 15 to September 24, work for a leaseholder after August 15 when harvesting began, and participate in the public fishery after October 1 to the end of the season. Also, he could work for a leaseholder at any time of year. The likely periods of unemployment would be during the winter and from July 15 to October 1 when he would be restricted to picking oysters in noncontaminated areas or to working for a leaseholder, particularly after the opening of the harvesting season on August 15. The same opportunities were also open to lessees, who could enjoy certain additional advantages. It was estimated that an oysterman who could engage in the various phases of the fishery from May 1 to year end could earn and receive in transfer payments (including unemployment insurance) up to $4000 per year.

A problem, however, is that few oystermen can obtain employment over most of the year in some phase of the oyster fishery. Also, the general methods of operation and the organization of the fishery do not provide an adequate foundation for an "industry." Although the term "industry" is used frequently in this report, the fishery is rather inactive in many areas owing to problems of maintaining a regular public fishery and of developing a more active leasehold fishery. It is a commercial activity, in the historical sense of the term, rather than an industrial activity. It consists of an unsophisticated hunting operation prosecuted with the aid of the simplest of tools, extremely low capital investment, and with resort to short-term finance. Current output of 3.5 million lb (35,000 boxes or 17,500 bl) is around the level that can be expected to continue whereas the physical and economic capacity of the grounds to carry oysters is much higher. More than half the current output still comes from the public fishery even after half a century of leasing (see chapt. 6). The possibility for expansion is mainly in the leasehold fishery unless substantial government support is given to the public fishery or there is a complete reversal of policy respecting the leasehold and public fisheries.

Chapter 2

STATEMENT OF THE PROBLEM

The prospect of significant scientific and technological change in the oyster fishery of the Maritime Provinces poses problems sufficiently important to merit special review. The prospect of change is a consequence of the effort of oyster producers and public servants, including scientists and administrators, to reestablish or expand the stocks and the production of oysters in the different oyster areas of the region. Although producers and public servants may look at the industry from different points of view, they agree that an increase in the output of oysters is desirable to increase the income of oystermen. Since much of the oyster ground in the Maritimes is adjacent to relatively low-income areas, an expansion of the oyster fishery could play a special role in the economic development of the Maritimes, an objective receiving increasing private and public support.

Features of the Industry

Operation at Low Level of Production

The industry is operating at a relatively low level of production attributable to the failure of the oyster stock to reproduce and grow in larger numbers, and to some failure within the industry to use available techniques to exploit the potential.

Failure of Oysters to Reproduce

The failure of oysters to reproduce in greater numbers is a result of a number of factors, including (i) location of oyster grounds in the Maritimes at the northern limits of the range of the American oyster, which has resulted in certain marginal environmental conditions being encountered, especially for reproduction, survival, and growth of young oysters; and (ii) difficulty and delay in the reestablishment of oyster stocks in some areas ravaged by disease.

Terms applicable to oysters of different sizes are as follows: "spat" refers to the early settled stage of the oyster as long as it is attached to the collector; "separated spat" refers to oysters smaller than 1.5–2 inches that have been removed from collectors before planting; "seed oysters" are larger than 1.5–2 inches and are ready for planting. On natural beds as distinct from the hatchery, "spat" refers to oysters generally smaller than 1.5 inches or up to 2 years of age (R. E. Drinnan, personal communication, December 8, 1967). In a survey in connection with this study, it was agreed that the term "seed oysters" should refer to young oysters about 1.25–1.5 inches in size (see also Table 12, p. 62).

Tendency to Resist Change

The nature of the commodity and the vicissitudes through which the industry has passed have produced: (i) a system of leaseholding characterized by numerous

holdings of small leases, although leaseholding enterprises may comprise several leases each held in the name of a different individual; (ii) the persistence of a method of production (harvesting) involving a low ratio of capital to labor; and (iii) a failure of leaseholders generally to stock their leases.

There is little movement of brood stock (mature oysters) onto unstocked leases to establish oyster populations. The risks of achieving good spawning, setting, and growth of oysters, when considered in terms of the number of years required for the process and the cost of brood stock even at prices below those received for market oysters, discourage the restocking of leases in most areas by these traditional means. The general shortage of seed is an important factor. Apart from this, the limited extent of planting young oysters reflects the estimated risks between time of seeding and time of harvesting perhaps 4–8 years later. Even if young oysters are available, the financial position of the leaseholder may be such that he is unable to forego more certain income from alternative employment in the present in order to invest his time (and money) in collecting and planting young oysters in the hope of a return in the future. Thus, when oysters are selling for the highest prices in the history of the fishery, the industry as a whole does not respond in the manner that would normally be expected. Instead of a general drive to increase the productiveness of private beds, there is some tendency for oystermen to wait for oysters to "come back." Or, the problem is expressed as "a shortage of seed oysters" for planting.

The origin of a large part of the output of market oysters is the public fishery, which is a source of oysters for planting and relaying and also of market oysters themselves. The availability of labor, the level of wages and other costs, and the productivity of labor in relation to the price of oysters makes transplanting and relaying oysters — double-handling or double-fishing — economically feasible under certain circumstances. The largest producers operate in this manner and overcome thereby both the general problem of shortage of seed and certain other risks, such as the possible mortality of oysters, that could be encountered in a longer-term farming operation.

CHANGES IN TECHNOLOGY

On the assumption that production of oysters in the Maritimes has been much below the attainable level, and also for political and scientific reasons, scientific research has been intensified over the last 40 years. As a result, two changes in technology have taken place, in sequence: (a) development of mechanical methods of harvesting (MacPhail; 1960, p. 93–95) and (b) development of the hatchery process for production of seed oysters.

Mechanical methods employing the escalator have not been widely adopted. At present, only a few mechanical harvesters are in existence in the whole fishery and fewer still in commercial use. Most oysters produced in the Maritimes are harvested by manual methods employing either oyster tongs or rakes. These methods are retained in the public fishery by regulation and on leases by certain relations that exist between prevailing wage rates and the number of oyster fishermen offering their services, and the limited availability of oysters and their consequent high price.

A greater availability of seed oysters could change the leasehold fishery rather drastically and could be expected to lead to a shift from a commercial to a more

industrial type of operation involving longer-term finance and larger investment per enterprise both in oysters and in equipment. The recent development of a private hatchery may determine whether the hatchery process is commercially feasible, and if it is, the manner in which it can be made available to the industry. Other problems will remain, such as those associated with adjustment to changes that might include a different policy of leasing, adoption of mechanical methods of production and harvesting, and different financial and marketing arrangements.

The crucial factor that could initiate economic change in the industry is the hatchery process or the development of other good sources of seed oysters. The availability of an abundance of seed would augur well for leaseholders and improve the prospect of extending the fishery onto unoccupied ground on which there is little likelihood of oysters spawning and reproducing in significant numbers owing to low water temperatures. If hatchery-produced seed oysters can be planted and grown successfully to market size without excessive mortalities and can be supplied at a price that offers an incentive to oystermen to purchase them, the rising expectations of oystermen can be expected to lead to other demands.

FUTURE INDUSTRY

Small leaseholders can be expected to want larger leases for seeding and to engage in oyster production on a larger scale than in the past. Existing and prospective leaseholders will want to establish leases on unoccupied ground, leading to intensified demand for leases, and problems related to existing leasing policy will develop if seed oysters become available in large quantities at economic prices. Should there eventually arise a scarcity of suitable ground in relation to the demand for it, a system of market pricing of leases might prove to be the most acceptable method of rationing the supply.

The effect of hatchery production of seed oysters on the output of market oysters and the anticipated pressure for larger leases doubtless will be accompanied by adoption of mechanical methods of cultivation and harvesting, such as drags, airlift dredges, or escalator harvesters. These can increase output per worker many-fold compared with manual methods and make possible the harvesting of an acreage far in excess of the size of most leasehold enterprises. Therefore, where bottom conditions and depth of water are suitable, greater availability of oysters can be expected to lead to the adoption by producers of more mechanical methods of production and harvesting requiring the employment of less labor for any given output. Such methods, in the absence of improved or intensive methods of raft culture or stringing techniques (J. C. Medcof, personal communication, August 23, 1966), will be more readily undertaken if the size of leases or leasehold enterprises can be enlarged to make effective use of the newer technology.

The volume and value of output of the industry could be markedly increased at the same time as employment is reduced by adoption of mechanical methods. Thus, technological and institutional changes in the oyster fishery probably will be accompanied by economic and social adjustment in the communities concerned. The extent of the changes, or, more particularly, the speed at which they are encouraged or permitted, are questions of political economy or of economic policy. A solution to whatever economic and social problems follow in the wake of technological and institutional change should be attainable by policies distinct from those pertaining to the fishery itself. Since the period of adjustment is expected to be a

decade or longer, an acute situation stemming from rapid change and displacement of labor is not anticipated. The dislocations would be the less noticeable the more oyster farming remains a part-time occupation.

SUMMARY

The industry may be changing from a commercial to an industrial operation involving much larger investment per enterprise in both oysters and equipment than has been the case to date. Mechanical harvesting has already been developed, but the adoption of the technique has been confined to only a few commercial producers. The crucial variable is considered to be the hatchery or any technique that would provide seed oysters economically to the industry.

Provision of seed oysters could result in marked changes. Assuming that financing is not a problem for producers, the successful introduction of the hatchery process, or suitable alternative, could well lead to increased demand for leasehold ground, a demand for larger leases, and the adoption of mechanical methods of cultivating and harvesting if such methods are the most economic. Should raft culture be feasible in some areas, the location of the industry would be determined more by climatic and water conditions than by the quality of the ground. Moreover raft culture would not require the use of mechanical harvesters. The hatchery process, the amount of leased ground, the size of leaseholds, and the adoption of either mechanical or raft culture methods as compared to traditional methods are interconnected aspects of the fishery, but they are not so rigidly related to one another that one cannot change at all without some change in the others.

Chapter 3

CRASSOSTREA VIRGINICA

The American or eastern oyster, *Crassostrea virginica,* is the commercial oyster of the Atlantic and Gulf of Mexico coasts of the United States and of the Maritime Provinces of Canada (Medcof, 1961, p. 9; Loosanoff, 1965). Relatively small quantities also occur on the Pacific coast, where it was introduced. The oyster, which once constituted the basis for "the most valuable fishery of the United States and one of the most valuable in the world" (Churchill, 1920 p. 5), is found mainly in sheltered bays and estuaries. At one time, oysters could be found from Massachusetts north to Maine, but they are now uncommon in this region. Apparently the oyster grounds of the Maritimes have always been separated geographically from those of the United States. Because of environmental factors, oysters do not grow in the Bay of Fundy, and they are almost absent from the coastal region of Nova Scotia bordering the Atlantic. *Crassostrea virginica* and bay scallops, *Aequipecten irradians sablensis,* once lived at Sable Island, 100 miles southeast of Canso, N.S., near the edge of the continental shelf (Clark et al., 1967).

The oyster grounds of the Maritime Provinces (Fig. 1), extend from Maisonnette, Caraquet, Shippegan, and Miscou in New Brunswick south along the Gulf of St. Lawrence and Northumberland Strait to Cape Breton Island, N.S. In Cape Breton, small beds can be found at a few locations in Inverness County but the main areas include Bras d'Or Lake, and South Harbour and North Harbour, two sheltered parts of Aspy Bay near the northern tip of the Island. In Prince Edward Island, the largest producer of the three Maritime Provinces, the main oyster areas are in Prince and Queens counties, which include the western and central parts of the province.

In these areas, environmental conditions are such that oysters can reproduce, and oyster stocks have existed in these locations for a long period of time. Information on the life cycle of the oyster is available from many sources. Early research in the Maritimes was begun in 1904 under the auspices of the Biological Board of Canada, which had stationed its movable laboratory at Malpeque in 1903 (Stafford, 1913). Oysters reproduce by spawning (Medcof, 1961, p. 16), which will not take place until water temperature has reached 68 F and then usually when it is rising. In the waters of the Maritimes, therefore, spawning may not occur until late June or early July. Oysters may spawn when they are about 1 inch in length or less than 2 years old, and thereafter will spawn annually as long as water conditions are suitable. Young oysters tend to be predominantly males, but as they grow the percentage of females increases because of a change in sex. The process of spawning may spread over a period of several days or weeks. Sperm and eggs are released into the water where fertilization takes place. Sperm carry a hormone that stimulates other oysters to spawn. A large population of adult

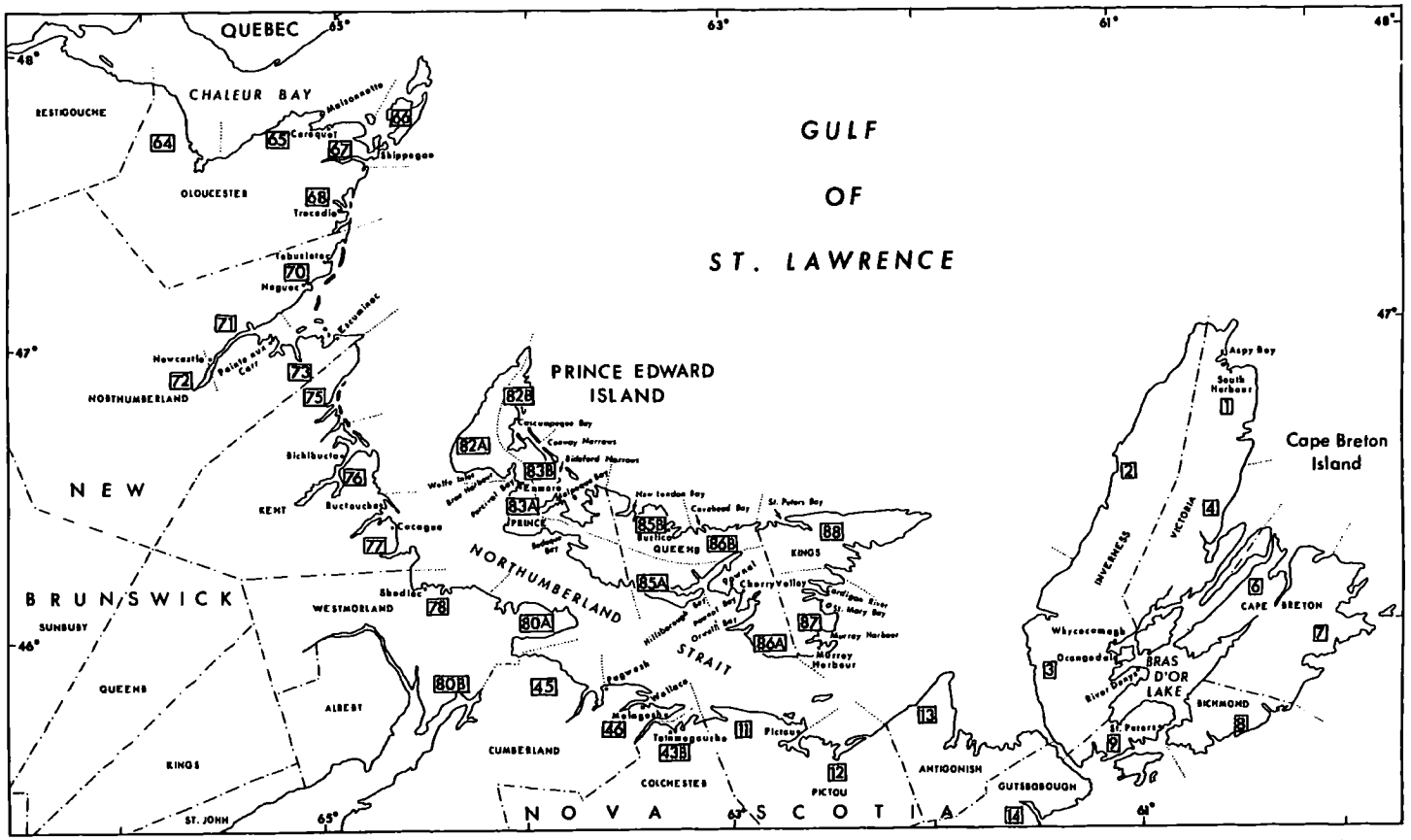

FIG. 1. Areas of oyster production, Maritime Provinces, Fisheries Statistical Districts marked by dotted lines and numbers in rectangles.

oysters is not necessarily required to produce a large year-class of young oysters, since a female may release 70 million eggs (or more) and a male an even larger number of sperm.

Fertilization usually occurs immediately or within a few hours after spawning, and the fertilized eggs soon develop into small larvae, which swim by means of vibrating hairs. In about a day a shell begins to form, making each larva appear like a small clam about 1/300th of an inch in length. At this stage a disc is formed that can be thrust out of the shell. The disc is covered with hairs and is used for swimming. The oyster is passing through the mobile stages of its life cycle.

"The larvae swim and drift. . . . do not float at the surface. . . . [and] are usually most abundant a few feet down. Even by vigorous swimming they do not move far horizontally. Their swimming efforts carry them mostly upward in the water. When they stop swimming they sink, and they may spend much time resting on the bottom. By swimming up they are often caught in tidal currents and carried about. They may be moved back and forth only short distances in their native area or they may be transported many miles from where they were spawned. . . . After 3 weeks it has grown to almost seven times its original size and is . . . about 1/75th of an inch high and barely visible to the naked eye. It still has its swimming disc . . . and other well developed organs. It has two eyes and a tongue-shaped foot . . . which it can thrust out between the shells for crawling and it is equipped now to attach itself to some support. Large numbers of oyster larvae die during the free-swimming period . . . . Only a fraction of 1% of fertilized eggs develop to full-grown larvae." (Medcof, 1961, p. 17–18.)

When the larvae are ready to settle they seek a firm surface free of slimy growths. The process of settlement involves, among other things, the extension of a "blob of cement . . . which flows into the space between the shell and the surface of attachment and sets firmly within a few minutes." (Medcof, 1961, p. 13.) The newly settled larvae are called "spat" and the settlement of many larvae is called a spatfall or a set of spat. Spatfall can occur at depths up to 25 ft. However, since clean bottom surfaces are frequently most prevalent near the shore as a result of the action of waves, spatfall often occurs in shallow water. If this is the case, young oysters may be exposed to certain hazards such as those associated with ice conditions in winter.

Once young oysters are attached to a firm surface they are no longer mobile. Their survival and growth then depends upon suitable environmental conditions, including the availability of food and the absence of predators and competitors. Food consists of microscopic plants and is obtained by filtering the water, at a rate depending on the size of oyster, water temperature, and other factors. A 4-inch oyster will filter, or pump, water at a rate as high as 8 gal/hr, though usually more slowly (Medcof, 1961, p. 21–22). Sometimes the supply of food is inadequate or feeding is hampered by the presence of silt or by a decline in salinity owing to heavy rains or spring runoff. Since feeding does not occur until water temperatures have reached 40–41 F (the upper limit is 80–90 F), in the Maritimes oysters feed for about half of the year only. Thus the amount of growth oysters can achieve annually in the Maritime Provinces is much less than that common in more southerly areas in the United States.

Except at the larval stage, oysters are immobile and must filter water to obtain food; therefore, a firm surface or bottom is necessary for them to flourish. The oysters may be covered and smothered if the bottom is too sandy and shifting; if the bottom is too soft so that they sink into it, they grow an elongated, curved, and misshapen shell and thus maintain access to the food supply. Excessive growth of

marine plants such as eelgrass also can lead to high mortalities since oysters can be smothered or starved as a result of being covered by dying plants. In winter, ice may damage or destroy oysters in shallow water.

Competitors such as mussels and slipper limpets and predators such as oyster drills and starfish are also hazards. Starfish have been the most serious predators in the Maritime Provinces and have, on occasion, destroyed nearly all the young oysters on a bed. In addition there is the possibility of disease decimating an oyster stock if the stock is not resistant to it. Disease has struck in the Maritimes in three different periods. Only the stocks in Cape Breton and in mainland Nova Scotia east of Cape George in Antigonish county have remained unaffected. These stocks may not be resistant to disease; however, those in the other areas have developed such resistance.

A favorable consequence of the limitations of environment in the Maritimes is that although in terms of weight oysters produce less meat in relation to the shell than in more southerly areas, the meat can be of exceptionally high quality and flavor. The relatively low production of meat makes oysters in the Maritimes generally economically unsuitable for shucking whereas the quality and flavor has resulted in a demand by consumers for fresh oysters on the half shell. The supply of oysters from northern areas being limited, the demand has led to high prices that afford a stimulus to the Maritime oyster industry.

The situation has been summarized by Needler (1932, p. 6).

Chapter 4

THEORETICAL CONSIDERATIONS: THE COMMODITY AND THE INDUSTRY

In this review of the history of the oyster industry of the Maritime Provinces over the last three-quarters of a century, it was decided that the approach should facilitate investigation of the industry as a whole rather than focus primarily or solely on its quantitative aspects and on its parts, the producing enterprises. The problem at issue is the probable effect of scientific and technological change on an industry having a certain organization, and functioning within a given economic and social setting. Nevertheless, the relevance of quantitative analysis and of microeconomic theory is recognized. Microeconomic analysis of a situation similar to that found in the public fishery for oysters has shown that, under certain conditions pertaining to utilization of a freely available common-property resource, the resource will be exploited more intensively than if it is a private-property resource (Gordon, 1954, p. 124–142; Scott, 1957, p. 42–43). Employment will tend to settle at a level where the return to labor equals the average product of labor rather than the marginal product; employment is excessive in terms of the usual criteria for profit maximization of firms (Scott, 1955, p. 116). Conditions that produce these results include freedom of entry of participants and consequent competition on the supply side. As a result of the "crowding," whatever economic rent the resource could have been made to yield will be nonexistent or drastically reduced below the level received under assumed conditions from a similar private-property resource.

Introduction of a leasing system changes the common-property resource condition. However, in respect to the public fishery, it can be deduced that economic rent tends to disappear whether the quantity of resource available and the output are high in relation to demand and the market price is low or whether they are low and the market price is high. In the first case even though output may be high in relation to inputs of labor and capital, the market price and the number of inputs adjust so that only minimal returns are earned by producers for their labor and capital. In the second, the market price of output, although higher, also would yield only minimal returns to labor and capital through adjustment of their quantity.

Consumers would be better off in the first case than in the second because they could purchase the commodity at a lower price and consumers' surplus would be the higher.

"the best way of looking at consumers' surplus is to regard it as a means of expressing, in terms of money income, the gain which accrues to the consumer as a result of a fall in price. Or better, it is the compensating variation in income, whose loss would just offset the fall in price, and leave the consumer no better off than before . . . [It] can be shown that this compensating variation cannot be less than a certain minimum amount, and will ordinarily be greater than that amount." (Hicks, 1950, p. 40–41; see Appendix A for additional microeconomic analysis.)

However, economic rent accrues to the supply side and it is theoretically possible that with certain supply and demand functions the same producers could be equally poorly off in the two cases, earning low or zero rent and receiving only minimal returns to labor and capital.

In either case, an improvement in economic welfare could be achieved for those supplying and consuming the commodity. Restricting entry of producers into the fishery could lead to the earning of economic rent if the number of producers were adjusted downward so that the total proceeds would enable them to earn more than minimal returns. If the restrictions are assured and lead producers to take a long view, producers might attempt to manage exploitation of the resource, even if only through improved harvesting practices, with success leading to expansion of the resource and a higher yield. The higher level of output would normally result in a fall in its average price, but producers who remain in the industry possibly still could receive a rent while consumers enjoy the increase in consumers' surplus.

The performance of the oyster fishery cannot be tested, however, by an exercise designed to identify aggregate cost and aggregate return functions or to measure changes in a magnitude such as economic rent. Consequently, an alternative approach, the "staple" approach, will be followed in presenting and discussing the history. This method has been used by several economic historians and is considered here to be appropriate to the objectives of this study. The leading innovator in the use of the staple approach was the late H. A. Innis (North, 1961; Watkins, 1963; p. 141–158; Easterbrook and Watkins, 1967). The adoption of the staple approach involves acceptance of the proposition that the commodity or staple does matter and that its nature or characteristics will be reflected in the industry and perhaps in the economy and society in a wider sense. In this study the oyster is the staple.

The oyster exhibits marked characteristics including the following: (1) its method of feeding; (2) its immobility during its life span except for the relatively short free-swimming larval stage of approximately 3.5 weeks; (3) its requirements with respect to temperature and salinity of water for reproduction and growth; (4) its two valves or shells.

The first characteristic requires that the oyster have easy access to water that is free of silt and rich in microscopic plants of suitable kinds. The second restricts the oyster to grounds on which it will neither sink nor be covered, so that it will not smother nor starve. The third confines the self-sustaining oyster populations to suitable grounds near the shore in sheltered bays and estuaries, limits spawning to a period during the summer when water temperature may be sufficiently high, results in dormancy of the oyster or a stoppage of feeding when water temperature falls below 40–41 F, and produces a relatively slow annual rate of growth owing to the shortness of the feeding and growing season in the Maritimes. The fourth characteristic affords some protection to the oyster in its natural habitat and facilitates its being identified by touch when it cannot be seen. Also, its two valves are, in effect, hermetically sealed when the temperature is below 40 F, and they provide a natural storage facility for the oyster within, and aid in handling, transporting, and holding in storage during marketing, provided cold air conditions prevail.

Given the social and economic conditions that prevailed in the oyster-producing areas, a series of consequences for the oyster industry can be deduced from the above basic facts.

(1) Accessibility of the natural oyster beds in shallow water near the shore enabled fishermen to harvest the product with simple equipment such as tongs and rakes. The technology is one involving a low ratio of capital to labor and, under the circumstances, can be expected to remain relatively unchanged for three reasons:
   (a) depletion of the resource even as early as the last two decades of last century, when completion of the Intercolonial Railway facilitated supplying markets in the Province of Quebec;
   (b) administrative regulations and social controls designed to conserve the resource and to maintain the fairness or equality of competition among participants, thus leaving differences in returns to individuals to differences in luck, skill, perseverance, and workmanship; and
   (c) seasonality of the fishery, which discouraged large-scale investment by individuals in the days when labor was relatively cheap and a common-property resource was being exploited.

(2) Since the public fishery was open to all entrants and required little investment, many persons tended to harvest oysters from the natural beds. There was little or no inducement to form companies so long as simple techniques were in vogue and the product was saleable without delay, although some individuals became buyers or dealers or perhaps operated from a schooner with a crew. Production from the public beds probably tended to be the sum of the production of individuals from nearby communities who considered they had first claim on the resources in their area. (An unknown number of schooners also participated in the oyster fishery and there are no records of the quantity of oysters taken by them. Consequently, early statistics of output may contain a wide margin of error.) (Kemp, 1899, p. 30–31.)

(3) When oysters were plentiful or relatively unexploited, output probably increased almost proportionally with the increase in inputs of labor and capital, but once the oyster stock failed to maintain itself and showed evidence of depletion, output per unit of labor and capital tended to decrease. The industry became an increasing cost industry, in the technical sense that the cost curves of production by each producer shifted upward. The fishermen then harvested a diminishing resource, and the volume taken by any one reduced the quantity available to another. The prospect of a continuing profitable fishery declining, a cycle of exploitation and depletion to some lower level of stock, output, and input undoubtedly followed with each participant seeking to maximize his net returns in any given short-run period by taking what he profitably could before the stock was diminished. In the absence of other effective conservation measures, regulations were introduced to reduce the legal period of fishing in each year, and to establish methods and approved practices.

(4) Probably a decline in the average quality of oysters accompanied the decline in output. In the usual sequence of harvesting a stock, the high-quality oysters in the deeper water at the mouth of bays frequently were taken first, leaving the lower-quality stocks at the head of bays and estuaries until later. Thus a continuance of output in any given area also was probably marked by a general decline in quality over the years (Needler, 1932, p. 7).

(5) The quality of the product, nevertheless, remained such that oysters from the Maritimes were sold mainly for consumption as fresh oysters in the shell, and accordingly were not shucked. This meant the export of both oysters and shells from the region and loss of opportunity for alternative uses of shells, e.g., as cultch on beds for the collection of young spat, especially on ground opened to oyster farming under lease.

(6) Handling oysters for market was a simple process. Although oysters may be consumed at any time during the year, they are in best condition in the fall after they have fattened and improved again in quality after spawning. Healthy oysters can be held for a time even if the temperature should rise above 40 F and for up to 4 months at temperatues below 40 F (e.g., 34–35 F) when they are dormant (Needler, 1934). With seasonal temperatures in the fall, oysters could be harvested, stored, and shipped (perhaps in refrigerated railway cars) without elaborate cold storage and packing facilities. The need for large-scale investment in marketing facilities in the production areas was absent and numerous buyers and shippers could engage in selling.

(7) In the earlier years, the marketing organization and the process of harvesting were decentralized, so that monopoly did not exist in either supply or demand. (Ultimately, relatively few firms marketed the product in the larger centers such as Montreal.) The tendency toward a decrease in the oyster stock and a decline in quality inevitably led to problems resulting from differences in the quality of the product offered by fishermen and shippers in

different areas. Although a grading system imposes constraints on all suppliers and may not affect all equally, it tends to be accepted because all suppliers and dealers may be afforded some protection against extreme forms of product differences that may disrupt marketing. Consequently, a system of grading oysters was introduced, but possessed limitations. Because production was almost exclusively of oysters for sale in the shell, grading was based on the size, shape, and appearance of the shell and not on the oyster meat itself, which remains unseen until time of consumption. However, as quality of the meat and condition of the shell do not stand to one another in a one-to-one relation, certain grading problems remain unsolved.

(8) The limited supply of oysters in the Maritimes in relation to demand led to attempts to increase output by oyster culture and involved:
   (a) an attempt by public authorities to restock and maintain the public fishery on the natural beds;
   (b) encouragement of oyster farming in suitable areas by establishment of private leases, which changed the commodity from a common-property to a private-property resource and placed much more responsibility on the individual leaseholder with respect to the maintenance of the oyster stock on his ground; and
   (c) initiation and broadening of a program of scientific research into problems facing oyster producers.

The attempts of government to maintain public beds by a program of cleaning and planting were generally ineffective in maintaining the fishery under changing conditions (involving some silting and pollution) and were eventually abandoned. The leasing system instituted in spite of delays from protracted debate over whether the provinces or the Dominion possessed jurisdictional control over the fishery was intended to stimulate output by granting property rights to the leaseholder over the resources developed on his lease. It was assumed that the arrangements under a system of leasing would enable each leaseholder to reap the benefits of his own labor and, by encouraging him to take a long view of his production plans, to raise the aggregate net income of the fishery. If the leaseholder could achieve successful spatfall, the immobility of oysters after they settle as spat would make a system of leases an appropriate part of a rational program of resource management.

Areas for leasing were opened on ground generally clear of oysters, so that oyster populations had to be established for the most part by artificial means such as seeding with young oysters, planting mature oysters as brood stock, and collecting spat. However, where conditions are marginal, even leaseholds may fail to achieve the intended objectives, especially if the leasehold enterprises are small and economically weak in relation to the obstacles likely to be encountered. If to natural obstacles are added special ones such as the spread of disease, the performance of leasehold enterprises may fall far below original expectations and leases may remain unused. In the Maritimes, many leases were established under special conditions that prevailed in the wake of oyster disease. These leases show a degree of underutilization similar to that of leases established earlier and on which oyster populations were destroyed.

The initiation and broadening of the program of scientific research also was a response to changing conditions, especially problems traceable to the effects of disease that may have been introduced with oysters imported from other areas to stock leases. Research may open the way to new techniques that will enable producers to avoid the overwhelming risks of the past; however, the industry as constituted may be unable to utilize most advantageously the apparent scientific advances.

Expansion of oyster farming on leaseholds may utilize the results of scientific research and take advantage of developments in technology. Otherwise, expansion

must depend largely on extensive government support of the public fishery, probably in the form of continuous extensive restocking of beds and close supervision of their exploitation. Alternatively, the public fishery might be turned over to private oyster culture under lease.

Chapter 5

ECONOMIC HISTORY OF THE OYSTER INDUSTRY OF THE MARITIMES

PART 1 — EARLY HISTORY TO 1912 AND THE PROBLEM OF JURISDICTIONAL CONTROL

The American oyster has apparently been present in the southern parts of the Gulf of St. Lawrence for a long time. Some oyster beds must have ceased to be productive before the end of the 16th century, an opinion based on the discovery of beds of mud and shells up to 30 ft in thickness (Found, 1927, p. 8).

Probably oyster beds were known to the Indians and exploited in the early days when western Europeans were active in the fisheries of the Gulf. Later, as settlement took place the rate of exploitation increased and practices developed that were inimical to the fishery. In the 1830's, Prince Edward Island passed an Act prohibiting the burning of live oysters for use as lime, and another Act limited the fishery to residents of the colony. In 1865, regulations were made for leasing by auction certain areas suitable for oyster production, and persons owning creek lands were encouraged to take out leases on their water frontage for oyster culture (Found, 1927, p. 3).

Depletion of some oyster beds probably occurred by the middle of last century, as the beds were being exploited both as a source of food for human consumption and as a source of fertilizer. The production of horses, hay, oats, and foodstuffs for sale in New Brunswick and Nova Scotia was not the type of agriculture to maintain soil fertility (Innis and Lower, 1933, p. 687–696). Also, continuation of the output achieved during the first stages of exploitation of a virgin natural resource is most unlikely, and unless the resource is so vast or reproduces so rapidly that its initial availability is not diminished, a lower output or yield must be expected (Christy, 1964, p. 27).

The upper limit over time to the level of output of a fishery will be the maximum sustainable yield. The best economic level of output — the level that will maximize aggregate net proceeds — will be below the level of maximum sustainable yield (Scott, 1957, p. 42–64). The best economic yield would be as large as maximum sustainable yield only if the resource were available as a free good. With oysters, this condition would be fulfilled if the marginal and average costs of harvesting output were zero. However, since these costs are greater than zero, the best economic yield will be below maximum sustained yield. There is no economic justification for worrying about some depletion of a resource and some decline in output below what is readily achievable under initial conditions. Questions of importance do arise, however, if the manner of exploitation reduces a resource considerably below its maximum sustainable yield because economic welfare may then fall below an attainable level.

Even before Prince Edward Island joined the Canadian Confederation in 1873, the Dominion had passed legislation that provided for granting licences or leases

"for the exclusive right of fishing oyster beds in any of the bays, inlets, harbours, creeks, rivers, or between any of the islands of the coast of Canada" (31, Victoria, cap 60, 1868, see Kemp, 1899, p. 37–38). The Dominion Act of 1868 also provided for the expenditure of a sum not exceeding $1000 per year for the formation of oyster beds and the restocking of exhausted fisheries. To protect the stock, regulations prepared under the Act placed prohibitions on fishing oysters from June 1 to September 1 of each year. In 1885 the close season was extended to September 15 (Found, 1927, p. 3), and this regulation remained unchanged until 1890. "In 1890, the only regulation in existence was that there should be a close season from June 1st to September 15th. . . . Apart from this restriction, any person could rake oysters at any place and in any manner he pleased, wholly regardless of the size of oysters taken or of injury to the beds . . ." (Patton, 1911, p. 7; see also Kemp, 1899, p. 37). Fishing therefore was prohibited during the period of spawning and the setting of spat.

Before completion of the Intercolonial Railway in 1876, most of the fish products consumed in Montreal had been obtained from suppliers in the United States rather than in the Maritimes, owing to the shorter distance between Montreal and the Atlantic Seaboard, the relative ease of transportation, and the variety of products available.

Opening markets for oysters in the central provinces was accompanied by an increase in production in the Maritimes until a decline of oyster stocks was clearly evident (Table 1). Output reached its highest levels in the 1880's and 1890's, with Prince Edward Island being the main producing area. Maximum recorded output for the three provinces occurred in 1882 and amounted to 64,646 bl valued at $193,938. In the mid-1890's, production began to decline. Nelson, investigating the industry in 1915, when oyster farming was being introduced on a rapidly expanding scale in Prince Edward Island, commented on the downward trend in production:

"[That] oyster production in Canada, and particularly in Prince Edward Island, has steadily been decreasing is evident from statistics . . . on page 47 in the report of the Dominion Shellfish Fishery Commission, 1912–1913 . . . we note a curious back-and-forth fluctuation from year to year; but if the entire series of years be divided into five-year periods, and the annual product be averaged for each five-year period . . . the annual catch in barrels is as follows:"

Period	Year	N.B.	N.S.	P.E.I.	Total	P.E.I. as % of whole
1	1876–1880	9,724	1,172	17,020	27,916	60
2	1881–1885	12,765	1,652	34,644	49,061	70
3	1886–1890	20,426	2,049	36,379	59,214	60
4	1891–1895	17,434	3,327	30,622	51,383	60
5	1896–1900	18,740	2,150	22,735	43,625	50
6	1901–1905	12,854	1,517	19,860	34,231	60
7	1906–1910	16,564	1,597	10,583[a]	28,744[a]	30
–	1911–1912	15,436	2,090	8,835	26,361	35

[a] For 1907–08 the quantity credited to P.E.I. was 1672 bl. Leaving this year out, the average for the remtining 4 years becomes 12,811 bl, 40% of the average total credited to the Dominion for the same period.

"The third period shows a maximum of oyster production in the Dominion and also in the two main oyster-producing provinces. The decline began in the middle of the fourth period (1891–1895), mainly in Prince Edward Island, which led in production up to 1906, when it sank to the level of New Brunswick. The decline in the latter province from the maximum has been little more than 20 per cent with 80 per cent decline in the island province. The difference in the rate of depletion has been explained as due to two main influences: the greater demand for the Island product and the discovery of new beds in New Brunswick, when several of the older beds were fished out." (Nelson, 1917, p. 61–62.)

M. J. Patton (1911, p. 5) also commented on the downward trend, as follows, "Considering the whole time the fishery has been engaged in [up to 1911], Prince Edward Island has given us more oysters than any other province. In 1882 the oyster crop of the province reached its maximum with a yield of 57,042 bbls . . . during the whole period from 1880 to 1891, the industry was remarkably healthy, the annual production averaging nearly 35,000 bbls. Beginning in 1892, the production began to fall off . . . in 1906, it shrank to 14,988 bbls.; and in 1907 . . . a minimum . . . of only 9,672 bbls . . . .

"The other provinces do not show up so badly as Prince Edward Island. New Brunswick reached the height of its production 1885–1890 with an annual average of approximately 21,000 bbls. After that, production declined to 12,470 bbls. in 1903. . . . In Nova Scotia, the proportionate decrease has been as large, but the small production in the province does not greatly affect the total for Canada."

TABLE 1. Output and value of oysters landed in the Maritime Provinces, 1876–1912.[a]

	Nova Scotia		New Brunswick		Prince Edward Island		Totals	
Year	Quantity *(bl)*	Value *($)*	Quantity *(bl)*	Value *($)*	Quantity *(bl)*	Value *($)*	Quantity *(bl)*	Value *($)*
1876	1,040	3,120	7,911	23,733	7,905	23,715	16,856	50,568
1877	980	2,940	7,738	23,214	20,850	62,550	29,568	88,704
1878	912	2,754	11,270	33,810	17,902	53,706	30,090	90,270
1879	1,067	3,201	9,420	28,260	18,145	54,435	28,632	85,896
1880	1,861	5,583	12,280	36,840	20,237	60,891	34,438	103,314
1881	2,270	6,810	8,413	25,239	20,815	62,445	31,498	94,494
1882	1,745	5,235	5,859	17,577	57,042	171,126	64,646	193,938
1883	1,343	4,029	10,317	30,951	33,380	116,640	50,540	151,620
1884	1,595	4,785	11,851	35,553	28,290	84,870	41,736	125,208
1885	1,310	3,930	27,368	82,104	28,204	84,612	56,876	170,646
1886	1,397	4,191	28,083	84,249	33,125	99,375	62,605	187,815
1887	1,716	5,148	23,196	69,588	36,448	109,344	61,360	184,080
1888	1,589	4,767	16,384	49,152	35,861	107,588	53,834	161,507
1889	2,532	7,596	17,760	53,280	41,257	123,771	61,549	184,647
1890	3,013	9,039	16,710	50,130	35,203	105,609	54,926	164,778
1891	4,318	12,954	14,934	44,802	41,030	123,090	60,282	180,846
1892	3,776	11,328	17,840	53,520	32,937	98,811	54,553	163,659
1893	3,488	10,464	16,365	49,095	29,627	88,881	49,480	148,440
1894	2,512	10,048	16,960	67,840	24,055	96,220	43,527	174,108
1895	2,540	10,160	18,070	72,280	25,463	101,852	46,073	184,292
1896	2,460	9,840	14,700	58,800	30,214	120,856	47,374	189,496
1897	2,372	9,488	19,835	79,340	20,915	83,660	43,127	172,448
1898	2,097	8,388	22,675	90,700	26,484	105,936	51,256	205,024
1899	2,027	8,108	17,250	69,000	18,236	72,944	38,513	150,052
1900	1,855	7,420	19,240	76,960	17,825	71,300	39,920	155,680
1901	1,690	6,760	14,460	57,840	24,972	99,888	41,122	164,448
1902	1,663	6,652	12,795	51,180	20,344	81,336	34,802	139,168
1903	1,354	6,770	12,470	62,350	18,333	91,665	32,157	160,785
1904	1,411	7,055	15,320	76,600	18,006	90,030	34,737	173,685
1905	1,466	7,330	14,300	71,500	17,656	88,280	33,422	167,100
1906	1,722	10,332	14,942	89,520	14,988	89,928	31,652	189,780
1907	1,337	8,022	15,435	92,610	9,672	77,376	26,444	178,008
1908	1,515	9,090	19,080	114,480	11,472	68,832	32,067	192,402
1909	1,716	10,296	19,340	116,040	13,519	94,633	34,575	220,969
1910	1,696	8,042	14,045	84,270	11,264	71,060	27,005	163,372
1911	2,090	9,183	15,436	77,180	8,835	44,175	26,361	130,538
1912	2,450	9,715	7,208	29,486	8,807	50,261	18,465	89,462

[a] Sources: 1876–1900 inclusive, Department of Marine and Fisheries (1902, p. 266); 1900–12 inclusive, Department of Fisheries (1963a, app. A) (figures have been converted to barrels at 200 lb/bl).

Once production had passed its peak, prices began to rise. In 1890, wholesale prices were $1.90/bl (2.5 bu); from 1890 to 1895, $2–$2.30/bl; from 1896 to 1907, $2.30–$4.50/bl; and in 1908–09, $6.50–$7/bl. These wholesale prices were supplied by A. Wilson and Son, Halifax, and were considered to be representative of those obtaining around November 1 of each year, f.o.b. point of shipment from the fishing grounds (Patton, 1911, p. 5). However, the estimated value of production for the earlier years (Table 1) indicates average prices of $3/bl or more in the 1890's. Prices rose during the period so that an output of 34,575 bl in 1909 was worth $220,969 compared to the maximum output in 1882, which was worth $193,938.

Although the oyster stocks in their natural state may have fluctuated in size, during the period of high output certain beds seriously declined. In New Brunswick, beds were exploited in both the southern and the northern areas (Kemp, 1898, p. 260–273). In 1868, Caraquet did not yield as it had. In 1883, the yield of Westmorland county, which included the Shediac area in particular, had declined. In 1885, Miramichi Bay and River were important areas. In 1886, only the beds in Gloucester and Northumberland counties were considered profitable, those of Shediac, Shemogue, Buctouche, and Richibucto having been depleted (Found, 1927, p. 12). In 1887, Caraquet and Bay du Vin furnished most of New Brunswick's output. Again, in 1888, Gloucester and Northumberland counties yielded most of the production.

In Prince Edward Island, the oysters of Malpeque Bay were not heavily exploited until yields of New Brunswick and of Bedeque Bay (P.E.I.) declined. "By 1878 the oysters had been 'completely extirpated' in Bedeque Bay by over-fishing, according to departmental reports, and the abundance of oysters on many New Brunswick beds had been seriously reduced. At this time the catches in the Malpeque Bay area were increasing, and the increase continued until the late eighties and early nineties. Then the yield commenced to decline and continued to do so until 1915–16 when disease completed the work of over-fishing." (Needler, 1931, p. 12.) In 1887 there were as many as 500 boats engaging in the fishery of Richmond Bay (Malpeque Bay) (Kemp, 1899, p. 20). In one day, 400 bl of oysters were sent by steamer to Quebec and 236 to Montreal. Eighty barrels were sent by express to Quebec (Kemp, 1898, p. 278).

There was a note of frustration in reports on the industry (Department of Marine and Fisheries, 1889, p. 127; Kemp, 1899, p. 22). Many complaints were made about wasteful methods and practices and of damage to many beds as a consequence of mud-digging by farmers in winter (Kemp, 1893, p. 10). Consequently, a Commission was appointed in 1887 to investigate and report on the conditions and requirements of the fishery. The Commissioners (F. Hackett, Chairman; A. Ogden; W. B. Deacon; J. H. Duvar, Secretary) emphasized special features of the oyster industry, especially ease of entry into the fishery, the small amount of capital required, the practices of fishermen, and the validity of the statistics, and made 12 recommendations designed to encourage private culture and to increase, yet control, the output from the public beds (Kemp, 1899, p. 30–31; App. D). An issue under study was the encouragement of private oyster culture. W. F. Ganong (cited in Kemp, 1899, p. 37) felt there were two futures open to the oyster industry of Acadia: free fishing by the people or vigorous Government interference to regulate the fishery on the public beds, and to give encouragement

to culture by corporations, with laws giving a culturist as good a right to his product, and as full protection from theft, as a farmer.

After the report of the Commission of 1887, the Department moved towards a program "of reserving areas for the restoration of public beds, and licencing limited sections of grounds to private applicants, for the purpose of encouraging natural and artificial cultivation . . . " (Kemp, 1899, p. 41). A conference in Ottawa in 1891 led to some extension or modification of regulations. A sum of $5000 was voted by Parliament for the survey of oyster beds and for planting and forming new ones. R. Simpson surveyed Shediac Harbour, which had been depleted, and about 270 acres were reserved by the Government for its own purposes. In 1892, the Department engaged F. and E. Kemp to expand the Department's program in oyster culture. F. Kemp returned to England, but E. Kemp was retained as oyster expert by the Department for three decades (Kemp, 1899, p. 42–47).

Changes in the regulations were made during the 1890's and the first decade of this century to control harvesting (Found, 1927, p. 4–5). In 1892, fishing through the ice was prohibited. In 1893, the first extended code of regulations was adopted respecting licences, registration of boats, minimum size of oysters, prohibition of fishing through the ice, restrictions on mud-digging, and harvesting tools. In 1894, an area in Tracadie Harbour, Antigonish County, N.S., was set aside for government purposes. For several years, annual regulations prohibited the use of drags and dredges in Prince Edward Island. In 1901, the closed season was extended from September 15 to September 22, and in 1904 was advanced from June 1 to May 21. In addition, minimum size limits were increased to 3 inches for mud oysters and 3.5 inches for long oysters. In 1901, the fishing of quahaugs was limited to designated areas, and mud-digging was prohibited in Trout River, Prince County, and in a portion of Bideford River.

In 1907, the closed season extended from April 1 to September 30. As fishing through the ice was prohibited, the effect of this regulation was to limit fishing to the period from October 1 until freeze-up, a period of a month to 6 weeks each year. An Order-in-Council, September 12, 1907, incorporated the regulations into the Consolidated General Fishery Regulations. These measures attempted to "save the fishery" by reducing the fishing season, restricting harvesting methods mainly to tonging and raking, establishing minimum sizes, and placing restrictions on the use of alternative resources such as quahaugs and "musselmud" for use as fertilizer (Found, 1927, p. 15).

In 1892, surveys by E. Kemp to restore public beds were carried out at Shediac, Cocagne, Buctouche, and Richibucto, N.B.; Tracadie, N.S.; and Bedeque Bay, Richmond Bay, Narrows and Bideford, Enmore, West River, East River, Vernon River, and Orwell Bay, P.E.I. Subsequent investigations also included Annapolis and Minas basins in 1895, and Yarmouth County, N.S., in 1896. In 1896, the beds in Bay du Vin were closely observed, and, in 1897, grounds in Bonaventure County, near Carleton in Quebec, were surveyed. In Bay du Vin, the Hatton Company was active and was granted a lease in 1888 for 15 years from October 1, 1891 (Department of Marine and Fisheries, 1892, p. 197–200, 1893, p. 1, iv). Few leases were established during this period in spite of repeated advocacy of such a policy. Efforts were concentrated on restoring public beds at several locations, including Shediac, Tracadie, and areas in Prince Edward Island

(see Department of Marine and Fisheries, and Department of the Naval Service, Annual reports, 1890's–1920's; see also Needler, MS, 1933, p. 1–7).

The attempt of the Department of Marine and Fisheries to maintain the fishery by a policy of cleaning and restocking depleted public beds probably had little effect on long-run trends in production. The suggestion of saving the natural beds by dividing them into sections and fishing each section in alternate years (Found, 1927, p. 15–16) would have introduced problems of marking the sections and regulating the harvest. Also, a certain amount of working of beds was said to improve their condition by helping rid them of weeds and enemies of oysters. The only appropriate course to follow seemed to be to establish oyster culture by private enterprise.

Failure to introduce a system of leases in the oyster fishery of the Maritimes was attributable not to lack of knowledge of oyster culture practices in other countries (see, reports of E. Kemp on practices in France and England; also Department of Marine and Fisheries, 1889, p. xxxi, cited in Kemp, 1899, p. 35–36, 50–75) but to lack of agreement between the Dominion and the provinces, notably Prince Edward Island, over the jurisdictional control of the fisheries. In Prince Edward Island, only one lease had been established before Confederation (Patton, 1911, p. 5; see also Commission of Conservation, 1912, p. 78–80). After Confederation, the Dominion held that jurisdiction over the fisheries had passed to it whereas Prince Edward Island held that the fishery remained under local laws (Kemp, 1899, p. 10). A few leases were granted by the Dominion to persons who wished to cultivate oysters in Prince Edward Island, but little progress was made in any of the provinces owing to failure to establish the validity of the federal leases. According to local law in Prince Edward Island, e.g., it was possible for mud-diggers to dig through a lease. Also, the beds that individuals sought to establish frequently were plundered, and the ground was allowed to fall back into a wild state. In these circumstances, leaseholding did not become common practice.

The question of jurisdiction over the granting of leases was placed before the Privy Council in 1898. The matter hinged upon the interpretation of sections 91 and 92 of the British North America Act. Section 91 said that the Dominion had exclusive legislative authority on all matters respecting "Sea Coast and Inland Fisheries" but section 92 gave the provinces exclusive power to issue licences to provide funds for provincial revenue. This raised the possibility of double taxation of oyster fishermen. The most important feature of the Privy Council judgement was that the British North America Act did not convey to the Dominion proprietary rights in fisheries, although the Act did convey the right of legislative jurisdiction. This latter right did, however, enable the federal government to affect the proprietary rights of the provinces to almost any degree, short of transferring them to others (Patton, 1911, p. 10).

The Privy Council decision that the Dominion did not have proprietary rights in the fisheries was probably more significant than the possibility of double taxation as a major deterrent to prospective leaseholders. There was some leasing, however, in the Bay du Vin area in New Brunswick in the late 1880's and early 1890's (Patton, 1911, p. 54), and the Barnes lease at Buctouche was surveyed in 1898.

Finally, in 1910–12 the Dominion acceded to an agreement with Prince Edward Island granting the province the right to give exclusive title to oyster ground to private individuals and companies (Patton, 1911, p. 3; see also

Commission of Conservation, 1912, p. 5–6; Department of the Naval Service, 1918, p. 18).

All provinces could now cope with some of the perils to which the oyster stock had been exposed over a long period (Found, 1927, p. 8–12). However the Dominion still was responsible for the administration and maintenance of the public fishery and for making and enforcing regulations (Needler, MS, 1933, p. 5).

Part 2 — 1912–1928: Divided Jurisdiction

After the jurisdictional dispute was settled, Prince Edward Island actively proceeded with surveying oyster grounds and instituting leases (Patton, 1913, p. 3–4). In 1912, applications for leases in Malpeque Bay were received, first from residents and eventually from nonresidents.

The province moved towards what it considered to be a systematic policy, taking into consideration the number of applications and the availability of ground. According to estimates there was plenty of good ground (Commission of Conservation, 1912, p. 80–82; Needler, MS, 1933, p. 13). Malpeque Bay contained 30,000 acres of which only perhaps 3000 acres comprised live beds. It was assumed that 100,000 acres were available for leasing in Prince Edward Island and that, if oysters could be grown in depths up to 30 ft, the amount of suitable acreage might be 300,000 acres. In June 1912, applications had been received for leases exceeding a total acreage of 1000 acres, approximately equal to the total acreage of all leases that had gone into effect during the earlier period of jurisdictional dispute. In 1913, approximately 5000 acres were leased and applications were received for 7000 more (Department of Marine and Fisheries, 1914, p. 305–306). Those who had previously engaged in the fishery were given favorable consideration but the largest growth was expected to occur in large areas outside local holdings. The formation of companies proceeded rapidly. Although the initial 5-acre leases were considered adequate in some localities, the limit was lifted because it was regarded as being far too small for companies (Commission of Conservation, 1912, p. 82–83).

Prince Edward Island probably attached considerable importance to the potential revenues from licences or leases to oyster fishermen, and such expectations were an important cause of the province's unwillingness to allow control of leasing to pass to the Dominion. The annual leasing fee was established on a rising scale, beginning at $1 per acre for each of the first 5 years, rising to $3 per acre for each of the next 5 years, and to $5 per acre for each of the remaining 10 years. Leases were renewable thereafter at $5 per acre per year. The lessee also was liable for the payment of any royalty that the province might levy on the oysters produced. (For the achievement of optimum utilization of the resource, a fixed levy or a percentage of profits would be a more suitable tax than a royalty.) Leases could not be sublet or disposed of without permission, and could be cancelled if the terms were not met. The term of leases was 20 years, renewable for a similar length of time.

In 1910, E. Kemp, of the Department of Marine and Fisheries, worked mainly at Malpeque, and used 1000 bl of shells to make a bottom on an area on the north side of Malpeque Bay (Department of Marine and Fisheries, 1911, p. 413). In 1911, he made an artifical bed of about 4 acres in Caribou Harbour, Pictou County, N.S.; he examined the Merigomish area but found no oysters; and he engaged some Indians and other residents to pick oysters around Big and Little Curtain islands and

Ram Island in Malpeque Bay (Department of Marine and Fisheries, 1912, p. 343–344). In 1912, some American stock was imported for planting at Caribou, but in 1913 these oysters were not growing so well as those that had been obtained from Malpeque Bay in 1911 (Department of Marine and Fisheries, 1912, p. 343; 1914, p. 303–304).

In 1913, a survey was made of Richibucto and an area suitable for growing quahaugs was found. Also, shells were placed on a bed in Bay du Vin that had been surveyed in 1912. Oyster culture in Malpeque Bay was progressing well, except for the spread of eelgrass and the alleged prevalence of poachers (Department of Marine and Fisheries, 1914, p. 303–304). However, by 1913, commercial activity in Prince Edward Island dwarfed that of the Department of Marine and Fisheries. The new companies were adopting American techniques and were importing oysters from the United States both for seeding and for holding before marketing. "The McNutt Malpeque Oyster Company and the Standard Cup Oyster Company have obtained an up-to-date plant in the shape of modern gasolene dredging boats from the United States and have laid large quantities of seed and other oysters. There are . . . 12 to 14 oyster companies fairly started in Richmond Bay [Malpeque Bay] with capital ranging from $25,000 to $150,000 and new companies are being continually formed . . ." (Department of Marine and Fisheries, 1914, p. 306).

Five hundred to seven hundred bushels of seed oysters of such a size as to be ready for market in a year were considered sufficient to stock a lease. In 1912, Sharp Bros. imported 100 bl of American seed oysters from Long Island and Oyster Bay at $5.35/bl delivered. The Inman beds at Shemody Creek in Malpeque Bay also were stocked with imported oysters, purchased at $4.50/bl and sold in the fall at $8/bl (Patton, 1913, p. 5–7). H. C. Mills, whose ground was in Malpeque Bay off Locke Shore, imported nearly 100 bl of American oysters. These, and probably other, imports occurred because of their availability and quality, the enthusiasm and speed at which companies were developing, and the prospect for profit, given the prices at which oysters could be obtained in the United States and sold to the Canadian trade. In 1908–10, when Malpeque oysters grown on natural beds in Malpeque Bay were selling for $6–$7/bl of 2.5 bu, a barrel of the same size would not bring the producer in Virginia more than $1.40. However, the producer in Virginia tended to earn more during a season than the fisherman in Prince Edward Island owing to the prevailing price and to the greater plentifulness of oysters, attributed largely to the practice of oyster culture (Found, 1927, p. 8; see also Department of the Naval Service 1915, p. 401). Some of the imports were Blue Point oysters, which were considered exceptionally desirable.

In the Canadian market, prices increased in 1910 to three or four times their level two decades earlier, and oysters were selling from $6.50 to $7 or even up to $10/bl at point of shipment(Patton, 1911, p. 5; Found, 1927, p. 8). In addition to domestic supplies in 1909–10, the equivalent of about 389,500 gal of oysters, raw and canned, was imported into Canada even with duties of 17.5–25% on oysters in the shell and of 1.5–3¢ per pint on shucked and preserved oysters. The value of imports was $369,166, and the duty paid was $43,669. The value of output in the Maritimes was $220,969 in 1909, $163,372 in 1910, $130,538 in 1911, and $89,462 in 1912, in general tending to be well below the value of imports (Patton, 1911, p. 5).

The decline in output of the Maritime oyster fishery after 1890 was not keenly felt by the Canadian fisherman owing to the rise in prices (Nelson, 1917, p. 62). He enjoyed a favorable position in the market owing to the quality of the product, which was demanded for consumption in the shell and which, therefore, did not compete directly with imports of oyster meat. This situation afforded a stimulus to private oyster culture, which was rapidly expanding in Prince Edward Island. However, even with the spread of private farms, the quality of oysters from the Maritimes was threatened for two reasons — depletion of oyster stocks on the best grounds and importation of oysters, especially from the United States, for seeding or planting. The American oysters were of different quality from the Canadian and when transplanted to northern water often lay dormant for a period. There was debate whether oysters imported from the United States for planting or seeding would eventually equal native stocks in quality.

There seemed to be ample room for expansion of the oyster industry of the Maritimes, as it produced about 0.2% of that of the United States in terms of volume and only about 1% of that of the United States in terms of value. Around 1910–14, output of the Maritimes was approximately 5,000,000 lb (not over 60,000 bu) with a value of $150,000. The industry of the United States in about the same period was yielding around 30,000,000 bu worth around $15,000,000 (Table 2). To assist those engaging in private oyster culture in the Maritimes,

TABLE 2. Oyster production of the United States (Churchill, 1920, p. 5).

Region	Private grounds		Public grounds		Total	
	Quantity *(bu)*	Value *($)*	Quantity *(bu)*	Value *($)*	Quantity *(bu)*	Value *($)*
New England States (1910)	5,549,318	3,439,450	92,703	157,584	5,942,021	3,597,034
Middle Atlantic states (1911–1912)	7,090,883	5,204,124	11,815,193	4,059,432	18,906,076	9,263,556
South Atlantic states (1910)	456,194	171,298	1,244,804	192,886	1,700,998	364,184
Gulf states (1918)	1,227,969	528,123	2,165,526	578,597	3,393,495	1,066,720
Pacific coast states (1915)	152,560	548,005	3,544	8,619	156,014	566,624
Total	14,476,924	9,891,000	15,301,770	4,967,118	30,098,694	14,788,118

research was expanded by the Biological Board of Canada (Needler, MS, 1933, p. 6). The early work on the life history of the oyster was commenced by Dr J. Stafford in 1904, when the Board's floating laboratory was stationed at Malpeque. In 1914, A. D. Robertson made a report on oyster grounds in Malpeque Bay, and in the same year Dr J. Nelson, from New Jersey, gave public lectures to oyster producers in Prince Edward Island (Medcof, 1961, p. 5). In 1915, Dr Nelson conducted an investigation of oyster propagation in Malpeque Bay. Although he may have been less optimistic about the amount of suitable ground than Premier Mathieson had been at a meeting of a Committee of the Commission of Conservation in Ottawa in 1912 (Commission of Conservation, 1912, p. 82–83), Dr Nelson

suggested that there were prospects for a marked expansion in output. His report stated that oyster propagation in Malpeque Bay showed the effects of the considerable depletion indicated by statistics, but there were still areas where planting of cultch would capture a fair set of spat. He emphasized the necessity of raising oysters from seed by artificial culture as the only way to restore the bay to its original productiveness. He thought that a quarter of the 32,000 acres in the domain could be made productive, which would make the annual product nearly a million bushels (Nelson, 1917, p. 78).

Enthusiasm waned, however, as a consequence of a disease that spread through the oyster stocks of Malpeque Bay during 1915 and 1916 (Needler, MS, 1933, p. 13), first observed in the summer of 1915 on beds south of Curtain Island. By 1916 it had spread to other parts of the Bay leaving only a few surviving oysters. Then it spread to Cascumpeque Bay (Department of Marine and Fisheries, 1921, p. 78–79). It was identified by the occurrence of yellow spots or pustules in the body of the oysters. A few oysters remained to spawn, and during the next few years sets of spat occurred at the heads of inlets. Most of the spat died before reaching marketable size, but gradually more oysters survived to an older age. In 1922 and 1923 oysters up to 3 years of age were found in a healthy condition and the stock showed signs of recovery, but the beds were reported to be silted. Oysters introduced into Malpeque Bay from Enmore in 1924, Mt. Stewart in 1928, Percival River in 1928, and again from Enmore in 1929, suffered heavy mortality in the 2nd year, most of them having died by that winter.

The hypothesis that the disease was carried by a parasite and was probably brought to Malpeque Bay by oysters introduced from the United States in 1913 or 1914 is supported by the extremely high mortality, suggesting something new to the population against which no resistance or immunity had been developed, and commencement of mortality soon after the introduction of seed oysters from the outside became general (Department of the Naval Service, 1918, p. 17; Department of Marine and Fisheries, 1921, p. 7–8). The disease was not harmful to humans, and, in 1925, as the stock recovered, some oysters were marketed from the disease-stricken area.

The report of 1917 stated that the natural public beds began to suffer as the demand increased and were on the verge of commercial exhaustion. As already stated, E. Kemp had been brought from England to advise on the best course to pursue but conditions made it impossible for him to achieve satisfactory results (Department of the Naval Service, 1918, p. 17–18). "Commercial exhaustion" and "satisfactory results" are qualitative rather than quantitative terms referring to some undefined standard.

In 1914, preceding the outbreak of "Malpeque disease" an infestation of starfish was reported on beds in Malpeque Bay (Department of the Naval Service, 1915, p. 397–400, see also 1918, for further reference to the menace of starfish). Starfish kill young oysters by fastening onto the two shells, or valves, and exerting a steady pull until the oyster weakens and the valves open, thereby enabling the starfish to devour the oyster within. Also young starfish of a given season can destroy oyster spat of the same season. (Medcof, 1961, chapt. 9; also, Needler, MS, 1933, p. 13). The Department's vessel *Ostrea* and two patrol boats mopped 394 baskets or approximately 394,000 starfish; however oystermen did not destroy starfish as they ought. In New Brunswick, quahaugs obtained from Pointe-du-Chêne

were planted near Richibucto. Also, the Shemogue Oyster Company transplanted more than 2000 bl of oysters from the Richibucto River above Chapel Point. Other producers were transplanting also. The beds at Caribou, N.S., were examined, and there was suspicion of poaching as large oysters were scarce.

In 1915, beds at Cocagne were inspected, but quahaugs were said to be more valuable than oysters because of the effects of mud-digging (Department of the Naval Service, 1916, p. 300–301). Problems existed in Kouchibouguac River and Bay as a consequence of silting and the presence of sawdust. A survey from Chapel Point to Molus River led to an estimate of a stock of 57,000 bl of oysters in that section of the Richibucto River. During the next few years there was a considerable movement of oysters from the Richibucto River to grounds with higher salinity of water, the Department of the Naval Service transplanting 200 bl in 1918. At Caribou, oysters from Prince Edward Island has grown better than those from the United States, but spatfall and reproduction were unsatisfactory. With disease of oysters running its course in the Malpeque area, the activities of E. Kemp were confined to the mainland provinces more than had been the case before 1915.

In 1917, production of oysters in the Maritimes fell to the lowest point during the period 1912–28. Output reached the low figure of 2,368,000 lb or 11,840 bl (Table 3). The effects of disease among oysters are evident in the decline in the

TABLE 3. Output and value of oysters landed in the Maritime Provinces, 1913–28.[a]

	Nova Scotia		New Brunswick		Prince Edward Island		Totals	
Year	Quantity *(lb)*[b]	Value *($)*	Quantity *(lb)*	Value *($)*	Quantity *(lb)*	Value *($)*	Quantity *(lb)*	Value *($)*
1913	679,400	12,283	2,160,000	54,000	2,590,200	84,222	5,429,600	150,505
1914	364,800	7,135	3,026,000	75,650	1,564,600	39,115	4,955,400	121,900
1915	318,400	6,687	2,499,600	62,490	1,241,200	37,729	4,059,200	106,906
1916	414,800	7,922	1,658,800	49,764	1,286,200	42,577	3,359,800	100,263
1917	375,800	8,105	1,385,200	41,556	607,600	20,730	2,368,600	70,391
1918	380,800	9,019	1,437,600	43,128	675,000	24,325	2,493,400	76,472
1919	290,200	7,633	1,468,600	58,740	678,400	31,160	2,437,200	97,537
1920	365,200	11,861	1,641,400	55,780	555,000	22,423	2,561,600	90,064
1921	471,200	15,087	2,218,800	52,428	758,400	25,669	3,448,400	93,184
1922	292,800	9,492	2,141,600	50,304	1,042,200	34,525	3,476,600	94,321
1923	553,000	14,753	2,914,800	67,051	807,000	25,836	4,274,800	107,640
1924	434,600	12,168	3,440,200	78,521	1,589,000	48,300	5,463,800	138,989
1925	528,800	15,747	2,407,600	49,880	1,055,600	31,852	3,992,000	97,479
1926	470,800	13,571	2,476,600	68,219	1,032,200	36,161	3,979,600	117,951
1927	363,400	10,552	2,714,800	78,093	814,200	29,068	3,892,400	117,713
1928	388,800	11,231	2,476,600	81,822	951,200	30,721	3,816,600	123,774

[a] Source: Department of Fisheries (1963a, app. A).

[b] 200 lb = 1 bl.

relatively low production of Prince Edward Island from 2,590,200 lb in 1913 and 1,286,200 lb in 1916 to 607,600 lb in 1917 and 550,000 lb in 1920. In the 1920's, production in the Maritimes rose from 2.6 million lb in 1920 to 5.5 million in 1924 and remained around 3.9 million lb (19,500 bl) from 1926 to 1928. Only in 1924 did production exceed the levels of 1913 and 1914, and only in 1923 and 1924 did it exceed the level of 1915 (4,059,200 lb), the year that oyster disease was first detected. With the exception of 1913, New Brunswick was the leading province in

terms of both production and value, with both falling off to some extent from 1914 to 1917. The value of total output fell from $150,505 in 1913 to the low level of $70,391 in 1917, and thereafter showed some gains, with fluctuations, reaching the figure of $123,774 in 1928. Average values of oysters per pound almost invariably were highest in Prince Edward Island; Nova Scotia and New Brunswick changed their ranking, sometimes one and sometimes the other being second in terms of actual value.

In the 1920's, Richibucto and Miramichi were important oyster-producing areas in New Brunswick. For the industry as a whole, an output of 50,000 bl annually (10 million lb) was suggested as a reasonable possibility for future production. Aggregate revenues perhaps would reach $500,000. However, oyster disease had discouraged Prince Edward Island producers and the two mainland provinces were exploiting only their public beds; the extent of leases on the mainland was effectively zero. Although opportunities for development were good and recovery from disease was evident, a solution to the problem of dual control of the fishery was needed before the industry could realize its full economic potentialities (Department of Marine and Fisheries, 1927, p. 22). The institution of leases by the provinces had ceased and the Dominion found it impossible to effect an expansion of any consequence in the public fishery.

On April 3, 1928, an agreement was reached between the Dominion and Prince Edward Island, ending the dual control that had existed since 1898 (see, Department of Marine and Fisheries, 1929, p. 24; Needler, MS, 1933, p. 6). Jurisdiction over the fishery was passed to the Dominion and the Fisheries Branch of the Department of Marine and Fisheries took steps to expand its investigations and to determine the best method of developing the industry. In 1928 and 1929, D. R. Dodge, an oyster farmer from Rhode Island, came to Malpeque. He succeeded in obtaining good spatfall in 1928 on cleaned beds, introduced oysters from other areas to build up a brood stock, and collected and planted spat in Grand and Bideford rivers. In 1929, A. W. H. Needler commenced research for the Biological Board of Canada with the assistance of W. J. Duchemin in 1929, and H. P. Sherwood, A. B. Needler, and E. T. McEvoy in 1930. The Prince Edward Island Marine Station was established near the head of Bideford River as a center for the oyster investigations.

Oyster farming was considered an effective means of reestablishing oyster stocks and combatting predators. With jurisdictional problems ending, there appeared to be less likelihood of delay in establishing leases. However, existing and prospective leaseholders were still wary and needed encouragement to farm. Nevertheless, the Fisheries Branch could, for the first time, look forward to planning for the whole industry if arrangements similar to those with Prince Edward Island could be made with the other two provinces.

Part 3—1928–1966: Jurisdictional Control Transferred to the Dominion and Problems of the Fishery

The arrangements between the Dominion and Prince Edward Island were not extended at once to the two mainland provinces. In 1931, the Shediac area of New Brunswick was placed under federal control (Department of Fisheries, 1932, p. 20; Needler, MS, 1933, p. 1), but an agreement was not reached with Nova Scotia until 1935 (Department of Fisheries, 1937, p. 19–20). Remaining areas of

New Brunswick were not transferred to the Dominion until later (e.g., Gloucester County was placed under the Dominion in 1944 (Department of Fisheries, 1946, p. 84)). The delay in placing oyster areas outside Prince Edward Island under federal responsibility did not restrict federal activity to those areas covered by federal–provincial agreements, because the federal authorities were responsible for maintenance and control of the public fishery and for regulation of both the public and the leasehold fishery. However, with limited funds and personnel, the federal program tended to develop first in those areas included in agreements.

Federal research centered in the Malpeque region. Malpeque Bay, formerly a major area of production (Needler, MS, 1933, p. 13) that had become famous for the quality of its product, was suffering from the most acute problems of any of the oyster areas as a consequence of oyster disease; it was considered to have a high potential for oyster production, was a locality where a few leaseholders were still active or interested in oyster culture, and, being in Prince Edward Island, was under federal control after 1928. In 1929, research was concentrated in the Bideford area, and included cleaning and planting two small beds, collecting spat, and measuring water temperatures. In 1930, activities were concentrated on the upper reaches of Bideford River, the Cooper bed farther down river, and Curtain Island bed. There was some transplanting of oysters, and good spatfall was achieved on bags of shells placed in the river (Department of Marine and Fisheries, 1930, p. 30, 255; Department of Fisheries, 1931, p. 237–238). In addition, investigations were made of the Hillsborough River, near Charlottetown, and at Wallace, N.S.

In 1931, oyster farming experiments in the Malpeque area were expanded (Department of Fisheries, 1932, p. 20–21, 187–190). Hillsborough River and other rivers tributary to Northumberland Strait, and Savage Harbour and other bays on the north shore of Prince Edward Island were investigated to determine the best use of grounds. A policy of leasing ground for oyster culture was begun in Malpeque Bay and on the north shore where the public fishery no longer existed. By 1933, 195 acres had been leased in Malpeque Bay, 8 acres in Cascumpeque Bay, 33 acres in Covehead and Brackley bays, and 8 acres in Savage Bay (Department of Fisheries, 1934, p. 168). Leases up to 5.5 acres were permitted per person, with priority given to owners of land on the nearby shore, and other residents considered next. It was not the policy of the Department to lease ground at the head of inlets: spatfall was most successful in these areas and they were preserved for governmental and public use as a source of oysters for restocking leases; and the quality of oysters at the head of bays tended to be inferior to that of oysters farther out where the water had higher salinity. Leases therefore were established in the deeper water. The establishment of leases was expected to lead to planting oysters and collecting spat on the leases and along the shores (Department of Fisheries, 1933, p. 165–167). In 1932 and 1933, 1517 bl of oysters were planted on leases and 309 bl of oysters were taken for sale. Over 3500 bu of shell cultch were put on leases to improve the bottom (Department of Fisheries, 1934, p. 168). In Malpeque, spatfall and production of small oysters occurred in the headwaters where the water was warm and wave action kept the bottom clean. However, the oysters were exposed to ice damage and lessees were permitted to pick them for seeding. The Department also engaged in oyster farming to provide small oysters for restocking purposes (Department of Fisheries, 1935, p. 183). Such a program was

encouraged as oysters constituted one of Canada's main imports of fishery products (Department of Fisheries, 1936, p. 19). Although collection of spat was on the whole successful, starfish proved to be a serious menace.

Not all the work of the Department was confined to Prince Edward Island during these years. In 1931, the Shediac area of New Brunswick was placed under federal control and a preliminary investigation was made of Shediac Bay and tributary rivers. These investigations were extended in 1932 (Needler, MS, 1933, p. 7). Production of oysters at Shediac, once an important area, had fallen even before the statistics were first reported in 1876. Documents available indicate that Shediac, Bedeque, and Malpeque had been heavily exploited in turn. Output from the Shediac area after 1876 was exceedingly variable, indicating failures in spat production.

Production at Shediac and vicinity was as follows (Needler, MS, 1933, p. 6):

Year	Bl
In the Shediac River to Cape Jouremain	
1876	450
1878	250
1879	200
In Shediac and Bideford	
1884	300
1885	100
1886	100
1887	100
1888	100
1889	50
1890	50
1891	50
1892	100
1893	150
1894	300
1895	300
At "Shediac"	
1896	200
1897	200
1898	150
1899	150
1900[a]	1500
1901	400
1902	400
1903[a]	1000
1904	800
1905	800
1906	600
1907	650
1908[a]	1050
1909	410
1910	400
1911	2960
1912[a]	1021
1913	1562
1914	4200
1915[a]	1950
1916	220
1917	350
In "Shemogue to Kent County"	
1918	720
1919	576
1920	131
1921	1266
1922	1293
1923	190
1924	168
1925	168
1926	89
In "Westmorland County"	
1927	204
1928	30
1929	35
1930	161
1931	628
1932	1071 (all at Shediac)

[a] Catches in the Department's reserve are included as follows (in barrels): 1900, 1400; 1903, 646; 1908, 234; 1912, 496; 1915, 599.

In 1893 and 1894, E. Kemp had cleared and planted certain silted beds in the southern part of the bay between Shediac Island and the mainland. Fishing had been permitted periodically in the reserve, and although statistics of output indicate the reserve must have prevented extreme depletion of the oyster stock in the bay, wide variations in the quantity of oysters harvested from year to year were characteristic of the area. In the 1920's, the reserve had not been effectively operated, although production had recovered in 1932. It was recommended in 1932 that the Department's reserve be reestablished and that leases be introduced if transplanting oysters from other areas and collecting spat proved successful. However, from 1932 to 1934, little success was achieved in spat collection. In 1935, problems of silting and of pollution were sufficiently serious that the hope of restoring Shediac Bay to the status of a major area of production was abandoned.

A problem at Shediac continued to be that of successful spatfall. Investigations in 1941 showed that the uncertain spatfall could not be attributed to pecularities of the oysters themselves or their larvae. Instead, changing water directions outside the bay probably could make the return of larvae to the bay possible or impossible. Wind direction and strength also seemed important (Medcof, MS, 1941, p. 11–12).

In 1935 an agreement with Nova Scotia stipulated that the Department endeavour to develop commercial oyster culture in the province as was being done in Prince Edward Island after the 1928 agreement (Department of Fisheries, 1937, p. 19–20). In 1934, Bras d'Or Lake was investigated as production there exceeded that of the Northumberland Strait area of Nova Scotia. In 1935, attempts to overcome the problem of the dark mantle in the Bras d'Or oysters were not successful, and the low salinity of the water affected quality. Spat collection was successful, and establishment of experimental plots was planned to determine the effects of moving oysters to saltier water. A public fishery existed in Denys Basin and the western part of St. Patrick's Channel. Provincial leases had been established in the area (Department of Fisheries, 1936, p. 191; 1937, p. 114), and the Department opened areas for leasing in 1937–38. However, a persistent problem in the Bras d'Or area was quality and flavor, and sale of oysters shucked rather than in the shell was encouraged.

Leases were established in Nova Scotia as follows: (1) Maximum size of lease was set at 6 acres. In Bras d'Or no area would be leased that had more than 1200 ft of shore area or that would be narrower than 50 ft. (2) In Northumberland Strait and George Bay no public beds would be leased although in Cape Breton some leases were opened on ground carrying oysters. (3) Unsuitable areas and areas useful for growing spat would not be leased. (4) Provincial leases that were in effect June 22, 1936, when the federal–provincial agreement was made would be continued. (5) Surveying leases would be done without charge. (6) Leases were to run for 20 years, renewable for a like period with rental at $1 per acre for each of the first 5 years and thereafter a royalty of 10¢/bl of 2.5 bu. (7) In the case of conflicting applications, owners of the foreshore opposite or adjacent to a lease would be considered first, with other residents of the district or the Province placed in a lower capacity. (8) The Department would assist and advise oystermen. (Anon., 1938.)

The Northumberland Strait area of Nova Scotia produced fewer than 1000 bl, with the largest yields occurring at Wallace, Tatamagouche, and Caribou (Department of Fisheries, 1937, p. 114). Conditions varied in the different rivers and estuaries. In Wallace, oysters were obtained from the lower parts of the channel of the Wallace River, and also in the northwest branch. Some oysters also were picked at low tide. Salinity of the water was high enough to produce a good quality product, at least from some of the beds, and there was suitable barren bottom at sufficient depth to escape ice. In Tatamagouche Bay, including Malagash, most of the oysters harvested were picked at low tide, and the quantity of suitable ground comprising deep, firm bottom was limited. A similar situation existed at Caribou. At Pugwash, oysters were harvested from the upper part of the channel, where low salinity and soft bottom resulted in a low quality product. At Merigomish, oysters were picked on flats in small sheltered inlets at the head of the Bay, whereas at Tracadie they were raked on ground covered with shallow water at low tide.

Experiments at Malagash on rearing oysters on tidal flats had scarcely commenced when a second wave of disease began to spread throughout hitherto uninfected areas in Prince Edward Island. Probably the disease was carried overland from Malpeque, either by movement of oysters or on the gear of fishermen (Logie, MS, 1958, p. 1–3; also Department of Fisheries, 1937, p. 109–110). The disease was first noticed in the Hillsborough River in 1936, and by 1938 it had spread to all important oyster areas in Prince Edward Island outside of Malpeque, with the exception of Bedeque Bay (which may also have been infected on an earlier occasion) (Homans, MS, 1939, p. 1, 2, 7, also MS, 1937, MS, 1938). Mortality of oysters in the Charlottetown area was estimated as high as 95%. Production fell

from 8000 bl in 1935 to 200 bl in 1938, and to about 100 bl in 1939. Oysters were transferred from Wallace and Malpeque to restore the depleted stocks; those from Wallace suffered heavy mortality whereas those from Malpeque were largely unaffected. Evidently Malpeque oysters were resistant, and resistant stock was made available to lessees in the Charlottetown–Hillsborough district. The great demand for disease-resistant stock led to renewed effort to increase the supply of resistant spat from the federal rearing grounds in Malpeque.

About a decade passed before the Charlottetown area showed gains in production. In 1938, the number of leases in Prince Edward Island had increased to 594, comprising a total area of 2130 acres (Table 4). Evidently the Malpeque–Cascumpeque region was developing into the chief oyster farming area, having

TABLE 4. Summary of development of oyster areas under cultivation in Prince Edward Island, 1932–38 (Department of Fisheries, 1939, p. 149).

Region	Year	No. areas under cultivation	Approx. total area *(acres)*	Oysters sold *(bl)*	Oysters planted *(bl)*
Malpeque–Cascumpeque including Darnley and New London bays	1932	26	110	254	0
	1933	47	203	935	181
	1934	85	388	1516	434
	1935	101	453	1303	979
	1936	202	862	3342	1093
	1937	336	1314	3192	1948
	1938	457	1729	5968	3451
Rustico to Savage bays	1933	9	41	428	50
	1934	13	63	595	92
	1935	26	116½	750	145
	1936	29	128	38	1
	1937	31	137	21	0
	1938	31	137	15	0
North Lake to Pinette	1935	11	16	136	0
	1936	12	18	53	3
	1937	16	29½	22	0
	1938	22	50	46	61
Bedeque Bay	1937	65	179	1934	0
	1938	69	184	3594	788
Brae Harbour and Wolfe Inlet	1937	15	30	6	0
	1938	15	30	4	0
Total	1932	26	110	254	0
	1933	56	244	1363	231
	1934	98	451	2111	526
	1935	138	585½	2189	1124
	1936	243	1008	3433	1097
	1937	463	1689½	5175	1948
	1938	594	2130	9627	4300

77% of the leases (81% of the leased area). The volume of oysters planted on leases in Malpeque–Cascumpeque from 1932 to 1938 was 5968 bl, and the quantity harvested was 3451 bl. For all areas, the quantity planted up to the end of 1938 was 9627 bl and the quantity harvested 4300 bl.

The appropriate quantity of oysters to plant on an acre depends in part on the policy or methods of the leaseholder and has been the subject of frequent

discussions. Needler (1941, p. 42) stated that if small oysters were planted every year, so that those for later crops were present among the current crop, most grounds could mature an average of about 100 bl of good market oysters annually. There would still be less than one-third enough oysters for a single layer over the bottom without overlapping. If the oysters could be evenly spread, the annual yield of good oysters might be greater, but this is difficult and experience indicates a maximum of about 100 bl. A crop of 100 bl/acre means about 50,000–60,000 marketable oysters per acre, but allowing for a 10% mortality in each of the 3 or 4 years on the maturing ground, about 80,000–90,000 oysters would have to be planted. The number of barrels would depend upon the size of the oysters. (See also Needler, 1938; Medcof, 1961, p. 67–69, where estimates are given that maximum yields per acre with multiple plantings can be about 200 boxes of marketable oysters every year.)

The relatively low volume of oysters harvested in relation to planted meant only a proportion of oystermen could have developed their leases to the point where revenues were equal to, or in excess of, expenditures. In 1939, for many leaseholders, an estimated interval of 5 years would be necessary before their leases would be yielding a profit. Detailed evidence on leases is lacking, but a summary of the general position of leaseholders as a group in the Malpeque–Cascumpeque area for the period 1935–39 is found in the annual report for 1939 (Department of Fisheries, 1940). Oyster culture might have reached a peak, or plateau, in the Malpeque–Cascumpeque region.

"Over $125,000 was spent in actual money in the five years 1935 to 1939 and sufficient time was spent by lessees to make the total effort more than $160,000. The total value of the oysters marketed is estimated at about $85,000, leaving an investment in excess of receipts of about $78,000. . . . At the level which was reached in 1938 and maintained in 1939 and at present market prices this requires that a production of about 8,000 barrels be reached." (Department of Fisheries, 1940, p. 149.)

The areas in Prince Edward Island recently affected by disease still needed help and Nova Scotia, both the mainland and Cape Breton, also demanded further attention. The outbreak of war in 1939 initially gave a stimulus to the industry and probably resulted in further involvement by the Department than might otherwise have occurred. Apart from a diminution in the supply of labor, progress in oyster culture was not adversely affected during the first few years of war. Restrictions in imports of oysters from the United States resulted in an increased demand for leases in many districts, even for relatives who might return after the war (Department of Fisheries, 1942, p. 89, 1943, p. 103). This increased demand was a consequence of rising prices for oysters. In Malpeque–Cascumpeque in 1941, e.g., all expenditures on leases had approximately been offset by revenues, and in 1943 net revenues had reached the figure of $15,000 (Department of Fisheries, 1945, p. 103). However, as the war progressed, the initial stimulus afforded by rising prices was weakened by rising costs, which, accompanied by shortages of labor, resulted in a decline in spat collection by oystermen. Although the Department attempted to fill the gap in spat collection, oyster farming activities generally declined towards the end of the war and the early postwar period.

"Soaring costs of labor and materials made the use of rearing trays unprofitable so people stopped putting out collectors. There was no economical means of rearing spat to bedding size. Oyster farming languished — first, on the mainland, next in those parts of the Island where it was not well established, and finally in Malpeque Bay itself." (Subjects discussed in Oyster

Farming Circulars from 1938 to 1945 are suggestive of the concern about reducing costs and combatting enemies such as starfish and the oyster drill.) (Medcof, 1961, p. 7.)

Because the public fishery is only a harvesting activity, it probably was not so affected by rising costs as was the leasehold fishery, and was prosecuted in all provinces without interruption during the war. The fishery in Cape Breton, mainly a public fishery, was a focus of attention of Departmental personnel. The special conditions pertaining in Bras d'Or respecting low salinity and its effect on the quality of oysters for sale in the shell had resulted in chronic problems of marketing the product advantageously. In 1939 the Department and the Nova Scotia Marketing Board cooperated in marketing Cape Breton oysters shucked and sold in bulk. The quality of the product was high enough to compete with oysters imported from the United States, but the yield of oyster meat per barrel of oysters was low. Consequently, a price of only $1.50/bl was received by the suppliers of oysters for shucking (Department of Fisheries, 1942, p. 91). In 1940, returns improved and a payment of $2.70/bl was obtained by oystermen even before an embargo was placed on importation of shelled oysters from the United States. In 1941, with a further rise in prices, producers received $4.90/bl for oysters for shucking. Four hundred and nine barrels of oysters produced 480 American gal of oyster meat worth $5.24/gal (Department of Fisheries, 1942, p. 91). The supply of oysters for shucking was obtained mainly from Denys Basin, Orangedale, and St. Patrick's Channel. In terms of scale or size the project was marginal and its continuance depended on the availability of oysters, and the yield and price of oyster meat.

Towards the end of the war, federal activities expanded into additional areas. At Malagash, tidal flats were used for raising both seed and market oysters by construction of dykes, as in European countries and in the United States (Department of Fisheries, 1949, p. 50, 1950, p. 19; see also Adams, MS, 1952). In New Brunswick, the largest producer in the period owing to the size of its public fishery, the transfer of Gloucester County to federal control in 1944 was followed by experimental work. Spat collection at Shippegan ran into difficulties owing to the smothering of spat on collectors by barnacles in 1948 and to the effects of tidal and wind action in 1949. In 1949, a survey also was made in Kent County which, though still under New Brunswick, had shown an interest in the federal program of assistance to oyster farming (Logie, MS, 1947).

Interest in oyster farming revived in the postwar period as shown by the increase in number of leases to nearly 1300 comprising 3100 acres in 1949–50. At Ellerslie, P.E.I., research was focused on methods of reducing costs of production, increasing the supply of small oysters for later maturing on leases, and combatting predators and enemies of oysters. Pollution in Bedeque Bay led to transferring Bedeque oysters to Malpeque. Since the Bedeque stock proved to be disease resistant, the annual movement of such oysters to Malpeque, although requiring double handling or fishing, added to the commercial use of leases in Malpeque in the late 1940's.

Shortage of seed was a factor limiting expansion of the industry. Unreliable spawning conditions and the high cost of rearing seed caused the Department to concentrate on seed culture and to develop areas adaptable to the production of seed. The Pictou river system and the tidal flats at Malagash were regarded as potential sources of seed. In Kent County, where the oyster industry showed

evidence of decline, the areas with greatest potentiality were considered to be Richibucto, Buctouche, and Cocagne (Department of Fisheries, 1951, p. 24). Spat collection was generally small in 1950 and 1951 and emphasis was placed on utilizing seed available in unexploited areas to augment the quantity reared on federal beds in Prince Edward Island and on some private leases. Movement of disease-resistant Prince Edward Island seed and stock to the mainland had to be avoided owing to the danger of introducing disease to the nonresistant stocks. Therefore, seed for expansion of oyster farming in mainland areas was sought in those areas themselves.

Possibly seed otherwise wasted could be collected in the northern area of New Brunswick. In 1952, 116 leases were established in Maisonnette, where seed and bedding oysters were unutilized, and more than 1000 bl of seed oysters were picked under permit for the new leaseholds. Picking seed had not been done previously, owing to the lack of ownership by any individual in respect to such stock when planted. The leases were surveyed to be 1 acre in size to accommodate all the original applicants, even though such an area was considered small (Department of Fisheries, 1953, p. 18). Natural seed production in the area was estimated to be 200–400 bl annually, which would serve as a source to replenish the leases. In other areas, even in Prince Edward Island, lack of spat curtailed commercial trials of techniques for rearing seed. Some spat was transferred from Orangedale, Cape Breton, to Tracadie, N.B. No spat was available at Shippegan (Department of Fisheries, 1953, p. 19). Unfortunately, the Maisonnette venture, well conceived in that suitable oyster ground was put to use for maturing oysters that would have been otherwise lost, was cut short by the spread of disease in mainland areas in the mid-1950's, and has not recovered.

A long-range program of oyster culture was initiated at Orangedale in 1953, but in 1955 starfish caused almost complete damage of spat below 2–2.25 inches. Spat would have to be grown to bedding size on trays to keep the young oysters free of the depredations of starfish. However, such methods would raise costs to prohibitive levels for commercial oyster culture. Consequently, the expansion in Bras d'Or did not materialize (Department of Fisheries, 1954, p. 16; 1956, p. 11; 1959, p. 20). No shucking is now (1966) done at Denys River, and the relatively small output of Bras d'Or, mainly from the public fishery, is sold in the shell.

In other areas, specific problems kept arising. The spread of eelgrass at Merigomish in 1952, for example, led to a decline in the small amount of leaseholding in the area (Department of Fisheries, 1953, p. 18). An infestation of boring sponge, *Cliona celata,* occurred in Prince County, P.E.I., in 1954 (Department of Fisheries, 1955, p. 17). Although good spatfall occurred in 1955 and Gloucester County, N.B., had its first set in 7 years (Department of Fisheries, 1956, p. 11), nevertheless, the general shortage of spat throughout the region encouraged the practice of picking small oysters along the shore as a source of seed for leases. The Department modified its policy by relaxing some restrictions on picking to make seed as accessible as possible to oystermen, to encourage farming and to spread revenue through the industry because the oysters would be "twice marketed." Furthermore, moving oysters from shallow to deeper water would reduce the likelihood of winter killing and damage (Department of Fisheries, 1955, p. 17).

A major problem in the 1950's was disease, which spread through mainland areas, eventually decimating the stocks from Maisonnette and Shippegan in the

north to Cape George in the east. The Charlottetown epidemic, 1936–39, had shown how devastating the effects of disease could be on nonresistant stock. Accordingly, the movement of oysters from one province to another had been prohibited, and this regulation had seemingly been effective in localizing the Malpeque disease to Prince Edward Island. There is evidence, nevertheless, that oysters from Prince Edward Island were moved to Kent County, N.B., in the early 1950's (Logie, MS, 1958b, p. 22; Medcof, 1961, p. 94). Surveys had shown in 1950 that the industry was declining in Kent County; some oystermen probably defied regulations in an attempt to increase the size of the local oyster population. In any event, disease occurred in Kent and Westmorland counties in 1953 and 1954 (Department of Fisheries, 1954, p. 16, 1955, p. 17). In 1955, mortality occurred in the Miramichi area, Shippegan, and at Malagash (and Pictou) (Department of Fisheries, 1956, p. 11; Medcof, 1961, p. 94). The minimum size limit was reduced from 3.5 to 3 inches, to permit harvesting slow-growing and young stocks before they were destroyed by disease. This change in regulations was accompanied by an increase in output in both Nova Scotia and New Brunswick. However, with large output and an earlier season (August 15 instead of September 1), warm weather hampered marketing. There was also concern in Prince Edward Island because oysters from some of the best beds in Malpeque were too thin for satisfactory marketing in 1955, and in May 1956 mortality at the rate of 25–30% occurred on affected beds. The situation generally improved, however, and no high mortalities were found in other parts of the island (Logie, MS, 1957, p. 1, MS, 1958b, p. 44).

In 1955–56, disease was running its course from Shippegan to Pictou. In 1957, the Department confirmed that disease had devastated the Merigomish–Pictou region. As mortalities probably had commenced there in 1955, the epidemic at Merigomish–Pictou was not regarded as a new one. However, that at Caraquet was considered to be a new outbreak, or an extension of that at Shippegan. The first mortalities at Caraquet were observed in midsummer 1957, and by November 75% of the oysters on leaseholds and experimental plots were destroyed. Few oysters were affected on the public grounds and reduction in the minimum size limit enabled fishermen to harvest over 4600 bl from Caraquet Bay (Logie, MS, 1958a). In 1960, mortalities of 25% probably caused by salinity variations, were in evidence in Bras d'Or but did not reach epidemic proportions, whereas Miscou Harbour became infected in 1961 with a range of mortalities of 92–98%. Thus, apart from Cape Breton, only a few unaffected areas remained, such as North Branch of Wallace River, Pugwash River, and upper waters of Richibucto, where both good grade and shucking oysters were taken (Medcof, 1961, p. 94; Department of Fisheries, 1963b, p. 19).

The causes of disease remained unidentified, owing perhaps to the rapidity with which successive crises arose. A virus or bacterium was not isolated, and the nature of the cells present in the pustules or in oyster tissues was not determined (Fraser, MS, 1938). Logie stated, "The outstanding faults of . . . the research on oyster disease have been . . . failure to test resistance of mainland oysters in 1955 except at Malagash and Shippegan, failure to examine tray lots sufficiently regularly in 1956, too great restriction of experimental lots in the 1954–57 model epidemic" (Logie, MS, 1958b, p. 42–43). However, in the last 12 years the histopathology has been well established and the strong possibility of a viral etiology suggested but not yet established (R. E. Drinnan, personal communication, January, 1970).

The consequences of the disease were not wholly disadvantageous. Diseased areas eventually recover even if unaided by transfers of resistant stock to them. After all areas have been visited by the epidemic, the fear of transmitting disease with stock transfer should cease, thus permitting free transfer of stock from good setting to good maturing grounds (Logie, MS, 1958b, p. 42–43).

A decrease of 90% in oyster production in Nova Scotia and New Brunswick occurred from 1955 to 1958 inclusive. In 1957, only 9000 bl were harvested, more than half of which came from the Caraquet public fishery and were taken in advance of the disease. The volume and value of production for the whole period, 1928–66, is given in Table 5. During the period up to 1956, New Brunswick was the leading

TABLE 5. Output and value of oysters landed in the Maritime Provinces, 1928–69.[a]

Year	Nova Scotia		New Brunswick		Prince Edward Island		Totals	
	Quantity *(lb)*[b]	Value *($)*	Quantity *(lb)*	Value *($)*	Quantity *(lb)*	Value *($)*	Quantity *(lb)*	Value *($)*
1928	388,800	11,231	2,476,600	81,822	951,200	30,721	3,816,600	123,774
1929	332,000	10,380	2,829,200	84,618	985,600	32,002	4,146,800	127,000
1930	399,000	12,142	2,772,400	63,226	977,600	26,516	4,149,000	101,884
1931	402,600	11,776	2,688,600	53,592	1,065,200	24,943	4,156,400	90,311
1932	540,600	10,463	2,491,000	38,345	1,174,600	17,623	4,206,200	66,431
1933	677,600	12,045	2,032,400	36,485	1,328,600	21,582	4,038,600	70,112
1934	646,800	10,870	1,654,600	34,143	2,032,000	36,852	4,333,400	81,865
1935	1,075,000	21,279	1,674,200	33,612	2,002,800	46,973	4,752,000	101,864
1936	983,800	23,955	1,821,800	35,178	1,348,400	34,614	4,154,000	93,747
1937	866,200	18,873	2,309,200	51,277	1,295,600	32,402	4,471,000	102,552
1938	777,200	16,240	2,473,800	45,966	1,048,400	29,232	4,299,400	91,438
1939	720,000	16,041	1,954,400	38,101	990,800	27,850	3,665,200	81,992
1940	582,400	13,422	2,257,000	56,230	816,400	26,138	3,665,800	95,790
1941	923,000	24,356	2,526,800	76,531	1,091,800	43,377	4,541,600	144,264
1942	1,098,600	34,769	2,786,200	79,254	1,471,800	52,476	5,356,600	166,499
1943	1,038,800	33,791	3,405,400	117,524	1,260,400	50,600	5,704,600	201,915
1944	1,021,000	37,300	4,671,000	162,200	1,494,000	63,900	7,186,000	263,400
1945	1,056,800	36,397	4,588,200	161,184	1,444,200	68,480	7,089,200	266,061
1946	893,200	34,602	5,096,800	183,398	2,024,200	99,212	8,014,200	317,212
1947	900,400	27,500	5,035,800	193,400	2,115,200	105,500	8,051,400	326,400
1948	797,000	33,700	7,561,000	261,200	3,079,000	122,500	11,437,000	417,400
1949	902,000	34,300	7,907,000	282,600	2,463,000	100,300	11,272,000	417,200
1950	861,000	33,400	6,546,000	207,800	3,277,000	106,700	10,684,000	347,900
1951	830,000	38,600	4,558,000	268,300	1,497,000	71,200	6,885,000	378,100
1952	917,000	46,300	4,240,000	275,000	2,735,000	87,300	7,892,000	408,600
1953	806,000	43,000	4,896,000	280,600	2,457,000	137,100	8,159,000	460,700
1954	542,000	28,100	2,330,000	137,000	2,129,000	128,300	5,001,000	293,400
1955	618,000	31,300	3,392,000	160,200	2,234,000	139,200	6,244,000	330,700
1956	336,000	20,700	1,207,000	125,800	2,507,000	203,500	4,050,000	350,000
1957	557,000	37,500	1,225,000	115,100	1,867,000	155,400	3,669,000	308,000
1958	332,000	19,600	165,000	19,700	2,360,000	263,000	2,857,000	302,300
1959	778,000	64,200	75,000	9,600	3,027,000	399,000	3,880,000	472,800
1960	712,000	41,700	6,000	500	2,792,000	360,700	3,510,000	402,900
1961	692,000	44,100	123,000	6,200	3,267,000	405,100	4,082,000	455,400
1962	636,500	49,700	217,000	5,900	2,405,500	300,800	3,259,000	356,400
1963	856,000	75,800	214,000	19,600	3,216,000	385,400	4,286,000	480,800
1964	634,000	61,000	391,000	30,000	2,803,000	370,000	3,828,000	461,000
1965	517,000	55,000	776,000	78,000	2,194,000	399,000	3,487,000	532,000
1966	748,000	97,000	700,000	97,000	2,072,000	365,000	3,520,000	559,000
1967	676,000	91,378	527,000	83,963	1,608,000	475,205	2,811,000	650,546
1968	578,000	89,206	744,000	138,203	1,763,000	373,527	3,085,000	600,936
1969	643,000	100,689	332,000	59,732	1,862,000	357,405	2,837,000	577,826

[a] Source: Department of Fisheries (1963a, app. A); Dominion Bureau of Statistics (no date).
[b] 200 lb = 1 bl.

producer except for 2 years, 1934 and 1935, when Prince Edward Island was first. In New Brunswick, highest production of 7,907,000 lb (39,535 bl) valued at $282,600 occurred in 1949. In Nova Scotia, production reached 1,098,600 lb (5,493 bl) in 1942, and in Prince Edward Island 3,277,000 lb (16,385 bl) in 1950. For the Maritimes as a whole, production reached a peak of 11,437,000 lb (57,185 bl) in 1948 and fell to its lowest level of 2,857,000 lb (14,285 bl) in 1958, when disease was prevalent on the mainland. Prices as high as $40/bl for ungraded oysters resulted in increased fishing activity (Department of Fisheries, 1959, p. 21–22). The lowest output in New Brunswick occurred in 1960 when only 6000 lb (30 bl) were harvested. The great decline in output in New Brunswick allowed Nova Scotia to move into second position in 1958 owing to the absence of disease in Cape Breton areas. In 1966, output for the Maritimes was 3,522,400 lb (17,612 bl) and was still below the relatively high levels that prevailed during the 1940's and into the 1950's. However, with rising prices, the value of landings generally exceeded $450,000 annually in the 1960's, reaching $560,500 in 1966 (Table 5).

On the assumption that the disease in mainland areas in the 1950's was "Malpeque disease" and that Prince Edward Island oysters were resistant, the period of recovery could be reduced to 10 years or less (or to one-half the recovery time after the original outbreak in Malpeque), by transplanting oysters from Prince Edward Island to the affected areas. "The prospects for this . . . prophecy [were] . . . considered so good that lessees in devastated areas [were] . . . urged to retain their holdings as sanctuaries for the introduced Prince Edward Island spawning stock . . . " (Logie, MS, 1957, p. 3; also Department of Fisheries, 1956, p. 14). Accordingly, a program of transplanting and establishing leases was put into effect. In each area, approximately 3 bl of Island oysters were given free to each oyster grower to plant on his lease, and large plantings were made on public fishing grounds and permanent government reserve areas (Medcof, 1961, p. 96).

Between 1957 and 1960, 10,874 bl of oysters from Prince Edward Island were planted in Nova Scotia and New Brunswick. In 1956 it had seemed that the mainland areas would suffer heavy mortalities, and consequently the Department experimented with planting oysters at Richibucto, Shippegan, and Malagash. These trials indicated that the transplants were resistant, and a larger-scale movement, mostly from Summerside Harbour, was then undertaken (Table 6). The two areas receiving oysters in 1957 were Shippegan and Wallace–Malagash. In Shippegan, production was relatively important as a source of cash income to residents; at Malagash, disease seriously disrupted the Department's program of rearing oysters on tidal flats. In 1958, transplants were made again at Shippegan, also in Northumberland and Kent counties in New Brunswick, and at Caribou and Pictou in Nova Scotia. In 1959, the largest volume of transplants was moved and the largest number of areas restocked. In 1960, 874 bl were transplanted to complete the program.

The transplants survived well and reproduced in all areas except Wallace–Malagash. In New Brunswick, intertidal zones showed spat of three year-classes (Department of Fisheries, 1961b, p. 13). Extensive attempts to collect spat were made in all areas, and people were encouraged to take out leases to speed recovery of the fishery. The Department's report for 1959–60 (Department of Fisheries, 1961a, p. 16) stated that Maritime oyster fishermen realized the rehabilitation of

TABLE 6. Rehabilitation transplants from Prince Edward Island to mainland areas (Drinnan and England, MS, 1965).

Area	1957	1958	1959	1960	1962	Total *(bl)*
		New Brunswick				
Shippegan area	1,000	100				1,100
Caraquet Bay			1,075	525		1,600
Lameque Bay			300			300
Mirimichi Bay		2,800	200			3,000
Kent Co. areas		1,500	300			1,800
Tracadie Bay				200		200
Shediac Bay				9	300	309
Miscou Hbr.					700	700
New Brunswick total						9,009
		Nova Scotia				
Wallace–Malagash		500				500
Caribou Hbr.			55	380		435
Pictou Hbr.			45			45
Amet Sd.				1,000		1,000
Merigomish Hbr.					140	140
Nova Scotia total						2,120
Grand total						11,129

disease-devastated areas could be accomplished most quickly by cultivation. As of December 13, 1959, approximately 700 applications for oyster leases, received during the past year, were awaiting examination and survey. Seventy per cent of the applications were from New Brunswick and Nova Scotia. In 1961, 898 applications were awaiting examination and survey (Department of Fisheries, 1963b, p. 23) and the trend continued. In 1966, there were 997 leases in effect in Prince Edward Island, 606 in New Brunswick, and 197 in Nova Scotia. Total acreage under lease in Prince Edward Island was 3052 acres, in New Brunswick 1410 acres, and in Nova Scotia 487 acres. Altogether in the Maritimes there were 1800 leases comprising 4949 acres, or an average of nearly 2.75 acres per lease (data from Economic Services, Department of Fisheries, Ottawa, Canada).

In the late 1950's, when disease in mainland areas was subsiding, shortage of seed oysters was again considered the most serious problem. There were two possible methods of overcoming it — to encourage oystermen to pick seed and otherwise unused oysters found in shallow water along the shores, and to grow seed for distribution among leaseholders. In 1957 the Department began to expand its program of rearing seed in shallow waters on its beds; apparently such a policy could effectively utilize late spat that otherwise would be wasted. Furthermore, experiments indicated that the rate of growth of spat on tidal flats was equal to, and perhaps better than, the rate of those grown on trays. In addition, it seemed imperative to avoid the cost of rearing trays (Department of Fisheries, 1959, p. 19). The discovery that spat could be grown in shallow water on suitable bottom opened the prospect of specialization in oyster production. Some areas could be used for spat production, others for rearing seed oysters, and others for maturing oysters (Medcof, 1961, p. 8). Until the 1960's each district had tried to be self-sufficient, partly as a consequence of the risk of transferring disease from one area to another.

A light spatfall in 1961, except for Shippegan and Gillis Cove (Department of Fisheries, 1963b, p. 21), was followed by another poor year in 1962 owing to low water temperature (Department of Fisheries, 1963c, p. 34). Lack of evidence of reproduction of the transplants in 1963 accentuated the marginal nature of the

environment in which oyster production occurs in the Maritimes, and strengthened the opinion that controlled production of seed oysters is necessary for a flourishing industry. However, the Department's aim of producing seed under natural conditions was soon frustrated. Silting and damage at Malagash, which required the construction of a new dyke, resulted in an ineffective program in that area. At Conway Narrows, where the Department was producing 100 to 160 bl annually, the spread of marine algae made harvesting difficult in 1962. (Spat could be successfully collected by Japanese methods of using shells on strings suspended in moderately deep water from racks or floats, and by a new method of laying shells on sheets of polyethylene plastic spread on the beach in the intertidal zone (Medcof, MS, 1962). From 1961 to 1964 the production and distribution of seed oysters from the Department's beds in Conway Narrows, P.E.I., was as follows. The oysters were sold at $10/bl (Department of Fisheries, 1966b, p. 39).

Distribution	Production (bl)				
to	1961	1962	1963	1964	Total
Prince Edward Island	75	38	88	77	278
Nova Scotia	4	5	5	15	29
New Brunswick	59	49	66	69	243
	138	92	159	161	550

The attempt to provide seed was commendable but the quantity that could be made available was not adequate.

Reliance on producing seed on tidal flats and on picking was abandoned in favor of the hatchery process. An experimental oyster hatchery was opened at Ellerslie in 1964. As the hatchery process has not yet been developed to the commercial stage, the industry has had to rely mainly on natural reproduction — which is uncertain and discourages leaseholders from incurring the expense of setting spat collectors — and on picking wild oysters to acquire seed. Consequently, the quantity of oysters on leases has remained far below the potential carrying capacity of the ground. A few leaseholders, who make the greatest use of their leases, engage in relaying oysters from contaminated areas onto their leases for purification before marketing. This procedure is commercially profitable for leaseholders who are advantageously situated to obtain oysters from contaminated areas. But such activity affords an insufficient basis for a flourishing industry.

There are three biological or environmental problems to be overcome: the shortage of seed oysters, the effects of starfish, and the prevalence of eelgrass. North of Miramichi Bay, principally in Shippegan and Caraquet, recovery of oysters has largely been absent. Transplants of resistant spat from Prince Edward Island to the mainland have shown consistently low mortalities, particularly in comparison with the highly susceptible spat from Cape Breton, but adult Prince Edward Island oysters transplanted to northern New Brunswick apparently required time for acclimatization and spawned 2 or 3 weeks later than the native Shippegan oysters. "Late spawnings mean late spatfalls. Spat that settle late in the year show heavy winter mortalities." (Department of Fisheries, 1964, p. 34.) In those same areas, as well as at Malagash, Tatamagouche, Brule, and in Prince Edward Island, the spread of eelgrass has been serious (Department of Fisheries, 1964, p. 34). Intensive fishing might possibly afford a means of control since it constitutes a method of cleaning oyster beds. Starfish are prevalent in several areas, especially in Bras d'Or where oyster cultivation has been retarded by them. Bras

d'Or Lake and North and South harbours in Aspy Bay, the latter being the scene of a very intensive fishery since 1960, have thus far escaped the effects of oyster disease — which may prove to be a disadvantage to those areas in the long run — and have particular problems associated with the rather low salinity of water and its effects upon the quality of oysters.

Although the hatchery process is still being developed, other technological changes, which to date have had little impact on the industry, have been proven effective: devices more efficient than tongs — including drags, suction dredges, and escalator harvesters, which make possible the harvesting of oysters by mechanical means (see MacPhail, 1960, p. 93–95). As a cost-reducing aid to the industry and as a means of harvesting seed oysters on its beds at Conway, the Fisheries Research Board with the support of the Department in 1960 modified and adapted an escalator harvester machine developed in the United States. Harvesters have since been tested on public beds and in commercial use and their technical advantages over the methods of tonging or raking oysters have been determined. The harvester has been used also to harvest soft shell clams, bar clams, and quahaugs.

If water depths and ground conditions are suitable, the harvester can cover ground from 10 to 60 times as fast as a man with hand tools. Tests at Conway Narrows on beds planted with known densities of oysters showed that the harvester captured about 95% of oysters in its path without undesirable disturbance of bottom soil or plant life. It moved at a rate of about 100 ft/min (about 60 times the rate of a tong fisherman). Whereas an oysterman may cease fishing when the density of oysters falls to about 25 bl/acre, the harvester fishing such a bed gathered oysters at the rate of 10 bu/hr, or $120–$150 worth an hour at the current prices for marketable oysters. The harvester also proved to be effective in cleaning beds and its use could be a means of controlling eelgrass.

The escalator has been shown to be an efficient and economic method of harvesting oysters. Two to four men are required to operate it with the use of a powered boat. However, the capacity of existing harvesters exceeds that required to harvest oysters on leases of average size. Should oysters one day become plentiful because of the hatchery process, leaseholders on the average undoubtedly will find the mechanical methods of harvesting unprofitable unless harvesters are acquired under group ownership or hired on a custom basis, or developed on a much smaller scale. Thus, on the mainland in particular, where leases are generally small, the leasehold system, developed to establish sanctuaries for transplanted oysters and encourage oyster farming, may prove to be a barrier to the adoption of mechanical methods of harvesting by individual leaseholders. Mechanical harvesting is not an important question if oysters are not plentiful or unavailable, but should the provision of seed oysters prove to be successful, the desire on the part of even a few leaseholders to develop enterprises large enough to use mechanical techniques effectively could lead to a number of problems. A shift from a commercial to an industrial type of operation can be expected to involve rather drastic changes in the industry and to raise questions concerning government policy.

Part 4 — Summary of History and Conclusions

The history of the oyster industry in the Maritimes suggests not only the nature of the problems that are likely to be encountered by those engaged in oyster culture on the extreme northerly range of the American oyster, *C. virginica,* but

also the complexity of the relation between the biological and environmental aspects of the fishery and the political and economic aspects. Although oysters can reproduce and grow in waters adjacent to the shore in the southern Gulf of St. Lawrence, natural reproduction has not been sufficient or certain enough in any given locality to replenish beds so as to maintain a regular and expanding commercial fishery under conditions of freedom of entry of fishermen. There has been an attempt to augment natural production by methods of oyster culture. Yet after four decades of research and eight decades or more of some form of regulation and direction, output is far below what is considered to be an attainable level and is not half so large as that recorded around the turn of the century.

After the entry of Prince Edward Island into the Dominion of Canada in 1873 and the completion of the Intercolonial Railway in 1876, exploitation of the oyster resources of the Maritimes increased both on the mainland around Shediac and Miramichi, N.B., and in Prince Edward Island. Depletion of beds was evident in the 1880's and led to demands for increased regulation of harvesting, restriction of such practices as mud-digging and fishing through the ice, government support of the fishery through restocking exhausted beds, and introduction of leases. The Dominion assumed responsibility for regulation of the fishery and up to 1910 a rather extensive body of regulations was developed. As a result of the recommendations of a Committee in 1887, the Dominion engaged an oyster expert in 1892 to restock and improve public beds, an activity continued into the early 1920's. The Dominion began to establish some leases, but a dispute with the provinces, especially with Prince Edward Island, over jurisdictional authority to grant leases, and a Privy Council decision in 1898, which cast serious doubts on the validity of federally granted leases, resulted in a stalemate as far as the institution of leases was concerned. Prince Edward Island evidently was reluctant to withdraw from granting leases since an important source of revenue would be lost. The Dominion withdrew from the establishment of leases and left this function to the provinces. The Dominion did, however, retain responsibility for maintaining the public fishery and of implementing regulations for the whole fishery. Therefore, there existed after 1910 an unsatisfactory dual control of the fishery by the provinces and the Dominion.

Withdrawal of the Dominion from granting leases was accompanied by a marked increase in the number of leases, particularly in the Malpeque area of Prince Edward Island, in the period 1912–15; the formation of companies to engage in oyster culture in the area; and the importation of oysters to stock the leases under the stimulus of rising prices for market oysters. Unfortunately, oyster disease was probably brought in with the imported stocks from the United States. The local stock was vulnerable. An epidemic disease broke out in Malpeque Bay in 1915 and before the end of the decade had decimated the stocks in Malpeque and Cascumpeque. Production of oysters in Prince Edward Island declined and New Brunswick rose to first position among the Maritime Provinces owing to the size of its public fishery. Meanwhile, activities of the Dominion in respect to the public fishery were confined largely to mainland areas still unaffected by oyster disease.

An agreement between Prince Edward Island and the Dominion in 1928 transferred the authority to grant leases to the Dominion and placed the control of the industry under federal jurisdiction. Research into the problems of the

affected areas was expanded under the Biological Board of Canada, which established the center of its operations at Ellerslie, and oystermen were encouraged to take out leases as a means of reviving the industry. It was considered desirable to discover more economical methods of rearing oysters. The Shediac area of New Brunswick was placed under federal control in the early 1930's, and an agreement with Nova Scotia in 1935 opened the way for expansion of federal research at Malagash and Bras d'Or. It was deemed reasonable that the Dominion Government, possessing greater resources than the provinces, should assume responsibility for research. Some progress was achieved in Malpeque in the 1930's. At Malagash, attention was given to rearing oysters on tidal flats. In Bras d'Or, problems were caused by the effects of low salinity of the water on the quality of oysters. The research program of the 1930's was interrupted by a second epidemic among oysters in the Charlottetown area in 1936; by 1939 it had spread to all important oyster areas in Prince Edward Island outside of Malpeque and Bedeque. Probably, the disease was carried to the Hillsborough River from Malpeque either by the movement of oysters or by fishermen. Attention to the problems of Prince Edward Island must have detracted from the progress planned for areas on the mainland during the last half of the 1930's until the outbreak of World War II.

In the postwar period, additional areas of New Brunswick were transferred to federal control. Regulations prohibiting interprovincial movement of oysters were in effect as mainland oysters were not resistant to disease. Interest in oyster farming increased in the 1940's as shown by expansion in the number of leases. Research was directed towards rehabilitation of depleted areas and to expansion of the supply of seed oysters. The Department of Fisheries of Canada engaged in the production of seed, encouraged leaseholders to gather seed along the shores, and assisted individuals to acquire leases on which to plant the seed oysters that had been picked. Thus, Maisonnette, e.g., was opened for leasing in the early 1950's to take advantage of supplies of seed oysters otherwise going to waste on the western shores of Caraquet Bay.

A third epidemic, which commenced in Kent and Westmorland counties in 1953, eventually spread by the late 1950's to Maisonnette on the north and to Pictou in the east. This epidemic also resulted in a drastic decline in production from New Brunswick in the late fifties. Nova Scotia was less affected than New Brunswick; Bras d'Or Lake, the largest producing area, was untouched. The cause of the outbreak was probably the (illegal) movement of oysters from Prince Edward Island to the mainland, but the long-run effects have not been wholly undesirable since disease-resistant stocks have since been built up in the mainland areas from oysters transplanted from Prince Edward Island. The transplants, exceeding 10,000 bl altogether, were put on various public beds and also were made available to oystermen who had, or were encouraged to establish, leases in order to develop oyster populations as rapidly as possible.

A continuing problem limiting production of market oysters has been described as a "shortage of seed." To overcome this obstacle, the Department of Fisheries of Canada attempted to produce seed on its farms. Some success was achieved, but depredations of starfish, spread of eelgrass, and other problems led to abandonment of reliance on seed farms and to development of a hatchery process for production of seed oysters in the 1960's. The successful development of the hatchery process, together with the adoption of a technological invention, the

escalator harvester, which was developed in the early sixties, could effect significant changes in the industry. The industry still relies heavily on the public fishery for a large proportion of its output, and also is characterized by leaseholds that are generally small because of political pressures in the different localities or the purpose of leases to serve mainly as sanctuaries for brood stock for the establishment of oyster populations in the wake of disease. The pattern of establishing small leases has been continued. The industry therefore consists mainly of small leaseholders and public fishermen whereas the nature of the environment, scientific developments, and technological change point in the direction of larger leases for economic production if higher income targets are to be set for oyster fishermen. Political and social problems will eventually accompany economic change, which itself will be a consequence of scientific and technological development designed to overcome biological and environmental problems in the industry.

Probably the establishment of leases was delayed by the jurisdictional dispute between the Dominion and the provinces during the last quarter of last century and by the Privy Council decision of 1898. The absence of leases may have resulted in lower output and higher prices in the first decade of this century than otherwise would have been the case so that when the jurisdictional question was solved by federal withdrawal from granting of leases there was an excessive rush into leaseholds, especially in Malpeque. Profits could be made from importing oysters from the United States even for spreading and harvesting for sale in Canada in the same year. The rush into leasing and the importation of oysters into Prince Edward Island was followed by the outbreak of oyster disease in Malpeque Bay. Slower development of leases over a longer period might have resulted in no importation and avoidance of disease. However, the industry would have then remained vulnerable to the effects of such a calamity. At least a resistant stock has now been developed except in Bras d'Or Lake and in Cape Breton generally.

The staple approach has been adopted in this section of the study as a method of indicating some of the relations that exist between the commodity and the industry. In particular, certain characteristics of the commodity make its cultivation possible and have led to the institution of leases. The history of the industry in the Maritimes, as in other countries, strongly suggests that a significant fishery cannot be maintained on public beds alone except at considerable government expense and under strictly enforced regulations. The accessibility of the commodity, freedom of entry by fishermen, geographical distribution of the oyster grounds, and various other factors have resulted in a decentralized industry comprised mainly of small producers. The vicissitudes through which the industry has passed have accentuated these features, which were themselves intensified by the ravages of oyster disease resulting in the control and regulation of the industry passing back to the federal jurisdiction. The federal government is now responsible for research, leasing, and regulation of various activities associated with oyster harvesting and culture; in contrast, control over the U.S. fishery resides with state and local authorities. The differences in the two situations can be attributed in part to differences in the size of the industry of the two areas and probably also to the more marginal position of the industry of the Maritimes owing to its geographical location. In the Maritimes, responsibility has passed to the jurisdiction with the greatest resources for providing leadership and direction to the industry to assist it in achieving a greater degree of sophistication, which apparently is necessary for it to flourish.

TABLE 7. Output and value of oysters landed in the Maritime Provinces, by months, 1965, 1966.[a]

	Nova Scotia				New Brunswick				Prince Edward Island				Maritimes Total			
	1965		1966[b]		1965		1966[b]		1965		1966[b]		1965		1966[b]	
	Quantity (lb)	Value ($)	Quantity (lb)	Value ($)	Quantity (lb)	Value ($)	Quantity (lb)	Value ($)	Quantity (lb)	Value ($)	Quantity (lb)	Value ($)	Quantity (lb)	Value ($)	Quantity (lb)	Value ($)
Jan.	-	-	-	-	-	-	1,500	225	350	62	-	-	350	62	1,500	225
Feb.	-	-	-	-	27,290	2,945	3,940	521	-	-	-	-	27,290	2,945	3,940	521
Mar.	-	-	-	-	53,556	4,385	28,968	3,054	-	-	-	-	53,556	4,385	28,968	3,054
Apr.	-	-	1,600	240	3,280	309	649	115	-	-	-	-	3,280	309	2,244	355
May	400	32	400	48	-	-	-	-	-	-	320	32	400	32	720	80
June	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aug.	500	36	840	210	-	-	-	-	19,370	2,615	1,000	160	19,870	2,651	1,840	370
Sept.	20,450	1,884	3,120	352	6,845	1,214	2,020	402	469,300	88,724	478,375	89,859	496,595	91,822	483,515	90,613
Oct.	304,190	33,594	294,678	37,232	409,415	41,721	448,930	64,248	1,208,380	215,359	1,099,871	187,371	1,921,985	290,674	1,843,479	288,851
Nov.	153,084	16,183	397,860	53,914	241,670	24,021	213,078	28,211	454,515	84,103	407,990	72,871	849,269	124,307	1,018,928	154,996
Dec.	17,077	2,246	45,150	5,429	34,581	3,849	10,136	1,448	41,300	7,690	81,980	14,584	92,958	13,785	137,266	21,461
Total	495,701	53,975	743,648	97,425	776,637	78,444	709,216	98,224	2,193,215	398,553	2,069,536	364,877	3,465,553	530,972	3,522,400	560,526

[a] Sources: Department of Fisheries, Economic Services, Ottawa, Ont., and Regional Office, Halifax, N.S.

[b] Preliminary figures.

Chapter 6

CONDITION OF THE FISHERY

SUPPLY

PATTERN OF OUTPUT

In preceding chapters, reference was made to some quantitative aspects of the oyster fishery: e.g., the volume and value of output; the number of leases, lessees, and licences; total acreage of leases and the average size of leases; and the relative importance of the public fishery. This section is concerned with supply of oysters, in particular with the seasonal variations in, and the geographical location of, output.

Table 7 presents statistics on landings and landed value of oysters in the Maritime Provinces, by months, for 1965 and 1966. In each of the three provinces the highest monthly output occurs in October, and output during the months of October and November accounts for 75–80% of total annual output. In 1965, output during these 2 months was around 2.75 million lb, whereas that for the whole year was below 3.5 million lb. In 1966, output during October and November exceeded 2.8 million lb but total output was only slightly above 3.5 million lb. In December, production is below that of either of the previous 2 months owing to depletion of stocks of market size, weather conditions, and the closure of the public fishery.

The relatively high level of output achieved from late summer to early winter is a consequence of the open season in the public fishery and of the importance of the public fishery as a source of oysters. Also, the fall months are suitable for harvesting both public beds and leases owing to the temperature and weather that normally prevail. The leasehold fishery legally can be continued through the winter and spring; the output from January through April is not significant (Table 7), except, perhaps, in New Brunswick in late winter. During the summer there is little or no production as sales are not permitted owing to the relaying of oysters from contaminated areas. Nor are oysters as suitable for consumption during the spawning season in summer as in the spring and fall when they are fatter.

Statistics showing both seasonal variation and location of output in greater detail for 1965 and 1966 are given in Appendix A. It should be emphasized that the geographical location of output is based on the records of sales of oystermen and not directly on the location of production. Nevertheless, in spite of some inaccuracies in the figures representing output by locality, the importance in Nova Scotia of statistical districts 1 and 3 (Fig. 1), which include South Harbour and Bras d'Or Lake respectively, in Cape Breton, is clearly shown.

South Harbour has been the scene of a new fishery since the late 1950's.

Landings and landed value of oysters, South Harbour, N.S., 1958–65. (Statistics provided by Fishery Officer.)

	Landings (lb)	Value
1958	16,800	$ 735
1959	546,000	48,600
1960	528,000	30,100
1961	482,000	30,700
1962	405,000	34,000
1963	304,000	25,100
1964	131,000	13,300
1965	111,000	12,600

In New Brunswick, districts that produce the largest output are 73, 76, and 77, which include the south side of the estuary of the Miramichi River and the Richibucto and Buctouche areas. In Prince Edward Island, districts 83A, 83B, and 86A, which contain Bedeque, Malpeque, and Charlottetown areas, are centers of production.

The seasonal nature of the fishery is in part a consequence of limiting the open season in the public fishery to the fall months. A larger or more productive leasehold fishery might well result in an increase in harvesting in late winter and spring and in less seasonal variation in employment in the fishery as a consequence both of the extension of the harvesting season and of work that could be done on leases during the year.

OYSTER ENTERPRISES

Although data are available on the volume and value of output, the number and acreage of leases, and the number of licences and permits issued to oystermen, information is lacking on other aspects of the fishery. The relations among lessees and licencees have not been known with certainty and an unclear picture has prevailed respecting the composition and activities of enterprises. Consequently, a survey was made to obtain estimates of certain economic magnitudes related to the activities of oyster enterprises. A discussion of some of the problems associated with the survey will be helpful in interpreting the results.

A survey that seeks to collect information about the oyster fishery as it is now conducted will not be of great assistance in making projections respecting the industry in the future. The industry is now a part-time activity whereas in the future it may become more highly sophisticated, using mass production techniques. The hatchery process may be utilized for rearing seed oysters in the most suitable areas from which the seed will be transferred to growing areas, resulting in geographical specialization of activity and perhaps specialization within enterprises. Or, firms may become integrated enterprises. A variety of possibilities may prove to be feasible. The industry cannot provide answers to these questions at present since no enterprises are functioning in such a manner.

Quantitative information about the oyster fishery was obtained by analysis of the activities not so much of individual lessees or licensees as of enterprises. An enterprise was defined as "a group of leases and/or licences and/or permits operated as a unit." (A. Sunter, personal communication, 1966). Although many enterprises consisted of either a single lease or licence many others were much more complex. It was not possible to identify oyster fishing enterprises in advance, but

they could be identified during the survey if one of their associated licences or leases was selected in the sample. If, e.g., a lease was drawn that proved to be under the control of an individual different from that in whose name it was recorded, the lessee indicated the name of the person in control who, as head of an enterprise, reported on all the leases and licences associated with the enterprise. He reported, however, for the enterprise as a whole and not by lease or by licence except in a few specific matters. As the probability of selection of an enterprise was approximately proportional to its size in terms of the number of licences and leases comprising it, a technique of weighting was used to remove biases in the results from this cause. Different weights were applied in each province owing to the differences in the relation between the number of licences and leases and the sampling ratios employed in each province (Table 8).

The procedures followed in deriving estimates can be explained briefly. If the value of a certain characteristic for the ith enterprise in the pth province is denoted by x_{pi} then an estimate of the total X_p is given by

$$\hat{X}_p = \frac{1}{c_p e_p} \sum_{i=1}^{e_p} \frac{x_{pi}}{z_{pi}} \tag{1}$$

where z_{pi} is the weight applicable to each enterprise and e_p and c_p are respectively the number of respondent enterprises and the adjustment for nonresponse.

Values for e_p and c_p were

	P.E.I.	N.B.	N.S.
e_p	106	99	76
c_p	.946969	.863247	.953490

An estimate of the number of enterprises E_p and an estimate of the mean $\hat{\bar{X}}_p$ per enterprise are given by

$$\hat{E}_p = \frac{1}{c_p e_p} \sum_{i=1}^{e_p} \frac{1}{z_{pi}} \tag{2}$$

$$\hat{\bar{X}}_p = \sum_{i=1}^{e_p} \frac{x_{pi}}{z_{pi}} \Big/ \sum_{i=1}^{e_p} \frac{1}{z_{pi}} \tag{3}$$

The corresponding estimates for the Maritime Provinces as a whole are given by

$$\hat{X} = \sum_{p=1}^{3} \hat{X}_p \tag{4}$$

$$\hat{E} = \sum_{p=1}^{3} \hat{E}_p \tag{5}$$

$$\hat{\bar{X}} = \hat{X} / \hat{E} \tag{6}$$

TABLE 8. Analysis of Maritime oyster fishery, 1966.

Estimated	Nova Scotia	New Brunswick	Prince Edward Island	Total	Mean	SD[a]
No. enterprises	412.70	901.83	701.83	2,016.35		
No. leasehold enterprises	114.84	526.65	533.04	1,174.53		
No. active leasehold enterprises	76.78	224.07	346.91	647.76		
No. active licensees	170.33	255.33	231.67	657.33		
Output of market oysters, public fishery, all enterprises (boxes)	4,868.29	5,007.62	13,419.37	23,295.28	11.55	19.59
Output of market oysters from leases, all enterprises (boxes)	3,149.65	156.33	18,894.44	22,200.41	11.01	24.47
Quantity of oysters relayed (boxes)	1,337.04	130.27	14,496.87	15,964.18	24.20	
Total output, public fishery (output from public fishery + oysters relayed) (boxes)	6,205.32	5,137.89	27,916.24	39,259.46		
Output attributable to leases (output from leases–oysters relayed) (boxes)	1,812.62	26.05	4,397.56	6,236.23		
Output of market oysters from leases, all leasehold enterprises (boxes)	3,149.65	156.33	18,894.44	22,200.41	18.90	42.01
Output of market oysters from leases, active leasehold enterprises (boxes)	3,149.65	156.33	18,894.44	22,200.41	34.22	76.02
Output of market oysters, public fishery, active licensees (boxes)	4,868.29	5,007.62	13,419.37	23,295.28	35.42	60.04
Employment, active leaseholds, including public fishery (weeks)	499.53	510.68	3,760.78	4,770.99	2.41	10.62
Employment, active licensees, public fishery only (weeks)	563.94	880.63	1,698.38	3,142.95	1.62	4.57
Vol oysters picked for seeding, active leaseholds (boxes)	663.49	203.23	1.574.96	2,411.68	3.72	
Vol oysters purchased for seeding, active leaseholds (boxes)	35.30	335.51	1,855.23	2,224.03	3.43	
Investment, all enterprises:						
Boats > 25 ft	19.856.96	51,066.26	147.468.26	218.391.48	108.31	205.12
Boats < 25 ft	30,403.77	67,090.10	100,658.42	198,152.29	98.27	167.39
Total no. boats	50,260.70	118,208.43	243,126.38	416.595.54	206.64	368.67
Gear	22.666.75	10,580.29	14,907.95	48,154.93	23.85	36.16
Shore equipment	39,026.33	0.00	246.870.33	355,896.72	166.57	332.53
All equipment, boats, gear	161,914.01	128,736.54	509.692.32	800,342.94	396.92	706.18
Net income, all enterprises	37.678.14	60,223.30	337.291.58	485,193.29	240.63	452.82
Active leaseholds	52,523.46	2,605.42	298.881.41	354.010.32	546.51	1,206.32
Active licensees	62,418.42	65.958.87	131.245.54	259,622.87	394.93	638.31

[a] SD = standard deviation.

The 1800 leases in effect about July 1, 1966, and the 992 licences in effect in 1965, which constituted the two lists from which the sample of oystermen was drawn, were found to be interconnected with one another in such a way that, according to the definition, the number of enterprises in the oyster fishery in 1966 was 2016. The estimated number by province was Nova Scotia, 413; New Brunswick, 902; and Prince Edward Island, 702. The estimated number of enterprises that included at least one lease was Nova Scotia, 115; New Brunswick, 527; Prince Edward Island, 533; and the Maritimes, 1175. However, not all leasehold enterprises were active. An active leasehold enterprise was defined as one on which at least 1 day's work had been devoted to oyster culture during the year. On this basis, the number of active leasehold enterprises was estimated at 648, or 55% of the estimated total number of leasehold enterprises. The number of active leasehold enterprises by province was Nova Scotia, 77; New Brunswick, 224; and Prince Edward Island, 347.

An active licensee was considered to be an oysterman who fished in the public fishery. However, not all persons who obtained a licence to engage in the public fishery actually did so. Therefore, the number of active licensees was smaller than the total number of licences issued. The estimated number of active licensees in the Maritimes in 1966 was 657, or approximately two-thirds of the total number of licensees in 1965. A licensee might be a leaseholder also. The estimated number of active licensees by province was Nova Scotia, 170; New Brunswick, 255; and Prince Edward Island, 232.

An estimate of the significance of the public fishery as a source of market oysters in the Maritimes in 1966 was reached by several steps. Estimates of the output of market oysters from the public fishery, by province, were Nova Scotia, 4,868 boxes; New Brunswick, 5,008 boxes; Prince Edward Island, 13,419 boxes; and the Maritimes, 23,295 boxes. The output of oysters reported from leases was estimated to be Nova Scotia, 3,150 boxes; New Brunswick, 156 boxes; Prince Edward Island, 18,894 boxes; and the Maritimes, 22,200 boxes. These figures indicate very low production from leases in New Brunswick; although the estimate of output from the public fishery in Prince Edward Island may be high, the total figures suggest nevertheless that the output from leases in the Maritimes was below that from the public fishery.

Further adjustments in these estimates should be made since the public fishery supports leasehold output by serving as a source of both seed oysters and oysters for relaying from contaminated areas. As the movement of seed oysters was not significant, and as the effect of seeding on output in any given year is difficult to assess, the movement of seed was disregarded. The movement of relayed oysters was significant, being estimated by province in 1966 as Nova Scotia, 1,337 boxes; New Brunswick, 130 boxes; and Prince Edward Island, 14,497 boxes. Relaying is closely connected to the output of market oysters from leases as the relayed oysters are harvested for sale only a few weeks after being put on leases in clean water. Some of the largest leaseholders utilize their leases as purifying grounds for relayed oysters. Subtracting the oysters relayed from the output of leases gave an estimated net output of leases, by province, in 1966 of: Nova Scotia, 1813 boxes; New Brunswick, 26 boxes; and Prince Edward Island, 4397 boxes.

These calculations may tend to overemphasize the importance of the public fishery and neglect the function that leases play in the process of marketing oysters

from contaminated waters. But if the calculations are accepted, the estimates indicate that in the Maritimes in 1966 oysters from leases comprised only 13% of output; the public fishery was the source of 87% of total output. Total estimated output from the public fishery was 39,259 boxes compared to 6236 boxes from leases. The importance of the public fishery as a source of relayed oysters was particularly significant in Prince Edward Island. Although the estimate may be large, the error is not considered to be such as to make it possible to say that the leasehold fishery is nearly as large as the public fishery. It can only be concluded, therefore, that the public fishery constituted a source for much more than half, and probably around four-fifths, of the market oysters produced in the Maritimes in 1966, a typical year.

The estimated average output from leases for all leasehold enterprises was 18.9 boxes and for active leaseholds 34.2 boxes. The estimated average output from the public fishery for each active licensee was 35.4 boxes. In all cases the deviations exceeded the average values, indicating a wide scatter in the performance of the different enterprises, and therefore the figures should be interpreted with caution.

The seasonal nature of the fishery (Table 7; Appendix A) was substantiated by estimates of employment of active lessees and licensees. Active lessees, or their employees, spent on the average per enterprise 2.4 weeks/year in the fishery whereas active licensees spent only 1.6 weeks. However, the average employment estimate for active lessees included any time that was spent in the public fishery whereas the average employment estimate for active licensees referred to the public fishery only.

Apart from using leases for storing oysters during the harvesting and marketing season, leases may be used for planting seed oysters, establishing a brood stock, and for cleansing relayed oysters. There is little movement of mature oysters onto leases as brood stock owing to the unfortunate experiences of leaseholders in achieving spawning, spatfall, and growth of oysters. Planting seed oysters also is carried out only on a small scale. The largest amount of seeding in 1966 occurred in Prince Edward Island where an estimated 1575 boxes were picked and 1855 boxes purchased. For the three provinces, 2412 boxes were picked and 2224 boxes purchased. These estimates may include some double-counting, but it appears that altogether about 4600 boxes of seed oysters were moved. Since the total area of leases comprised more than 5000 acres, the amount of seeding was below 1 bu/acre of total leased ground. Assuming all leased ground was suitable for rearing oysters (this is not strictly correct), the volume of planting of seed oysters was about 4% of the amount recommended for multiple planting and about 2.5% of the amount recommended for single planting.

Investment per enterprise included an estimate of the value of boats, gear, and equipment owned by oystermen and available for use in the oyster fishery. Each of the categories, with the possible exception of gear, could well have other uses. Boats, especially those over 25 ft long, might be used for lobstering and other fishing. Gear in most cases referred to gear used in the oyster fishery and consisted mainly of tongs and rakes. Shore equipment included sheds and vehicles, which could have other uses also. Average investment per enterprise in 1966 was estimated to be $397. For the three provinces, investment per enterprise in boats under 25 ft in length was $98 and was exceeded by that in boats over 25 ft in length at $108. Estimated average investment in all boats per enterprise was $206. Investment in shore equipment was $166.57 per enterprise and included a zero estimate for

New Brunswick. Average investment in gear was $23.85. However, as in the case of estimates of average output, there was a wide difference in the level of investment from one enterprise to another since the size of the deviations far exceeded the average investment figures.

It was difficult to obtain estimates of costs and returns. Most oystermen enter the fishery not so much to earn a return on investment as to obtain a return for labor. They regard the oyster fishery as a means of earning extra income chiefly during the harvesting season. Frequently little attention is paid to depreciation on capital and to the earning of a return on investment as these items are small, especially if they are devoted only to the oyster fishery. In the public fishery, beds will be fished until the yield falls perhaps to half a box of oysters per fisherman per day as oystermen place a minimal return per day on their labor. If the fishery yields well at the beginning of the season before the oysters are diminished in numbers by harvesting, oystermen can be said to earn a rent in the sense that their earnings are in excess of the minimal amount that would bring forth their labor.

Since the output of the public fishery comprises more than half of that of the total fishery and can be obtained with the minimum of capital, costs of production of many enterprises are mainly labor costs. As many leases are virtually inoperative, costs are not applicable to them. On the other hand, the relatively few leaseholders who resort to relaying oysters from contaminated waters must include in their costs the purchase or the fishing of the oysters and the spreading of them on leases in the summer, and the fishing of them the second time for market in the fall and winter.

Net income from oystering — gross income minus operating expenses including hired labor — was more satisfactorily reported by interviewees than gross income and far more accurately reported than total net income from all sources. Net income from oystering per enterprise is a function of the volume of oysters produced but not necessarily an uniquely determined function. For example, a given volume of oysters that have been fished or handled twice yields a smaller net income than the same volume fished from the public fishery. Net income figures indicate that oystering is an ancillary occupation, between fishing seasons for other species or seasons for other employment. Average net income for all enterprises, active and inactive, in 1966 was estimated to have been $240.63, for active leaseholds $546.51, and for active licensees $394.93. Average net income was highest in Prince Edward Island and lowest in New Brunswick.

Many leaseholders, nevertheless, were cautiously optimistic and the number of applications for additional leases was extensive. Although most leaseholders favored an increase in the amount of leased land permitted for one person, clearly the majority favored only limited expansion, e.g., from 3 acres to 6 or 12 acres but not to 25, 50, or 100 acres. Some explicitly favored keeping the industry open only to small producers rather than permitting it to gravitate into the control of a few large producers. When the desire to become a full-time oysterman was expressed, the aim was to become the operator of an enterprise that would yield some predetermined level of income so that other employment would not be necessary. To be a full-time oyster producer would not necessarily be equivalent to being employed the year round in the oyster fishery.

There was general recognition that if "oysters would come back" they would be an important source of income. With existing prices, a lease of 3–5 acres would yield perhaps $1000–$3000 annually and would increase income from 50 to 100%.

If 100 boxes per acre per year could be harvested, a lease of 3–5 acres would yield gross revenues of $6000–$10,000/year. Since oysters are not likely to "come back," the economics of oyster production would inevitably become more complicated than it had been in the past. Only a minority of oystermen had given much thought to the possible relations between costs and returns and only a few had conducted experiments to ascertain what the interconnections might be. Consequently, various views were held about the role of government in respect to the rehabilitation and expansion of the industry.

DEMAND

MARKETING

Once oysters have been harvested they are packed and graded for market. The customary package is the box containing 1.5 bu. Grading is based on the shape of the shell and on the relation of its length to its width, provided the minimum sizes have been met. There is dissatisfaction with the grading system, especially among buyers and dealers, and the system may be modified. Once packing and grading have been completed, the oysters normally are forwarded mainly to brokers and wholesalers in the larger cities of eastern Canada, especially Montreal, where they are kept in storage until they are sold. Storing oysters, whether in the distributing centers or in the producing areas, involves keeping the oysters dormant at a temperature below 40 F. The limited supply in relation to demand means that, on the whole, the disposal of the annual output of the Maritimes is not a problem (see Prince Edward Island Fisheries Development Committee, 1956, p. 21). Occasionally difficulties may arise, but during the last few years oysters have been moved easily to market at rising prices from one year to the next.

In each producing region or locality in the Maritimes there tends to be one or more buyers or assemblers or shippers. Six to eight shippers handle the bulk of the output of Prince Edward Island. In Cape Breton and on the mainland, shippers in the different localities handle oysters from their respective regions. Sometimes buyers in one locality serve as agents of buyers or shippers in another district. However, a proportion of oystermen, even if their production is small, may sell directly at established prices to dealers in the larger centers. The practice of shipping directly to a broker or wholesaler is followed when, as the small shippers say, they do not wish to obtain unemployment insurance stamps, which are issued by local buyers, and when they do wish to receive the local buyers' markup.

In the cities, firms who purchase oysters from one another or directly from shippers in the producing areas include restaurants and chain stores as well as jobbers and wholesalers who normally handle a wide range either of fish or food products. Frequently rather longstanding relations have existed between shippers in the producing areas and brokers, wholesalers, and other buyers in the consuming areas. Although competition exists among buyers in the main market centers and among buyers in the producing areas, a balance of power exists with the result that the business of marketing the annual output is undertaken by a number of firms. The number is smaller than it was before disease swept through the various oyster areas.

Perhaps 75% or more of the output of the Maritimes is sold in Quebec, mainly in Montreal. Montreal is served largely by two main brokers and four or five main wholesalers. From 5 to 15% of Maritimes oysters are sold in Toronto and vicinity. Few sales are made west of Toronto and only occasionally are oysters from the Maritimes shipped to the United States. The bulk of the trade in fresh oysters and oyster meat in Toronto consists of products imported from the United States. Dealers in Toronto are much more closely connected with suppliers in the United States than in the Maritimes. In Toronto, and in southern Ontario generally, the relatively low price of American products and the more standardized grading of them has been accompanied by a pattern of consumption rather different from that in Quebec.

THEORETICAL ASPECTS

Research on the demand for oysters and other fishery and food products is being carried forward in the United States, yet it is still necessary to report largely as Christy has done that "there are no readily available analyses of the demand and price structure of this commodity" (Christy, 1964, p. 57). Nevertheless, if it could be identified and plotted on a graph showing the quantities that would be purchased by consumers on the horizontal axis and the corresponding average prices that would be paid for oysters per unit (say, box or pound) on the vertical axis, the demand curve for oysters with respect to price would be downward sloping from left to right. Statistics of production and average values at least suggest that a relation of this nature exists between quantities available for sale and the average price. Moreover, the quantities consumed would respond rather sensitively to changes in price (Christy, 1964, p. 65; see also Bell and Hazleton, 1967, p. 31–44). In particular, a reduction in price would be accompanied by such a relative increase in quantity purchased that total expenditure on the commodity would increase. Conversely, a percentage rise in price in the significant ranges would be associated with such a relatively large reduction in the quantity purchased that total expenditure by consumers on the commodity would decline.

Given the quantity and quality of oysters available during any marketing season, determinants of the market price, or landed value, of oysters include those normally discussed under the theory of demand. The demand (curve) for oysters, and hence the price of oysters, will be the greater (lie further to the right) the stronger the preferences or tastes of consumers for oysters; the larger the number of consumers; the higher the incomes of consumers (unless oysters are what is called an "inferior" or "poor man's" good, which seems not to be the case); the lower the price of complementary goods, which are consumed jointly with oysters; and the higher the price of competing goods; which causes consumers to shift expenditures away from the substitutes and towards the commodity oysters. In the United States, shrimp and crabs are suspected of being effective substitutes for oysters. "In support of this position, it may be noted that while the consumption of oysters was declining from 170,000,000 pounds in 1890 to 70,000,000 in 1954, shrimp production increased from 4,000,000 to 268,000,000 pounds and crabs from 7,000,000 to 141,000,000 pounds . . . 100 years earlier . . . it was reported that the inhabitants of New York City ate more oysters than beef" (Wheatley, et al., 1959, p. 70; see also Christy, 1964, p. 60). In Canada, imports of oysters in the shell and of oyster meat into markets west of Montreal seem to play the role of substitute goods

for oysters from the Maritimes in southern Ontario (oyster dealers in eastern Canada, personal communication).

The value of oyster imports, fresh or frozen, into Canada in 1966 was $511,000, an amount nearly equivalent to the total landed value of oysters in the Maritimes. In addition, imports of canned oysters, perhaps not nearly as close a substitute for the domestic product as fresh and frozen oysters, were valued at $614,000 (Table 9). The United States is the chief supplier of imports of fresh

TABLE 9. Imports of oysters into Canada, 1966 (Dominion Bureau of Statistics, MS, 1966, table III, p. 20–21). (Figures rounded to nearest thousand.)

	Fresh or frozen		Canned	
	Quantity *(cwt)*	Value *($'000's)*	Quantity *(cwt N)*	Value *($'000's)*
France	28	1	–	–
Hong Kong	22	1	26	2
Japan	48	3	10,266	580
United States	7,586	507	263	32
Total	7,684	511	10,555	614

and frozen oysters, amounting to 7586 cwt valued at $507,000 in 1966, and Japan is the chief supplier of canned oysters amounting to 10,266 cwt net and valued at $580,000. No exports of oysters from Canada are explicitly reported in the official statistics.

Because of lack of data, it is impossible to isolate and measure the effects of the determinants of the (price) demand (curve) for oysters at any given time or period and to establish the position and slope of the curve. Possibly, e.g., since 1945 the short-run demand curve has been shifting to the right as a result of rising money incomes and increases in population, especially in urban centers. The shift to the right explains the tendency for prices to rise, particularly after 1950, and therefore for the landed value of output to rise in relation to the volume of output. In the depression period of the 1930's, the demand curve possibly shifted to the left owing to decreases in the average level of income of consumers. The shift to the left explains the decline in prices from 1929 to 1932 and the tendency for the landed value of output to fall in relation to the volume of output, which was relatively constant during those particular years.

It has been argued that the demand for oysters decreased in the U.S. over a rather long period. Per capita consumption fell but the decline seemed to be attributable largely to the decline in domestic output. In respect to demand, Wheatley et al. (1959, p. 80) suggested "real" prices for oysters in the period from 1900 to 1940 tended to decrease and the costs of producing increased. An increasing population with rising economic incomes and a rise in the price levels of other substitute production left only changing consumer preferences to explain the long fall in popularity. Since 1945, total domestic consumption has been fairly stable in the face of rising real prices. The 75-year decline in the demand for, and per capita consumption of, oysters seems to have ended.

Demand for and Supply of Oysters

THE RECORD

The decline in output in Prince Edward Island from 1822 to 1920 was followed by a slow upward trend, marked by fluctuations, into the 1960's. Except for 1900, production in New Brunswick remained below that of Prince Edward Island until 1907. New Brunswick usually occupied first place among the three provinces from 1908 until 1955. However, the effects of the spread of disease among oysters in mainland areas during the last half of the 1950's reduced production in New Brunswick to nearly zero and caused New Brunswick to fall to third position from 1958 to 1964. In 1965, output of 776,600 lb in New Brunswick exceeded that of Nova Scotia, but a decrease in 1966 to 709,200 lb caused New Brunswick to fall back to third position. Throughout the period, production in Nova Scotia has generally been the lowest of the three provinces. However, from 1930 to 1950, some gains were achieved. Between 1950 and 1966, output in Nova Scotia fluctuated between 917,000 and 514,700 lb.

Two cycles in output occurred. A marked rise in output from 1876 into the 1880's was attributable to increases in production in both Prince Edward Island and New Brunswick. High levels of production, occasionally in excess of 12 million lb/year, were reached between 1882 and 1891. After 1891 a long downward trend in output continued until 1917 and was followed by some recovery in the 1920's and 1930's. The rise in output in the 1940's to the high level of 11.4 million lb in 1948 was caused largely by the increase in output in New Brunswick. Output declined again during the 1950's and fluctuated around 4 million lb/year during the late 1950's and early 1960's.

The value of output has fluctuated from year to year, but scarcely was above $200,000 in any year from 1876 to 1940. Since 1940, an upward trend in the landed value of output has been caused by the increase in output in the 1940's and by marked increases in the average landed value of oysters per pound in the 1950's and 1960's. In 1966, when output was 3,522,400 lb, the lowest level reached during the whole period under review except for the 8 years 1876, 1915–1919, 1958, and 1962, the value of output reached the maximum figure of $560,500.

Statistics of the landed value of oysters per pound are given in Table 10. From 1876 to 1893 an average landed value of 1.5¢/lb was recorded and from 1894 to 1902 an average value of 2¢. After 1902, annual estimates have shown changes from year to year. Movements in the average price of oysters follow changes in business conditions rather closely. From 1902 to 1950, prices reached a peak of 4¢/lb in 1919 and a low point of 1.6¢ in 1932. In 1947, average landed value was again 4¢/lb but fell to 3.2¢ in 1950. Increases after 1950 resulted in an average price of 12.2¢/lb in 1959 and, after 3 years of minor decreases to 10.9¢/lb in 1962, in a landed value of 15.9¢/lb in 1966.

Unless economic conditions change drastically, as in a period of deflation and unemployment, the oyster industry of the Maritimes can be expected to continue to have a high average landed value per pound. Output may possibly move through another cycle. If it does, the cycle probably will be less pronounced and of shorter duration than that from 1940 to 1958 just as this latter cycle was somewhat less marked than that from 1876 to 1917. In the absence of another natural cycle, output will probably remain in the range of 3–5 million lb annually with landed value

TABLE 10. Average landed value (cents per pound) of oysters, Maritime Provinces, 1876–1969.[a]

Year	Value	Year	Value	Year	Value	Year	Value	Year	Value	Year	Value	Year	Value
1876	1.5	1891	1.5	1906	3.0	1921	2.7	1936	2.2	1951	5.5	1966	15.9
1877	1.5	1892	1.5	1907	3.4	1922	2.7	1937	2.3	1952	5.2	1967	23.1
1878	1.5	1893	1.5	1908	3.0	1923	2.5	1938	2.1	1953	5.6	1968	19.5
1879	1.5	1894	2.0	1909	3.2	1924	2.5	1939	2.2	1954	5.9	1969	18.2
1880	1.5	1895	2.0	1910	3.0	1925	2.4	1940	2.6	1955	5.3		
1881	1.5	1896	2.0	1911	2.5	1926	3.0	1941	3.2	1956	8.6		
1882	1.5	1897	2.0	1912	2.4	1927	3.0	1942	3.1	1957	8.4		
1883	1.5	1898	2.0	1913	2.8	1928	3.2	1943	3.5	1958	10.6		
1884	1.5	1899	2.0	1914	2.4	1929	3.1	1944	3.7	1959	12.2		
1885	1.5	1900	2.0	1915	2.6	1930	2.4	1945	3.7	1960	11.5		
1886	1.5	1901	2.0	1916	3.0	1931	2.2	1946	3.9	1961	11.1		
1887	1.5	1902	2.0	1917	3.0	1932	1.6	1947	4.0	1962	10.9		
1888	1.5	1903	2.5	1918	3.1	1933	1.7	1948	3.6	1963	11.2		
1889	1.5	1904	2.5	1919	4.0	1934	1.9	1949	3.7	1964	12.1		
1890	1.5	1905	2.5	1920	3.5	1935	2.1	1950	3.2	1965	15.3		

[a] Source: For 1876–99, estimates based on statistics of the Department of Marine and Fisheries (1902, p. 266; see Chapt. 5, Table 1). For 1900–69, see Department of Fisheries (1963a, app. A, table 2) and Dominion Bureau of Statistics (no date).

varying from $450,000 to $650,000. If inflation of prices continues, landed value of any given level of output will also tend to rise through time. Probably an increase in output on a sustained basis will occur only as a result of: technological change such as the commercial introduction of the hatchery process of rearing oysters for seed; the development of some alternative method of propagation; or the introduction of an alternative method of managing the public fishery such as making it a private property resource.

PROJECTIONS

Although data respecting the long-run supply and demand (curves) for oysters from the Maritimes are generally lacking and projections for the industry must be extremely tentative, there is merit, especially from the point of view of those concerned with forming policy for the industry and of those wishing to invest in it, in suggesting what the industry may be like in the future. Although the possibility of exports to Western Europe should not be overlooked, it is assumed that the chief markets for Maritime producers will be in eastern Canada and northeastern United States.

An additional oyster-producing region in Canada is British Columbia where output is based largely on the Japanese oyster, *Ostrea gigas,* which was introduced successfully, and not on the native oyster, *Ostrea lurida. Ostrea gigas* can be grown in suitable locations along both shores of the Strait of Georgia and among the islands of the Strait and Gulf. Landings and landed value of oysters in British Columbia from 1959 to 1969 were (Department of Fisheries, 1961–69; Department of Fisheries and Forestry, 1970; figures for 1969 are preliminary):

	Landings (lb)	Landed Value
1959	6,952,000	$407,000
1960	5,879,000	339,000
1961	6,387,000	369,000
1962	7,857,000	466,000
1963	12,768,000	635,000
1964	11,509,000	588,000
1965	11,301,000	612,000
1966	12,416,000	802,000
1967	9,626,000	733,000
1968	7,236,000	562,000
1969	9,130,000	720,000

The industry in British Columbia differs from that in the Maritimes since nearly all of British Columbia's output is shucked before being marketed. The volume of output in terms of shucked oysters is approximately 150,000 gal of oyster meat annually. There is little or no evidence of competition between the oyster industry of British Columbia and that of the Maritimes owing to the geographical distance between the two areas and to the differences in the products (Elsey, 1933: Yonge, 1960. p. 176–178; Department of Fisheries, 1966a; Quayle, MS, 1961; Anon., 1966, p. 13–14).

Even though other suppliers may become competitively significant, an indication of market potentialities can perhaps best be given by a summary of the condition of the oyster fishery in the United States. A complete history of the oyster industry of the United States would involve analysis of the long-run decline of an industry that at one time was the country's most valuable fishery (Wheatley et al., 1959, p. 59, 61). However, the decline in output has not been uniform throughout the industry and thus the condition of the fishery varies from one area to another. Production on the west coast, where special circumstances pertain, has for almost three decades remained relatively constant at 9–10 million lb of oyster meat and constitutes about one-fifth of total output. There has been a marked decline in production along the Atlantic coast whereas in the Gulf of Mexico the volume of output has expanded in the 1960's.

A brief description of the oyster industry in the United States can be given (Churchill, 1920; Galtsoff et al., 1930, p. 197–198; Galtsoff, 1958; Loosanoff, 1965). Oyster production, formerly centered in the middle Atlantic states (New York, New Jersey, Pennsylvania, and Delaware) and in the Chesapeake Bay area of Maryland and Virginia, has declined. Changes in the estuarine environment are considered to be causal factors. Wallace (1966; see also Galtsoff, 1943; Chipman, 1948) points out that oyster production has been inversely proportional to population growth in the middle Atlantic and New England states, and that only in parts of the south Atlantic coast, Gulf, and west coast does oyster production even approach the volume of 20 years ago. Currently, oyster production in Massachusetts is limited mainly to four areas in the Cape Cod region and to relatively few operators. (In Wareham and Wellesley a natural set of oysters still occurs and there are some leases. At Chatham and elsewhere oysters are obtained from Long Island for relaying. Towns control leases, for the most part small, say up to 3 acres. Total acreage is estimated at considerably less than 1000 acres (personal communication; see also, The Commonwealth of Massachusetts, 1912; Shaw, 1962).) Oyster farming in Rhode Island has disappeared, and only a few growers have remained active in Connecticut and New York. Consequently the prospects for oyster farming have become the subject of a review by both scientists and oystermen.

The New England area has had a record of oyster farming since the early part of last century and the output of oysters is maintained above the level that would have prevailed had sole reliance been placed on natural spatfall and reproduction. In the early 1900's, oyster farming commenced in the outer Chesapeake area although the major proportion of output in the upper Chesapeake Bay was maintained as a public fishery open to any citizen of Maryland. The history of the industry in New York points up the general pattern of change. From 1900 to 1965, two major areas of production were Raritan and Jamaica bays, located near New York City, but, as pollution increased, producers were forced to seek purer water farther east on Long Island. During the earlier part of the period, beds on the Hudson River were exploited as a source of seed. However, increasing pollution on the Hudson beds was compensated by regular spatfall occurring along the Connecticut shore of Long Island Sound. A system of oyster culture accordingly evolved that involved moving seed oysters from Connecticut to leaseholders in Massachusetts, Rhode Island, and New York. An industry in Rhode Island developed comprising leases amounting to several thousands of acres.

A serious storm destroyed the grounds and adult population of oysters in Connecticut in 1950. Failure of spatfall thereafter caused the New England industry to decline rapidly. In New York, four companies have resorted to artificial propagation of oysters and one has been developing a "natural-controlled" experiment. These leading producers in the state are confronted with a new situation by virtue of the prevalence of predators and the danger of the spread of oyster disease called MSX. High rates of mortality among young oysters have been experienced when the seed has been placed on the rearing grounds. A difficulty that was encountered on one occasion was an overabundance of algal food causing oysters to starve as a result of clogging the gills. On the general subject of pollution, see Erichson-Jones (1964).

The last good spatfall in the New England area occurred in 1958 and since then the region has had to rely on importing seed or has resorted to artificial means of producing seed. Seed is short in supply all along the Atlantic coast. Perhaps the absence of spatfall is related more to the rise in pollution, including silting, than to the presence of disease. Nevertheless, MSX has

been a problem in Delaware and Chesapeake bays and its effects have been intensified by environmental changes on land and in the sea. Dredging and pollution of seed beds upriver in Delaware Bay have resulted in shifts in suitable locations for the production of seed. Also, the great demand for fresh water by the city of New York, which now taps the Delaware watershed, has reduced the freshwater flow into Delaware Bay and has resulted in an increase in salinity, permitting oyster disease and predators to move farther up into the Bay with consequent destruction of oyster populations. A proposed dam on the Potomac River may have similar adverse effects on oysters in parts of Chesapeake Bay (R. F. Smith and L. D. Stringer, personal communication, 1966).

South of Delaware, the oyster fishery is predominantly a public fishery. In Chesapeake Bay there is a tradition of public fishing. Maryland's oyster fishery is primarily a public fishery supported by state funds, and oystermen are required to use tongs and sailing vessels without engines. Only the poorer ground can be leased (Truitt, 1931; Quittmeyer, 1956; Christy, 1964). In Virginia, formerly a source of oysters for more northerly areas, up to 75,000 acres were under lease in 1945, but difficulties were being encountered owing to depletion of the large natural beds, which served as a source of seed (Moore, 1910; Loosanoff, 1932?; Newcombe and Menzel, 1945; Makin, 1946; Wheatley et al., 1959; Corps of Engineers, 1961). In the south Atlantic states from North Carolina to Florida, South Carolina is the largest producer. In general, the tendency has been not to resort to leasing, and techniques have remained rather unsophisticated in comparison with those employed by some producers in the north. Nevertheless, a comprehensive argument respecting the merits of, and principles to be followed in, a program of leasing is contained in a document published more than six decades ago on the oyster industry of North Carolina (Coker, 1905, 1907). Possibly producers farther north had captured the main markets and the incentive to increase production in the south was accordingly reduced. However, with the coming of MSX in 1957 in the north, the outlook of oystermen in the south appears to have changed; much unutilized oyster ground exists in the south as the estuaries have remained relatively unchanged owing to smaller concentrations of population and of industry than found in the northeast. Even in 1956, South Carolina was encouraging the production of seed for shipment outside the state (Smith, 1949; Lunz, 1956, p. 83–87; Andrews, 1957). Lunz explains that shells can be planted in May and a wild harvest collected 18 months later. South Carolina produces from .75 to 1 million bu of oysters, practically all of which grow intertidally. About 85% of production is canned, 2% sold in the shell, and 13% in the raw shuck trade in oyster meat.

In the Gulf states (west coast of Florida, Alabama, Mississippi, Louisiana, and Texas) production has shown some fluctuation but not a long-run downward trend; the Gulf area now may account for nearly half the production of oysters in the United States (see Moore and Pope, 1910; Burr, 1933; Engle, no date; Ingle and Smith, 1949; Hofstetter, 1959). Texas permitted leases up to 100 acres in size and Louisiana up to 1000 acres. The fishery in the Gulf is largely a public fishery whose output frequently is affected by pronounced changes in weather involving hurricanes and heavy rains. Predation of crabs, snails, and oyster drills is significant as is mining of shells and fossils, a large industry that has both favorable and unfavorable effects on oysters. The mining industry, which employs large dredges, has an unfavorable effect on oyster grounds, but the product of the industry can be used in preparing oyster beds. Dr R. F. Smith and Mr L. D. Stringer (personal communication, 1966) and Colberg and Windham (1965) pointed out that the demand for Gulf oysters outside the Gulf states has not been comparable to the demand for oysters from the north. Gulf oysters grow nearly the year round and consumers have claimed the meat is watery and not very tasty, partly as a consequence of the water having relatively low salinity. However, with shortages of oysters in the north, consumers perhaps are now accepting Gulf oysters more than before. The Gulf states are considered to be producing well below their potential.

On the west coast of the United States three species of oysters are cultivated, the native oyster, *O. lurida,* which carries the market name of Olympia oyster although the latter name is more properly applied only to those from Olympia in Puget Sound, the eastern oyster, *C. virginica,* and the Japanese oyster, *Crassostrea gigas.* The native oyster is the smallest of the three species and the least important. In the cultivation of *O. lurida,* an elaborate system of dykes has been developed and methods adopted somewhat along the lines of those employed in France. Supplies of native oysters were augmented by the introduction of the eastern oyster after the gold rushes (see Galtsoff, 1929, 1949; McKie, 1945; Barrett, 1963), but these transplants met with only modest success. In this century, Japanese oysters have been successfully introduced; the output of this species, called the Pacific oyster, comprises nearly all of the total

output. The California oyster industry has become concerned almost entirely with raising Japanese oysters.

One problem on the west coast has been reliance on annual imports of seed from Japanese producers who have been having some difficulty in their own industry in production of seed. Thus the west coast industry is being driven to become more self-sufficient than it has been for several decades, through the production of seed in the natural or, if necessary, an artificially created, environment and possibly by the introduction of additional species such as the European oyster, *Ostrea edulis*, which may be more adaptable than *C. virginica*. Production has been relatively constant, or has increased slightly for two decades or more. Developments of a progressive nature seem as likely to occur in the industry on the west coast as in any part of the United States.

Although the prospects for the U.S. oyster industry have been discussed rather optimistically (see Glude, 1960, p. 131–134), production is far below previous levels. Output has been falling during a period when demand apparently has been increasing (Abramson, MS, 1960, also Wheatly et al., 1959, p. 80). The trend in the volume and value of oyster meat produced in the United States can be indicated by reference to certain years during the period 1929–65: in 1929, output was 90,063,784 lb of oyster meat valued at $13,324,077; in 1937, output reached 95,626,800 lb but the value of output was only $8,703,454; in 1939, output was still at the relatively high level of 93,006,500 lb and value at the relatively low figure of $8,190,333; in 1945, however, the value of output was approximately three times its prewar level although output was only 75,627,300 lb of oyster meat; since 1950, output declined from a high figure of 82,242,300 lb in 1952 to 51,216,000 lb in 1966. Value of output has fluctuated relatively less than volume of output during the same period. Value of output reached the high figure of $33,204,187 in 1961 when output was 62,303,500 lb and the lower figure of $27,105,996 in 1963 for 58,442,600 lb. In 1966, the value of output was $27,366,000. The relatively small decline in aggregate value over the period is attributable to the rising average price of oyster meat per pound (Appendix C).

The output of oysters from the Maritimes is a very small percentage of the total production of oysters in the United States. In 1965, production in the Maritimes of 3,522,400 lb of oysters in the shell was only 6.4% of the production of oyster meat in the United States. In 1966, the figure stood at 6.9%. The product of the Maritimes is differentiated from that of the United States. *Crassostrea virginica* grows more rapidly in the warmer waters of the United States than in the cooler waters of the Maritimes, produces a higher proportion of meat to shell by weight, and has a quality and flavor that has led to its being utilized more in the form of shucked oyster meat than as oyster in the shell. If the production of oysters in the Maritimes expands so that markets in addition to those in Quebec become important, the special quality and flavor of the Maritimes' product may enhance its sale in metropolitan centers in northeastern United States. It is impossible to state what the market potentialities are: export shipments to the United States and Europe have been small, but problems of supply have probably prevented consistent market development. If it can correctly be assumed that barriers to the development of a trade in oysters from the Maritimes to major cities in nearby regions of the United States are minimal, it may be concluded that the problems confronting the fishery in the Maritimes during the next 5 or 10 years will be more critical on the supply than on the demand side.

The capacity of oyster grounds in the Maritimes is estimated to be far greater than current levels of production. The estimates, however, probably contain an error because much of the leased ground has never been cultivated in a manner that would enable the lessee to determine its productiveness. Effects of disease and shortage of seed have hampered such trials. Nevertheless, potential levels of

production are presented in Table 11. The figures are impressive but should be interpreted with caution. The assumptions from which they are derived should be made explicit.

TABLE 11. Estimated potential oyster production in the Maritime Provinces (1 box = 100 lb).

	Production per year *(lb)*		
Acreage	A *(200 boxes/acre)*	B *(100 boxes/acre)*	C *(50 boxes/acre)*
5,000 acres (current leases)	100,000,000	50,000,000	25,000,000
10,000 acres (twice current leases)	200,000,000	100,000,000	50,000,000

Consider the estimates for a total acreage of 5000 acres, an area approximately equivalent to the total acreage under lease in the Maritimes. Not all of the leased ground comprises bottom suitable for rearing oysters. Nevertheless, additional ground is most certainly available so that 5000 acres is in no sense an unrealistic figure on which to base some tentative conclusions. Given that at least 5000 acres of suitable bottom are available for oyster culture, output will depend upon the average productiveness of each acre. Assuming an appropriate initial number of young oysters per acre, productiveness of oyster ground per acre per year will be governed not only by the rate of mortality among oysters but also by those factors that determine the rate of growth and quality of oysters (the condition of the bottom, availability of food, temperature and salinity of the water, and length of the season during which temperature exceeds 40 F so that the oysters can feed and grow), and by other factors such as the severity of storms and the effects of ice on oysters in shallow water in winter.

Medcof (1961, p. 68–69) and Wharton (1963, p. 45–50) estimated output of market oysters per acre under assumed conditions and methods of culture. The system of multiple plantings involves planting young oysters and harvesting mature oysters from a given piece of ground each year. The advantages of this method are that working the bed annually helps to keep it cleaner and more free of eelgrass than would otherwise be the case, causes the oysters to be moved and clusters to be separated so that the shape of the shells is improved, and facilitates the attainment of a higher yield per acre than is likely to be reached under the system of single planting. This latter method simply involves seeding an area with an appropriate quantity of young oysters and leaving them undisturbed until they have matured perhaps 3–5 years later and are ready to be harvested. The size of oysters for planting is assumed to be 1.5–2 inches in diameter. In the system of multiple plantings, the suggested maximum rate is 25 boxes per acre per year, whereas in the system of single planting the suggested rate is 35–40 boxes per acre every 3 or 4 years, depending upon the length of time required for the young oysters to grow to market size. No allowance has been made for the natural spawning and spatfall of oysters as an alternative source of oysters in place of seed. The experience of oystermen in many districts probably makes this assumption realistic.

In the system of multiple plantings, estimated yields could be as high as 200 boxes of market oysters per acre per year without overcrowding and resultant misshapen shells. Annual yields of this amount per acre would cause 5000 acres

to produce 1 million boxes (100 million lb) of oysters per year, an output 25 times the size of current production. The system of single planting was estimated to yield up to 300 boxes per acre after 3 or 4 years, or at the rate of 75–100 boxes per acre per year. Under this system, 5000 acres would produce on the average 375,000–500,000 boxes (37.5 million–50 million lb) annually, an output 9–12 times the current output of the Maritimes. An increase in the period from planting to maturity from 3 to 4 years reduces the annual yield per acre by 25%; from 4 to 5 years by 20%; from 5 to 6 years by 16.67%. The productiveness of grounds is greater the shorter the required period for growth of oysters, the lower the mortalities, and the larger the output of oysters for any given volume of oysters planted.

The estimated output that might be realized from 5000 acres, allowing for normal mortality rates of 10% per year among oysters, ranges from 100 million lb/year at the upper extreme to 37.5 million–50 million lb at the lower. Once a system is in operation, the annual amount of oysters demanded for planting would be 125,000 boxes with multiple plantings and 50,000 boxes with single plantings. All estimates for an area of 10,000 acres are assumed to be twice as large as those for an area of 5000 acres.

These estimates probably require further modification or adjustment, however. They have been based on estimates of densities of oysters that would not result in overcrowding. An oysterman rarely cultivates his lease in this manner. Furthermore, oystermen refer to harvesting only three boxes of oysters for each box of 1.5-inch oysters planted. The estimates above in connection with single and multiple plantings are based on potential yields of around eight boxes of market oysters for each box of 1.5- to 2-inch oysters planted. It seems, therefore, that oystermen expect to recover from any given plantings at least 50% fewer oysters than the quantities estimated (Table 11, A and B). It may be more realistic to say that column B is more indicative of the upper limits of the potential range of output than is column A and that the potential annual yield from 5000 acres under systems of multiple and single plantings should be estimated to be between 50 million and 25 million lb, respectively, or from 12 to 6 times current levels. Potential yield from 10,000 acres would lie between 100 million and 50 million lb, or would be from 24 to 12 times current levels.

The estimates of 25–50 million lb of oysters from 5000 acres are from two to four times the recorded maximum yield of the whole industry. There is a significant difference between the assumptions underlying these estimates, however, and the conditions pertaining in the fishery in the 1800's and more especially in 1948 when the large yields of 11–12 million lb were recorded. In those periods the resource was largely available for harvesting at little or no expense for rearing. The estimates of 25–50–100 million lb per year from 5000 acres are based on the existence of a program of oyster culture involving the regular planting of seed. In the past, seed oysters have been made available in rather small quantities at a price of $10 per box; separated seed produced commercially in hatcheries might cost as much as $25 per box. If this latter price should prove to be realistic, the cost of seed oysters would be a major item of expense of leasehold enterprises.

Some tentative conclusions can be reached respecting the profitableness of regular seeding (Table 12). Certain differences may be obscured between the experiences of oystermen planting 1.5-inch oysters and the estimates of researchers

TABLE 12. Cost of rearing oysters from seed — comparative estimates, based on a 4-year cycle with no crowding of oysters. Values in parentheses are calculated. Medcof's (1961) estimates are based on 1.5- to 2-inch seed, estimates of oystermen on 1.5-inch seed.

	Program I — multiple plantings		Program II — single planting	
	Medcof	Oystermen	Medcof	Oystermen
Planting	25 boxes/acre/year (100 boxes/acre/4 years)		35–40 boxes/acre/4 years	
Yield *(boxes/acre/year)*	200	75	(75)	(30)
(boxes/acre/4 years)	(800)	(300)	300	120
Plantings: yield	⅛	⅓	⅛	⅓
Cost after 4 years @ $25/box seed	$2500		$875–$1000	
Cost/box market oysters	$3.12	$8.33	$3.00(±)	$8.00(±)
Cost/lb market oysters	$.0312	$.0833	$.03(±)	$.08(±)

who have assumed bedding oysters 1.5–2 inches in diameter are being planted. Oysters of the larger sizes for planting should require a shorter period to mature, should show a smaller amount of mortality in terms of numbers even though the rate of mortality is proportionally as high as that for smaller seed oysters, and, if produced in a hatchery, should command a higher price than seed oysters of smaller size. In the calculations, a price of $25 per box has been used for all seed oysters even though Table 12 refers to two different sets of data, which explicitly include reference to seed oysters of slightly different size ranges. However, the calculations have been kept as simple and straightforward as possible on the grounds that complicated analysis would at best also be hypothetical and that simple deductions are useful.

The average cost of producing market oysters from seed will depend in part upon the volume of market oysters that can be reared from a given volume of seed. The probable range of the seed component of costs per pound of market oysters is from 3 to 8¢. The lower the price of seed, the lower the range of average cost per pound of market oysters grown from seed. Table 12 does not include an allowance for interest on the investment in seed oysters for the 4-year period as an element on the total average cost of producing oysters. Nor is the total average cost of oyster production indicated. The shapes of the production functions of oyster enterprises also are unknown. Possibly the assumption of linear functions would be plausible. However, the point to be emphasized is that Table 12 is of little assistance in deriving answers to some of these interesting questions about total and average costs of production of oyster enterprises.

Nevertheless, the estimates can serve as a basis for a useful comparison. Relaying oysters is a prominent feature of the oyster fishery in some areas of the Maritimes. Oystermen pay as much as $20/bl ($10/box or 10¢/lb) for relayed oysters. Relayed oysters may grow a small amount during the period that they are placed on leases for purification. Consequently the relaying component of the cost of production of market oysters that are purchased initially as relayed oysters might therefore be slightly below 10¢/lb for market oysters. Costs of spreading the relayed oysters would tend to raise the figure. However, if the cost of relayed oysters is as high as 10¢/lb, the purchase of seed oysters 1.5 inches or more in diameter (slightly larger than the definition of seed oysters adopted at the beginning of this report) would be no more costly, and perhaps considerably less costly, than relaying.

If the larger yields from seed oysters can be achieved, the landed value of market oysters could decline perhaps as much as 5¢/lb or even more and oystermen would be as well off economically by rearing oysters from seed as by relaying at current prices for relayed oysters and current prices for market oysters.

The extent to which output can expand before price must fall by 5¢/lb landed value in order to clear the markets of that output is unknown. As supply increases, some reduction of prices can be expected. However, if the demand for oysters is elastic, as is suspected (see section on theoretical aspects), the fall in price would be proportionally smaller than the increase in output. Moreover, increased production of oysters in the Maritimes could be accompanied by increased demand. An increase in output accompanied by some reduction in average costs and prices might result in U.S. markets becoming profitable additional outlets to those now being supplied by producers in the Maritimes. The economics of relaying is considered to be an approximation of what the economics of rearing oysters from seed could be like from the point of view of costs.

If the practice of rearing oysters from seed should become widely adopted, the quantity of seed demanded annually to stock 5000 acres is estimated to be 50,000 boxes for single plantings on a 4-year rotation, and 125,000 boxes for multiple plantings. Multiple plantings would require an expenditure of $3,125,000 for seed per year and single plantings an expenditure of $1,250,000. If the high ratio of plantings to yield (1:3) pertains, the difference in the yield of the two programs would be 225,000 boxes per year. Since the difference in expenditure per year on seed under the two systems would be $1,875,000 on the assumption that the cost of seed is $25 per box, each additional box of market oysters produced by the system of multiple plantings beyond the level of output obtained by the system of single plantings would cost an additional $8.33 per box for seed. If the low ratio of plantings to yield (1:8) pertains, the difference in yield of the two programs would be 600,000 boxes. In these circumstances, each additional box of market oysters produced by multiple plantings would cost only an additional $3.12 for seed. As Table 12 also indicates, the lower the planting:yield ratio, the more intensive can be the method of oyster culture in respect to the ultilization of ground. Technically, the lower the marginal cost of output in a competitive situation the larger the most profitable level of output for the firm of any given capacity determined, for example, by acreage under lease.

The type of situation that may confront the individual leaseholder or leaseholding enterprise in the next decade can be indicated. In accordance with the estimates of Medcof, it is assumed that the period of growth required for seed oysters of the size of a 50-cent piece or larger to reach maturity is at least 4 years and that a system of multiple plantings at the rate of 25 boxes per acre per year will, after 4 years, lead to an output of 100 boxes per acre per year. If the price of seed is $25 per box, investment in seed for each of the first 4 years will be $625 per acre per year, and at the end of 4 years will amount to $2500 per acre. If 100 boxes per acre per year can be harvested each year beginning in the fall of the 4th year, gross proceeds in the 4th year will be perhaps $2000–$2500/acre, assuming landed values of $20–$25/box of market oysters. Thus, at the end of the first 4 years even under the most favorable conditions about all that can be expected are gross proceeds equivalent to the total investment in seed up to that time. In the 5th year,

an expenditure on seed of $625 would be offset by gross returns of $2000–$2500, leaving $1375–$1875/acre net of costs of seed up to that time. Subsequent years would yield similar proceeds per acre per year net of costs of seed. The period from the beginning of plantings to the commencement of harvesting would constitute the lean years for an oysterman employing this system.

These estimates can be compared with those for the Chesapeake region in the United States in 1963. The estimates were based on a 60-acre oyster farm brought into production over a 3-year period with 20 acres being prepared and seeded each year according to a system of single plantings. To prepare the bottom for planting requires 10,000 bu of shell/acre, each acre is seeded at the rate of 500 bu/acre, and at the end of 3 years each acre produces 1000 bu of oysters. In each of the first 3 years the following costs will be incurred:

Expenses per 20 acres	
10,000 bu of shell/acre at 25¢/bu × 20 acres	= $ 50,000
500 bu of seed/acre at $1.50/bu × 20 acres	= 15,000
Total for shell and seed	= $ 65,000
Other expenses, boat, labor, etc.	= 5,000
Total	= $ 70,000
Expenses on 60 acres after 3 years	= $200,000
Income/year in the 3rd year and thereafter	
Value of output from 20 acres	
1000 bu/acre × 20 acres × $4.50 (or more)	= $90–$120,000+

Ratio of gross income:gross expenses in the 3rd year and thereafter is estimated to be 2:1; annual outlays are estimated to be approximately 50% of annual receipts. These estimates are said to pertain today (Wharton, 1963, p. 45–50, also personal communication, 1968).

If a program of single plantings is followed, a planting of 35–40 boxes/acre is recommended and this would involve expenditure on seed of $875–$1000/acre in the 1st year of a 4-year cycle. If a harvest of 300 boxes is obtained 4 years later the gross proceeds would range from $6000 to $7000 at the end of the period or returns would be $5000–$6000/acre net of cost of seed every 4 years.

Therefore, if an oysterman has 4 acres of suitable ground under lease, the system of multiple plantings, once in operation, would yield on the basis of the above estimates involving a 4-year cycle, between $5500 and $7400/year net of cost of seed. On the same lease a system of single plantings involving the planting of one acre each year would yield between $5000 and $6000/year. According to the system of multiple plantings, the oysterman would have an investment of $10,000 at any given time in 400 boxes of seed (i.e., $25/box × 100 boxes/4 acre per year × 4 years) whereas under a system of single plantings investment in seed would be $4000 for 160 boxes (i.e., $25/box × 40 boxes/year × 4 years). The particular circumstances surrounding each oysterman, especially in respect to the amount of output he could produce for any given input of seed, would govern the most economical method.

In this connection, two reasons for caution should be stated. First, the experience of some oystermen has been nearer the recovery of only three boxes of market oysters for each box of seed planted than the estimated recovery of eight boxes of market oysters for each box of seed. If such is in fact the case — and it is facts of this kind that should be established — the above-estimated returns net of cost of seed per acre should be reduced by more than 60%. Thus an oysterman with a 4-acre lease would receive between $2200 and $3000/year net of cost of seed under a system of multiple plantings and around $2000–$2400/year under a system of single plantings. Second, a cycle longer than 4 years may well be required for oysters to grow to market size. The lengthening of the growth period will reduce

the profitableness of oyster production. Some oystermen mentioned up to 8 years as being a reasonable growth period in some localities.

An industry has evolved that consists largely of small enterprises that in the past have shown evidence of being too weak economically to cope with many problems with which they have been confronted. Even under ideal environmental conditions, small enterprises impose low ceilings on the upper level of individual income that can be earned by oystermen. Small enterprises will tend to be synonymous with small acreages unless the economic development of raft culture or stringing techniques reduces the existing close connection between oyster production and the condition of the bottom and enables oystermen to utilize the space in water more effectively. (Suitableness of an area for oyster production would then depend more on water conditions than on bottom conditions. Although the cost of trays has hitherto been prohibitive, improvements in this method may offset the costs involved by capitalizing on other advantages, such as protection from predators, and lead to the intensive cultivation of a given space in water. Adoption of the method would require new estimates both of suitable areas of production and of costs and returns.) The best size (range) of firms cannot be determined on the basis of available evidence, but will depend in part on the objectives of the lessee and environmental conditions that affect the choice of technique. If the problem of the shortage of seed is overcome and expansion of output meets no insuperable biological and environmental obstacles, least cost methods that favor an increase in the average size of firms will, unless demand is so great that markets will take all the oysters the Maritimes can produce, cause small leaseholds to operate within certain constraints imposed by a price structure that will reflect the competitive pressure of larger firms that may develop within, or be permitted to enter, the industry. Under these circumstances, small leaseholders might be either better off or worse off than they are at present, and larger firms could be operating with an investment per enterprise of $75,000 or upwards and with an annual gross turnover of a similar amount.

Summary and Conclusions

The oyster fishery in the Maritime Provinces is producing at a relatively low level and the source of a large proportion of output is the public fishery, not the leaseholds. This situation can be explained in terms of the experience of oystermen in the past and the particular circumstances under which they are now operating. These circumstances have resulted in little response on the part of oystermen generally to expand the production of oysters by the ordinary techniques of oyster culture under conditions of rising prices.

Estimates of potential output are impressive and if they can be realized a vastly different industry than has been developed to date will be brought into being. If output increases, the market price of oysters can be expected to decline, but the finding of markets for a much larger volume of production than that which is now yielded by the fishery is not considered to be the immediate problem. Instead, problems relating to supply are regarded as most important initially. The history of the industry supports this view. If supply proves not to be a problem in the sense that production can be expanded readily, then eventually demand will determine the quantity of oysters that can be sold at prices that will afford an acceptable

return to producers. The distinctiveness of the product of the Maritimes, which has led to its being consumed largely as fresh oysters in the shell rather than as shucked oysters as is largely the case in the United States, could be a factor that would enable Maritime producers to gain and hold markets even in the face of strong competition from producers elsewhere. The final position, or moving equilibrium, towards which the industry is likely to move has yet to be determined, and is a matter that may merit continuous review and appraisal.

Relaying oysters, a practice followed by oystermen in several areas in the Maritimes, is considered to be the operation that, from the point of view of costs, is nearest the system of rearing market oysters from seed produced in a hatchery. Initial calculations suggest that rearing oysters from seed may prove to be a less costly method of producing market oysters than the process of relaying. However, rearing from seed requires a longer commercial period of production than does relaying and the risks to oystermen would be proportionally greater as a result. If the cost of hatchery seed does prove to be as high as $25/box, then the extent to which the industry will be able to expand will depend a great deal on the achievement of high yields per box of oysters planted. If yields are low, the average cost of rearing mature oysters will be high. If average costs are high per unit of output, average landed value of market oysters cannot fall very much if average costs are to be covered.

The lower the yield obtained from any input of seed at a predetermined price, the higher will be the cost curves of the individual firms for any output, the supply curve for the industry will lie to the left, and aggregate output will be low. Conversely, the higher the yields obtained from any input of seed, the lower the cost curves of the individual firms for any output, the supply curve for the industry will lie to the right, and aggregate output will be high. In both cases the average landed value probably would be lower and the volume of output higher than the levels that will prevail if current practices continue. Any technique that may be developed that reduces the cost of seed oysters below that of the hatchery process or reduces any aspect of costs will permit more manoeuvre than would otherwise be possible on the part of the industry in respect to the expansion of production.

Chapter 7

SUMMARY AND CONCLUSIONS

This study focused on: (a) the characteristics of the oyster that make it responsive to methods of culture; (b) the nature and complexity of the institutional arrangements, including the regulations, that have evolved over time in the oyster fishery of the Maritimes; and (c) the interrelations between the commodity, environment, and political and economic factors, which have resulted in a contemporary situation in which output is not responding to high and rising prices owing to a shortage of seed.

The history of the industry indicates that development of oyster culture in the Maritimes was delayed until this century owing in part to a jurisdictional dispute between the Dominion and the provinces. Probably many people in the different oyster producing areas questioned the wisdom or necessity of establishing private leases for oyster culture. As time passed, the jurisdictional dispute was resolved by withdrawal of the Dominion from the granting of leases; however, the Dominion retained responsibility for regulating the fishery and maintaining the public fishery. Establishment of leases began on a large scale almost immediately in Prince Edward Island, especially from 1912 to 1914, in the Malpeque Bay (Richmond Bay) area. However, the spread of oyster disease, which probably was introduced through the importation of oyster stocks, decimated the oyster populations in most of western Prince Edward Island in the course of a few years.

Since the provinces could not cope with the problems of the industry in the postwar period, responsibility for supervision and support of the fishery was passed back to the Dominion by Prince Edward Island in 1928, Nova Scotia in 1935, and New Brunswick, in stages, commencing in 1931. Expansion of output was hampered by a second outbreak of disease in oyster stocks in the Charlottetown area in the late 1930's and by disruptions associated with the effects of World War II. Interest in the fishery increased again after the war; leases were established for planting seed that otherwise would be unutilized and collecting spat to increase the size of oyster populations under private control.

A third outbreak of disease occurred in the late 1950's, spreading throughout mainland areas from Shippegan–Caraquet in the north, to Cape George in the south and east, and leaving mainly Cape Breton unaffected. Movement of disease-resistant oysters from Prince Edward Island to the affected areas, and establishment of leases on which the transplants could be placed to restock depleted oyster populations, has not been followed by any considerable increase in output from mainland areas, although there has been some recovery in the commercial catch from New Brunswick areas south of the Miramichi. Failure of the transplants, and of oysters generally in the Maritimes, to reproduce and grow in larger quantities has led to a shortage of seed for planting leases. Consequently, the public fishery, the fishery associated with natural beds that are not leased, has continued to be the mainstay of the industry. The public fishery was the source of more than 50% of the output

of market oysters in the Maritime Provinces in 1966. If oysters relayed from public beds onto leases for purification and marketing are considered, the public fishery was the source of approximately 80% of total output.

Total output in 1966 exceeded 3.5 million lb (including the weight of shells) and was produced by approximately 650 active leasehold enterprises and 650 public fishermen (with some double-counting of leaseholders and public fishermen). The total number of enterprises, consisting of leaseholders and public fishermen, was approximately 2000. Average investment per enterprise was below $400 and average net income from oystering was approximately $240. Active leasehold enterprises showed an average net income from oystering of $546. It is evident that the industry is comprised mainly of small-scale producers, only a portion of whom can be classified as active on the basis of having devoted at least 1 day's work to the fishery in 1966.

The industry may now continue largely in its traditional form or it may undergo drastic transformation as it experiences technological and economic change. It is assumed, of course, that oyster farming, involving some practices akin to assembly-line techniques, is economically feasible in the Maritimes. It is difficult to gather evidence that unambiguously supports this assumption since leaseholders have been confronted for more than half a century with a series of unanticipated difficulties, including the present shortage of seed. These difficulties have resulted in the output of oysters from leases remaining discouragingly low. If oyster culture should not prove to be successful on what is now leased ground, a shift in policy to convert the public beds to privately managed grounds probably would result in an increase in output, and in income earned, from these areas. Some political repercussions probably would result from such a shift, and the problem of protection of the beds would have to be met. To convert the public beds into a private property resource would involve introduction of such measures as the sale or leasing of the public grounds to private enterprise. Restriction of entry by such means as competitive bidding or the drawing of lots, which would result in whatever economic rent is yielded accruing to the state or to the participants respectively, would have various implications from the point of view of management of the resource.

A problem with the leasehold fishery is that it consists mainly of small producers, many of whom have little capital to invest in oyster culture. If seed oysters should prove to be costly, then, unless capital can be made available to small producers, many will not be able to invest in seed in spite of the high price of market oysters. In addition, unless the use of trays or the stringing of oysters proves feasible and permits intensive cultivation of oysters in a given space of water without regard to the nature of bottom conditions, small leases place low limits on the amount of income that a single leaseholder can earn from oyster farming. Within the economic range, the higher the price at which seed can be made available the greater will be the importance of finance and probably the greater the demand for larger leases by those who can arrange finance. If the aim is to promote economic efficiency and establishment of an industry with the economic strength to exert a regional impact on distant markets, a method of effecting rapid change in this direction would be to open oyster grounds on a large scale to individuals and companies able to obtain finance. However, the selection of other objectives, such as the development of entrepreneurship within the fishery, suggests that a less drastic shift in policy would be appropriate.

The evolution of the existing system of leases can be clearly explained in terms of the history of the fishery. Limitations have generally been placed on the size of any given lease. The size varies widely, from one of 40 acres and several of 20 acres in Prince Edward Island, down to those of 1 acre. In the mainland, where most of the leases have been established since World War II, leases of 4–6 acres are common, although the average size for the Maritimes is just under 3 acres. The larger leases have been established in large bays and deep water, where tonging is impracticable and mechanical harvesters would be necessary for economic operations. An aim has been to treat individuals in each community equitably, and leases have been instituted in areas only after the communities concerned have agreed that leases be established. The policy has been to lease a certain acreage of ground in any given area and to divide the ground equitably among an approved list of applicants. Those receiving priority frequently have been persons owning property adjacent to the shore. Other residents, especially if they have earned a livelihood in primary production, are considered next. Persons situated in distant places have been given low priority or have been denied the opportunity to obtain a lease. Changes in the names and employment of lessees over time have resulted in leases now being held by persons engaged in a wide variety of occupations, including business and the professions. Leases are surveyed free of charge to the lessees and the annual rental has been $1/acre. A condition for holding a lease is that oyster culture be carried out, but the shortage of seed has caused many lessees to be inactive.

The complex, and rather cumbersome, administrative system involves collecting annual rents by the Department of Fisheries and Forestry of Canada, cancelling leases where there is failure to pay the rent, and reinstating leases if rents are not paid too tardily. The size limit on a lease granted to an individual has been circumvented by the practice of granting a lease to the wife, relatives, and neighbors who apply and who qualify for leased oyster ground. By making arrangements with other individuals, a lessee can gain control of several leases and thereby develop an oyster enterprise of several acres. This system has prevented the control of leased ground from passing into the hands of a few individuals or companies. It has also prevented individuals keenly interested in oyster culture from gaining control of sufficient acreage in a number of localities to develop what would be viable enterprises. The shortage of seed oysters apparently has been a factor causing such persons not to press for more ground.

Apart from political considerations, the rationale underlying past policy apparently has been that the resource, including both the public fishery and potential rearing ground, is essentially common property, analogous to crown land, and that access to its exploitation should be open and equitable. There has been an aversion to resort to the price mechanism through the competitive purchase or rental of ground as a means of limiting access to the resource, as might apply under institutional arrangements commonly associated with private property. A shift towards making the fishery more like a private property resource than it is at present would inevitably involve consideration of legal obligations that may apply to present leaseholders. Furthermore, the availability of seed will raise questions of finance and the organization of the industry.

If the demand (curve) for oysters from the Maritimes and the economics of oyster production under conditions that will pertain in future were known, it would

be possible to estimate the optimal development of the industry. If demand in relation to costs were to place a severe limitation on expansion, then, in accordance with the principle of producing output for the least aggregate cost, production would be concentrated in the most productive areas. But regional concentration of output need not mean that output would necessarily center in one general location. The limits of efficient output could be reached in Malpeque with the result that, although Malpeque might be a generally lower average cost area than a more northerly location on the mainland, it would be cheaper to engage in production in the northern areas up to some limit than to expand production further at Malpeque. Thus, regional dispersion of output would occur. The larger the demand and the greater the differences in the rates of return desired by different oystermen, the greater the possibilities for the extension of production into different areas up to the limit of profitable cultivation.

The problem of coordinating plans and of effecting economic change probably will be greater in an industry comprised of many small-scale, part-time oystermen than in an industry possessing at least a central core of producers in each of the various regions. Thus, it is desirable to open the way for establishment of larger and more specialized enterprises, on the average, than now is the case. Leaseholders would tend not to be confined to such low ceilings as now apply to an income from oyster culture. They would have more scope to offer leadership to the industry through the exercise of entrepreneurial and business skills and to utilize improved technology. Organization of the oyster industry, however, need not be a prime responsibility of government. Nevertheless, government could assist in developing channels of communication among oyster growers and perhaps laying a foundation for an Oyster Producers' Association. Such a body could well be a medium through which a marketing organization might develop at a later date when, if output expands significantly, the supplying of more distant markets would be an important issue and the desire arise for the development of storage facilities and "orderly marketing" the year round. The oyster is an exceptional commodity since, if storage facilities are developed in the producing areas, over-supplies of oysters could be returned to their natural habitat for reharvesting at a later date.

Presumably, a significant rise in available seed oysters will lead to dissatisfaction with existing institutional arrangements and raise questions related to economic change. Government may provide central direction and leadership to the industry during the early stages, but presumably decisions will be made within the industry as soon as possible. Although government will be continuously involved in policy-making, it is recognized that "development programs which are shaped and motivated by the welfare objective, to the neglect of sound developmental concepts, can lead to failure to adequately achieve either objective" (Canadian Council on Rural Development, 1967, p. 15). Policy can be expected to lie between strongly supporting numerous small oyster producers and opening oyster areas without discrimination to the highest bidders who, in the shortest possible time, probably would develop the largest and strongest industry with the minimum of public assistance. Whatever compromise is achieved, the industry should be encouraged to move towards a more effective utilization of the resource. Such an outcome would be preferred to continuing the existing conditions from the standpoint both of those who will develop entrepreneurial and business skills and eventually will constitute the core of oyster producers and those who will demand the product.

REFERENCES

ABRAMSON, J. D. MS, 1960. Economic aspects of markets for middle Atlantic oysters. Paper presented before Gulf and Caribbean Fisheries Institute, Florida, November 17, 1960. (Mimeo.)

ADAMS, J. R. MS, 1952. Oyster investigation at Malagash, 1939–1942. Fish. Res. Board Can. MS Rep. 472: 63 p.

ANDREWS, J. D. 1957. The survival and growth of South Carolina seed oysters in Virginia waters. Proc. Nat. Shellfish Ass. 47: 3–17.

ANON. 1938. Notice to those interested in oyster farming in Nova Scotia. Ottawa, Can.

1956. Report of the Prince Edward Island Fisheries Development Committee. Charlottetown, P.E.I.

1966. The Pacific oyster. Trade News 18(10–11): 13–14. Prepared by members of the staff of the Nanaimo station of the Fisheries Research Board of Canada.

BARRETT, E. M. 1963. The California oyster industry. Calif. Dep. Fish. Game, Fish Bull. 123: 103 p.

BELL, F. W., AND J. E. HAZLETON [ed.] 1967. Recent developments and research in fisheries economics. Papers presented at a conference on fisheries economics, 1965. Oceania Publications, Inc., Dobbs Ferry, N.Y. xv + 233 p.

BURR, J. G. 1933. Studies in oyster culture on the Texas coast. Game, Fish, Oyster Comm. Bull. 6. Austin, Tex. 24 p.

CANADIAN COUNCIL ON RURAL DEVELOPMENT. 1967. First report and review, 1967. Ottawa, Can.

CHIPMAN, W. A. 1948. A serious situation confronting the oyster industry. U.S. Fish. Wildlife Serv. Separate 205.

CHRISTY, F. T., JR. 1964. The exploitation of a common property natural resource: the Maryland oyster industry. University Microfilms, Inc., Ann Arbor, Mich.

CHURCHILL, E. P., JR. 1920. The oyster and the oyster industry of the Atlantic and Gulf coasts. U.S. Dep. Com., Bur. Fish. Doc 890: 51 p.

CLARK, A. H., JR., D. J. STANLEY, J. C. MEDCOF, AND R. E. DRINNAN. 1967. Ancient oyster and bay scallop shells from Sable Island. Nature 215: 1146–1148.

COKER, R. E. 1905. Oyster culture in North Carolina. N.C. Geol. Surv. Econ. Pap. 10. Raleigh, N.C.

1907. Experiments in oyster culture in Pamlico Sound, North Carolina. N.C. Geol. Econ. Surv. Bull. 15. Raleigh, N.C.

COLBERG, M. R., AND D. M. WINDHAM. 1965. The oyster based economy of Franklin County, Florida. U.S. Dep. Health, Educ. Welf. Pub. Health Serv. Florida State Univ., Tallahassie, Florida.

COMMISSION OF CONSERVATION. 1912. Canada: sea fisheries of eastern Canada. Proc. Comm. Fish. Game Fur Bearing Animals. Comm. Conserv. Ottawa, June 4–5, 1912. Ottawa, Can.

CORPS OF ENGINEERS. 1961. Chesapeake Bay fishing harbours study, Maryland and Virginia. United States Army, Washington 25, D.C.

DEPARTMENT OF FISHERIES. 1931. First annual report of the Department of Fisheries (sixty-fourth annual fisheries report of the Dominion) for the year 1930–31. Ottawa, Can.

1932. Second annual report of the Department of Fisheries (sixty-fifth annual fisheries report of the Dominion) for the year 1931–32. Ottawa, Can.

1933. Third annual report of the Department of Fisheries (sixty-sixth annual fisheries report of the Dominion) for the year 1932–33. Ottawa, Can.

1934. Fourth annual report of the Department of Fisheries (sixty-seventh annual fisheries report of the Dominion) for the year 1933–34. Ottawa, Can.

1935. Fifth annual report of the Department of Fisheries (sixty-eighth annual report of the Dominion) for the year 1934–35. Ottawa, Can.

1936. Sixth annual report of the Department of Fisheries (sixty-ninth annual fisheries report of the Dominion) for the year 1935–36. Ottawa, Can.

1937. Seventh annual report of the Department of Fisheries (seventieth annual fisheries report of the Dominion) for the year 1936–37. Ottawa, Can.

1939. Ninth annual report of the Department of Fisheries (seventy-second annual fisheries report of the Dominion) for the year 1938–39. Ottawa, Can.

1940. Tenth annual report of the Department of Fisheries (seventy-third annual fisheries report of the Dominion) for the year 1939–40. Ottawa, Can.

1942. Twelfth annual report of the Department of Fisheries, seventy-fifth annual fisheries report of the Dominion, for the year 1941–42. Ottawa, Can.

1945. Fourteenth annual report of the Department of Fisheries, seventy-seventh annual fisheries report of the Dominion, for the year 1943–44. Ottawa, Can.

1946. Fifteenth annual report of the Department of Fisheries (seventy-eighth annual fisheries report of the Dominion) for the year 1944–45. Ottawa, Can.

1949. Nineteenth annual report, 1948–49. Ottawa, Can.

1950. Twentieth annual report, 1949–1950. Ottawa, Can.

1951. Twenty-first annual report, 1950–1951. Ottawa, Can.

1953. Twenty-third annual report, 1952–1953. Ottawa, Can.

1954. Twenty-fourth annual report, 1953–1954. Ottawa, Can.

1955. Twenty-fifth annual report, 1954–1955. Ottawa, Can.

1956. Annual report of the Department of Fisheries for the fiscal year 1955–56. Ottawa, Can.

1959. Annual report of the Department of Fisheries for the fiscal year 1957–58. Ottawa, Can.

1961a. Annual report of the Department of Fisheries for the year 1959, and the financial statements of the Department for the fiscal year 1959–60. Ottawa, Can.

1961b. Annual report of the Department of Fisheries for the year 1960, and the financial statements of the Department for the fiscal year 1960–61. Ottawa, Can.

1963a. Notes and statistics on the oyster fishery of the Maritime Provinces. Economics Branch, Halifax, N.S.

1963b. 32nd annual report, 1961. Ottawa, Can.

1963c. 33rd annual report, 1962. Ottawa, Can.

1964. 34th annual report, 1963. Ottawa, Can.

1966a. Fisheries fact sheets. Ottawa, Can.

1966b. 35th annual report, 1964. Ottawa, Can.

1967. 36th annual report, 1965. Ottawa, Can.

1968. 37th annual report, 1966. Ottawa, Can.

1969. 38th annual report, 1967. Ottawa, Can.

DEPARTMENT OF FISHERIES AND FORESTRY. 1970. Annual report for the fiscal year ended March 31, 1969. Ottawa, Can.

DEPARTMENT OF MARINE AND FISHERIES. 1889. Annual report of the Department of Fisheries, Dominion of Canada, for the year 1888. Ottawa, Can.

1892. Annual report of the Department of Fisheries of the Dominion of Canada, 1891. Ottawa, Can.

1893. Annual report of the Department of Marine and Fisheries. Part II. Fisheries. Ottawa, Can.

1902. Thirty-fourth annual report of the Department of Marine and Fisheries, 1901. Ottawa, Can.

1911. Forty-fourth annual report of the Department of Marine and Fisheries, 1910–11. Ottawa, Can.

1912. Forty-fifth annual report of the Department of Marine and Fisheries, 1911–12. Ottawa, Can.

1914. Forty-seventh annual report of the Department of Marine and Fisheries, 1913–14. Ottawa, Can.

1921. Fifty-fourth annual report of the Fisheries Branch of the Department of Marine and Fisheries for the year 1920. Ottawa, Can.

1927. Sixtieth annual report of the Fisheries Branch, Department of Marine and Fisheries, for the year 1926–27. Ottawa, Can.

1929. Sixty-second annual report of the Fisheries Branch, Department of Marine and Fisheries, for the year 1928–29. Ottawa, Can.

1930. Sixty-third annual report of the Fisheries Branch, Department of Marine and Fisheries, for the year 1929–30. Ottawa, Can.

DEPARTMENT OF THE NAVAL SERVICE. 1915. Forty-eighth annual report of the Fisheries Branch, Department of the Naval Service, 1914–15. Ottawa, Can.

1916. Forty-ninth annual report of the Fisheries Branch, Department of the Naval Service, 1915–16. Ottawa, Can.

1917. Fiftieth annual report of the Fisheries Branch, Department of the Naval Service, 1916–17. Ottawa, Can.

1918. Fifty-first annual report of the Fisheries Branch, Department of the Naval Service, for the year 1917. Ottawa, Can.

1920. Fifty-second annual report of the Fisheries Branch, Department of the Naval Service, for the year 1918. Ottawa, Can.

DICKIE, L. M. 1962. Effects of fishery regulations on the catch of fish. *In* Economic effects of fishery regulations. FAO Fish. Rep. 5: 97–133.

DOMINION BUREAU OF STATISTICS, EXTERNAL TRADE DIVISION. MS, 1966. Trade of Canada, imports by commodities. Cat. 65-007. Ottawa, Can.

(No date) Fisheries Statistics of Canada. Ottawa, Can.

DRINNAN, R. E., AND L. A. ENGLAND. MS, 1965. Further progress in rehabilitating oyster stocks. Fish. Res. Board Can. St. Andrews Biol. Sta. Circ. 48: 4 p.

EASTERBROOK, W. T., AND M. H. WATKINS. 1967. Approaches to Canadian economic history. McClelland and Stewart, Ltd., Toronto (Carleton Libr. 31).

ELSEY, C. R. 1933. Oysters in British Columbia. Biol. Board Can. Bull 34: 34 p.

ENGLE, J. B. (no date) The condition of the natural oyster reefs and other public oyster bottoms of Alabama in 1943, with suggestions for their improvement. U.S. Fish. Wildlife Serv. Spec. Sci. Rep. 29: 42 p.

ERICHSON-JONES, J. R. 1964. Fish and river pollution. Butterworth's, London, England.

FOUND, W. A. 1927. The oyster fishery on the Canadian Atlantic Coast. Special appended report, I. *In* Report of the Department of Marine and Fisheries for 1909–10. 2nd ed. King's Printer, Ottawa, Can. 23 p.

FRASER, R. MS, 1938. Pathological studies of Malpeque disease. A report on laboratory investigations of the Biological Board of Canada 1937–38. Fish. Res. Board Can. MS Rep. (Biol.) 144: 25 p.

GALTSOFF, P. S. 1929. Oyster industry of the Pacific coast of the United States, appendix VIII to report of Commission of Fisheries for the fiscal year, 1929. U.S. Dep. Com., Bur. Fish. Doc. 1066: 36 p.

1943. Increasing production of oysters and other shellfish in the United States. U.S. Fish. Wildlife Serv. Fish. Leafl. 22.

1949. The oyster and the oyster industry of the United States. U.S. Fish. Wildlife Serv. Fish. Leafl. 187.

1958. The past and future of oyster research. Proc. Nat. Shellfish. Ass. 48.

GALTSOFF, P. S., H. F. PYRTHERCH, AND H. C. MACMILLAN. 1930. An experimental study in production and collection of seed oysters. U.S. Dep. Com., Bur. Fish. Doc. 1088: 69 p.

GANONG, W. F. 1899. Economics of mullusca of Acadia. From Deputy Minister's report for 1890. *In* E. Kemp The oyster fisheries of Canada, a survey and practical guide to oyster culture. Ottawa, Can.

GLUDE, J. B. 1960. The future of the United States oyster industry from a biologist's viewpoint. Proc. Gulf Caribbean Fish. Inst. Nov.

GORDON, H. S. 1954. The economic theory of a common property resource: the fishery. J. Polit. Econ. April: 124–142.

HICKS, J. R. 1950. Value and capital. 2nd ed. Oxford, England.

HOFSTETTER, R. P. 1959. The Texas oyster fishery. Tex. Game Fish Comm. Bull. 40: 38 p. Austin, Tex.

HOMANS, R. E. S. MS, 1937. Oyster mortality in the Charlottetown region, 1937. Fish. Res. Board Can. MS Rep. (Biol.) 145A: 9 p. + 14 tables.

MS, 1938. Oyster mortality in the Charlottetown region, 1938. Fish. Res. Board Can. MS Rep. (Biol.) 145B: 35 p.

MS, 1939. Oyster mortality in the Charlottetown region. Fish. Res. Board Can. MS Rep. (Biol.) 204: 13 p.

HUNTER, D. J. 1888. Annual report for Prince Edward Island. Annu. Fish. Rep.

INGLE, R. M., AND F. G. W. SMITH. 1949. Oyster culture in Florida. Univ. Miami, Miami, Florida.

INNIS, H. A., AND A. R. M. LOWER. 1933. Select documents in Canadian Economic History, 1783–1850. Toronto, Can.

KEMP, E. 1893. Report on the oyster fishery of Canada, 1892. Ottawa, Can. 13 p.

1898. Report on oyster culture. Annu. Fish. Rep.

1899. The oyster fisheries of Canada, a survey and practical guide to oyster culture. Ottawa, Can. 101 p.

LOGIE, R. R. MS, 1947. Green-gilled oysters are wholesome. Fish. Res. Board Can. St. Andrews Gen. Ser. Circ. 6: 1 p.

MS, 1957. Recent oyster mortalities and a method for restoring the fishery. Fish. Res. Board Can. St. Andrews Gen. Ser. Circ. 28: 3 p. (Also available in French)

MS, 1958a. Epidemic oyster disease and rehabilitation transfers in 1957. Fish. Res. Board Can. St. Andrews Gen. Ser. Circ. 31: 2 p. (Also available in French)

MS, 1958b. Epidemic disease in Canadian Atlantic oysters *(Crassostrea virginica)*. Fish. Res. Board Can. MS Rep. (Biol.) 661: 95 p.

LOOSANOFF, V. L. 1932? Observations on propagation of oysters in James and Corrotoman rivers and the seaside of Virginia. Commission of Fisheries, Newport News, Virginia. 46 p.

1965. The American or eastern oyster. U.S. Dep. Interior Circ. 205. Washington, D.C.

LUNZ, G. R. 1956 Cultivation of oysters in ponds at Bear's Bluff laboratories. Proc. Nat. Shellfish. Ass. 46.

MACKIN, J. G. 1946. A study of oyster strike on the seaside of Virginia. Va. Fish. Lab. Contrib. 25: 18 p. Richmond, Va.

MACPHAIL, J. S. 1960. Use of the escalator in oyster farming. Trade News 13: 5–7.

MCKIE, J. S. 1945. Planting and marketing oysters in the Pacific. U.S. Fish Wildlife Serv. Fish. Leafl. 52.

MEDCOF, J. C. MS, 1941. Oyster investigation in 1941. Fish. Res. Board Can. MS Rep. (Biol.) 239: 83 p.

1961. Oyster farming in the Maritimes. Fish. Res. Board Can. Bull. 131: 158 p.

MS, 1962. Collecting spat and producing bedding oysters on shell strings. Fish. Res. Board Can. St. Andrews Gen. Ser. Circ. 36: 3 p.

MOORE, H. F. 1910. Condition and extent of oyster beds of James River, Virginia. Washington, D.C.

MOORE, H. F., AND T. E. B. POPE. 1910. Oyster culture experiments and investigations in Louisiana. Doc. 731, Washington, D.C.

NEEDLER, A. W. H. 1931. The oysters of Malpeque Bay. Biol. Board Can. Bull. 22: 35 p.

1932. Oyster farming on the Atlantic coast of Canada, a bulletin of information and instructions for the use of oyster farmers. Ottawa, Can. 17 p.

MS, 1933. Oyster investigations at Shediac, 1932. Biol. Board Can. MS Rep. (Biol.) 76: 14 p.

1934. The storage of oysters in the shell. Biol. Board Can. Bull. 44: 4 p.

1938. Oyster farming circular No. 5, the capacity of an acre. May.

1941. Oyster farming in eastern Canada. Fish. Res. Board Can. Bull. 60: 83 p.

NELSON, J. 1917. An investigation of oyster propagation in Richmond Bay, Prince Edward Island, during August, 1915. Ottawa, Can.

NEWCOMBE, C. L., AND R. W. MENZEL. 1945. Future of the Virginia oyster industry. Commonwealth 12(4). (Va. Fish. Lab. Contrib. 22)

NORTH, D. C. 1961. The economic growth of the United States, 1790–1860. Prentice-Hall Inc., Englewood Cliffs, USA.

PATTON, M. J. 1911. The Canadian oyster industry. *In* Land, fisheries, game, and minerals, 1911. Rep. Comm. Conserv. Ottawa, Can. 20 p.

1913. Oyster farming in Prince Edward Island. *In* Fourth Annual Report. Comm. Conserv. Ottawa, Can. 14 p.

PRINCE EDWARD ISLAND FISHERIES DEVELOPMENT COMMITTEE. 1956. Report of the Prince Edward Island Fisheries Development Committee. Charlottetown, P.E.I. 178 p.

QUAYLE, D. B. MS, 1961. Denman Island oyster disease and mortality, 1960. Fish. Res. Board Can. MS Rep. (Biol.) 713: 10 p.

QUITTMEYER, C. L. 1956. The seafood industry of the Chesapeake Bay states of Maryland and Virginia. University Microfilms Inc., Ann Arbor, Mich. 68 p.

SCOTT, A. D. 1955. The fishery; the objectives of sole ownership. J. Polit. Econ. April: 116–124.

1957. Optimum utilization and control of fisheries. *In* R. Turvey and J. Wiseman [ed.] The economics of fisheries. Food and Agriculture Organization of the United Nations, Rome.

SHAW, W. N. 1962. Raft culture of oysters in Massachusetts. Bur. Comm. Fish. Bull. 197: 15 p.

SMITH, R. O. [O. R.?] 1949. Summary of oyster farming experiments in South Carolina, 1939–40. U.S. Fish Wildlife Serv. Spec. Sci. Rep. 63: 20 p.

STAFFORD, J. 1913. The Canadian oyster, its development, environment and culture. Comm. Conserv. Ottawa, Can. 159 p.

SUNTER, A. 1966. Notes. Dominion Bur. Statist. Ottawa, Can.

THE COMMONWEALTH OF MASSACHUSETTS. 1912. A report upon the quahaug and oyster fisheries of Massachusetts, including the life history, growth, and cultivation of the quahaug *(Venus mercenaria)*, and observations on the set of oyster spat in Wellfleet Bay. Wright and Potter Printing Co., State Publishers, Boston, Mass.

TRUITT, R. V. 1931. The oyster and the oyster industry of Maryland. Md. Conserv. Dep. Conserv. Bull. 4: 48 p.

WALLACE, D. H. 1966. Oysters in the estuaries environment. *In* Symposium on estuarine fisheries. Amer. Fish. Soc. Spec. Publ. 3.

WATKINS, M H. 1963. A staple theory of economic growth. Can. J. Econ. Polit. Sci. May: 141–158.

WHARTON, B. H. 1963. The Maryland oyster industry. Maryland National Bank, Baltimore, Md.

WHEATLEY, J. J., C. L. QUITTMEYER, AND L. A. THOMPSON. 1959. The economic implications of the York River oyster industry. Bur. Population Econ. Res., Univ. Virginia. Charlottesville, Va.

YONGE, C. M. 1960. Oysters. Collins Co., Publishers, London and Glasgow. 209 p.

ADDITIONAL REFERENCES

ANON. 1939. Can. Fisherman 26(10).

BOLITHO, H. [ed.] 1960. The glorious oyster. Sidgwick and Jackson, Publishers, London, England. 174 p.

COLE, H. A. 1954. Purification of oysters in simple pits. Min. Agr. Fish. Fish. Invest. Ser. II, XVIII(5), London, England. 12 p.

1956. Oyster culture in Great Britain, a manual of current practice. London, England. 39 p.

COLE, H. A., AND E. W. KNIGHT-JONES. 1949. The setting behavior of larvae of the European flat oyster *(Ostrea edulis)*. Min. Agr. Fish. Fish. Invest. Ser. II, XVII(3). London, England.

DRINNAN, R. E., AND J. C. MEDCOF. MS, 1961. Progress in rehabilitating disease affected oyster stocks. Fish. Res. Board Can. St. Andrews Gen. Ser. Circ. 34: 3 p.

GAARDER, TORBJØRN. 1959. Oysters and oyster culture in Norway. Department of Secretary of State. Ottawa, Can.

GALTSOFF, P., H. F. PRYTHERCH, AND H. C. MACMILLAN. 1930. An experimental study in production and collection of seed oysters. U.S. Dep. Com., Bur. Fish. Doc. 1088: 69 p.

KESTEVAN, G. L. 1941. The biology and cultivation of oysters in Australia. Commonwealth Australia Counc. Sci. Ind. Res. Pam. 105: 32 p. Melbourne, Australia.

LUBET, P. E. 1961. Rapport au gouvernement de la Yougoslavie sur l'ostreiculture et la mytiliculture. (2e mission) Food and Agriculture Organization of the United Nations, Rome. 20 p.

MILLAR, R. H. 1961. Scottish oyster investigations 1946–1958. Dep. Agr. Fish. Scotland Mar. Res. 1961(3). 76 p. Edinburgh.

1963. Investigations of the oyster beds in Loch Ryan. Dep. Agr. Fish. Scotland Mar. Res. 1963(5): 23 p. Edinburgh.

NIKOLIC, M., AND I. STOJNIC. 1962. A system of oyster culture in floating shellfish parks. Gen. Fish. Counc. Mediter. Stud. Rev., Biol. Inst. Roving, Yugoslavia Doc. 18. Rome.

ORTON, J. H. 1937. Oyster biology and oyster culture. (Based on the Buckland lectures for 1935) London, England. 211 p.

QUITTMEYER, C. L., ET AL. 1966. A report on the Chesapeake Bay fisheries of Maryland. Seafood Advisory Comm. Wye Inst. Centreville, Md.

SUPREME COMMANDER FOR THE ALLIED POWERS. 1947. Japanese oyster seed export program for 1947. Gen. Headquarters S.C.A.P., Nat. Resour. Sect. Tokyo.

1950. Oyster culture in Japan. Rep. 134. Tokyo.

SHELBOURNE, J. E. 1967 [1957?]. The 1957[1?] oyster of the rivers Crouch and Roach, Essex, and the influence of water currents and scour on the distribution, with an account of comparative dredging experiments. Min. Agr. Fish. Food, Fish. Invest. Ser. II, XXI(2): 25 p. London, England.

TURNBRIDGE, B. R. 1962. Occurrence and distribution of the dredge oyster *(Ostrea sinuata)* in Tasman and Gilden bays. Mar. Dep., Wellington, New Zealand.

U.S. BUREAU OF COMMERCIAL FISHERIES. 1967. Fishery statistics of the United States, 1965. U.S. Bur. Com. Fish. Statist. Dig. 59.

1968. Fishery statistics of the United States, 1966. U.S. Bur. Com. Fish. Statist. Dig. 60.

VAN SOMEREN, V. D., AND P. J. WHITEHEAD. 1961. An investigation of the biology and culture of an east African oyster *(Crassostrea cucullata)*. Colon. Office Fish. Publ. 14: 35 p. London, England.

WAUGH, G. D. 1957. Oyster production in the rivers Crouch and Roach, Essex, from 1951 to 1954. Min., Agr. Fish. Fish. Food, Fish. Ser. II, XXI(1): 47 p. London, England.

Appendix A

MICROECONOMIC ANALYSIS OF A FISHERY

A number of significant variables should be taken into account since we are dealing with a whole industry rather than a particular firm within an industry. A problem in the theory is to bridge the gap between the firm and the industry. The ability of a public fishery to replenish itself will affect the degree of exhaustion of the fishing stock for any given amount of fishing so that, assuming a simple logistic-type model of the dynamics of fish populations (cf. Dickie, 1962, p. 97–133) and a fish stock of a given initial magnitude, the amount of fishing will determine output in the long run. If price can be assumed to vary inversely with output, the total value of output will not likely be a linear function of output. The assumption of diminishing returns per unit of effort for any given stock would mean that, given the cost of effort, aggregate costs of fishing are a rising and nonlinear function of output. When plotted on the usual type of graph drawn in the first quadrant with output on the horizontal axis and costs on the vertical axis, aggregate costs will rise to the northeast until maximum output is reached and then will bend back to the northwest if additional effort is expended on the fishery and output falls in the long run below maximum sustainable yield.

Small aggregate output can be associated with either a high or a low level of effort. In the first case, the fishing stock is heavily exploited and is reduced to a low basic level over time whereas in the second case the stock is not heavily exploited and is relatively plentiful. In the intermediary range, we can assume there is a level of effort that results in maximum sustained yield of the fishery in terms of volume. If demand for output is given and is elastic throughout the whole range, the maximum sustained yield will result in maximum value of output over time. If demand is inelastic throughout, maximum sustained yield will result in minimum value of output over time; an inelastic demand would tend to result in a low level of exploitation of a fish stock. But several complications enter here because we are dealing with a whole industry in the long run and shifts in demand may occur. If price elasticity and cross-price elasticity of demand for the product are low enough or income elasticity of demand is high enough or if population with a preference for the commodity increases fast enough, price may rise sufficiently over time to result in a continually rising value of output even if output declines as a consequence of an increasing amount of effort being devoted to the exploitation of the resource as a result of its rising price. In other words, starting from an initial position probably below that of maximum sustained yield, price might be rising, effort increasing or not diminishing (appreciably), and output falling but the value of output rising until something stops the sequence.

Theory suggests that the amount of effort devoted to a fishery characterized by freedom of entry will depend on the relation of aggregate costs to aggregate returns. In the public fishery for oysters, which is prosecuted with the minimal amount of capital so that costs of effort are mainly wage costs and returns to effort (labor) are the value of output, cost of effort seems to be determined by some notion of an acceptable minimum wage that can be assumed to reflect alternative opportunities. (We shall disregard participation in the public fishery for the purpose of earning unemployment insurance stamps.) Considering the existing price of oysters and the price of other commodities, fishermen will fish public beds so long as they can gather at least half a box of oysters a day. In other words, oyster fishermen wish to make at least $7–$10 a day tonging oysters. If the price of oysters were higher, fishermen with the same notions of a minimum wage would fish an oyster stock down to lower levels of daily yield in any given season whereas if the price of oysters were lower they would stop fishing sooner. Until the stock of any bed is fished down to the point that it yields only the minimal acceptable return to effort in any harvest season, fishermen can be said to earn a rent in the sense that they earn in the early part of the season a daily return in excess of the minimal amount for their effort.

A rise in price of oysters in any given year would tend to call forth additional effort in the oyster fishery and result in an increase in output for that year over what it would otherwise have been. The prospect for the continuance of equal yields in the future may or may not be reduced but it presumably would be.

If we call the minimal return to effort the "supply price of effort," and the value of output the "return to effort," the analysis can be assisted with the use of graphs.

Figure A-I shows possible levels of output of a fishery over time depending upon the amount of fishing effort per year. OM of effort corresponds to maximum sustained output

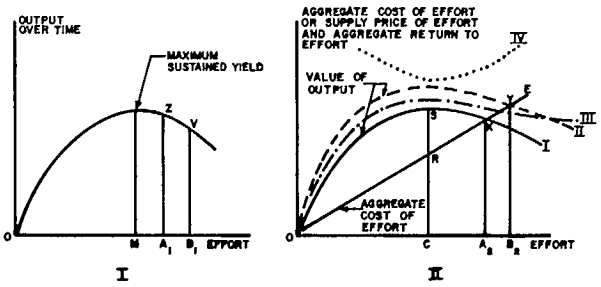

FIG. A. Microeconomic analysis of a fishery.

whereas OA_1 of effort has gone beyond the point of maximum sustained yield. In Fig. A-II, with average price of output given, aggregate return to effort, or value of output, over time is shown. Curve I is the result of multiplying points on the output curve of Fig. A-I by the assumed price of output. If the price of output is higher, the value of output curve in Fig. A-II would be above Curve I, e.g., Curve II. There would be a curve for each assumed price. However, if the selling price of output is lower the higher the output, and demand is elastic, then the curve that shows the value of output corresponding to different amounts of effort over time is the locus of a point that shifts from one price curve to another (e.g., from Curve II to Curve I) and that would mark out a curve with less curvature than either I or II (Curve III). Up to the range of maximum sustained output its slope is positive but numerically less than that of either Curve I or Curve II, whereas for levels of effort above that corresponding to maximum sustained yield its slope is negative and numerically less than that of either Curve I or Curve II. If demand is inelastic throughout, the value of output corresponding to different levels of effort is shown by Curve IV, with a shape opposite to Curve III. Unit price elasticity of demand would result in a constant value of output for different levels of effort and would be shown by a straight line parallel to the horizontal axis and drawn at the appropriate height depending upon the strength of demand. An increase in demand would raise all the value-of-output curves for the range of effort shown on the graph and a decrease in demand would lower the curves.

If the supply price of effort is given, e.g., by some minimal return below which effort will not be attracted into the fishery, the aggregate cost curve of effort, or the supply curve of effort, will be determined as shown by OE in Fig. A-II. Its slope will be the rate of return (or cost) necessary to call forth effort. The theory of a common-property resource implies that OA_2 of effort will be expended (Fig. A-II), if price corresponds to Curve I, and aggregate return will be A_2X. The amount of physical output can be seen by referring to Fig. A-I, which indicates that A_1Z will be the level of output through time if effort is OA_1 ($=OA_2$). The higher the price of output the larger will be the volume of effort expended, e.g., OB_2, which is greater than OA_2. In any given year, the expansion of effort by an amount equivalent to A_1B_1 ($=A_2B_2$) could lead to a temporary increase in output for that year. But once the fishery stock has adjusted there would follow a decline in output over time as seen in the reduction from A_1Z to B_1V (Fig. A-I) if effort remains at OB_2.

Over a period of years as effort increases a fishery may move from position A_1 to position B_1 (Fig. A-I) or outwards from X to Y (Fig. A-II) until some limit to price increase is reached or some low level of output is reached, which diminishes the prospect of effort earning its minimum daily return as determined by some preset figure or existing alternative opportunity. If the volume of effort devoted to a fishery should prove to be excessive, the fishery might experience a sequence of positions downward with respect to effort, upward with respect to output, and downward with respect to price until some balance is reached or the trend is reversed. Any position such as X or Y, where Curves I and II, respectively (Fig. A-II), cut OE, would be one in which no rent accrues to producers. A position corresponding to effort of $OC < OA_2$ (Fig. A-II) would, with returns indicated by Curve I, yield a rent equivalent to SR, the difference between aggregate return to effort and aggregate cost of effort.

In the unrealistic case of a nonexhaustible resource that replenishes itself as fast as it can be taken, the production function in Fig. A-I would be linear with respect to effort, as the industry would not be an increasing cost industry with respect to output because there would be no diminution in incremental output with respect to incremental effort. The resource would be exploited more heavily than one that is exhaustible or eventually subject to diminishing yields with respect to effort. In these circumstances, price elasticity, cross-price elasticity, and income elasticity would have to be high enough (in an increasingly affluent society), or population would have to increase sufficiently rapidly, to result in a continually rising value of output, as output expands towards infinity. In this situation, compared with the previous one where diminishing yield with respect to effort is assumed, gains would accrue to consumers since the commodity would be plentiful and cheap whereas producers would tend to earn only minimal returns as a result of "crowding." Producers could participate in the gains by consuming some of their own output and, because of the lowness of its price, could experience an improvement in welfare unless the gains are dissipated by such excessive fishing and depression of prices that the adverse effects upon their incomes more than offset the advantages enjoyed because of the low price. Such a situation might be described as a rather vicious "staple trap" on the supply side (see Watkins, 1963, p. 150–151).

Appendix B

OUTPUT AND VALUE OF OYSTERS LANDED IN THE MARITIME PROVINCES, BY STATISTICAL DISTRICT, 1965, 1966.[a]

Statist. Dist.	1965 Quantity (lb)	1965 Value ($)	1966[b] Quantity (lb)	1966[b] Value ($)
	Nova Scotia			
1	110,742	12,638	212,273	31,914
3	210,000	25,200	330,450	42,403
4	22,500	2,112	35,500	4,717
6	–	–	5,700	533
7	909	108	4,275	665
8	28,800	2,475	54,660	6,482
11	10,600	873	40,200	4,422
12	21,800	2,180	1,000	100
13	19,100	1,337	2,400	192
21	–	–	950	142
43B	9,540	951	7,180	823
45	7,100	710	3,915	453
46	54,610	5,391	45,145	4,579
Total	495,701	53,975	743,648	97,425
	New Brunswick			
65	–	–	3,050	488
67	–	–	16,100	2,576
70	41,660	6,562	15,725	3,017
71	500	76	400	56
73	78,405	11,567	166,858	33,170
75	2,300	345	2,500	250
76	423,355	35,439	252,773	22,838
77	201,957	21,328	210,206	30,336
78	28,460	3,127	39,944	5,161
80A	–	–	1,660	332
Total	776,637	78,444	709,216	98,224
	Prince Edward Island			
82A	26,000	3,510	100	4
82B	700	35	–	–
83A	581,100	104,131	546,390	102,688
83B	1,367,880	259,606	1,335,620	225,118
85A	5,600	392	3,900	780
86A	211,935	30,879	183,526	36,287
Total	2,193,215	398,553	2,069,536	364,877

[a] Source: Department of Fisheries, Economics Services, Ottawa, Ont., and Regional Office, Halifax, N.S.

[b] Preliminary figures.

Appendix C

OYSTER PRODUCTION IN THE UNITED STATES

The output in weight and value of oyster meat of Maine is negligible, of Massachusetts decreased by four-fifths, and of Rhode Island and Connecticut by more than nine-tenths, compared to levels reached before the turn of the century. In 1966, New England produced 408,000 lb valued at $849,000. In the years 1880–1966, highest output of 26,629,071 lb valued at $2,445,470 occurred in 1910. However, the middle Atlantic region (New York, New Jersey, Pennsylvania, and Delaware) together experienced even relatively greater decline than New England. Over the period the middle Atlantic states showed a 95% decline in output to 917,000 lb valued at $1,168,000.

In the Chesapeake region (Maryland and Virginia) Maryland's output fell to around one-eighth and Virginia's to one-quarter of the earlier levels. Output of the Chesapeake region in 1966 was 21,232,000 lb valued at $14,543,000. Among the south Atlantic states, South Carolina rose to first position before the turn of the century and produced between 2.5 and 3.8 million lb of meat per year in the period 1960–66. For the south Atlantic states as a whole, ouput has shown a fluctuation of 50% or more since 1930, ranging from a peak of 6,384,500 lb in 1936 to 2,261,100 lb in 1955. In 1966, output was 3,657,000 lb worth $1,575,000 compared to the higher value recorded of $2,019,830 in 1963.

From 1964 to 1966, the Gulf oyster catch comprised about one-third of the total output of oysters in the United States. Output increased on the west coast of Florida in the 1960's, and also in Mississippi, Louisiana, and Texas, so that these states are producing at levels approaching, and sometimes exceeding, those of the past. Louisiana is the largest producer, having achieved annual outputs in the period 1961–64 comparable to the high levels reached in the period after 1880. In 1966, output from Louisiana dropped to 4,764,000 lb of oyster meat valued at $2,156,000. Total output from the Gulf states in 1966 was 17,182,000 lb valued at $6,493,000.

On the Pacific coast, output fell off in the 1920's but fluctuated between 7.9 and 13.5 million lb from 1937 to 1966. In 1966, total output was 7,820,000 lb of oyster meat worth $2,738,000. Of this output, the eastern (Atlantic) oyster, *C. virginica,* accounted for only 13,000 lb, and the Olympia or western oyster, *O. lurida,* for only 35,000 lb, whereas the Japanese or Pacific oyster, *C. gigas,* accounted for 7,772,000 lb or over 99% of output. Production of both eastern and western oysters has declined on the west coast in the long run.

In summary, statistics pertaining to the oyster industry of the United States for half a century and longer show that the most drastic decreases in output have occurred in the northeast and have been progressively less pronounced in the more southerly regions of the Atlantic coast. Output from the west coast has been relatively constant for nearly three decades and is dependent largely on farming practices. The Gulf and the south Atlantic regions are considered to be significant potential areas and have shown some gains in the 1960's. In the Gulf area, there is not evidence of a long-run downward trend in output. Unless methods of oyster culture can arrest the decline in output that has occurred in Maryland and Virginia, middle Atlantic states, and New England, output of the southern regions will comprise a rising percentage of the total output of the United States.

Appendix D

SPECIAL COMMISSION (1887) RECOMMENDATIONS ON CONDITIONS AND REQUIREMENTS OF THE OYSTER FISHERY

Kemp (1899, p. 30–31) stated that the oyster fishery was different from lobster and other fisheries in that it was prosecuted without expense. A $10 boat and a $1 oyster-tong were all that were needed. No vessels were specially built for the trade. The large numbers of schooners that annually fished the beds were part of the ordinary coasting marine. Since there was no system of registration or licence, the quantities taken by this fleet were unknown. Evidently many more oysters were taken than appeared on the official returns. Probably half as many

young oysters were destroyed by reckless fishing as were recorded as captured (20,000–30,000 bl). About sixty thousand empty flour barrels are required annually, at 12.5¢ apiece.

The value of the "floating plant" was perhaps as follows:

		Value	Product in 1886 *(bl)*
Prince Edward Island	650 boats & tongs	$10,650	33,125
New Brunswick	550 boats & tongs	6,150	28,083
Nova Scotia	30 boats & tongs	330	1,397
Total		$17,130	62,605

Thus, $17,000 would cover the whole oyster fishery giving employment during 3 months to perhaps 1500 "occasional fishermen."

The Commissioners recommended that one general law or regulation should cover the whole of the Canadian Atlantic seaboard, with the following provisions:

I. That existing oyster beds be reserved to the public and that their limits be officially defined;

II. That mud-digging be prohibited within 60 yards of any officially recognized workable live oyster beds; that suitable portions of bays, creeks, estuaries, or harbors be considered closed for oyster fishing; and said closed portions be laid off for the digging of shell manure;

III. That bays of considerable extent in which are many oyster beds be marked off in two or more divisions, and that the divisions be fished only in alternate years;

IV. That the closed season be maintained from June 1st to September 15th in each year, both days inclusive;

V. That under penalty of forfeiture of boat and appurtenances, no fisherman shall bring ashore (excepting for authorized purposes) any "round" oyster that does not measure fully 2 inches in diameter of shell, nor any long (oblong) oyster that does not measure fully 3 inches of outer shell, and that possession of such undersized oysters by any persons shall be punished by fine;

VI. That all winter fishing for oysters be prohibited (Commissioner Ogden dissented);

VII. Temporary or permanent proclamation to close localities where the supply is so nearly exhausted as to warrant closure;

VIII. That under section 21, subsection 4 of the Fisheries Act a liberal inducement be offered under a system of leases to persons who will undertake under stringent regulations to grow oysters on private beds;

IX. Easy and inexpensive arrangements, by which persons owning water frontage may lease their own foreshores for oyster culture from the Government;

X. That Parliament be invited to appropriate a sum or sums for the formation of oyster beds in various waters and places found adapted for that purpose, and for transplanting oysters, and restocking exhausted fisheries by natural or artificial means — in accordance with section 21, subsection 5 of the Fisheries Act;

XI. The appointment of a responsible officer of fisheries, capable of the position, and to rank with the Superintendent of Pisciculture, as General Superintendent of Oyster Fisheries, and to have general superintendence of all public and private oyster culture;

XII. A system of registration of oyster boats, with other details to be arranged by the Department.

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